2014

A Factor Endowment Explanation for China's Emergence as an International Trading Power: Calibrating the Dornbusch-Fischer-Samuelson Model for China's Trade, 1968-2008

Roger White
Whittier College, rwhite1@whittier.edu

In: Current Issues in International Trade
Editor: Gouranga G. Das
ISBN: 978-1-63321-405-7

Chapter 7

A FACTOR ENDOWMENT EXPLANATION FOR CHINA'S EMERGENCE AS AN INTERNATIONAL TRADING POWER: CALIBRATING THE DORNBUSCH-FISCHER-SAMUELSON MODEL FOR CHINA'S TRADE, 1968-2008

Roger White*
Whittier College, CA, US

ABSTRACT

Much has been made of the rise of China's economy and its emergence as a global trading power. Standard trade theory holds that comparative advantage is the basis for mutually beneficial exchange and, as such, it is the basis for international trade. In this chapter, we examine changes in labor supplies, capital stocks, and technology as possible explanations for the rise of China as an international trading power. Calibration of the Dornbusch-Fisher-Samuelson model suggests that China has gained comparative advantage relative to the US and to the cohort of high income countries considered in this study. Even though US production has increased since 1968 at both the extensive margin and at the intensive margin, China's emergence as a trading power may have adversely affected US labor. To discern the extent of labor market effects that may be attributable to increased trade, and particularly the effects of increased trade with China, we conduct a regression analysis using data for the years 1972-2007 to explore trade-induced changes in industry-level employment and average wages for both production workers and non-production workers in the US manufacturing sector. Among other findings, greater import penetration from China has negatively affected employment of both production workers and non-production workers, and increased exports to China have had a limited positive effect on the average wages of non-production workers.

Keywords: China, Comparative advantage, Exports, Imports, Manufacturing

* Whittier College, Department of Economics. 13406 E. Philadelphia Street, Whittier, CA 90608 USA. Email: rwhite1@whittier.edu.

INTRODUCTION

In December 1978, China embarked on a series of transformative economic reforms that emphasized the adoption of capitalist market principles. The reforms and associated open-door policies led China's economy to become integrated into the global economy by way of increased international trade and investment flows. China's trade volume (i.e., the sum of its exports and imports) ranked 29th in the world in 1978 at $64.5 billion; however, by 2011, its trade volume had increased, in real terms, to $2.72 trillion, second only to the United States as the world's top trading country [18]. Thus, during this period, China's trade volume increased at an average annual rate of 12 percent. This growth in trade volume coincided with a period during which China's real Gross Domestic Product (GDP) grew at a robust average annual rate of nearly 10 percent.

The importance of trade as a determinant of economic growth is established in Frankel and Romer [7]. Rather than focusing on the relationship between China's increased trade volume and its economic growth, in this chapter we explore changes in relative factor endowments (i.e., capital, labor, and technology) as the underlying basis for China's emergence as an international trading power. Specifically, we apply data for China and 97 countries for which complete data are available during the period from 1960 through 2008 to the Dornbusch-Fisher-Samuelson (DFS) model of comparative advantage [2]. We calibrate the DFS model to consider changes in China's factor endowments relative to i) the full cohort of 97 trading partners, ii) the United States, and iii-vii) cohorts of trading partners that are categorized by World Bank income classifications (i.e., high, middle, upper middle, lower middle, and low income countries). The calibration exercises provide insights/expectations regarding shifts in China's comparative advantage.

The DFS model extends the factor endowments approach to comparative advantage determination introduced by Ricardo [16] and extended by Heckscher [9] and Ohlin [15]. Emphasizing the contribution of Dornbusch, Fisher and Samuelson, Krugman [13] described the model as "160 years of international economics in one paper." Heuristically, the model permits consideration of the impacts of changes in relative labor supplies, advances in technology, and changes in capital stocks, either in isolation or collectively, on comparative advantage. We rely on the most basic version of the DFS model as it is sufficient for the purpose of motivating an empirical examination of the potential influences of trade on industry-level employment and average wages in the US manufacturing sector.

Between 1968 and 2008, the rest of the world (i.e., the 97 trading partners in our dataset), realized growth in its collective labor force and capital stock and it experienced technology gains. China, however, experienced even larger increases in the size of its labor force, its capital stock, and the level of technology embodied in its output. The more rapid growth in factor endowments for China has implications for factor productivity and factor prices which, in turn, affects product prices and the range of products for which China and the rest of the world hold comparative advantage in the production of. Because changes in factor endowments have implications for production, it follows that they also affect the pattern of international trade.

David Ricardo formalized the concept of comparative advantage as the basis for mutually-beneficial exchange. All trading partners hold a comparative advantage in the production of at least one good or service (i.e., each trading partner can produce at a lower opportunity cost than another producer). In Ricardo's example, Britain ultimately produces and exports cloth to Portugal in exchange for port wine. The result is that, in aggregate, consumers in both Britain and Portugal are able to consume more cloth and more port wine than if the countries remained in isolation. Both countries benefit in a macro sense from the voluntary exchange; however, wine producers in Britain and cloth producers in Portugal, driven out of business by more efficiently-produced imports, are worse off as a result of the exchange, and cloth consumers in Britain and wine consumers in Portugal are worse off due to higher product prices. In other words, standard trade theory predicts that specialization and trade in accordance with comparative advantage will produce "winners" and "losers" on a micro level. The net benefits, however, are expected to be positive – again, in a macro sense – as the gains received by the winners exceed the losses incurred by the losers.

Our econometric analysis examines the effects of increased trade, particularly increased trade with China, on workers in the US manufacturing sector. Specifically, we examine data for 75 3-digit Census of Population Industrial Classification (CIC) industries in the US manufacturing sector during the period from 1972 through 2007 to determine the extent to which increased trade flows affect industry-level employment and average annual wages for production and non-production workers. Effectively, calibration of the DFS model allows for examination of the underlying basis for observed increases in trade, and our econometric analysis considers the potential effects of this trade on US workers.

We proceed as follows. We next introduce the DFS model and then glean predicted shifts in comparative advantage by calibrating the model. This is followed by a presentation of the findings from our econometric analysis. We end with final thoughts and conclusions.

A Dornbusch-Fisher-Samuelson Model Primer

Establishing an Initial Equilibrium

Considering all countries other than China as "foreign", and identifying these countries by "*", we begin by assuming that both China and foreign are able to produce and consume large numbers of goods. Denoting these goods with the lowercase letter '*z*', we order all *z* goods along a continuum that ranges in value from zero to one to produce an index of goods identified as Z. We next define *a(z)* and *a*(z)* as the unit labor requirements for the z^{th} good in China and foreign, respectively. Combining the unit labor requirements as $\frac{a^*(z)}{a(z)}$ results in a measure of China's productivity to foreign's productivity in terms of the z^{th} good. Using this ratio, we rank all goods along the (0, 1) continuum in descending order of China's comparative advantage. Graphically, we plot the resulting *A(z)* schedule, $A(Z) = \frac{a^*(z)}{a(z)}$, against our index of goods, *Z*, in Figure 1.

To determine which goods will be produced in China and which will be produced in foreign, we must consider the ratio of nominal wages in China to nominal wages in foreign: $\frac{w}{w^*} = \Theta$. This ratio is measured on the *y* axis in Figure 1. Because the DFS model is a longrun model, full-employment and perfect competition are assumed. Perfectly competitive markets imply that the cost of producing a given good *z* in China is *p(z) = wa(z)*. Likewise, the cost of producing the same good in foreign is *p*(z) = w*a*(z)*. The good, *z*, will be cheaper to produce in China if *wa(z) < w*a*(z)*, or, equivalently, if $\Theta < A(z)$. Thus, as noted in Figure 1, for a given *A(z)* schedule, the ratio of China-to-foreign nominal wage rates establishes the pattern of comparative advantage and, hence, the pattern of international specialization.

