



Trade cost reduction, subcontracting and unionised wage[☆]

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HIGHLIGHTS

- ▶ We show the effects of a trade cost reduction in a one-way trade.
- ▶ The domestic firm allocates production between formal and informal productions.
- ▶ Several new results are obtained.
- ▶ We also show the implications of a symmetric trade cost reduction in a two-way trade.

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ABSTRACT

We show the effects of trade cost reduction in the presence of a domestic firm's strategic output allocation between formal in-house production and subcontracting to the informal sector. Considering a one-way trade, we show that trade cost reduction increases the in-house unionised wage, in-house employment, union utility, the formal–informal wage gap and consumer surplus, it reduces informal production and the profit of the domestic firm, and it creates an ambiguous effect on welfare. Whether trade cost reduction increases the income gap between the domestic producer and the labour union is ambiguous, and depends on the trade cost and the cost of subcontracting. Considering a two-way trade with symmetric segmented markets, we show that a symmetric trade cost reduction reduces the domestic unionised wage, domestic in-house employment, union utility, it increases informal production, consumer surplus and it creates ambiguous effects of the profits.

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1. Introduction

The effects of globalisation on labour markets have attracted significant interest in recent years. Although globalisation creates the beneficial welfare effect through fierce product market competition, there is concern that a more competitive product market reduces power of the trade union, thus creating the end of higher wage for many workers (see, Rodrik, 1997, and the references cited therein). As documented in Niblett (2005), the negative perception in the

European Union towards increased globalisation is an important reason for the rejection of the European Constitution by French and Dutch voters. The theoretical results of Huizinga (1993) and Sørensen (1993), which show that unionised wage is higher under autarky than under free trade, provide theoretical justification for this concern.

However, there are other views also. Gaston and Trefler (1995), Naylor (1998, 1999), Gürthzgen (2002), Munch and Skaksen (2002), Bastos and Kreickemeier (2009) and Bastos et al. (2009) show that the negative effects of trade cost reduction on unionised labour markets may not be justified. Naylor (1998, 1999) and Bastos and Kreickemeier (2009) show that a two-way trade liberalisation increases unionised wage. Munch and Skaksen (2002) builds on Naylor (1998, 1999) and show that the effects of trade cost reduction on unionised wage may be ambiguous when the firm's decision on exporting is endogenous. Gaston and Trefler (1995) argue that unilateral trade liberalisation may either increase or decrease unionised wage under “efficient union–firm bargaining”, where firm and union bargain over both

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wage and employment. Gürthzgen (2002) shows that if the firms compete like Bertrand oligopolists, unilateral trade liberalisation may either increase or decrease the unionised wage. Bastos et al. (2009) show that unilateral trade liberalisation may increase unionised wage by affecting the disagreement utility of the firms if the union is an open shop, where all workers are not union members. The empirical evidence on this topic, although scarce, is also mixed (see, Gaston and Trefler, 1995 and Konings and Vandebussche, 1995).

The above-mentioned theoretical works looked at several important aspects of the contemporary world and provided useful insights, yet they ignored an important empirical regularity, i.e., the involvement of informal sector in the production process.¹ It is often found, particularly in the developing countries, that the firms undertake formal in-house production and also subcontract to the informal producers within the country.² The participation of the informal sector in the production process creates concerns about the effects of the policy variables on formal and informal wages. For example, Aleman-Castilla (2006) shows that Mexican trade opening in the 1990s increased industry wage differentials and widened the formal–informal wage gap. Based on the official information from the Annual Survey of Industries and National Sample Survey Organisation in India, Maiti and Marjit (2009) demonstrate a sharp wage rise in both formal and informal sector, by more than three to four times, from 1989–90 to 2005–06 in the period of economic reform.

The significant presence of informal production activities motivates us to see the impact of trade reform on the unionised wage, distributive gain of producer and worker, and the wage-gap between the formal and informal workers. We develop a simple model of unilateral trade cost reduction in Section 2 where a domestic firm takes strategic decision on formal in-house production and subcontracting to the informal producers. The in-house wage is determined by a labour union, while the informal wage is determined by the competitive condition. We show that the domestic firm may produce in-house and also subcontract to the informal sector in order to reduce the in-house unionised wage as well as getting a strategic benefit in the product market. In this situation, a trade cost reduction increases the in-house unionised wage, in-house employment, union utility and the formal–informal wage gap, but it reduces informal production and the profit of the domestic firm. Although a lower trade cost reduces the import competing domestic firm's total employment, which is the sum of informal and formal in-house employment, it increases the unionised wage due to its strategic effect on the domestic firm's formal–informal output allocation.

We have considered Cournot competition in the final goods market and have shown the effects of unilateral trade cost reduction under the “right-to-manage”³ model of labour union where all workers in the unionised sector are union members. Thus, we highlight the effects of a new factor, i.e., the formal–informal output composition effect of a trade cost reduction, by deliberately ignoring the other factors such as Bertrand competition, the export-market expansion effect

¹ According to the recent estimate provided jointly by ILO and WTO (WTO-ILO, 2009), the informality increases from 50.1% in early 1990s to 52.8% in late 1990s and then changes to 52.2% in early 2000s in Latin American economies. In Africa, this increases initially from 60.9% in early 1990s to 63.6% in late 1990s and then reduces to 55.7% in early 2000s. On the other hand, Asia accounts for higher informality and it was 78.3% in early 1990s and drops to 68.5% in late 1990s in Asia. After that, it increases to 78.2% and goes to the level that was in the early 1990s.

