research paper series

Globalisation and Labour Markets

Research Paper 2003/15

Globalization and relative wages: Some theory and evidence

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Leverhulme Centre for Research on Globalisation and Economic Policy

The Centre acknowledges financial support from The Leverhulme Trust under Programme Grant F114/BF

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Acknowledgements

This paper was presented at the 2003 RES Conference at Warwick University in the special session on "Fragmentation of Production and International Trade", organised by the Leverhulme Centre for Research on Globalisation and Economic Policy (GEP). The authors thank Robert Baldwin and Glen Cain for their help in providing the wage series used in this paper. Doug Nelson acknowledges financial support from the Leverhulme Trust under Programme Grant F114/BF.

Globalization and relative wages: Some theory and evidence

by

Joseph Francois and Douglas Nelson

Abstract

In this paper, we first present a simple theoretical model of globalization between similar countries to motivate the empirical work that follows. Specifically, we examine the linkages between trade volumes and relative wages in a specialization model along the lines of Ethier (1982). The core of the empirical analysis involves bivariate time-series analysis. There we find some evidence of a relationship between growth in intermediate goods and the skill premium, though perhaps not the evidence expected. Our results point to a link between globalization and wages, but one that benefits unskilled workers. Specifically, we find that, in all cases, increased trade volumes are associated with *lower skilled wages* and *higher unskilled wages*. That is, increased trade would seem to *reduce* wage inequality. The consistent sign pattern across the systems estimated strikes us as suggestive and warranting additional work.

JEL classification: F12, F16

Keywords: globalization, wages, imperfect competition

Outline

Non-Technical Summary *(500 words)*

The growth in research on the link between trade and wages seems to be abating, and the collective prior among economists on the empirical magnitude of that link seems to have stabilized around the existence of some statistically significant but practically small effect of trade on the decline in the relative wage of unskilled workers. However, the state of this body of research still seems somewhat unsatisfactory. The great majority of both theoretical and empirical work addresses the link between trade and wages within the context of the Heckscher-Ohlin-Samuelson (HOS) model, generalized in a variety of straightforward ways. This tends to focus attention on North-South trade, where the Stolper-Samuelson effects would be most pronounced. That is, given substantial liberalization in North-South trade and falling frictional costs of trade, the substantial differences in relative commodity and factor prices between North and South might cause us to expect large effects. However, as a number of students of this topic have pointed out, the volume of North-South trade is quite small, with the, somewhat controversial, implication that the leverage for Stolper-Samuelson effects is also small.

We depart from the bulk of this literature. As with current empirical research on trade patterns, which has examined the implications of imperfect competition models, we provide an exploratory empirical analysis of a relatively simple monopolistic competition model of the link between trade and labor markets. Given the ease with which the HOS model yields an estimating framework, it is not surprising that the empirical literature on trade and wages has derived primarily from competitive models of the HOS family. By contrast, imperfectly competitive models come in a variety of forms, most of which do not yield as readily to empirical representation as do the competitive models. In this paper, we first present a simple theoretical model of globalization between similar countries to motivate the empirical work that follows. Specifically, we examine the linkages between trade volumes and relative wages in a specialization model along the lines of Ethier (1982). The core of the empirical analysis involves bivariate time-series analysis. There we find some evidence of a relationship between growth in intermediate goods and the skill premium, though perhaps not the evidence expected. Our results point to a link between globalization and wages, but one that benefits unskilled workers. Specifically, we find that, in all cases, increased trade volumes are associated with *lower skilled wages* and *higher unskilled wages*. That is, increased trade would seem to *reduce* wage inequality. It is important to note that, since all the variables in the system are assumed to be jointly endogenous, the coefficients in the cointegrating vector cannot really be interpreted in the same way as the coefficients in a structural equation. Nonetheless, the consistent sign pattern across the systems estimated strikes us as suggestive and warranting additional work.

I. Introduction

The growth in research on the link between trade and wages seems to be abating, and the collective prior among economists on the empirical magnitude of that link seems to have stabilized around the existence of some statistically significant but practically small effect of trade on the decline in the relative wage of unskilled workers. However, the state of this body of research remains somewhat unsatisfactory. The great majority of both theoretical and empirical work addresses the link between trade and wages within the context of the Heckscher-Ohlin-Samuelson (HOS) model, generalized in a variety of straightforward ways. This tends to focus attention on North-South trade, where the Stolper-Samuelson effects would be most pronounced. That is, given substantial liberalization in North-South trade and falling frictional costs of trade, the substantial differences in relative commodity and factor prices between North and South might cause us to expect large effects. However, as a number of students of this topic have pointed out, the volume of North-South trade is quite small, with the, somewhat controversial, implication that the leverage for Stolper-Samuelson effects is also small.

In this paper we make a significant departure from the bulk of this literature. As with current empirical research on trade patterns, which has examined the implications of imperfect competition models, we provide an exploratory empirical analysis of a relatively simple monopolistic competition model of the link between trade and labor markets.

Given the ease with which the HOS model yields an estimating framework, it is not surprising that the empirical literature on trade and wages has derived primarily from competitive models of the HOS family. By contrast, imperfectly competitive models come in a variety of forms, most of which do not yield as readily to empirical representation as do the competitive models. Nonetheless, this is not the first attempt to evaluate the links between trade and wages under conditions of imperfect competition. The closest empirical analysis to that presented here is Borjas and Ramey (1994). In that paper, the authors develop a simple theory of Nash bargaining between a firm and a union in an industry characterized by rents.[1] Assuming an empirical connection between concentration and rents, the authors hypothesize that increased competition in concentrated sectors will shrink rents, reducing returns to labor in those sectors. If unskilled workers are concentrated in sectors characterized by large rents and unions, increased competition in those sectors will cause the aggregate wage for unskilled workers to fall due to: reduction in the wage premium via a change in the bargain; shrinkage in the size of the high wage sector; and increased supply of unskilled labor to other sectors. This structure is used to motivate a discussion of a time series analysis of the long-run relationship between *net imports* of trade in durable goods and the relative wage of skilled versus unskilled workers. The main empirical result is that "the durable goods deficit as a percent of GDP has the same long-run trend as the college premium from 1963 to 1988" (Borjas and Ramey, pg. 226). The empirical work reported in this paper will also examine the long-run relationship between trade volumes and wages at the macro level, but the precise choice of variables will reflect a different theoretical framework.

One of the difficulties in interpreting the Borjas/Ramey analysis is that the framework is essentially microeconomic, while the empirical analysis is macroeconomic.[2] As a result, the theoretical link between a broad aggregate like trade volume and the economywide wage premium seems quite unclear. Feenstra and Hanson (1996) provide an alternative analysis, with a more fundamentally macroeconomic basis. In their model, falling costs of outsourcing allow firms to move the most labor-intensive part of their production process offshore, with the implication that the relative demand for unskilled labor (relative skilled labor) falls, leading to an increase in the skill premium.[3] In Feenstra and Hanson (1999) the

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[1] This is essentially the model developed in Brander and Spencer (1988). Alternative models of union preferences and of the underlying bargain, raising more-or-less the same questions as those in Borjas and Ramey, are developed in Grossman (1984); Mezzetti and Dinopoulos (1991); and Gaston and Trefler (1995).