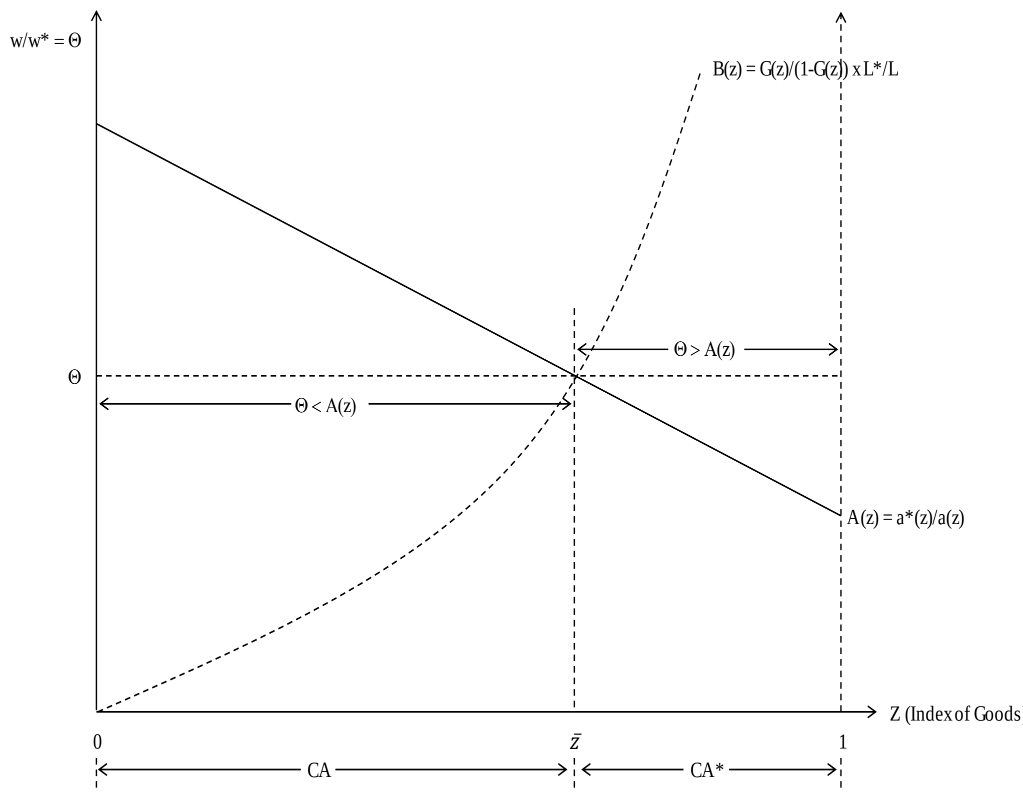


Figure 1. Initial Equilibrium in the DFS Framework.

In Figure 1, $\bar{z}$ represents the marginal good that both countries produce (i.e., the good for which $\Theta = A(z)$). All goods to the left of $\bar{z}$ along the continuum will be produced in China since $\Theta < A(z)$, and all goods to the right of $\bar{z}$ will be produced at foreign because $\Theta > A(z)$. This means that the range of the continuum for which China holds comparative advantage (CA) is given as $0 \rightarrow \bar{z}$, and the range of the continuum for which foreign holds comparative advantage in production (CA*) is given as $\bar{z} \rightarrow 1$.

To establish a value for Θ, we must add the *B(z)* schedule to Figure 1. This requires invoking a simplifying assumption that all consumers spend a constant fraction of their income on each *z* good. This restricts movement of the *B(z)* schedule to represent only changes in relative labor supplies. We define *G(z)* to be the fraction of world income spent on China-produced goods, and we assume that these expenditure shares remain constant. The total value of spending on China's production is given by the product of the nominal wage rate, *w*, and the labor supply, *L*, or the product of *G(z)* and world income. Since world income is the sum of China's income and foreign's income, we have that $wL = G(z)(wL+w^*L^*)$. Solving for $\frac{w}{w^*}$ (i.e., Θ) results in $\frac{w}{w^*} = \frac{G(z)}{1-G(z)} x \frac{L^*}{L} = \Theta$. Thus, our expression for the *B(z)* schedule, illustrated in Figure 1, is given as $B(z) = \frac{G(z)}{1-G(z)} x \frac{L^*}{L}$.

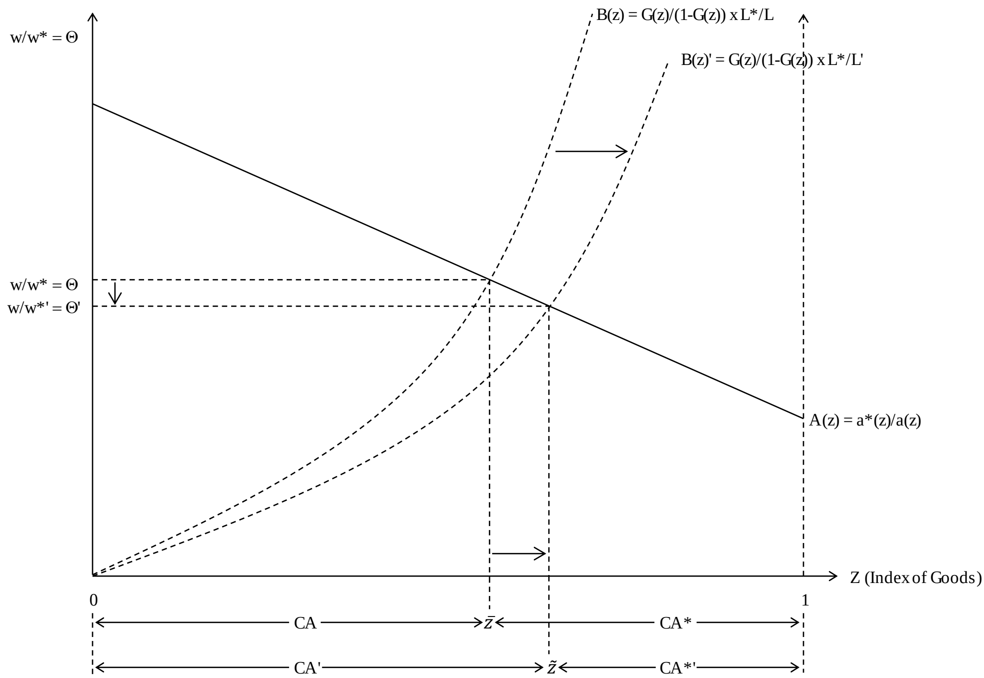
Examples of Comparative Statics Using the DFS Model

In Panel A of Figure 2, we illustrate a hypothetical increase in *L* relative to *L** which, all else equal, causes the *B(z)* schedule to pivot down. This pivot moves us to a new equilibrium where the *B(z)'* schedule intersects the *A(z)* schedule and Θ decreases to Θ'. The resulting gain in comparative advantage for China (i.e., the loss of comparative advantage by foreign) is illustrated by the movement along the *x* axis from $\bar{z}$ to $\hat{z}$. The basis for the change in comparative advantage is intuitive. To ensure full-employment, the increase in *L* relative to *L** produces a decrease in *w* relative to *w**, and as Θ decreases we see that *p(z)* decreases relative to *p*(z)*.

Similar to the example of an increase in L relative to L*, we can trace the comparative statics associated with changes in relative capital stocks (*K* and *K**) or technology levels (*T* and *T**) to determine corresponding changes in comparative advantage. Increases in *K** or *T** lower the foreign unit labor requirement (*a*(z)*). Likewise, an increase in either *K* or *T* would lower China's unit labor requirement (*a(z)*). The effects of changes in capital stocks and technology levels are analogous in terms of shifting the *A(z)* schedule and, thus, in affecting price levels (*p(z)* and/or *p*(z)*) and in the determination of comparative advantage.

Assuming that the foreign capital stock, *K**, increases relative to China's capital stock, *K*, we have that *a*(z)* decreases relative to *a(z)* and, as a result, the *A(z)* schedule shifts down to *A(z)'* and a new equilibrium is established at the intersection of the *A(z)'* schedule and the *B(z)* schedule. This is illustrated above in Panel B of Figure 2. As a result of the increased productivity of foreign labor, Θ decreases to Θ' and foreign gains comparative advantage. This is illustrated by the movement along the *x* axis from $\bar{z}$ to $\tilde{z}$. The basis for these dynamics is as follows. This increase in the productivity of foreign workers increases *w** relative to *w*; however, the proportional decrease in Θ is less than the proportional decrease in the *A(z)* schedule (as indicated by the vertical distances between Θ and Θ' and between the *A(z)* and *A(z)'* schedules). Thus, *p*(z)* falls to *p*(z)'*. Since both changes in relative capital stocks and technology levels produce analogous shifts in the *A(z)* schedule, identical comparative statics apply in the case where *T** increases relative to *T*.

