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GLOBALIZATION, AMERICAN WAGES, AND INEQUALITY

Past, Present, and Future

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A strange argument has begun making the rounds in the globalization debate, one that asserts there is a puzzle in American politics: economics teaches that globalization leads to national gains, yet popular opinion is ambivalent at best about it. This puzzle even comes with a plausible-sounding explanation: globalization's benefits are huge but diffuse (consisting of lower prices for imported goods), while its costs are small but concentrated (workers displaced by imports); hence, the gains are hard to see but the losses are all too visible.

The alleged puzzle and the fashionable-again explanation forwarded to resolve it should sound strange to economists, as they are clearly at odds with what the most conventional theory teaches about the likely results of the rich U.S. economy integrating with a poorer global economy. While this integration is indeed "win-win" in *between countries*, it is pitilessly "win-lose" in terms of individual outcomes *within* countries. That is, the U.S. and its poorer trading partners both end up with higher *national* incomes due to trade, but at the same time, this trade makes many (and possibly most) workers in the U.S. *worse-off*. This sad result is known to trade economists as the "curse of Stolper-Samuelson," named after the theory that predicts it.

This paper revisits the insights of Stolper-Samuelson and estimates the impact on American wages of trade flows between the rich U.S. economy and a poorer global economy. Estimates are derived using a relatively simple model originally deployed by Krugman (1995) in the "trade and wages" debate that flared up in the early 1990s. Despite a rather conservative methodology, this paper finds that:

- Trade with poorer nations had by 1995 led to a rise in relative earnings of skills vis-à-vis labor of just under 5%, relative to baseline of no trade with poor nations. This is an amount roughly equal to 12.5% of the dramatic increase in earnings inequality that happened between 1980 and 1995.

- By 2006, trade flows between the U.S. and its poorer trading partners increased relative earnings inequality by just under 7% relative to a no - trade baseline.

- Over the next 10-20 years, *if* some prominent forecasts of the reach service-sector offshoring hold true, and, *if* current patterns of trade roughly characterize this offshoring, *then* globalization could increase relative wages by 25% over this time.

Background

Evolution of Trade Theory

In the late 1970s and early 1980s, it became apparent that the bulk of U.S. trade flowed to and from the other rich countries of the globe. This type of trade (call it *rich/rich trade*) was counter to the classical theory positing that nations traded to exploit *differences* in economic structure, and, economists forwarded new theories about why rich/rich trade dominated. Essentially, the research focused on questions like: why did Japan and the United States both export and import autos from one another? This "new trade theory" emphasized contingent historical factors combined with increasing returns to productive scale to explain these trade flows.

The implications of rich/rich trade for U.S. distributional outcomes were far from clear (indeed, most new trade models assumed only 1 factor of production for simplicity, hence, there was no room for distributional conflict). On balance, however, even though rich/rich trade is far from costless, it is much more likely to be win-win across the broad spectrum of the American workforce, or to at least provide no consistent upward redistribution.

In the late 1980s and early 1990s, the share of U.S. trade flows accounted for by less developed countries (LDCs) increased rapidly and became significant enough to send economists back to earlier models of trade to assess its impact on the American economy. An essential insight of these models is that trade with LDCs (call it *rich/poor* trade) leads the United States to specialize in production that results in increased demand for *skills*, credentials, and capital (shorthanded as skills throughout the paper) and reduced demand for raw labor, thereby increasing already-present income differentials.

This theory, and the striking coincidence between growing rich/poor trade and the rise in inequality over the past two decades, is why the effects of globalization on American workers are worthy of great concern.

Trade and Wage inequality

The Stolper-Samuelson Theorem

Reductions in trade costs have at least two potential impacts on wages. First, workers employed in industries directly in competition with low-cost imports from abroad can expect to see immediate dislocation and/or wage pressures. Second, as relative prices change across industries, the return to factors of production, including different kinds of labor inputs, can be expected to change as well. The equilibrium outcome of the second effect was first demonstrated by Stolper and Samuelson (1949).

The Stolper-Samuelson Theorem (SST) predicts that falling costs for trade between rich and poor nations harm each nation's *scarce* factor of production. "Scarce", however, has a specific (and non-intuitive) meaning: scarcity in the domestic economy is measured *relative to its abundance in the global economy*. In the U.S. for example, production workers constitute the majority of the domestic workforce, but the ratio of this group relative to white-collar and managerial labor is much lower in the U.S. than in the global economy. Hence, production labor is the "scarce" factor in the United States, and is accordingly the group harmed by falling trade costs.[1]

A brief example can capture the essential insights of the theory. A slightly more rigorous exposition can be found in **Technical Appendix 1**.