² It is often the case that firms in South Asian and Latin American countries undertake formal in-house production and also subcontract to the informal producers (WTO, 2009 and Ulyssea, 2010). The evidences of informal production can also be found in the recent works by Schneider and Enste (2000), Boeri and Garibaldi (2005), Guha-Khasnabis and Kanbur (2006) and Mehrotra and Biggeri (2007), to name a few. As an example, Bata, a well-known shoe manufacturer in India, produces in-house and also subcontracts to outside producers in the country.

³ The ‘efficient bargaining’ model, which stipulates that the firms and unions bargain over wages and employment, is an alternative to the right-to-manage model. See, Layard et al. (1991) for arguments in favour of the right-to-manage models.

of bilateral trade cost reduction, “efficient union–firm bargaining” and open shop union, which had been responsible for the beneficial wage effect of a trade cost reduction. Hence, our analysis suggests that even in a quantity setting oligopoly where all workers are union members, the adverse wage effect of unilateral trade cost reduction may not be justifiable in economies where the domestic firms can allocate productions between formal and informal sectors.

In our analysis, the effect of a trade cost reduction on the unionised wage is due to the following reason. Given the amount of subcontracting to the informal sector, a trade cost reduction increases the output of the foreign firm and reduces the domestic firm's in-house production. Hence, given the amount of subcontracting, a lower trade cost reduces the union's labour demand and the unionised wage. This wage effect tends to increase the domestic firm's incentive for in-house production and reduces its incentive for subcontracting. The strengths of the competition and wage effects determine the net effect of a trade cost reduction on the domestic firm's in-house production, employment and wage. We find that the wage effect, which increases the domestic firm's production efficiency by reducing the marginal cost of production, dominates the competition effect.

If the domestic firm produces in-house and also subcontracts to the informal sector, a trade cost reduction increases union utility but reduces profit of the domestic firm. However, it does not imply immediately whether a lower trade cost either increases or decreases the income gap between the domestic producer and the labour union, since the domestic profit can be higher or lower than the union utility. If the cost of subcontracting is relatively small, the profit of the domestic firm is higher than the union utility, and a lower trade cost reduces the gap between the domestic firm's profit and the union utility. However, if the cost of subcontracting is not small, the profit of the domestic firm can be higher or lower than the union utility depending on the trade cost and the cost of subcontracting. In this situation, a lower trade cost may either increase or decrease the gap between the domestic profit and the union utility depending on the trade cost and the cost of subcontracting. Thus, our paper also sheds light on the distributional effects of a trade cost reduction, which is often a concern to the policy makers (OECD, 2008).

The basic mechanism behind our results can be related to the hold-up problem on investments.⁴ In our analysis, the in-house labour union extracts rent from the domestic firm and induces the domestic firm to reduce its production. The possibility of subcontracting to the informal sector reduces the labour union's rent extraction capacity and therefore, reduces the hold-up problem on domestic production. A lower trade cost intensifies product-market competition and tends to reduce the hold-up problem by reducing the labour union's rent extraction capacity. As a result, a trade cost reduction encourages the domestic firm to shift its output from the informal sector to in-house production.

We extend our basic model of Section 2 in Section 3 to consider the effects of a symmetric trade cost reduction under a two-way trade between symmetric segmented markets. We find that the implications of a symmetric two-way trade cost reduction are significantly different from that of under a unilateral trade cost reduction, as considered in Section 2. A symmetric trade cost reduction reduces the domestic unionised wage, domestic in-house employment and union utility. However, it increases informal production, consumer surplus and creates ambiguous effects on the profits.

The reasons for the difference in results between Sections 2 and 3 can be attributable to the domestic firm's strategic incentive for subcontracting for reducing the hold-up problem. In contrast to a unilateral trade cost reduction, a symmetric trade cost reduction under a

⁴ See (Tirole, 1988) for a general analysis on the hold-up problem of investments. One may refer to Haucap and Wey (2004) and Mukherjee and Pennings (2011) for the hold-up problems created by the labour union on the R&D investment.

two-way trade expands market for the domestic firm and, ceteris paribus, this market expansion effect increases labour demand for the domestic in-house labour union. This higher labour demand encourages the domestic labour union to extract rent from the domestic producer by increasing the unionised wage, thus creating a hold-up problem for the domestic producer. However, the domestic producer can reduce the hold-up problem by shifting production from the formal in-house production to the informal production, which, in turn, helps reducing the unionised wage. The other effects follow from this strategic effect of subcontracting on the unionised wage.

It is worth mentioning that subcontracting to the domestic informal sector in our analysis can be interpreted alternatively as outsourcing to another country. With this interpretation, the presence of the domestic labour union may encourage the domestic firm to outsource its production to a foreign country. Thus, our paper can be related to Koskela and Schöb (2010) (and the references therein), showing the effects of the cost of outsourcing to a foreign country on domestic employment. Considering a competitive product market, they show that a lower cost of outsourcing to a foreign country reduces domestic unionised wage but it may increase or decrease domestic employment. In contrast, we consider an imperfectly competitive product market and show the effects of a lower trade cost. Thus, our paper has a broader application than subcontracting to the domestic informal sector only, and it may analyse the situations of developed countries as well.

The remainder of the paper is organised as follows. Section 2 describes the basic model and shows the implications of a trade cost reduction under a one-way trade. Section 3 shows the implications of a trade cost reduction under a two-way trade. Section 4 concludes.

2. One-way trade

Assume that there are two countries, called domestic and foreign. Each country has one firm producing a homogeneous product and competing in the domestic country. The firm in the domestic country is called firm 1 and the firm in the foreign country is called firm 2. The inverse demand function in the domestic country is $P = a - Q$, where P is price and Q is the total output.

