

# Tariffs and Wages in Trade Theory

*Henry Thompson\**

## Abstract

The theory of production and trade is motivated in large part by the effects of tariffs on wages. General equilibrium models that examine these effects include constant costs, factor proportions, specific factors, imperfect competition and noncompetitive factor market. The present paper reviews the effects of tariffs on wages in small open economies across this broad range of trade theory. From this wide perspective, tariffs support wages only under narrow sets of assumptions. There should be no presumption that tariffs support wages.

## 1. Introduction

The effects of tariffs on wages remain a focus of trade theory motivated by protection of import competing manufactures in developed countries. The general equilibrium of production and trade provides the theoretical setting with all outputs and factor prices adjusting to tariffs. The present paper surveys the thread of the effects of tariffs on wages in general equilibrium from constant costs to factor proportions, imperfect competition, and noncompetitive factor markets. Results also apply to tariffs in developing countries aiming to protect capital or land, and to nontariff barriers that raise prices for import competing industries. The present paper complements Edwards (1988) who surveys a range of models focused on developing countries.

Tariffs may be thought to support wages in developed countries in the face of falling global prices of manufactures as developing countries continue to enter global markets. Developing country tariffs remain high. Tariffs remain part of the political and economic landscape even as trade agreements have proliferated. The simple average US manufacturing tariff has fallen to 4% by 2016 but with a strong skew toward the 19% maximum. Tariffs are higher in other developed countries. Quotas and nontariff barriers that similarly raise domestic prices are more popular than ever.

The present paper examines the general issue of whether tariffs have predictable effects on factor prices in small open economies. The section below reviews tariffs and wages with classical constant cost input coefficients, followed by sections on factor proportions, specific factors, and imperfect competition.

## 2. Tariffs and wages with constant costs

The Ricardian constant cost model has fixed input coefficients for a single factor of production labor  $L$  that is paid the wage  $w$ . Fixed coefficients are  $a_{LX}$  in export

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\*Thompson (Corresponding author): Department of Economics, Haley Center, Auburn University, AL 36849, USA. Tel: +1-334-844-2910; Fax: +1-334-844-4615; E-mail: henry.thompson@auburn.edu.

production and  $a_{LM}$  in import competing production. Where  $t$  is the tariff, the condition for specializing in  $X$  is  $1 + t < a_{LM}p_X/a_{LX}p_M$  where the  $p_j$  are exogenous prices for the small open economy. The wage  $w$  is determined by competitive pricing of the export,  $w = p_X/a_{LX}$ .

Chipman (1965a) reviews this  $1 \times 2$  constant cost model. Jones (1961), Dornbusch et al. (1977) and Eaton and Kortum (2012) extend the model to many goods and countries, and find the link between tariffs and wages is relaxed. Eaton and Kortum (2002) introduce geographic frictions that weaken the link between tariffs and wages.

Jones (1973) considers the constant cost  $2 \times 2$  model with a second input capital  $K$  added to labor, Jones (1973) shows factor intensity is critical to the effects of tariffs on wages. Assume the import competing good is labor intensive. The condition for production of both goods is that input ratios span the endowment ratio  $a_{KX}/a_{LX} > K/L > a_{KM}/a_{LM}$ . Competitive pricing implies price equals cost,  $p_X = a_{LX}w + a_{KX}r$  and  $(1 + t)p_M = a_{LM}w + a_{KM}r$  implying  $w = ((1 + t)a_{KX}p_M - a_{KM}p_X)/b$  where  $b \equiv a_{LM}a_{KX} - a_{KM}a_{LX} > 0$ . The tariff is restricted to  $(a_{KM}p_X - a_{KX}p_M)/a_{KX}p_M < t < (a_{LM}p_X - a_{LX}p_M)/a_{LX}p_M$ .