Suppose that the labor force of the U.S. can be divided into *workers* (those who supply raw labor) and *managers* (those who supply skills, capital, and credentials). Assume further that there are just 2 sectors in the U.S. economy, call them apparel and aircraft. Lastly, assume apparel is the more labor-intensive business: the production of apparel requires a higher ratio of workers to managers than does aircraft production.

Now, say that falling trade costs (a tariff cut for example) reduces the price of imported apparel, leading prices of *domestically produced* apparel to fall as well. The lower prices lead domestic apparel producers to produce less, and employ fewer workers and fewer managers. Higher relative prices for aircraft lead to an expansion in this industry (supported by an increase in exports).

The problem for workers is, of course, that the *ratio* of workers to managers laid-off by apparel makers is too

high to allow all the workers to be absorbed into the expanding aircraft sector *at the going wage for workers*. If these workers want a job, they must agree to a wage cut. Further, it's not just the unemployed labor that takes a wage cut—*it's all workers economy-wide*. Any incumbent worker in either aircraft or apparel not agreeing to this wage cut could be replaced with an unemployed worker.

The process works in reverse for managers. The apparel sector does not shed *enough* managers in order to meet extra demands generated by increased aircraft exports. This imbalance bids up their wages.

Lastly, as workers have become cheaper relative to managers, both aircraft and apparel producers have incentives to adopt new production techniques that economize on managers and more intensively use workers. At the end of the economy's adjustment to the tariff cut, the apparel industry has contracted, the aircraft industry has expanded, workers' wages have fallen, managers' wages have increased, and both industries use a higher share of workers than previously. These are the standard predictions of mainstream trade theory.

Consistent with the standard gains from trade results, the *gross gains* for managers outweigh the *gross losses* of workers, hence the national economy sees *net gains* from trade. It is these net gains which constitute the argument in favor of global integration; however, the gross losses cause workers to worry about globalization. This fear is *utterly rational* in light of economic theory, and the size of the losing group is much larger than is commonly appreciated.

Wage Cuts Without Tariff Cuts

While the above example and underlying theory rely on changes in trade policy to generate sectoral movements, one gets similar results if global factor supplies change (say, if the formerly autarkic economy of China joins the capitalist trading system).

To see how, consider the Rybczynski theorem (RT), an important complement to the SST. The RT theorem predicts that if the prices of apparel and aircraft are flexible, an increase in the quantity of the factor (say labor) intensively used in a given sector (say apparel) will lead to a declining price for that sector's output. This sparks an SST-type adjustment in the wages of workers and managers, driving down workers' wages as before.

Rybczynski originally framed his argument in terms of a closed economy, but one can look at it as a prediction of what will happen when labor - abundant nations (think China and India) are integrated into the world economy, increasing the global labor pool (say through offshoring). In this case, the RT predicts that the price of labor-intensive commodities will fall as a result of the increase in the global labor pool, and, these falling prices will harm labor's wages in countries (like the U.S.) abundant in skills, capital, and credentials.

To test the reasonableness of this, think of the price of DVD players, apparel, and the price of call center operations, and whether or not the expansion of the global labor pool has reduced their prices. Given these price reductions, resources in the United States will move out of producing these commodities and into the production of goods requiring a greater input of skills, capital, and credentials. This move sets off the SST chain of causation, leading to a fall in wages and a rise in the return to skills, capital, and credentials. Hence, SST results occur *even without changing trade costs*—wages in the United States fall resulting from the integration of labor abundant economies into the global trading regime. This is surely one of the more intuitive aspects of the economics of globalization.

Globalization's Costs

Not just unemployment or adjustment

Note for a second what all of this does *not* say: that these losses are the *adjustment cost* of workers' unemployment spell between jobs. This temporary adjustment cost is not even factored in the SST (which, like many economic theories, assumes full-employment). These adjustment costs are, of course, real and should be of concern to policy makers, but they are not the first-order costs of globalization (it is interesting to note that these adjustment costs may actually be greater for rich/rich trade, as the cost differentials between rich nations are thin, and, production may shift back and forth between rich and poor countries more readily because of this).