We assume that production requires labour and the domestic firm's output can be produced in-house and/or outsourced to the informal sector.⁵ For simplicity, we assume that one unit of labour is required to produce one unit of output, irrespective of in-house or informal production. We consider that there is a labour union which determines firm 1's in-house wage, w , while considering the competitive wage rate as the unionised workers' reservation wages, which are assumed to be zero, for simplicity. This is quite common in the theoretical literature.

The competitive wage, which is assumed to be zero, prevails in the informal sector, thus creating different labour market institutions in the formal and informal sectors. Hence, the labour cost for informal production is zero. However, it is well documented that involvement of the informal sector creates transaction and/or administrative costs (Ulyssea, 2010; Maiti and Marjit, 2011). So, the effective unit cost of production in the informal sector is the summation of competitive labour cost and the transaction and administrative costs. We assume that the constant per-unit transaction and administrative costs of informal production are c . Therefore, the effective unit cost of informal production is c . Hence, the trade off for the domestic firm is clear. Subcontracting to the informal sector helps to bypass the unionised wage, w , but it attracts the transaction and administrative costs, c , related to informal production. We will assume in the following analysis that $c > \frac{a}{12}$. Otherwise, firm 1 will never produce in-house in equilibrium.

We assume, for simplicity, that the constant marginal cost of production of the foreign firm is zero. However, it needs to incur a per-unit trade cost t . Hence, the effective unit cost for the foreign firm is t .

In line with Crene and Davidson (2004) and Mukherjee (2008), where the firms stagger output decisions among different plants, we consider that the domestic firm can stagger its output decision among in-house production and subcontracting to the informal sector. More particularly, we consider that the domestic firm determines its output under subcontracting before its in-house production, which is determined simultaneously with the foreign firm's output choice.⁶ Hence, we consider the following game. At stage 1, the domestic firm (firm 1), determines the amount of subcontracting, k , which internalises its effects on its in-house production, q_1 , the foreign firm's (firm 2's) output, q_2 , and firm 1's in-house unionised wage, w . At stage 2, the labour union in firm 1 determines wage, w , which internalises its effects on q_1 and q_2 . At stage 3, given the amount of subcontracting, k , and the unionised wage, w , firms 1 and 2 determine q_1 and q_2 simultaneously and the profits are realised. We solve the game through backward induction.

Firms 1 and 2 maximise the following expressions to determine q_1 and q_2 respectively:

$$\pi_1 = (a - q_1 - q_2 - k - w)q_1 + (a - q_1 - q_2 - k - c)k \tag{1}$$

$$\pi_2 = (a - q_1 - q_2 - k - t)q_2. \tag{2}$$

The equilibrium values can be found as

$$q_1 = \frac{a - 3k + t - 2w}{3} \tag{3}$$

$$q_2 = \frac{a - 2t + w}{3}. \tag{4}$$

Eq. (3) gives the labour union's demand for labour. The labour union's demand for labour or firm 1's in-house production is inversely related to the amount of subcontracting and the unionised wage but it is directly related to the trade cost. Eq. (4) shows that firm 2's output is directly related to the unionised wage and inversely related to the trade cost. It is interesting to note that the amount of subcontracting by the domestic firm does not have direct impact on the foreign firm's output. This is because the foreign firm considers the total output of the domestic firm, which is $(k + q_1)$, as given while taking its output decision.

Now we determine the unionised wage. The labour union maximises the following expression to determine w :

$$\text{Max}_w \frac{w(a - 3k + t - 2w)}{3}. \tag{5}$$

The equilibrium wage can be found as

$$w = \frac{a - 3k + t}{4}. \tag{6}$$

It follows from Eq. (6) that firm 1 can reduce the unionised wage by increasing the amount of subcontracting to the informal sector.

Eq. (6) also suggests that given the amount of subcontracting, a trade cost reduction reduces the unionised wage. It then implies immediately that if subcontracting is not an option to firm 1, i.e., $k = 0$, trade cost reduction reduces the unionised wage.

Substituting Eq. (6) into Eqs. (3) and (4), we get that

$$q_1 = \frac{a - 3k + t}{6} \tag{7}$$

⁵ See, e.g., Ulyssea (2010) for a work where production process involves both formal and informal sectors.

⁶ We will discuss later on why this sequence of output choice is beneficial for the domestic firm.

$$q_2 = \frac{5a-3k-7t}{12}. \quad (8)$$

If firm 1 produces in-house and also subcontracts, it maximises the following expression to determine k :

$$\text{Max}_k [(a+3k+t)(a-3k+t) + 3(5a-3k+5t-12c)k]/36. \quad (9)$$

The equilibrium amount of subcontracting can be found as

$$k^* = \frac{5a+5t-12c}{12}. \quad (10)$$

Eq. (10) shows that a lower trade cost reduces the amount of subcontracting by firm 1. Hence, we have the following trade off. Given k , a lower t reduces w . However, a lower t reduces k , which tends to increase w . The net effect depends on these effects.

Using the equilibrium value of k , we get the equilibrium w , q_1 and q_2 as

$$w^* = \frac{12c-a-t}{16} \quad (11)$$

$$q_1^* = \frac{12c-a-t}{24} \quad (12)$$

$$q_2^* = \frac{5a-11t+4c}{16}. \quad (13)$$

Note that $w^* < c$.

It is immediate from the above analysis that whether firm 1 produces in-house and/or subcontracts to the informal sector depends on a , c and t . Since our purpose is to show the implications of the domestic firm's output allocation among formal in-house production and subcontracting to the informal sector in determining the effects of a trade cost reduction, let us restrict our attention to that equilibrium where firm 1 produces in-house and also subcontracts to the informal sector, and export by firm 2 is positive.