Panel A: An Increase in L Relative to L*



Panel B: An Increase in K* and/or A* Relative to K and A

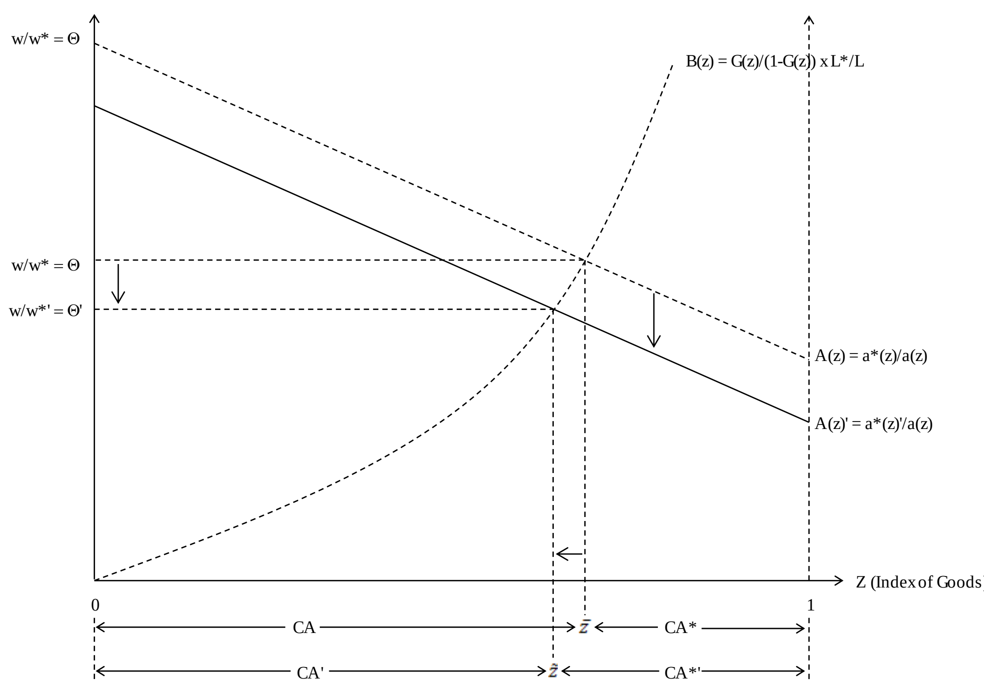


Figure 2. Examples of Comparative Statics in the DFS Framework.

Table 1. Possible DFS Outcomes

Panel A: Home gains / Foreign loses Comparative Advantage

Outcome	Δ Θ	Δ A(z)	Δ B(z)
1	+	+	No Δ
2	+	+	-
3	-	No Δ	-
4	-	+	-
5	No Δ	+	-

Panel B: Foreign gains / Home loses Comparative Advantage

Outcome	Δ Θ	Δ A(z)	Δ B(z)
6	+	No Δ	+
7	+	-	+
8	-	-	.
9	-	-	+
10	No Δ	-	+

Panel C: No change or indeterminable change in Comparative Advantage

Outcome	Δ Θ	Δ A(z)	Δ B(z)
11	+[a]	+[a]	+[a]
12	-[a]	-[a]	-[a]
13	No Δ	No Δ	No Δ

[a] The outcome, with respect to comparative advantage, is dependent on the relative magnitudes of the shifts in the A(z) and B(z) schedules.

Panel D: Outcomes that are not consistent with the DFS Model

Outcome	Δ Θ	Δ A(z)	Δ B(z)
i	+	No Δ	No Δ
ii	+	No Δ	-
iii	+	-	No Δ
iv	+	-	-
v	-	+	No Δ
vi	-	+	+
vii	-	No Δ	No Δ
viii	-	No Δ	+
ix	No Δ	+	No Δ
x	No Δ	+	+
xi	No Δ	-	-
xii	No Δ	-	No Δ
xiii	No Δ	No Δ	+
xiv	No Δ	No Δ	-

Possible Outcomes and (In)Consistencies within the DFS Framework

Given possible changes in *L*, *K* and/or *T* relative to *L**, *K** and/or *T**, there are 27 potential outcomes – in terms of combinations of shifts of the *A(z)* schedule, pivots of the *B(z)* schedule, and the value of Θ . Table 1 lists these outcomes and identifies, in Panel D, the 14 that are inconsistent with the DFS model. An example of such inconsistency is a downward shift of the *A(z)* schedule – perhaps due to technological advancements in the foreign country relative to the home country – with no corresponding pivot of the *B(z)* schedule. The DFS model predicts that such a scenario would yield a decrease in Θ . Thus, an observed outcome of no change (or an increase) in Θ , is not consistent with the DFS model.

In the next section, we present our calibration exercises involving the DFS model. We have identified the possible outcomes here since observation of an outcome(s) that is not consistent with the predictions of the DFS model would call into question the model's usefulness.

DATA/VARIABLE CONSTRUCTION AND RESULTS FROM CALIBRATING THE DFS MODEL

Variable Construction

As has been noted, we begin our analysis by calibrating the DFS model for China relative to i) all countries, ii) the US, and, separately, to those countries classified as iii) high income, iv) middle income, v) upper middle income, vi) lower middle income, and vii) low income. The categorization of countries is based on the 1990 World Bank income classifications.[1] Countries were classified by their 1990 World Bank classifications, as this year is the nearest to the middle of the reference period. Further, the classification is static in that countries are categorized throughout the reference period to reduce variation caused by a country(ies) moving between cohorts. Data from the Penn World Table 7.0 [10] are used to complete the calibration exercises. Consideration of comparative statics requires data for capital stocks, labor supplies, and technologies for both China and the respective trading partners. Further, considering that the ratio of nominal wage rates, China-to-foreign, is depicted on the vertical axis of the DFS diagram, requires a measure of relative wages.

The capital stock series was constructed following the methodology employed in Hummels and Levinsohn [11]. For all countries, the 1960 capital stock value is assumed to equal to 2.5 times the country's real GDP value. In subsequent years, the capital stock is estimated as the sum of the capital stock estimate for the prior year less 13.33 percent depreciation plus any new investment: $K_{it} = [K_{it-1} \times (1 - 0.1333)] + INVEST_{it}$. Following this methodology, given the depreciation rate, by 1968 the entire initial capital stock has depreciated and the capital stock series/estimates employed in our analysis are based solely on the timing and the levels of capital investment.

[1] Classifications are available at: http://siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls.

Labor supply values are difficult to obtain or estimate for many countries, particular for the early years in our reference period; however, when data are available, there is a strong correlation (0.98) between labor force values and population values [18]. Thus, to facilitate the inclusion of more countries in our data, we employ population values as a proxy variable for labor supplies [18].

Solow [17] residuals were estimated to quantify the levels of technology embodied in each country's output. Employing annual data over the 1968-2008 period for all 98 countries in our dataset, a two-factor (capital and labor) Cobb-Douglas production function was estimated. Due to the presence of panel-level heteroskedasticity and first-order serial correlation, the Feasible Generalized Least Squares technique was employed. The resulting coefficients were then employed in conjunction with annual estimates of labor and capital to estimate the corresponding levels of embodied technology. Specifically, $T_{it} = \left(\frac{real\ GDP}{L^{0.1364} \times K^{0.8706}} \right)_{it}$. Finally, nominal GDP per capita values are employed as a proxy for nominal wages. As such, the variable does not capture wage income solely nor does it represent variation in wages within an economy. However, GDP per capita is a measure of average income. Absent a better alternative measure, its use would seem an appropriate substitute. Table 2 presents descriptive statistics.

Table 2. Descriptive Statistics

	N countries; obs.	Labor: L	Capital: K	Technology: T	GDP per capita
All Countries (incl. China)	98; 4,018	19,579,284 (69,652,379)	539,084,289 (483,032,058)	1.6078 (2.4866)	8,881 (10,254)
All Countries (excl. China)	97; 3,977	13,677,447 (36,227,406)	532,470,729 (468,944,387)	1.5835 (2.4859)	8,954 (10,280)
China	1; 41	548,173,528*** (156,825,257)	3,534,580,073*** (4,124,567,184)	1.4119 (0.2423)	1,570*** (1,588)
USA	1; 41	119,713,264*** (22,924,971)	9,607,399,804*** (4,048,101,260)	3.2836*** (0.1698)	30,698*** (7,341)
High Income (incl. USA)	24; 984	14,240,180 (26,195,397)	551,055,017 (500,823,229)	2.7030*** (0.1371)	23,831*** (8,515)
Middle Income	40; 1,640	8,428,057*** (12,408,130)	563,061,174 (510,365,007)	1.1152*** (1.3425)	6,425*** (4,750)
Upper Middle Income	11; 451	12,441,490 (19,451,884)	691,705,364*** (612,688,060)	1.8340 (1.7510)	11,362*** (5,637)
Lower Middle Income	29; 1,189	6,905,721*** (7,787,910)	514,265,102 (456,615,708)	0.8426*** (1.0269)	4,552*** (2,516)
Low Income (excl. China)	33; 1,353	19,631,084 (55,721,884)	130,140,838*** (156,691,472)	1.2826*** (2.0454)	1,198*** (1,297)

Standard deviations in parentheses. "***" denotes statistical significance from the corresponding "All Countries (including China)" mean value at the 1% level of significance.

