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**Working Paper**

## Employment risk and optimal trade policies

Diskussionsbeiträge - Serie II, No. 338

**Provided in Cooperation with:**

Department of Economics, University of Konstanz

*Suggested Citation:* Choi, Eun Kwan; Chen, Jiong (1997) : Employment risk and optimal trade policies, Diskussionsbeiträge - Serie II, No. 338, Universität Konstanz, Sonderforschungsbereich 178 - Internationalisierung der Wirtschaft, Konstanz

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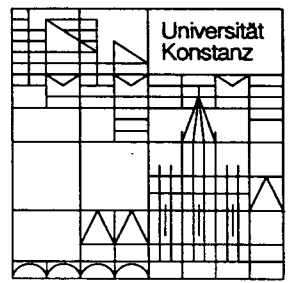
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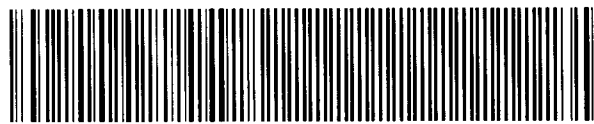
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W 113 (338)



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# **Employment Risk and Optimal Trade Policies**

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Serie II - Nr. 338

Februar 1997

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## EMPLOYMENT RISK AND OPTIMAL TRADE POLICIES

### **Abstract**

This paper considers trade policies and welfare in a Harris-Todaro model with risk averse workers. Workers are assumed to have identical and homothetic preferences, but their incomes differ, depending on whether and where they are employed. When workers are equally weighted, maximizing social utility is equivalent to maximizing the utility of a rural worker. An optimal policy consists of a production subsidy on the exportable and an import tariff. This model explains the widespread use of import tariffs of manufactured goods along with production subsidies on the export sectors in some LDCs.

Key words: Employment Risk, Trade Policies

JEL Classification Number: F13

## EMPLOYMENT RISK AND OPTIMAL TRADE POLICIES

### 1. Introduction

While some developing countries have relied on import substitution policies (Ballassa, 1988), some East Asian LDCs such as South Korea and Taiwan have adopted outward-looking strategies. They have promoted exports by subsidizing production of exportable goods extensively, but have limited imports of finished manufactures. Despite the theory that a tariff hurts a small open economy, these countries have experienced phenomenal economic growth. On the whole, these strategies seem to have been quite successful. During the 1963-73 period, the growth rates of strongly outward-oriented developing countries were 7.4%, whereas those of strongly inward-oriented developing countries recorded an average growth rate of about 1.7% (World Bank, 1987).

The Harris-Todaro (1970, HT hereafter) model of a labor surplus economy captures a stylized fact in many LDCs: continuous labor migration to the urban sector and high urban unemployment. Wage is assumed to be flexible and employment is guaranteed in the rural sector, whereas in the urban sector wage is fixed institutionally at a level above the competitive wage. As a result, the urban workers face unemployment risk; the urban workers earn a higher fixed wage if employed, but earn nothing if unemployed. The HT model explains the use of production subsidies on the exportable goods in these countries (Bhagwati and Srinivasan, 1974). However, it does not explain why an import tariff should also be employed, despite its widespread use in LDCs.<sup>1</sup> Chen and Choi (1994) demonstrate that a tariff is welfare-reducing in an HT economy.

The underlying assumption of the HT model is that the flexible rural wage is determined at a level equal to the expected wage in the urban sector. In other words, workers are indifferent between a random compensation in the urban sector and a nonrandom rural wage, equal to the expected wage in the urban sector. This implies

that workers are risk neutral. With the exception of Corden and Findlay (1975) suggesting that workers may be risk averse, the literature has since adopted the risk neutrality assumption to explore the properties and policy questions within the HT model (e.g., Marjit, 1991; Neary, 1981; Chao and Yu, 1990).

