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OPEN ECONOMY LECTURES

"Offshoring to China: The Local and Global Impacts of Processing Trade"

Robert C. Feenstra
University of California, Davis

April 18-20, 2011

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"With creative and thoughtful research, Rob Feenstra consistently brings to our attention important and interesting insight related to international trade and investment. I have had good fortune to collaborate with him on a book project on China's trade and learned a lot. Through these Open Economy Lectures, Rob presents an analysis of processing trade in China and its implications for the world economy, rich and comprehensive in insight, and yet clear and accessible in style. Anyone interested in international trade, multinational firms, or the Chinese economy will benefit from reading the lectures."

Shang-Jin Wei
Director of the Chazen Institute of International Business
N. T. Wang Professor of Chinese Business and Economy
Professor of Finance and Economics
Columbia University Graduate School of Business

"This set of three lectures by Rob Feenstra presents the state-of-the-art literature on offshoring in a very accessible way and with very interesting applications to China, especially to its processing trade. The book looks both at the micro and macro aspects of offshoring. Such a book, written by someone who himself has done path-breaking research on these topics, is going to be a very valuable reference for researchers and a very useful textbook all over the world in graduate courses in international trade that aim to comprehensively cover the literature on offshoring."

Devashish Mitra
Professor of Economics &
Gerald B. and Daphna Cramer Professor of Global Affairs
Syracuse University

"An important event for graduate international trade programs in China, Professor Robert Feenstra inaugurates the Open Economy Lectures that will bring a series of world-class trade economists to Chinese campuses in coming years. Professor Feenstra's lectures on Chinese processing trade use theoretically sound empirical methodologies to analyze various aspects of a very topical policy issue for China and its trading partners. A must read for our aspiring students who are fascinated with China's rise in global trade."

LIN Guijun
Professor of Economics and Vice President
University of International Business & Economics (UIBE)

<u>Lecture 1</u>: Local Impact of Processing Trade

China plays a truly remarkable role in world trade. It has grown from being the third largest trader in 2004 (Branstetter and Lardy, 2008), to being the top exporter in 2009, and even overtaking the United States in the size of its gross domestic product (GDP) today. China is being credited with helping to pull the emerging market economies out of the 2008-2010 global recession. And looking to the future, China will continue to play a leading role as it invests in vast infrastructure projects – such as the 2008 Olympics and a land-route across Colombia that will be a "dry" alternative to the Panama Canal – on a scale that equals the largest projects in recent history.

The rapid transformation of the Chinese economy over the past several decades will be familiar to you in the audience, and it also brings back to me warm memories of my first trips to China. The first trip was in 1993 and the second in 1997, both with my colleague Wing Woo from UC Davis, and accompanied by my former students Shunli Yao and Wen Hai on one trip or the other. The 1997 trip was to visit Chinese Customs on a project that involved correcting the differing reports between China and the United States on the size of the bilateral trade balance (Feenstra, Hai, Woo and Yao, 1999). On those trips I returned home with many gifts, and I told my young daughter about the Friendship Store, where I had purchased some of them. She was very eager to come to China to shop there, but in the time between the first and second trips, I found that the ground floor had been converted from handicrafts to sunglasses and simple electronic items, and on the next visit, one more floor was gone, which symbolized to me the rapid changes within the Chinese economy. When I came home and told my daughter about that she was even more anxious to come, before all the floors disappeared entirely! Well, she got her wish in 1999 when I visited Beijing with my whole family and shopped for the final time at the

Friendship Store. This transformation of the Friendship Store in Beijing is a simple example that illustrates the dramatic transformation within the Chinese economy, from the production of simple manufactured items to ever more sophisticated products today.

In these lectures I will focus on one special feature of the transformation in the Chinese economy, and that is the role played by *processing trade*. China has made greater use of export processing zones than any other country, allowing for duty-free imports of parts for processing that are then shipped around the world. In the early stage of China's economic opening, the government permitted foreign trade and investment only in Special Economics Zones located in the southern coastal provinces of Guangdong and Fujian. In the mid to late 1980s, the government expanded the number of regions where such activities were permitted, and by the 1990s, foreign trade and investment were allowed (subject to government approval) throughout the country (Demurger, *et al*, 2002). Since accession to the World Trade Organization (WTO) in 2001, there has been a rapid growth in processing exports from export processing zones, especially by foreign firms. In these lectures I will examine the local impact of processing trade on the Chinese economy, and also its global impact on the world economy.

In the first lecture, I will be reviewing the models of offshoring that can be used to understand these export processing zones, and their impact on the wages of high-skilled and low-skilled labor. In my second lecture, I will introduce foreign firms into the treatment of offshoring, so that I will distinguish the outsourcing activity done by Chinese companies for foreign firms, from the assembly activity done by foreign-owned firms operating in China. Understanding the reasons for multinational firms to keep these activities within their own boundaries, versus outsourcing them to independent plants, is important in theory and for understanding the rapid increase in processing exports by foreign-owned firms in China.

In my third lecture I will return to the project that brought me to China initially, and that was the measurement of the trade balance with the United States. To be more specific, I will talk about potential macroeconomic consequences of offshoring. The macroeconomic issues that command the most attention in discussions between China and the United States are the trade balance and exchange rates, and that is what I will spend most of the lecture discussing.

1.1 Wages and Employment in U.S. and Chinese Manufacturing

Let me begin with offshoring and its impact on wages in the United States. In Figures 1.1 and 1.2, I use data from the U.S. manufacturing sector to measure the wages of "nonproduction" relative to "production" workers. As their name suggests, nonproduction workers are involved in service activities, while production workers are involved in the manufacture and assembly of goods. These two categories can also be called "non-manual" versus "manual", or "white collar" versus "blue collar." Generally, nonproduction workers require more education, and so we will treat these workers as skilled, while production workers are less skilled.

In Figure 1.1, we see that the earnings of nonproduction relative to production workers in the U.S. moved erratically from the late 1950s to the late 1960s, and from that point until the early 1980s, relative wages were on a downward trend. It is generally accepted that the relative wage fell during this period because of an increase in the supply of college graduates, skilled workers who moved into nonproduction jobs. Starting in the early 1980s, however, this trend reversed itself and the relative wage of nonproduction workers increased steadily to 2000, with a slight dip in 2001. The same increase in the relative wages of skilled workers can be found for other industrial and developing countries, including Hong Kong and the rest of China, as I shall discuss in a moment.

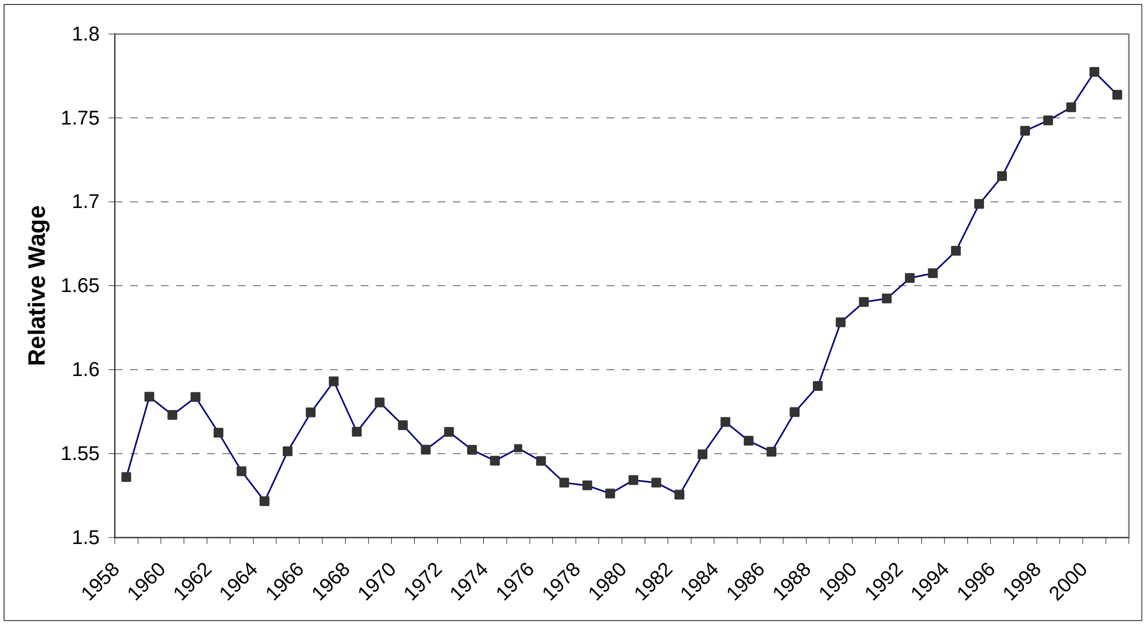

Figure 1.1: Relative Wage of Nonproduction/Production Workers, U.S. Manufacturing

Source: Updated from National Bureau of Economic Research productivity database.

Turning to Figure 1.2, we see that there has been a steady increase in the ratio of nonproduction to production workers through the end of the 1980s, but then a fall in the 1990s. The increase in the relative supply of workers can account for the *reduction* in the relative wage of nonproduction workers through the 1970s, as shown in Figure 1.1, but is at odds with the *increase* in the relative nonproduction wage during the 1980s. The rising relative wage should have led to a shift in employment *away* from skilled workers, along a demand curve, but it did not. Thus, the only explanation consistent with these facts is that there has been an *outward shift* in the demand for more-skilled workers during the 1980s, leading to an increase in their relative employment and wages, as shown in Figure 1.3.

What factors can lead to an outward shift in the relative demand for skilled labor? Such a shift can arise from the use of computers and other high-tech equipment, or *skill-biased technological change.* Researchers such as Berman, Bound and Griliches (1994) argued that such technological change – and not international trade – was the dominant explanation for the rising relative wage of skilled labor in the United States, and other countries. Their reason for rejecting international trade as an explanation was the finding that the majority of the increase in the manufacturing wage and employment of non-production workers was caused by shifts *within* industries, and not by shifts *between* industries (Berman, Bound and Griliches, 1994, Table IV; but see also Bernard and Jensen, 1997, Table 1). That is, the outward shift in relative demand being illustrated in Figure 1.3 applied to many individual industries, as well as in the aggregate. In their view, that ruled out the Heckscher-Ohlin model as an explanation, since in that model they expected to see a shift between industries instead of within industries.

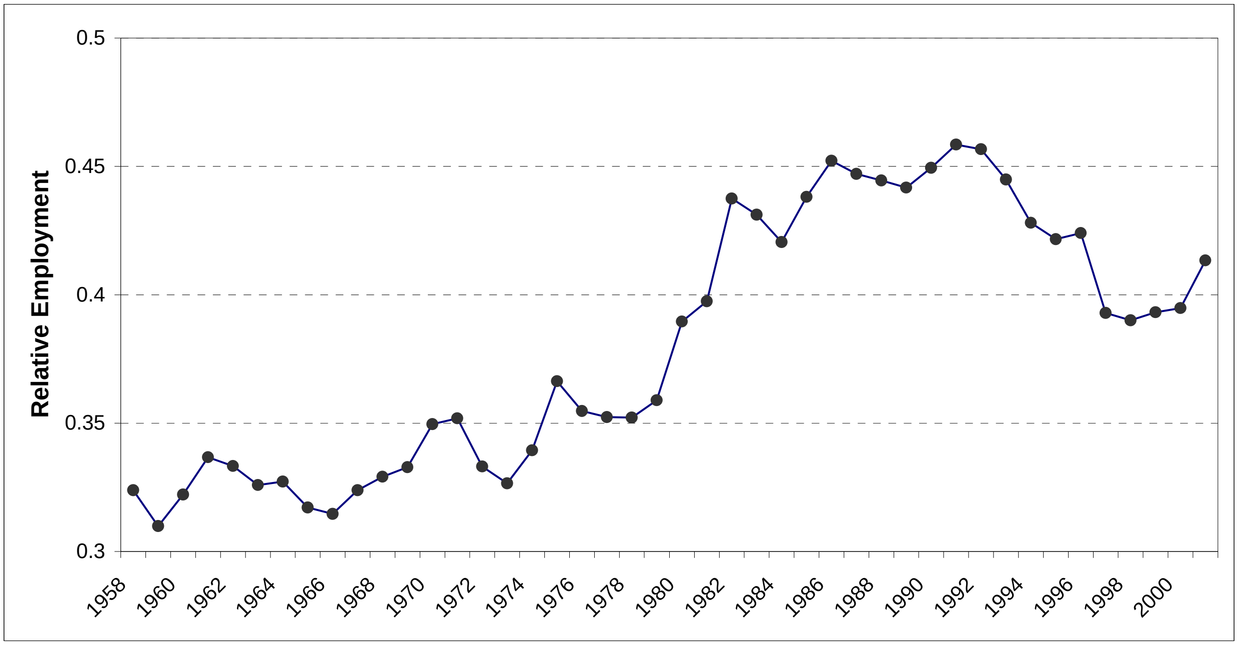

Figure 1.2: Relative Employment of Nonproduction/Production Workers, U.S. Manufacturing

Source: Updated from National Bureau of Economic Research productivity database.

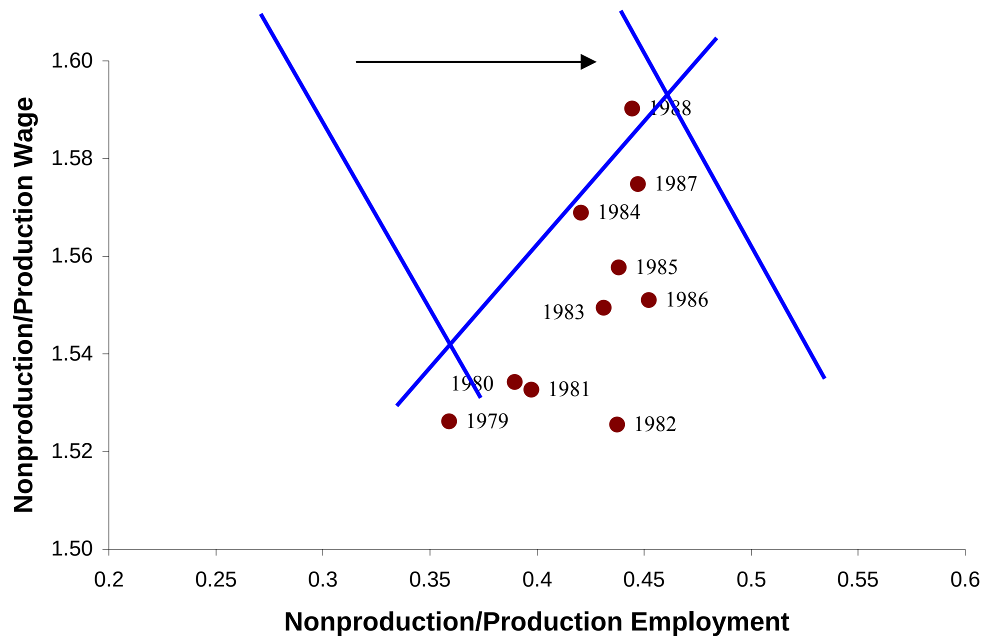

Figure 1.3: Nonproduction/Production Workers, 1980s

Source: National Bureau of Economic Research productivity database.

Figure 1.4 is drawn from the work of Liugang Sheng, a Ph.D. student at UC Davis (Sheng and Yang, 2011), and it shows that the same basic trends in wages and employment that are found in the U.S. are also evident in the manufacturing sector within China during the 1990s and 2000s. Specifically, Figure 1.4 demonstrates that the relative wage of college/non-college workers (analogous to the production/non-production worker categories for the U.S.) was fairly constant during the 1990s but rose rapidly in the 2000s. In fact, the rise in the relative wage occurs around the time of China's accession to the WTO and the decline in trade costs with China that followed. At the same time, the relative supply of college workers displays a constant upward trend over these decades. These facts again suggest that the relative *demand* for college workers in China must also be rising over both decades, particularly during the 2000s following China's enactment of reductions in trade barriers. The question is: what factors can explain this change in wages that has occurred in the many countries, including the United States and more recently in China itself?

1.2 Offshoring Model

The basic Heckscher-Ohlin (HO) model does not work well to explain the change in wages that has occurred in the United States and China, because when trade is opened in that model, factor prices tend to move in *different* directions in the two countries. But what we have actually seen is that the relative wage of skilled workers has increased in many countries, both advanced and developing. So we need to look beyond the HO model, and there are two leading models to use: the early work of Feenstra and Hanson (1996, 1997), and the more recent work of Grossman and Rossi-Hansberg (2008). I will discuss both of these models.

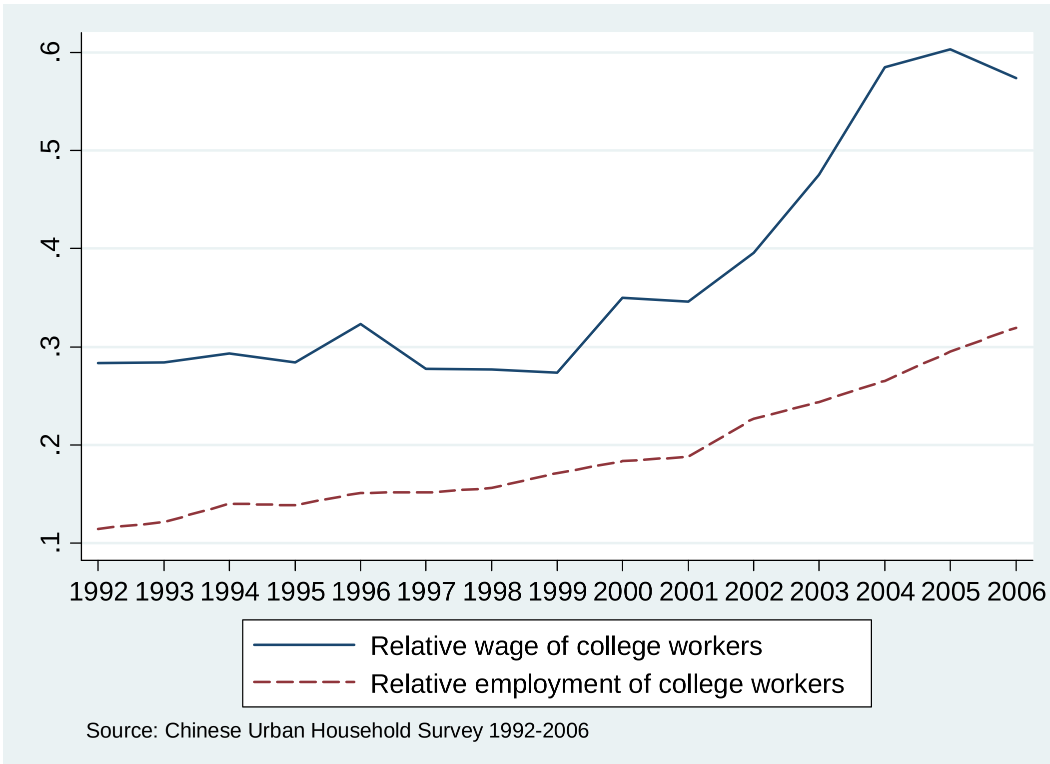

Figure 1.4: Relative Wage and Employment of College/non-College Workers in Chinese Manufacturing

Source: Sheng and Yang (2011)

In my work with Gordon Hanson (Feenstra and Hanson, 1996, 1997), we present a model of an industry in which there are many "activities," denoted by z, arranged along a "value chain." For convenience, we arrange these activities in increasing order of their ratio of high-skilled to low-skilled labor used in each activity. The structure of this model is very similar to the Heckscher-Ohlin model with a continuum of goods (Dornbusch, Fischer and Samuelson, 1980), except that we now think of all these activities as taking place within the same industry.

Formally, Feenstra and Hanson specify the unit-costs of each activity in the "home" country (think of the United States) as depending on low-skilled labor with wage w_L, high-skilled labor with wage w_H, and capital with rental r. The cost function for activity z is:

$$c(w_L, w_H, r, z) = B[w_L a_L(z) + w_H a_H(z)]^{\theta} r^{1-\theta},$$

which combines low-skilled and high-skilled labor in the proportions $a_L(z)$ and $a_H(z)$, and then further combines total labor with share θ and capital with share $1-\theta$. We suppose that the same technologies used in the foreign country (think of Mexico or China), except that we allow the country-wide technology parameter B* to differ from B. The outputs x(z) from these activities are combined in a Cobb-Douglas fashion to produce a single, final output:

$$Y = \int_0^1 \alpha(z) x(z) dz .$$

We suppose that relative wage of high-skilled labor is higher in the foreign country, and the rental on capital is also higher:

$$\frac{w_H}{w_L} < \frac{w_H^*}{w_L^*}, \quad \text{and} \quad r < r^* .$$

Then just like the Heckscher-Ohlin model with a continuum of goods, Feenstra and Hanson find that in a trade equilibrium countries specialize in different portions of the skill continuum. Under their assumption that the relative wage of high-skilled labor is higher abroad, and that goods are arranged in increasing order of their skill intensity, then the ratio of the home to foreign unit-costs is downward sloping, as shown by the schedule c/c* in Figure 1.5. Foreign production – or offshoring – occurs where the relative costs at home are greater than unity, in the range [0,z'), whereas home production occurs where the relative costs at home are less than unity, in the range (z',1]. The borderline activity z' is determined by:

$$\frac{c(w_L, w_H, r, z')}{c(w_L^*, w_H^*, r^*, z')} = 1 \ .$$

Using this unique borderline activity z', we can then calculate the demand for labor in each country. At home, for example, the relative demand for high-skilled/low-skilled labor is:

$$D(z') = \frac{\int_{z'}^{1} \frac{\partial c}{\partial w_H} x(z)dz}{\int_{z'}^{1} \frac{\partial c}{\partial w_L} x(z)dz} \ .$$

It can be shown that this schedule is a downward sloping function of the relative wage. A downward sloping relative demand curve applies to the foreign country, too, where now we integrate over the activities in [0, z'). In both countries, equilibrium factor prices are determined by the equality of relative demand and supply.