A tariff raises the wage according to  $\partial w/\partial t = a_{KX}p_M/b > 0$ . A tariff also lowers  $r$  and changes the domestic price of  $M$  according to  $p_M dt = a_{LM}dw + a_{KM}dr$ . The percentage change in the price of  $M$  because of the tariff is  $dt/(1 + t) = \theta_{KM}r' + \theta_{LM}w'$  where the prime denotes percentage change and  $\theta_{iM}$  is the income share of factor  $i = K, L$ . The constant export price implies  $p_X' = 0 = \theta_{KX}r' + \theta_{LX}w'$ . Since  $w' > 0$  and  $r' < 0$  the tariff raises the real wage in the magnification effect of Jones (1965). This real wage effect is relaxed in the three factor constant cost model as shown by Thompson (2010).

Ruffin (1988, 1992) develops a related  $2 \times 2$  model with fixed unit inputs of skilled labor  $S$  and labor  $L$  each independently able to produce either good. Trade occurs between labor groups that specialize according to comparative advantage with endowments determining the direction of international trade. Assume labor has the comparative advantage in import competing production,  $a_{SM}/a_{SX} > (1 + t)p_M/p_X > a_{LM}/a_{LX}$ . A tariff raises wages to  $w = (1 + t)p_M/a_{LM}$  but does not affect skilled wages  $w_s = p_X/a_{SX}$ . The effect on real wages depends on labor's consumption share of the higher priced import competing good.

*With constant cost production and the single input labor, only tariffs that alter specialization have wage effects. In constant cost models including capital, tariffs raise wages assuming labor intensive imports. Including a third factor of production, wage effects depend on factor intensity and real wages on consumption shares as well.*

### 3. Tariffs and wages with substitution

Substitution allows the input mix to adjust to factor price changes owing to tariffs along the contract curve. Stolper and Samuelson (1941) show tariffs raise wages assuming labor intensive import competing production in the model with two factors and two goods. Dixit and Norman (1980) present this fundamental model that is reviewed and refined by Francois and Nelson (1998). Both sectors become more capital intensive to relieve pressure on the labor market as labor intensive production increases. Jones (1965) shows real wages rise regardless of consumption shares in the magnification effect. Thompson (2003) shows the model is robust to parametric relaxation of sufficient technical conditions.

Skilled labor or natural resources are critical to trade for many countries, motivating a third factor of production in the basic two factor model. Factor price adjustments are analyzed in the  $3 \times 2$  model by Ruffin (1981), Suzuki (1982), Jones and Easton (1983) and Thompson (1985). Suppose labor  $L$  is the most intensive input in import competing production and natural resources  $N$  in export production,  $a_{LM}/a_{LX} > a_{KM}/a_{KX} > a_{NM}/a_{NX}$ . A tariff would seem to raise wages based on factor intensity but the link is weak if  $L$  and  $K$  are similar in intensity with  $N$  very intensive in  $X$ . If labor is a complement with capital, a rising capital return lowers labor demand and wages may fall as shown by Thompson (1993).

The literature on production and trade with numerous factors of production includes Chipman (1965b), Chang (1979), Ethier (1984) and Thompson (1987). In applications there is empirical support for separating skilled labor groups, capital vintages, energy and various natural resource inputs.

*In factor proportions' models, tariffs on labor intensive imports necessarily raise wages only in the model with two factors. Wage effects depend on factor substitution as well as intensity in models with three or more factors.*

#### 4. Tariffs and wages with specific factors

In the specific factors' model originated by Samuelson (1971) and Jones (1971a) each sector employs shared labor and its own capital  $K_j$ . A tariff raises wages but consumption shares determine the effect on real wages in the neoclassical ambiguity of Ruffin and Jones (1977). If labor is specific to import competing production, a tariff raises real wages as applied by Amiti and Davis (2010). As another motivation for specific factors' models, land or natural resources may be specific to export production.

Suppose labor is specific to import competing production with two shared factors as in Thompson (1989). Tariffs would be expected to raise wages but labor may be a complement with shared capital. Tariffs that raise the capital return would lower labor demand leading to falling wages. Familiar properties of the specific factors' model rely on the assumption of two inputs in each sector.