Corden and Findlay (1975) suggested among others that production subsidies and import tariffs are not desirable in the risk neutral case.<sup>2</sup> Their implicit criterion for evaluating policies was the net change in total output. In this paper we use social utility as a welfare criterion to evaluate trade policies and investigate the implications of risk aversion on trade policies of a small open economy. Workers are assumed to be risk averse, willing to accept a nonrandom wage which is lower than the expected wage in the urban sector. Specifically, rural wage is equal to *certainty equivalent wage* in the urban sector. We adopt a social welfare function that gives equal weights to all workers. The most striking result is that when an optimal production subsidy is employed, an import tariff is welfare improving when workers are risk averse. This result may provide an explanation why so many LDCs restrict imports of manufactured goods.

## 2. The Basic Model

The economy consists of two sectors; the urban sector produces a manufactured good X and the rural sector an agricultural good Y. All consumers are workers and receive income from labor services and capital endowment. To extend the Harris-Todaro model to an open economy with risk averse workers, we employ the following assumptions:

- (i) Supplies of capital (K) and labor (L) inputs are fixed.
- (ii) Each worker has one unit of labor and the ownership of the capital inputs is uniformly distributed among consumers.
- (iii) Capital is fully employed, but labor unemployment exists in the urban sector due

to wage rigidity.

- (iv) The economy is small and imports the urban output  $X$  and exports the rural output  $Y$ .
- (v) Workers are risk averse and have identical and homothetic preferences.
- (vi) There is no price uncertainty or production uncertainty.

Because the aggregate capital endowment  $K$  is uniformly distributed among  $L$  workers, each worker owns  $k = K/L$  units of capital and receives capital income  $rk$ , where  $r$  is the rental rate. Assumption (ii) is used to abstract from distributional issues and to focus on the aggregate welfare analysis. Although workers have identical preferences in consumption, they may be classified into three categories depending on their income levels. Rural workers are fully employed and receive a flexible wage  $w$ . An urban employed worker receives the fixed wage  $W$ , which is institutionally set at a higher level than the competitive wage  $w$  and, thus  $W$  is not allowed to move either downward or upward. An urban worker earns no labor income if unemployed and relies on capital income only.

Let  $L_i$  and  $K_i$  denote the labor and capital employed in sector  $i$ , respectively. The output of the urban manufacturing sector is

$$X = F(L_x, K_x), \quad (1a)$$

and the output of the rural sector is

$$Y = G(L_y, K_y), \quad (1b)$$

where  $F(\cdot)$  and  $G(\cdot)$  are linearly homogeneous production functions.

Capital is a variable input and is mobile between the two sectors. Thus, capital rental  $r$  is the same in both sectors. However, following the HT model, we assume that due to wage rigidity in the urban sector, wages are different between the two sectors.



Profit of the urban sector is

$$\pi_x = PF - WL_x - rK_x, \quad (2a)$$

where  $P$  is the producer price of the urban output and  $W$  is the fixed urban wage. Let  $y$  be the numeraire. Then the profit of the rural sector is

$$\pi_y = G - wL_y - rK_y, \quad (2b)$$

where  $w$  is the flexible rural wage and the price of the numeraire is  $P_y = 1$ . Note that marginal product of each input is homogeneous of degree zero in  $K$  and  $L$ .

Perfect competition in product markets implies that the zero profit condition holds in "long run" equilibrium, although some "equilibrium" labor unemployment exists in the urban sector because of wage rigidity. Thus, prices are equated to unit costs,

$$P = Wa_{Lx} + ra_{Kx}, \quad (3a)$$

$$1 = wa_{Ly} + ra_{Ky}, \quad (3b)$$

where  $a_{ij}$  denote the amount of factor  $i$  employed to produce one unit of product  $j$ . Due to wage rigidity, there exists some unemployment  $L_u$  in the urban sector. Total demand for labor in the two sectors falls short of the labor supply,

$$(1 + \lambda)L_x + L_y = L, \quad (4a)$$

where  $\lambda \equiv L_u/L_x$  is the relative unemployment in the urban sector. Capital market clearing requires

$$K_x + K_y = K. \quad (4b)$$

To complete the description of the production side of the model, an additional equation

is needed to connect the wages in the two sectors. In the HT model, workers are assumed to be risk neutral, and hence expected urban wage is equal to the flexible rural wage,

$$w = W/(1 + \lambda).$$

In this paper, workers are assumed to be risk averse and they must be paid extra compensation above the nonrandom rural wage for taking a chance in the urban sector, i.e.,  $w < W/(1 + \lambda)$ . This relationship will be more formally described in terms of utility functions later in the paper.