Lemma 1. *If firm 1 produces in-house and also subcontracts to the informal sector (i.e., $k^* > 0$ and $q_1^* > 0$), export by firm 2 is positive for $t < t^* \equiv \frac{5a+4c}{11}$.*

Proof. It follows from Eq. (13) that $q_2^* > 0$ if $t < \frac{(5a+4c)}{11}$ and $q_2^* = 0$ if $t \geq \frac{(5a+4c)}{11}$. Therefore, the prohibitive trade cost is $t^* = \frac{(5a+4c)}{11}$ and firm 2 exports if $t < t^*$. ■

Now we derive the condition under which firm 1 finds both in-house production and subcontracting profitable. The following result is immediate from Eqs. (10), (12), (13) and $t < t^*$.

Lemma 2. *If export by firm 2 is positive, firm 1 produces in-house and also subcontracts to the informal sector is the equilibrium outcome for $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$.*

If either of the inequalities shown in Lemma 2 is violated, firm 1 does not engage in both in-house production and subcontracting to the informal sector. It is immediate from Eqs. (10) and (12) that firm 1 does not subcontract to the informal sector for $t < \frac{(12c-5a)}{5}$ and it does not produce in-house for $12c-a < t$. It is now clear that $c > \frac{a}{12}$ is required to ensure that firm 1's in-house production occurs in equilibrium.

The reason for Lemma 2 is as follows. If t is very high, the domestic firm faces less competition from the foreign firm and captures larger market share. Hence, the high demand for labour increases the in-house unionised wage significantly, thus making the in-house production costlier compared to subcontracting. However, if t is very small, firm 1's low market share creates low demand for labour and reduces the unionised wage significantly. In this situation, subcontracting is not profitable, even if commitment to subcontracting provides a strategic benefit in the product market. For the intermediate values of t , firm 1 produces in-house and also subcontracts to the informal sector for balancing the effects of the unionised wage and the cost of subcontracting, as well as gaining the strategic benefit in the product market.

If firm 1 produces only in-house, the unionised wage will be $w = \frac{a+t}{4}$. However, firm 1's commitment to the informal production creates the unionised wage as $w^* = \frac{12c-a-t}{16}$, which is lower than $w = \frac{a+t}{4}$ under the condition shown in Lemma 2 for the co-existence of in-house production and subcontracting. Hence, commitment to subcontracting allows firm 1 to save on the unionised wage as well as to gain the strategic benefit in the product market.

It may be worth noting that if firm 1 produces in-house and also subcontracts, the unionised wage is more than the competitive wage but it is less than the transaction and/or administrative cost of subcontracting, i.e., $0 < w^* = \frac{12c-a-t}{16} < c$.

Proposition 1. *Consider the equilibrium outcome where export by firm 2 is positive and firm 1 is producing in-house and subcontracting to the informal sector, i.e., $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$. A lower trade cost increases both in-house output (and employment) of firm 1 and the in-house unionised wage.*

Proof. The results are immediate from Eqs. (11) and (12). ■

The reason for the above result is as follows. If t declines, given the amount of subcontracting to the informal sector, it increases the output of the foreign firm, and lowers the in-house production of the domestic firm. As a result, given the amount of subcontracting, a lower t reduces the labour demand faced by the union, thus reducing the unionised wage. Hence, the competition effect following a trade cost reduction creates a wage effect, which increases the domestic firm's incentive for in-house production and reduces its incentive for subcontracting. This wage effect tends to increase firm 1's in-house labour demand and the unionised wage. We find that the wage effect, which creates production efficiency in firm 1, dominates the competition effect, and a lower t increases firm 1's in-house employment, the unionised wage and therefore, the union utility.⁷ Hence, an implication of our result is that a trade cost reduction increases formal employment by reducing the domestic firm's informal activity. Given the constant informal wage in our analysis, the above result also suggests that a trade cost reduction increases formal-informal wage gap.

To show the effects of a trade cost reduction on the unionised wage and employment through the effects on the formal-informal output composition, we have considered a simple objective function of the labour union. However, we show in Appendix A that our result is not due to this simple objective function of the labour union.

At this point, it may be worth discussing the reason for considering the particular sequence of firm 1's output choice for our analysis. It follows from the above analysis that if firm 1 determines the amount of subcontracting before its in-house production and is engaged in both the activities in equilibrium, it reduces the unionised wage below c . However, if firm 1 considered the in-house production before subcontracting,

⁷ Formally, the union utility is $U^* \equiv w^* q_1^* = \frac{(12c-a-t)^2}{384}$.

the unionised wage could be reduced up to c , since, in this situation, c would act as firm 1's alternative marginal cost of production. Hence, by considering the amount of subcontracting before in-house production, firm 1 can reduce the unionised wage to a greater extent.

If firm 1 considered in-house production before subcontracting, the cost of subcontracting, c , creates an upper bound for the unionised wage at any trade cost. If the trade cost is high, firm 1 produces large amount of output and creates the unconstrained unionised wage higher than c . Hence, the upper bound on the unionised wage created by the cost of subcontracting is binding in this situation and the union charges c as the equilibrium unionised wage. A lower trade cost in this situation will not affect the unionised wage as long as the upper bound on the unionised wage is binding. However, if the trade cost is low, firm 1 produces a small amount and creates the unconstrained unionised wage lower than c . In this situation, the union charges the unconstrained unionised wage as the equilibrium wage and a lower trade cost reduces the unionised wage.