Suppose now that the home firm wishes to offshore more activities. The reason for this could be a capital flow from the home to foreign country, reducing the rental abroad and increasing it at home; or alternatively, technological progress abroad, neutral across all the activities, but exceeding such progress at home. In both cases, the relative costs of production at home rise, which is an upward shift in the relative cost schedule. As a result, the borderline

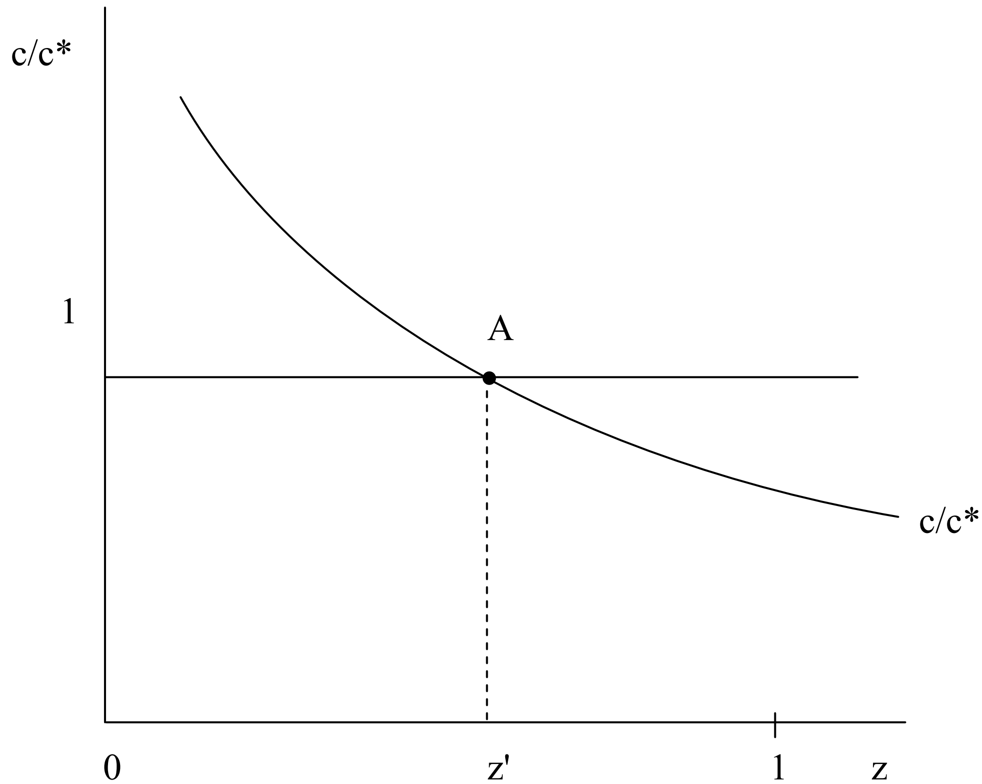

Figure 1.5: Value Chain of Production

between the activities performed at home and abroad therefore shifts from the point z' to the point z*, with z* > z', as shown in Figure 1.6.

What is the impact of this increase in offshoring on the relative demand for high-skilled labor at home and abroad? Notice that the activities no longer performed at home (those in-between z' and z*) are *less* skill-intensive than the activities still done there (those to the right of z*). This means that the range of activities now done at home are more skilled-labor intensive, on average, than the set of activities formerly done at home. For this reason, the relative demand for high-skilled labor at home increases, as occurred in the U.S. during the 1980s. That increase in demand will also increase the relative wage for high-skilled labor, as shown in Figure 1.7.

What about in the foreign country, such as Mexico or China? The activities that are newly sent offshore (those in-between z' and z*) are *more* skill-intensive than the activities that were initially done in the foreign country (those to the left of z'). That means that the range of activities now done abroad is also more skilled-labor intensive, on average, than the set of activities formerly done there. For this reason, the relative demand for high-skilled labor in the foreign also increases. With this increase in the relative demand for skilled labor, the relative wage of high-skilled labor *also* increases in the foreign country. That outcome occurred in as Mexico during the 1980s, as well as in China after 2000, as shown in Figure 1.4.

To summarize, this model of Feenstra and Hanson gives an explanation for the increase in the relative demand for skilled-labor that is observed in both industrial and developing countries. Of course, this explanation does not *prove* that offshoring was the source of the wage changes, since *skill-biased technological change* is equally well an explanation. So determining which of these explanations accounts for the actual changes observed is an empirical question, which we turn to next.

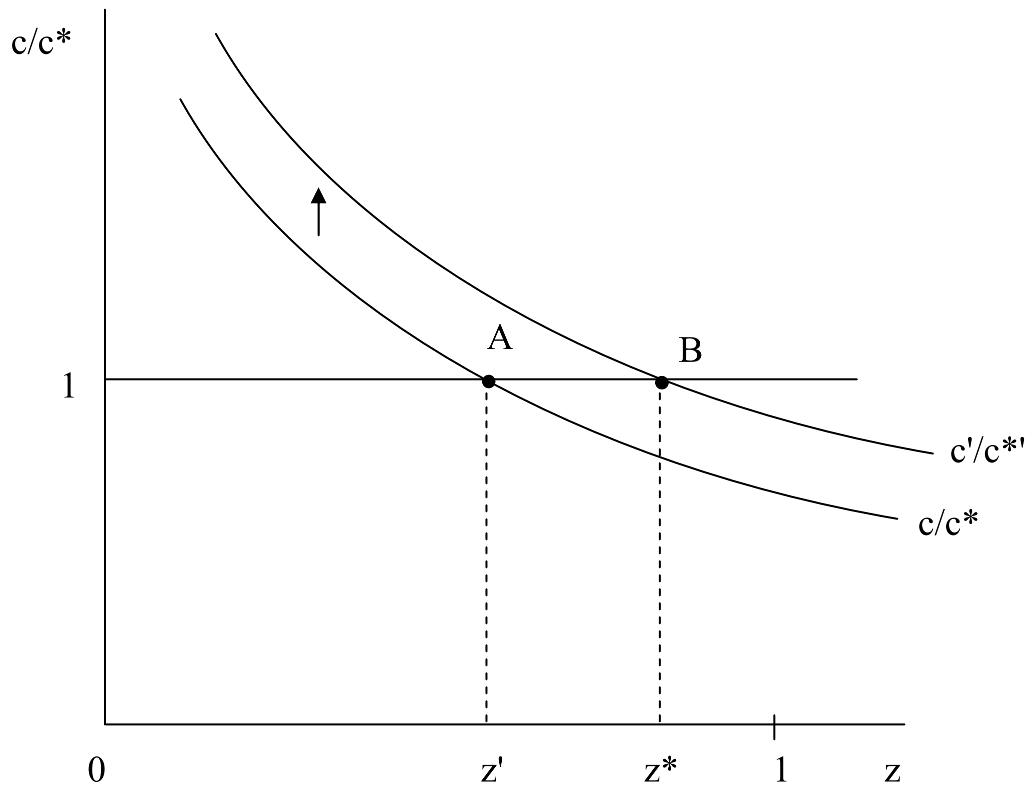

Figure 1.6: Increase in Offshoring

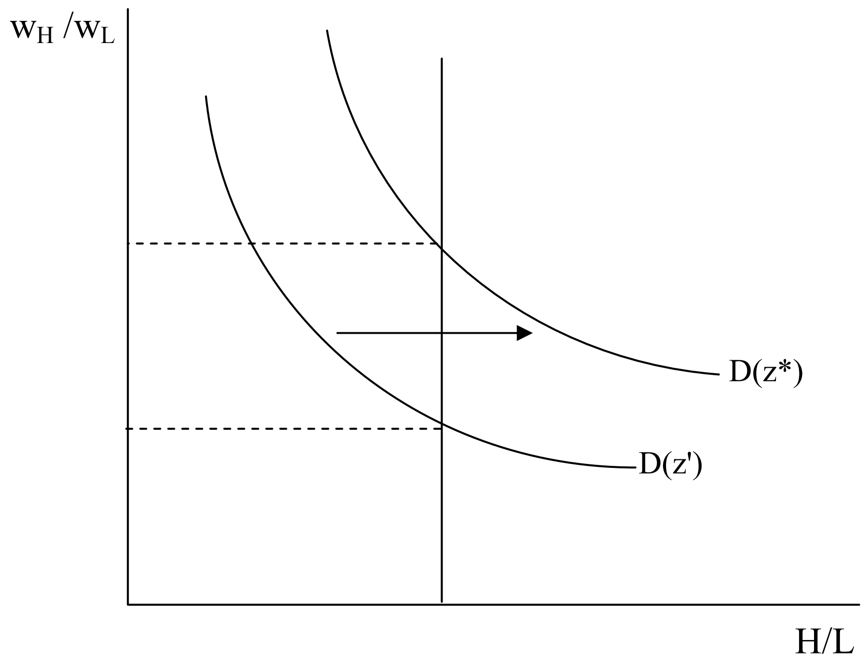

Figure 1.7: Increase in the Relative Demand for Skilled Labor

1.3 Evidence from Hong Kong

Summarizing our argument so far, the decision of companies to purchase intermediate inputs from overseas will most certainly affect their employment at home, and can be expected to differentially affect skilled versus low-skilled workers. With firms in industrial countries facing a higher relative wage for low-skilled labor than that found abroad, the activities that are offshored would be those that use a large amount of low-skilled labor, such as assembly of components and other repetitive tasks. Moving these activities overseas will reduce the relative demand for low-skilled labor in the industrial country, in much the same way as replacing these workers with automated production. *This means that outsourcing has a qualitatively similar effect on reducing the relative demand for low-skilled labor within an industry as does skilled-biased technological change, such as the increased use of computers.* Thus, determining which of these is most important is an empirical question.

To address this question, we use a *short-run cost function,* specified as the translog cost function, which is written in a general notation (dropping the industry subscript n) as,

$$\ln C = \alpha_0 + \sum_{i=1}^{M} \alpha_i \ln w_i + \sum_{k=1}^{K} \beta_k \ln x_k + \frac{1}{2} \sum_{i=1}^{M}\sum_{j=1}^{M} \gamma_{ij} \ln w_i \ln w_j + \frac{1}{2} \sum_{k=1}^{K}\sum_{\ell=1}^{K} \delta_{k\ell} \ln x_k \ln x_\ell + \sum_{i=1}^{M}\sum_{k=1}^{K} \phi_{ik} \ln w_i \ln x_k$$

where w_i denotes the wages of the optimally chosen inputs $i=1,\ldots,M$, and x_k denotes either the quantities of the *fixed* inputs or outputs $k=1,\ldots,K$, or any other shift parameters. In this cost function, there are just two optimally chosen factors – high-skilled and low-skilled labor – while capital and output are treated as fixed in the short run.

The usefulness of the translog function comes from computing its first derivatives, $\partial \ln C/\partial \ln w_i = (\partial C/\partial w_i)(w_i/C)$. Because $\partial C/\partial w_i$ equals the demand for the chosen input i, it follows that $(\partial C/\partial w_i)(w_i/C)$ equals the *payments to factor i relative to total costs,* which we denote by the cost-shares s_i. Thus, differentiating the cost function above with respect to $\ln w_i$, we obtain,

$$s_i = \alpha_i + \sum_{j=1}^{M} \gamma_{ij} \ln w_j + \sum_{k=1}^{K} \phi_{ik} \ln x_k, \quad i=1,\ldots,M.$$

Given annual data on factor cost shares, wages, and fixed inputs and outputs, this set of linear equations can be estimated over time for a given industry to obtain the coefficients γ_{ij} and ϕ_{ik}. Alternatively, the equations can be estimated for a single year, or the change between two years, by pooling data across industries. In the latter case, we are assuming that the *same* cost function applies across the industries. Despite this strong assumption, the cross-industry approach is popular and we will follow it here.

Now suppose that we have two chosen inputs – high-skilled and low-skilled labor. Focusing on the share equation for high-skilled labor, it will depend on wages for both types of labor, as well capital, output, and all other structural variables, z_n. When estimating the factor cost share relationship above by pooling data across industries, as in Berman, Bound and Griliches (1994) for the United States, researchers feel that the cross-industry variation in wages has little information: wages differ across industries principally due to quality-variation of workers, so we do not expect high-wage industries to economize on those (high-quality) workers. Accordingly, the wage terms are typically dropped from the right side of the factor cost share equation when pooling data across industries. This leaves just fixed capital, output, and other structural variables. Taking the difference between two years, the estimating equation for the wage-share of high-skilled labor (s_{nH}) in industries n=1,…,N becomes:

$$\Delta s_{nH} = \phi_0 + \phi_K \Delta \ln K_n + \phi_Y \Delta \ln Y_n + \phi_z{}' \Delta z_n, \quad n=1,\ldots,N,$$

where z_n denotes the vector of structural variables that shifts costs, and ϕ_z is the corresponding vector of coefficients. In particular, when the wage-share of high-skilled labor is increasing, we are interested in determining how much of that increase is due to changes in capital, output, and the structural variables.

Estimates of the above relationship for Hong Kong, from Hsieh and Woo (2005), are shown in Table 1.1. Columns (1)-(4) present results for the period 1981-1996, with and without the inclusion of several control variables. In each case the log change in the capital-output ratio (to control for capital-skill complementarity) and the log change in output (to control for cyclical output differences across industries) are included. Also included are controls for trends in skill upgrading prior to the period of interest and trends in global skill-biased technological change.

The key variable of interest is offshoring to China, which is measured by the log change in the share of intermediate imports from China to Hong Kong relative to total industry output plus intermediate imports. This measure captures the extent to which industry output in Hong Kong is increasingly reliant on the use of intermediate imports, or offshoring, from China. Evidence for this trend is made clear by Figure 1.8. This figure demonstrates that beginning around 1986 the use of Chinese inputs in the production of final exports by Hong Kong firms rose rapidly—i.e., Hong Kong began re-exporting goods that originated in China, likely as intermediate goods.

In an attempt to restrict the variation in the outsourcing measure to variation that is plausibly exogenous to changes in the demand for skilled labor, an instrumental variable strategy is adopted. Specifically, the value-added labor share of an industry in 1976 is used as an instrument for future offshoring. The results in Table 1.1 suggest a positive relationship between the outsourcing measure and the wage bill share of non-production (high-skilled) workers, with

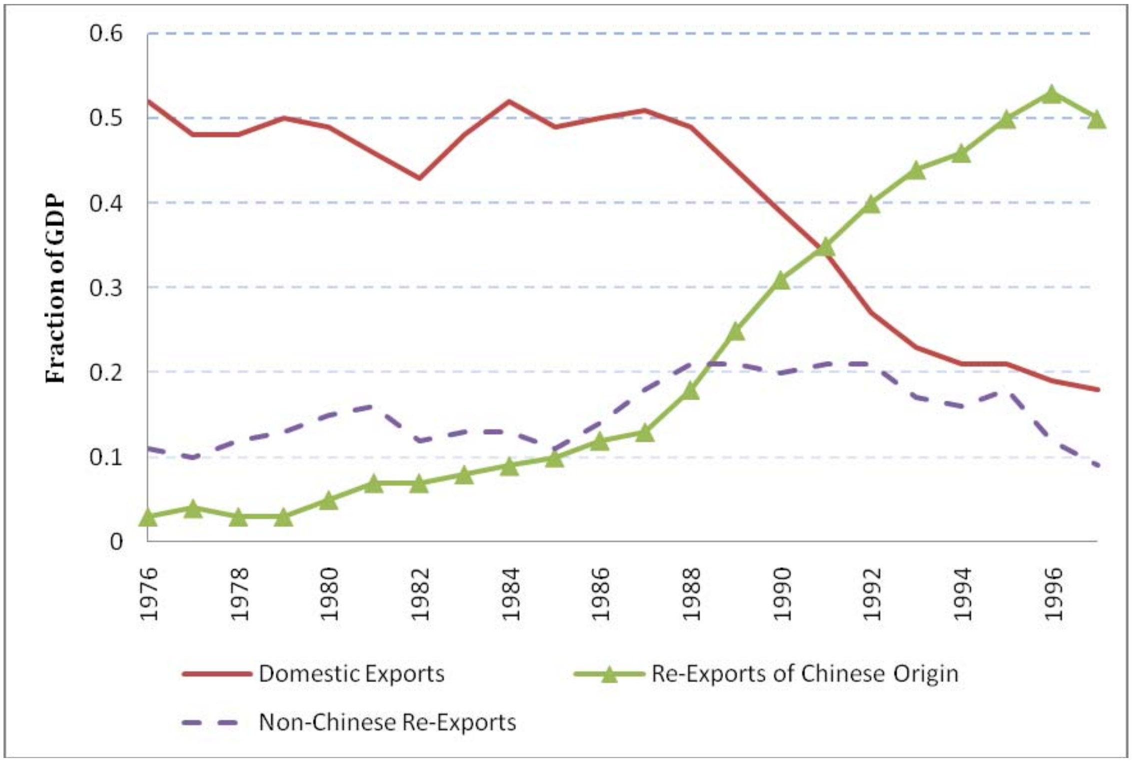

Figure 1.8: Exports & Re-Exports by Hong Kong Firms

Source: Hsieh and Woo (2005)

Table 1.1. Relationship Between Imported Intermediates from China and the Demand for Skill in Hong Kong, 1981-1996

Dependent Variable: ΔLn(non-production worker wage bill share)

Independent Variable	**(1)**	**(2)**	**(3)**
ΔLn[imported intermediate inputs /(shipments+imported intermed.)]	0.421 (0.183)	0.403 (0.155)	0.416 (0.174)
ΔLn(K/Y) and ΔLn(Y)	Yes	Yes	Yes
1971-1976 Trends	No	Yes	No
World Skill-Biased Technical Change	No	No	Yes

Note: Standard Errors in parentheses. Time-period dummies included. The 1971-76 time trend is the change in employment share of non-production workers in an industry over the period. Control for World Skill-Biased Technical Change is the worldwide rate of SBTC and the change in the wage-bill share of non-production workers in the U.S. The offshoring measure is instrumented with the value-added share of labor in production in 1976.

Source: Hsieh and Woo (2005)

little variation in the magnitudes of the effect across columns. Focusing on the coefficient in column (1), a one standard deviation change in outsourcing can explain 43 percent of the change in the wage-bill share of non-production workers over the period—clearly a large effect. So these results from Hong Kong support the model of Feenstra and Hanson whereby an increase in offshoring raises the relative wage of high-skilled labor. Evidence supporting the link between offshoring and wages (or employment) has also been found for many other countries.[1]

1.4 Alternative Model of Offshoring

Let me conclude this lecture by summarizing a second model of offshoring, due to Gene Grossman and Esteban Rossi-Hansberg (2008). These authors prefer to think of "tasks" performed by high-skilled or low-skilled labor, rather than "activities" that combine factors, which is what Feenstra and Hanson used. Grossman and Rossi-Hansberg present a simple two-sector model of the economy, where in each sector and for each factor there is a continuum of tasks. Any of these tasks could be offshored, and if that occurs, then the home firm will use its *own* technology abroad. While Grossman and Rossi-Hansberg do not specify whether the offshoring is done inside or outside of the firm, the fact that the home technology is transferred abroad suggests a multinational relationship between the firms.

Focusing first on low-skilled labor, offshoring one unit of task i from home (the U.S.) means that $\beta t(i)$ units of low-skilled labor must be employed abroad (such as in China). The tasks are ordered so that the function $t(i)$ is increasing, as shown in Figure 1.9. The amount $\beta t(i)$

1 Specifically, evidence has been found for Austria (Dell'mour et al, 2000; Egger et al. 2007; Lorentowicz et al., 2005; Marin, 2004), Denmark (Munch, 2008), Germany (Geishecker, 2002; Marin, 2004), Japan (Head and Ries, 2002), Mexico (Feenstra and Hanson, 1997; Hanson and Harrison, 1999), Sweden (Becker et al. 2005), the U.K. (Anderton and Brenton, 1999; Görg, et al 2001), and Western Europe (Crinò, 2007b, 2008). Recent evidence for the United States, including the offshoring of service activities, is provided by Amiti and Wei (2005a,b, 2006), Crinò (2007a), Ebenstein et al. (2009), Liu and Trefler (2008), Sitchinava (2008), Ottaviano et al. (2010), Voigtlaender (2008), and Wright (2010).

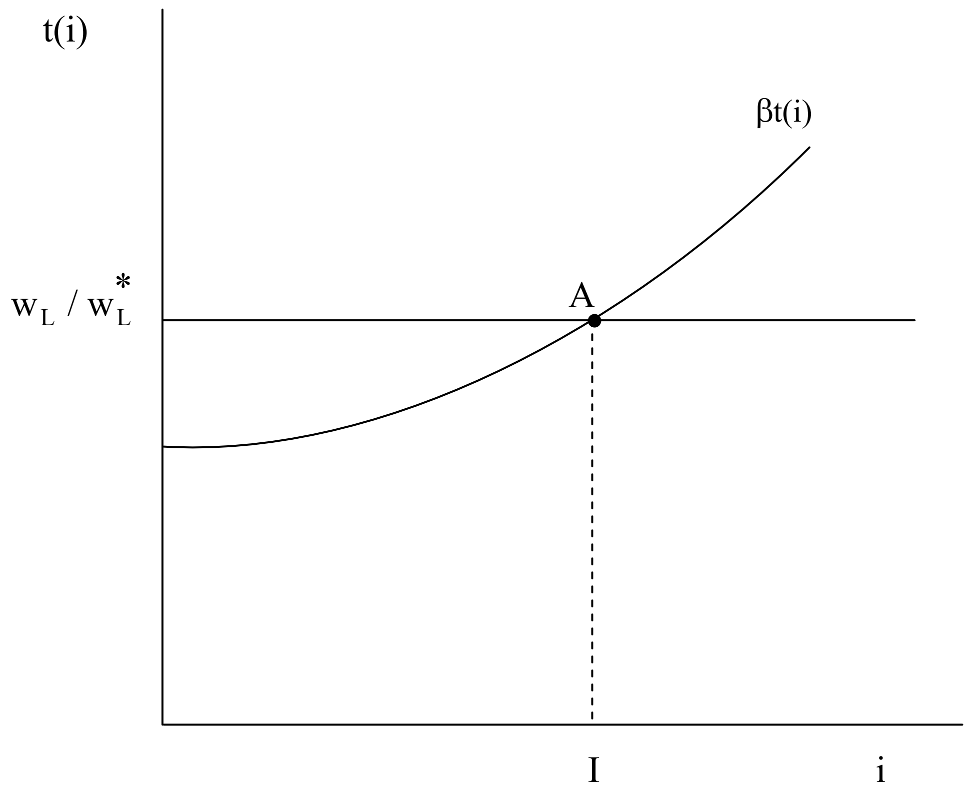

Figure 1.9: Equilibrium with Costs of Offshoring

indicates the "extra" labor that must be employed abroad to accomplish an additional task. This formulation is similar to Paul Samuelson's (1952) "iceberg" transport costs, in the sense that it is the services of low-skilled labor itself that gets used up in the offshoring process.

We follow Grossman and Rossi-Hansberg in further assuming that the offshoring costs $\beta t(i)$ are identical in the two sectors. Then the equilibrium amount of offshoring is determined where the costs of performing the borderline task abroad, or $w_L^* \beta t(I)$, equals its cost at home,

$$w_L^* \beta t(I) = w.$$

This equilibrium condition is illustrated in Figure 1.9, where the tasks for $i < I$ are offshored to the foreign country, and the tasks for $i \geq I$ and kept at home.

