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# Globalization and U.S. Wages: Modifying Classic Theory to Explain Recent Facts

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The last 10 to 15 years have seen dramatic changes in globalization and technology juxtaposed with dramatic changes in U.S. earnings: Have the former been driving the latter? Back in the mid-1990s, most research found that the effect of trade on U.S. wages was relatively minor; for example, this was the tenor of a three-paper symposium on "Income Inequality and Trade" in the Summer 1995 issue of this journal. But since the mid-1990s, globalization has taken some new forms: China, for example, was barely on the global economic map in 1995. The patterns of inequality and wages have taken new forms, too. Thus, earlier conclusions are being reconsidered. For example, Nobel laureate Paul Krugman had found in his earlier research on trade and wages, like most others, that the impact of trade on U.S. earnings had been small. But in Krugman (2008), he now conjectures that past might not be prologue: "It's no longer safe to assert that trade's impact on the income distribution in wealthy countries is fairly minor. There's a good case that it is big, and getting bigger."

This paper seeks to review how globalization might explain the recent trends in real and relative wages in the United States. We begin with an overview of what is

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new during the last 10–15 years in globalization, productivity, and patterns of U.S. earnings. To preview our results, we then work through four main findings: First, there is only mixed evidence that trade in goods, intermediates, and services has been raising inequality between more- and less-skilled workers. Second, it is more possible, although far from proven, that globalization has been boosting the real and relative earnings of superstars. The usual trade-in-goods mechanisms probably have not done this. But other globalization channels—such as the combination of greater tradability of services and larger market sizes abroad—may be playing an important role. Third, seeing this possible role requires expanding standard Heckscher–Ohlin trade models, partly by adding insights of more recent research with heterogeneous firms and workers. Finally, our expanded trade framework offers new insights on the sobering fact of pervasive real-income declines for the large majority of Americans in the past decade. We believe that the connections between globalization, technology, and wages have become much more important during the last 10–15 years.

## New Patterns in Globalization and Wages

The forces of economic globalization have been building since soon after the end of World War II. But the context and patterns of globalization and U.S. wages have evolved in important ways since the mid-1990s. We begin by reviewing what we see as the main changes.

### Five Changes Affecting Globalization and Technology

First, political barriers to trade have been declining. At the multilateral level, the Uruguay Round, in many ways the most comprehensive trade agreement ever, was implemented largely in the decade after its 1994 closing. At the national level, a number of far-reaching unilateral, bilateral, and regional liberalizations have been implemented since the mid-1990s as well, including the North American Free Trade Agreement and China's accession to the World Trade Organization in December 2001. At the industry level, the Information Technology Agreement was signed in 1996, whereby 70 countries representing about 97 percent of world trade in information technology products agreed to eliminate duties on certain information technology products.

Second, natural barriers to trade are declining, especially as a result of the information technology revolution surrounding the Internet. Since Netscape's initial public offering in August 1995, connectivity and communication facilitated by information technology and the Internet have driven marginal transmission costs of voice and data to near zero. This change has reduced the costs of trading goods, and for international trade and investment in services, vastly expanded the scope of what services are tradable.

Third, the U.S. economy has seen a dramatic acceleration in aggregate labor productivity growth since the mid-1990s. The U.S. Bureau of Labor Statistics reports that nonfarm business sector output per hour growth accelerated from 1.4 percent per year over 1973–1995 to 2.5 percent per year over 1996–2009 (Bureau of Labor Statistics data series #PRS85006092, as reported on 9/1/11 at ⟨http://www.bls.gov⟩). A large literature has analyzed this faster U.S. productivity growth and has found a central role for the production and use of information technology hardware (for example, Jorgenson, Ho, and Stiroh in the Winter 2008 issue of this journal, and the references therein)—which, remember, is the one industry in the past generation that implemented a global free trade agreement.

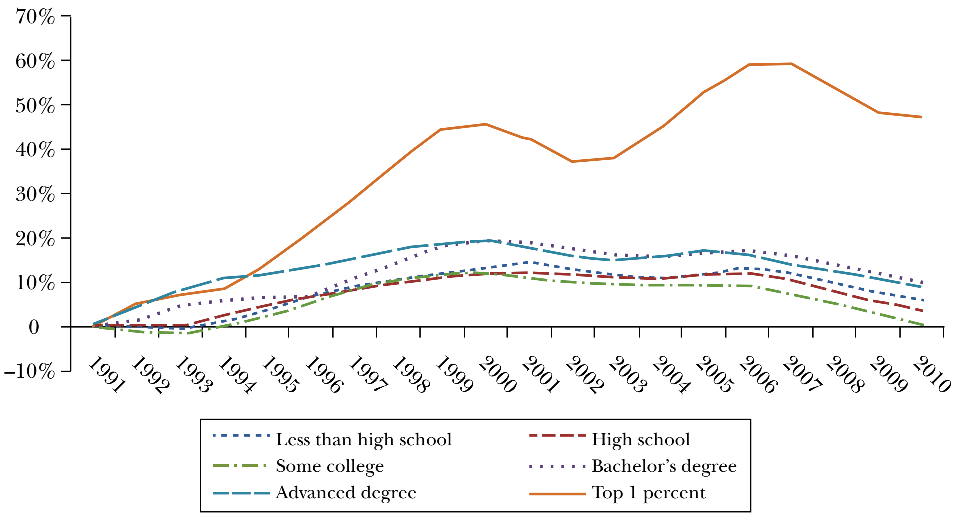
Fourth, GDP growth has accelerated worldwide since the mid-1990s—in particular, in middle- and low-income countries such as Brazil, Russia, India, and China. From 1990 through 2008, annual growth in U.S. gross domestic product averaged 2.7 percent—in contrast to 1990–2008 annual averages of 3.4 percent for the overall world, 4.6 percent for emerging and developing countries as a whole, 6.3 percent in India, and a remarkable 9.9 percent in China (calculated from International Monetary Fund 2008, tables A1–A4.)