Proposition 1 considers the situation where the domestic firm produces in-house and also subcontracts to the informal sector. However, as mentioned above, if subcontracting is not an option or subcontracting is not an equilibrium outcome (which occurs for $t < \frac{(12c-5a)}{5}$), a lower trade cost reduces the unionised wage. Further, trade cost reduction may switch the domestic firm's production strategy either from no in-house production to both in-house production and subcontracting, or from both in-house production and subcontracting to only in-house production. The implications of the domestic firm's change in the production strategy follow easily from our analysis.

If a lower trade cost changes the domestic firm's production strategy from no in-house production to both in-house production and subcontracting, it is trivial that a trade cost reduction increases the unionised wage and employment.

An interesting situation arises if a trade cost reduction changes the domestic firm's production strategy from both in-house production and subcontracting to only in-house production. In this situation, it can be seen that the effect of a trade cost reduction on the unionised wage depends on the initial trade cost and the new trade cost. This is due to the following reason. As we have shown, if firm 1 produces in-house and also subcontracts to the informal sector, trade cost reduction increases the unionised wage, whereas, if firm 1 produces only in-house, trade cost reduction reduces the unionised wage. Since in-house production and subcontracting to the informal sector occurs for a relatively higher trade cost compared to the trade cost which creates in-house production only as the equilibrium outcome, the relationship between the trade cost and the unionised wage follows an "inverted U" path. It is then immediate that if a lower trade cost shifts firm 1's production strategy from "in-house production and subcontracting" to "in-house production only", whether it increases or reduces the unionised wage depends on the initial trade cost and the new trade cost.

We summarise the above discussion in the following proposition.

Proposition 2. *If a lower trade cost switches the domestic firm's production strategy from no in-house production to both in-house production and subcontracting, it is trivial that a lower trade cost increases the unionised wage. However, if a trade cost reduction changes the domestic firm's production strategy from in-house production and subcontracting to in-house production only, the effect of the trade cost reduction on the unionised wage depends on the initial and the new trade costs.*

We have seen the effects of a trade cost reduction on the unionised wage and union utility. Now we want to see the effect of a trade cost reduction on the domestic profit, which is

$$\pi_1^* = \frac{[(3a-4c+3t)(12c-a-t) + (5a-12c+5t)^2]}{192}, \tag{14}$$

if firm 1 produces in-house and also subcontracts to the informal sector.

Proposition 3. *If firm 1 producing in-house and subcontracting to the informal sector is the equilibrium outcome, i.e., $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$, a lower trade cost reduces the profit of firm 1.*

Proof. We get from Eq. (14) that $\frac{\partial \pi_1^*}{\partial t} > (<) 0$ for $t > (<) \frac{40c-23a}{23}$. Since firm 1 produces in-house and also subcontracts to the informal sector for $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$, a lower trade cost reduces firm 1's profit in this situation, since $\frac{(40c-23a)}{23} < \frac{(12c-5a)}{5}$. ■

The reason for the above result is as follows. Trade cost reduction reduces the domestic firm's profit by making the foreign firm more cost efficient, increasing the unionised wage and reducing the domestic firm's total output.

It is well known from the "Heckscher–Ohlin" and "Specific Factor" models that a major concern of trade liberalisation is about its effects on income distribution among the different factors of production (more specifically between capital and labour). Returns to various types of labour (e.g., skilled and unskilled, formal and informal) as an indirect effect of trade reform is also a growing concern (Acemoglu, 1999 and Klein et al., 2010). An increase in income inequality may be an important reason for adopting a more protectionist public policy. Scheve and Slaughter (2007) point out that income redistribution to share globalisation's benefits is important to sustain international integration. It also follows from OECD (2008) that the increasing income inequalities can be a major concern for preventing increased international integration. This concern of trade liberalisation on income distribution encourages us to see how a trade cost reduction affects income distribution between the workers and the firm owner.

We have seen that if firm 1 produces in-house and also subcontracts to the informal sector, a lower trade cost increases union utility but it reduces the profit of the domestic firm. It is then immediate that if firm 1 produces in-house and also subcontracts, a lower trade cost increases income gap between the unionised and the informal workers. However, it is not so straightforward whether a trade cost reduction reduces or increases the gap between the domestic profit and union utility. It depends on whether the profit of the domestic firm is higher or lower than the union utility.

Proposition 4. *Consider that firm 1 producing in-house and subcontracting to the informal sector is the equilibrium outcome, i.e., $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$. If c is relatively small (i.e., $\frac{a}{12} < c < \frac{a}{8}$), a lower trade cost reduces the gap between the domestic firm's profit and the union utility. If c is not small (i.e., $\frac{a}{8} < c$), a lower trade cost may increase or reduce the gap between the domestic profit and union utility depending on the trade cost, t , and the cost of subcontracting, c .*

Proof. We get that $(\pi_1^* - U^*) = \frac{2[(3a-4c+3t)(12c-a-t) + (5a-12c+5t)^2] - (12c-a-t)^2}{384}$ and $\frac{\partial(\pi_1^* - U^*)}{\partial t} > 0$ for $\text{Max}\{0, \frac{(12c-5a)}{5}\} < t < \text{Min}\{t^*, (12c-a)\}$.

If $c > \frac{5a}{12}$, we get that $t^* < (12c-a)$ and the relevant trade costs are $\frac{(12c-5a)}{5} < t < t^*$. We get that $(\pi_1^* - U^*) < 0$ at $t = \frac{(12c-5a)}{5}$ but $(\pi_1^* - U^*) \geq 0$ at $t = t^*$.