### **Output Prices and Factor Prices**

In the Heckscher-Ohlin trade model, an increase in the price of a traded good necessarily raises one factor price and lowers the other, depending on the capital intensity of traded goods. How does a change in the terms of trade affect factor prices in the HT model? Since the urban wage is fixed, a change in  $p$  only affects capital rental  $r$  and the flexible rural wage  $w$ . Differentiating (3a) and (3b) and noting that  $Wda_{Lx} + rda_{Kx} = wda_{Ly} + rda_{Ky} = 0$  yields

$$dP = a_{Kx}dr,$$

$$0 = a_{Ly}dw + a_{Ky}dr.$$

Thus, we get

$$\partial r / \partial P = 1/a_{Kx} = X/K_x > 0. \quad (5a)$$

$$\partial w / \partial P = -k_y(X/K_x) < 0, \quad (5b)$$

where  $k_y = K_y/L_y$ . Thus, in the Harris-Todaro model, an increase in the price of the

importable raises rental on capital input and reduces the flexible wage in the export sector. Observe that unlike the Stolper-Samuelson Theorem in the Heckscher-Ohlin model, this result does not depend on the factor intensity rankings of traded goods. The result also holds regardless of risk attitudes of workers, because employment risk only affects individual workers, and the competitive firms do not face risk in the price or production uncertainty.

The intuition for this Stolper-Samuelson-like result is straightforward: an increase in the price of the manufactured good necessarily will increase the rental rate ( $r_X$ ) in that sector since the urban wage rate ( $W$ ) is fixed, which leads to an increase in the rural rental rate ( $r_Y$ ) since capital is mobile between sectors. For a small country, the price of the agricultural product is also fixed by the world market, thus the rural wage rate ( $w$ ) has to decrease in order for the zero-profit condition to hold.

### **Risk Aversion**

Consumer preferences are represented by a monotone increasing and concave utility function,  $U = U(C, D)$ , where  $C$  and  $D$  denote consumption of the exportable and the importable, respectively. Let  $I$  denote consumer income, and  $p$  be the consumer price of the manufactured good  $X$ . In the absence of production tax or subsidy,  $p = P$ . Let  $C(p, I)$  and  $D(p, I)$  be the demand functions obtained by maximizing  $U$  subject to the individual's budget constraint,  $C + pD = I$ . Then the indirect utility of a consumer is written as

$$V \equiv V[p, I] = U[C(p, I), D(p, I)].$$

Since workers are risk averse in income,  $V_{II} < 0$ .<sup>3</sup>

Workers have identical preferences, but their incomes are different, depending on whether they are employed in the rural sector, employed in the urban sector or

unemployed. Let  $I^y$ ,  $I^e$ , and  $I^u$  denote his income when he is employed in the rural sector, the urban sector and when he is unemployed, respectively, i.e.,

$$I^y = rk + w. \quad (6a)$$

$$I^e = rk + W. \quad (6b)$$

$$I^u = rk. \quad (6c)$$

The indirect utility of the worker in the rural sector is

$$V^y = V[p, rk + w]. \quad (7a)$$

If a worker is employed in the urban sector, his utility is  $V^e = V[p, rk + W]$ , but it is  $V^u = V[p, rk]$  if unemployed. The expected utility of the representative urban worker is then

$$V^x \equiv \beta \cdot V[p, rk + W] + (1 - \beta)V[p, rk], \quad (7b)$$

where  $\beta = 1/(1 + \lambda)$  is the probability of employment in the urban sector. Note that  $\beta$  and  $\lambda$  move in the opposite directions.

Let the risk premium  $\rho$  be implicitly defined by

$$\beta V[p, rk + W] + (1 - \beta)V[p, rk] \equiv V[p, rk + \beta W - \rho]. \quad (8)$$

The left side of (8) is expected utility of a worker entering the urban sector. Note that if the certainty equivalent income on the right side of (8) were equal to the income of a worker when unemployed ( $\rho = \beta W$ ), then the left side would be greater than the right side for all  $\beta > 0$ . Thus, certainty equivalent income of the urban worker must be greater than the income of an unemployed worker ( $\rho < \beta W$ ). Expected urban wage is  $\beta W$ , and expected total income of a worker in the urban sector is  $rk + \beta W$ . If the

worker is risk neutral, then  $\rho$  is zero, but  $\rho$  is positive if the worker is risk averse in income ( $V'' < 0$ ).