Finally, these first four factors have helped to propel a surge in flows of international trade and investment, both worldwide and into and out of the United States. Much of this surge has come from middle- and low-income countries. By 2005, U.S. imports from non-oil developing countries surpassed the value of imports from industrial countries. In addition, U.S. prices of manufactured imports from developing countries declined dramatically. Here again, China stands out: its share of global exports rose from only about 3 percent in 2001 to about 11 percent today, such that it is now the world's largest exporting country. This surge in trade has involved intermediates as well as final products, and services as well as goods (for example, Feenstra 1998; Blinder 2006; Jensen 2011). For the U.S. economy, this surge in trade was far larger for imports than for exports, with resulting historic multilateral trade deficits for the United States peaking at over 5.3 percent of GDP in 2006.

**Three Changes in the Patterns of U.S. Wages**

In general, U.S. wages have moved in an upward trajectory over time, with a pattern of rising inequality since the 1970s. However, these patterns have taken on different shapes in the last 15 years or so (for example, Autor 2010a, b; Goldin and Katz 2008; Piketty and Saez 2006; Saez 2012). The key patterns are visible in Figure 1, showing patterns of earnings from 1991 to 2010 for five education groups and also for the top 1 percent of U.S. earners. Of course, these patterns are affected by cyclical factors, with 2000 near the top of a strong business cycle and 2010 one year from the bottom of a severe downturn, but the patterns are nonetheless revealing (and are qualitatively the same if the data end in 2007 before the financial crisis). Figure 1 shows cumulative percentage changes relative to 1991 in mean real (that is, adjusted for price inflation) money earnings for working adults (aged 25 and above) by educational cohort in terms of the highest level of education attained, which is an easily available (if basic) measure of worker skills. The figure also shows cumulative percentage changes relative to 1991 in mean real income (excluding

*Figure 1*
**Changes in U.S. Real Income, Working Adults, by Education and for Top 1 Percent**




*Sources:* The nominal wage data in Figure 1 come from the U.S. Bureau of the Census, Table P-18—Educational Attainment, People 25 Years Old and Over by Mean Income and Sex, 1991 to 2010. Nominal wages are converted into 2010 real wages using the CPI-U-RS index of consumer prices from the United States Bureau of Labor Statistics. The real-income data for the top 1 percent of tax filers comes from Saez (2012, supplemental table A4), where each year's nominal income is deflated using the same price index.
*Notes:* Figure 1 shows cumulative percentage changes relative to 1991 in mean real (that is, adjusted for price inflation) money earnings for working adults (aged 25 and above) by educational cohort in terms of the highest level of education attained. All percentage changes along the *y*-axis are actually log changes (which approximate percentage changes), smoothed to three-year moving averages to eliminate occasional annual volatility. There are important measurement differences between these two wage sources—Census Table P-18 and Saez (2012, supplemental table A4). One is the units of observation: Table P-18 measures income for individual workers; Saez measures income for tax units, which can contain more than one worker because they can consist of, for example, an individual, a head of household with children dependents, or a couple with children dependents. That said, the basic income patterns in Figure 1 are robust to measurement issues.

capital gains) for the top 1 percent of all tax units filing returns to the U.S. Internal Revenue Service.

Figure 1 contains three key messages about U.S. earnings. First, in the second half of the 1990s, all groups of workers by education status experienced strong increases in real income; but after about 2000, all these groups of workers experienced *declines* in real income, such that over the full 1991–2010 period, growth in real earnings was very weak. Post-2000, all five educational groups shown suffered falls in average real money incomes, and over the full 20 years, average real income grew less than 10 percent for all five groups. This picture of poor real earnings performance improves only slightly when factoring in changes in the roughly 18 percent of total labor compensation accounted for by nonmonetary benefits (including life insurance, health insurance, stock and stock-option grants). How could falling real incomes for so many American workers coexist with ongoing U.S. GDP and productivity growth during the 2000s? Part of the answer was sharply higher earnings by capital. Corporate profits rose strongly over the 2000s—as they had in the late 1990s, too. As a share of GDP, U.S. corporate profits reached 12.4 percent in 2010—the highest percentage ever recorded in the roughly 60 years the U.S. government has tracked this item. Of course, this high level was in part a result of high unemployment and low labor earnings in the aftermath of the Great Recession.

Second, many of the standard measures of income inequality that focus on the very broad middle of the distribution rose very modestly, if at all, since the mid-1990s. For example, the ratio of the median annual earnings of college graduates to high school graduates stood at 1.69 in 1999 and 1.71 in 2009 (the similar ratio for mean earnings was unchanged at 1.79). The ratio of the earnings of the median worker to the earnings of the worker at the 10$^{th}$ percentile of the overall income distribution actually declined during this time.[1]

Third, the income of the highest-earning workers has risen dramatically both in absolute terms and relative to all others. Average real income of this top 1 percent of IRS tax filers rose from $534,264 in 1991 to a peak of $1,003,791 in 2007 and was still $857,477 in 2010. The share of U.S. income (again, excluding capital gains) accounted for by this top 1 percent rose from just 7.7 percent in 1973 to 13.5 percent in 1995 and 16.5 percent in 2000; this share then rose further, to 18.3 percent in 2007—although it has declined since then in the wealth meltdown of the Great Recession. High-income earners tend to be highly educated, but this linkage is not perfect: for example, Bill Gates is a college dropout. We, like many others, will refer to this small group of highly skilled, highly compensated workers as *superstars* (Rosen 1981).[2]

## Relating Trade, Technology, and Wages

### Old Frameworks Applied to the New Facts

A conceptual framework should fit the circumstances. From the mid-1970s to the mid-1990s, rising levels of U.S. wage inequality took the form of a pervasive, economywide increase in returns to skills that were easily identified by education (for example, college versus high school) or occupation (for example, white- versus blue-collar). It was thus not surprising that much analysis of income inequality used models that assumed two homogenous types of labor: skilled and unskilled. Similarly, many labor economists used a one-product model that focused on technology

[1] The 50–10 statistic comes from Figure 3 of Autor, Katz, and Kearney (2008). The education-based ratio is based on the authors' own calculations using the data in the note to Figure 1.