[2] By "microeconomic" we refer to the fact that the Borjas/Ramey analysis is partial equilibrium in nature and extended to a claim about economywide effects by a number of auxiliary hypotheses of uncertain theoretical and empirical validity. A more natural empirical implementation of the underlying model would focus directly on the sectoral level, examining the relationship between trade, rents (or correlates such as concentration), union coverage, and wage premia. Interestingly, this is essentially what Gaston and Trefler (1995) do, and their results are broadly supportive of models in which international competition suppresses rents that support payment of wage premia.

[3] Feenstra and Hanson (1996) are primarily interested in accounting for the fact of a rising skill premium in both North and South, so their model is simplified in ways that stress this phenomenon. In

authors use cross-sectional methodology to examine the relationship between the wage premium and outsourcing (proxied by measures of intermediate import volumes). Among other important results, Feenstra and Hanson find that outsourcing has a sizable effect on relative wages. The empirical work reported in this paper will emphasize trade in intermediate goods, though we will focus on a more highly aggregated treatment of the economy in a time series framework.

A final body of work closely related to that in this paper attempts to analyze the trade-wage relationship in a monopolistic competition/division of labor framework. Building on the fundamental work of Ethier (1982) and Markusen (1990), Markusen and Venables (1997, 1999) develop a two-sector, two-factor model characterized by one conventional (i.e. constant returns to scale) sector and one sector characterized by monopolistic competition and division of labor induced external scale economies.[4] As with the Feenstra/Hanson analysis, Markusen and Venables are interested in North-South issues, so their two-country model involves endowment differences as well as the division of labor structure. Within this framework, the authors show that effects of a reduction in barriers to multinationalization have ambiguous effects on the wage premium. Using a similar production structure, Lovely and Nelson (2000) examine trade between similar countries and wages, Francois and Nelson (2001) analyze trade and foreign direct investment between similar countries, and its effect on the wage premium, and the recent book by Dluhosch (2000) and the paper by Burda and Dluhosch (2002) emphasize outsourcing and relative wages. Models of this last sort suggest a connection between the volume of trade in intermediate goods and relative wages. Thus, where Borjas/Ramey analyze net trade in intermediate goods and Feenstra/Hanson analyze imports of intermediate goods, we will be analyzing total trade in intermediate goods.

The next section presents a simple theoretical model of globalization between similar countries to motivate the empirical work that follows. As with Borjas/Ramey,

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particular, they develop a one-sector economy with a continuum of inputs, and two countries. Feenstra and Hanson (1997) focus on the Mexican case, finding that FDI is positively associated with the skill premium there. It should be noted that similar implications can emerge in models of outsourcing based on more conventional trade models. See, for example, Jones and Kierzkowski (2001), Deardorff (2001), and Kohler (2001).

[4] See Francois and Nelson (2002) for an expository development of this class of model.

the core of the analysis involves bivariate time-series analysis. There we find some evidence of a relationship between growth in intermediate goods and the skill premium, though perhaps not the evidence expected. Our results point to a link between globalization and wages, but one that benefits unskilled workers. The final section of the paper concludes.

II. A Geometry of Relevant Mechanics

In this section we examine the linkages between relative wages and specialization models along the lines of Ethier (1982). To keep the exposition relatively brief and (hopefully somewhat) clear, we rely on graphical mechanics here. The full algebraic development of these graphical tools can be found in Francois and Nelson (2002). Our starting point is returns related to the international division of labour.

While the notion that the division of labour has both micro and macroeconomic foundations goes back at least to Adam Smith, and most clearly to Allyn Young, it lived a sort of shadowy existence until the development of a number of simple formalisations in the early 1980s permitted direct introduction of these ideas into the main corpus of economic theory.[5] One of the fundamental barriers to formalization lay in the difficulty of treating the macroeconomic aspect of division of labour seriously in a tractable framework. The macroeconomic aspect of the analysis rests on the recognition that an increasing division of labour involves a fundamental transformation of the technology (increasing "roundaboutness") at the level of the economy as a whole. In addition, there is the effect, beautifully summarized by Marshall (1890) in terms of "... the part which nature plays in production shows a tendency to diminishing return, the part which man plays shows a tendency to increasing return". That is, as we are now well aware, any serious treatment of the macroeconomic aspects of the division of labour leads fairly directly to increasing returns and, thus, to nonconvexities in the feasible set.

[5] Buchanan and Yoon (1994) collect a number of key papers from both the shadowy early period (including the relevant passage from Smith, and Young's classic essay) and the current emergence as a core element of both micro and macroeconomic research. Krugman's (1995) Ohlin Lectures are a fascinating presentation of the relationship between ideas and models in this area.

The key step in formalizing these essential notions was Wilfred Ethier's (1982) insight that the Spence-Dixit-Stiglitz model of monopolistic competition could be reinterpreted as a model of the division of labour. In addition to a perfectly competitive, constant returns to scale sector, the Ethier model has a sector which uses specialized inputs to produce a final consumption good. Allyn Young-like roundaboutness is represented by the fact that productivity in this sector is increasing in the variety of such inputs. On the other hand, the division of labour among producers of specialized inputs is limited by increasing returns and fixed resources.[6] As was clear from the start of this literature, this model was characterized by macroeconomic increasing returns as well as the microeconomic increasing returns at the level of specialized inputs.[7]

We assume an economy that is endowed with skilled (*S*) and unskilled (*L*) labour, which are used to produce two final consumption goods: differentiated manufactures (*M*); and a standardized good, wheat (*W*). Good *W* is produced from *S* and *L* according to a standard neoclassical production function:[8]

$$W = f\left(L, S\right),\ f_L, f_S > 0,\ f_{LL}, f_{SS} < 0. \tag{1}$$

Since good *W* is completely standard, we focus on developing the production of *M*, which is characterized by increasing returns due to specialization from intermediate goods, along the lines of Ethier (1982) and Francois and Nelson (2002). Together with equation (1), the production side of Ethier-type general equilibrium models can be represented in reduced form as:

$$m = g\left(L, S\right),\ g_L, g_S > 0, \tag{2}$$

[6]This aspect of the model was also essential to the model of Spence (1976) and Dixit-Stiglitz (1977). In the SDS model these are final consumption goods, while in the Ethier model they are producer goods.

[7]In addition to Ethier's original analysis, see Markusen (1990) and Francois and Nelson (2002) for treatments that stress the division of labour/macroeconomic increasing returns aspects of the Ethier model. This property of the Ethier model also led to its adoption as the theoretical basis of one of the fundamental models of endogenous growth (e.g. Romer, 1987).