To focus on the potential of substitution, consider a specific factors' model with shared factors, labor  $L$  and skilled labor  $S$ , in a model not in the literature. Assume import competing production is labor intensive,  $a_{LM}/a_{SM} > a_{LX}/a_{SX}$ . Substitution terms  $S_{kh}$  are positive (negative) when factors  $k$  and  $h$  are substitutes (complements) as described by Jones and Scheinkman (1977) and Takayama (1993). Own substitution terms  $S_{kk}$  are negative. Constant returns imply  $wS_{Lh} + sS_{Sh} + r_hS_{Kh} = 0$  for each factor  $h$  where  $s$  is the skilled wage. The comparative static model (1) has full employment in the first four equations, competitive pricing in the last two, and sector specific capital returns  $r_j$  in the system

$$\begin{pmatrix} S_{LL} & S_{LS} & S_{LX} & S_{LM} & a_{LX} & a_{LM} \\ S_{LS} & S_{SS} & S_{SX} & S_{SM} & a_{SX} & a_{SM} \\ S_{LX} & S_{SX} & S_{XX} & 0 & a_{XX} & 0 \\ S_{LM} & S_{SM} & 0 & S_{MM} & 0 & a_{MM} \\ a_{LX} & a_{SX} & a_{XX} & 0 & 0 & 0 \\ a_{LM} & a_{SM} & 0 & a_{MM} & 0 & 0 \end{pmatrix} \begin{pmatrix} dw \\ ds \\ dr_X \\ dr_M \\ dq_X \\ dq_M \end{pmatrix} = \begin{pmatrix} dL \\ dS \\ dK_M \\ dK_X \\ dp_X \\ p_M dt \end{pmatrix} \quad (1)$$

Consider a *ceteris paribus* change in the import price  $p_M dt$  owing to a tariff in the vector of exogenous changes. Solve for the wage effect  $\partial w / \partial t$  with Cramer's rule.

For simplicity rescale the capital inputs to  $a_{MM} = a_{XX} = 1$ , skilled labor  $S$  and labor  $L$  to  $a_{SX} = a_{LX} = 1$ , and the import competing good  $M$  to  $a_{SM} = 1$ . Assume skilled labor is a uniform substitute and labor a similar substitute for export capital in the substitution terms  $S_{LS} = S_{LX} = S_{SX} = S_{SM} = 1$ . Labor intensity is then described by the single term  $a_{LM}$  and import capital substitution by the single term  $S_{LM}$ . Assume labor intensive imports  $a_{LM} = 1.1$  with labor and import capital complements  $S_{LM} = -0.1$ . A tariff lowers wages according to  $\partial w/\partial t = -0.02$ , an elasticity with the scaling. The higher price of capital in import competing production lowers demand for labor. In contrast  $S_{LM} = 1$  implies  $\partial w/\partial t = 0.18$  with real wages falling if labor spends more than 18% of its income on the imported good.

*In specific factors' models with mobile labor, tariffs necessarily raise wages assuming the only other input is sector specific capital. Even then, real wages depend on consumption shares. If labor specific to import competing production, tariffs necessarily raise wages only assuming a single shared input.*

## 5. Tariffs and Wages with Imperfect Competition

Price searching involves demand as in the analysis of a monopoly exporter by Melvin and Warne (1973) and Casas (1989). In a similar model not in the literature, consider an import competing monopoly facing domestic demand but taking the world price  $p_M$ . The monopoly chooses optimal output  $x_M$  based on marginal revenue and marginal cost. If the world price  $p_M$  is less than the associated optimal price  $p_O$  then the monopoly produces  $x_M$  assuming price covers average cost. Imports are the difference between the quantity demanded  $q_D$  and output  $x_M$ . Tariffs raising  $p_M$  to  $(1+t)p_M$  have no effect on  $x_M$  but lower  $q_D$  and imports. Tariffs do not affect wages.

Monopolistic pricing can also be treated as the parametric relaxation of competitive pricing as in Thompson (2002). Consider an import competing monopoly in a small open economy. In an otherwise competitive economy, a tariff might not raise wages owing to the weak price link. This parametric pricing condition provides a first order approximation to any price searching model. Oligopoly models involve some degree of price searching implying similar weakened links between tariffs and wages.

The foundation of imperfect competition in labor markets is Johnson and Mieczkowski (1970), Jones (1971b), Herberg and Kemp (1971) and Bhagwati and Srinivasan (1971). Minimum wages are introduced to general equilibrium by Brecher (1974). Impediments to wage adjustments weaken tariff effects as in Davidson et al. (1988) and Thompson (2003).