[2] Existing research documenting and/or examining the causes of rising superstar earnings include Gabaix and Landier (2008), Gordon and Dew-Becker (2007), Kaplan and Rauh (2010), Lemieux (2006), Piketty and Saez (2003, 2006), and Saez (2012).

innovations boosting demand for skilled workers. Many trade economists used a two-product model with differing factor intensities and with perfect labor mobility across the two sectors.

Given the pervasive shifts in relative wages, it was natural to base empirical analysis on the intuition of the classic Stolper–Samuelson theorem that rising U.S. returns to skill were driven by rising prices of skill-intensive products relative to unskilled-intensive products. Some authors looked for Stolper–Samuelson effects with small general equilibrium simulation models (for example, Krugman 1995; Cline 1997), and some examined observed prices directly (see summary in Slaughter 2000). Others looked for the labor supplies embodied in trade flows (for example, Borjas, Freeman, and Katz 1997). Most studies found some link from trade to rising inequality, but with a few exceptions, the magnitude was not large. Cline's (1997) comprehensive survey argued that "a reasonable estimate based on the literature would be that international influences contributed about 20 percent of the rising wage inequality in the 1980s."

During the more recent period of what seems to be accelerating global exposure of the U.S. labor market, one might expect these effects to be even stronger: surely trade must anchor the returns of the homogenous lower-skilled categories of labor? But the uneven performance of skilled workers, with some wage declines and superstar increases, suggest that models based on two types of labor cannot capture what is occurring. In response, labor economists like Autor, Levy, and Murnane (2003) have developed a more sophisticated theory of skill-biased technological change in which computers and other innovations in information technology complement highly skilled nonroutine cognitive tasks, substitute for moderately skilled routine tasks, and have little effect on less-skilled manual tasks. The result is downward pressure on wages and employment opportunities on moderately skilled workers, such that inequality between them and their less-skilled counterparts no longer rises. Autor (2010b) discusses this "polarization" of the U.S. labor market.[3]

Efforts to apply the simple two-factor Stolper–Samuelson framework to recent data have run into various problems. For example, using U.S. factor inputs at the most disaggregated level for which skill measures are available, the factor content of U.S. imports from developing countries is *not* especially intensive in unskilled labor (Edwards and Lawrence 2010). A large share of U.S. manufactured imports from developing countries is in skill-intensive industries such as computers and electronics. Indeed, Mishel, Burnstein, and Shierholz (2009) estimate that the education mix of the net factor content of U.S. trade in recent years is very similar to that of the labor force overall (of course, this might to some extent reflect a measurement problem whereby the imports of Chinese unskilled-intensive hours of iPad assembly are classified by the

[3] Goldin and Katz (2007) and Yellen (2006) suggest that the globalization of production has similar properties in inducing polarization of wage distribution. They argue that suppliers of personal services at the low end escape downward pressures from trade because these services must be provided locally. But those at the top are rewarded by trade, while those in the middle are hurt. A related issue may be that returns to skills may be changing outside of conventional educational measures—for example, the returns to noncognitive skills discussed in Heckman, Stixrud, and Urzua (2006).

U.S.-measured skill-intensive final good). Bivens (2007) analyzed a simulation model that simply *assumes* all developing-country imports are unskilled-intensive and that all goods imported to the U.S. economy are also made domestically—thus clearly leading to an upward-biased estimate of how trade might affect inequality—yet he found that increased U.S. trade with developing countries boosted the U.S. skill premium by only about 2 percent between 1995 and 2006.

Thus, a number of trade-based studies of U.S. wages have, perhaps surprisingly, not found much connection between surging U.S. imports from low-wage countries and recent U.S. wage trends when analyzed by the traditional Stolper–Samuelson trade logic.

**Let's Be More Specific: Newer Trade Frameworks**

The standard Heckscher–Ohlin model with mobile workers between industries implies wages are due to general returns to skill. In settings with different types of firms and workers, international trade can also affect the returns to worker attributes that are more "specific" to the worker-employer match. Research on worker mobility has long found that human capital is partly specific to industries and occupations (for example, Jacobson, LaLonde, and Sullivan 1993; Neal 1995; Kambourov and Manovskii 2009). The field of international trade has seen a surge of research developing and analyzing a richer set of interactions among firms and workers of different types. For example, if workers are at least partly immobile across industries, then freer trade often boosts earnings of workers specific to export industries while lowering earnings of their specific counterparts in import-competing industries (an intuition first developed in classic papers such as Jones 1965; Mussa 1974; and Neary 1978). Alternatively, if autarchic product or labor markets are not perfectly competitive, trade has a pro-competitive effect. For example, unionized workers may be forced to accept lower wages if freer trade makes the demand curves faced by firms more sensitive to price (Rodrik 1997) or affects rents to be shared (Lawrence and Lawrence 1985).

In many new trade models, heterogeneous firms and workers interact in previously unexplored ways. For example, in the Melitz (2003) model (described elsewhere in this symposium) reductions in trade costs boost profitability in the most productive (and thus exporting) firms. This raises profit inequality across firms—but there is no wage inequality in the basic version of the model because workers are assumed to be identical. In other heterogeneous-firm models, wage inequality does arise by assuming some sort of link from profits to wages. Examples here include notions of fairness (Egger and Kreickemeier 2009); rent sharing (Amiti and Davis 2008); and incentives to search for quality workers (Helpman, Istkhoki, and Redding 2010), reduce worker shirking (Davis and Harrigan 2007), or upgrade skills (Verhoogen 2008). Other theories focus on the process by which firms match with heterogeneous workers who span a continuum of skills. Here, opening to trade can alter the process by which workers sort into firms and, through this, impact earnings related to skill. Sometimes, trade can have wage effects that resemble classic Stolper–Samuelson linkages. But wage outcomes in these heterogeneous firms and workers settings can be quite different and can potentially describe recent U.S. wage trends with stagnant earnings for both less- and moderately-skilled workers and rising superstar earnings (Blanchard and Wilmann 2011; Costinot and Vogel 2010; Manasse and Turrini 2001).

