Prices and Wages in Trade Theory

Henry Thompson

Auburn University

June 2010

JEL F10

Contact information
Economics, Comer Hall
Auburn University AL 36849
334-844-2910, fax 5639
thomph1@auburn.edu
Prices and Wages in Trade Theory

Abstract. General equilibrium trade theory develops relationships between product prices and wages from classical fixed unit input models to neoclassical, factor proportions, specific factors, and noncompetitive pricing models. The present paper surveys this range of models with a focus on whether falling prices of labor intensive manufactured imports should be expected to lower wages in developed countries. Some novel models fill gaps in the logical historical progression.
Prices and Wages in Trade Theory

The wage effects of changing prices due to domestic tariffs or changing international prices remain a primary focus of trade theory. In classical trade models with the single input labor and fixed input coefficients, trade unambiguously raises wages. Neoclassical trade theory stresses the increased utility and higher national income due to specialization. In the Heckscher-Ohlin model with two factors and two products, the wage falls if imports are labor intensive turning attention to winners and losers due to trade.

General equilibrium production models with more than two factors strive to isolate conditions determining how prices affect wages, as do models with noncompetitive pricing in product markets or factor markets. The present paper reviews the common thread of the effects of prices on wages across this range of classical fixed cost, factor proportions, specific factors, and noncompetitive models.


Declining prices of manufactured imports seem likely to continue for the coming decades. The simple average US manufacturing tariff for 459 industries has fallen to 4% but there is a strong skew toward the 19% maximum. The issue is whether downward pressure on wages should be anticipated as
world prices for manufactures fall and protection continues to diminish under the array of trade agreements.

The present paper focuses specifically on general equilibrium wage adjustments in small open economies facing world prices for two products. The first section examines wage adjustments with classical fixed unit input coefficients. The second section turns to factor proportions models with cost minimization and neoclassical production functions. The third considers specific factors models with labor the shared factor or a specific factor. The fourth and fifth sections summarize models with noncompetitive pricing in factor markets and product markets. A few novel models fill gaps in the logical historical progression of the theory.

1. Prices and wages with classical fixed input coefficients

The classical trade model has fixed unit input coefficients for the single input labor. With a falling price of imports and complete specialization in exports, the wage increases due to global efficiency gains. When there are two inputs, however, the wage effect depends on factor intensity as developed by Jones (1973).

Suppose input ratios span the endowment in the condition $\frac{a_{KX}}{a_{LX}} > \frac{K}{L} > \frac{a_{KM}}{a_{LM}}$ where $a_{ij}$ is the fixed input of factor $i$ in product $j$. The two inputs are labor $L$ and capital $K$. The product input ratios span the endowment ratio $K/L$. A decrease in the price of the labor intensive import lowers the wage in an effect identical to the Stolper-Samuelson (1941) effect with cost minimization of neoclassical production functions as developed by Thompson (2010). This wage result, however, depends on the assumption of two factors.

Consider the model with labor and any number of other inputs all with fixed input coefficients. Suppose labor is employed only in the import competing sector where $t$ is the tariff rate. The import
sector wage \( w_M = (1+t)p_M^*/a_{LM} \) must be greater than the potential export sector wage \( w_X = p_X^*/a_{LX} \). Eliminating the tariff, the wage falls to the higher of \( p_M^*/a_{LM} \) or \( w_X \). If the relative import price is greater than labor’s opportunity cost of producing the export, \( p_M^*/p_X^* > a_{LM}/a_{LX} \), then labor remains in the import competing sector and the percentage change in \( w_M \) equals the percentage change in the price of the imported product, \(-t/(1+t)\). The real wage falls since the wage falls more than the average product price.

The change in the real wage depends on consumption shares if labor moves to the export sector under the condition \( p_M^*/p_X^* < a_{LM}/a_{LX} \). The percentage wage decrease \([a_{LMPX^*}/a_{LX}(1+t)p_M^*) - 1]\) is then larger than the percentage import price decrease of \(-t/(1+t)\).

Fixed unit inputs are consistent with concepts from factor proportions theory as Ruffin (1988, 1992) shows in a model that separates labor \( L \) and skilled labor \( S \). Each type of labor produces either of the two products independently with fixed unit inputs. Factors are employed according to comparative advantage as in the classical model but factor proportions determine the direction of trade as in the factor proportions model. Assume labor has a comparative advantage in producing the import competing product \( M \) relative to the export \( X \) in the condition \( a_{SX}/a_{SM} < a_{LX}/a_{LM} \). For a range of preferences in autarky, each type of labor would be employed according to comparative advantage. Full employment implies \( L = a_{LM}q_M \) and \( S = a_{SX}q_X \) where \( q_j \) is the output of product \( j \). The wage \( w \) of unskilled labor is tied to the import price, \( w = p_M^*/a_{LM} \). World prices are given by \( p_X^* > p_X \) and \( p_M^* < p_M \). The wage \( w \) falls to \( p_M^*/a_{LM} \) unless the increase in the export price \( p_X^* \) is large enough to attract labor. The condition for a fall in the wage is \( a_{LX}/a_{LM} > p_X^*/p_M^* \). Reversing that inequality, the economy specializes with labor moving to the export sector and the wage increasing to \( p_X^*/a_{LX} \). The wage falls with the lower price of labor intensive imports as in the factor proportions model unless the economy
specializes as in the classical model. This model links concepts and properties of the classical and factor proportions models.