[8]That is, $X = g(S,L)$, where $g(\cdot)$ is linear homogeneous, twice differentiable, and strictly concave.

$$m = d(W), \quad f = d_W < 0, d_{WW} < 0, \tag{3}$$

$$M = h(m) = \theta \cdot m, \quad \frac{\partial \theta}{\partial m} > 0, \ \frac{\partial \theta}{\partial m^*} > 0, \ \frac{\partial (\partial \theta / \partial m^*)}{\partial t} < 0 \tag{4}$$

Her we have the production technology for bundles of factors used in manufacturing (*m*) and the production of wheat each being linear homogeneous (equations 1 and 2). Both factors are costlessly mobile between sectors and the markets for *S*, *L*, *W* and *m* are perfectly competitive, leading to the transformation surface defined in (3). With an appropriate choice of units, the factor bundle *m* is exactly the amount of factors used in production of an individual intermediate good *x* in the large group monopolistically competitive equilibrium (Francois and Nelson, 2002).

The critical feature of the model, marking its departure from standard neoclassical models, is the production externality in (4). Note that the efficiency effect related to the externality follows from both the size of the home manufacturing sector *m* and also the foreign manufacturing sector *m**. The importance of Home and Foreign effects will also be a function of barriers to effective market integration (trade barriers, transport costs, etc.) measured by *t*. As these barriers go down (i.e. as globalization proceeds), the contribution of Foreign manufacturing scale to the efficiency of the domestic sector rises. The underlying process for moving resources between sectors (and implicitly for assembling bundles of factors used in production) is assumed to be Heckscher-Ohlin. This implies the following:

$$\Omega = \frac{w_1}{w_2} = \Omega(m), \ \Omega_m > 0. \tag{5}$$

Relative wages, Ω, will be a function of the relative pattern of production. As we increase the production of *m* we also then boost the relative income of the factor (assumed here to be skilled labour) used intensively in the *m* sector. The basic structure of this economy is summarized in Figures 1 and 2.

Figure 1 illustrates the production processes assumed, while Figure 2 represents the production side of general equilibrium within an economy, given trading costs, trade in specialized intermediates, and an underlying Heckscher-Ohlin technology. (Both figures are developed in Francois and Nelson 2002). In Figure 2, the lower left quadrant represents the Heckscher-Ohlin transformation technology from equation (3). The upper left, from equation (4), gives a mapping from physical resources (denoted *m*) used in production of specialized intermediate manufactures *x*, leading ultimately to production of final manufactures *M*. The non-linearity in this quadrant follows from specialization economies. The solid line in this quadrant corresponds to the transformation technology in autarky, while the dotted line corresponds to the transformation technology when we have trade in intermediates. The upper right quadrant then gives us the effective, or realized product transformation (RPT) surface for the economy. Again, the solid line represents autarky, and the dotted line represents a trade equilibrium. Because we have assumed an underlying Heckscher-Ohlin technology, we can also add the fifth quadrant at the bottom. This involves the function Ω, defined in equation (5), which maps relative wages to changes in resource allocation.

Now that we have outlined the basic model, we proceed to sketch our analysis of the effect of globalisation on the relative wages of unskilled workers. To keep the analysis simple, consider the completely symmetric case. That is, countries have identical endowments, technologies, and preferences. Samuelson's angel simply divides the integrated equilibrium by allocating factors in equal quantities between the two economies. With costly trade, both economies will look qualitatively like that in Figure 2, but since the transformation surface in the upper left quadrant is determined by conditions in both countries, as we reduce trading costs, there will be an outward shift in the surface as, along the lines of Krugman's (1980) original discussion of home market effects, we observe a substitution from home to foreign varieties.

What are the implications of this shift for relative wages? As with most honest answers in economics, "it depends." Consider, in Figure 3, that with the shift in the consumption opportunities of final goods (*W*,*M*), equilibrium might shift from point e_0 to $e_{0,A}$ or to $e_{0,B}$.[9] In both cases, we have an expansion in manufacturing output, linked to global productivity gains that ultimately relate to an increased scale of global production. However, there is an underlying ambiguity as to whose wages go up, and whose go down. This is reflected in the lower, fifth quadrant. This

[9] As we note in Francois and Nelson (2002), the consumption opportunity set is no longer a pure technological relationship, but depends on trading conditions as well.

ambiguity also follows from related efficiency gains related to the global volume of FDI within this class of models (Francois and Nelson 2002; Markusen and Venables 1999). To complicate the situation further, the possibility of instability along the global transformation surface means that globalization may imply dramatic shifts in production and trade volumes, with underlying productivity gains from international specialization, but again with an underlying ambiguity as well. The class of global specialization (i.e. monopolistic competition) models does point to a link between global integration through rising trade and investment levels on the one hand, and wages on the other. However, the direction of this link is ultimately an empirical question.

III. Some Simple Empirics

As with the macroeconomic predictions of endogenous growth theory and the new geography, both of which are based on essentially the same model as that developed in the previous section, compelling empirical tests are hard to conceive. The model in the previous section suggests that globalization, however defined, implies an expanded division of labor, potentially increasing demand for one class of labor relative to another. Thus we need to examine the relationship between increased trade (indirectly measuring the increased division of labor) and the relative wage. Furthermore, because the relationship is derived in a comparative static fashion, there is a benefit from examining it in a time series framework that allows us to look at long and short run components. Before reporting our results, we first describe the data and the technique.

Our basic data on wages come from Baldwin and Cain (2000).[10] These are five measures of the average wage by a variety of skill aggregates: unskilled workers defined as less than high school education (W_{u1}); unskilled workers defined as high school education or less (W_{u2}); high school graduates (W_m); skilled workers defined as high school education or more (W_{s1}); and skilled workers defined as greater than high school education (W_{s2}). Logs of these series are shown in Graph 1. From these

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[10] These measures are derived from the annual March *Current Population Survey*, produced by the Bureau of the Census for the Bureau of Labor Statistics. Baldwin and Cain (2000) provide details of the construction of these variables.

variables, we constructed three measures of the relative wage: $RelW1 = W_{u1}/W_{s1}$; $RelW2 = W_{u2}/W_{s2}$; and $RelW3 = W_{u1}/W_{s2}$. Graph 2 shows logs of these series. The proximate spur to the boom in analysis of these series is illustrated in Graph 2, where we see all three measures of the unskilled wage relative to the skilled wage rise until about 1980, and then drop fairly dramatically.

Our theoretical discussion suggests that there is a link between an expanding global division of labor and the relative wage in which trade plays a fundamental part. The question of the appropriate variable for analysis here is a tricky one. Our wage data come entirely from the US, so there is some question as to whether we should be using US trade volumes or world trade volumes. On the one hand, US trade volumes reflect the actual relationship of the US to the world division of labor, on the other, the specification of intensity of division of labor in the model is determined by the world market as a whole.[11] We remain agnostic and consider both. In addition, it is not clear, as a practical matter, whether we should be using total trade, total manufactures trade, total intermediate goods trade, or some other measure. In the model, the increasing returns at the macroeconomic level derive from the presence of greater variety in inputs, suggesting that we should focus on industrial intermediates.[12] However, the actual variable is far from perfect and a better measure of the extensiveness of the global division of labor in the "manufacturing" sector might be all non-food, non-minerals trade, or even all trade. As with relative wages, we remain agnostic and consider several series. For intermediates we consider: intermediate trade excluding oil; and intermediate trade excluding oil and autos. For merchandise trade we consider: merchandise trade excluding food; merchandise trade excluding food and oil; and total merchandise trade. For all five of these variables we consider US trade only and world trade. All variables are analyzed in logarithmic form. Our various measures of US and world trade are illustrated in Graphs 3 (intermediate good trade) and 4 (total commodity trade).