**Applying New Frameworks to the Data**

Countries have experienced a wide variety of wage changes after trade liberalization, as surveyed by Goldberg and Pavcnik (2007). New theories of trade with heterogeneous firms and workers, by allowing explanations of inequality that reflect more than the returns to broad skill categories, offer some possibility of explaining these patterns. However, testing these new theories against particular episodes—such as the recent U.S. experience—requires different empirical approaches from Stolper–Samuelson analyses. After all, Stolper–Samuelson analyses are based on the general-equilibrium Heckscher–Ohlin trade framework in which there is no relationship between a worker's wages and the trade (or lack thereof) in that worker's industry. In contrast, various specific-factors theories must be tested by linking wages to firm and/or industry characteristics. Indeed, in the Heckscher–Ohlin model, wages by skill are the *same* in all industries, so any observed correlation between wages and industry features merely signals the types of workers employed in an industry with those characteristics: industries with large import volumes likely employ unskilled workers doing mundane tasks.

Recent empirical research surveyed comprehensively by Harrison, McLaren, and McMillan (2010) has examined the effect of trade on wages at the level of firms, occupations, regions, and industries. Some U.S. studies link data on trade and other variables to individual worker data. Ebenstein, Harrison, McMillan, and Phillips (2009) find no effect of import competition at the level of industry wages, but they find that workers displaced from manufacturing earn 3–9 percent less if reemployed in other sectors. Autor, Dorn, and Hanson (2011) find that Chinese manufacturing imports did not reduce wages within manufacturing, but did depress local wages more generally by 2 percent over 17 years. McLaren and Haboyan (2010) reach qualitatively different conclusions about NAFTA's impact, finding no impact on local wages but downward pressure on industry wages. Liu and Trefler (2008) find that outsourcing of traded services has reduced U.S. industry earnings, but that these effects are "tiny;" Liu and Trefler (2011) examine the effect of traded services on U.S. occupational switching.

One way to read these studies is that they examine labor-market adjustments, such as labor-force participation, unemployment, and occupational change, about which the classic Heckscher–Ohlin model is silent. As an empirical issue, these may well be the most important short- to medium-run adjustment margins to globalization, rather than wages. Thus the Heckscher–Ohlin model might be best suited for examining longer-run wage outcomes. Our view is that a more-complete accounting of wage outcomes in the overall U.S. economy needs at least a model that integrates both general and specific returns. In the next section of this paper, we offer such an approach rooted in the classic Heckscher–Ohlin trade model.

## A Heckscher–Ohlin Trade Model with a Richer Wage Structure

### The Basic Heckscher–Ohlin Framework

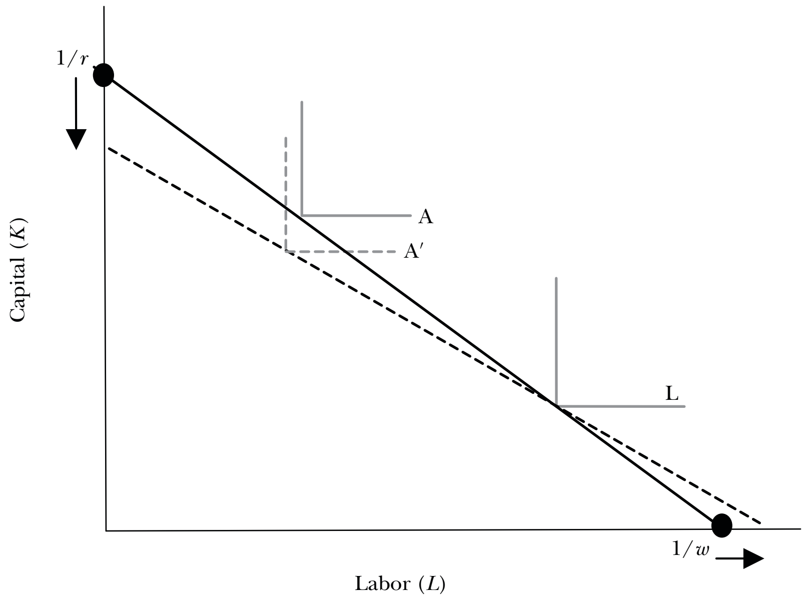
In the standard one-sector model with skilled and unskilled workers, relative demand for labor depends only on relative wages within the sector. There is only one margin of adjustment following a shock to relative labor demand or supply: namely, a shift in relative wages, the size of which depends on the factor elasticity of substitution. However, any university dean knows that wages of finance professors seem to be determined not by conditions inside the education industry, but elsewhere. A key feature of the Heckscher–Ohlin framework is precisely this: the industry is not the market. Multiple products mean more margins of adjustment to industry shocks besides relative wages—for example, relative outputs can change, too. Counter to much of the firm- and individual-level work set out above, wages depend on conditions in the market as a whole, and not just in the particular worker-firm match.

Figure 2 describes a world where the industry is decidedly not the market: instead, the whole economy is the market. The right-angle shapes are unit-value isoquants, showing the quantities of capital $K$ (physical or human) and labor $L$ required to produce 1 unit of value—say, \$1 of value—of the capital-intensive (A) and labor-intensive (L) goods at prevailing exogenous goods prices and technologies. Unit-value isoquants in which inputs are always used in fixed proportions to produce a unit of output and there is zero elasticity of factor substitution (this is called "Leontief" technology) are a simplifying assumption. No key results depend on this assumption (Leamer 1995). The location of each isoquant depends on *both* technology and goods prices. The straight lines are unit-cost lines, showing the costs of $K$ and $L$, $r$ (the capital cost) and $w$ (the wage), such that total costs are \$1: that is, $1 = wL + rK$. (Actually we see the reciprocals of $r$ and of $w$, rather than $r$ and $w$ directly.) $K$ and $L$ are assumed to be mobile across industries, which is why the industry is not the market. Wages are determined such that profits are zero in both industries (or else factors would move between industries); this is indicated by the heavy straight line. The reciprocals of $r$ and $w$ ($1/r$ and $1/w$) are the heavy dot intercepts of this line.