Labor unions introduce monopsony power to labor markets, reducing competition. Gaston and Trefler (1995) find tariffs may lower wages for unionized labor when the import competing industry is a price searcher. Fisher and Wright (1999) find tariffs lower wages in a unionized import competing industry when imports are from a unionized foreign industry.

*Imperfect competition in product markets or factor markets weakens and may reverse the effects of tariffs on wages.*

## 6. Conclusion

General equilibrium trade theory suggests that tariffs are not reliable policy to raise or support wages. In constant cost models with only labor input, tariffs that reduce

specialization lower wages. Including other inputs, the effects of tariffs on wages depend on factor intensity and perhaps consumption shares. In factor proportions' models with two factors, tariffs raise wages if imports are labor intensive. With more than two factors, the effects on wages may reverse. In specific factors' models, tariffs may not raise wages. Imperfect competition in product markets weakens or reverses any positive effect of tariffs on wages. Noncompetitive factor markets similarly lead to ambiguous effects on wages. These same conclusions hold for developing country tariffs aiming to support capital rents or natural resources prices.

Falling global prices of manufactures promise to continue as developing countries enter global markets. Continued or increased pressure for tariffs and other forms of protection can be anticipated. Trade theory contributes by making the point that tariffs should not be presumed to have positive effects on wages. The long run implications of tariffs for wages considering the potential of investment, economic growth and labor skill upgrading are much bleaker than the present comparative static effects. The bottom line is that tariffs aiming to support wages or other factor prices remain as ill-advised as ever.

## References

- Amiti, Mary and Donald Davis, "Trade, Firms, and Wages: Theory and Evidence," *Review of Economic Studies* 79 (2010):1–36.
- Bhagwati, Jagdish and T. N. Srinivasan, "The Theory of Wage Differentials: Production Response and Factor Price Equalization," *Journal of International Economics* 1 (1971):19–35.
- Brecher, Richard, "Minimum Wage Rates and the Pure Theory of International Trade," *Quarterly Journal of Economics* 88 (1974):98–116.
- Casas, Francisco, "Tariffs and Quotas in the Presence of Foreign Monopoly," *Canadian Journal of Economics* 1(1989):195–201.
- Chang, Winston, "Some Theorems of Trade and General Equilibrium with Many Goods and Factors," *Econometrica* 47 (1979):709–26.
- Chipman, John, "A Survey of the Theory of International Trade, Part 1: The Classical Theory," *Econometrica* 33 (1965a):477–519.
- , "A Survey of the Theory of International Trade, Part 3: The Modern Theory," *Econometrica* 34 (1965b):18–78.
- Davidson, Carl, Lawrence Martin and Steven Matusz, "The Structure of Simple General Equilibrium Models with Frictional Unemployment," *Journal of Political Economy* 96 (1988):1267–93.
- Dixit, Avinash and Victor Norman, *Theory of International Trade: A Dual, General Equilibrium Approach*, Cambridge: Cambridge University Press (1980).
- Dornbusch, Rudiger, Stanley Fisher, and Paul Samuelson, "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review* 67 (1977):823–39.
- Eaton, Jonathan and Samuel Kortum, "Technology, Geography, and Trade," *Econometrica* 70 (2002):1741–80.
- and —, "Putting Ricardo to Work," *Journal of Economic Perspectives* 26 (2012): 65–90.
- Edwards, Sebastian, "Terms of Trade, Tariffs, and Labor Market Adjustment in Developing Countries," *World Bank Economic Review* 2 (1988):165–85.
- Ethier, Wilfrid, "Higher Dimensional Issues in Trade Theory," in Ron Jones and Peter Kenen (eds), *The Handbook of International Economics*, vol. 1, New York: Elsevier (1984).