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[11] This, in a sense is the fundamental point of Ethier's (1982) paper which, after all, is called: "National and International Returns to Scale in the Modern Theory of International Trade".

[12] Note that this is essentially what Borjas/Ramey focus on, however, where they use net trade in intermediates, the theoretical framework motivating our analysis suggests total trade in intermediate goods.

It is now well known that many macroeconomic series are, or at least appear to be, non-stationary. Thus, our first step in the analysis is to check for the stationarity of our series. Table 1 reports augmented Dickey-Fuller (ADF) tests of the series in levels and first differences. If the null of a unit root in levels is accepted and then rejected for the first difference, we will conclude that the series is *I*(1). If the null of a unit root is accepted for the first-differenced series, we test perform the test on the second-difference, and if the ADF test rejects a unit root, we conclude that the series is *I*(2). In all cases we begin with a specification including a trend and an intercept and 9 lags. We then use the Akaike information criterion to select the lag order (Lütkepohl, 1993, chapter 4). The table reports the lag length selected, the value of the test statistic, and the *P*-value calculated using MacKinnon's (1996) tables that correct for sample size. As table 1 suggests, all series are integrated, virtually all of the wage series and all of the trade series appear to be *I*(1). The relative wage series, however, are another story. The logs of *RelW1* and *RelW3* appear to be *I*(2), while *RelW2* appears to be stationary. Thus, our analysis of the long-run relationship between trade volume and relative wages will be carried out in the framework of a tri-variate vector autoregression between measures of trade volume and measures of skilled and unskilled wages.

The next step in the analysis involves testing for the presence of cointegration between the wage series and the various trade volume series. For this purpose we apply Johansen's methodology as implemented in *EViews*.[13] Suppose we have a p-dimensional vector autoregressive (VAR) process (in our case, p = 3). Then, abstracting from intercepts and trends:

$$\mathbf{x}_t = \Pi_1 \mathbf{x}_{t-1} + \ldots + \Pi_k \mathbf{x}_{t-k} + \varepsilon_t . \qquad (6)$$

Johansen (1995, chapter 4) rewrites (1) in difference ("error correction") form to get:

$$\Delta \mathbf{x}_t = \Pi \mathbf{x}_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta \mathbf{x}_{t-i} + \varepsilon_t , \qquad (7)$$

where

[13] We have checked our results in both TSP and PC-Give.

$$\Pi = \sum_{i=1}^{k} \Pi_i - \mathbf{I}, \tag{8}$$

and

$$\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j. \tag{9}$$

Johansen then shows that the hypothesis of cointegration is the hypothesis that the matrix Π has reduced rank, i.e. $\Pi < p$.[14] If the rank of $\Pi = p$ (i.e. Π has full rank), then the vector process $\mathbf{x}_t$ is stationary (i.e. there are no integrated variables); if the rank of $\Pi = 0$, there is no cointegrating relationship and (2) corresponds to a traditional time series model in differences; if the rank of Π (call it r) is between 0 and p, then there are r cointegrating relationships among the variables in $\mathbf{x}_t$.[15] Johansen's method applies a maximum likelihood procedure that provides estimates of the number of cointegrating relations and of the cointegrating vectors themselves (Johansen, 1995, Part II).

We follow the recommendation of Franses (2001) and estimate all systems with an intercept and a linear trend, focusing our selection efforts on the lag structure. In the cases of all systems involving the US volume variables, the systems with optimally chosen lags identified 3 cointegrating relations, implying that the rank of $\Pi = 3$, so we do not report those analyses and we do not discuss those systems further. In tables 2-11 we report the analysis for systems involving two wage variables and one trade volume variable. The results in Tables 2-6 are for systems in which the wage variables are the two extreme values (W_{u1} and W_{s2}) with each of the international trade volume variables in turn. The results in Tables 7-11 correspond to systems 7-11 involve W_1 and W_{s1}, in principle covering the entire labor force. The

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[14] In this case, by Granger's representation theorem (Johansen, 1995, theorem 4.2) $\Pi = \alpha\beta'$, where α and β are $p \times r$ matrices, β is the cointegrating vectors, and α the adjustment coefficients. In the case of our analysis, since all the components of $\mathbf{x}_t$ are taken to be $I(1)$, if the p (= 3) components of $\mathbf{x}_t$ are cointegrated then $\beta'\mathbf{x}_t$ should be an $I(0)$ process.

[15] Another way of saying this is that if Π is of full rank, then any linear combination of the $\mathbf{x}_t$ will be stationary; if it is a zero matrix, then any linear combination of the $\mathbf{x}_t$ will be a unit root process; and if $0< r < p$, then there are r linearly independent and stationary linear combinations of the $\mathbf{x}_t$. As Dickey, Jansen, and Thornton (1991), among others, point out, this implies that tests of cointegration like that used here are multivariate analogues of the Dickey-Fuller test.

results in all cases are very similar. In all cases, the Johansen method identifies two co-integrating relations and when we normalize the estimated vectors to identify the relationship between volumes and wages we find the very interesting result that, in all cases, increased trade volumes are associated with *lower skilled wages* and *higher unskilled wages*. That is, increased trade would seem to *reduce* wage inequality. It is important to note that, since all the variables in the system are assumed to be jointly endogenous, the coefficients in the cointegrating vector cannot really be interpreted in the same way as the coefficients in a structural equation. Nonetheless, the consistent sign pattern across the systems estimated strikes us as suggestive and warranting additional work.

IV. Summary and Directions for Future Work

In this paper we have argued that, in the literature on trade and labor markets, more attention needs to be given to North-North trade, which is considerably larger in magnitude than the North-South trade that implicitly motivates much of the existing research. In this context, we follow an expanding body of scholarship in research on directions of trade in suggesting that, if North-North trade is relevant, frameworks alternative to the HOS model and its extensions are potentially useful. Thus, in section I we develop one such model, which has the implication that trade volumes are a potentially important explanatory variable when attempting to understand the link between globalization and wages. Section II presents some preliminary empirical results on this question. While emphasizing the preliminary nature of those results, we find it interesting that there is evidence of a negative relationship between trade based on division of labor and the skill premium.

While there is certainly room for additional work on the theoretical model presented in this paper, the primary need is for more detailed and more careful empirical work. It turns out that the dimensionality of Π in our analysis is quite sensitive to the lag chosen. This suggests that, especially given the relatively short time period (about 30 years), there may be a problem with specification. In particular, we may have omitted an important variable from the system. We hope to pursue this question in future research.