How do capital costs $r$ and wages $w$ change? Consider anything that, at these initial factor prices, makes the capital-intensive industry more able to produce \$1 worth of output using fewer inputs: for example, a rise in its output price or a technological change favoring that industry (that is to say, lowering unit costs in that industry at initial $r$ and $w$). Either of these effects would shift A to A′ towards the origin, since less $K$ and $L$ are now required to make a capital-intensive good of value \$1. As the diagram shows, the only way to restore equilibrium is for the unit-cost line to flatten (the dotted line). Thus, $w$ must fall and $r$ must rise to restore zero profit equilibrium. This result embodies the Stolper–Samuelson intuition: changes in product prices or production technology that raise the profitability of a sector, at initial wages, tend to raise the wages of factors employed intensively in that sector.

As discussed earlier, this elegant Heckscher–Ohlin model does not seem well-suited to explain many of the recent wage developments; for example, the highly

*Figure 2*
**A Basic Heckscher–Ohlin Model**




*Notes:* The axes show quantities of labor and capital. There are two industries (A and L), the upper left using capital intensively relative to the lower right. The right-angle shaped lines are unit-value isoquants, showing combinations of labor and capital needed to produce one dollar's worth of the two goods. The downward-sloping lines are isocost lines showing the combination of capital costs and wages such that there is full employment of factors at given technologies and product market prices. The dotted isocost line corresponds to a rise in the relative price of the capital-intensive goods. The heavy dot intercepts on the $x$- and $y$-axes show the reciprocal of the equilibrium factor prices of $L$ and $K$, so a movement on the axis towards the origin is an increase in factor prices.

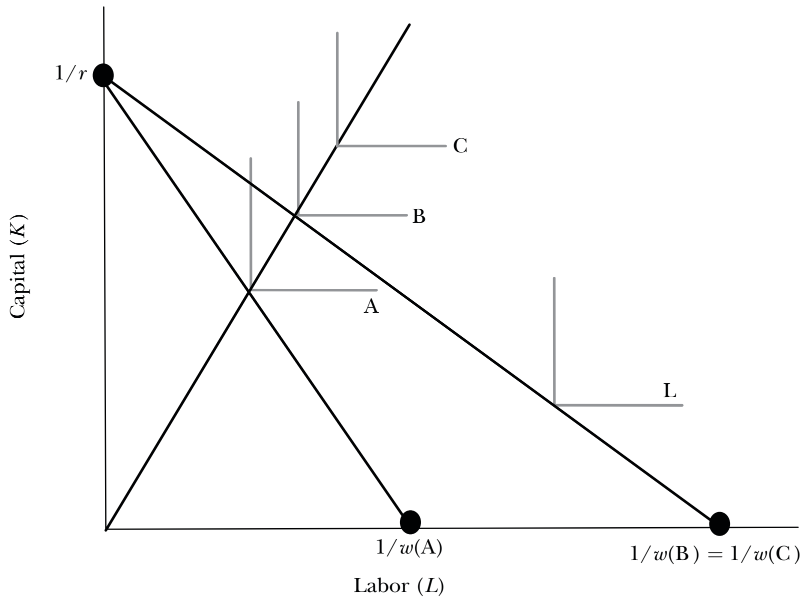
skilled, highly-paid workers whose "superstar" earnings have risen so dramatically. Also, its assumption of homogeneous firms does not allow consideration of worker returns specific to particular firms or industries, or specific to noncognitive or nonroutine skills.

**A Richer Heckscher–Ohlin Framework**

Following Leamer (1995, 2012), consider extending the basic Heckscher–Ohlin model to allow capital and heterogeneous labor with varying amounts of "talent." This approach also allows capital–talent complementarity: that is, talented workers are more productive when working with capital, whereas they are no more productive in unskilled tasks.

Figure 3 presents this richer model. It shows four unit-value isoquants: three for workers with respective talents A, B, and C in the capital-intensive sector and another in a labor-intensive sector, L, where talent is assumed not to affect productivity. The diagram also shows the single $r$ (common since capital is assumed to be

*Figure 3*
**A Richer Heckscher–Ohlin Model**

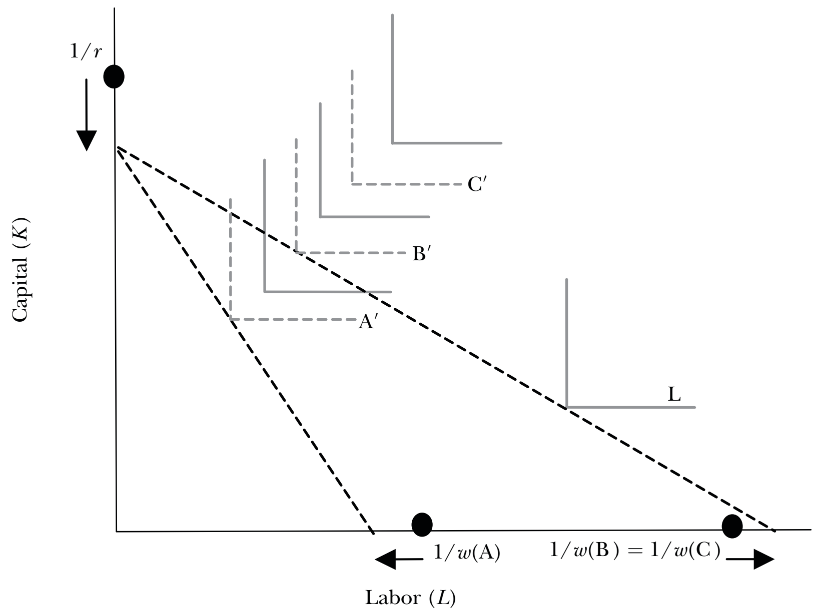



*Notes:* In Figure 2, there is only one worker type. Here, there are three workers types: highly talented to less talented (A to C). The highly talented are assumed more productive in the capital-intensive industry. All talent types are assumed equally productive in the labor-intensive industry. The downward-sloping isocost line show the combination of capital costs and wages so there is full employment of all talent types and types B and C are indifferent between the industries they choose. See also the notes to Figure 2.

mobile across sectors) and a set of wages that maintains full employment. The most talented type-A workers are more productive, by assumption, when renting capital. Thus they can command, at the given $r$, a high wage consistent with the position of the dot on the labor axis, $1/w(\mathrm{A})$ (determined in turn by the tangency with the unit-value isoquant A). Now consider type-B workers. As drawn, with wages $w(\mathrm{B})$, they are the marginal talent level: just indifferent between working in the $K$-intensive industry—where their talents at $w(\mathrm{B})$ make them sufficiently productive to be profitably employed there but insufficiently productive to profitably command $w(\mathrm{A})$—or working in the $L$-intensive industry. Finally, the type C's earn $w(\mathrm{C}) = w(\mathrm{B})$, the same as type Bs, but only if they work in the $L$-intensive sector (L).