The equilibrium condition above needs to be supplemented with the zero-profit and the full-employment conditions to determine the full equilibrium. We will suppose for the moment that foreign wages are fixed, and also that the product prices of the two goods being produced are fixed, so we are treating the home country as small. Then the zero-profit conditions are that the sum of costs for domestic and offshored labor equals the price:

$$p_j = w_L a_{Lj}(1 - I) + w_L^* a_{Lj} \int_0^I \beta t(i) di + w_H a_{Hj}, \; j = 1,2.$$

Using the equilibrium offshoring condition $w_L^* \beta t(I) = w$, zero profits are re-written as:

$$p_j = w_L a_{Lj} \Omega(I) + w_H a_{Hj}, \;\; j = 1,2, \quad \text{where,} \quad \Omega(I) \equiv (1 - I) + \int_0^I t(i) di \, / \, t(I) < 1.$$

Notice that in this zero-profit condition, offshoring acts just like a low-skilled labor-saving technological innovation, or another form of skill-biased technological change. An increase in the range of offshored tasks, I, reduces the amount of labor needed at home, $\Omega'(I) < 0$.

Now suppose there is a reduction in the costs of offshoring, which is a fall in β. In Figure 1.10, there is an increase in the amount of offshoring as I increases to I', holding wages fixed for the moment. But in equilibrium, home wages will not be fixed, and to simultaneously determine the home wages and the equilibrium offshoring of tasks, we substitute the offshoring equilibrium condition again into the zero-profit condition to obtain:

$$p_j = w_L^* a_{Lj}[\beta t(I)\Omega(I)] + w_H a_{Hj}, \qquad j = 1,2.$$

With foreign wages w_L^* fixed from our small-country assumption, there are two equations to determine the two unknowns, which are the amount of offshoring I and the home skilled wage w_H. But we can easily guess at the solution to the above two equations: keep the home wage for skilled labor w_H fixed, and for any fall in β adjust the amount of offshoring I in both industries so that $[\beta t(I)\Omega(I)]$ is also fixed. In that way, the above zero-profit conditions continue to hold. If we hold $[\beta t(I)\Omega(I)]$ fixed at a constant k, then the range of offshoring tasks is determined by $t(I)\Omega(I) = k / \beta$. Note that while $\Omega'(I) < 0$, the function $t(I)\Omega(I) = (1 - I)t(I) + \int_0^I t(i)di$ is clearly increasing in I, since $d[t(I)\Omega(I)] / dI = (1 - I)t'(I) > 0$. It follows that with a fall in offshoring costs β, the equilibrium amount of offshoring I rises. Furthermore, since home wages for low-skilled workers are given by $w_L = w_L^* \beta t(I) = w^* k/\Omega(I)$, these also rise as offshoring increases, since $\Omega'(I) < 0$.

So the conclusion from the small-country version of the Grossman-Rossi-Hansberg model is that the wage of high-skilled labor at home, w_H, is unchanged, while the wage of low-skilled labor, w_L, increases. The reason for this result is that offshoring acts like a productivity increase for low-skilled labor: that group that gains the most from offshoring, because their

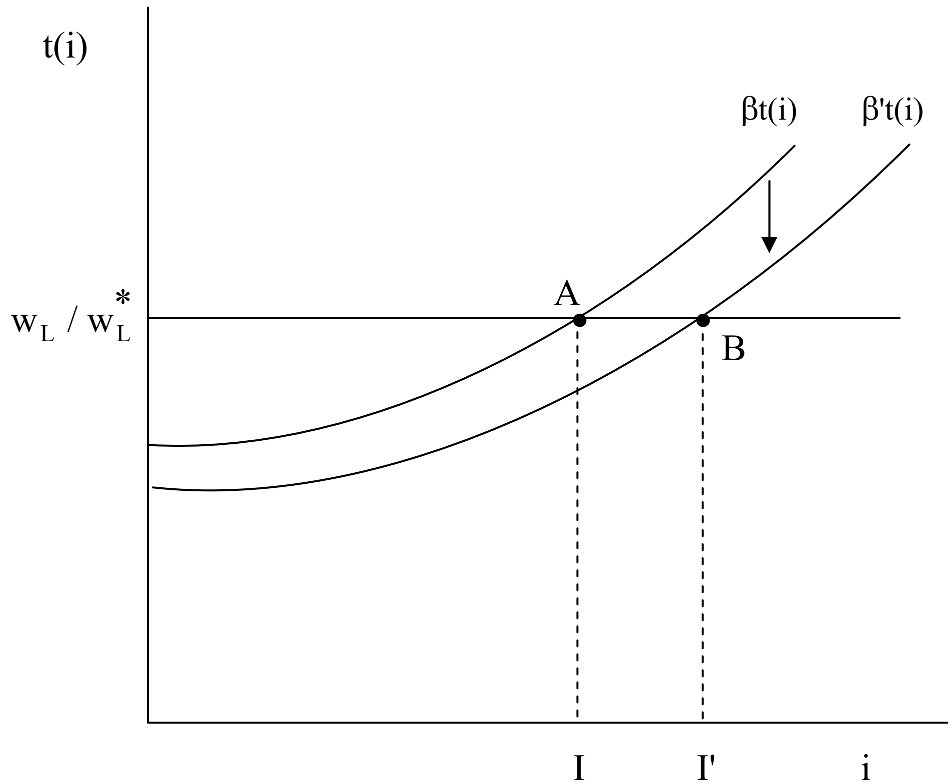

Figure 1.10: Reduction in the Costs of Offshoring

productivity is enhanced. But this result runs contrary to the evidence from the United States and China, where the relative wage of *high-skilled labor* has increased. The opposite result can re-appear in the model once we focus on the large-country case, where the product prices p_j, j = 1,2, are determined endogenously. In that case, we need to take into account how outputs change due to offshoring, and the resulting impact on prices.

The only way the low-skilled labor can remain fully employed at home in the presence of offshoring is for there to be a *magnified* increase in the output of the low-skilled-intensive sector. That result follows from the Rybczynski Theorem, which holds in a modified version here. Since both sector are offshoring the activities up to I, the full-employment condition for low-skilled labor is:

$$y_1 a_{L1}(1-I) + y_2 a_{L2}(1-I) = L\,,$$

which is rewritten as: $$y_1 a_{L1} + y_2 a_{L2} = L/(1-I).$$

Thus, a rise in offshoring will have the same impact on sector outputs as an effective increase in the endowment of low-skilled labor. Through the usual Rybczynski effect, this will have a magnified impact on the home output of the low-skilled-intensive sector, and thereby also raise that output on world markets and lower its relative price. By the usual Stolper Samuelson results, that will reduce the relative wage of low-skilled labor. So the price effect works against low-skilled labor, whereas the productivity effect of offshoring works in its favor. In general, either of these effects can dominate, so the relative wage can move in either direction.

To sharpen these results, suppose that preferences are Cobb-Douglas. We follow Grossman and Rossi-Hansberg in assuming that both industries in the foreign country is uniformly less productive than at home, applying the Hicks-neutral productivity disadvantage $A^*>1$ abroad. In addition, the home country still has the low-skilled labor technological advantage of $\Omega(\mathrm{I}) < 1$ due to offshoring, as described above. It is still possible that there is "adjusted factor price equalization", meaning that $w_L\Omega = w_L^* A^*$ and $w_H\Omega = w_H^* A^*$, as we shall assume. The fact that the ratio of effective factor prices $w_L\Omega / w_H$ and $w_L^*\Omega / w_H^*$ are then equal across countries means that the factor intensities are also equal, $a_{Lj} = a_{Lj}^*$ and $a_{Hj} = a_{Hj}^*$, for industries j = 1,2, where $A^* a_{Lj}^*$ and $A^* a_{Hj}^*$ are the foreign labor requirements per unit of output. The cost shares are then $\theta_{Lj} \equiv w_L \Omega a_{Lj} / p_j = w_L^* A^* a_{Lj}^* / p_j$ for low-skilled labor, and $\theta_{Hj} \equiv w_H \Omega a_{Hj} / p_j = w_H^* A^* a_{Hj}^* / p_j$ for high-skilled labor.

With this notation, we can state the conditions under which the price effect dominates the productivity effect, so that the relative wage of high-skilled labor rises with offshoring, or when the converse result holds:

<u>Proposition 1</u> (Feenstra, 2010)

Suppose that demand in both countries is Cobb-Douglas, with expenditure shares on the two goods of α_j, j = 1,2. Then if the elasticities of substitution in production σ_j are sufficiently less than unity and the home country is sufficiently large, so that the following inequality holds:

$$\sigma_j < \frac{L/\Omega}{(\frac{L}{\Omega} + \frac{L^*}{A^*})} - \left\{ \frac{L^* / A^*}{(\frac{L}{\Omega} + \frac{L^*}{A^*})} \left[\frac{\alpha_1 \alpha_2 (\theta_{H1} - \theta_{H2})^2}{\alpha_1 \theta_{H1} \theta_{L1} + \alpha_2 \theta_{H2} \theta_{L2}} \right] \right\}, \text{ for } j = 1,2,$$

then the price effect dominates the productivity effect, so that the relative wage of high-skilled labor rises with increased offshoring. If this inequality is reversed for j = 1,2, then the relative wage of high-skilled labor falls instead.

From this result, we see that a necessary condition to obtain a rise in the relative wage of high-skilled labor is that the elasticities of substitution in production are less than unity (as obtained from the above inequality when $L \rightarrow \infty$). That was the case in the model by Feenstra and Hanson (where it was assumed that the elasticities of substitution in production were zero). Conversely, if the inequality in Proposition 1 is reversed, then the productivity effect necessarily dominates the price effect, and the relative wage of high-skilled labor will fall due to offshoring. That is the result in the small-country version of the model by Grossman and Rossi-Hansberg.

Even without Cobb-Douglas preferences, results similar to the large-country case (with elasticities of substitution less than unity) occur if there are more factors than goods. For example, suppose there is only a single sector in both countries. That good will still be traded to compensate for the labor earnings from offshoring. In this case, Grossman and Rossi-Hansberg argue that there is a third effect at work, which they call the labor-supply effect. The effective increase in low-skilled labor due to the productivity effect cannot be absorbed by Rybczynski-like reallocation across sectors, and instead will lead to a fall in the relative wage of low-skilled labor. In this case, it turns out that if the initial amount of offshoring is small, then the labor-supply effect will definitely dominate the productivity effect, so that the relative wage of low-skilled labor falls.

So in the end, the large-country version of the model by Grossman and Rossi-Hansberg has similar predictions to what was obtained from my own earlier model with Gordon Hanson. The benefit of the new model, however, is that it can also allow for the offshoring of high-skilled labor, which is a phenomenon that is happening between the United States and India, in particular. In addition, this new model can be extended to explain both foreign offshoring to processing firms in China, as well as offshoring within multinational corporations in China.

Since China's accession to the WTO in 2001, there has been an enormous increase in the activities of multinational enterprises in China, particularly within the processing trade sector. In the next lecture, I will start by showing how the model by Grossman and Rossi-Hansberg can be extended to explain that phenomenon, as well as other differences between foreign outsourcing to Chinese companies and offshoring within multinational enterprises.

<u>Lecture 2</u>: Theory of the Processing Firm

In Lecture 1, I argued that one of the most remarkable features of international trade in the Chinese economy is the extent to which the country has embraced processing trade. China continues to serve as a site for offshoring production from other countries. In this lecture, I want to talk in more detail about what we mean by offshoring, which in its broadest conception deals with the organization of international trade and investment. To understand what I mean here by "organization," it is easiest to go back to the definition of economics that we give in our introductory classes: the study of *what* to produce; *how* to produce it; and *for whom* to produce it. The field of international trade has been primarily concerned with what goods should a country produce, and for whom to export the goods. Deciding what to export, and conversely what to import, is the old question of the pattern of international trade. While this will continue to be an important issue for research, attention has recently shifted to the question of *how* to organize the production of goods.

There are two distinct ways to answer the question of *how*. First, we need to determine *which country* production occurs in, and that is what offshoring means: if part of the production process is shifted overseas, then it is offshored. Second, there is the question of whether to keep the process *within the firm* or not: if it sent outside the firm, then it is outsourced. This second question can only be answered by reference to a theory of the boundaries of the firm, developed outside the assumption of perfectly competitive markets. This question has recently been addressed by scholars in international trade such as Pol Antràs, Gene Grossman, Elhanan Helpman, and many others, who are showing how insights from the literature on the "organization of the firm" can be applied to questions of international trade. These are the issues that I shall address in this second lecture.

2.1 Outsourcing versus Offshoring

The terms “foreign outsourcing” and “offshoring” are often used interchangeably, so it is useful at the outset to define them carefully. Consider a firm that it making a decision about where and how to engage in a portion of its production process: the assembly of components, for example, or research and development. We represent the choices of this firm in Figure 2.1. Along the side of the diagram, the firm can engage in this process at home or in a foreign country. Along the top of the diagram, the firm can decide whether to keep the process within the firm, which is “vertical integration,” or whether to “outsource,” which is contracting with another firm. In the case where the process is kept at home, we therefore have either “domestic integration” within the firm, or “domestic outsourcing” outside the firm. Conversely, if the production process is sent abroad, then the production occurs either within a vertically integrated “multinational firm,” or in the final case where production is sent abroad outside the firm, we have “foreign outsourcing.” This exhausts the four possibilities.

Where does “offshoring” enter the picture? A narrow definition of offshoring, used sometimes in business circles, is when a firm sends a portion of its production process abroad but keeps it in-house, so it becomes a multinational: this is the lower-left cell in Figure 2.1. Under this narrow definition, offshoring and foreign outsourcing are two distinct strategies of the firm. But a more common definition of “offshoring” is that it encompasses both the multinational strategy *and* foreign outsourcing, i.e. it refers to any transfer of production overseas, whether it is done within or outside the firm. Under this definition, “offshoring” encompasses both choices in the lower row of Figure 2.1. Grossman and Rossi-Hansberg (2008) use this broader definition of offshoring, as I will do here.

Ownership of Production Process

Location of Production Process		Vertical Integration	Outsource
	Home Country	Domestic Integration	Domestic Outsourcing
	Foreign Country	Multinational	Foreign Outsourcing

Figure 2.1: Organization Choices for the Firm

There has been a flourishing of research in international trade dealing with the organizational choices of the firm as illustrated in Figure 2.1. The decision of whether to outsource or not, i.e. whether to locate activities inside or outside the firm, is analyzed by using a theory of the boundaries of the firm. One popular theory is the property-rights approach of Grossman, Hart and Moore (Grossman and Hart, 1986, Hart and Moore, 1990), under which firms are just collections of agents, some of whom are engaged in production (call them workers) and others sell the final good (call them managers). Both parties obtain disutility from exerting effort, and it is assumed that it is impossible to write a contract for payment contingent on these efforts, so that the first-best, competitive outcome cannot be obtained. As a result, workers and managers share the surplus (or profits) under Nash-bargaining, which creates an inherent inefficiency in the amount of effort each party is willing to exert.

One way to offset this inefficiency is to break apart the firm, so that the production processes are outsourced. In that case, the workers engaged in production become self-employed and have better incentives to provide high effort. But the first-best is still not achieved because those self-employed workers are still subject to a "hold up" problem: the firm they are selling to cannot credibly promise to pay them at first-best levels for their output (because contracts cannot be written), so efforts are still second-best. Conversely, when the firm is integrated, then the incentives of the managers (who are the owners) are improved, because under the property-rights approach they have the residual right of control over all assets. In particular, this means that they have the right to seize the output of the workers performing the tasks that are now integrated. This improves the outside options of the owners should Nash bargaining break down, and improves their efforts, but worsens the incentives for the workers employed in the integrated firm.

So we see that outsourcing versus integration have differing incentives on the effort levels of the two parties. Depending on which organizational choice gives the highest joint surplus, the firm will integrate or not. These ideas have a natural application in international trade where we assume that the difficulties in enforcing contracts are more severe *across* countries than *within* countries. For example, Antràs (2005) assumes that contracting problems and Nash-bargaining only occur *across* countries, and furthermore, only affects the labor-intensive portion of production; the capital-intensive portion is performed in the North. Wages are cheaper in the South, so the firm wants to shift the labor-intensive portion of production there, but in so doing faces the inefficiencies due to incomplete contracts and bargaining discussed above. Antràs (2003) argues that it is optimal for highly capital-intensive Northern firms to keep Southern production in-house, i.e. to operate as a multinational, whereas more labor-intensive Northern firms will outsource the production activity to the South. Antràs (2005) extends this model to allow for exogenous reductions in the capital-share parameter as the product matures, leading to a natural product cycle as the firm moves from the North to the South, and from integration to outsourcing.

Antràs and Helpman (2004) further allow for heterogeneity in the productivity of Northern firms, leading to a more complete choice between the four organizational forms displayed in Figure 2.1.[2] Fernandez and Tang (2011) have recently applied the insights of the Antràs and Helpman (2004) model and the work of Feenstra and Hanson (2005) to analyze processing trade in China, using a property-rights approach. The main goal of this lecture is to explain this recent work of Fernandez and Tang (2011). Before that, however, I return to the model of Grossman and Rossi-Hansberg (2008) that was introduced in Lecture 1.

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[2] See also the papers summarized in Helpman (2006) and Helpman, Marin and Verdier (2009).

2.2 Application of Grossman-Rossi-Hansberg Model

In Lecture 1, I did not deal with the outsourcing decision, but only the choice of whether to offshore or not. The first model that I discussed, due to Feenstra and Hanson (1996, 1997), has arms-length transactions between firms at home and abroad. Both factor prices and technologies differ across countries. Feenstra and Hanson refer to this as a "foreign outsourcing" model, which is accurate in the sense that the parties involved are at arm's length: the choice is whether to shift more activities overseas, which is moving between the left and right cells on the bottom row of Figure 2.1. Following that, I turned to the more recent model of Grossman and Rossi-Hansberg (2008), which also has factor prices differing across countries. Foreign technology differs from that at home, but if the domestic firm shifts production abroad, then it *carries with it the home technology*. For that reason, we might think of this model as applying to a home firm shifting its own technology abroad, without suffering any adverse consequences from sharing the technology with a foreign partner. In other words, the model can be interpreted as the choice between the top and bottom cells on the left column of Figure 2.1, i.e. whether a domestic integrated firm should become a multinational. I stress that this is only an interpretation, and the ownership structure in Grossman and Rossi-Hansberg (2008), like in Feenstra and Hanson (1996, 1997), is not explicitly discussed.

I would now like to turn to an extension of the Grossman and Rossi-Hansberg model, in which we do explicitly introduce a difference between outsourcing to Chinese firms and offshoring within a multinational enterprise. This extension is due to Zhiyuan Li, at the Shanghai University of Finance and Economics.

In the model of Li (2010), firms are motivated to choose the organizational form for each offshored task based on the prospect for savings in factor costs. Foreign subsidiaries of multinationals in the North (the United States) benefit from lower communication costs when they perform offshored tasks in the South (think of China), but must pay an efficiency wage premium to prevent their workers from shirking.[3] Efficiency wages stem from imperfect international monitoring, and the ability to monitor workers' efforts depends on proximity. For multinational offshoring, shirking in the South can only be partly detected by the headquarters in the North. However, monitoring within arms-length suppliers located in the South is perfect due to onsite monitoring by their owners. Thus, foreign subsidiaries of multinationals must pay a higher efficiency wage than local firms, $w_m > w^*$, in the South.

While outsourcing to an arm's-length supplier in the South does not require these higher wages, it still requires higher communication costs. For example, it is easier to arrange a face-to-face meeting within the multinational firm than between arms-length parties. This trade-off thus generates different offshoring cost schedules for these two organizational forms. Li (2010) shows that multinationals can have the offshoring costs $\beta t(i / K_m)w_m$, whereas outsourcing to a Chinese firm has the costs $\beta t(i / K_o)w^*$, where $K_m > K_o$ reflects the better communication technology of the multinationals. In Figure 2.2, the curve with steeper slope is the offshoring cost schedule for outsourcing and the other curve is for multinational offshoring. The higher offshoring cost of multinational production at the point where $i = 0$ is due to the relatively higher efficiency wage paid to their workers. On the other hand, the steeper slope of the arms-length outsourcing cost curve is due to higher communication costs in arms-length suppliers.

The set of tasks performed in different organizational forms are determined endogenously by which organization has the lowest cost. So in Figure 2.2, *outsourcing* is done for the tasks in

[3] The use of "North" and "South" to denote an industrial and developing country, respectively, is common in some economic models. This convention does not fit China very well, however, since it is in the northern hemisphere but is a "southern" country in the model. Perhaps it would be better to use "East" (for China) and "West" (for the U.S.). But to maintain similarity with the literature, we continue to use North (for the U.S.) and South (for China).