Figure 1

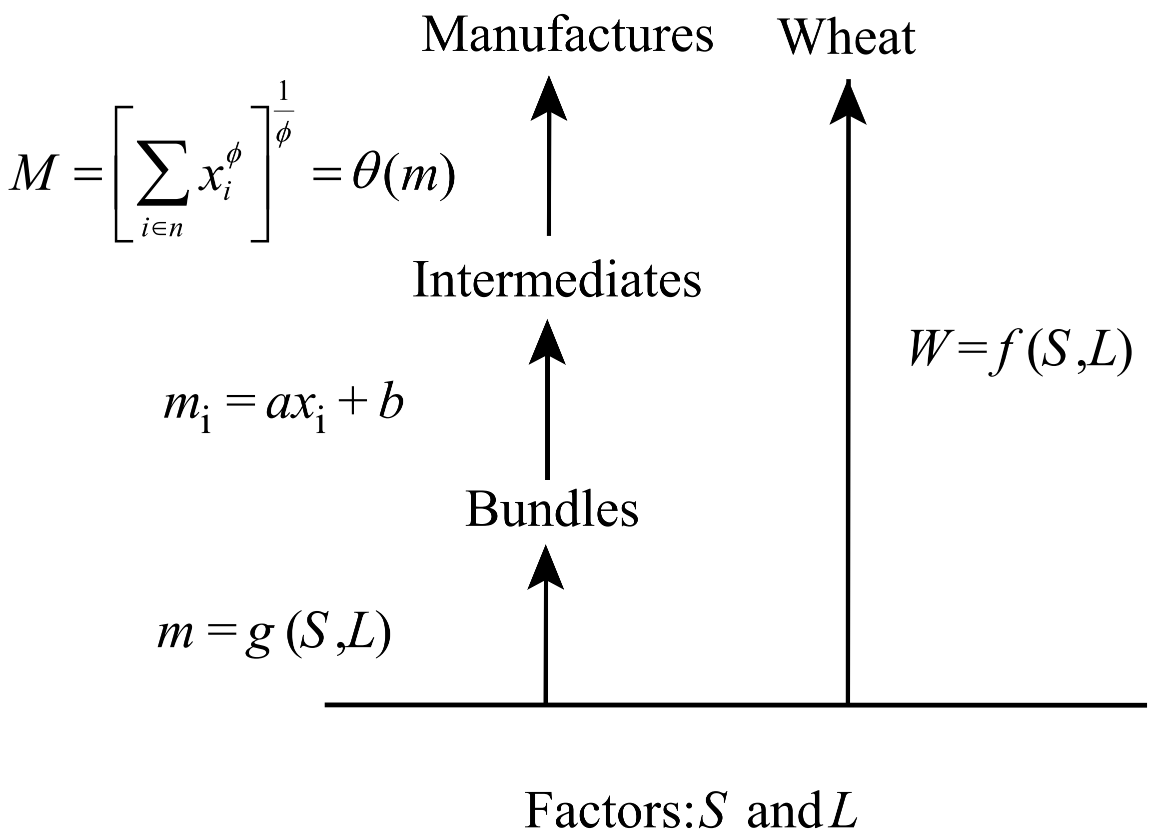
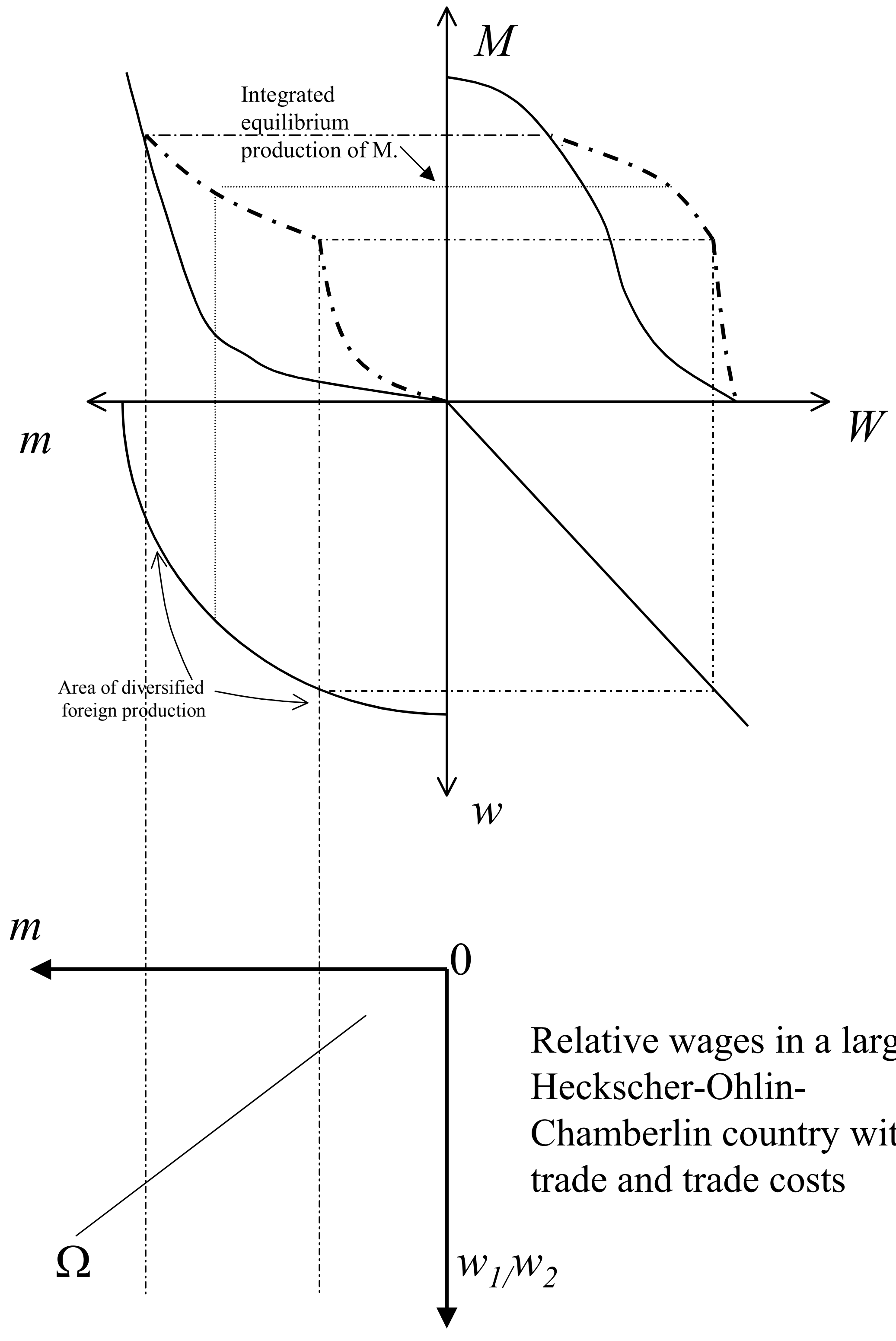
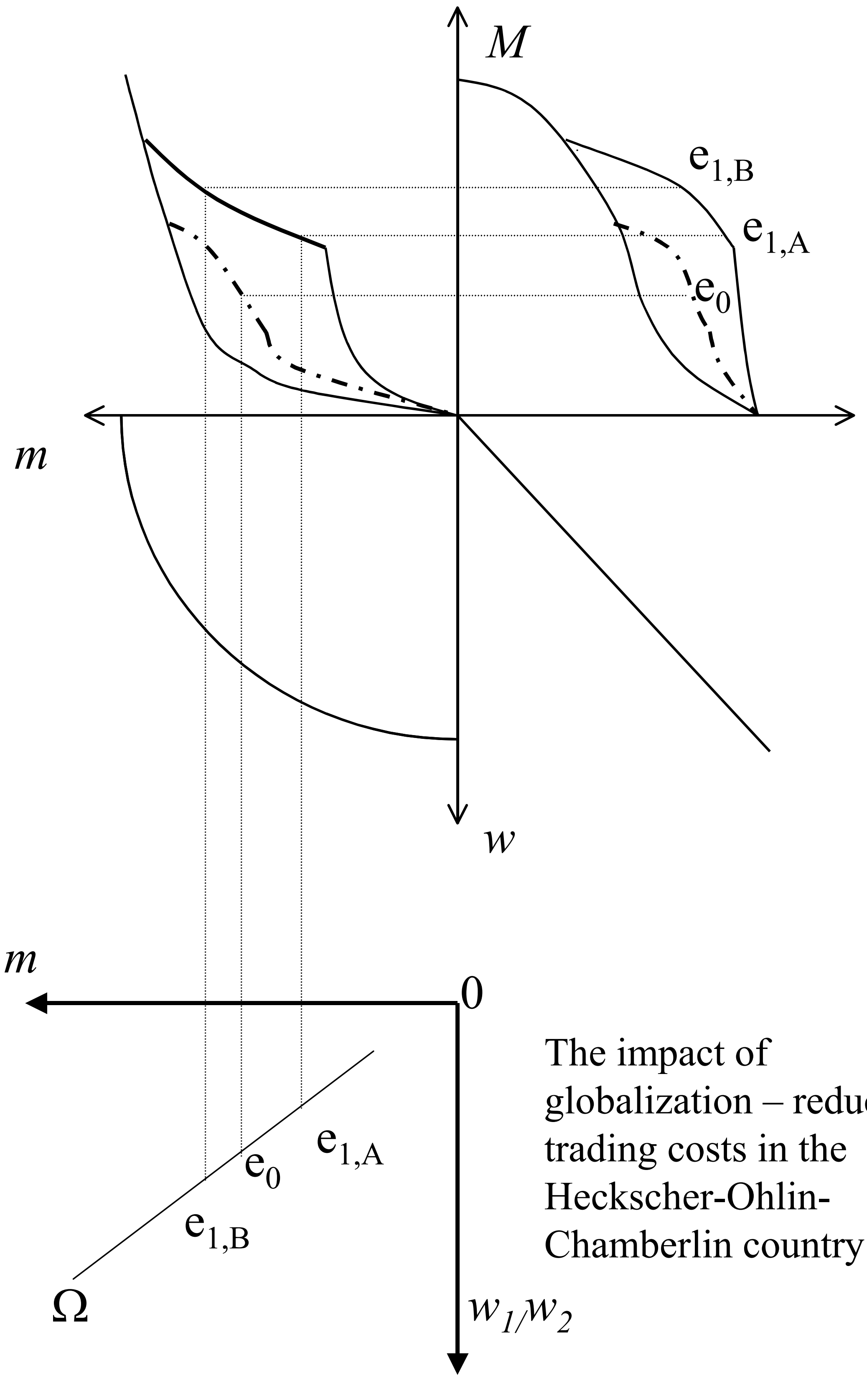