What does inequality look like in this economy? First, wage inequality stems from talent–capital complementarity: type-A workers pay the same $r$ as others but are more productive with capital and so can command a higher wage consistent with zero profits (shown by the intercept on the $L$-axis lying closer to the origin). Untalented type-C workers, insufficiently complementary, optimally work in the $L$-intensive sector. In sum, the market sorts heterogeneous worker types and determines a competitive talent premium where no rents are shared.

*Figure 4*
**Changes in the Richer Heckscher–Ohlin Model**




*Notes:* The dotted "right-angle" shapes are unit-value isoquants following a rise in relative prices or technical change in the capital-intensive industry. The dotted isocost lines show the combination of capital costs and wages so there is full employment of all talent types and types B and C are indifferent between the industries they choose after the increase in output prices in the capital-intensive industry. The arrows on the axes originating from the heavy dots show the rise in capital prices and wages of type A's and the fall in wages of type B's and type C's. See also the notes to Figure 3.

Second, if talent is unobservable to the econometrician, then inequality will have a "within-group" feature: $w$(A) versus $w$(B) for observably identical workers in the same industry.

Third, and related, the model can explain the "fractal" nature of inequality: that is, within-group wage inequality in successively narrower and narrower defined groups. There is inequality between all labor in the economy. There is also inequality between all MBA graduates, some of whom are unobservably talented and work with a lot of capital and command high wages while some are unobservably not so talented and are paid the same as other MBAs working with less capital.

How is inequality affected by a price rise or technical advance favoring the $K$-intensive sector? One might suppose a straightforward answer, namely a rise in wages of all talented workers. Not so.

The reason is set out in Figure 4, where the talent-specific, $K$–intensive unit-value isoquants have shifted and are now the dotted A′, B′, and C′ following a rise in that sector's price (or its improved technical opportunity)—for simplicity holding all other product prices fixed.

As in the traditional case, $r$ rises.[4] And as in the traditional case, with $r$ rising, wages in the $L$-intensive sector must fall to restore profitability. That means $w$(C) falls. But as well as lowering wages in the L sector, it also reduces wages for the type-B workers, even though they are in the $K$-sector and even though their market demand has risen. Type-B workers are insufficiently talented to command higher wages in the face of the increased price of capital with which they have to work. Type-C workers lose along with the type-B because their wages match those of the type-B workers. The gainers are the type-A workers. They experience the negative effect of higher capital rental charges but this is completely offset by the favorable productivity effect: in the diagram, their intercept point on the $L$-axis moves to the left. (Formally, what drives the rise in wages of the A-workers is the Jones (1965) "amplification," the fact that the percentage increase in capital costs is less than the percentage increase in the price of the capital-intensive good, which means that even after paying higher capital costs, there is more left over to pay workers.)

Thus, it is *not* the case that the wages of *all* workers fall in response to a relative increase in the price of the capital-intensive good, as in Figure 2. There are winners and losers. The winners are the most talented workers matched with, or sorted into, the industry where their talent matters most: where they are most effective in operating the expensive capital. The losers are workers with less talent, even if they are working in the capital-intensive sector or in the labor-intensive sector where their talent does not help them.

If one regards the type-A workers as the most skilled, like those with advanced degrees and/or special skills, type-B workers represent the moderately skilled, perhaps ranging from those with nonprofessional degrees to those with some college, and type-C workers represent the less-skilled, like those with only a high school degree or less education, then our model can explain Figure 1: rising wages for those few at the very top and falling relative and stagnating real wages for all others. To flesh this out more we need to be more specific on what we mean by capital and talent.

**Applying This Richer Heckscher-Ohlin Framework to the Recent U.S. Experience: Capital and Talent in the Modern Global Economy**

Does the model help us understand recent U.S. wages? Since the key is the talent–capital complementarity, along with price and/or technology changes in particular sectors, we focus on the possible different interpretations of "capital" and "talent" in the U.S. economy.

From this perspective, one initial puzzle might be how this enriched Heckscher–Ohlin model applies to talented workers at Goldman Sachs, Microsoft, Disney, Facebook, and Google, who don't seem to work with much physical capital. But suppose all labor in Figures 3 and 4 are actors, and the capital with which

[4] To see this graphically observe that one cannot draw a new isocost line with its origin at the previous value of $1/r$ (the large dot on the vertical) that is tangent to both the new unit value isoquant B′ *and also* L. The isocost line must flatten, which implies that $r$ must rise and $w$(B) fall.

they work is *intellectual or intangible* capital—movie scripts, special effects, software, scenery, and directorial and editorial talent.[5] Talented actors with good scripts are potentially very profitable and thus have unit-value isoquants A. Less-talented actors are not quite talented enough to command $w$(A) but can earn a lower wage $w$(B) working with the same ratio of intangible capital, or they can work in an intangible-capital–extensive sector along with the untalented (that industry might be movies with poor scripts/scenery/special effects, or nonmovie industries that also use intangible capital but not as intensively, like the cinemas that rent the movies, or industries also using software but not as intensively).

Now globalize the movie industry, such that previously domestic-only actors can now potentially command global audiences. This globalization could arise from a number of forces discussed earlier: foreign GDP growth that stimulates demand for entertainment in newly emerging middle classes, or governments removing restrictions on imports of U.S. movies, or the information technology revolution reducing the costs of cross-border digital distribution of films. Whatever the causes, the result is a shift in A and B to A′ and B′, leaving L the same. In turn, it is *not* the case that *all* actors earn higher real incomes. The most talented actors become superstars, now earning stratospheric wages. The less-talented actors earn less, even if they remain in the movie industry. They earn less because that is the only way that they can now be profitably employed in the movie industry at their talent levels. The other parties who earn more are, of course, the owners of "capital."