Rather, the losses specified by the SST are the *permanent* wage - losses suffered by labor in this economy.

If labor in these models is proxied empirically by production and non-supervisory workers, who constitute roughly 75% of the entire U.S. workforce. Hence, while gross *gains* may exceed *gross* losses as trade expands, it is not the case that *winners* outnumber *losers*.

Also, and importantly, lower wages for labor are not confined to the sector most immediately in competition with imports. In a fluid labor market, labor's wages decline across the economy.

Unfortunately, this basic axiom of economic theory seems to be ignored by many analysts. Bradford, Greico, and Hufbauer (2005), in what they bill as a comprehensive accounting of the gains and losses attributable to trade liberalization, count only the costs of direct displacement as a debit in the balance sheet of globalization, and do not even acknowledge wage losses through the Stolper-Samuelson channel. Failing to count the largest cost of globalization is, of course, an excellent way to make the cost/benefit analysis of integration come out well to those favoring the *status quo*. The following section uses a simple model to quantitatively assess trade's impact on U.S. wages and earnings inequality.

Estimates of Trade's Impacts

Krugman (1995) used a simple *computable general equilibrium* model to examine the issue of international trade and wage inequality. This paper uses the same model to get a rough estimate of how much offshoring has impacted American wage inequality in the past, at present, and could possibly impact it in the future. The mechanics and assumptions behind the model are described more fully in **Technical Appendix 2**.

The essential features, however, can be described as follows, and follow from the earlier description of the SST. The United States is assumed to be abundant in skills, capital, and credentials (shorthanded as skills) relative to the rest of the world (ROW), and (hence by definition) relatively deficient in labor. This implies that skills in the U.S. are relatively cheap, leading to the U.S. exporting skills-intensive goods and importing labor-intensive goods. Consistent with the SST, as production in labor-intensive industries is replaced with production in skills-intensive industries, demand for labor falls while demand for skills rises,

Trade and Wages: Past, Present, and Future

By now, it is generally conceded by unbiased analysts that the United States has seen a sharp increase in inequality over the past 25 years. Many proponents of the globalization status quo minimize the empirical relevance of globalizations costs for American workers. The *de minimus* argument scales the impact of trade against the much wider march towards a less equal economy.

Past

In the early 1990s a flurry of studies addressed this issue. The resulting estimates are spread widely, but most indicated that trade could account for roughly 10-40% of the total rise in inequality that occurred in the 1980s and early 1990s. The observation that "most" of the rise in inequality was generated by factors other than trade was often emphasized to allay anxieties about globalization.

Present

Findings from this first round of the trade and wages debate are now a decade old, yet are still often invoked in contemporary debates. Academic interest in the topic essentially waned after 1995 as wages for all workers began rising; a tight labor market trumped all other influences. However, this does not mean that trade stopped dragging on some workers' wages. There are many determinants of wage growth, and just because the net outcome of them all is positive does not mean that all are benign.

Future

Looking forward, the issue of service-sector offshoring is becoming increasingly important The ability of U.S. companies to import work that was traditionally considered untradeable (for example, call center opertions, software programming, and various business process services), has increased and has led to anxieties over job security spreading over a much wider swath of the American workforce. Service-sector offshoring essentially gives globalization a much larger lever with which to impact U.S. labor markets, and, upends what was a widely-shared conclusion in the trade and wages debate of the 1990s: the impact of trade on U.S. labor markets was bounded by the (relatively) low share of U.S. workers employed in tradeable industries.

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"In 1993, roughly 15 percent of American workers were employed in manufacturing. The vast majority of unskilled workers were employed producing nontraded goods, such as retail trade and various services. In such a world, it is hard to see how pressures on wages emanating from traded goods can determine wages economy-wide." (Freeman 1995)

"In particular, imports of manufactured goods from eveloping countries are still only about 2 percent of the combined GDP of the OECD. The conventional wisdom is that trade flows of this limited magnitude cannot explain the very large changes in relative factor prices that have occurred…" (Krugman 1995)

"…when the large portion of the economy that is nontradeable and the limits of international specialization imposed by home orientation in consumption and production are taken into account, there is much more limited scope for trade to affect relative factor prices." (Cline 1997)

Note that these quotations are not meant as illustrations of myopia on the part of the authors: these were (and are) some of the smartest authors writing on trade's labor market impacts. What they illustrate is the sea change in perceptions about trade's potential impact on the U.S. economy in the era of offshoring.