At the beginning of each period, a worker can enter the rural sector earning the certain but flexible wage  $w$ , or he can enter the urban sector, earning a higher and fixed urban wage  $W$  if employed, or face unemployment. The equilibrium probability of employment  $\beta = 1/(1 + \lambda)$  satisfies the condition that expected utility of income in both sectors,  $V^x$  and  $V^y$ , are the same, i.e.,

$$V[p, rk + \beta W - \rho] = V[p, rk + w]. \quad (9)$$

This equilibrium condition reduces to the Harris-Todaro condition when the worker is risk neutral in income. Equation (9) shows the relationship between the equilibrium rural wage and the fixed urban wage when workers are risk averse, and hence is called the general HT condition. From (9) and (8), we get

$$w = \beta W - \rho(\beta, p, rk, W). \quad (10)$$

Although the risk premium function  $\rho(\cdot)$  depends on the parameters of (8), it can also be observed when the labor market is in equilibrium. The observed difference between the expected wage in the urban sector and the rural wage is thus the risk premium in equilibrium,  $\rho = \beta W - w$ .

All workers are assumed to have identical and homothetic preferences. We employ a social utility function which gives equal weights to all workers. That is, the social utility is the sum of utilities of all workers. However, consumer income depends on whether he is employed in the rural sector, or the urban sector, or unemployed.

Using the probability of employment, total social utility is  $(L - L_y)V^x + L_y V^y$ , or

$$S = (L - L_y) \cdot \{\beta V[p, rk + W] + (1 - \beta)V[p, rk]\} + L_y \cdot V[p, rk + w]. \quad (11)$$

Because workers are mobile between the urban and the rural sectors, the rural wage  $w$  is in equilibrium when the general HT condition in (9) is satisfied. Thus,

$$S = L \cdot V[p, rK + w] = LV^y. \quad (12)$$

That is, the social utility of all workers is the utility of a rural worker (or the expected utility of an urban worker before employment status is known) multiplied by the total number of workers.

### 3. Tariff, Production Subsidy, and Welfare

We now investigate the welfare implications of production subsidy and import tariff when workers are risk averse. Let  $t$  denote a specific tariff levied on imports, and let  $p^*$  be the foreign price of the importable. The domestic consumer price of the importable is  $p = p^* + t$ . Producer price is  $P = p + s$ , where  $s$  is per unit production subsidy on the manufactured good. Import demand is

$$Q(p, I) = D(p, I) - X(P), \quad (13)$$

where  $I$  is consumer income, which is endogenously determined. The government collects tariff (or quota) revenue  $(p - p^*)Q$ , but pays production subsidy  $sX$ . Following convention, we assume that net government revenue,  $(p - p^*)Q - sX$ , is rebated to all workers equally. The per capita rebate is  $(p - p^*)q - sx$ , where  $q = Q/L$  and  $x = X/L$ .<sup>4</sup> With the rebate, social utility is given by

$$\begin{aligned} S = (L - L_y) \cdot \{ & \beta V[p, rk + W + tq - sx] + (1 - \beta) V[p, rk + tq - sx] \} \\ & + L_y \cdot V[p, rk + w + tq - sx]. \end{aligned} \quad (14)$$

Since the expected utility of the urban worker is equal to the utility of the rural worker

for any given level of tariff revenue, (14) reduces to

$$S = LV(p, I^Y) \equiv V[p, (rK + wL + (p - p^*)Q - sX)/L], \quad (15)$$

where  $I^Y = (rK + wL + (p - p^*)Q - sX)/L$  is rural worker's income after the revenue rebate. Since the labor endowment  $L$  is given, social welfare is maximized if and only if the utility of the rural worker is maximized.