Thus, this model seems to have a number of attractively accurate predictions. The stars in the Harry Potter films earn more. The owner of the Harry Potter "capital," author J. K. Rowling who owns the script copyrights, earns more. The movie industry expands. But actors not in *Harry Potter* earn less, because at their talent levels they have to take lower wages to accommodate the increased costs of paying copyright-holders. And less-talented actors also face lower wages if they don't work in movies. Likewise, star computer programmers earn more in the expanded software industry; if they also own the intellectual and reputational capital, like Mark Zuckerberg, Sergei Brin, and Larry Page, they earn the capital rents as well.

A similar logic can apply to highly educated occupations, such as bankers and lawyers, if the talented ones among them are complementary with capital in financial and legal services. What is the capital here? One interpretation is that $L$ is hours and $K$ is human capital, so that a high $K/L$ production technology is one with intensive use of banking or legal human capital per hour. This might reflect complexity of the task at hand, and so a rise in the output price of the industry is an increase in the price of complex financial and legal services. Thus, assume that

[5] Much of this capital comes close to sounding like other workers. What matters formally is that the ownership of the capital be distinct from individuals, so that one can distinguish between the earnings of capital and the earnings of workers. For example, the copyright to the script is owned by the movie studio, as opposed to the actor, so that $r$ is the rental price paid by the studio of scripts and $w$ is actor wages. Of course, if the script is owned by the actor as well, then all returns accrue to the actor. The increasing importance of intangible capital in the United States is documented by Corrado, Hulten, and Sichel (2005, 2009).

talented lawyers working on complicated cases are more productive than untalented lawyers on similar cases and also than if they were processing routine legal administration. Then the model predicts a rise in wages for the most talented and a rise in the return to human capital when legal services globalize. Here, human capital might be embodied in workers or it might be a law firm's contacts and know-how among its partners. But such an increase in these capital costs lowers wages for the less talented (like paralegals) and hence within-industry inequality rises. A further possibility is that the productivity of top lawyers is further enhanced by working with other top lawyers, in which case the unit-value isoquant for A types shifts in again, raising $w$(A) yet more. Of course, to understand fractal inequality, one would have to assume further that even talented lawyers or bankers are imperfect substitutes for each other; that is to say, criminal lawyers are more productive when matched to criminal cases than property lawyers.

What of chief executive officers and top managers, such as Jack Welch or Steve Jobs? Suppose now that capital is reputational or organizational capital at the firm. Thus, a high capital/labor ratio firm has a high reputation, very efficient supply chains, or well-structured hierarchies. Think of Apple, for example, which has relatively little physical capital but very high design and reputational capital as well as organizational capital in managing multicountry production. Consider now a rise in relative prices for such high-capital firms—one perhaps triggered by global trade liberalization, or fast growth in emerging markets, boosting demand for their services. Indeed, a rise in demand for reputation or organizational capital may well be a consequence of globalization, where these intangible assets (like supply-chain management) can be spread across borders via multinational firms (Markusen 2002; Spence 2011). The Internet revolution, bringing a rise in anonymous remote transactions, might increase the return to reputation. The model predicts a rise both in highly talented wages and a fall in lesser-talented wages, even if working for the same firms, and a rise in the returns to good capital: in this case, company reputation or organizational capability. This interaction gives an extra dimension to the outsourcing literature, in which workers suffer because unskilled tasks can be outsourced. Here that finding remains true, but in addition, able managers gain from outsourcing because they can apply their scarce talents to managing the outsourcing process.

Note from our above examples that "globalization" should be conceived of quite broadly. The traditional trade mechanisms revolve around changes in the prices of tradable products—often in response to changes in trade policy. Here, globalization means something broader: any change that raises profits in the capital-intensive sector at current product prices, factor prices, and technology. In this broader meaning of the term, a rise in globalization still could be triggered by traditional mechanisms such as trade policy. But it could be triggered by many other mechanisms as well—especially for the widening span of tradable services (as described in Jensen 2011) that are often fostered by information technology innovations (as documented by Fort 2012): for example, rising global demand for American banking services, consulting services, movies, and sports triggered by rising global GDP.

**What about Technological Change in This Richer Heckscher–Ohlin Model?**

Cheaper communications—and what we have in mind here is the Internet—increase the scope for outsourcing and/or increase market size. More efficient semiconductors make computer capital more efficient. Both changes potentially shift unit-value isoquants in Figure 4. But the message of this model is that inequality might rise or fall, depending on the interactions between the technical change and the worker types. To illustrate, suppose the *K*-intensive industry is music, and talents refer to musicians. To modify Leamer (1995) slightly, the question is whether the technical change improves microphones or mixing desks. A better microphone improves the relative productivity of the most musical and thus shifts in type A's unit-value isoquant and raises the talent premium as above. A better mixing desk renders production of studio-quality music within the reach of even the most talentless. This might squeeze the gap between A and B; then wages of type A's fall, and wage inequality might fall.

A recent current of literature suggests that computers might not just affect the productivity of the skilled versus the unskilled, but also the productivity of those performing nonroutine activities (for example, Goos and Manning 2007; Autor 2010b). These papers mostly look at the consequent effects on employment. In general, if we relabel the industries in Figure 3 and 4 as nonroutine and routine, and assume that computers make it relatively cheaper to perform routine tasks such that the price of the routine industry falls, then employment in routine tasks falls and the effects on wages depend crucially on the effect on talent and the industry concerned.

All this illustrates a general point: namely, that inequality in information-rich societies looks totally different from that in the past (Leamer 1995). To illustrate this, consider physically strong workers, valuable workers in their day in rural societies with no machinery to perform heavy tasks. With the advent of manufacturing and more recently computers, cheaper capital removes most of their comparative advantage; these "talented" workers work alongside other worker types, and wages are equal.[6]

But now computers don't just do routine tasks, but carry information all over the world. This now raises the potential return to physically strong workers in entertainment services such as NFL football. Such workers leave manufacturing to play NFL football and endorse consumer brands, where their talent is complementary with the global market and reputation capital in the entertainment industry. Workers segregate and inequality rises, but not necessarily along educational lines; in this example, football players need not be the most educated.