A decade ago, substantially fewer than 20 percent of American workers could be plausibly identified as being in direct competition with workers around the globe. This was enough to allow trade to put downward pressure on wages, but, it did mean that there was a natural ceiling on this impact.

If offshoring represents (among other things) an expanded number of industries that are now "tradeable", the reassuring tone of the above quotations no longer holds. Put simply, if offshoring doubles the number of workers who are employed in industries that are now tradeable, then it will (at least roughly) double the impact globalization has on American labor markets.

leading to greater inequality (as skill-owners are generally thought to be starting from relatively higher incomes than those offering only labor). Compared to other estimates in the literature, this CGE model generally yields relatively modest estimates of trade's impacts on U.S. earnings.[2]

The volume of trade conducted with lower-wage trading partners is the relevant factor in assessing the impacts of globalization on U.S. labor markets. This paper uses the share of U.S. GDP accounted for by trade (defined as the *average* of imports and exports) with non-OECD countries (as OECD countries are generally rich, and trade with them will not necessarily follow the predicted patterns regarding the labor-intensity of imports and exports that drives the inequality-inducing effects of trade), non-OPEC countries (as oil is not generally thought to compete with U.S. production), and including Turkey and Mexico (the two poorest OECD nations) for this parameter.

Past and present

Table 1 below presents the first set of results. The first row shows this LDC trade-share expressed as a percentage of GDP for 1995 and 2006. The second row shows the increased spread in relative earnings generated by feeding this data into the CGE model. The 1995 results are presented to verify that the model's results are well in line with earlier rounds of the trade and wages debate, and they are generally in line with the Krugman (1995) results, showing a 4.8% increase in relative wages stemming from rich/poor trade flows. The difference between the results in Krugman (1995) and in this paper is attributable to the LDC share for 1995 in this paper being higher (by about a percentage point) than Krugman's estimate, which was for the entire OECD, not just the U.S.

By 2006, relative wages are 6.9% higher relative to a no-LDC trade baseline, meaning that the impacts of rich/poor trade have risen by over 40% in the past decade.

TABLE 1

Results: Past and Present

	1995	*2006*
LDC Share (data input)	3.5%	4.9%
Relative Wage Change (CGE output)	4.8%	6.9%
Absolute Change in:		
Raw labor	-2.8%	-4.0%
Skills	2.0%	2.9%

TABLE 2

Jobs currently offshorable and forecasts for the coming decade

Current	Offshorable Jobs	Trade Share	LDC Trade Share
	14,500	12.5%	3.1%
Forecast for newly offshorable jobs by:	(New) Offshorable Jobs (thousands)	Implied Trade Share	Implied LDC Share
Forrester Research	20,000	29.8%	10.9%
Bardhan* and Kroll* (2004)	14,850	25.4%	9.3%
Kletzer#+ and Jensen + (2005)	36,800	44.4%	6.2%
McKinsey Global Institute (2005)	12,029	22.9%	8.4%
Van Welsum and Vickery (2005)	18,100	28.2%	10.3%
Blinder (2006)	21,275	30.9%	11.3%
Average	20,509	30.2%	11.0%

Obviously, nobody knows for sure what will happen in the future. However, a number of economic researchers and observers have made forecasts as to the number of jobs that could be potentially "up for grabs" in the future, as technology, policy, and the introduction of billions of workers from China, India, and the former Eastern Bloc countries into the capitalist global economy make more jobs internationally contestable, particularly through service-sector offshoring.

Table 2 below translates a number of forecasts of offshoring's future reach into implicit trade shares (both total and LDC trade) in U.S. GDP (this is the necessary variable for the CGE models). The baseline estimate, shown in the first row of the table, is the share of jobs that are potentially tradeable in 2006, based on current trade shares in national income. **Technical Appendix 3** provides the precise methodology for this translation.