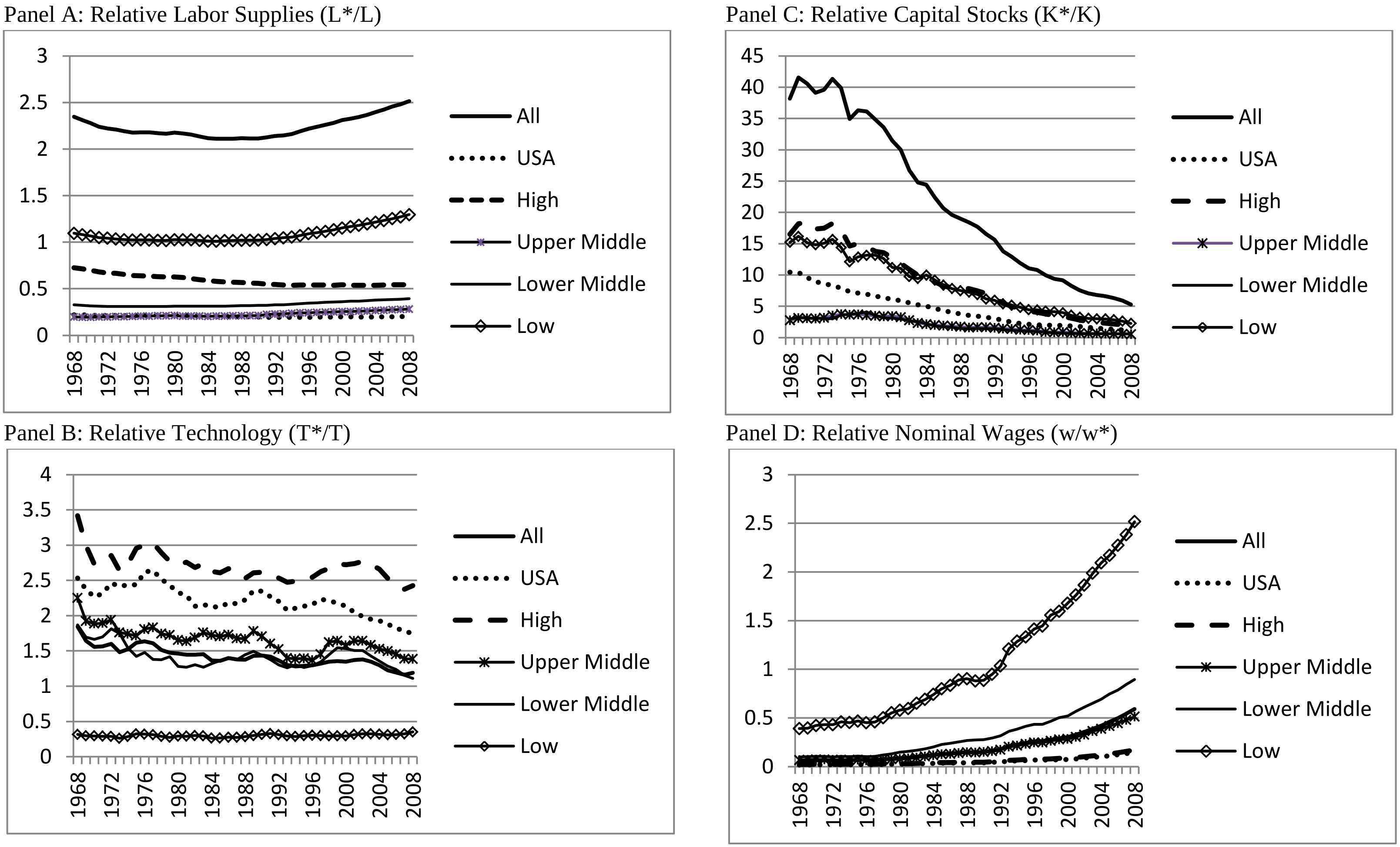


Figure 3. Relative Changes in Factor Endowments and Nominal Wages by Comparison Cohort, 1968-2008.

Calibration Results, by Cohort

Figure 3 illustrates the ratios for each of the four variables of primary interest over the reference period. The corresponding values for 1968, 1978, 1988, 1998, and 2008 are presented in Table 3. Focusing on the cohort of 97 trading partners (i.e., the cohort labeled "All"), we see that the ratio of foreign-to-China labor supplies (L^*/L) increased from 2.35 to 2.52, a 7.24 percent increase, during the reference period. Similarly, the ratio of foreign-to-China capital stocks (K^*/K) decreased 86.21 percent from 38.16 to 5.26. We also see that the ratio of foreign-to-China technology (T^*/T) decreased from 1.85 to 1.19, a decline of 35.5 percent. Finally, the China-to-foreign ratio of nominal GDP per capita (w/w^*) increased by more than 933 percent from 0.06 to 0.59.

For the considered trading partner cohorts, we categorize observed dynamics into two groups. For the US and the cohort of high income countries, the calibration exercises indicate that the shifts in factor endowments are such that China has gained comparative advantage. For all other cohorts (i.e., all trading partners, middle income countries, upper middle income countries, lower middle income countries, and low income countries), the results of the exercise are ambiguous.

We first consider the changes noted above for the "All Countires (excl. China)" cohort. These changes are illustrated in Panel A of Figure 4. These same directional changes in labor supplies, capital stocks, embodied technologies, and nominal wages are found for all trading partners/cohorts considered except for the US and the high income country cohort. The increase in L^*/L leads to an upward pivot of the *B(z)* schedule to *B(z)'*. The decreases in K^*/K and T^*/T shift the *A(z)* schedule upward since improved technology and more capital per worker would lower the unit labor requirement for China more so than for the foreign cohort. We also see that the ratio of China-to-foreign nominal GDP per capita values rises. The change in comparative advantage is ambiguous since we do not know if the upward shift in the *A(z)* schedule is somewhat minor, as represented by the move from *A(z)* to *A(z)'*, in which case China loses comparative advantage, or is larger, as is represented by the move from *A(z)* to *A(z)''*, in which case China gains comparative advantage.

Table 3. Observed Changes, 1968-2008, and Corresponding DFS Outcomes

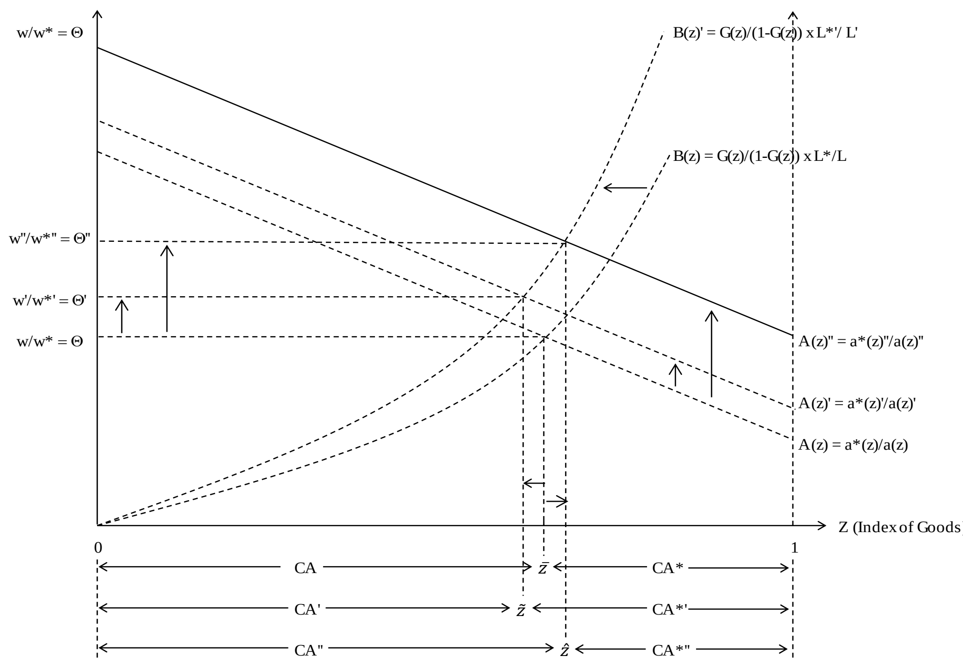
All trading partners	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	2.35	1.85	38.16	0.06
1978:	2.17	1.52	34.81	0.08
1988:	2.12	1.37	18.98	0.15
1998:	2.26	1.35	9.94	0.28
2008:	2.52	1.19	5.26	0.59
%Δ, 1968–2008:	7.24%	-35.50%	-86.21%	933.62%
Δ A(z), Δ B(z), Δ Θ:	+	+		+
DFS Outcome (from Table 1): **#11: Indeterminable change in comparative advantage.**				

US	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	0.22	2.53	10.45	0.02
1978:	0.21	2.52	6.63	0.02
1988:	0.20	2.23	3.75	0.04
1998:	0.20	2.21	1.99	0.07
2008:	0.20	1.76	1.12	0.15

Table 3. (Continued)