*Summarizing the wage effects of falling import prices in models with fixed input coefficients,*

*wages necessarily rise only when labor is the single input. Otherwise there is no presumption
wages fall with fixed input coefficients.*

2. **Prices and wages with neoclassical cost minimization and substitution**

Neoclassical wage adjustments to falling import prices involve moving along the contract curve. Stolper and Samuelson (1941) show that falling prices of labor intensive imports lower wages in the 2x2 production box as both sectors increase labor intensity and import competing production falls. The magnification effect of Jones (1965) implies a declining real wage regardless of consumption shares.

With more than two inputs, however, wages may rise. Substitution as well as intensity determine wage adjustments in the three factor model developed by Suzuki (1982), Jones and Easton (1983), Ruffin (1981), and Thompson (1985). There is ample motivation for the third factor: separating skilled labor allows focus on unskilled labor intensive imports; and natural resources are the motivation for a good deal of trade. Thompson (2009) shows US energy input has a stronger wage impact than the capital stock from 1949 to 2006.

Suppose labor L is the most intensive input in the import competing sector with skilled labor (or natural resources) S most intensive in export production in the three factor intensity ranking is $a_{LM}/a_{LX} > a_{KM}/a_{KX} > a_{SM}/a_{SX}$. A falling import price might lower wages but a low degree of labor intensity suggests little wage pressure. If labor and capital were complements, a falling capital return would increase labor demand. Cost in the labor intensive import sector could fall in spite of a rising wage. The range of potential wage adjustments is illustrated by the 13 magnification effects of Thompson (1993).
Applied models of production and trade should separate factors to the extent possible in the data. Aggregation leads to distortions including opposite qualitative comparative static results even for factors not involved in the aggregation. The assumption of only two skilled labor groups is questioned by Leamer (1994). Clark, Hofler, and Thompson (1988) show there are at least 6 separate labor skill groups in US manufacturing. Chipman (1979), Chang (1979), Ethier (1984), and Thompson (1987) develop high dimensional models with numerous inputs. With various skills of labor as well as natural resources, energy, and capital inputs, there is no presumption about the effects of falling import prices on any wages.

In models with competitive pricing, falling import prices necessarily imply lower wages only when there is no more than one other factor of production.

3. Prices and wages with specific factors

In the specific factors model of Jones (1971a) and Samuelson (1971) each sector employs its own capital $K_j$ along with shared labor. A decrease in import prices may raise or lower the real wage depending on consumption shares in the neoclassical ambiguity developed by Ruffin and Jones (1977).

If labor is specific to the import competing sector, falling import prices lower real wages due to the magnification effect. This specific labor model is motivated by labor immobility or export production utilizing natural resources or skilled labor. Comparing this outcome with the mobile labor model, the benefit of mobility is apparent.

Suppose labor is specific to import competing production but there is another shared factor along with capital. Thompson (1989) develops this model with the export sector employing only the two shared factors. If labor is a complement with capital and the capital return falls, the demand for labor rises and wages can rise even with falling import prices. The wage specific to the import competing sector does not depend directly on the import price.
A model not in the literature opens the specific factors model to substitution between shared labor and other inputs. Suppose specific capital inputs $K_X$ and $K_M$ combine with shared inputs of labor $L$ and skilled labor $S$ (or natural resources). With labor intensive imports in the condition $a_{LM}/a_{SM} > a_{LX}/a_{SX}$ falling import prices would lower wages but the following analysis illustrates the potential of substitution when there are more than two inputs.

 Aggregate substitution terms $S_{hk}$ describe flexibility of input $h$ with respect to the price of factor $k$ as developed by Jones and Scheinkman (1979). A positive (negative) $S_{hk}$ indicates factors $h$ and $k$ are substitutes (complements). Constant returns imply $\Sigma_h w_h S_{hk} = 0$. Rescale factors to $w_h = 1$ and $\Sigma_h S_{hk} = 0$.

The comparative static model in (1) is based on full employment in the first four equations and competitive pricing in the last two equations. Returns to capital are $r_X$ and $r_M$. The comparative static system is

$$\begin{bmatrix}
S_{LL} & S_{LS} & S_{LX} & S_{LM} & a_{LM} \\
S_{LS} & S_{SS} & S_{SX} & S_{SM} & a_{SM} \\
S_{LX} & S_{SX} & S_{XX} & 0 & a_{XX} \\
S_{LM} & S_{SM} & 0 & S_{MM} & 0 & a_{MM} \\
a_{LM} & a_{SM} & 0 & a_{MM} & 0 & 0
\end{bmatrix}
\begin{bmatrix}
dw \\
ds \\
dr_X \\
dr_M \\
dq_X \\
dq_M
\end{bmatrix}
= 
\begin{bmatrix}
dL \\
dS \\
dK_x \\
dK_m \\
dp_x \\
dp_m
\end{bmatrix}
= 
\begin{bmatrix}
0 \\
0 \\
0 \\
0 \\
0 \\
0
\end{bmatrix}. \tag{1}
$$

Consider the decreased import price $p_M$ in the vector of exogenous variable changes with the export price $p_X$ and factor endowments constant. Cramer’s rule leads to the solution for $\partial w / \partial p_M$.