Table 3 presents results from plugging these forecasts of trade shares into the same model used previously to

TABLE 3

Offshoring's projected impact on the returns to raw labor and skills

	Ratio	***Labor***	***Skills***
High (Jensen/Kletzer)	25.0%	-15.0%	10.0%
Low (MGI)	12.0%	-7.0%	5.0%
Blinder	17.0%	-10.1%	6.9%
Average	16.0%	-9.4%	6.6%

Forecasting Offshoring's Importance and Future Patterns of Trade

The estimate of offshoring's potential future reach that has best pedigree comes from Alan Blinder, Princeton professor and chairman of the Council of Economic Advisors (CEA) under President Clinton. Blinder wrote in a *Foreign Affairs* magazine article that offshoring's impact could mean that "2 to 3 times" as many jobs could be internationally contestable as are presently in the manufacturing sector (which supplies the vast majority of contestable jobs today).

In a follow-up piece with substantially more data-crunching behind it, Blinder estimates that 22-29% of the entire U.S. workforce are *potentially offshorable* over roughly the next one or two decades. This is a slightly smaller estimate than his Foreign Affairs article, but, he seems much more confident about it, so, the midpoint of this latter estimate is used in this paper.

Lori Kletzer and J. Bradford Jensen provide the high-end estimate of the potential future tradeability of jobs in the U.S. economy. They use the implied domestic tradeability of various industries and occupations to gain an estimate that 38% of existing jobs are potentially tradeable, which works out to about 30 million more than currently (Kletzer and Jensen 2005). Their estimate, while the highest in the literature, is more rigorously grounded than all but the Blinder (2007) forecast. As such, it seems like a reasonable upper-bound for the table.

The lowest estimate comes from the McKinsey Global Institute (MGI), in its report on the Emerging Global Labor Market (MGI 2005). This report estimates that 9% of total U.S. employment is potentially offshorable over the next decade.

Beyond the simple question of *how many* jobs will be up for grabs is the equally important issue of what will they look like in terms of education, skills, and credential requirements.

Many researchers have argued that offshoring is, in fact, as much about the *change* in American comparative advantage as an expansion of industries that are tradeable. Fully arguing this point is beyond the scope of this paper, but, one point can be made. While researchers (Alan Blinder, again, and, most famously) have shown that the occupations most likely to become "tradeable" in the future tend to have, if anything, higher wages and/or education than the average, it does not then follow that offshoring implies a reversal of comparative advantage for the U.S. "Potentially tradeable" does not mean "inevitable net import", which is what must happen for the comparative advantage of the U.S. to fully reverse.

When the U.S. runs a 7% of GDP trade deficit, it may seem that anything tradeable will naturally be a net import (instead of export) for the U.S.. But, over time this deficit will unwind and the U.S. economy will become a net exporter of a wide range of products again. It seems likely in the future that a greater proportion of labor-intensive service-sector jobs will be offshored and replaced by imports than will skills-intensive service-sector jobs. While it is inevitable that many currently poor countries will tend to close the gap between their own and U.S. income levels over time, it seems hard to imagine that in the next decade, a relatively balanced trade relationship between the U.S. and LDCs will consist of the U.S. importing skills, capital, and credential-intensive goods like aircraft and professional services, and, exporting labor-intensive goods like apparel and furniture.

Given this, it seems reasonable to examine what it implies for the U.S. economy to have much more trade done following the same rough patterns of comparative advantage that have characterized the past. This view is hardly a radical one, and, in fact, is accepted by many of those who are notably unconcerned about the effects of trade or offshoring on the U.S. economy (see Appendix 2 for a list of representative quotes).

One should note that if this view is wrong and offshoring completely reverses the pattern of comparative advantage of the United States, then the U.S. will actually be made poorer *in the aggregate*. This point is made most famously by Samuelson (2004).

glean the retrospective impact of trade flows on relative earnings. With trade at levels forecast in Table 2, relative returns would increase by 12-25% relative to a no LDC-trade scenario. This is an amount equal to (roughly) between 40% and 80% of the *total* increase in the inequality in earnings that occurred between 1979 and 2004. Offshoring, in short, has the potential to wedge apart incomes to a huge degree in a very short time.

Table 3 also takes the last step and translates these relative income results into *absolute* values for changes in earnings of labor and skills. It is, again, a fundamental finding of trade theory that a country's "scarce" factor of production (labor in the United States) loses in *absolute*, not just relative terms, as trade expands.