### The Effects of Tariff and Subsidy

Recall that preferences are identical and homothetic, so that the income elasticity of demand for the importable good is unity. Thus, the demand for the importable good increases proportionately as income increases, and is independent of the distribution of income among consumers. Observe that the certainty equivalent income of an urban worker is equal to  $I^Y$  in equilibrium. Thus, the total certainty equivalent income is simply  $LI^Y$ . Let  $d(p)$  denote the demand for the importable good when income is \$1, i.e.,  $d(p) = D(p, 1)$ . Then Roy's identity implies  $V_p = -V_I d(p) \times \text{income}$ .

Actual aggregate income is  $I^A = (rK + WL_x + wL_y + tQ - sX)$ . Let  $\theta$  denote the ratio of rural worker's income,  $I^Y$ , to the actual per capita income,  $I^A/L$ , i.e.,

$$\theta = I^Y L / I^A = (rK + wL + tQ - sX) / (rK + WL_x + wL_y + tQ - sX). \quad (16)$$

Then the total certainty equivalent income of all workers is  $I^Y L = \theta I^A$ . It can be shown that  $\theta = 1$  when workers are risk neutral, but  $\theta < 1$  when workers are risk averse.<sup>5</sup>

Recall that  $\beta W > \rho \geq 0$ . So,  $\theta$  is bounded below.<sup>6</sup>

We now investigate how production subsidy and tariff will affect the social utility. Differentiating (15) totally and noting that the aggregate certainty equivalent income is  $LI^Y$ , we get

$$dS = L dV^Y = L (V_p dp + V_I dI^Y)$$

$$= L[-d(p)I^Y V_I dp + V_I dI^Y] = V_I(-\theta D dp + L dI^Y) \quad (17)$$

where  $D = D(p, I^A)$  is actual aggregate demand for the manufactured good. Using  $P = p + s = (p^* + t) + s$ ,  $dP = dt + ds$  and  $dp = dt$  given  $dp^* = 0$ , the change in the aggregate certainty equivalent income can be written as

$$\begin{aligned} L dI^Y &= d(rK + wL + tQ - sX) \\ &= K(\partial r/\partial p)dp + L(\partial w/\partial p)dp + tdQ + Qdt - sX'dp - Xds. \end{aligned}$$

Using (5a) and (5b), we get

$$\begin{aligned} L dI^Y &= [L(X/K_X)(k - k_y)]dp + tdQ + Qdt - sX'dp - Xds \\ &= [(XK_Y/K_X)(1 - L/L_Y) + D - sX']dt + [(XK_Y/K_X)(1 - L/L_Y) - sX']ds + tdQ \\ &= [A + D - sX']dt + [A - sX']ds + tdQ, \end{aligned} \quad (18)$$

where  $A \equiv L(X/K_X)(k - k_y) - X = (XK_Y/K_X)(1 - L/L_Y)$ . Substituting (18) into (17) yields

$$dS = V_I(-\theta D dp + L dI^Y) = V_I\{[(1 - \theta)D + A - sX']dt + [A - sX']ds + tdQ\} \quad (19)$$

It is shown in the appendix that

$$dQ = [1/(1 - tD_I)]\{[D_p^u + D_I Y' - (1 - pD_I)X']dt + [D_I Y' - (1 - pD_I)X']ds\} \quad (20)$$

where  $D_p^u$  is the slope of the compensated demand curve along a given indifference curve. Assume that both goods are normal ( $D_I > 0$  and  $C_I = 1 - pD_I > 0$ ). Then,  $1 - tD_I > 1 - pD_I > 0$ . From (20), an increase in tariff or production subsidy shifts the import demand curve to the left, i.e.,  $\partial Q/\partial t < 0$  and  $\partial Q/\partial s < 0$ . Moreover,

$$\partial Q/\partial s - \partial Q/\partial t = -D_p^u/(1 - tD_I) > 0. \quad (21)$$



That is, a decrease in consumption tax (i.e., an increase in the production subsidy followed by an equal decrease in tariff) increases import demand.