Manufactures
Wheat
$M = \left[\sum_{i \in n} x_i^{\phi} \right]^{\frac{1}{\phi}} = \theta(m)$
Intermediates
$W = f(S, L)$
$m_i = ax_i + b$
Bundles
$m = g(S, L)$
Factors: S and L

Figure 2

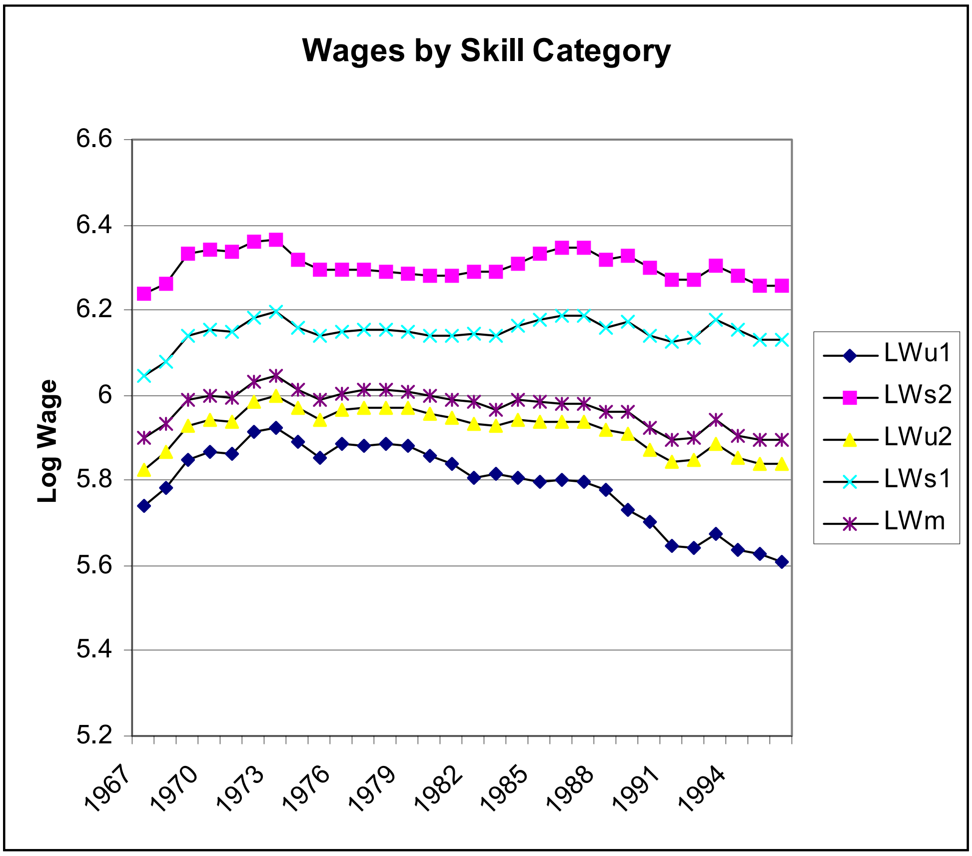


Relative wages in a large Heckscher-Ohlin-Chamberlin country with trade and trade costs