On average, offshoring leads to an absolute decline of 9.4% in the returns to raw labor, and, a 6.6% increase in

the return to skills. To put this in some historical perspective, earnings for workers without a college degree rose by just 2.2% between 1979 and 2005. It took the full-employment boom of the late 1990s to finally push these earnings (in 2001) above the 1979 level. The implied loss due to offshoring would push these wages well below the 1979 levels, completely undoing (and then some) the entire increase in these wages over the past three decades.

Conclusion

The potential level of redistribution caused by offshoring is vast, and, so should be the policy response. The failure of the economics profession to educate the larger public (including the policymaking and pundit-class elites) on this too-little known aspect of trade theory explains much of the chasm between elite and popular attitudes towards globalization. Whatever the reasons for this failure, a serious understanding of what globalization means for the U.S. economy and its workers, and what must be done to hold the broad American working- and middle-classes whole in the face of global integration requires this failure be corrected.

Endnotes

1. Empirical studies in the trade and wages debate have generally used production and non-supervisory labor as a proxy for labor in the U.S., and, non-production and supervisory labor as a proxy for skills. Occasionally, workers with a 4-year college degree stand in for skills, with the rest of the workforce standing in for labor.
2. A more disaggregated version of this same model (Cline 1997), for example, yielded impacts almost 4 times as large.
3. The model itself is a simple excel spreadsheets available from the author upon request.

Appendix 1

On the large and diffuse gains from trade

Brad DeLong, in a forum hosted by the *Financial Times*' Martin Wolf:

"In the United States, at least, the problem is that most beneficiaries from globalization don't really know that they are beneficiaries, or how much they benefit. Feckless congressmen and congresswomen don't understand that the American economy is cushioned from their fiscal policy stupidities by the ability of the U.S. government to sell bonds internationally on a jaw-droppingly unbelievable scale. Home sellers in California don't realize that they got such a good price because of financing from across the Pacific. Walmart shoppers see the "made in China" stickers, but don't understand what a good deal they are getting because the rulers of the PRC are desperate to sell the products that their workers make at always low prices in order to stay as close as possible to full employment. The task is primarily one of making perceptions agree with reality, and only secondarily one of changing reality."

Bradford et al. (2004)

"While the gains from increased trade generate a permanent rise in income, the associated losses are temporary. Nevertheless, they are very real, and are concentrated on a small fraction of Americans."

Appendix 2

Quotes on offshoring as "being just more of the same trade."

"Outsourcing is just a new way of doing international trade…More things are tradable than were tradable in the past. And that's a good thing."

N. Gregory Mankiw

"As long as the American workforce retains its high level of skills and remains flexible as firms position themselves to improve their productivity, the high-value portion of the service sector will not evaporate."

Doug Irwin

"As with putting together hardware, building software systems is likely to happen locally. There will be less demand for basic programming and more demand for higher-value, higher-paid systems integration."

Virginia Postrel

"There is also no evidence that jobs in the high-value-added sector are migrating overseas. One thing that has made offshore outsourcing possible is the standardization of such business tasks as data entry, accounting, and IT support. The parts of production that are more complex, interactive, or innovative—including, but not limited to, marketing, research, and development—are much more difficult to shift abroad."

Daniel Drezner

"Moreover, these highest earning occupations appear to be in the same sectors where U.S. international trade comparative advantage is observed".

Catherine Mann

"Even though some IT tasks will be done abroad, many more jobs will be created in America, and higher-paying ones to boot."

Economist *magazine editorial*

"In particular, imagine a country which is relatively abundant in skilled labor, like the United States and begins to trade with a country which is relatively abundant in unskilled labor, like India. In such a case, trade may increase the real income of skilled labor in the United States and lower that of unskilled labor…Nothing changes in such an analysis of commercial policy when we consider outsourcing".

Bhagwati et al.

Technical Appendix 1

The relationship between wages and prices, or the Stolper-Samuelson Theorem

Cutting to the chase, what follows are the principal predictions of what the Stolper-Samuelson model predicts for skill-abundant U.S. economy.

Assume 2 countries that produce 2 goods with 2 factors of production. Call the countries the U.S. and the

ROW (rest of world), and, call the factors skills and labor. Skill is used intensively in both countries in the production of aircraft, while labor is used intensively in both countries in the production of apparel.