All trading partners	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
%Δ, 1968–2008:	-9.03%	-30.69%	-89.24%	809.44%
Δ A(z), Δ B(z), Δ Θ:	-	+		+
DFS Outcome (from Table 1): **#2: China gains comparative advantage.**				
High Income cohort	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	0.73	3.42	16.47	0.02
1978:	0.63	2.89	13.78	0.03
1988:	0.57	2.53	7.93	0.05
1998:	0.54	2.67	3.75	0.08
2008:	0.54	2.43	1.79	0.17
%Δ, 1968–2008:	-25.13%	-29.00%	-89.15%	712.97%
Δ A(z), Δ B(z), Δ Θ:	-	+		+
DFS Outcome (from Table 1): **#2: China gains comparative advantage.**				
Middle Income cohort	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	0.52	2.03	5.70	0.08
1978:	0.52	1.54	7.01	0.09
1988:	0.53	1.55	3.18	0.20
1998:	0.60	1.52	1.74	0.36
2008:	0.67	1.23	1.12	0.69
%Δ, 1968–2008:	28.90%	-39.25%	-80.39%	742.00%
Δ A(z), Δ B(z), Δ Θ:	+	+		+
DFS Outcome (from Table 1): **#11: Indeterminable change in comparative advantage.**				
Upper Middle Income cohort	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	0.20	2.25	2.74	0.07
1978:	0.21	1.74	3.46	0.07
1988:	0.21	1.67	1.72	0.15
1998:	0.25	1.62	0.91	0.26
2008:	0.28	1.39	0.54	0.51
%Δ, 1968–2008:	43.51%	-38.38%	-80.42%	666.82%
Δ A(z), Δ B(z), Δ Θ:	+	+		+
DFS Outcome (from Table 1): **#11: Indeterminable change in comparative advantage.**				
Lower Middle Income cohort	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	0.33	1.87	2.96	0.10
1978:	0.31	1.38	3.55	0.12
1988:	0.32	1.45	1.46	0.27
1998:	0.35	1.45	0.83	0.46
2008:	0.39	1.11	0.58	0.89
%Δ, 1968–2008:	20.14%	-40.53%	-80.36%	806.74%
Δ A(z), Δ B(z), Δ Θ:	+	+		+
DFS Outcome (from Table 1): **#11: Indeterminable change in comparative advantage.**				
Low Income cohort	Δ L*/L	Δ T*/T	Δ K*/K	ΔΘ
1968:	1.10	0.32	15.21	0.39
1978:	1.02	0.29	13.14	0.50
1988:	1.02	0.28	7.48	0.90
1998:	1.12	0.29	4.23	1.56
2008:	1.30	0.35	2.26	2.52
%Δ, 1968–2008:	18.35%	11.16%	-85.16%	543.80%
Δ A(z), Δ B(z), Δ Θ:	+	+/-?		+
DFS Outcome (from Table 1): **#11: Indeterminable change in comparative advantage.**				

Panel A: Ambiguous Change in China's Comparative Advantage relative to All, Upper Middle Income, Middle Income, Lower Middle Income, and Low Income Cohorts



Panel B: Gain in China's Comparative Advantage relative to the USA and High Income Cohort

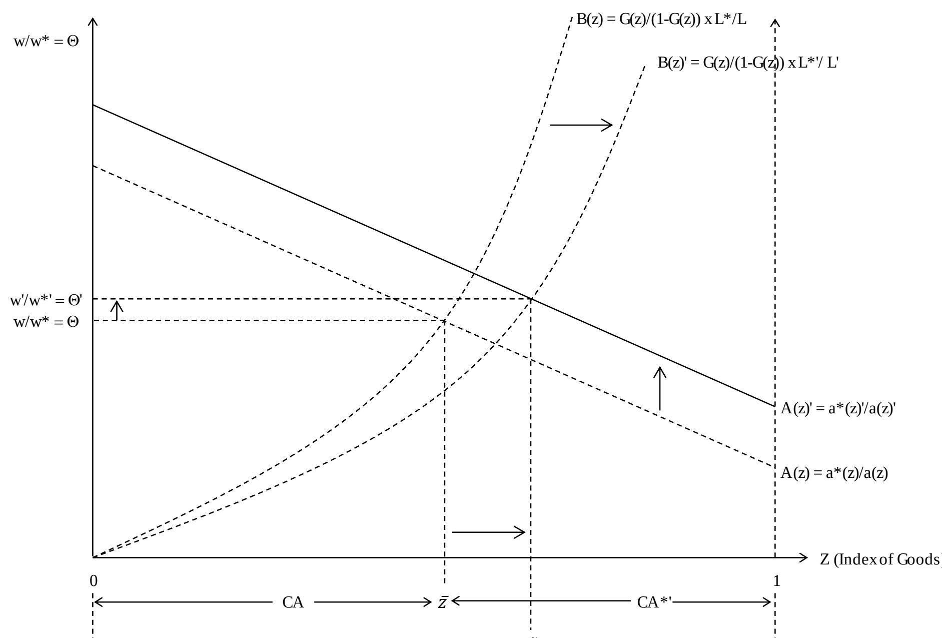


Figure 4. Predicted Change in China's Comparative Advantage, 1968-2008.

Again looking to Table 3 and focusing on the US, we see that the ratio of US-to-China labor supplies decreased over the reference period by roughly 9 percent. Thus, the *B(z)* schedule would pivot downward. The ratios of US-to-China capital stocks and technologies decreased by 89.2 percent and 30.7 percent, respectively, which would cause the *A(z)* schedule to shift up. Finally, the ratio of China-to-US nominal GDP per capita values increased by more than 809 percent. A like pattern of changes in relative factor endowments is observed when we compare China to the high income country cohort. The corresponding dynamics are illustrated in Panel B of Figure 4, showing China's gain in comparative advantage relative to the US (and to the high income country cohort) as represented by a move to the right along the horizontal axis from $\bar{z}$ to $\tilde{z}$.

As noted at the outset, the typical worker gains as a result of trade through greater purchasing power which results from the greater efficiency that is gained when production shifts following changes in factor endowments. However, it is also possible that some workers, as a result of the anticipated shifts in production, experience negative consequences (e.g., unemployment or reduced wages) due to trade. In the next section, we employ regression analysis to determine if Stolper-Samuelson effects, in the forms of lower industry employment or reduced average industry wages have been realized by US workers in response to increased trade. We analyze these effects for production and non-production workers separately, while placing particular emphasis on trade with China.

TRADE AND U.S. MANUFACTURING EMPLOYMENT AND WAGES

The Econometric Model

To produce our baseline estimation equations, we adopt a framework utilized by Mann [14], Freeman and Katz [8], and Kletzer [12]. The general-form equation is given as equation (1).

$$\Delta \ln L_{jt} = \beta_1 \Delta \ln D_{jt} + \beta_2 \Delta \ln\left(\frac{X}{S}\right)_{jt} - \beta_3 \Delta \ln\left(\frac{M}{S}\right)_{jt} + \beta_R \Delta \ln R_{jt} + \beta_V \Delta \ln V_{jt} \qquad (1)$$

An analogous equation has the change in industry-level average wages $\left(\Delta \ln W_{jt}\right)$ as the dependent variable. Δ is the difference operator, and ln denotes the natural logarithm. Equation (1) provides insight into the anticipated relationships between industry-level employment and average wages and the components of industry sales. Specifically, all else equal, employment (L) and wages (W) are expected to be positively related to increases in domestic demand (D) for domestic output. Similarly, a positive relationship is expected between increases in exports as a share of domestic shipments $\left(\frac{X}{S}\right)$ and both employment and wages. On the contrary, an increase in imports relative to domestic shipments $\left(\frac{M}{S}\right)$ is anticipated to be negatively related to wages and employment.

Modifying the general form equations to include i) a vector of time dummy variables, Ω_t, that control for unobservable variation in industry-level employment and/or average wages due to policy changes, ii) a vector of industry dummy variables, ϑ_j, that control for time-invariant industry-specific characteristics, iii) error terms, ε^1_{jt} and ε^2_{jt}, that are assumed to be independent and identically distributed, iv) a common intercept term, α_0, and v) to avoid possible multicollinearity problems when performing the regression analysis, the change in total industry-level exports (X) as a measure of foreign demand for domestic output and the change in the import penetration rate $\left(\frac{M}{D}\right)$ (i.e., imports as a share of total domestic market sales) in place of imports as a share of domestic shipments yields equations (2) and (3), which are our baseline estimation equations.

$$\Delta \ln L_{jt} = \alpha_0 + \beta_1 \Delta \ln D_{jt} + \beta_2 \Delta \ln X_{jt} - \beta_3 \Delta \ln\left(\frac{M}{D}\right)_{jt} + \beta_R \Delta \ln R_{jt} + \beta_V \Delta \ln V_{jt} + \beta_\Omega \Omega_t + \beta_\vartheta \vartheta_j + \varepsilon^1_{jt} \tag{2}$$

$$\Delta \ln W_{jt} = \alpha_0 + \gamma_1 \Delta \ln D_{jt} + \gamma_2 \Delta \ln X_{jt} - \gamma_3 \Delta \ln\left(\frac{M}{D}\right)_{jt} + \beta_R \Delta \ln R_{jt} + \beta_V \Delta \ln V_{jt} + \beta_\Omega \Omega_t + \beta_\vartheta \vartheta_j + \varepsilon^2_{jt} \tag{3}$$