The first order conditions for optimal tariff and production subsidy can be derived from (19) and using  $dQ$  in (20):

$$\partial S/\partial t = (1 - \theta)D + A - sX' + t(\partial Q/\partial t) = 0, \quad (22a)$$

$$\partial S/\partial s = (A - sX') + t(\partial Q/\partial s) = 0. \quad (22b)$$

Substituting (22b) into (22a) yields  $t = (1 - \theta)D/(\partial Q/\partial s - \partial Q/\partial t)$ . Using (21), we get the optimal tariff and production subsidy

$$t = - (1 - \theta)D/(\theta DD_I + D_p) \geq 0, \quad (23a)$$

$$s = [A + t(\partial Q/\partial s)]/X' < 0. \quad (23b)$$

If workers are risk neutral, then  $\theta = 1$ , and the optimal tariff is zero, but the optimal production subsidy reduces to  $A/X' < 0$ . Note that since the importable is a normal good,  $(\theta DD_I + D_p) = D_p^u + (\theta - 1)DD_I < D_p^u < 0$ . If workers are risk averse, then optimal tariff is positive. Since  $t > 0$ , (23b) implies that optimal production subsidy is negative. These results are summarized below:

**Proposition1**: If workers are risk neutral, then the optimal tariff is zero and optimal production subsidy on the importable is negative. If workers are risk averse, however, the optimal tariff is positive and the optimal production subsidy on the importable is negative.

Note that a tariff can be broken down into a consumption tax and a production subsidy. Thus, if the optimal tariff and production subsidy are of the same magnitudes, then the optimal policy would be a net consumption tax. However, (23a) and (23b) indicate that

no comparisons of the magnitudes of the tariff and the production subsidy can be made a priori.

Next, consider optimal tariff when no production subsidy is used. Then from (22a) the optimal tariff is

$$t = - [(1 - \theta)D + A]/(\partial Q/\partial t). \quad (24a)$$

If workers are risk neutral, optimal tariff is negative, but if workers are risk averse, optimal tariff can be positive or negative, depending on the extent of risk aversion.

On the other hand, if no tariff is used, then

$$s = A/X' < 0. \quad (24b)$$

That is, regardless of risk attitudes, optimal production subsidy is negative when  $t = 0$ .

When a positive tariff is used, optimal production subsidy is  $s = [A + t(\partial Q/\partial s)]/X' < 0$ .

**Proposition2:** If workers are risk averse, an import tariff can be welfare improving even when no production subsidy is used. If no import tariff is employed, optimal production subsidy is negative regardless of risk aversion.

The following example illustrates the case of a positive tariff when no production subsidy is used. Suppose that, initially, with  $t = 0$  (when there is free trade),  $W = 2w$ , which means  $P \cdot MPL_x = 2MPL_y$ , or the labor productivity in the urban sector is twice as much as that in the rural sector. First, consider the case where workers are risk neutral. A simple algebraic manipulation leads to  $\beta = L_x/(L_u + L_x) = 1/2$ , or the urban employment rate is 50%. Suppose now a positive tariff ( $t > 0$ ) is levied on imports and results in, say,  $W = 3w$ , and hence  $\beta = 1/3$ , which is to say that for every 3 workers drawn from the rural sector by an even higher urban wage, 2 workers would be

unemployed. Since  $P \cdot MPL_x = 2MPL_y$  still holds, there will be a production loss and a welfare loss. To see this, suppose a rural worker produces one unit while an urban worker produces two units. Before the tariff is levied, 3 workers produce 3 units in the rural sector; after the tariff, only 1 of them is employed in the urban sector, producing 2 units.

If workers are risk averse, however, they will not accept  $\beta = 1/3$  if a tariff results in the same wage relation as before,  $W = 3w$ . Recall that the Stolper-Samuelson-like result in Proposition 1 is independent of risk attitudes. Suppose that a higher rate of employment is required, say,  $\beta = 2/3$ , for some level of risk aversion. In this case, out of every 3 workers drawn from the rural sector, 2 will be employed in the urban sector, producing 2 units each, and obviously, there will be a gain in production because of the tariff.