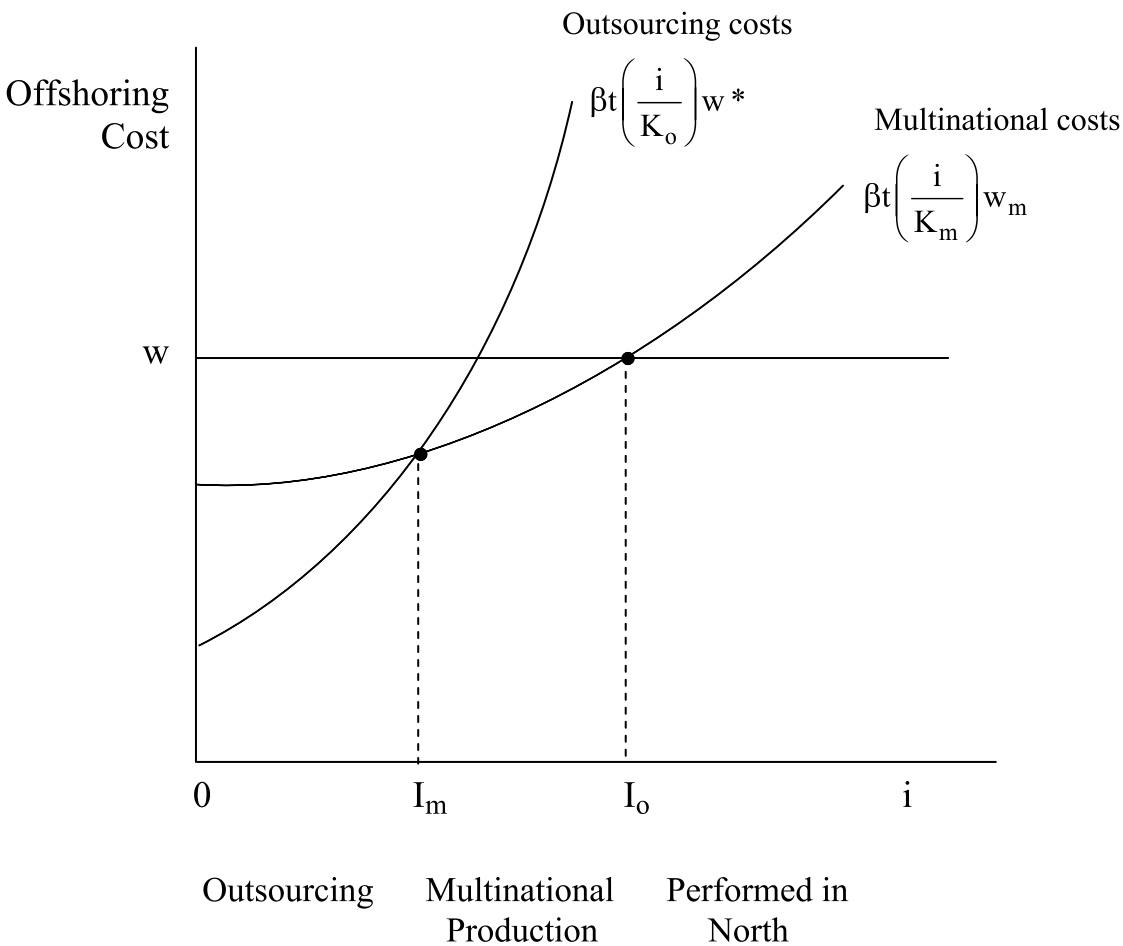

Figure 2.2: Choice of Organizational Form under Offshoring

Source: Zhiyuan Li (2010)

the range $[0,I_m]$, while multinational offshoring is done for the tasks in the range $[I_m,I_o]$, and the Northern firm does production at home for the tasks in $i > I_o$. As in the model of Grossman and Rossi-Hansberg, these ranges respond to a reduction in offshoring costs, which is modeled as a drop in β. With a reduction in β to β', the direct effect is a proportional drop of the two curves, as illustrated in Figure 2.3. In that case the lowest cutoff task for multinational production, I_m, does not change, but the highest cutoff task for multinational production, I_o, shifts to the right, as illustrated by I'_o. Therefore, the direct impact of a fall in offshoring costs is an expansion in the range of tasks undertaken by multinationals in the South.

There is a further indirect effect due to a reduction of the efficiency wage, which stems from a larger opportunity cost of shirking. Since the labor demand for performing each unit of task is the offshoring cost, β, times the unit labor requirement in the developed country, a reduction of β decreases the labor demand in multinationals and thus reduces w_m, causing a higher opportunity cost of shirking for the workers. This indirect impact leads to a further shift downwards in the multinational offshoring curve, which moves the cutoff task I_o further to the right and the cutoff task I_m to the left, as illustrated in Figure 2.3. Both the direct and indirect effects make multinational offshoring become more prevalent.

Li (2010) goes one step further to argue that in industries where more frequent communication is needed, this effect is stronger. The intuition is simple. For industries demanding more frequent communication, the outsourcing cost curve becomes relatively steeper than that of multinational offshoring. This makes multinational offshoring more attractive relative to arms-length offshoring. Thus, the reduction in offshoring costs makes multinational offshoring even more prevalent.

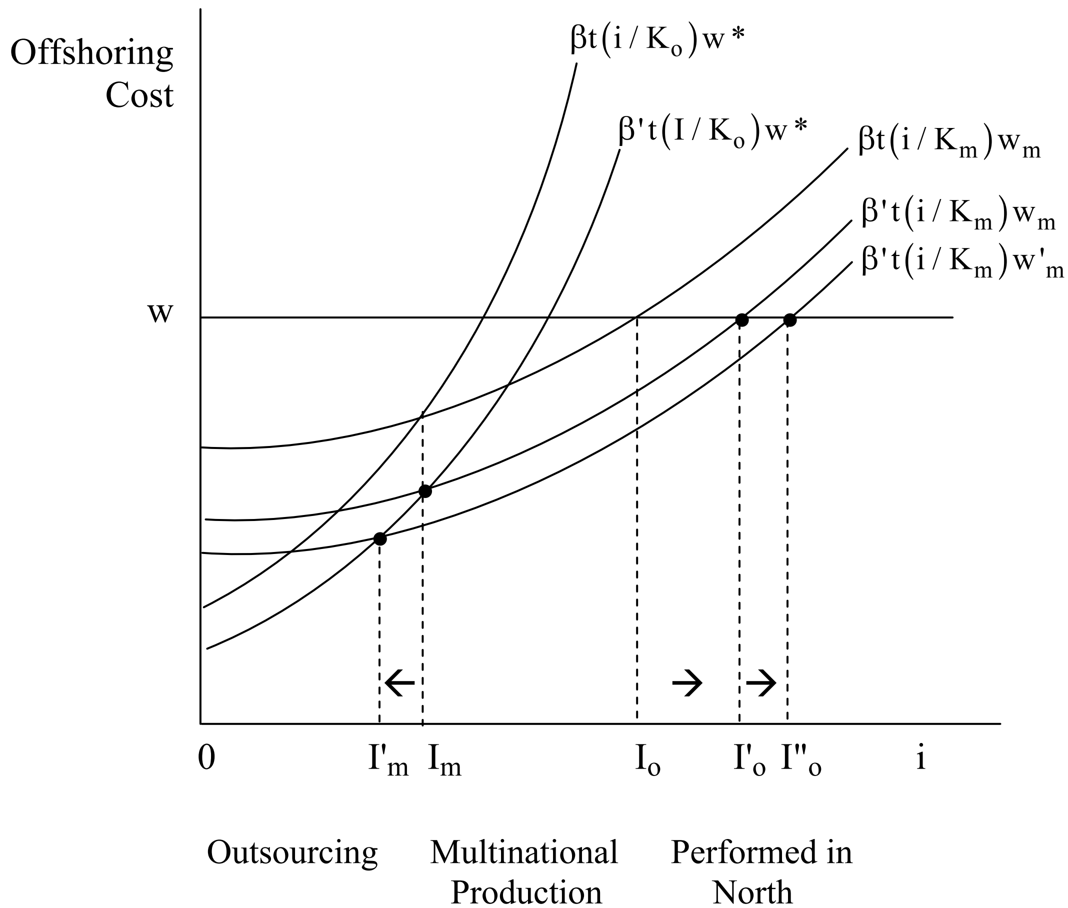

Figure 2.3: Fall in Offshoring Costs from β to β'

Source: Zhiyuan Li (2010)

Let us now confront the prediction of Li's model with the evidence for China. Since early in the new century, there has been a dramatic increase in processing exports by multinational corporations in China. This is shown in Figure 2.4, where there has been tremendous growth in processing exports by wholly-foreign-owned enterprises. Some amount of this increase is likely explained by a loosening of Chinese restrictions on foreign investment with its accession to the WTO. But that cannot be the whole story, since these wholly-foreign-owned enterprises *did not* enter into exporting of ordinary trade, as shown in Figure 2.5. For ordinary trade, the dramatic increase has been by domestic-owned enterprises.

Li's model is able to explain the fact that China's multinational offshoring increased much more rapidly than arms-length outsourcing from 1992 to 2008. Presumably, during these years the cost to engage in offshoring with China decreased due to China's accession to the WTO in 200, the introduction of new export processing zones (Demurger, *et al,* 2002), etc. This reduction in β leads to an expansion of multinational activity in processing trade as shown in Figure 2.3. In his empirical work, Li tests this prediction by examining how reductions in offshoring costs that are due to the establishment of export processing zones (EPZs) affect the organization of Chinese offshoring. Formally, Li tests the following empirical specification:

$$\text{Multinational}_{jct} = \alpha_{jc} + \alpha_t + \beta_1 \text{EPZ}_{ct} + \beta_2 \text{EPZ}_{ct} \times \text{Communication}_j + \theta X_{ct} + \varepsilon_{jct},$$

where the dependent variable, $\text{Multinational}_{jct}$, is the multinational offshoring share of product j in city c in year t; EPZ_{ct} equals to unit if city c has an export processing zone in year t, and equal to zero otherwise; $\text{EPZ}_{ct} \times \text{Communication}_j$ is the interaction of the EPZ indicator and a measure of communication intensity, which is normalized to lie between zero and unity. Other control variables such as other policy zone dummies, non-agriculture population, the number of

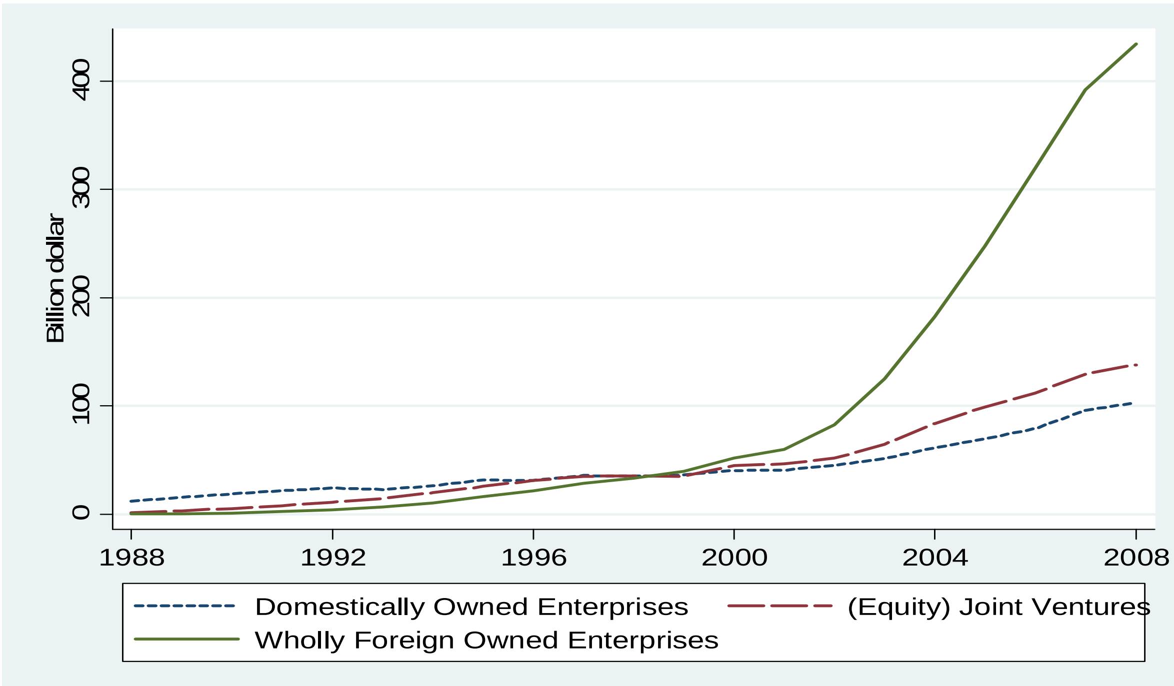

Figure 2.4: Chinese Processing Exports by Firm Ownership, 1988-2008

Source: China Customs trade data

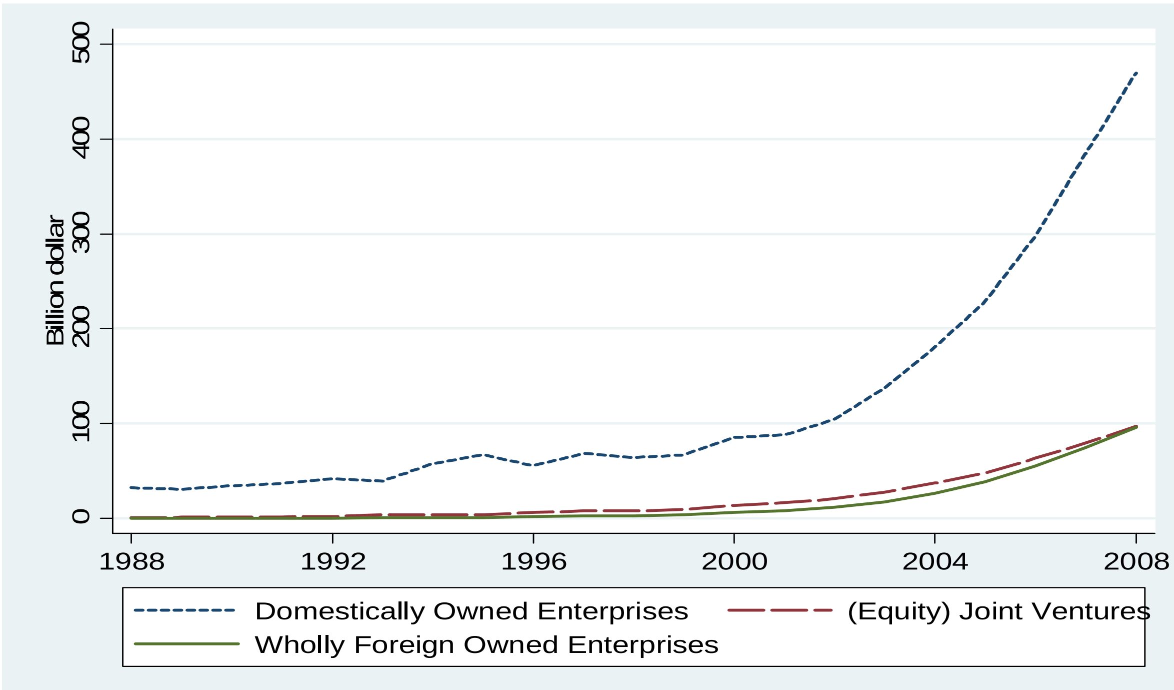

Figure 2.5: Chinese Ordinary Exports by Firm Ownership, 1988-2008

Source: China Customs trade data

students in secondary schools, and a proxy of transportation infrastructure are included in the vector X_{ct}. In order to control for the possibility that an EPZ is established only when $\text{Multinational}_{jct}$ increases fast enough, a second specification is tested, called the "random trend model", which simply adds a time trend, $\gamma_{jc}t$.

The estimation results are shown in Table 2.1, where we focus on the second specification that includes a time trend. The results show that for the least communication intensive industries, there is no significant change to the multinational offshoring share when the city establish an EPZ (the coefficient of EPZ_{ct} is negative and insignificant). But for communication-intensive industries, the establishment of an EPZ has a substantial impact on expanding multinational exports (the coefficient of $\text{EPZ}_{ct} \times \text{Communication}_j$ is positive and significant at the 5% level). Indeed, the establishment of the EPZ can lead to an eight percentage point (9.01–1.05=7.96) increase in the multinational offshoring share for the most communication-intensive industries in that city. Since there were close to fifty EPZ's established in China since its accession to the WTO, an eight percent increase in exports from each of this cities is a sizable effect.

2.3 Processing Trade and the Property Rights Theory of the Firm

This model by Zhiyuan Li that I have discussed addresses the question of whether the Chinese plant had to be *owned by* (or *internalized within*) the multinational or not. To answer this, the model appealed to communication costs within the firm. This is just one of several reasons why a headquarters firm might decide to enter into joint venture or some other contractual arrangement with a Chinese firm rather than just purchasing goods from it. The more general reason that is given for a firm to organize through vertical integration versus outsourcing is *transactions costs,* which we introduced in the beginning of this lecture, and return to now. Let

Table 2.1: Effect of Reductions in Offshoring Costs on Firm Organization in China

Dependent variable: Processing export share by wholly foreign owned firms

	Basic Model		**Random Trend**	
Estimation Method	Within	FD	Within	FD
	(1)	(2)	(3)	(4)
EPZ Dummy	-6.02***	-1.60	-1.05	-0.94
	(1.68)	(1.18)	(1.11)	(1.16)
EPZ*Communication	11.28*	10.97**	9.01**	9.01**
	(6.17)	(4.56)	(4.22)	(4.15)
High-tech Dummy	2.54*	2.52*	2.56*	2.45
	(1.53)	(1.39)	(1.31)	(2.02)
Non-agriculture Population	2.08**	4.67***	3.76***	4.35***
	(0.95)	(0.74)	(0.75)	(0.75)
Secondary School Student	13.78*	12.71	7.68	2.64
	(8.28)	(8.29)	(6.73)	(5.37)
Transportation Infrastructure	0.042*	0.106***	0.083***	0.11***
	(0.022)	(0.018)	(0.018)	(0.019)
Constant	14.55***		0.51	
	(3.80)		(0.33)	
Product-city fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Product-city trend	No	No	Yes	Yes
Observations	38,5923	291333	291,333	228,003
Product-city pairs	92,108		63,323	
Within R-squared	0.083	0.014	0.003	0.002

Note: Cluster robust standard errors at city level are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable: Multinational, calculated by wholly foreign owned firm's processing exports divided by overall processing exports, times 100. FE: Fixed effect panel estimation; FD: First differencing panel estimation.

Source: Zhiyuan Li (2010)

me now explain the mathematics behind the transactions cost approach, and apply it to processing trade in China.

Nash Bargaining

The starting point for all transactions costs models is the concept of Nash Bargaining. Proposed by John Nash (1950), this approach gives a simple solution to a bargaining game satisfying certain axiomatic properties. In particular, suppose that there are two agents labeled as h and m. For example, h could be the "headquarters" of a company that is negotiating with a plant "manager" m to build a product. For now, we will keep the application simple and suppose that h and m are bargaining over some reward, or rent, denoted by R. We specify that the two agents might have different bargaining weights, which are denoted by β for the headquarters and (1-β) for the manager. Furthermore, these two agents have different payoffs that they can get if the bargaining breaks down altogether. In that case, they receive their outside options or threat-point payoffs of R_0^h and R_0^m. Later we will specify that these payoffs depend on the claim that the owner (which can be the headquarters or manager) has to the output of the firm, leading to the *property rights* approach. But for now, these outside options can be any non-negative values that sum to less than R. Then Nash proposed that the solution to the bargaining game between the two agents would be given by:

$$\max_{R^h, R^m} \left(R^h - R_0^h\right)^{\beta} \left(R^m - R_0^m\right)^{(1-\beta)} \text{ subject to } R^h + R^m = R.$$

This objective function is like a Cobb-Douglas function with weights β and (1-β). The reader will guess that the solution gives the payoffs $(R^h - R_0^h)$ and $(R^m - R_0^m)$ in the relative shares β and (1-β), so that $(R^h - R_0^h) = \beta\tilde{R}$ and $(R^m - R_0^m) = (1-\beta)\tilde{R}$. These solutions will satisfy the constraint $R^h + R^m = R$ provided that $R^h + R^m = \tilde{R} + R_0^h + R_0^m = R$, so that $\tilde{R} = R - R_0^h - R_0^m$. The magnitude $\tilde{R}$ is sometimes called the "quasi-rents" of the game, since it is the rents available to the agents over and above their threat-point payoffs. It follows that the Nash-bargaining solution is:

$$R^h = R_0^h + \beta(R - R_0^h - R_0^m), \text{ and } R^m = R_0^m + (1-\beta)(R - R_0^h - R_0^m).$$

In the work by Antràs and Helpman (2004), they made a simplification to this Nash bargaining solution by supposing that the threat-point payoffs are themselves proportional to the rents R. For example, suppose that $R_0^h = \rho^h R$ and $R_0^m = \rho^m R$. Then the payoffs in the Nash bargaining solution can instead be written as:

$$R^h = \rho^h R + \beta R(1-\rho^h - \rho^m) = \beta^h R, \text{ where } \beta^h \equiv \rho^h + \beta(1-\rho^h - \rho^m)$$

and $$R^h = \rho^m R + (1-\beta)R(1-\rho^h - \rho^m) = \beta^m R, \text{ where } \beta^m \equiv \rho^m + (1-\beta)(1-\rho^h - \rho^m).$$

This structure of payoffs is important, because it shows that agent h will take actions in order to maximize not the entire rent R, but rather, the portion $\beta^h R$ (minus the costs to h of taking such actions). Likewise, agent m will take actions in order to maximize $\beta^m R$ (minus the costs to m of taking such actions). We refer to β^h and β^m as the *ex-post bargaining weights* of the two agents, and note that $\beta^h + \beta^m = 1$ by construction, so that we really only need to solve for the ex-post bargaining weights of one agent (say, the headquarters).

Let us further suppose that the total rent $R(x_h, x_m)$ depends on the actions x_h and x_m chosen by the two agents, which might be labor inputs with alternative wages w_h and w_m, for example. Then using the above payoffs, it follows that agent h chooses his labor input to solve the problem:

$$x_h^* \equiv \underset{x_h}{\arg\max} \ \beta^h R(x_h, x_m) - w_h x_h \quad , \tag{H}$$

while agent m chooses her labor input to solve the problem:

$$x_m^* \equiv \underset{x_m}{\arg\max} \ (1-\beta^h) R(x_h, x_m) - w_m x_m \, . \tag{M}$$

This setup makes it clear that the solutions to these problems will usually be quite different from the first-best (FB) outcome, which would solve the problem:

$$\max_{x_h, x_m} \ R(x_h, x_m) - w_h x_h - w_m x_m \, . \tag{FB}$$

If the two agents worked together to maximize the total surplus available to them, without thinking about how these surplus would be divided, then they would act according to (FB). But when they act non-cooperatively to maximize their respective shares of the surplus, then with Nash-bargaining they act according to (H) and (M). Notice that the sum of the solutions to problems (H) and (M) is:

$$R(x_h^*, x_m^*) - w_h x_h^* - w_m x_m^* \, , \tag{NB}$$

which we label as the Nash-bargaining (NB) solution. In general, the Nash-bargaining solution cannot exceed the first-best, and in many examples will be strictly less. This illustrates the inherent inefficiency of bargaining solutions. Let us know see how this inefficiency works itself out when a firm makes its organizational choice to offshore to China.

Model of Processing Trade in China

In the work of Antràs and Helpman (2004), a headquarters firm h in the North is deciding whether to outsource some of its work to a plant with manager m, and whether this plant should be located in the North or the South. The decision for the headquarters is as depicted in Figure 2.1, where we let $k \in \{V, O\}$ denote the ownership structure of the plant (vertically integrate or outsource), and we replace Home and Foreign with North and South, letting $\ell \in \{N,S\}$ denote the plant location in either one of these countries.

Antràs and Helpman (2004) present their work as an application of the property-rights approach to the theory of the firm, but they did not actually expect to be able to test their model. Contrasting the results of their model with the alternative approach of Grossman and Helpman (2002) and Holstrom and Milgrom (1994), they state that: "… it is hard to see how to test these predictions with the available data."

Surprisingly, the data needed to test a version of their theory *is* available, from the Chinese trade statistics. Those statistics keep track of the ownership of firms making exports. In addition, the Chinese trade statistics keep track of whether imports and exports are for ordinary or processing trade, and *within* processing trade, whether it falls into the categories "processing with supplied materials" or "processing with imported materials." Feenstra and Hanson (2005) called the former category "pure assembly," meaning that the inputs are provided by the firm outside of China, and the latter category "import and assembly," meaning that the firm in China make the decision of what inputs to buy. So focusing just on processing trade, we obtain the organizational choices shown in Figure 2.6.