The essential relationship for the SST is the following set of zero-profit conditions in the apparel and aircraft industries:

(1) $hS_j + wL_j = P_j C$
(2) $hS_c + wL_c = P_c C$

Where:

S	=	to skilled workers
L	=	laborers
w	=	returns to labor
s	=	returns to skills
j (subscript)	=	aircraft (jets)
c (subscript)	=	apparel (clothing)
p	=	goods price

The zero-profit condition implies that payments to the factors of production must exhaust the value of each industry's output.

Dividing both sides of equation (1) by the total aircraft output (J) and equation (2) by the total apparel output (C) allows us to write (1) and (2) in matrix form:

$$(3) \begin{vmatrix} a_{sj} & a_{sc} \\ a_{sj} & a_{sc} \end{vmatrix} * \begin{vmatrix} h \\ w \end{vmatrix} = \begin{vmatrix} p_j \\ p_c \end{vmatrix}$$

Here, is the input of skills used to produce a single unit of aircraft, is the proportion of economy-wide skills used to produce a single unit of apparel, and so on. We can then solve for factor returns (the earnings of skills and labor) by inverting the technology matrix:

$$(4) \begin{vmatrix} h \\ w \end{vmatrix} = \begin{vmatrix} a_{sj} & a_{sc} \\ a_{sj} & a_{sc} \end{vmatrix} * \begin{vmatrix} p_j \\ p_c \end{vmatrix}$$

Given this, it is clear that the returns to factors depend *entirely* on the prices of goods (when factor endowments and productivity are held constant). A decline in the price of apparel will harm the wages of labor and raise the returns to skills. A decline in the price of aircraft will harm the returns to skills and raise labor's wages.

In regards to the trade angle, removing a tariff on apparel harms labor's wage and raises the return the skill. Similarly (and perhaps more important in regards to the contemporary globalization debate in U.S. politics), an increase in the global supply of labor that decreases the price of apparel (through Rybczynski effects) will also harm labor's wage.

The decline in returns to labor induces firms in both industries to use more it, and, to economize on skills. Taking the aircraft industry, assuming that its isocost line (the combination of labor and skills input combinations that are equal) has a slope equal to the relative earnings of skills and labor (h/w), an increase in this slope (assuming well-behaved isoquants) will lead it to use a higher proportion of skills in production.

Similar reasoning holds for apparel—higher relative returns for skills induces firms to use more labor per unit of output.

As both industries use a higher proportion of labor in output, and, assuming that labor and skills are in fixed supply and are fully-employed, this means, by definition, that apparel (the labor-intensive industry) must contract (with imports rising to satisfy that local consumption no longer met by domestic production), and, aircraft (the skills-intensive industry) must expand (with exports rising to absorb domestic production not sold to local consumers).

Technical Appendix 2

The Simulation Model

Krugman (1995) offered a simple CGE model as an illustrative exercise to obtain an estimate of the correct order of magnitude about trade's impact on inequality within wage incomes.

His results suggested that trade flows could explain about 10% of the entire rise in wage inequality that had characterized the previous decades. The relative modesty of this effect was a direct result of the facts that (1) trade flows still remained a relatively small part of the U.S. economy, and, (2) trade flows with less developed countries (LDCs), the type that seemed most relevant to generating inequality, remained a relatively small part of total U.S. trade flows.

Here, Kurgman's model is used with a variety of forecasts about the extent and reach of offshoring over

the next decade to provide a rough estimate as to how much this will affect U.S. incomes. The final results sketch out the changes in relative returns to labor and the returns to skills, capital and credentials consistent with the various forecasts of offshoring's reach in the U.S. economy The essential elements are as follows.[3]

The model is a 2x2x2 model (2 countries, 2 goods, and 2 factors of production) with skills and labor being the factors of production. Good 1 is skills-intensive and is produced and exported by the U.S. to the ROW. Good 2 is labor-intensive and is imported from the ROW to the U.S.

The following assumptions are used in the model:

Initial ratio of earnings of labor and skills: 1 to 2
Share of skills in industry 1 employment: .5
Share of skills in industry 2 employment: .2
Share of skills-earnings in national income: .4

Given these, the following parameters fall out as residuals:

Share of skills payments in industry 1 value-added: 2/3
Share of skills payments in industry 2 value-added: 1/3
Share of good 1 in total expenditure: 5/7

All prices (including factor prices) are normalized to 1, with the earnings of labor being the numeraire. Asset units are measured as halves, so that the initial endowment is set at 70 units of labor and 60 (halves of) skills.