To control for additional influences on employment, we expand the vectors $\Delta \ln V_{jt}$ and $\Delta \ln R_{jt}$, which include industry-level changes in technology, constructed as Solow residuals [17], and changes in capital-labor ratios that are also industry-specific. Industry capital-labor ratios are given as the value of plant and equipment divided by production employment. To control for business cycle fluctuations, the annual change in the manufacturing sector capacity utilization rate is included.

$$\Delta \ln L_{jt} = \alpha_j + \beta_1 \Delta \ln DOM_{jt} + \beta_2 \Delta \ln EXP_{jt} + \beta_3 \Delta \ln IMPPEN_{jt} + \beta_4 \Delta \ln CAPUTIL_t + \beta_5 \Delta \ln KL\ RATIO_{jt} + \beta_6 \Delta \ln TECH_{jt} + \beta_\Omega \Omega_t + \beta_\vartheta \vartheta_j + \varepsilon_{jt} \tag{4}$$

In equation (4), the vector L_{jt} includes industry production and non-production employment. DOM_{jt}, representing domestic demand, is equal to industry shipments less exports plus imports. Foreign demand is given by EXP_{jt}, while $IMPPEN_{jt}$ represents import competition. Equation (5) is an analogous estimation equation where the vector W_{jt} includes average industry wages of production and non-production workers.

$$\begin{aligned}\Delta \ln W_{jt} &= \alpha_j + \beta_1 \Delta \ln DOM_{jt} + \beta_2 \Delta \ln EXP_{jt} + \beta_3 \Delta \ln IMPPEN_{jt}` \\ &+ \beta_4 \Delta \ln CAPUTIL_t + \beta_5 \Delta \ln KL\ RATIO_{jt} + \beta_6 \Delta \ln TECH_{jt} \\ &+ \beta_\Omega \Omega_t + \beta_\vartheta \vartheta_j + \varepsilon_{jt} \qquad (5)\end{aligned}$$

The relevant finding for US workers from the DFS calibration exercise presented in Section 3 is China's gain of comparative advantage. This suggests possible variation in the effects of exports and imports on domestic wages and employment across trading partners grouped by average income levels. More specifically, distilling the separate effects of, say, import competition by income cohort we may anticipate a stronger proportional influence on domestic employment if the import competition is from low income countries and a weaker, albeit still potentially negative, if from high income countries. Estimating modified versions equations (4) and (5) allow us to discern these cohort-specific effects.

Econometric Results

To examine the industry-level effects of trade on employment and average wages, data from the Annual Survey of Manufacturers [19; 20] for the years 2006 and 2007 have been appended to data for the years 1972-2005 that are from the NBER-CES Manufacturing Industry Database [1]. The resulting dataset includes US manufacturing industries categorized according to the 2002 NAICS classification system. Trade data, categorized according to the 1987 SIC classification system (1972-2001) are from Feenstra [4; 5] and Feenstra et al. [6]. Trade data for the years 2002-2007, categorized according to the 2002 NAICS classification system (2002-2007) are from the US ITC [21]. Capacity utilization rates for the US manufacturing sector are from the FRBSL [3]. All data series have been mapped to the 3-digit Census of Population Industrial Classification (CIC) system. The resulting dataset includes 75 3-digit manufacturing industries.[1] While the regression models we estimate are dynamic equations, Table 4 presents descriptive statistics for the static variables over the full reference period and for the first and final years of the reference period.

In the typical manufacturing industry during the typical year, there were roughly 2.5 production workers for every non-production worker. Annual wages were typically about 55.6 percent higher for non-production workers as compared to production workers. About two-thirds (67.8%) of the sector's exports went to high income trading partners. Another 28.2 percent went to middle income countries, 4.3 percent went to low- income countries, and 3 percent went to China. Similarly, about two-thirds of the sector's imports (67.2%) were sourced from high income countries, while 22.2 percent of imports were from middle income

[1] See Appendix B for industry listing.

countries, 10.6 percent were from low income trading partners, and 7.7 percent of imports were from China.

Comparing 2007 to 1972, we see a considerable decrease in the employment of production workers, a modest decrease in non-production worker employment, and slight increases in average annual wages for both production workers and non-production workers. Both exports and imports increased; however, the increase in imports (593%) was considerably greater than the increase in exports (382%). Exports to low income countries increased proportionally more (727%) than did exports to middle income (502%) or high income countries (323%). Likewise, imports from low income countries increased by a staggering 11,445 percent, while imports from middle income (1,280%) and high income countries (318%) increased proportionally less. Both exports and imports, at least in terms of manufactures, increased for all trading partner cohorts but shifted toward low income countries and, to a lesser extent, toward middle income countries and away from high income countries. It is noteworthy that both imports and exports increased proportionally more than did the size of the domestic market. Thus, the average import penetration rate increased as did the degree of import penetration that each cohort accounted for. Even so, it is the average import penetration rate from low income countries that increased, proportionally, the most: a near 50-fold (4,909%) increase from 0.17 in 1972 to 8.52 in 2007.

Table 4. Descriptive Statistics

	1972-2007 N = 2,700 (a)	1972 N = 75 (b)	2007 N = 75 (c)
Production Worker Employment	158,493	177,121	120,632
	(166,004)	(175,531)	(131,237)
Non-production Worker Employment	62,718	57,631	51,333
	(71,604)	(55,092)	(57,915)
Avg. Annual Production Worker Wages	31,785	32,655	33,224
	(8,455)	(6,831)	(9,608)
Avg. Annual Non-production Worker Wages	49,430	49,896	52,550
	(7,822)	(5,438)	(9,859)
Exports (2000 US$)	5,240	1,920	9,260
	(9,530)	(3,070)	(14,800)
Exports to High Income Countries	3550	1,370	5,790
	(6,540)	(2,300)	(9,600)
Exports to Upper Middle Income Countries	377	167	592
	(730)	(297)	(1,140)
Exports to Lower Middle Income Countries	1100	300	2,220
	(2,350)	(475)	(3,650)
Exports to Low Income Countries (excl. China)	227	79	653
	(526)	(158)	(1,320)
Exports to China	159	0	1,339
	(223)	(0)	(1,078)
Imports (2000 US$)	7,830	2,410	16,700
	(16,900)	(4,520)	(28,000)
Imports from High Income Countries	5,260	2,080	8,680
	(12,300)	(4,400)	(17,700)

Table 4. (Continued)

	1972-2007 N = 2,700 (a)	1972 N = 75 (b)	2007 N = 75 (c)
Imports from Upper Middle Income Countries	508	130	909
	(1,370)	(450)	(2,140)
Imports from Lower Middle Income Countries	1230	172	3,260
	(3,690)	(418)	(6,910)
Imports from Low Income Countries (excl. China)	832	33	3,810
	(2,760)	(116)	(7,470)
Imports from China	605	0.0000	2,964
	(1,080)	(0.0000)	(6,019)
Import Penetration Rate	0.1461	0.0583	0.2669
	(0.1565)	(0.0558)	(0.2271)
Import Penetration from High Income Countries	0.0931	0.0491	0.1248
	(0.0893)	(0.0524)	(0.1077)
Import Penetration from Upper Income Countries	0.0095	0.0029	0.0117
	(0.0172)	(0.0061)	(0.0160)
Import Penetration from Lower Income Countries	0.0204	0.0046	0.0452
	(0.0323)	(0.0120)	(0.0517)
Import Penetration from Low Income Countries	0.0231	0.0017	0.0852
(excl. China)	(0.0713)	(0.0091)	(0.1490)
Import Penetration from China	0.0131	0.0000	0.0671
	(0.0422)	(0.0000)	(0.1153)
Domestic Demand (2000 US$)	53,000	42,100	64,800
	(61,400)	(42,000)	(82,600)
Capital-Labor Ratio	218,755	296,653	221,399
	(326,132)	(324,046)	(251,711)
Technology	2.18	3.97	10.60
	(10.2)	(34.3)	(91.8)
Capacity Utilization Rate	79.70	83.41	79.07
	(3.84)	(0.00)	(0.00)

Non-weighted industry averages listed. Domestic demand, export, and import values in millions.