Analogous to Antràs and Helpman (2004), we will let $k \in \{V,O\}$ denote the ownership structure of the plant in China, and now let $\ell \in \{N,S\}$ denote the party who has control over the inputs decision: "North" indicating a U.S. or other headquarters outside of China, and "South" indicated the plant within China. For example, vertical integration (k = V) in the first column indicates that the Northern headquarters owns the plant, so it is a foreign-owned firm operating in China. In the second column, outsourcing (k = O) means that a firms abroad in contracting with a firm in China to assemble a product. In either case, the inputs used in the assembly can be

Control Over Input Choices, $\ell \in \{N,S\}$	**Ownership of Production Process,** $k \in \{V,O\}$: North/Foreign (vertically-integrate)	South/Chinese (outsource)
North/Foreign (pure-assembly)	Foreign-owned firm, choosing its inputs $\beta_V^N \equiv \delta + \beta(1-\delta)$	Chinese-owned firm, foreign choice of inputs $\beta_O^N \equiv \gamma + \beta(1-\gamma)$
South/Chinese (import-and-assembly)	Foreign-owned firm, Chinese choice of inputs $\beta_V^S \equiv \delta + \beta(1-\delta-\gamma)$	Chinese-owned firm, choosing its inputs $\beta_O^S \equiv \beta(1-\gamma)$

Figure 2.6: Organization Choices for the Firm in China

under the control of the foreign, Northern headquarters ($\ell = N$) or under the control of the Southern, Chinese manager ($\ell = S$).

Feenstra and Hanson (2005) developed a theory of firm ownership and control that fits the choices shown in Figure 2.6, and applied it to processing trade in China. Their theory uses the property rights approach, but is partial equilibrium. Recently, Fernandes and Tang (2011) developed a version of that theory that combines elements of both Antràs and Helpman (2004) and Feenstra and Hanson (2005), and is again applied to processing trade in China. I will present a simplified version of the Fernandes and Tang (2011) model, that allows us to analyze the organizational choices illustrated in Figure 2.6.

As in our earlier discussion, we assume that the headquarters has Nash bargaining weight β and the Chinese manager has weight $(1-\beta)$. Then we need to specify the outside options of the parties under each form of organization to determine the ex-post bargaining weights. The most important assumption of the property-rights approach is that the owner of a vertically-integrated firm is entitled to the output in the case of disagreement with the manager, so that Nash bargaining breaks down. We will suppose that there is still some loss in output, however, reflecting the idea that the production process is not completed with bargaining breaks down. Denoting the first-best revenue by R, in the case of disagreement we suppose the Northern headquarters of a vertically-integrated firm obtains the outside option $R_V^N = \delta R$. The manager in this case receives an outside option of zero. Using the notation introduced above, it follows that the ex-post bargaining weight of the headquarters in the case of vertical-integration and pure-assembly is:

$$\beta_V^N \equiv \delta + \beta(1-\delta) .$$

This ex-post bargaining weight is shown in the upper-left cell of Figure 2.6.

Continuing to assume that the plant in China is vertically-integrated, suppose that the Chinese manager now make the decision of what inputs to purchase, in the second row of Figure 2.6. The Northern headquarters is still entitled to the residual output in the case of disagreement with the Chinese manager, but Feenstra and Hanson (2005) assumed that the manager also had an outside option that is non-zero in this case. Since the manager had control over the input purchases, this knowledge will be useful even if the Chinese plant does not reach agreement with the Northern headquarters, in which case the manager can still earn the outside option γR. We assume that $\gamma < \delta$, reflecting the idea that experience in purchasing inputs is less important that plant ownership . In this case, the ex-post bargaining weight of the Northern headquarters is shown in the lower-left cell of Figure 2.6:

$$\beta_V^S \equiv \delta + \beta(1 - \delta - \gamma) < \beta_V^N .$$

Now consider the case where the plant is Chinese owned, in the second column of Figure 2.6. Under pure-assembly, the Northern headquarters will be making the choice of inputs, so we assume that it has some outside option which is again worth γR. The ex-post bargaining weight of the Northern headquarters becomes:

$$\beta_O^N \equiv \gamma + \beta(1 - \gamma) < \beta_V^N ,$$

where this inequality follows from our assumption that $\gamma < \delta$. So both β_V^S and β_O^N are less than β_V^N, which is the bargaining weight of the Northern headquarters when it owns the plant and controls the inputs choice. Fernandes and Tang (2011) make further assumptions to ensure that $\beta_V^S < \beta_O^N$, which holds when $\gamma < \delta$ but γ is not too small, in which case we obtain the ranking:

$$\beta_V^S < \beta_O^N < \beta_V^N .$$

The final case we need to consider is when the plant is Chinese owned *and* the local manager has control over the input decision. In that case, we suppose that the outside option of the headquarters is zero, while the Chinese manager can still earn γR by virtue of her input decisions, so that the ex-post bargaining weights of the headquarters become:

$$\beta_O^S \equiv \beta(1-\gamma) < \beta_V^S < \beta_O^N < \beta_V^N .$$

Thus, the model of Fernandes and Tang (2011) gives a well-determined ranking of the ex-post bargaining weights of the headquarters, depending on the ownership of the plant and control over the inputs. Following Antràs and Helpman, Fernandes and Tang further assume that plant production in each case is subject to fixed costs, and impose the following ranking:

$$f_O^S < f_V^S < f_O^N < f_V^N .$$

That is, the fixed costs are highest for vertically-integrated plant where input decision are made in the North, reflecting the difficulty of governing that plant, and lowest for an outsourcing plant where input decisions are made entirely in China, the South.

The model is completed by specifying the production process that combines inputs from the headquarters h and the plant manager m. Suppose that their inputs x_h and x_m are combined in a Cobb-Douglas production function with the inputs x_i to produce a final good y,

$$y = Ax_h^{\eta_h} x_i^{\eta_i} x_m^{\eta_m}, \text{ with } \eta_h + \eta_i + \eta_m = 1 .$$

The headquarters is always located in the North and faces the wage of w^N for the input x_h that is used, while the plant manager is always located in the South, with wage w^S, and naturally we assume that $w^N > w^S$ which gives the incentive to offshore production to the South. Control over the input choice x_i can be given to the headquarters or the plant manager, and in either case the input is purchased on world market at the price of p_i. Note that the parameter A multiplying the production function reflects the technical efficiency of the plant. Antràs and Helpman along with Fernandes and Tang allow for plants of varying productivity, in the style of Melitz (2003), but we ignore that extension here for simplicity.

This good is sold under monopolistic competition subject to the inverse demand,

$$p_y = By^{-1/\sigma},$$

where $\sigma>1$ is the constant elasticity of substitution and demand, and B is a shift parameter. It follows that revenue is:

$$R(x_h, x_i, x_m) = p_y y = By^{\alpha} = BA^{\alpha}\alpha x_h^{\alpha\eta_h} x_i^{\alpha\eta_i} x_m^{\alpha\eta_m}, \quad \alpha = \frac{(\sigma-1)}{\sigma}.$$

Therefore, given the ownership structure $k \in \{V, O\}$, if control of the inputs choice rests with the Northern headquarters ($\ell = N$, or pure-assembly), then the problem for the headquarters is to choose both the inputs x_h and x_i to maximize its surplus:

$$x_h^*(k, N) \equiv \underset{x_h}{\arg\max}\ \beta_k^N R(x_h, x_m) - w^N x_h - p_i x_i - f_k^N,$$

$$x_i^*(k, N) \equiv \underset{x_i}{\arg\max}\ \beta_k^N R(x_h, x_i, x_m) - w^N x_h - p_i x_i - f_k^N,$$

while the manager solves the problem:

$$x_m^*(k, N) \equiv \underset{x_m}{\arg\max}\ (1-\beta_k^N) R(x_h, x_i, x_m) - w^S x_m.$$

In contrast, if control over the input choices rests with the Chinese manager ($\ell = S$, or import-and-assembly), then the headquarters chooses only x_h to maximize its surplus:

$$x_h^*(k, S) \equiv \underset{x_h}{\arg\max}\ \beta_k^S R(x_h, x_m) - w^N x_h - f_k^N,$$

while the manager chooses both the inputs x_m and x_i to maximize her surplus:

$$x_m^*(k,S) \equiv \underset{x_m}{\arg\max}\ (1-\beta_k^S)R(x_h, x_i, x_m) - w^S x_m - p_i x_i,$$

$$x_i^*(k,S) \equiv \underset{x_i}{\arg\max}\ (1-\beta_k^S)R(x_h, x_i, x_m) - w^S x_m - p_i x_i.$$

Putting together these solutions for the headquarters and plant manager, we obtain the joint surplus in the Nash-bargaining solution:

$$R[x_h^*(k,\ell), x_i^*(k,\ell), x_m^*(k,\ell)] - w^N x_h^* - p_i x_i^* - w^S x_m^* - f_k^\ell. \qquad \text{(NB')}$$

Notice that this surplus depends on the ownership structure $k \in \{V,O\}$ and control over inputs denoted by $\ell \in \{N,S\}$.

Now we come to the key assumption that is made in the property rights literature, including the various trade papers referenced above. The assumption is that k and l are chosen to *maximize* this surplus, so that the ownership k and control structure ℓ satisfy:

$$\max_{k,\ell}\ R[x_h^*(k,\ell), x_i^*(k,\ell), x_m^*(k,\ell)] - w^N x_h^* - p_i x_i^* - w^S x_m^* - f_k^\ell.$$

That is, despite the inefficiency created by the Nash-bargaining solution, we assume that the ownership and control structure is chosen to make the surplus as large as possible: Nash-bargaining then determines how that surplus is divided between the headquarters and the manager. Notice that the joint surplus can be quite sensitive to the ownership and control structure, since that will influence the ex-post bargaining weight β_k^ℓ, and therefore the input provided by the headquarters and plant manager.

We would like to characterize the ownership-control structure that solves the above problem, depending on the North and South wages and also the share of headquarters services η needed in production. One way to achieve this is to solve for the bargaining weight β_k^ℓ that maximizes (NB'), and then choose the ownership structure that corresponds as closely as possible to that bargaining weight. This approach gives us the following result:

<u>Proposition 2</u> (Antràs and Helpman, 2004; Fernandes and Tang, 2011)

(a) The Nash-bargaining weight $\beta_k^S(\eta_h)$ that maximizes (NB') under import-and-assembly, is an increasing function of η_h, the headquarters' share in costs, with $\beta_k^S(0)=0$ and $\beta_k^S(1)=1$.

(b) The Nash-bargaining weight $\beta_k^N(\eta_h+\eta_i)$ that maximizes (NB') under pure-assembly is an increasing function of $\eta_h+\eta_i$, the headquarters' share in costs including the input costs, with $\beta_k^N(0)=0$ and $\beta_k^N(1)=1$.

Part (a) of this result is analogous to what Antràs and Helpman (2004) find in their analysis of ownership and location: when the headquarters' services are more important in costs, then it should have greater bargaining weight to obtain a value for surplus that is as high as possible. Part (b) generalizes this to the three-input case. Under pure-assembly, the headquarters chooses its own services along with the inputs, and the Nash bargaining weight β_k^N that maximizes (NB') is increasing in the *sum* of $\eta_h+\eta_i$. Under import-and-assembly in part (a), the headquarters only chooses its own services, and the Nash bargaining weight β_k^S that maximizes (NB') is increasing in its own share η_h.

An immediate implication of this result is contained in part (a) of the Corollary:

<u>Corollary</u>

(a) If the headquarters has a *high* share of costs η_h, or respectively a *low* share of costs, then it is optimal to give ownership to the *headquarters* h, respectively the *manager* m.

(b) If input search has a *high* share of costs η_i, then it is optimal to give control over input search to the *same* party that has ownership.

That is, as the headquarters share of costs η_h rise in Proposition 2, parts (a) or (b), then so too will the Nash-bargaining weight of the headquarters, $\beta_k^S(\eta_h)$ or $\beta_k^N(\eta_h+\eta_i)$, that maximizes the joint surplus (NB'). In other words, the headquarters must be given a high ex-post bargaining weights so that it has good incentives. That is achieved by giving the headquarters ownership of the vertically-integrated firm, putting it in the left-hand column of Figure 2.6, where $\beta_V^N > \beta_O^N$ and $\beta_V^S > \beta_O^S$, depending on whether the headquarters (North) or Chinese manager (South) makes in the input decisions.

Part (b) of this Corollary addresses the question of which agent should be making the input decision: if the share of input η_i is high, then it should be the *same* agent that has ownership of the production process. This follows again from the logic of Proposition 2. To see this, suppose that $\eta_i \to 1$. In Proposition 2(a), this means $\eta_h \to 0$ and $\beta_k^S \to 0$. Then the ownership and control structure should give the headquarters the minimum ex-post bargaining power possible, which occurs when the Chinese manager owns the plant and makes the inputs decisions. Alternatively, suppose $\eta_i \to 1$ in Proposition 2(b), so that $\eta_h+\eta_i \to 1$ and $\beta_k^N \to 1$. Then the ownership and control structure should give the headquarters the maximum ex-post bargaining power possible, which occurs when the headquarters owns the plant and makes the input decisions.

Feenstra and Hanson (2005) refer to the case where the same agent owns the plant and makes the inputs decisions as *concentrated ownership and control* (i.e. the Southern/Chinese manager under outsourcing with import-and-assembly, β_O^S, or the Northern/foreign headquarters under vertical integration with pure-assembly, β_V^N). This can be contrasted to *divided ownership* *and control,* when different parties each have responsibility (i.e. either the Southern/Chinese manager chooses the input under vertical integration, β_V^S, or the Northern/foreign headquarters chooses the inputs under Chinese ownership and outsourcing, β_O^N). From above, we have the following ranking of bargaining weights for the headquarters:

$$\beta_O^S < \beta_V^S < \beta_O^N < \beta_V^N .$$

Notice that the two extreme cases in this ranking have *concentrated ownership and control:* the same party owns the plant and it controls the input decision. These two cases are shown on the *diagonal* in Figure 2.6. In contrast, the two middle cases in the above ranking illustrate *divided ownership and control:* different parties own the plant and control the input decision, which occurs along the *off-diagonal* in Figure 2.6.

Estimating the Property-Rights Model for China

Let us now see how these predictions line up with the evidence from China. In Table 2.2, we show the shares of processing exports from China (over 1997-2002) coming from the various ownership/control regimes. It is immediately apparent that for all provinces, shown in the left panel of the table, close to 75% of exports come from cases of *divided* ownership and control, i.e. on the off-diagonal cells. The right panel of Table 2.2 shows just interior provinces. In that case, there is only about 50% of exports coming from divided ownership and control, with a similar amount coming from *concentrated* ownership and control, on the diagonal of the right panel. From the above Corollary, part (b), such cases of concentrated ownership and control can arise when the share of costs devoted to input search are high. We might hypothesize that input search in the interior provinces is more time-consuming and costly, due to thinner markets, than

Table 2.2: Processing Exports by Input Control and Factory Ownership Regime

Control over Inputs:	**All Provinces**		**Interior Provinces**	
	Ownership of Factory:		***Ownership of Factory:***	
	Foreign	Chinese	Foreign	Chinese
Foreign Buyer (pure-assembly)	0.083	0.271	0.177	0.110
Chinese Factory (import-and-assembly)	0.496	0.146	0.416	0.297

Notes: This table shows means for shares of processing exports by factory ownership (foreign versus Chinese) and input-control regime (pure-assembly versus import-and-assembly) for observations by year, industry, destination country, origin province, and trade zone status. The first two columns show results for all provinces; the second two columns show results for interior provinces (all provinces excluding the southern coastal provinces of Shanghai, Zhejiang, Fujian, Guangdong, Hainan). Data are for 1997 – 2002.

Table 2.3: Processing Exports depending on Trade Zone Status

Control over Inputs:	**Inside SEZs**		**Outside SEZs**	
	Ownership of Factory:		***Ownership of Factory:***	
	Foreign	Chinese	Foreign	Chinese
Foreign Buyer (pure-assembly)	0.081	0.076	0.084	0.317
Chinese Factory (import-and-assembly)	0.745	0.098	0.442	0.157

Notes: This table shows mean shares of processing exports by factory ownership and input-control regime for goods produced inside (columns 1 and 2) and outside (columns 3 and 4) of Special Economic Zones. See also notes to Table 2.2.

Source: Feenstra and Hanson (2005)

in the coastal provinces. That would explain why a greater proportion of exports from the interior provinces have the concentrated ownership and control regime, on the diagonal, than for the coastal provinces.

This difference between the coastal and the interior provinces also show up when we examine processing activity inside and outside of the Special Economic Zones (SEZ's), in Table 2.3. For processing trade within the SEZ's, in the left panel of the table, there is only 18% of exports coming from cases of concentrated ownership and control, on the diagonal; while for processing exports from outside the SEZ's there is a somewhat more, with 24% of exports coming from cases of concentrated ownership and control, on the diagonal. This difference could be explained by higher costs of input search outside of the SEZ, due to a thinner market than within the SEZ. The other difference between the left and right panels of Table 2.3 is that within the SEZ a great deal of exports – nearly 75% – come from Chinese-owned factories that also choose the inputs under import-and-assembly; whereas outside of the SEZ, only about 45% of exports come from that regime. From the Corollary, part (a), that difference is consistent with the Chinese processing firm having a higher share of costs within the SEZ, and therefore more likely to retain ownership of the plant to improve its incentives.

A final comparison is made between low-tech and high-tech industries, in Tables 2.4 and 2.5. The low-tech industries are apparel and footwear, and the high-tech industries are office machines and electrical machinery. For the low-tech industries, between 24% and 41% of exports come from concentrated ownership and control (on the diagonal), whereas for the high-tech industries only 9 – 18% of processing exports come from this regime. That difference can arise from greater costs associated with input search in low-tech industries. That hypothesis may sound like a paradox, since high-tech goods presumably require high-quality components, but it

Table 2.4: Processing Exports for Low Value-Added Industries

Control over Inputs:	Apparel		Footwear	
	Ownership of Factory:		*Ownership of Factory:*	
	Foreign	Chinese	Foreign	Chinese
Foreign Buyer (pure-assembly)	0.225 (0.003)	0.286 (0.003)	0.104 (0.007)	0.178 (0.007)
Chinese Factory (import-and-assembly)	0.302 (0.003)	0.187 (0.002)	0.579 (0.009)	0.140 (0.003)

Notes: This table shows mean shares of processing exports by factory ownership and input-control regime for Apparel (SITC 84, columns 1 and 2) and Footwear (SITC 85, columns 3 and 4). See also notes to Table 2.2.

Table 2.5: Processing Exports for High Value-Added Industries

Control over Inputs:	Office Machines		Electrical Machinery	
	Ownership of Factory:		*Ownership of Factory:*	
	Foreign	Chinese	Foreign	Chinese
Foreign Buyer (pure-assembly)	0.033 (0.006)	0.211 (0.013)	0.070 (0.006)	0.246 (0.005)
Chinese Factory (import-and-assembly)	0.693 (0.016)	0.062 (0.008)	0.575 (0.007)	0.109 (0.004)

Notes: This table shows mean shares of processing exports by factory ownership and input-control regime for Office Machines (SITC 75, columns 1 and 2) and Electrical Machinery (SITC 77, columns 3 and 4). See also notes to Table 2.2.

Source: Feenstra and Hanson (2005)

is plausible that the market for high-tech inputs is more reliable in its quality than the market for low-tech components, and therefore it is easier to identify and purchase the high-tech inputs. The other difference between Tables 2.4 and 2.5 is in the proportion of Chinese-owned factories that choose the inputs under import-and-assembly: more exports – 69% versus 30% –come from such factories assembling office machines than those assembling apparel (though these percentages are about the same for electrical machinery and footwear). From the Corollary, part (a), that difference can arise from the Chinese processing firm having a higher share of costs when assembling office machines than when assembling apparel, due to the greater attention to quality needed in the production of office machines.

These examples in Table 2.2 – 2.5 illustrate the variation in the data than can be used to estimate the model due to Antràs and Helpman (2004) and Fernandes and Tang (2011). These authors further elaborate the model by introducing fixed costs as discussed above, and allowing firms to differ in the productivities, as in the Melitz (2003) model. That leads to an endogenous range of ownership/control regimes that are chosen, depending on the productivity of firms. A simpler approach, used by Feenstra and Hanson (2004), is to directly test the connection between the export shares in each ownership/control regime and the share of costs devoted to headquarters services, input search, and processing activity. Denoting those shares by η_h, η_i, and η_m, as in the model above, and the share of exports in each regime by X_V^N (vertical integration with Northern/foreign control of inputs), X_O^N (outsourcing to the Chinese firms with Northern/foreign control of inputs), X_V^S (vertical integration with Southern/Chinese control of inputs), and X_O^S (outsourcing with Southern/Chinese control of inputs), we hypothesize the following relationship between these variables:

$$\ln X_V^N = \alpha_{0V}^N + \underbrace{\alpha_{1V}^N}_{(+)} \frac{\eta_h}{\eta_m} + \underbrace{\alpha_{2V}^N}_{(+)} \frac{\eta_i}{\eta_m},$$

$$\ln X_O^N = \alpha_{0O}^N + \underbrace{\alpha_{1O}^N}_{(-)} \frac{\eta_h}{\eta_m} + \underbrace{\alpha_{2O}^N}_{(-)} \frac{\eta_i}{\eta_m},$$

$$\ln X_V^S = \alpha_{0V}^S + \underbrace{\alpha_{1V}^S}_{(+)} \frac{\eta_h}{\eta_m} + \underbrace{\alpha_{2V}^S}_{(-)} \frac{\eta_i}{\eta_m},$$

$$\ln X_O^S = \alpha_{0O}^S + \underbrace{\alpha_{1O}^S}_{(-)} \frac{\eta_h}{\eta_m} + \underbrace{\alpha_{2O}^S}_{(+)} \frac{\eta_i}{\eta_m}.$$

The sign pattern of the coefficients is obtained from the above Corollary. From part (a), having a higher share of cost in headquarters services makes it more likely that the Northern/foreign firm has ownership of the Southern/Chinese plant, under vertical integration, leading to $\alpha_1 > 0$ in the first and third equations but $\alpha_1 < 0$ in the second and fourth. From part (b), having a higher share of costs in input search makes it more likely that the same party has ownership and control, leading to $\alpha_2 > 0$ in the first and last equations but $\alpha_2 < 0$ in the second and third.