The production for each good is modeled as a standard constant elasticity of substitution (CES) function of the form:

$$(1)\ X_i = [\delta_{hi} H_i^{-\rho} + \delta_{li} L_i^{-\rho}]^{-1/\rho}$$

Here X is the output of good i, while δ is the "distribution parameter" associated with factors of production H (skills) and L (labor) respectively. The parameter ρ measures the substitutability of skills and labor in production (and, is related to the elasticity of substitution by the relation: $\rho = [(1/\sigma)-1]$, where is the elasticity of substitution.

Given (1), the unit cost function can then be derived:

$$(2)\ c(w_h, w_l) = [\delta_{xh}^{1/(1+\rho)} w_h^{\rho/(1+\rho)} + \delta_{li}^{1/(1+\rho)} w_l^{\rho/(1+\rho)}]^{1+1/\rho}$$

Here, w represents the return to skills (h) and labor (l), respectively.

Lastly, the factor demand for unit output can be obtained (for skills):

$$(3)\ a_{hi} = ((1+p/p))[\delta_{si}^{1/(1+p)} w_h^{p/(1+p)} + \delta_{li}^{1/(1+p)} w_l^{p/(1+p)}]^{1/p} w^{1+p}$$

From here, output of both goods can be determined by the requirement that both skills and labor are fully employed, hence:

$$(4)\ H = a_{hi} X_1 + a_{h2} X_2$$
$$L = a_{l1} X_1 + a_{l2} X_2$$

Which yields:

$$(5)\ X_1 = D^{-1}[a_{12} H - a_{h2} L], X_2 = D^{-1}[-a_{l1} H + a_{h1} L]$$

Where $D = a_{h1} a_{l2} - a_{h2} a_{l1}$

Given the output and prices (unit costs) of each good, the trade vector is just the share of trade in U.S. output, or, the difference between the share of good 1 in output and in consumption:

$$(6)\ T = P_1 X_1 / (P_1 X_1 + P_2 X_2) - 5/7$$

In the initial setup, with all prices normalized at 1, the T vector is 0 - all of the output of both industries is consumed.

The strategy for the estimates in this paper, following directly from Krugman (1995), is to then change the relative return of skills (raising it). This increases the output of good 1 (the asset-intensive good) and decreases the output of good 2 (the labor-intensive good). The Cobb-Douglas consumption function, however, insures that the share of total expenditure (consumption) on each good remains the same. Hence, some of good 1 is exported and some of good 2 is imported. The upshot is that for every level of trade shares in GDP, there is a corresponding (and unique) change in relative earnings associated with it. It is these results that are reported in the paper.

Technical Appendix 3

Translating jobs forecasts to trade shares

To get the share of jobs potentially offshorable in 2000, the share of trade flows (the average of imports and exports) in industry shipments was multiplied by employment in these industries. The trade data and industry shipment data are from the Bureau of Economic Analysis (BEA) while the employment counts are from the Bureau of Labor Statistic (BLS).

The reverse calculation is performed to translate the jobs identified as potentially offshorable into implied trade flows in industry shipments - the parameter needed for the estimates of trade's impacts on labor markets.

It should be noted that any possible bias in this is probably downwards. Manufacturing workers on average produce much more output per worker than service employees. So, a given dollar of trade flows is associated with fewer jobs in manufacturing than in services. Manufacturing flows dominate imports and exports in 2000, so, applying the ratio of trade flows and employment from 2000 to the coming decade will probably underestimate the impact of offshoring on U.S. labor markets.

In 2000, trade flows equaled 49% of goods output and 4% of services output. Multiplying this by employment in these sectors yields 15.6 million jobs that are potentially offshorable. Forrester Research reports that 315,000 jobs were actually offshored in services in 2003. This represents about 2% of all "potentially offshorable" jobs. By 2015, Forrester reports that 1.6 million jobs will (annually) be offshored. Assuming that the ease of offshoring remains the same over that time, then, this implies 75 million "potentially offshorable" jobs. If one assumes that the ease of offshoring doubles over that time (so that 4% of the potentially offshorable jobs actually leave), this implies that about 38 million jobs are "potentially offshorable".

Given that Forrester stresses the factors making it easier to offshore jobs over time, I will use the latter estimate, which implies that about 20 million *extra* jobs will be offshorable in 2015 as compared to today, an largely in line with the estimates of the other studies in this group.

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