Chang (1979) shows this system determinant with three inputs is positive.

With no loss of generality rescale products to unit capital inputs $a_{MM} = a_{XX} = 1$ and standardize inputs to $a_{SM} = a_{SX} = a_{LX} = 1$. Assume skilled labor is a substitute for other inputs and labor is a substitute
for export capital with substitution terms $S_{LS} = S_{LX} = S_{SX} = S_{SM} = 1$, Cobb-Douglas with the scaling. Focus shifts to labor and import capital in the $a_{LM}$ term for factor intensity and the $S_{LM}$ term for factor substitution.

If $a_{LM} = 1.1$ making imports labor intensive and $S_{LM} = -0.1$ with labor and import capital complements, then $\frac{\partial w}{\partial p_M} = -0.02$ which is an elasticity with the scaling. A fall in the import price raises the wage as the expanding export sector substitutes toward labor with its rising capital price. As the price of import capital falls, the declining import sector increases demand for complementary labor. If $S_{LM} = 1$ with labor and import capital substitutes it follows that $\frac{\partial w}{\partial p_M} = 0.18$. The real wage rises if labor spends more than 18% of income on the imported product.

*In specific factors models, the only necessary decrease in real wages due to falling import prices occurs when labor is specific to the import competing sector and there is no more than a single shared input.*

4. Prices and wages with noncompetitive pricing

Monopoly price searching introduces demand to the general equilibrium. Melvin and Warne (1973) and Casas (1989) analyze aggregate utility with an exporting domestic monopoly in the world market but do not consider wage adjustments. Thompson (2002) develops the model of price taking monopolies in small open economies facing world prices, and finds weaker wage effects than with competitive pricing. With an import competing monopoly, falling prices of labor intensive imports may increase wages although the wage/rent ratio falls. With an export monopoly, wage effects of falling import prices are weaker than with competitive pricing.

Thompson (2002) analyzes monopoly pricing as a parametric relaxation of competitive pricing, a first order approximation to any model of noncompetitive pricing. Wage effects of falling import prices are weaker but in the same direction as the competitive model. If the labor intensive import competing
monopoly is a price taker, wages fall with the import price but by less than with competitive pricing. The wage may fall by less than the import price in percentage terms, relaxing the magnification effect.

Falling import prices do not affect the wage in an import competing monopoly facing domestic demand and the world price $p_M$. The monopoly chooses optimal output $q_{\text{opt}}$ based on marginal revenue and marginal cost. If the world price is below the optimal monopoly price $p_M < p_{\text{opt}}$ the monopoly nevertheless produces $q_{\text{opt}}$ as long as $p_M$ is above average cost. Imports are the difference between quantity demanded $q_D$ at $p_M$ and the optimal output $q_{\text{opt}}$. A decrease in $p_M$ has no effect on $q_{\text{opt}}$ but the increase in $q_D$ implies increased imports. With no change in monopoly output there is no effect on wages.

Oligopoly models include some degree of price or quantity searching power. Similar conclusions on wages hold as with monopoly pricing due to this wedge between the oligopoly price and the competitive price. Wage adjustments are weaker in oligopoly models than with competitive pricing. Falling wages due to falling import prices are necessary under more limited conditions than with competitive pricing.

Noncompetitive pricing conditions with monopolies or oligopolies cut the link between prices and cost, dampening wage adjustments. Introducing noncompetitive pricing across the range of models in the first three sections, wage decreases are smaller in magnitude than with competitive pricing.

*If wages would fall with competitive pricing, noncompetitive pricing weakens the adjustment.*

5. **Prices and wages with factor market distortions**

Factor market distortions are introduced to general equilibrium models by Johnson and Miezkowski (1970), Jones (1971b), Herberg and Kemp (1971), and Bhagwati and Srinivasan (1971).
Impediments to wage adjustments weaken price effects on wages. Thompson (2003) utilizes a parametric wedge between sector wages $w_1 = yw_2$ to analyze robustness of the Stolper-Samuelson result and finds the intensity link between prices and wages can be reversed. Even if there is a distortion only in the capital market, the price/wage effect can be reversed.

*Falling import prices can raise wages when there is imperfect factor mobility across sectors. The effects of prices on wages are weakened due to factor market distortions.*

6. Conclusion

Prices and wages promise to remain a political and economic issue. The main lesson from trade theory is that wages should not be presumed to fall due to falling import prices. Wages must fall only when there are two inputs or when labor is specific to the import competing industry that shares only a single factor with the rest of the economy. These results are further weakened with noncompetitive pricing in product markets or factor markets. There is no theoretical consensus that wages fall with falling import prices.

Falling import prices under a wide range of conditions, however, may lead to falling wages. The empirical question of whether falling import prices lower wages promises to remain a central issue for research in international economics.
References