## 5. Concluding Remarks

This paper investigated the properties of a generalized HT model with risk averse workers. It is assumed that the consumer-worker receives income from capital endowment and also from the sale of labor services, but labor income depends on whether and where the worker is employed. To focus on the welfare impacts of trade policies on LDCs, we assume that capital endowments are uniformly distributed among workers. Since labor is mobile between the urban and the rural sectors, risk averse workers insure that the flexible rural wage is equal to the certainty equivalent wage, which is less than the expected wage in the urban sector.

We employ a social welfare function which gives equal weights to all workers. It is shown that maximizing social welfare is equivalent to maximizing the utility of the rural worker. Thus, any policy that raises the utility of a rural worker (or the expected utility of an urban worker) raises social welfare. If workers are risk neutral, then a tariff

necessarily hurts a small open economy, and hence the traditional HT model cannot explain the widespread use of tariffs in LDCs. We have shown, however, that if workers are risk averse and an optimal production subsidy is used, an import tariff necessarily improves the welfare of an HT economy.

This model provides a possible explanation for the widespread use of production subsidies in the export sector and import tariffs in some developing countries. If workers are risk averse, an optimal policy consists of a negative production subsidy and a positive tariff. A negative production subsidy on the importable is equivalent to a production subsidy in the export sector. Our analysis shows that export promotion strategy alone is not optimal in an HT economy but it should be supplemented by an import tariff. This result is consistent with the policies of some LDCs such as South Korea and Taiwan.

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## Appendix

With aggregate income  $I^A$ , the import demand can be written as  $Q = D(p, I^A) - X(P)$ , and,

$$dQ = D_p dp + D_I dI^A - X' dP, \quad (A1)$$

where  $I^A = rK + wL_y + WL_x + tQ - sX = PX + Y + tQ - sX$ ,

$$\begin{aligned} dI^A &= PX' dP + X dP + Y' dP + t dQ + Q dt - sX' dP - X ds \\ &= (pX' + X + Y') dP + Q dt - X ds + t dQ. \end{aligned} \quad (A2)$$

Substituting (A2) into (A1) yields,

$$\begin{aligned} dQ &= D_p dp + D_I [(pX' + X + Y') dP + Q dt - X ds + t dQ] - X' dP \\ &= D_p dt + [D_I (pX' + X + Y') - X'] dt + [D_I (pX' + Y') - X'] ds + t D_I dQ \\ &= [D_p + D D_I + D_I Y' - (1 - p D_I) X'] dt + [D_I Y' - (1 - p D_I) X'] ds + t D_I dQ \end{aligned}$$

Rearranging terms, we get (20).

## Footnotes

1. See also Choi and Beladi (1993) for optimal tariff policies for a small open economy with general unemployment risk.

2. In Corden and Findlay (1975), production subsidies and import tariffs are considered separately, whereas this paper permits the government to use both instruments simultaneously.

3. It is well known that the direct utility function  $U(\cdot)$  is concave if and only if the indirect utility function  $V(p, I)$  is concave in income.

4. In addition to rebates of net government revenue, the total profits,

$$\Pi = PF + G - WL_x - rK_x - wL_y - rK_y,$$

are also distributed to consumers as dividends, but they are equal to zero in equilibrium.

$$\begin{aligned} 5. \quad \theta &= (rk + w + tq)/(rk + WL_x/L + wL_y/L + tq) \\ &= (rk + w + tq)/(rk + (1 + \lambda)(w + \rho)L_x/L + wL_y/L + tq) \\ &= (rk + w + tq)/(rk + (w + \rho)(L - L_y)/L + wL_y/L + tq) \\ &= (rk + w + tq)/(rk + w + tq + \rho(1 - L_y/L)) \\ &= (rK + wL + tq)/(rK + wL + tq + \rho(L_x + L_u)). \end{aligned}$$

6. In most countries, labor income is 3 - 4 times capital income. To get a reasonable estimate, assume that  $WL_x + wL_y = 3 rK$ . Let  $L = 1$ , and assume that  $L_y = .3, L_x = .6$ , and that urban wage is twice the rural wage,  $W = 2w$ . Then actual per capita income,  $r + WL_x/L + wL_y/L = 2w$ , whereas rural worker's income, equal to certainty equivalent income of the urban worker,  $rk + w = 1.5 w$ . In this case,  $\theta = .75$ .