So we see that the model leads to easily testable predictions on the coefficients of the relative input shares. But these equation are not really independent, because the share of exports coming from each ownership/control type sums to unity across the four possibilities. So Feenstra and Hanson take the first case and subtract it from the others, obtaining:

$$\ln X_O^N - \ln X_V^N = (\alpha_{0O}^N - \alpha_{0V}^N) + \underbrace{(\alpha_{1O}^N - \alpha_{1V}^N)}_{(-)} \frac{\eta_h}{\eta_m} + \underbrace{(\alpha_{2O}^N - \alpha_{2V}^N)}_{(-)} \frac{\eta_i}{\eta_m},$$

$$\ln X_V^S - \ln X_V^N = (\alpha_{0V}^S - \alpha_{0V}^N) + \underbrace{(\alpha_{1V}^S - \alpha_{1V}^N)}_{(?)} \frac{\eta_h}{\eta_m} + \underbrace{(\alpha_{2V}^S - \alpha_{2V}^N)}_{(-)} \frac{\eta_i}{\eta_m},$$

$$\ln X_O^S - \ln X_V^N = (\alpha_{0O}^S - \alpha_{0V}^N) + \underbrace{(\alpha_{1O}^S - \alpha_{1V}^N)}_{(-)} \frac{\eta_h}{\eta_m} + \underbrace{(\alpha_{2O}^S - \alpha_{2V}^N)}_{(?)} \frac{\eta_i}{\eta_m}.$$

Because we have chosen the first case – the vertically-integrated plant with Northern/foreign control over the input choice (i.e. pure assembly) – as the reference, we find that all coefficients in this revised system are negative or uncertain. The intuition is that higher headquarters costs or input shares make it less likely to observe any of the other cases (or uncertain) relative to the Northern ownership and control reference.

With these prediction on the coefficients, the system of equations can be estimated using data for Chinese processing trade by location (city in China), products (8-digit Harmonized System, HS), and destination countries. Feenstra and Hanson call the variable η_h / η_m the "outbound value-added ratio" and η_i / η_m the "inbound value-added ratio." The denominator of both these ratios, which is η_m, is measured by the share of Chinese value-added in processing exports at the 1-digit Standard International Trade Classification (SITC) level. These shares are obtained from estimated provincial input-output tables for processing trade. The numerators are obtained from the markups on goods re-exported to, or imported from, Hong Kong. Specifically, the markup on goods exported from China to Hong Kong and then re-exported to the rest of the world is used to measure the headquarters services η_h, while the markup on goods imported by Hong Kong and then re-exported to China is used to measure the input search costs η_i (both these markups are measured relative to the value of the good in China).[4]

Estimation is then performed over all processing trade in China during 1997 – 2002, with the results shown in Table 2.6. The first estimating equation above is shown in column (1) of Table 2.6, where the expected negative signs on both coefficient are obtained, though only the

[4] Because of the errors involved in estimating the Hong-Kong markup and the input-output table for processing trade within China, both the value-added ratios are measured at the 1-digit SITC level rather than the 8-digit HS level, used for the Chinese trade data; these ratios also vary across years, across provinces (since the processing input-output table differs across provinces), and across destination markets (for the outbound ratio).

Table 2.5: Estimates of the Property Rights Model for China

	Northern/Foreign ownership & Chinese control over inputs (1)		**Chinese ownership & Northern/Foreign control over inputs (2)**		**Southern/Chinese ownership & control over inputs (3)**	
Outbound VA ratio	-0.007 (0.014)		0.013 (0.021)		0.035* (0.017)	
Inbound VA ratio	-0.34** (0.054)		-0.036 (0.072)		-0.17** (0.050)	
Years:	*1997-99*	*2000-02*	*1997-99*	*2000-02*	*1997-99*	*2000-02*
Hong-Kong	-0.061	0.24	0.16	0.59**	0.001	0.26
	(0.20)	(0.15)	(0.23)	(0.16)	(0.22)	(0.16)
SEZ	-0.21	0.47**	0.19	-0.90**	0.12	-0.48**
	(0.15)	(0.11)	(0.31)	(0.20)	(0.24)	(0.16)
North coast	0.32	-0.18	-0.25	-0.018	0.54*	-1.53**
	(0.21)	(0.16)	(0.24)	(0.15)	(0.24)	(0.18)
Beijing area	0.11	-0.21	-0.12	-0.040	0.32	-1.18**
	(0.20)	(0.15)	(0.20)	(0.12)	(0.22)	(0.16)
Shanghai area	-0.14	0.57**	-0.56**	0.72**	0.027	-0.48**
	(0.19)	(0.14)	(0.22)	(0.12)	(0.20)	(0.14)
South coast	0.75**	1.94**	0.25	2.42**	1.10**	-0.14
	(0.29)	(0.20)	(0.37)	(0.24)	(0.30)	(0.21)

Notes: Standard errors are in parentheses. * significant at the 5% level; ** significant at the 1% level. N = 1,118,883, across 8-digit harmonized system (HS) products, provinces, years, and destination markets. Each column shows the estimates for choosing an ownership/control regime relative to foreign ownership and foreign control of inputs. The inbound (outbound) value-added ratio equals the markup on Hong Kong re-exports entering (leaving) China, divided by the value-added in processing trade within China. These ratios are measured at the 1-digit SITC industry rather than 8-digit HS product, so the standard errors (in parentheses) are corrected for correlation of errors across observations in the same one-digit industry and year. The variable SEZ equals one if the HS products are produced in a Special Economic Zone (including high-technology development zones), and Hong-Kong equals one if the good is re-exported through Hong Kong. All regressions include indicator variables for the year (with 2002 excluded). The northern coast consists of Heilongjiang, Jilin and Liaoning; the area around Beijing includes Beijing/Tianjin, Hebei and Shandong; the area around Shanghai includes Shanghai, Jiangsu and Zhejiang; and the southern coastal provinces consist of Fujian, Guangdong, and Hainan Island.

Source: Feenstra and Hanson (2005)

coefficient on the inbound value-added ratio, η_i / η_m, is significantly different from zero. In the second equation in column (2), the expected signs are uncertain on the outbound ratio and negative on the inbound ratio, which is confirmed, though the estimate is not significant. For the third equation in column (3), we expected the outbound value-added ratio to have a negative coefficient but find instead that it is positive, while the inbound ratio turns out to have the negative coefficient, both of which are significant. In summary, these estimates provide some support for the property rights model as applied to Chinese processing trade.

Feenstra and Hanson also allow the intercept term of the above equations to vary over time and Chinese regions, with the coefficients shown at the bottom of Table 2.5. We did not predict any sign pattern for the intercept terms included in the equations above, which would go beyond the details of the Antràs and Helpman (2004) and Fernandes and Tang (2011) models. But Feenstra and Hanson show how these coefficients are related to human-capital specificity ψ in different regions of the country: the higher is human-capital specificity, the lower are the outside options available to the headquarters or the local managers should the Nash bargain break down. We can also think of human-capital specificity as an inverse measure of market thickness, since outside options are improved as markets become thicker.

Using the region and time-specific intercept terms from Table 2.5, the estimates for human-capital specificity ψ are reported in Table 2.6. They vary depending on whether we consider processing exports from inside or outside of the SEZ, where ψ is lower for exports from the SEZ because the market is thicker in these locations. In addition, human-capital specificity ψ varies depending on whether processing exports in the estimating equation are those goods re-exported through Hong Kong, or whether they are direct exports to the destination countries.

Table 2.6: Parameter Estimates of Human-Capital Specificity (ψ)

		SEZ, HK Re-exports		SEZ, Direct exports		No SEZ, Direct exports	
		1997-99	*2000-02*	*1997-99*	*2000-02*	*1997-99*	*2000-02*
	Region:						
ψ	Interior	0.38	0.33	0.41	0.35	0.48	0.43
		(0.05)	(0.04)	(0.06)	(0.04)	(0.06)	(0.05)
	North coast	0.36	0.34	0.39	0.38	0.44	0.48
		(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.06)
	Beijing area	0.40	0.35	0.43	0.38	0.51	0.50
		(0.06)	(0.04)	(0.06)	(0.05)	(0.06)	(0.07)
	Shanghai area	0.33	0.28	0.34	0.30	0.38	0.34
		(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)
	South coast	0.21	0.22	0.21	0.23	0.22	0.24
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
β	Any region	0.69	0.69	0.69	0.69	0.69	0.69
		(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)

Notes: Parameters estimates are calculated from the coefficients in Table 2.5. The parameter ψ is the degree of human-capital specificity, and β is bargaining weight of the Northern/foreign firm. Standard errors are in parentheses, and all coefficients are significant at the 1% level.

Source: Feenstra and Hanson (2005)

From Table 2.6, we see that the estimates of ψ, the degree of human-capital specificity, are highest in Beijing, the Interior and the North, and lowest in the South Coast. Since this parameter reflects the *loss* in the return to human-capital investments when bargaining breaks down, lower values of ψ may indicate a thicker labor market and stronger outside options for the Chinese managers. Comparing the estimates in the first two columns of Table 2.6 with those in the second two columns, we see that *direct* exports have slightly *higher* estimates of ψ than do re-exports through Hong-Kong. That is, by *not* using Hong-Kong traders to handle processed exports, parties face slightly higher project specificity of human-capital investments (presumably because the Hong Kong traders can help arrange a new match). This human-capital specificity is increased further when processing occurs outside of SEZ.

Feenstra and Hanson argue that it is highly plausible that human-capital specificity is lowest in the southern coastal provinces due to the concentration of international commercial activity in that region. To examine this interpretation, Figure 2.7 plots the estimates of ψ in Table 2.6 against each region's share of total processing exports, averaged over the time periods 1997-99 and 2000-02. A higher regional share of national export processing activity is one indication of thicker regional markets. Estimates of ψ are clearly decreasing in the regional processing export share, suggesting that human-capital specificity is lower in regions with more developed export industries.

Feenstra and Hanson also discuss an interpretation of ψ as a measure of the ability of parties to contract over investments, with lower values of ψ indicating greater ease of contracting. They find it plausible that contracting costs would also be lower in the southern coastal provinces, which have a longer history of dealing with foreign investors and stronger commercial institutions. Figure 2.8 plots estimates of ψ against the average time in months

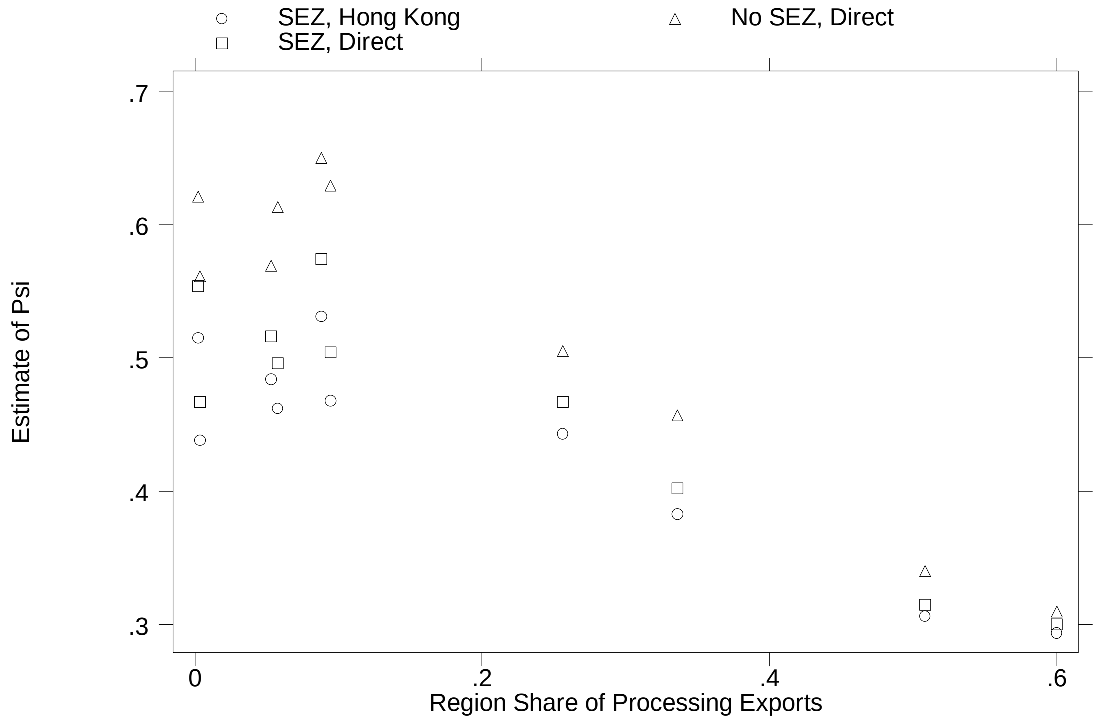

Figure 2.7: Human-Capital Specificity (ψ) and Regional Export Activity

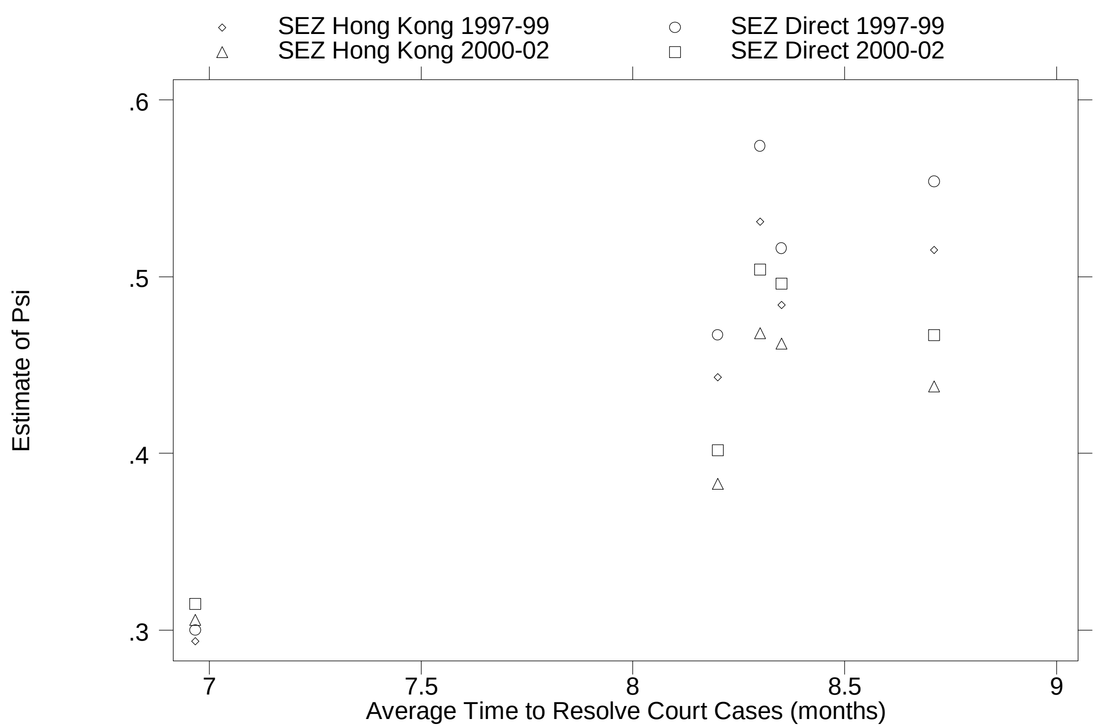

Figure 2.8: Human-Capital Specificity (ψ) and Court Costs

Source: Feenstra and Hanson (2005)

needed to resolve commercial court cases (averaged over cities in each Chinese region). The court data, reported in Dollar, Wang, Xu and Shi (2004), are based on a survey of business executives conducted China's major cities in 2001. The estimates of ψ are higher in regions in which it takes more time to resolve commercial disputes. The time needed to resolve court cases is substantially lower in China's South Coast, consistent with the lower estimates of ψ found in that region.

Lastly, Table 2.6 also reports the estimate of β, the Nash bargaining weight for Northern/foreign firms, which is 0.69 (standard error of 0.12) across all regions and time periods. This estimate of the (ex-ante) bargaining weight β is insignificantly different from 0.5, which corresponds to simple Nash bargaining.

To summarize, in this chapter we have explored a property-rights theory of the firm applied to their international decisions, as elaborated by Antràs and Helpman (2004). Fernandes and Tang (2011) applied that general equilibrium model to the case of processing trade in China. Feenstra and Hanson (2005) developed a simpler partial-equilibrium model with some of the same features: in particular, the decision of who should own the firm and who should control the input decisions depends on the shares of the headquarters, Chinese manager, and input search in total costs. We have argued here that the empirical specification in Feenstra and Hanson can be viewed as a neat application of the theory in Antràs and Helpman (2004) and Fernandes and Tang (2011). The empirical results from Feenstra and Hanson point to a very important role for the property right model, and transactions costs more generally, in understanding the structure of processing trade within China.

<u>Lecture 3</u>: Global Impact of Processing Trade

In my first lecture I mentioned a trip that I made to China in 1997, to work on a project that involved correcting the differing reports between China and the United States on the size of the bilateral trade balance.[5] That is a topic that always stays in fashion, and in fact, was discussed when President Hu visited President Obama in January of this year. During that visit, Pascal Lamy, the WTO Director-General, published an editorial in the *Financial Times* entitled "'Made in China' tells us little about global trade." Mr. Lamy discusses the familiar case of the Apple iPhone, which is assembled in China and then exported to the U.S. and elsewhere. He stated: [6]

> According to a recent Asian Development Bank Institute study, the phone contributed $1.9bn to the US trade deficit with China, using the traditional country of origin concept. But if China's iPhone exports to the US were measured in value added – meaning the value added by China to the components – those exports would come to only $73.5m.

Mr. Lamy goes on to say:

> The statistical bias created by attributing commercial value to the last country of origin perverts the true economic dimension of the bilateral trade imbalances. This affects the political debate, and leads to misguided perceptions. Take the bilateral deficit between China and the US. A series of estimates based on true domestic content can cut the overall deficit – which was $252bn in November 2010 – by half, if not more.
>
> Measures we use also change the way trade affects jobs too. Research on Apple's iPod shows that out of the 41,000 jobs its manufacture created in 2006, 14,000 were located in the US. Some 6,000 were professional posts. Yet since US workers are better paid, they earned $750m, while only $320m went to workers abroad. Indeed, the iPod may have never existed if Apple had not known that Asian companies could supply components, while both Asian workers and Asian consumers would manufacture and buy it. Statistics that measure value added can provide a more reliable way of seeing how trade affects employment. (*Financial Times*, January 24, 2011)

I was interviewed by National Public Radio in the United States during that visit, on the same topic. I spent a good 15 minutes talking to the reporter, describing all manner of trade and

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5 See Feenstra, Hai, Woo and Yao (1999). Other recent work on this topic for China and other countries is provided by Koopman, et al. (2008, 2010).

6 See the study for the Asian Development Bank Institute by Yuqing Xing and Neal Detert (2010) at: http://www.adbi.org/files/2010.12.14.wp257.iphone.widens.us.trade.deficit.prc.pdf .

macroeconomic aspects of the Chinese economy. But in the end, I had only ten words included on the radio, which were: "the U.S. trade deficit with China tends to be exaggerated"! Well, that is true enough, but hardly does justice to the macroeconomic aspects of offshoring, which is what I would like to discuss in this lecture.

When thinking about the trade balance between China and the United States, we naturally add the exchange rate into the discussion, and that leads to three distinct questions:

Question 1: Is the RMB under-valued relative to the U.S. dollar?

Question 2: Would an appreciation of the RMB relative to the U.S. dollar lead to significant change in the China-U.S. trade balance?

Question 3: Does the growing importance of China in U.S. trade affect the "pass-through" relationship of changes in the dollar exchange rate to changes to U.S. import prices?

I will not address the first of these questions, in part because I believe that the evidence is highly inconclusive (e.g. Cheung, Chinn and Fujii, 2010), but also because I do not believe that this question can be answered without reference to a particular model. That is where the second question comes in. Those who argue that the RMB is under-valued relative to the dollar generally believe that a RMB appreciation would reduce the U.S. trade deficit with China, at least eventually. Again, I will argue below that the evidence on this point is quite inconclusive. The final question shifts the focus from the RMB-$ exchange rate to the overall U.S. multilateral exchange rate, and the "pass-through" relationship between changes in that exchange rate and U.S. import prices. Some researchers have argued that the pass-though relationship is reduced by the growing importance of China in U.S. trade, as I shall discuss.

3.1 Exchange Rates and the Trade Balance

The potential link between the RMB/$ exchange rate is most certainly influenced by the large amount of processing trade with China. An appreciation of the RMB against the dollar is intended to raise prices for U.S. customers, but it also *lowers* the dollar prices at which Chinese firms purchase inputs. Therefore, the net impact on the dollar prices of processed goods is much less than normally believed.

This linkage between exchange rates and the prices of processed goods can be illustrated using the framework developed by my colleague at UC Davis, Deborah Swenson, in joint work with Anne Gron (1996). In their model, a firm is sourcing some inputs locally and other inputs from abroad. The specific example that the authors have in mind is that of the automobile industry, where foreign firms often produce cars and car components both in the U.S. and in their own country. We will instead apply this model to a firm in China engaged in processing trade, employing labor with share μ and imported intermediate inputs with share $(1 - \mu)$. Then marginal costs are $Q^{\alpha} w^{\mu} (e_y w^*)^{(1-\mu)}$, where: Q is output; w and w* are factor price indexes for China and the foreign country, respectively; and e_y converts the foreign factor prices into yuan. Gron and Swenson allow for monopolistic competition so that firms will charge the markup of $\eta/(\eta - 1)$ over marginal costs, where η is the elasticity of demand.[7] Then the relationship between the output price (P) and the factor prices and exchange rate (e_y) is given by:

$$\ln P = \ln[\eta / (\eta - 1)] + \alpha \ln Q + \delta_1 (1 - \mu) \ln(e_y w^*) + \delta_2 \mu \ln w + \varepsilon ,$$

where $\delta_1 = \delta_2 = 1$ in the model, but are estimated as coefficients in empirical work.

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[7] Gron and Swenson (1996) assume that the elasticity of demand is constant, so that markups charged by the firm do not change. We will dispense with this assumption later in this lecture.

In the application we are considering, the foreign country is the United States, so multiplying w* (in \$) by the RMB/\$ (or yuan/\$) exchange rate e_y, converts the cost of foreign inputs into the local Chinese currency. Then suppose there is an appreciation of the RMB, which is a decrease in e_y. From the above equation, the RMB price of the Chinese good would also decrease, by the amount $\delta_1(1-\mu)$ times the percentage RMB appreciation. To convert the RMB price of the Chinese good into dollars we would divide P by e_y, or subtract $\ln e_y$ from the above equation. So an appreciation of the RMB (fall in e_y) would therefore *increase* the dollar price by the amount $[1-\delta_1(1-\mu)]$ time the percentage appreciation. What we see, therefore, is that the use of imported inputs in processing trade *reduces* the impact of exchange rate changes on the prices of Chinese exports: instead of the dollar prices rising by the amount of the appreciation, they will only rise by $[1-\delta_1(1-\mu)]$ times the appreciation. If the share of imported inputs $(1-\mu)$ is high, then we could expect to see a substantially reduced impact of exchange rates on the prices of processed goods, as firms change their sourcing of inputs to utilize the now-cheaper inputs more intensively.