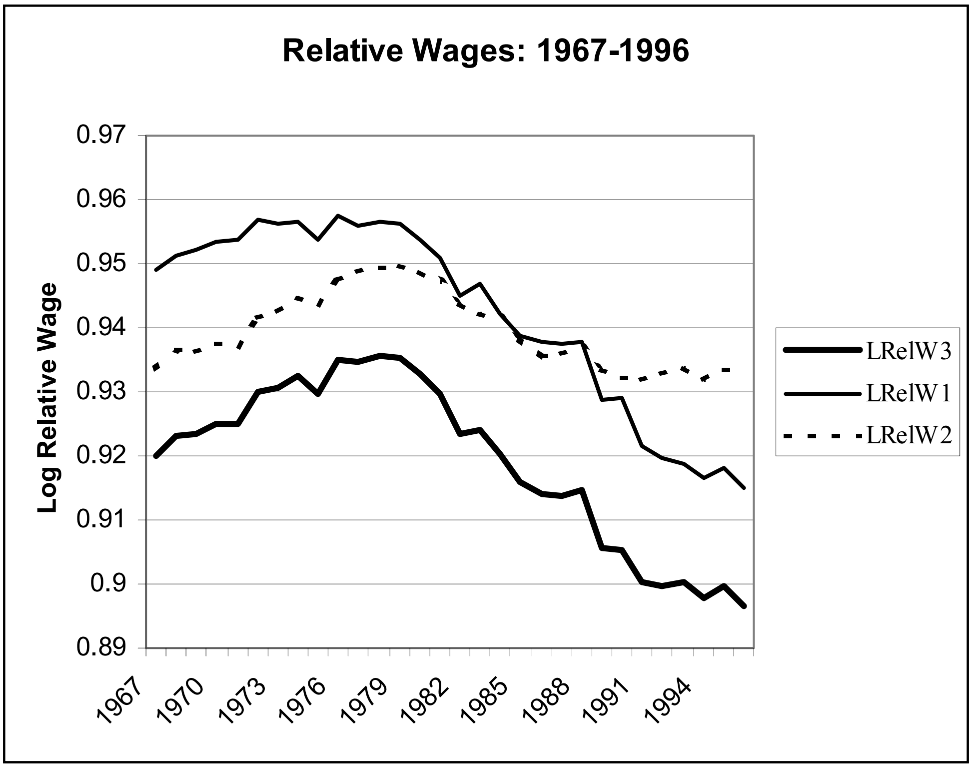
Figure 3



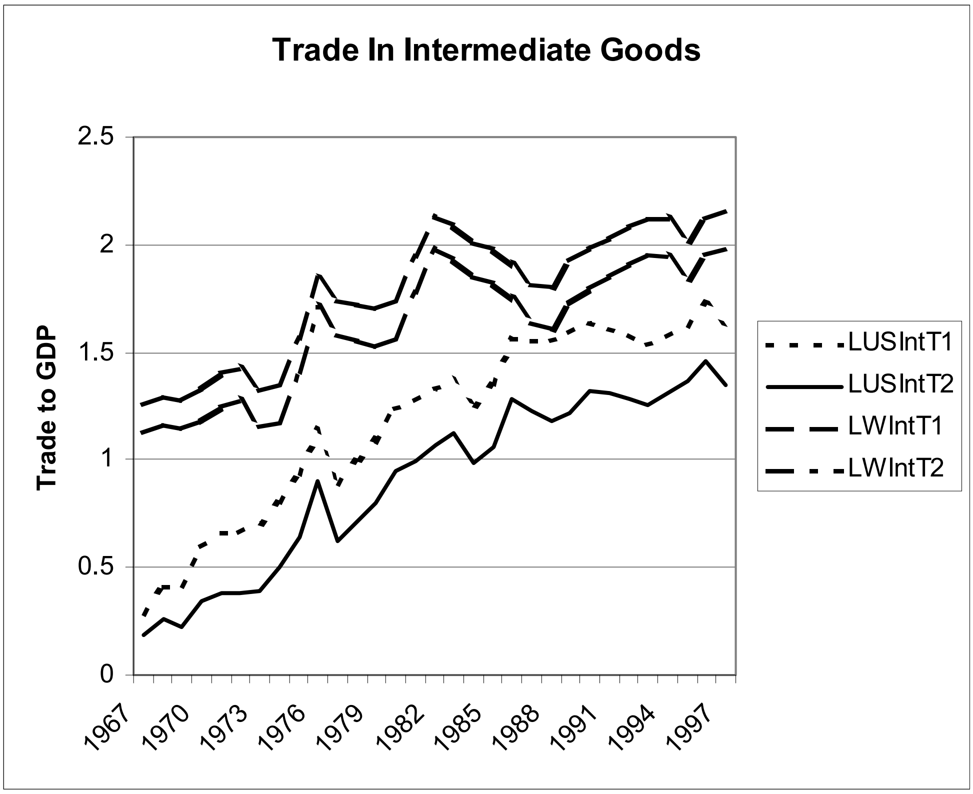
The impact of globalization – reducing trading costs in the Heckscher-Ohlin-Chamberlin country