Estimating equations (4) and (5) allows determination of the respective influences of exports and import penetration on industry-level employment and average wages. We first estimate each regression model while allowing for separate effects for China and for all other trading partners. These results are presented in Table 5. To consider variation in the influences of exports to and import penetration from China and the cohorts that have been determined based on per capital income, we estimate modified versions of equations (4) and (5). Results are presented in Table 6. Due to the presence of panel-level heteroskedasticity and first-order serial correlation in the data, we employ the Feasible Generalized Least Squares estimation technique. Beginning with results presented in Table 5, we see that year-to-year increases in import penetration from China, correspond, all else equal, with reductions in both production worker employment and non-production worker employment (columns (a) and (b), respectively). Given the functional forms of the estimation equations, we can say that a one percent increase in import penetration from China for the typical industry corresponds with 0.28 percent and 0.86 percent decreases in production worker and non-production worker employment, respectively. A like increase in import penetration from other countries corresponds with a 0.21 percent decrease in production worker employment, a 0.69 percent decrease in non-production worker employment, and a 0.25 percent decrease in average annual wages for production workers (column (c)). For the same three estimations, we find that in response to a one percent increase in exports to China, non-production worker employment increases by 0.005 percent, while a like increase in exports to the rest of the world results in a 0.01 percent increase in production worker employment, a 0.02 percent increase in non-production worker employment, and a 0.001 percent decrease in average annual wages for production workers.

Considering the remaining variables in Table 5, we see that increased domestic demand corresponds with higher employment and higher average wages for both production and non-production workers. Increases in industry-level capital-labor ratios correspond with lower employment of both production workers and non-production workers but is positively related to average wages of production workers. Technological advances correspond with lower production worker employment and higher average wages for non-production workers. As the magnitudes of coefficient estimates and the pattern of statistical significance for these variables are consistent across Tables 5 and 6, we restrict our focus to the trade-related variables from this point forward.

Table 5. Estimated Trade-Induced Labor Market Dynamics

Dep. Var.:	Δ ln Prod. Employment$_{jt}$ (a)	Δ ln Non-Prod. Employment$_{jt}$ (b)	Δ ln Avg. Prod. Wages$_{jt}$ (c)	Δ ln Avg. Non-Prod. Wages$_{jt}$ (d)
Δ ln China Import Penetration Rate$_t$	-0.2849***	-0.8649***	0.2260	0.7355
	(0.0870)	(0.2194)	(0.9405)	(1.5348)
Δ ln All except China Import Penetration Rate$_{jt}$	-0.2062***	-0.6877***	-0.2473***	0.0357
	(0.0295)	(0.0745)	(0.0319)	(0.0521)
Δ ln Exports to China$_t$	-0.0002	0.0050*	0.0015	-0.0026
	(0.0011)	(0.0029)	(0.0012)	(0.0020)
Δ ln Exports to all except China$_{jt}$	0.0096***	0.0202***	0.0010***	-0.0005
	(0.0031)	(0.0078)	(0.0033)	(0.0054)
Δ ln Domestic Demand$_{jt}$	0.1316***	0.2103***	0.1138***	0.0762***
	(0.0074)	(0.0188)	(0.0081)	(0.0131)
Δ ln Capital-Labor Ratio$_{jt}$	-0.7655***	-0.2975***	0.1085***	0.0177
	(0.0098)	(0.0247)	(0.0106)	(0.0172)
Δ ln Technology$_{jt}$	-0.0012**	0.0001	0.0003	0.0017*
	(0.0006)	(0.0014)	(0.0006)	(0.0010)
Δ ln Capacity Utilization Rate$_{jt}$	-0.0222	0.0097	-0.0192	-0.1486
	(0.0967)	(0.2438)	(0.1045)	(0.1706)
Constant	-0.0035	-0.0034	-0.0149***	-0.0053
	(0.0053)	(0.0133)	(0.0057)	(0.0093)
Wald χ^2	19,213***	1,324***	1,762***	689***
Log Likelihood	5,694.62	3,431.48	5,503.55	4,305.66
Pseudo R^2	0.8871	0.3512	0.4188	0.2198

Robust standard errors in parentheses. "***", "**", and "*" denote significance from zero at the 1%, 5%, and 10% levels, respectively.

Table 6. Estimated Trade-Induced Labor Market Dynamics, Cohort-Specific Effects

Dep. Var.:	Δ ln Prod. Employment$_{jt}$ (a)	Δ ln Non-Prod. Employment$_{jt}$ (b)	Δ ln Avg. Prod. Wages$_{jt}$ (c)	Δ ln Avg. Non-Prod. Wages$_{jt}$ (d)
Δ ln China Import Penetration Rate$_t$	-0.2861**	-0.6793**	0.0644	-0.0503
	(0.1147)	(0.2893)	(0.1240)	(0.2022)
Δ ln Low Income Import Penetration Rate (excl. China)$_{jt}$	-0.3316**	-1.3992***	-0.4966***	0.1649
	(0.1353)	(0.3413)	(0.1463)	(0.2385)
Δ ln Lower Middle Income Import Penetration Rate$_{jt}$	-0.2210**	-0.4611*	0.0174	-0.1391
	(0.1019)	(0.2571)	(0.1102)	(0.1796)
Δ ln Upper Middle Income Import Penetration Rate$_{jt}$	-0.1449	-0.4658	-0.6008***	-0.2993
	(0.1296)	(0.3270)	(0.1401)	(0.2285)
Δ ln High Income Import Penetration Rate$_{jt}$	-0.1978***	-0.6729***	-0.2071***	0.0959
	(0.036)	(0.0908)	(0.0389)	(0.0635)
Δ ln Exports to China$_t$	0.0002	0.0013	0.0015	-0.0029
	(0.0018)	(0.0046)	(0.0020)	(0.0032)
Δ ln Exports to Low Income Countries (excl. China)$_{jt}$	0.00005	0.0042	0.0004	0.0002
	(0.0014)	(0.0036)	(0.0016)	(0.0025)
Δ ln Exports to Lower Middle Income Countries$_{jt}$	0.0046**	0.0122*	0.0001	-0.0010***
	(0.0020)	(0.0052)	(0.0022)	(0.0036)
Δ ln Exports to Upper Middle Income Countries$_{jt}$	-0.0032**	0.0004	-0.0018	0.001
	(0.0015)	(0.0039)	(0.0017)	(0.0027)
Δ ln Exports to High Income Countries$_{jt}$	0.0098***	0.0097	0.0086***	0.0064
	(0.0029)	(0.0073)	(0.0031)	(0.0051)
Δ ln Domestic Demand$_{jt}$	0.1303***	0.2078***	0.1144***	0.0783***
	(0.0074)	(0.0188)	(0.0081)	(0.0131)
Δ ln Capital-Labor Ratio$_{jt}$	-0.7655***	-0.2994***	0.1072***	0.0187
	(0.0098)	(0.0246)	(0.0106)	(0.0172)
Δ ln Technology$_{jt}$	-0.0012**	0.0001	0.0003	0.0017*
	(0.0005)	(0.0014)	(0.0006)	(0.0010)
Δ ln Capacity Utilization Rate$_{jt}$	-0.046	-0.0380	-0.0141	-0.1496
	(0.0972)	(0.2454)	(0.1051)	(0.1714)
Constant	-0.0031	-0.0037	-0.0148***	-0.0044
	(0.0053)	(0.0133)	(0.0057)	(0.0093)
Wald χ^2	19,304***	1,336***	1,779***	707***
Log Likelihood	5.699.73	3,435.49	5,508.28	4,312.42
Pseudo R^2	0.8875	0.3533	0.421	0.2241

See Table 5 notes.

Table 6 presents coefficient estimates from the regression models that have been modified to allow for variation in the influences of exports and import penetration across trading partner cohorts. The negative consequences of increased import penetration on employment of both production workers and non-production workers are greatest if the source of the rising import penetration is the low income trading partner cohort. A one percent increase in import penetration from low income countries corresponds with a 0.33 percent decrease in production worker employment and a 1.4 percent decrease in non-production worker employment. By comparison, given the same one percent increase in import competition from China, employment of production workers and non-production workers would decrease by 0.29 percent and 0.68 percent, respectively. Increased import competition from low, upper middle, and high income countries is also found to negatively influence average wages of production workers. With respect to increased exports, the pattern of significance is less clear. Higher exports to high income countries correspond with increased production worker employment and average wages. Likewise, increased exports to lower middle income countries correspond with increased employment for production and non-production workers alike. No significant effect, for employment or average wages, is reported for increased exports to China.

CONCLUSION

We have employed data that span the period from 1968 through 2008 to calibrate the DFS model of Ricardian comparative advantage. The calibration exercise has allowed us to explore changes in relative factor endowments (i.e., capital, labor, and technology) as the underlying basis for China's emergence as an international trading power. Our evaluation of the DFS model serves two purposes. By considering changes in China's factor endowments relative to those of the full cohort of 97 trading partners, the United States, and cohorts of trading partners that have been categorized based on World Bank income classifications, we gain insights regarding changes in comparative advantage. Results from the calibration exercises suggest that China has gained comparative advantage relative to the US and in comparison to the high income country cohort during the reference period. For all other cohorts, the change in China's comparative advantage is ambiguous.