The conclusion for this theoretical analysis is that we should expect only a weak relationship between RMB/\$ rate and the prices of processed goods for U.S. consumers. It follows that there is even a weaker relationship between the exchange rate and the amount purchased by U.S. consumers, and therefore between the exchange rate and the trade balance in processed goods. That very weak relationship is estimated by Yuqing Xing (2011), for example. So I conclude that the RMB/\$ exchange rate is unlikely to be responsible for the trade imbalance between the United States and China. Rather, I would agree with researchers who look for more structural explanations for the trade imbalance. For example, Qingyuan Du and Shang-Jin Wei

(2010a,b) along with Wei and Xiaobo Zhang (2011) argue that China's trade surplus is to a large extent related to a gender imbalance between men and women: as more men are seeking wives among slightly fewer women, it leads to greater savings for homes and other wealth used to attract brides. Du and Wei find that this effect has led to significantly higher rates of savings than would prevail in a country with equal numbers of men and women, and that this effect can explain more than half of observed current account imbalances.

A related argument is put forward by Yang Yao of the China Center for Economic Research at Peking University who argues that China is in the midst of a "double transition" (Yao, 2011). The first element of this transition is the rural-urban migration that is driving the export-led growth in Chinese cities. This migration keeps wage growth suppressed and allows China to maintain its comparative advantage and high growth rates in labor-intensive industries.[8] The second element is the fact that the one-child policy, implemented in 1979, has had the effect that 2.6 working persons only need to support one non-working person. The combined effect of these trends is rapid, export-driven GDP growth along with high savings rates, which inevitably leads to a large current account surplus. The implication then is that China's current account surplus cannot be "tamed" via exchange rate normalization—rather, until China's surplus rural labor is exhausted and the demographic transition slows, the surplus will persist.

3.2 Exchange Rates and U.S. Import Prices

This brings us to the third question that I posed at the outset: does the growing importance of China in U.S. trade affect the pass-through relationship of changes in exchange rate to changes to U.S. import prices? This third question is linked to the second because they

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[8] Dooley et al (2003, 2004a,b) make a similar argument that the Chinese government intends to run trade surpluses as a means to bring in workers from the countryside for employment in manufacturing. Feenstra and Hong (2010) evaluate this argument quantitatively, and discuss the prospects for switching to domestic demand to support employment.

both make use of pass-through relationships. But in this third question, we are asking whether changes in the dollar against *any* other currencies have a more diminished effect on U.S. import prices in recent years. That idea has been put forward by many researchers at the Federal Reserve Bank of the United States (Gust, et al. 2006; Ihrig, et al., 2006; Marazzi, et al., 2005). They point to the presence of China as a growing source of U.S. imports as one reason why the pass-through relationship to U.S. prices might be more muted. They are not simply referring to the fact of processing trade, or the fact that the RMB is roughly tied to the dollar but, rather, whether the presence of China as an increasingly important exporter has changed the overall relationship between the dollar exchange rate and import prices.

I believe that the answer to this question is "yes," but it is a tricky argument because it requires changing one assumption normally used in the monopolistic competition models, and that is the assumption of CES preferences. In joint work with Paul Bergin (Bergin and Feenstra, 2009), we introduce a class of preferences new to the monopolistic competition literature that allows the markups of firms to vary due to market pressures. These preferences arise from the translog unit-expenditure function for a consumer:[9]

$$\ln e(p) = \alpha_0 + \sum_{i=1}^{\tilde{N}} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{\tilde{N}} \sum_{j=1}^{\tilde{N}} \gamma_{ij} \ln p_i \ln p_j \, ,$$

where without loss of generality we impose the symmetry restriction that $\gamma_{ij} = \gamma_{ji}$. The parameter $\tilde{N}$ is the maximum number of possible products, but many of these might not be produced: the prices used for products not available should equal their reservation prices (where demand is zero). In the CES case the reservation prices are infinite, so these prices drop out of

[9] The translog unit-cost function was introduced by Diewert (1976, p. 120).

the CES expenditure function (where the infinite prices are raised to a negative power). But in the translog case we need to explicitly solve for the reservation prices.

In order for the translog expenditure function to be homogeneous of degree one, we need to impose the conditions,

$$\sum_{i=1}^{\tilde{N}} \alpha_i = 1 \text{, and } \sum_{i=1}^{\tilde{N}} \gamma_{ij} = 0 .$$

I will further impose a strong form of symmetry on the γ_{ij} coefficients, which is:

$$\gamma_{ii} = -\gamma\left(\frac{\tilde{N}-1}{\tilde{N}}\right), \text{ and } \gamma_{ij} = \frac{\gamma}{\tilde{N}} \text{ for } i \neq j, \text{ with } i, j = 1, \ldots, \tilde{N} .$$

That is, I require that the $[\gamma_{ij}]$ matrix has the same negative value on the diagonal, and the same positive value on the off-diagonal terms, with the rows and columns summing to zero as needed for the expenditure function to be homogeneous of degree one. Notice that it does no harm to make these parameters depend on $\tilde{N}$, which is just a fixed maximum number.

Now suppose that some of the varieties are not available, so the prices faced by the consumer equal his or her reservation prices. Then using these strong symmetry restrictions we can solve for the reservation prices for goods not available, substitute these back into the expenditure function, and obtain a reduced-form expenditure function that is very convenient to work with. In particular, this reduced-form expenditure function remains valid even as the number of available products – which we denote by N – varies. The following result shows that the reduced form expenditure function is still a symmetric translog:

<u>Proposition 3</u> (Feenstra, 2003; Bergin and Feenstra, 2009)

Suppose that the strong symmetry restrictions, with $\gamma > 0$, are imposed on the expenditure function. In addition, suppose that only the goods i=1,…,N are available, so that the reservation prices $\tilde{p}_j$ for j=N+1,…, $\tilde{N}$ are used. Then the expenditure function becomes:

$$\ln e(p) = a_0 + \sum_{i=1}^{N} a_i \ln p_i + \tfrac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} c_{ij} \ln p_i \ln p_j \,.$$

where,

$$c_{ii} = -\gamma(N-1)/N, \text{ and } c_{ij} = \gamma/N \text{ for } i \neq j \text{ with } i, j = 1,\ldots,N,$$

$$a_i = \alpha_i + \tfrac{1}{N}\left(1 - \sum_{i=1}^{N} \alpha_i\right), \quad \text{for } i = 1,\ldots,N,$$

$$a_0 = \alpha_0 + \left(\frac{1}{2\gamma}\right)\left\{\sum_{i=N+1}^{\tilde{N}} \alpha_i^2 + \left(\frac{1}{N}\right)\left(\sum_{i=N+1}^{\tilde{N}} \alpha_i\right)^2\right\},$$

Notice that this reduced form expenditure function looks like a conventional translog function, but now it is defined over the *available* goods i=1,…,N, while the strong symmetry restrictions on γ_{ij} continue to hold on the coefficients c_{ij}, but using N rather than $\tilde{N}$. To interpret the coefficient a_i, they imply each of the coefficients α_i is increased by the same amount to ensure that the coefficients a_i sum to unity over the available goods i=1,…,N. Finally, the term a_0 incorporates the coefficients α_i of the unavailable products. If the number of available products N rises, then a_0 falls, indicating a welfare gain from increasing variety.

With this result, we can work with the reduced-form expenditure function, knowing that the reservation prices for unavailable goods are being solved for in the background. We can differentiate the unit-expenditure function to obtain the expenditure shares,

$$s_i = a_i + \sum_{j=1}^{N} c_{ij} \ln p_j .$$

The elasticity of demand is obtained by differentiating these shares,

$$\eta_i = 1 - \frac{\partial \ln s_i}{\partial \ln p_i} = 1 - \frac{c_{ii}}{s_i} = 1 + \frac{\gamma(N-1)}{s_i N} .$$

We see that the elasticity of demand is inversely related to the market share of each firm: as the market share approaches zero then the elasticity is infinite. With equal-sized firms charging the same prices, the market share is $s_i = 1/N$, and in that case the elasticity is simplified as:

$$s_i = 1/N \quad \Rightarrow \quad \eta_i = 1 + \gamma(N-1) ,$$

which is linearly related to the number of firms in the market. If we also chose $\gamma = 1$, which is an allowable choice for the translog parameter, then we find that the elasticity of demand equals the number of firms in the market, $\eta_i = N$.

These observations I have made on the elasticity carry over to the markups charged by firms. The optimal prices under monopolistic competition are:

$$p_i = w_i \left(\frac{\eta_i}{\eta_i - 1} \right) = w_i \left(1 + \frac{s_i N}{\gamma(N-1)} \right) ,$$

so the markups are increasing in each firm's market share. As the shares approach zero then we approach the perfectly competitive equilibrium, and when there are fewer firm then the markups correspondingly rise.

Competition between China and Mexico in the U.S. Market

Let me now use this framework to return to the question of how a growing China can impact prices in the United States. The observation made by many researchers at the Federal Reserve Bank in the U.S. is that as the dollar has depreciated in recent years, the impact on import prices has been less than expected: instead of rising by 50% of the appreciation in foreign currencies, import prices have risen by only 20%, so pass-through has declined from 0.5 in the 1980s to something like 0.2 today. This decline in the pass-through of the exchange rate to import prices is attributed to the presence of China as a competitor in many markets. It can be reasoned the China's presence, together with its essentially fixed exchange rate to the dollar, limits the increase in prices that might occur from other, flexible rate countries such as Mexico. So it is really the interaction of fixed and floating rate countries, in a model with endogenous markups, which has led to the declining pass-through of exchange rates to import prices.

Bergin and Feenstra (2009) make this argument formally by using translog preferences, together with a three country model: Mexico, denoted by x; China, denoted by y (for yuan); and the United States, denoted by z. They abstract from many of the features of our earlier offshoring model, including any intermediate inputs. Instead, they simply assume that Mexico and China compete for sales in the United States, which is realistic enough. They model the U.S. demand for the products of these two countries as following the translog preferences, and for simplicity, suppose that the U.S. produces a separate homogeneous good. Then with a depreciation of the dollar, the question is how the Mexican and Chinese firms will respond.

Following Bergin and Feenstra, we assume that Mexican firms are symmetric, facing marginal cost of w_x and charging the prices of p_x in peso. Their dollar prices are then $e_x p_x$, where e_x is the floating $/peso exchange rate. Likewise, Chinese firms are symmetric and face marginal costs of w_y while charging the prices p_y in yuan, so their dollar prices are $\bar{e}_y p_y$, where $\bar{e}_y$ is the fixed $/yuan exchange rate. From the translog share equations, the market shares of each Mexican and Chinese firm in the U.S. are given by:

$$s_x = a_x - \frac{\gamma N_y}{N}\left[\ln(e_x p_x) - \ln(\bar{e}_y p_y)\right],$$

$$s_y = a_y - \frac{\gamma N_x}{N}\left[\ln(\bar{e}_y p_y) - \ln(e_x p_x)\right],$$

where N_x or N_y denotes the number of Mexican or Chinese varieties sold in the U.S. market, with $N_x + N_y = N$. I will assume that there is a U.S. taste bias towards products from Mexico, meaning that:

$$\alpha_x > \alpha_y \quad \Leftrightarrow \quad a_x > a_y.$$

This assumption is strongly supported by results from gravity equations, for example, which give a bias in favor of countries sharing a border with the importer.

The pricing equation for each firm gives us their optimal prices as a function of market shares, and using the log approximation, $\ln[1 + s_i N / \gamma(N-1)] \approx s_i N / \gamma(N-1)$ which is valid for small shares, we can write the optimal prices as:

$$\ln p_x \approx \ln w_x + \frac{a_x N}{\gamma(N-1)} - \frac{N_y}{(N-1)}\left[\ln(e_x p_x) - \ln(\bar{e}_y p_y)\right],$$

$$\ln p_y \approx \ln w_y + \frac{a_y N}{\gamma(N-1)} - \frac{N_x}{(N-1)}\left[\ln(\bar{e}_y p_y) - \ln(e_x p_x)\right].$$

These are two equations to solve for the two prices – of Mexican and Chinese goods – depending on their marginal costs. We can solve this system for the dollar prices:

$$\ln(e_x p_x) = \frac{1}{\gamma(N-1)} + \ln(e_x w_x) + \frac{N_y}{(2N-1)}\frac{A}{\gamma},$$

and

$$\ln(\bar{e}_y p_y) = \frac{1}{\gamma(N-1)} + \ln(\bar{e}_y w_y) - \frac{N_x}{(2N-1)}\frac{A}{\gamma},$$

where the parameter A reflects the bias in favor of Mexican firms:

$$A \equiv [(\alpha_x - \alpha_y) - \gamma[\ln(e_x w_x) - \ln(\bar{e}_y w_y)].$$

Notice that this parameter depends in part on an assumed taste bias in favor of Mexican as compared to Chinese products, $\alpha_x > \alpha_y$, and also depends on the marginal costs in the two locations, which we assume does not overturn the initial taste bias favoring Mexico. That is, we will assume that $A > 0$.

Holding wages fixed, the effect of a dollar depreciation on the dollar prices of Mexican and Chinese goods can be easily solved as:

$$\frac{d\ln(e_x p_x)}{d\ln e_x} = 1 - \frac{N_y}{(2N-1)} > 0,$$

and,

$$\frac{d\ln(\bar{e}_y p_y)}{d\ln e_x} = \frac{N_x}{(2N-1)} > 0.$$

We see from the first equation that the dollar depreciation raises the dollar price of Mexican goods, but by an amount *less than unity.* The greater is the number of Chinese varieties N_y – reflecting more competition from China – the smaller is this pass-through coefficient. From the second equation, the rise in the dollar price of Mexican goods also induces a rise in the dollar price of Chinese goods, even though its exchange rate is fixed. The result is obtained because Chinese firms respond to the rise in Mexican prices by increasing their own prices. The amount by which Chinese prices rise is smaller, however, as the number of Mexican varieties shrinks.

Pass-through of the multilateral exchange rate

So far, I have solved for the pass-through of the dollar/peso rate to the dollar prices of Mexican and Chinese goods. In practice, pass-through is often measured using multilateral (aggregate) import prices and exchange rates. To achieve that here, define the import price and multilateral exchange rate by taking trade-weighted shares:

$$\ln P_m \equiv (s_x N_x)\ln(e_x p_x) + (s_y N_y)\ln(\bar{e}_y p_y),$$

$$\ln E_m \equiv (s_x N_x)\ln(e_x) + (s_y N_y)\ln(\bar{e}_y).$$

The weights using in these aggregates are the total share of U.S. imports coming from Mexico, (s_xN_x), and the total share of imports coming from China, (s_yN_y). We shall treat these shares as constant when differentiating the aggregates (as they would be in any price index). So we obtain the total change in import prices and the multilateral exchange rate:

$$d\ln P_m = (s_x N_x)d\ln(e_x p_x) + (s_y N_y)d\ln(\bar{e}_y p_y),$$

$$d\ln E_m = (s_x N_x)d\ln(e_x),$$

where we make use of the fact that the yuan exchange rate is fixed. Dividing these equations, we obtain the multilateral pass-through of the exchange rate:

$$\frac{d\ln P_m}{d\ln E_m} = 1 - \frac{N_y}{(2N-1)}\left(\frac{s_x - s_y}{s_x}\right) < 1 \text{ iff } (s_x - s_y) > 0.$$

Thus, the pass-through of the multilateral exchange rate is less than unity provided that the per-firm (or per-product) share of Mexico exports to the U.S. exceeds that for China, $(s_x - s_y) > 0$. This condition is guaranteed to hold provided that A > 0, so there is a "North American bias" in favor of Mexico, which we have already assumed. Furthermore, we see that the pass-through is reduced when the number of Chinese firms selling into the U.S. market, N_y, expands.

Let us now consider how to estimate the pass-through including this type of interaction effect. Using the above theoretical results, the import price index P_m can be solved as:

$$\ln P_m = \frac{1}{\gamma(N-1)} + [1 - B(s_y N_y)]\ln \tilde{E}_m + B(s_y N_y)\ln(\bar{e}_y w_y) + \left(\frac{\alpha_x - \alpha_y}{\gamma}\right)B(s_y N_y)(s_x N_x),$$

where the multilateral exchange rate is,

$$\ln \widetilde{E}_m \equiv [(s_x N_x)\ln(e_x w_x) + (s_y N_y)\ln(\bar{e}_y w_y)],$$

and the coefficient B is given by,

$$B \equiv \frac{(s_x - s_y)}{s_x s_y (2N-1)} > 0 \text{ provided that } A > 0.$$

We see that the translog expenditure function leads to an approximately log-linear equation for the import price: it is only approximately log-linear because the term B is not a constant, but is an endogenous variable that depends on relative wages and numbers of firms.

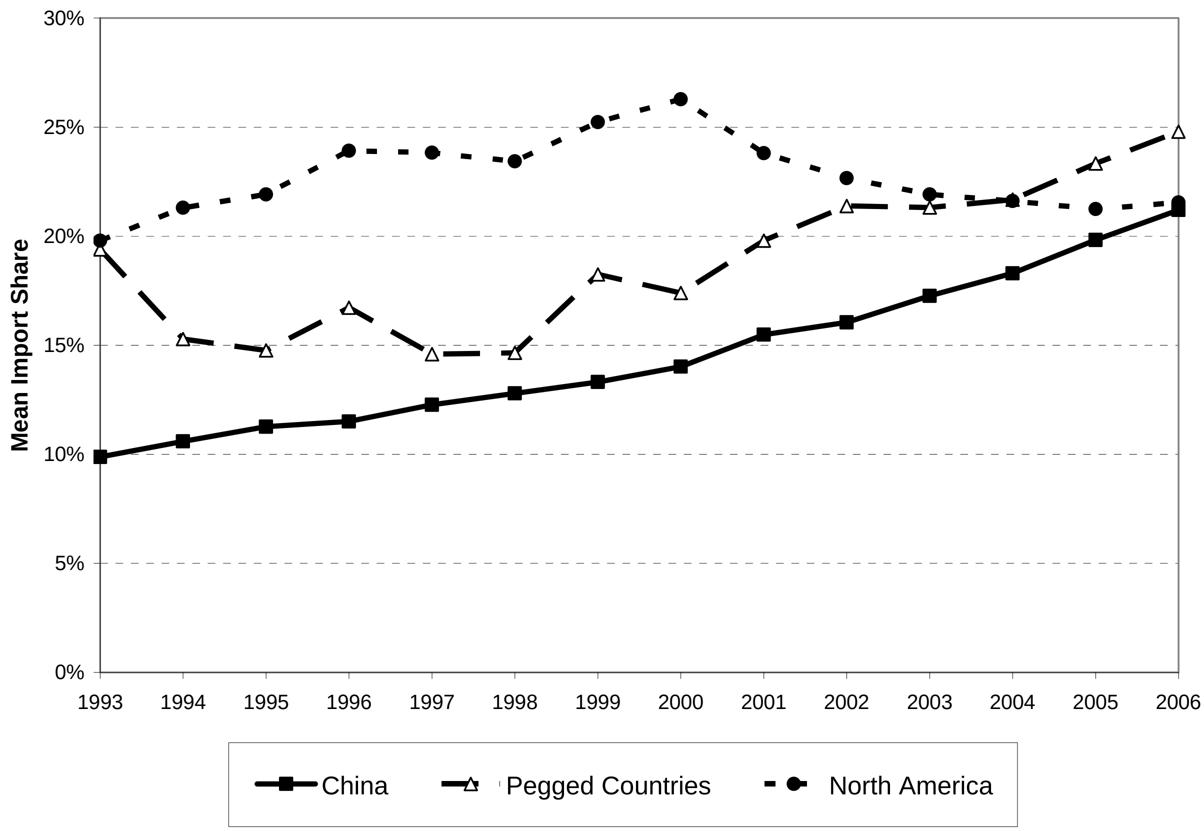
Notice that the pass-through equation includes an interaction term between the multilateral exchange rate and the Chinese import share. An increase in the number of Chinese firms selling in the U.S. market will definitely reduce the pass-through of the exchange rate. Stated differently, an increase in the Chinese share will lower the pass-through of the exchange rate, provided that the increase in the share reflects an increase in the number of Chinese firms, that is, reflects the extensive margin of Chinese exports rather than the intensive margin.

Data and Estimating Equation

The data used to estimate this equation is drawn from a set of monthly import prices across 5-digit Enduse industries. The same data are used by Feenstra, Mandel, Reinsdorf and Slaughter (2009) to analyze the Information Technology Agreement, which eliminated tariffs on all high-technology products beginning in 1997. Because the high-tech products require special treatment for tariffs they are omitted by Bergin and Feenstra (2009), as reported here.

Chinese competition is gauged by the share of U.S. import purchases coming from China plus Hong Kong. Figure 3.1 shows that the average share of Chinese imports grew steadily from 10% in 1993 to 22% in 2006. Bergin and Feenstra then broaden their analysis to consider the share of imports from not just China, but from all countries with a peg to the U.S. dollar (Klein and Shambaugh, 2006). As seen in Figure 3.1, this share initially falls from 20% to about 15%, which is explained by the December 1994 peso crisis in Mexico which led to the abandonment of the dollar peg. The peg share subsequently rises to 25% by 2006, which follows the growth in the China share.

Figure 3.1: Shares of U.S. Imports by Region of Origin



Source: Bergin and Feenstra (2009)

Initially, consider a regression of import prices on industry fixed effects and the effective exchange rate. The effective exchange rate is the nominal exchange rate times the Producer Price Index from each country, and then averaged over exporting countries, obtaining $\text{ExchPPI}_j^{t-\ell}$. The current monthly value and 6 lags of the effective exchange rate, $\ell = 0,1,...,6$ are included in the regression. The pass-through regressions should also include prices of goods that compete with the imports, such as domestic U.S. prices. So Bergin and Feenstra include the U.S. export prices P_{Xj}^t in each 5-digit Enduse industry.