If $c < \frac{5a}{12}$, we get that $t^* \leq (12c-a)$ for $\frac{a}{8} \leq c$. Hence the relevant trade costs are $0 < t < t^*$ for $\frac{a}{8} < c < \frac{5a}{12}$, and $0 < t < (12c-a)$ for $\frac{a}{12} < c < \frac{a}{8}$.⁸ If $\frac{a}{8} < c < \frac{5a}{12}$, we get that $(\pi_1^* - U^*) \geq 0$ at $t = 0$ but $(\pi_1^* - U^*) > 0$ at $t = t^*$. However, if $\frac{a}{12} < c < \frac{a}{8}$, we get that $(\pi_1^* - U^*) > 0$ at both $t = 0$ and $t = 12c-a$.

⁸ Note that c needs to be higher than $\frac{a}{12}$ in order to ensure in-house production by the domestic firm.

It follows from the above analysis that $(\pi_1^* - U^*) > 0$ for the relevant ranges of the trade cost if $\frac{a}{12} < c < \frac{a}{8}$. However, if $\frac{a}{8} < c$, $(\pi_1^* - U^*) \geq 0$ depending on t and c . ■

It is intuitive that if the cost of subcontracting is relatively small, it reduces the domestic firm's in-house activity, thus reducing the union utility. In this situation, the profit of the domestic firm is supposed to be higher than the union utility, and a lower trade cost will reduce the income gap between the domestic producer and the labour union. However, if the cost of subcontracting is relatively high or the trade cost is sufficiently small, it reduces the domestic firm's informal activity, thus increasing the union utility. High in-house activity of the domestic firm may create a higher union utility compared to the domestic profit, and a lower trade cost increases the income gap between the domestic producer and the labour union.

So far we have looked at the effects of a trade cost reduction on domestic profit and union utility when the domestic firm produces in-house and also subcontracts. Now we will see how a lower trade cost affects the sum of domestic profit and union utility as well as consumer surplus and domestic welfare, consisting of domestic profit, union utility, consumer surplus and the utility of the informal workers, which is zero since the informal workers get their reservation wages.

Proposition 5. Consider that firm 1 producing in-house and subcontracting to the informal sector is the equilibrium outcome, i.e., $\text{Max}\left\{0, \frac{(12c-5a)}{5}\right\} < t < \text{Min}\{t^*, (12c-a)\}$. A lower trade cost reduces the sum of domestic profit and union utility.

Proof. If firm 1 produces in-house and also subcontracts, we get that the sum of domestic profit and union utility, i.e., $(\pi_1^* + U^*)$, is convex with respect to t and attains the minimum value at $t = \frac{92c-45a}{45}$, which is lower than $\text{Max}\left\{0, \frac{(12c-5a)}{5}\right\}$, suggesting that $(\pi_1^* + U^*)$ rises with a higher t for $t \in \left(\text{Max}\left\{0, \frac{(12c-5a)}{5}\right\}, \text{Min}\{t^*, (12c-a)\}\right)$. ■

The above result suggests that if the trade cost reduces, the loss of domestic profit is higher than the gain in union utility and makes the domestic producer and the unionised workers together worse off.

Finally, we see the effects of a lower trade cost on consumer surplus and domestic welfare.

Proposition 6. Consider that firm 1 producing in-house and subcontracting to the informal sector is the equilibrium outcome, i.e., $\text{Max}\left\{0, \frac{(12c-5a)}{5}\right\} < t < \text{Min}\{t^*, (12c-a)\}$. A lower trade cost increases consumer surplus but the effect of a lower trade cost on domestic welfare is ambiguous and depends on the market size, a , cost of subcontracting, c and the trade cost, t .

Proof. If firm 1 produces in-house and also subcontracts, we get that consumer surplus is equal to $\frac{(11a-4c-5t)^2}{512}$, suggesting that a lower trade cost increases consumer surplus.

Now see the effects of a lower trade cost on domestic welfare when firm 1 produces in-house and also subcontracts, i.e., $\text{Max}\left\{0, \frac{(12c-5a)}{5}\right\} < t < \text{Min}\{t^*, (12c-a)\}$. Since $c < \frac{a}{12}$ (required for firm 1's positive in-house production), $\frac{12c-5a}{5} \geq 0$ for $c \geq \frac{5a}{12}$ and $t^* = \frac{5a+4c}{11} \geq 12c-a$ for $c \leq \frac{a}{8}$, we look at the following three intervals: (i) $t \in (0, 12c-a)$ for $c \in (\frac{a}{12}, \frac{a}{8})$, (ii) $t \in (0, \frac{5a+4c}{11})$ for $c \in (\frac{a}{8}, \frac{5a}{12})$, and (iii) $t \in (\frac{12c-5a}{5}, \frac{5a+4c}{11})$ for $c > \frac{5a}{12}$.