The calibration exercises motivate our examination of the effects of trade on industry-level employment and average wages in the US manufacturing sector. Examining data for 75 3-digit CIC industries in the United States' manufacturing sector during the period from 1972-2007, we find relatively small, yet statistically significant, negative effects of rising import penetration from China on employment of production workers and of non-production workers. These effects, however, are not particularly pronounced relative to reported effects for countries categorized as low income or as middle income (i.e., lower middle income or upper middle income). We find no evidence of significant effects of trade with China (exports or imports) on average wages for production workers or non-production workers. Likewise, we do not report significant positive/offsetting employment effects that are attributable to increased US exports to China.

It is important to recognize that, due to more disaggregate data not being available, the analysis presented here involves the use of data that are classified at a relatively broad (i.e., 3-digit CIC) industry level. Heterogeneity across industries, and even across firms within industry classifications, along with period/year specific variation make it difficult, if not impossible, to infer precise employment and wage effects. As a result, we choose to be reserved in our interpretations and in our conclusions. That being said, we do report significant influences of greater exports and rising import competition on industry-level employment and average wages. Additional research is needed to discern more precise estimates of trade-induced employment effects.

APPENDIX A: COUNTRY LISTING, BY INCOME CLASSIFICATION

High Income (24): Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States;

Upper Middle Income (11): Barbados, Brazil, Gabon, Greece, Korea (Republic of), Mexico, Portugal, South Africa, Trinidad & Tobago, Uruguay, Venezuela;

Lower Middle Income (29): Algeria, Argentina, Bolivia, Cameroon, Chile, Colombia, Costa Rica, Cote d`Ivoire, Dominican Republic, Ecuador, El Salvador, Fiji, Guatemala, Iran, Jamaica, Jordan, Malaysia, Morocco, Nicaragua, Panama, Paraguay, Peru, Philippines, Romania, Senegal, Syria, Thailand, Turkey, Zimbabwe;

Low Income (34): Bangladesh, Benin, Burkina Faso, Burundi, Central African Republic, Chad, China, Congo (Dem. Rep.), Egypt, Equatorial Guinea, Ethiopia, Gambia, Ghana, Guinea, Haiti, Honduras, India, Indonesia, Kenya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Nepal, Niger, Nigeria, Pakistan, Rwanda, Sri Lanka, Tanzania, Togo, Uganda, Zambia.

APPENDIX B: CIC INDUSTRY CLASSIFICATIONS

100 Meat Products; 101 Dairy Products; 102 Canned and preserved fruits and vegetables; 110 Grain mill products; 111 Bakery products; 112 Sugar and confectionery products; 120 Beverage industries; 121 Miscellaneous food preparations & kindred products; 130 Tobacco manufactures; 132 Knitting mills; 140 Dyeing & finishing textiles, except wool & knit goods; 141 Floor coverings, except hard surface; 142 Yarn, thread, and fabric mills; 150 Miscellaneous textile mill products; 151 Apparel and accessories, except knit; 152 Miscellaneous fabricated textile products; 160 Pulp, paper, and paperboard mills; 161 Miscellaneous paper and pulp products; 162 Paperboard containers and boxes; 172 Printing, publishing, & allied industries, except newspapers; 180 Plastics, synthetics, and resins; 181 Drugs; 182 Soaps and cosmetics; 190 Paints, varnishes, and related products; 191 Agricultural chemicals; 192 Industrial and miscellaneous chemicals; 200 Petroleum refining; 201 Miscellaneous petroleum and coal products; 210 Tires and inner tubes; 211 Other rubber products, and plastics footwear and belting; 212 Miscellaneous plastics products; 220 Leather tanning and finishing; 221 Footwear, except rubber and plastic; 222 Leather products, except footwear; 231 Sawmills, planning mills, and millwork; 232 Wood buildings and mobile homes; 241 Miscellaneous wood products; 242 Furniture and fixtures; 250 Glass and glass products; 251 Cement, concrete, gypsum, and plaster products; 252 Structural clay products; 261 Pottery and related products; 262 Miscellaneous nonmetallic mineral & stone products; 270 Blast furnaces, steelworks, rolling & finishing mills; 271 Iron and steel foundries; 272 Primary aluminum industries; 280 Other primary metal industries; 281 Cutlery, hand tools, and other hardware; 282 Fabricated structural metal products; 290 Screw machine products; 291 Metal forgings and stampings; 292 Ordnance; 300 Miscellaneous fabricated metal products; 310 Engines and turbines; 311 Farm machinery and equipment; 312 Construction and material handling machines; 320 Metalworking machinery; 321 Office and accounting machines; 322 Electronic computing equipment; 331 Machinery, except electrical, not

elsewhere classified; 340 Household appliances; 341 Radio, T.V., and communication equipment; 342 Electrical machinery, equipment, and supplies, not elsewhere classified; 351 Motor vehicles and motor vehicle equipment; 352 Aircraft and parts; 360 Ship and boat building and repairing; 361 Railroad locomotives and equipment; 362 Guided missiles, space vehicles, and parts; 370 Cycles and miscellaneous transportation equipment; 371 Scientific and controlling instruments; 372 Optical and health services supplies; 380 Photographic equipment and supplies; 381 Watches, clocks, and clockwork operated devices; 390 Toys, amusement, and sporting goods; 391 Miscellaneous manufacturing industries.

REFERENCES

[1] Becker, R.A. & Gray, W.B. (2009) NBER-CES Manufacturing Industry Database. Online. Available at: http://www.nber.org/data/nbprod2005.html.

[2] Dornbusch, R., Fischer. S., & Samuelson. P. (1977) "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review* 67(5): 823-839.

[3] Federal Reserve Bank of St. Louis (FRBSL) (2012) Capacity Utilization: Manufacturing (NAICS) (MCUMFN), Release: G.17 Industrial Production and Capacity Utilization. Online. Available at: http://research.stlouisfed.org/fred2/series/MCUMFN?cid=3.

[4] Feenstra, R.C. (1997) "U.S. Exports, 1972-1994, with State Exports and Other U.S. Data", NBER Working Paper no. 5990.

[5] Feenstra, R.C. (1996) "U.S. Imports, 1972-1994: Data and Concordances", NBER Working Paper no. 5515.

[6] Feenstra, R. C., Romalis, J. & Schott, P.K. (2002) "U.S. Imports, Exports and Tariff Data, 1989-2001", NBER Working Paper no. 9387.

[7] Frankel, J.A. & Romer, D. (1999) "Does Trade Cause Growth?", *American Economic Review* 89, 3: 379-399.

[8] Freeman, R.B. & Katz, L.F. (1991) "Industrial Wage and Employment Determination in an Open Economy," in *Immigration, Trade, and the Labor Market*, John M. Abowd and Richard B. Freeman, eds. Chicago, IL: University of Chicago Press.

[9] Heckscher, E. (1919) "The Effect of Foreign Trade on the Distribution of Income", *Ekonomisk Tidskriff* 497–512. Translated as chapter 13 in American Economic Association, *Readings in the Theory of International Trade*, Philadelphia: Blakiston, 1949, 272–300, and a new translation is provided in Flam and Flanders.

[10] Heston, A., Summers, R. & Aten, B. (2011) Penn World Table Version 7.0, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania (May). Online. Available at: https://pwt.sas.upenn.edu/.

[11] Hummels, D. & Levinsohn, J. (1995) "Monopolistic Competition and International Trade: Reconsidering the Evidence," *The Quarterly Journal of Economics* 110(3): 799-836.

[12] Kletzer, L.G. (2002) *Imports, Exports and Jobs: What does trade mean for employment and job loss?*, Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

[13] Krugman, P. (2008) "*International Trade Models."* Lecture, International Economics, Lecture 18 from Princeton University, Princeton, September 18, 2008.
[14] Mann, C.L. (1988) "The Effect of Foreign Competition in Prices and Quantities on the Employment in Import-Sensitive U.S. Industries," *The International Trade Journal*, 2(4), 409-444.
[15] Ohlin, B. (1933) *Interregional and International Trade,* Cambridge, Mass.: Harvard University Press.
[16] Ricardo, D. (1817) *On the Principles of Political Economy and Taxation,* London: John Murray.
[17] Solow, R.M. (1957) "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics* 39(3): 312-320.
[18] World Bank (2012) World Development Indicators, Washington, DC: World Bank. Online: http://databank.worldbank.org.
[19] US Census Bureau (US Census) (2011) 2007 Economic Census. Series ID# EC0731SG1. Online. Available at: http://factfinder2.census.gov/faces/nav/ jsf/pages/ searchresults.xhtml?refresh=t.
[20] US Census Bureau (US Census) (2008) Annual Survey of Manufactures. Online. Available at: http://www.census.gov/manufacturing/asm/historical_data/index.html.
[21] US International Trade Commission (US ITC) (2012) Interactive Tariff and Trade DataWeb – Version 3.0. Online. Available at: http://dataweb.usitc.gov/.