The estimate of this regression, reported in column (1) of Table 3.1, shows incomplete pass-through of exchange rates of 0.21, which is the sum of all the coefficients on the current and lagged exchange rate. A coefficient of roughly similar magnitude is obtained on the export price. This first regression omits any other control variables, which are then added in the subsequent columns of Table 3.1. These other specifications test the effect of Chinese competition on pass-through by interacting the exchange rate with the share of Chinese imports, Share_{jchina}^t, in each Enduse category j:

$$\ln P_{Mj}^t = \alpha_j + \sum_{\ell=0}^{6} \beta_\ell \ln \text{ExchPPI}_j^{t-\ell} + \sum_{\ell=0}^{6} \delta_\ell [\ln \text{ExchPPI}_j^{t-\ell} \times \text{Share}_{jchina}^t] + \gamma \ln P_{Xj}^t + \theta' Z_j^t + \varepsilon_{jt}.$$

The sum of the coefficients δ_ℓ on the interaction term is the incremental pass-through due to changing the China share from zero to one. The additional terms Z_j^t appearing in this regression are control variables such as imports tariffs, the Chinese share of imports and other terms suggested by the theory.

The second regression of Table 3.1 includes the interaction between the exchange rate and the Chinese import share. The estimate of the interaction term is negative but small in

Table 3.1: Pass-through Regressions using the Multilateral Exchange Rate
Dependent Variable – Import Price Index

	(1)	(2)	(3)	(4)
	Using China Share			
Exchange rate	0.208** (0.009)	0.241** (0.009)	0.341** (0.012)	0.348** (0.012)
Export price	0.224** (0.016)	0.275** (0.016)	0.224** (0.016)	0.157** (0.016)
China share *Exch. Rate		-0.035** (0.003)	-0.565** (0.043)	-0.340** (0.043)
China share			2.593** (0.212)	2.056** (0.205)
Import Tariff				-0.013 (0.084)
China share *time				-0.001** (0.000)
China share *(1-China share)				-0.007 (0.052)
R^2	0.81	0.82	0.83	0.85
Observations	2694	2694	2694	2694

Notes: * significant at 5%, ** significant at 1%; standard errors are in parentheses.
Regression specification is run over 23 5-digit Enduse categories within consumer goods, capital goods, autos and chemicals (Enduse 2-4) for which no imports are covered by the Information Technology Agreement, from September 1993 – December 2006. OLS is estimated with 6 lags of the exchange rate and fixed effects for 5-digit Enduse categories.

Source: Bergin and Feenstra (2009)

magnitude. In third regression, the Chinese import share itself as a control. In that case, the interaction term of the exchange rate with the Chinese share becomes much larger in magnitude, with a coefficient of –0.57, and is statistically significant. In the final regression, import tariffs are included as a control and several other variables suggested by the theory. Even though the import prices are tariff-free, changes in the tariff levels will still affect import prices under imperfect competition, as in the translog model presented here. Including these additional controls reduces the magnitude of coefficient on the interaction term to –0.34, which is still significantly different from zero.

Rather than using only the Chinese share to represent a fixed exchange rate country, we can broaden that import share to include all countries with pegged exchange rates to the dollar. The corresponding regression results, reported in Table 3.2, show pass-through coefficients that are similar to the earlier specification. For example, in regression (3) of Table 3.2 we find that the interaction between the pegged share and the exchange rate has a coefficient (summed over current and lagged values) of –0.51, and highly significant. This coefficient is reduced to –0.26 when additional controls are added. We can conclude that our analysis of pass-through applies more broadly than just to China, but to trade with pegged countries more generally.

To summarize, we have shown here that the increased exports from China to the U.S., which consist in large part of offshored activities, play a significant role in the pass-through of the dollar exchange rate to U.S. import prices. As the dollar has fallen in recent years, import prices have not risen by as much as expected. Our argument is that the competition from Chinese producers has limited the price increases that could be expected from other, floating rate countries, such as Mexico. With import prices rising less than expected, overall U.S. inflation is also moderated, which is a macroeconomic consequence of increased globalization.

Table 3.2: Pass-through Regressions using the Multilateral Exchange Rate
Dependent Variable – Import Price Index

	(1)	(2)	(3)	(4)
	Using Pegged Share			
Exchange rate	0.208** (0.009)	0.227** (0.009)	0.349** (0.013)	0.341** (0.013)
Export Price	0.224** (0.016)	0.229** (0.016)	0.187** (0.015)	0.204** (0.015)
Peg share *Exch. Rate		-0.015** (0.002)	-0.510** (0.037)	-0.264** (0.039)
Peg share			2.376** (0.176)	1.363** (0.185)
Import Tariff				-0.012 (0.086)
Peg share *time				-0.001** (0.000)
Peg share *(1-Peg share)				0.032 (0.041)
R^2	0.81	0.81	0.83	0.84
Observations	2694	2694	2694	2694

Notes: * significant at 5%, ** significant at 1%; standard errors are in parentheses.
See Table 3.1 for further notes.

Source: Bergin and Feenstra (2009)

3.3 Conclusions

In less than three decades, China has grown from having a negligible role in world trade to being one of the world's largest exporters, as well as a substantial importer of raw materials, intermediate inputs, and other goods. This growth in trade brings opportunities as well as challenges. For industrial countries, China presents the opportunity of a low-cost labor force. Whether the goods are simple toys sold by Mattel, or personal computers sold by Lenovo or sophisticated components for the European Airbus, a large part of Chinese exports involves contracting manufacturing for goods that are designed elsewhere. This phenomenon, known as "processing trade," has been the focus of these lectures, and it means that China's success in contract manufacturing will reverberate to its trading partners.

Even while China acts as a manufacturing base for firms worldwide, its sheer size and rapid growth also creates challenges for many countries. On the export side, China is a formidable competitor in many markets, overlapping in its export composition with other middle-income countries in Asia and beyond. These countries often attribute declines in their own export demand to competition from China. And on the import side, too, China's impact is felt worldwide. Its demand for raw materials, especially to fuel the investment boom of recent years (including the 2008 Olympics), creates market pressure and higher prices for building materials. Likewise, the slowdown in China's industrial production in the midst of the 2008-2009 global crisis contributed to a dramatic fall in the commodity prices, and its subsequent growth contributed to expansion elsewhere. So the implications of China's rapid growth and expanding trade are both domestic and international in scope.

In these lectures, I began by presenting my work with Gordon Hanson (1996, 1997, 1999) as a model of processing trade, or offshoring. The activities being offshored from countries such as the United States are those consistent with comparative advantage, that is, those relying on less-skilled labor and taking advantage of lower wages for such workers in China. This model allows us to predict within-industry shifts in demand towards high-skilled labor, just as occurred in the U.S. during the 1980s and China more recently. Because the model relies on trade in intermediate inputs, and its predictions are consistent with the evidence from U.S. and Chinese manufacturing, then we conclude that this model is a good description of *materials offshoring*.

But the evidence for the 1990s in the United States, and for Europe, is that it is not just the less-skilled activities that are sent abroad; instead it may be medium or high-skilled activities. That fact does not sit well with the comparative advantage-based rationale for offshoring, and requires a specification of the extra costs involved with offshoring. That is where the recent work of Grossman and Rossi-Hansberg (2008) comes in so useful. By allowing for a rich structure of offshoring costs, it can predict that either the low-skilled activities are offshored, or that the high-skilled activities are sent abroad, depending on the costs of offshoring. The former case is what we discussed in Lecture 1, where we have found that the predictions of Grossman and Rossi-Hansberg are similar to Feenstra and Hanson, provided that attention is paid to whether we are assuming a small country or a large country. In contrast, the offshoring of high-skilled activities appears to describe *services offshoring,* has become more important in the world economy. In that case, Grossman and Rossi-Hansberg (2008) predict that it is the lower-end of high-skilled activities that will be offshored, i.e. those relying on more routine activities and less face-to-face communication. This prediction appears to fit the recent facts for the United States and Europe, where those workers have faced more job losses (Crinò, 2007a,b, 2008). We have not explored the potential role of China in services offshoring.

In Lecture 2, I discussed in more detail about what we mean by offshoring, which in its broadest conception deals with the organization of international trade and investment and the question of *how* to produce goods and services. There are two distinct ways to answer the question of *how*. First, we need to determine *which country* production occurs in, and that is what offshoring means: if part of the production process is shifted overseas, then it is offshored. Second, there is the question of whether to keep the process *within the firm* or not: if it sent outside the firm, then it is outsourced. This second question can only be answered by reference to a theory of the boundaries of the firm, developed outside the assumption of perfectly competitive markets. This question has recently been addressed by scholars in international trade such as Antràs and Helpman (2004), whose model and its extension to China by Fernandes and Tang (2011) was discussed in detail. The empirical specification in Feenstra and Hanson (2005) can be viewed as an application of the theory in Antràs and Helpman and Fernandes and Tang. Their empirical results point to a very important role for the property right model in understanding the structure of processing trade within China.

In Lecture 3, I argued that China is too big a player to ignore even for macroeconomic issues. There I analyzed the issue of how changes in the RMB or multilateral dollar exchange rate are passed-though to the prices of goods in the United States. The model presented relied on a translog expenditure function and variable markups charged by firms, which leads to a role for China in affecting pass-through behavior from other countries. We found that the growing share of China in U.S. imports has contributed to the fall in the pass-though of the exchange rates to the United States, and therefore kept down import prices even while the dollar depreciates. These findings suggest that China has played a role in moderating U.S. inflation.

To conclude, I began these lectures by arguing that the widespread use of processing trade in China, which has accelerated since its accession to the WTO in 2001, has been a unique feature of its development experience. More than any other economy, China has relied on and taken advantage of linkages with the rest of the world through serving as a site for processing activities. It has been able to secure the benefits of globalization for workers and firm-owners engaged in these activities. But we should not expect these forces to remain static into the future. As wages rise and a middle-class with purchasing power is formed, there is a new focus today on domestic – rather than international – demand to continue to maintain growth. In this sense, China has joined the group of industrial economies that must look equally well within their countries, in addition to external demand, as the drivers of future growth.

References

Amiti, Mary and Shang-Jin Wei, 2005a, "Service Offshoring, Productivity, and Employment: Evidence from the United States," IMF Working Paper 05/238, International Monetary Fund, Washington, D.C.

Amiti, Mary and Shang-Jin Wei, 2005b, "Fear of Service Outsourcing: Is It Justified?" *Economic Policy,* 20(42), 308-347.

Amiti, Mary and Shang-Jin Wei, 2006, "Service Offshoring and Productivity: Evidence from the United States," National Bureau of Economic Research working paper no. 11926.

Anderton, Bob and Paul Brenton, 1999, "Outsourcing and Low-Skilled Workers in the UK," *Bulletin of Economic Research,* 51(4), 267-285.

Antràs, Pol, 2003, "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics,* 118, 1375-1418.

Antràs, Pol, 2005, "Incomplete Contracts and the Product Cycle," *American Economic Review,* 95(4), 1054-1073.

Antràs, Pol, and Elhanan Helpman, 2004, "Global Sourcing," *Journal of Political Economy,* 112(3), June, 552-580.

Becker, Sascha O., Karolina Ekholm, Marc-Andreas Muendler, and Robert Jaeckle, 2005, "Location Choice and Employment Decisions: A Comparison of German and Swedish Multinationals," *Review of World Economics*, 141(4), 693-731.

Bergin, Paul R. and Robert C. Feenstra, 2009, "Pass-through of Exchange Rates and Competition Between Fixers and Floaters," *Journal of Money, Credit and Banking*, 41(s1), 35-70.

Bernard, Andrew B. and J. Bradford Jensen, 1997, "Exporters, Skill Upgrading, and the Wage Gap," *Journal of International Economics,* 42(1/2), February, 3-32.

Branstetter, Lee and Nicholas Lardy, 2008, "China's Embrace of Globalization," in Loren Brandt and Thomas Rawski, eds., *China's Economic Transition: Origins, Mechanisms, and Consequences.* Cambridge University Press, 2008.

Cheung, Yin-Wong, Menzie D. Chinn and Eiji Fujii, 2010, "China's Current Account and Exchange Rate," in Robert C. Feenstra and Shang-Jin Wei, China's Growing Role in world Trade, Chicago: University of Chicago Press and NBER, 231-271.

Christensen, Laurits R., Dale W. Jorgenson and Lawrence J. Lau, 1975, "Transcendental Logarithmic Utility Functions", American Economic Review 65, 367-383.

Crinò, Rosario, 2007a, "Service Offshoring and White-Collar Employment," CESifo Working Paper 2040.

Crinò, Rosario, 2007b, "Skill-Biased Effects of Service Offshoring in Western Europe," CESPRI-Bocconi University Working Paper 205.

Crinò, Rosario, 2008, "Service Offshoring and Productivity in Western Europe," CESPRI-Bocconi University Working Paper 220.

Demurger, Sylvie, Jeffrey D. Sachs, Wing Thye Woo, Shuming Bao, Gene Chang, and Andrew Mellinger. 2002. "Geography, Economic Policy, and Regional Development in China." *Asian Economic Papers,* 1(1), Winter, 146-197.

Dell'mour, R., P. Egger, K. Gugler, and M. Pfaffermayr, 2000, "Outsourcing of Austrian Manufacturing to Eastern European Countries: Effects on Productivity and the Labor Market," in Sven Arndt, H. Handler and D. Salvatore, eds., *Fragmentation of the Value Added Chain.* Austrian Ministry for Economic Affairs and Labour: Vienna.

Diewert, Erwin W., 1976, "Exact and Superlative Index Numbers," *Journal of Econometrics,* 4, 115-145.

Dollar, David, Shuilin Wang, Lixin Colin Xu and Anqing Shi, 2004, "Improving City Competitiveness through the Investment Climate: Ranking 23 Chinese Cities," mimeo, The World Bank, published in Chinese by the Finance and Economics Publishing House, http://www.cityindicators.org/Deliverables/SSRN-id530744_12-4-2007-1026158.pdf .

Dooley, Michael P., David Folkerts- Landau, and Peter Garber, 2003, "An Essay on the Revived Bretton Woods system," NBER Working Paper no. 9971.

Dooley, Michael P., David Folkerts- Landau, and Peter Garber, 2004b, "The Revived Bretton Woods System: The Effects of Periphery Intervention and Reserve Management on Interest Rates and Exchange Rates in Center Countries," NBER Working Paper no. 10332.

Dooley, Michael P., David Folkerts- Landau, and Peter Garber, 2004b, "Direct Investment, Rising Real Wages and the Absorption of Excess Labor in the Periphery," NBER Working Paper no. 10626.

Dornbusch, Rudiger, Stanley Fischer, and Paul A. Samuelson, 1980, "Heckscher-Ohlin Trade Theory with a Continuum of Goods," *Quarterly Journal of Economics*, 95(2), September, 203-24.

Du, Qingyuan and Shang-Jin Wei, 2010a, "A Sexually Unbalanced Model of Current Account Imbalances", NBER Working Paper No. 16000.

Du, Qingyuan and Shang-Jin Wei, 2010b, "Sex Ratios and Exchange Rates," NBER Working Paper no. 16788.

Ebenstein, Avraham, Ann Harrison, Margaret McMillan, and Shannon Phillips, 2009, "Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys," NBER working paper no. 15107.

Egger, Peter, Michael Pfaffermayr, and Andrea Weber, 2007, "Sectoral Adjustment of Employment to Shifts in Outsourcing and Trade: Evidence from a Dynamic Fixed Effects Multinomial Logit Model," *Journal of Applied Econometrics,* 22, 559-580.

Feenstra, Robert C., 2003, "A Homothetic Utility Function for Monopolistic Competition Models, Without Constant Price Elasticity," *Economic Letters,* 78, 79-86.

Feenstra, Robert C., 2010, *Offshoring in the Global Economy: Theory and Evidence.* MIT Press.

Feenstra, Robert C. and Gordon H. Hanson, 1996, "Foreign Investment, Outsourcing and Relative Wages," in R.C. Feenstra, G.M. Grossman and D.A. Irwin, eds., The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati, MIT Press, 89-127.

Feenstra, Robert C. and Gordon H. Hanson, 1997, "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras," Journal of International Economics, 42(3/4), May, 371-393.

Feenstra, Robert C. and Gordon H. Hanson, 1999, "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the U.S., 1979-1990," Quarterly Journal of Economics, August, 114(3), 907-940.

Feenstra, Robert C. and Gordon H. Hanson, 2005, "Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm," Quarterly Journal of Economics, 120(2), May 2005, 729-762.

Feenstra, Robert C. and Chang Hong, 2010, "China's Exports and Employment," in *China's Growing Role in World Trade*, edited by Robert C. Feenstra and Shang-Jin Wei, NBER and Univ. of Chicago Press, 2010.

Feenstra, Robert C., Wen Hai, Wing T. Woo, and Shunli Yao, 1999, "Discrepancies in International Data: An Application to China-Hong Kong Entrepôt Trade," *American Economic Review*, May 1999, 338-343.

Feenstra, Robert C., Alan Heston, Marcel P. Timmer, and Haiyan Deng, 2009, "Estimating Real Production and Expenditures Across Countries: A Proposal for Improving the Penn World Tables," *Review of Economics and Statistics*, 91(1), 201-212.

Feenstra, Robert C., Benjamin Mandel, Marshall B. Reinsdorf, and Matthew J. Slaughter, 2009, "Effects of Terms of Trade Gains and Tariff Changes on the Measurement of U.S. Productivity Growth," NBER Working Paper no. 15592.

Fernandes, Ana and Heiwai Tang, 2011, "Determinants of Vertical Integration in Export Processing: Theory and Evidence from China," Tufts University and Centro Studi Luca d'Agliano.

Geishecker, Ingo, 2002, "Outsourcing and the Relative Demand for Low-skilled Labour: Exemplary Evidence from German Input-Output Data," DIW-Berlin, manuscript.

Görg, Holger, A. Hijzen and R.C. Cline, 2001, "International Fragmentation and Relative Wages in the U.K.," Research Paper 2001/33, Leverhulme Centre for Research on Globalization and Economic Policy, University of Nottingham.

Gron, Anne and Deborah Swenson, 1996, "Incomplete Exchange-Rate Pass-Through and Imperfect Competition: The Effect of Local Production," *American Economic Review*, 86(2), 71-76

Grossman, Gene M. and Esteban Rossi-Hansberg, 2008, "A Simple Theory of Offshoring," *American Economic Review,* 98(5), 1978–1997.

Grossman, Sanford J. and Oliver D. Hart, 1986, "Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94(3), August, 691-719.

Gust, Christopher, Sylvain Leduc and Robert J. Vigfusson, 2006, "Trade Integration, Competition, and the Decline in Exchange-Rate Pass-Through," Board of Governors of the Federal Reserve System International Finance Discussion Paper #864.

Hart, Oliver D. and John Moore, 1990, "Property Rights and the Nature of the Firm," *Journal of Political Economy,* 98, 1119-1158.

Helpman, Elhanan, 2006, "Trade, FDI, and the Organization of Firms," *Journal of Economic Literature,* 44, 589-630.

Helpman, Elhanan, Dalia Marin and Thierry Verdier, eds., 2009, *The Organization of Firms in a Global Economy*, Harvard University Press.

Hsieh, Chang-Tai and Keong T. Woo, 2005, "The Impact of Outsourcing to China on Hong Kong's Labor Market," *American Economic Review*, 95(5), 1673-87.

Ihrig, Jane E., Mario Marazzi and Alexander D. Rothenberg, 2006, "Exchange-Rate Pass-Through in the G-7 Countries," Board of Governors of the Federal Reserve System International Finance Discussion Paper #851.

Klein , Michael W. and Jay Shambaugh, 2006, "Fixed Exchange Rates and Trade," *Journal of International Economics* 70, 359-383.

Koopman, Robert, Zhi Wang, Shang-Jin Wei, 2008, "How Much of Chinese Exports is Really Made In China? Assessing Domestic Value-Added When Processing Trade is Pervasive," NBER working paper no. 14109.

Koopman, Robert, William Powers, Zhi Wang, Shang-Jin Wei, 2010, "Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains," NBER working paper no. 16426.

Li, Zhiyuan, 2010, "Task Offshoring and Organizational Form: Theory and Evidence from China", Shanghai University of Finance and Economics Working Paper

Liu, Runjuan and Daniel Trefler, 2008, "Much Ado About Nothing: American Jobs and the Rise of Service Offshoring to China and India," NBER working paper no. 14061.

Lorentowicz, Andzelika, Dalia Marin, and Alexander Raubold, 2005, "Is Human Capital Losing from Outsourcing? Evidence for Austria and Poland," Discussion Papers in Economics 715, University of Munich, Department of Economics

Marazzi, Mario, Nathan Sheets, Robert J. Vigfusson, Jon Faust, Joseph E. Gagnon, Jaime Marquez, Robert F. Martin, Trevor A. Reeve and John H. Rogers, 2005, "Exchange Rate Pass-through to U.S. Import Prices: Some New Evidence," Board of Governors of the Federal Reserve System International Finance Discussion Paper #833.

Marin, Dalia, 2004. "'A Nation of Poets and Thinkers' - Less So with Eastern Enlargement? Austria and Germany," Discussion Papers in Economics 329, University of Munich, Department of Economics.

Melitz, Marc, 2003, "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), November, 1695-1725.

Munch, Jakob Roland, 2008, "Whose Job Goes Abroad? International Outsourcing and Individual Job Separations," mimeo.

Nash, John, 1950, "The Bargaining Problem," *Econometrica*, 18, 155–62.

Ottaviano, Gianmarco I.P., Giovanni Peri, Greg C. Wright, 2010, "Immigration, Offshoring and American Jobs," NBER working paper no. 16439.

Samuelson, Paul A, 1952, "The Transfer Problem and Transport Costs: The Terms of Trade when Impediments are Absent," *Economic Journal,* 62, 278-304.

Sheng, Liugang and Dennis T. Yang, 2011, "Ownership, Processing Trade and Wage Inequality: Evidence from China", work in process.

Sitchinava, Nino, 2008, "Trade, Technology, and Wage Inequality: Evidence from U.S. Manufacturing, 1989-2004," University of Oregon, Ph.D. dissertation.

Voigtlaender, Nico, 2008, "Many Sectors Meet More Skills: Intersectoral Linkages and the Skill Bias of Technology," University of California, Los Angeles.

Wei, Shang-Jin and Xiaobo Zhang, 2011, "The Competitive Saving Motive: Evidence from Rising Sex Ratios and Savings Rates in China," *Journal of Political Economy,* 3(119), 511-564.

Wright, Greg C., 2010, "Revisiting the Employment Impact of Offshoring," University of California, Davis.

Xing, Yuqing and Neal Detert, 2010, "How the iPhone Widens the United States Trade Deficit with the People's Republic of China," ADBI Working Paper Series, No. 257.

Xing, Yuqing, 2011, "Processing Trade, Exchange Rates and China's Bilateral Trade Balances," GRIPS Discussion Paper 10-30, http://ssrn.com/abstract=1745862

Yang, Yao, 2011, "China's Export-Led Growth Model", East Asia Forum, http://www.eastasiaforum.org/2011/02/27/chinas-export-led-growth-model/