We get that domestic welfare is convex with respect to t and attains a minimum value at $\tilde{t} = \frac{308c-15a}{255}$. (i) If $c \in (\frac{a}{12}, \frac{a}{8})$, \tilde{t} needs to be between 0 and $(12c-a)$. We get in this situation that $(12c-a) < \tilde{t}$ for $c \in (\frac{a}{12}, \frac{15a}{72})$

but $\tilde{t} \in (0, 12c-a)$ for $c \in (\frac{15a}{72}, \frac{a}{8})$, suggesting that a lower trade cost increases welfare in the former situation but it may reduce domestic welfare in the latter situation. (ii) If $c \in (\frac{a}{8}, \frac{5a}{12})$, \tilde{t} needs to be between 0 and $\frac{5a+4c}{11}$. We get in this situation that $\tilde{t} \in (0, \frac{5a+4c}{11})$ for $c \in (\frac{a}{8}, \frac{5a}{12})$, suggesting that a lower trade cost reduces (increases) domestic welfare for $t > (<) \tilde{t}$. (iii) If $c > \frac{5a}{12}$, \tilde{t} needs to be between $\frac{12c-5a}{5}$ and $\frac{5a+4c}{11}$, which implies $c < \frac{5a}{7}$. We get in this situation that $\tilde{t} \in (\frac{12c-5a}{5}, \frac{5a+4c}{11})$ for $c \in (\frac{5a}{12}, \frac{45a}{74})$ but $\frac{5a+4c}{11} < \tilde{t}$ for $c \in (\frac{45a}{74}, \frac{5a}{7})$, suggesting that a lower trade cost increases welfare in the latter situation but it may reduce domestic welfare in the former situation. These results show that the effects of a lower trade cost on domestic welfare is ambiguous and depends on the market size, a , cost of subcontracting, c and the trade cost, t . ■

A lower trade cost makes the consumers better off by intensifying product-market competition. However, we have seen in Proposition 5 that a lower trade cost makes the domestic firm and the unionised workers together worse off. Thus, a lower trade cost creates opposing effects on the consumers and on the domestic producer and the unionised workers together, and generates ambiguous effects on social welfare.

3. The implications of a two-way trade⁹

We have considered in Section 2 that the firms compete only in the domestic market. Now we want to see the effects of a lower trade cost on the unionised wage if the firms sell their products in both countries. It must be noted that our analysis of Section 2 will remain even if the firms sell in both countries with segmented markets and only the cost of exporting to the domestic country reduces. However, things will change if we consider that the costs of exporting to both countries change. We will take up this issue in this section. To address this issue, we keep all the assumptions of Section 2 but introduce demand in the foreign country. We assume that the inverse market demand function in the foreign country is also $P = a - Q$. The per-unit costs of exporting to the domestic and to the foreign countries are symmetric, and they are denoted by t .

To keep the expressions similar to Section 2, we consider the following game structure. At stage 1, the domestic firm (firm 1), determines the amount of output to be produced through subcontracting for the domestic and foreign markets, i.e., k_d and k_f . At stage 2, the labour union in firm 1 determines wage, w . At stage 3, firm 1 determines its in-house outputs for the domestic and foreign markets, i.e., q_{d1} and q_{f1} , and firm 2 determines outputs for the domestic and foreign markets, q_{d2} and q_{f2} , and these outputs are determined simultaneously. The profits are realised. We solve the game through backward induction.

Although we consider k_d and k_f given the constant returns to scale technologies, we will see that the sum of k_d and k_f will be important.¹⁰ To avoid repetition, we skip the details and report the equilibrium values only. Given k_d , k_f and w , we get that $q_{d1} = \frac{a+t-2w-3k_d}{3}$, $q_{f1} = \frac{a-2t-2w-3k_f}{3}$, $q_{d2} = \frac{a-2t+w}{3}$ and $q_{f2} = \frac{a+t+w}{3}$. It follows from these expressions that the sum of k_d and k_f is important for $q_{d1} + q_{f1} = \frac{2a-t-4w-3(k_d+k_f)}{3}$, which is the labour demand faced by the domestic labour union. The equilibrium unionised wage is $w = \frac{2a-t-3(k_d+k_f)}{8}$, which also depends on the sum of k_d and k_f . Finally, firm 1 determines the sum of k_d and k_f as $k = k_d + k_f = \frac{10a-24c-5t}{12}$.

It follows from the equilibrium wage that, ceteris paribus, a lower t increases w , which is similar to the conclusion derived in the previous papers with a two-way trade and symmetric trade cost reduction. A symmetric trade cost reduction creates a market expansion effect for

⁹ We thank an anonymous referee for encouraging us to look at this aspect of the problem.

¹⁰ One would find a similar result if considered the total amount of subcontracting instead of the amount of subcontracting for each market separately.

the domestic firm, which, in turn, increases domestic output, labour demand faced by the union and the unionised wage. However, there is another effect in our analysis. A lower t in our analysis increases the amount of subcontracting. This effect is in contrast to Section 2 and due to the market expansion effect under the symmetric trade cost reduction. The domestic firm increases the amount of subcontracting under a symmetric trade cost reduction in order to reduce the unionised wage rise. Hence, a symmetric trade cost reduction creates strategic effects, which are opposite to the case of the unilateral trade cost reduction considered in Section 2.

Using $k = k_d + k_f = \frac{10a-24c-5t}{12}$, we get that the equilibrium unionised wage is $w = \frac{24c-2a+t}{32}$, showing that a lower trade cost reduces the unionised wage. The effect of a higher amount of subcontracting following a trade cost reduction dominates the market expansion effect of a lower trade cost, thus creating this result.