- Francois, Joseph and Douglas Nelson, "Trade, Technology, and Wages: General Equilibrium Mechanics," *Economic Journal* 108 (1998):1433–99.
- Gaston, Noel and Daniel Trefler, "Union Wage Sensitivity to Trade and Protection: Theory and Evidence," *Journal of International Economics* 39 (1995):1–25.
- Fisher, Timothy and Donald Wright, "Unionized Oligopoly and Trade Liberalization," *Canadian Journal of Economics* 32 (1999):799–816.
- Herberg, Horst and Murray Kemp, "Factor Market Distortions, the Shape of the Locus of Competitive Outputs and the Relation between Product Prices and Equilibrium Outputs," in Jagdish Bhagwati, Ron Jones, Robert Mundell, and Jaroslav Vanek (eds), *Trade, Balance of Payments and Growth: Essays in Honor of Charles P. Kindleberger*, Amsterdam: North Holland (1971).
- Johnson, Harry and Peter Miezowski, "The Effects of Unionization on the Distribution of Income: A General Equilibrium Approach," *Quarterly Journal of Economics* 84 (1970):539–61.
- Jones, Ron, "Comparative Advantage and the Theory of Tariffs: A Multi-country Multi-commodity Model," *Review of Economic Studies* 28 (1961):161–75.
- , "The Structure of Simple General Equilibrium Models," *Journal of Political Economy* 73 (1965):57–72.
- , "A Three Factor Model in Theory, Trade, and History," in J. Bhagwati, R. Jones, R. Mundell, and J. Vanek (eds), *Trade, Balance of Payments, and Growth*, Amsterdam: North-Holland (1971a).
- , "Distortions in Factor Markets and the General Equilibrium Model of Production," *Journal of Political Economy* 79 (1971b):437–59.
- , *World Trade and Payments*, ch. 8, New York: Little, Brown, & Co. (1973).
- Jones, Ron and Stephen Easton, "Factor Intensities and Factor Substitution in General Equilibrium," *Journal of International Economics* 15 (1983):65–99.
- Jones, Ron and José Scheinkman, "The Relevance of the Two-sector Production Model in Trade Theory," *Journal of Political Economy* 85 (1977):909–35.
- Melvin, James, and R. D. Warne, "Monopoly and the Theory of International Trade," *Journal of International Economics* 3 (1973):117–34.
- Ruffin, Roy, "Trade and Factor Movements with Three Factors and Two Goods," *Economics Letters* 7 (1981):177–82.
- , "The Missing Link: The Ricardian Approach to the Factor Endowments Theory of Trade," *American Economic Review* 77 (1988):759–72.
- , "First and Second Best Comparative Advantages and International Trade," *Economica* 59 (1992):453–63.
- Ruffin, Roy and Ron Jones, "Protection and Real Wages: The Neoclassical Ambiguity," *Journal of Economic Theory* 14 (1977):337–48.
- Samuelson, Paul, "Ohlin was Right," *Scandinavian Journal of Economics* 4 (1971):365–84.
- Stolper, Wolfgang and Paul Samuelson, "Protection and Real Wages," *Review of Economic Studies* 9 (1941):58–73.
- Suzuki, Katsuhiko, "A Synthesis of the Heckscher-Ohlin and the Neoclassical Models of International Trade: A Comment," *Journal of International Economics* 14 (1983):141–44.
- Takayama, Akira, *Analytical Methods in Economics*, Ann Arbor, MI: University of Michigan Press (1993).
- Thompson, Henry, "Complementarity in a Simple General Equilibrium Production Model," *Canadian Journal of Economics* 18 (1985):616–21.
- , "A Review of Advancements in the General Equilibrium Theory of Production and Trade," *Keio Economic Studies* 24 (1987):43–62.
- , "Do Tariffs Protect Specific Factors?," *Canadian Journal of Economics* 22 (1989):406–12.
- , "The Magnification Effect with Three Factors," *Keio Economic Studies* 30 (1993):57–64.

- , “Price Taking Monopolies in Small Open Economies,” *Open Economies Review* 13 (2002):205–09.
- , “Robustness of the Stolper-Samuelson Factor Intensity Price Link,” in Kwan Choi (ed), *Handbook of International Trade*, London: Blackwell (2003).
- , “The Fixed Factor Proportions Model of Production and Trade,” *Keio Economic Studies* 47 (2010):17–28.