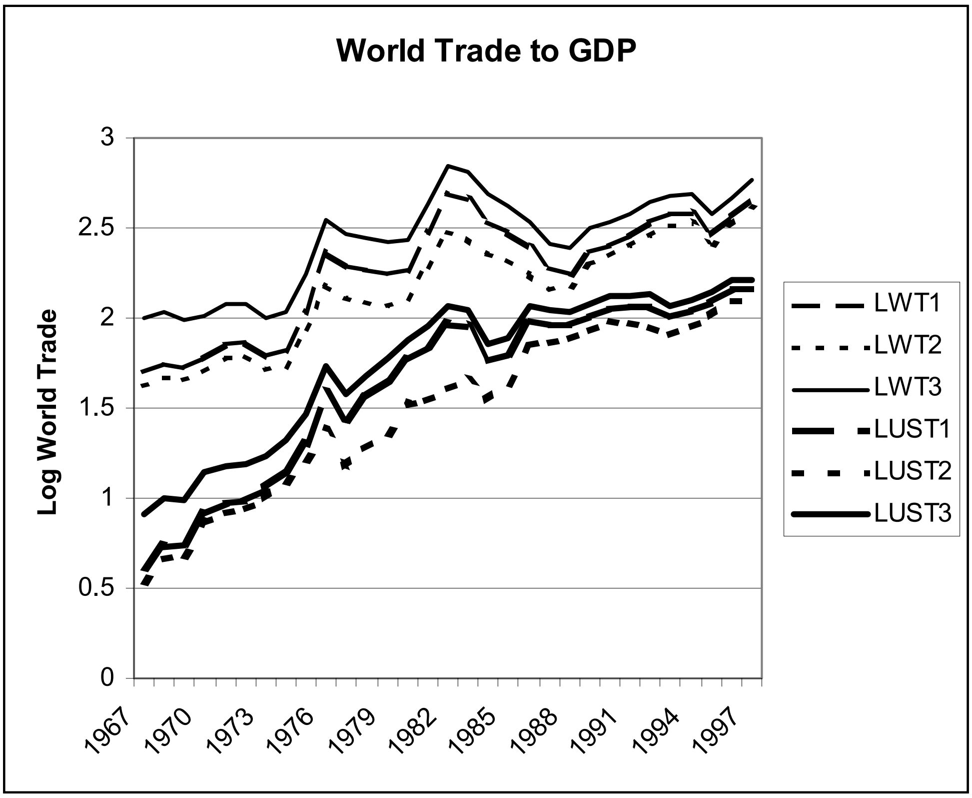
Graph 1



Graph 2



Graph3



Graph 4

Table 1: Unit Root Tests

	Levels			First-differences			Second differences		
	n-lags	τ	P-value[*]	n-lags	τ	P-value*	n-lags	τ	P-value*
LWu1	2	-2.65612	0.26079	2	-2.82804	0.06816			
LWu2	3	-2.82460	0.20163	3	-2.42894	0.14439	3	-2.98530	0.00453
LWm	2	-3.07627	0.13175	2	-3.28274	0.02633			
LWs1	2	-2.77848	0.21642	2	-3.29920	0.0254			
LWs2	5	-1.79216	0.67807	2	-2.69009	0.08923			
LRelW1	3	-2.36574	0.38631	2	-2.08257	0.25277	5	-3.09276	0.00361
LRelW2	5	-3.63328	0.04798						
LRelW3	2	-2.30494	0.41738	3	-1.56898	0.48307	2	-4.50528	0.0001
LUSIntT1	2	-1.45765	0.81707	2	-4.20487	0.00342			
LUSIntT2	2	-1.39285	0.83978	4	-2.64705	0.09789			
LUST1	2	-1.34575	0.85186	2	-3.23514	0.03019			
LUST2	2	-1.97791	0.58456	2	-4.25412	0.00305			
LUST3	2	-1.32590	0.85740	2	-3.48036	0.01777			
LWIntT1	3	-1.70141	0.72040	3	-3.15573	0.03568			
LWIntT2	3	-1.81823	0.66540	3	-3.21543	0.03148			
LWT1	3	-1.70898	0.71698	3	-3.0377	0.04555			
LWT2	3	-1.94053	0.60385	3	-3.19521	0.03285			
LWT3	3	-1.79725	0.67561	3	-3.03491	0.04581			

[*] The P-values are calculated from MacKinnon's (1996) response surface program.

Table 2A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990259	160.1775	42.44	48.45
At most 1 **	0.814052	49.02451	25.32	30.45
At most 2	0.302602	8.649565	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990259	111.1530	25.54	30.34
At most 1 **	0.814052	40.37494	18.96	23.65
At most 2	0.302602	8.649565	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Table 2 B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS2	LWU1	LWINTT1	@TREND(68)
1.000000	0.000000	0.038385	0.003040
		(0.02079)	(0.00052)
0.000000	1.000000	-0.222767	0.023434
		(0.04512)	(0.00113)

Table 3A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.992275	165.7942	42.44	48.45
At most 1 **	0.814332	49.07665	25.32	30.45
At most 2	0.303068	8.665605	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.992275	116.7175	25.54	30.34
At most 1 **	0.814332	40.41104	18.96	23.65
At most 2	0.303068	8.665605	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Table 3B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS2	LWU1	LWINTT2	@TREND(68)
1.000000	0.000000	0.022584	0.003158
		(0.02200)	(0.00054)
0.000000	1.000000	-0.224710	0.023254
		(0.03764)	(0.00092)

Table 4A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990885	158.5036	42.44	48.45
At most 1 **	0.779477	45.75461	25.32	30.45
At most 2	0.326109	9.472485	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990885	112.7490	25.54	30.34
At most 1 **	0.779477	36.28212	18.96	23.65
At most 2	0.326109	9.472485	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Table 4B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS2	LWU1	LWT1	@TREND(68)
1.000000	0.000000	0.032790	0.003108
	(0.01213)	(0.00035)	
0.000000	1.000000	-0.177492	0.020477
	(0.02362)	(0.00067)	

Table 5A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.989340	159.4215	42.44	48.45
At most 1 **	0.817266	50.43153	25.32	30.45
At most 2	0.330744	9.638111	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.989340	108.9900	25.54	30.34
At most 1 **	0.817266	40.79342	18.96	23.65
At most 2	0.330744	9.638111	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Table 5B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS2	LWU1	LWT2	@TREND(68)
1.000000	0.000000	0.069837	0.002117
	(0.01594)	(0.00042)	
0.000000	1.000000	-0.191222	0.022839
	(0.04912)	(0.00129)	

Table 6A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990565	158.4702	42.44	48.45
At most 1 **	0.792155	46.55141	25.32	30.45
At most 2	0.308353	8.848316	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.990565	111.9188	25.54	30.34
At most 1 **	0.792155	37.70310	18.96	23.65
At most 2	0.308353	8.848316	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Table 6b: Normalized cointegrating coefficients (std.err. in parentheses)

LWS2	LWU1	LWT3	@TREND(68)
1.000000	0.000000	0.024410	0.003432
	(0.01273)	(0.00034)	
0.000000	1.000000	-0.199643	0.020327
	(0.02343)	(0.00063)	

7A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999202	211.6449	42.44	48.45
At most 1 **	0.744256	40.43904	25.32	30.45
At most 2	0.274852	7.713123	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999202	171.2059	25.54	30.34
At most 1 **	0.744256	32.72592	18.96	23.65
At most 2	0.274852	7.713123	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

7B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS1	LWU1	LWINTT1	@TREND(68)
1.000000	0.000000	0.037713	0.002297
		(0.00400)	(0.00012)
0.000000	1.000000	-0.115240	0.022416
		(0.03501)	(0.00109)

8A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999747	241.3093	42.44	48.45
At most 1 **	0.761399	42.53393	25.32	30.45
At most 2	0.287720	8.142821	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999747	198.7754	25.54	30.34
At most 1 **	0.761399	34.39111	18.96	23.65
At most 2	0.287720	8.142821	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

8B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS1	LWU1	LWINTT2	@TREND(68)
1.000000	0.000000	0.025492	0.002277
		(0.00678)	(0.00022)
0.000000	1.000000	-0.106715	0.022495
		(0.03149)	(0.00101)

9A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.998073	189.9045	42.44	48.45
At most 1 **	0.721242	39.86463	25.32	30.45
At most 2	0.318606	9.206756	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.998073	150.0399	25.54	30.34
At most 1 **	0.721242	30.65788	18.96	23.65
At most 2	0.318606	9.206756	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

9B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS1	LWU1	LWT1	@TREND(68)
1.000000	0.000000	0.025713	0.002272
	(0.00295)	(0.00013)	
0.000000	1.000000	-0.107367	0.019674
	(0.01816)	(0.00079)	

10A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999961	283.2799	42.44	48.45
At most 1 **	0.738422	39.44352	25.32	30.45
At most 2	0.260999	7.258929	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.999961	243.8364	25.54	30.34
At most 1 **	0.738422	32.18459	18.96	23.65
At most 2	0.260999	7.258929	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

10B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS1	LWU1	LWT2	@TREND(68)
1.000000	0.000000	0.057122	0.001722
	(0.00100)	(2.9E-05)	
0.000000	1.000000	-0.108600	0.021675
	(0.04031)	(0.00115)	

11A: Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.996321	174.4325	42.44	48.45
At most 1 **	0.717681	39.90927	25.32	30.45
At most 2	0.328452	9.556085	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.996321	134.5232	25.54	30.34
At most 1 **	0.717681	30.35318	18.96	23.65
At most 2	0.328452	9.556085	12.25	16.26

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 2 cointegrating equation(s) at both 5% and 1% levels

11B: Normalized cointegrating coefficients (std.err. in parentheses)

LWS1	LWU1	LWT3	@TREND(68)
1.000000	0.000000	0.024610	0.002500
	(0.00354)	(0.00015)	
0.000000	1.000000	-0.111723	0.019763
	(0.01986)	(0.00085)	

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