Assuming that firm 1 sells the outputs produced through subcontracting symmetrically between the markets, i.e., $k_d = k_f$,¹¹ we find the equilibrium outputs as $q_{d1}^* = \frac{24c-2a+25t}{48}$, $q_{f1}^* = \frac{24c-2a-23t}{48}$, $q_{d2}^* = \frac{10a+8c-21t}{32}$ and $q_{f2}^* = \frac{10a+8c+11t}{32}$. We consider that $c > \frac{a}{12}$ and $t \in [0, \text{Min}\{\frac{24c-2a}{23}, \frac{10a+8c}{21}\}]$ so that all these outputs are positive. Firm 1's total in-house output and therefore, firm 1's in-house employment is $q_{d1}^* + q_{f1}^* = \frac{24c-2a+t}{24}$, the equilibrium profit of firm 1 is $\pi_1^* = \frac{44a^2-160ac+192c^2-44at+80ct+107t^2}{192}$, the equilibrium union utility is $U^* = \frac{(24c-2a+t)^2}{768}$ and the profit of firm 2 is $\pi_2^* = \frac{4(5a+4c)^2-20t(5a+4c)+281t^2}{512}$. The total outputs in the domestic country and in the foreign country are $q_{d1}^* + q_{d2}^* + k_d^* = q_{f1}^* + q_{f2}^* + k_f^* = \frac{22a-8c-11t}{32}$ and the profit of firm 2 is $\pi_2^* = \frac{4(5a+4c)^2-20t(5a+4c)+281t^2}{512}$. It is immediate from these expressions that a lower trade cost may either increase or decrease the profits of firm 1 and firm 2, reduces union utility and makes consumers in both countries better off.

The following proposition summarises the discussions of this section.

Proposition 7. Consider a two-way trade with symmetric segmented markets, firm 1 produces in-house and also subcontracts, and firm 1 sells the outputs produced through subcontracting symmetrically between the markets.¹² A symmetric trade cost reduction (i) increases the amount of subcontracting, (ii) reduces firm 1's in-house production (and therefore, in-house employment), (iii) reduces the unionised wage and union utility, (iv) makes the consumers better off and (v) creates an ambiguous effect on the profits of firms 1 and 2.

4. Conclusion

There are two important developments in the contemporary world. On the one hand, globalisation creates concerns about its effects on wage and employment in the liberalised country. On the other hand, it is found that firms, particularly in developing countries, are engaged in both formal and informal activities. So far, the literature did not pay much attention to these aspects together. This paper fills this gap in the literature, and shows the implications of the domestic firm's strategic decision on formal and informal productions in determining the effects of a trade cost reduction.

Considering one-way trade, we show that if the domestic firm produces in-house and also subcontracts to the informal sector, a lower trade cost increases the domestic firm's in-house unionised wage, in-house employment, union utility and the formal-informal wage gap, but it reduces the domestic firm's informal production and the domestic profit. The factor attributable to our results is the domestic firm's strategic output allocation between formal production and

subcontracting to the informal sector, which has been overlooked in the literature. We also show that if the domestic firm produces in-house and also subcontracts to the informal sector, a lower trade cost may either increase or decrease the income gap between the domestic producer and the labour union, depending on the cost of subcontracting and the trade cost. Thus, our analysis sheds light on the distributional effects of a trade cost reduction.

We extend our basic model to show the effects of a symmetric trade cost reduction under a two-way trade. We find that the implications of a symmetric trade cost are significantly different from that of under unilateral trade cost reduction. A symmetric trade cost reduction reduces the domestic unionised wage, domestic in-house employment, union utility, it increases informal production, consumer surplus and it creates ambiguous effects on the profits.

Appendix A

A more general objective function of the labour union

Assume that the labour union maximises $U = w^\alpha L^{(1-\alpha)}$, where w and L are the wage and employment in the unionised sector, α (resp. $(1-\alpha)$) is the union's weight on wage (resp. employment) and $\alpha \in [0,1]$.¹³ Given this objective function and the Eqs. (1)–(4) in the text, the union determines w by maximising the following expression:

$$\text{Max}_w w^\alpha \left(\frac{a-3k+t-2w}{3} \right)^{1-\alpha} \tag{A1}$$

The equilibrium wage can be found as

$$w = \frac{\alpha(a-3k+t)}{2} \tag{A2}$$

We get from Eqs. (3), (4) and (A2) that

$$q_1 = \frac{(1-\alpha)(a-3k+t)}{3} \tag{A3}$$

$$q_2 = \frac{a(2+\alpha)-t(4-\alpha)-3\alpha k}{6} \tag{A4}$$

Firm 1 maximises the following expression to determine k :

$$\text{Max}_k [(1-\alpha)(a-3k+t)((a+t)(2-2\alpha)+6\alpha k)+3k((a+t)(2+\alpha)-6c-3\alpha k)]/18. \tag{A5}$$

The equilibrium amount of subcontracting can be found as

$$k^* = \frac{(a+t)(7\alpha-4\alpha^2)-6c}{18\alpha-12\alpha^2} \tag{A6}$$

It follows from Eq. (A6) that if t falls, it reduces the amount of subcontracting.

We get from Eqs. (A2)–(A4) and Eq. (A6) that

$$w^* = \frac{\alpha(6c-\alpha(a+t))}{12\alpha-8\alpha^2} \tag{A7}$$

¹¹ Our results can hold even if the outputs produced through subcontracting are sold asymmetrically between the markets.

¹² See footnote 11.

¹³ Although α can lie between 0 and 1, perhaps $\alpha \in [0, 0.5]$ is a more sensible restriction.

$$q_1^* = \frac{(1-\alpha)(6c-\alpha(a+t))}{18\alpha-12\alpha^2} \quad (\text{A8})$$

$$q_2^* = \frac{a(4-3\alpha)-t(8-5\alpha)+2c}{12-8\alpha}. \quad (\text{A9})$$

It follows from Eqs. (A7)–(A9) that if t reduces, it increases the unionised wage, formal employment and the output of the foreign firm.

It is worth pointing out that if α is very small, the equilibrium amount of subcontracting is zero (see Eq. (A6)) and the expressions of the objective functions are different from those shown in Appendix A. Hence, the analysis of Appendix A should be restricted to those α s for which subcontracting is a profitable option to the domestic firm. Otherwise, subcontracting has no real meaning in our analysis.

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