[6] In terms of the diagram, an economy with little intangible capital in it (it might be a closed economy, or a developing economy, or an economy with mostly routine production technologies such as 60 years ago) has a high price of intangible capital and thus a relatively "flat" unit cost line. Thus there are no or very few A-type workers with enough talent to work in the capital-intensive industry. All workers of all talent types work together in the labor-intensive industry and are paid the same; we have a very low-inequality country but with talented workers matched into basic industries. An alternative view is that such intangible capital was mostly unimportant in earlier days of industrialization when tangible capital was most important such that there was not a separate industry intensive in the use of intangible capital—and thus there were not separable industries like A, B, and C. Beaudry and Green (2003) present a model where modern economies use capital and skilled labor intensively, a combination that tends to lower unskilled wages.

**Relating Heterogeneity in This Richer Heckscher–Ohlin Model to Heterogeneity Elsewhere**

Suppose now that heterogeneity is not in workers, but rather in firms. This kind of model is considered by Melitz (2003), Helpman, Istkhoki, and Redding (2010), and others. Suppose the *K*-intensive industry has the opportunity to export and that some firms are more "talented," which in this context means more productive, in that industry. Such firms export and their talent, perhaps being superior owner-managers, earns higher returns than that of owner-managers of lesser firms. Thus, within the *K*-intensive sector there emerges profit inequality, in the sense of inequality of returns to the scarce factor that is correlated with observables such as exporting status.

The original Melitz (2003) model had no wage inequality, because workers were the same ability, but it did have profit inequality. Indeed, the aim of that model was to explain how trade led to productivity growth via the sorting of firms, as Melitz and Trefler explain in their paper in this volume.

Researchers have sought to add labor-market imperfections to this basic model. In Helpman, Istkhoki, and Redding (2010), workers differ by ability, and firms screen and bargain over quasi-rents with them. Larger firms screen workers more intensively and so employ higher ability mixes, workers who are able to bargain higher wages. As a result, within-group wage inequality emerges in a single sector using a particular *K*-intensity. Falling trade barriers create larger exporting firms, and so within-sector wage inequality rises.[7] This result essentially follows from matching followed by rent sharing. As they remark, general equilibrium effects from other sectors can arise as standard Stolper–Samuelson effects.[8]

In the model we have presented, there is no rent sharing (for simplicity) but there is sorting of workers among sectors, similar to Costinot and Vogel (2010). In that model, there is no capital, but rather there are many industries each employing one worker with a certain skill who performs a certain task. The key talent/complementarity (assignment) relationship is between tasks and production: high skilled are substitutable for low skilled, but high- and low-skilled workers in a skill-intensive industry produce more than such workers in a low-skill-intensive industry.

[7] Wage inequality in the Helpman, Istkhoki, and Redding (2010) model is driven by a number of factors. First, due to assumed matching problems, there are unemployed and employed and hence inequality for that reason. Second, within the employed, some are in exporting firms and some domestic, the former of which screen out low-ability types. So inequality results for that reason as well. Third, each firm is assumed to bargain a single wage for all its workers depending on the average expected ability level, so inequality is affected by the size of each firm. Furthermore, inequality is the same if all firms are purely domestic or all purely exporting, so the relation between inequality and exporting volume is hump-shaped such that inequality initially rises and then falls.

[8] However, it is worth noting that in a supplement to the paper (Helpman, Istkhoki, and Redding 2010, technical appendix, section 5.2) they extend their model to include a second sector, the nearest parallel to our model set out above. Like Davidson, Martin, and Matusz (1988), they consider a second sector that employs workers without search frictions. As they comment, changes in relative wages "will be determined by Heckscher–Ohlin forces, which directly affect between-group wage inequality, but have no effect on within-group inequality in the differentiated sector" (p. 20, section S5.2).

Opening to trade for a skill-abundant country allows it to specialize in skill-intensive tasks, which in turn raises skilled wages—similar to the analysis we have presented.

## Conclusions and Future Research

We hope that readers will take from our paper three main conclusions about the recent trends in U.S. real and relative incomes. First, to date there is little evidence that globalization through the classic channel of international trade in goods, intermediates, and services has been raising inequality between more-skilled and less-skilled workers. Second, there is at least suggestive evidence that globalization has been boosting the real and relative earnings of superstars. The usual trade mechanisms probably have not done this, but other globalization channels—in particular, the combination of greater tradability of services and larger market sizes abroad—may be playing an important role. Third, our analysis sheds new light on the sobering fact of pervasive real-income declines for the large majority of Americans in the past decade. These real-income declines may be part of the same globalization and innovation forces shaping returns to superstars and to capital.

These conclusions must be placed in the proper context, which is "there is so much more we need to know from future research." A good deal of recent empirical work investigates the effects of trade on the adjustment process of particular workers, occupations, and industries (which simple models ignore), and documents (the sometimes long-lasting) adverse effects. Our goal here, however, has been to advance some basic models describing the economywide evolution of, for example, widespread real-wage declines but rising earnings of superstars. Of course, future research will hopefully explore not only the experience of the United States but that of many other countries as well—both developed and developing.

For superstars, we do not yet fully understand product prices in sectors that employ superstars relatively intensively. This is both because existing industry data do not distinguish highly talented individuals well (if at all), and because many of the sectors in which we presume superstars are concentrated like finance, law, consulting, athletics, and entertainment do not have reliable data on product prices (or much else). Nor do we have good data on personal attributes that make individuals potential superstars. We suspect that for at least some of these superstar-intensive industries, globalization has played an important role in boosting demand for their services—both via the information technology revolution reducing their natural trade costs and thus boosting their tradability, and via fast economic growth around the world boosting demand for their services. But these conjectures await additional analysis.

With regard to the sobering falls in real income for the large majority of Americans, our framework does add some new insights. We agree with Autor (2010a) that explaining falling real income for so many American workers remains a daunting empirical challenge. Much research to date has focused on income inequality, not income levels. We argue that this focus should change, because the post-2000 real-income declines are pervasive, new, and troubling. Our enriched trade framework offers some possible explanations for how globalization and/or innovation can boost superstar real earnings yet reduce real earnings of so many others.

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