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A Survey of Trade and Wage Inequality: Anomalies, Resolutions, and New Trends

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Abstract

This paper surveys recent studies on trade and wage inequality. We first introduce some trade-based explanations for increased wage inequality. There are, however, a number of criticisms of this line of thought based on the "trade-wage inequality anomaly," the "price-wage anomaly," and the small volume of trade. Mainly due to these criticisms, trade-based explanations for rising wage inequality have been limited in the economic literature. Rather, the primary explanations for wage inequality have been based on skill-biased technological change. Some trade models, however, have weakened the above criticisms, and more economists now argue that the effect of trade, though relatively small compared to that of technological change, is more significant than generally believed. Finally, we attempt to link new trends in inequality, such as job polarization and within-group inequality, to the trade and wage inequality literature.

Keywords: Trade, Wage inequality, Trade-wage inequality anomaly, Price-wage anomaly, Skill-biased technological change, Outsourcing, Variety-skill complementarity, Skill intensity reversal, Job polarization, Within-group inequality

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1 Increased Trade and Increased Wage Inequality

As Figure 1 shows, the relative wage of high-skilled to low-skilled workers began to increase in U.S. manufacturing industries in the late 1980s, and this phenomenon was also observed in Mexico.[1] As can be seen, these two countries showed surprisingly similar movements in relative wages in the late 1980s and early 1990s.[2] What is the cause of this recent increase in wage inequality in these countries?

The data also indicate that, as shown in Figure 2, U.S.-Mexican trade as a percentage of U.S. GDP increased dramatically during the same period.[3] Hence, this increased trade might have contributed to the recent increase in skill premiums in both countries.[4] Past studies, such as Wood (1994), have investigated the possible relationship between trade and wage inequality. It is still a topic of interest and heated debate among economists.

However, there are a number of criticisms of trade-based explanations for increased wage inequality. One criticism is based on the "trade-wage inequality anomaly"—a discrepancy between the standard Heckscher-Ohlin (H-O) model and the data. According to the H-O model, the relative wage of high-skilled to low-skilled workers should increase in the high-skill abundant U.S. but decrease in low-skill abundant Mexico after trade liberalization. However, as we have seen in Figures 1 and 2, the data show that the wage inequality increased along with the increase in trade in both countries in the late 1980s and early 1990s. This is the "trade-wage inequality anomaly."

A second criticism is based on the "price-wage anomaly"—another discrepancy between the standard H-O model and the data. In the H-O model, an increase in the relative wage of high-skilled to low-skilled workers should be driven by an increase in the relative price of high-skill to low-skill intensive goods in the high-skill abundant U.S. This price-wage linkage is known as the Stolper-Samuelson theorem of the H-O model. However, the data reveal that the relative prices of high-skill intensive goods were declining or constant during the 1980s, while the relative wage of high-skilled workers was increasing in the U.S. (Lawrence and Slaughter, 1993).

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[1] Here, we use non-production and production workers as an index for high-skilled and low-skilled workers (Berman et al., 1994; Sachs and Shatz, 1994; Berman et al., 1998; Hanson and Harrison, 1999; Robertson, 2004). We calculate the U.S. relative wage during the period 1980-2000 on the basis of the U.S. Annual Survey of Manufactures (ASM). We calculate the Mexican relative wage on the basis of the Mexican Monthly Industrial Survey (*Encuesta Industrial Mensual*, or EIM) by first calculating the average monthly wage of non-production relative to production workers. The annual average is then produced by averaging this monthly relative wage.

[2] We note that the U.S. and Mexican relative wages are shown on different scales in Figure 1, as here we seek to emphasize the qualitative movements of these series. Kurokawa (2011a) emphasizes the quantitative difference between the same series during the period 1987-1994, when the North American Free Trade Agreement (NAFTA) was enacted. Kurokawa (2011b) examines the data during the period 1994-2000.

[3] Here, U.S.-Mexican trade is defined by the sum of U.S. exports to and U.S. imports from Mexico. The data for trade and GDP are from the International Trade Administration and the Bureau of Economic Analysis (BEA).

[4] This paper mainly focuses on the U.S. and Mexico; however, the same increase in the relative wage of high-skilled workers during the 1980s and into the 1990s can be found in Australia, Canada, Japan, Sweden, and the United Kingdom (Feenstra and Hanson, 2003).

A third criticism is based on the volume of trade. For example, as shown in Figure 2, the share of U.S.-Mexican trade in U.S. GDP was only 2.5 percent in 2000. Trade-based explanations for increased wage inequality have often been criticized due to this small volume of trade. Krugman (1995) provides numerical examples to explain why the small volume of trade in the U.S. makes it unlikely that trade can account for the change in wages.

Therefore, mainly due to these three criticisms, trade-based explanations for increased wage inequality have been limited in the economic literature. Rather, the primary explanations have been based on skill-biased technological change. There are many possible reasons for skill bias. For example, Krusell et al. (2000) consider the possibility of capital-skill complementarity. A sharp decrease in equipment prices in the 1980s led to an increase in the demand for high-skilled workers, who were complements for this equipment, and a decrease in the demand for low-skilled workers, who were substitutes. Hence, the relative demand and thus the relative wage of high-skilled to low-skilled workers increased. This technology-based explanation is consistent with the decrease in the price of high-tech goods and the increase in wage inequality both in the U.S. and in Mexico.

Using trade models, however, a few economists have successfully weakened all/some of the above criticisms that are based on the trade-wage inequality anomaly, the price-wage anomaly, and the small volume of trade. Feenstra and Hanson (1996), for example, show that foreign direct investment shifts production activities from the North to the South and thus increases the North's outsourcing of low-skill intensive goods to the South, and these goods are high-skill intensive goods by the South's standards. Thus the skill intensity of production rises in both the North and the South, raising the relative demand and thus the relative wage of high-skilled to low-skilled workers in both types of countries. In the North, this increase in the relative wage of high-skilled workers is accompanied by an increase in the relative price of domestic production to imports, which is compatible with U.S. data. They also find that 15-33 percent of the shifts towards high-skilled workers within U.S. manufacturing industries during the period 1979-1985 can be explained by outsourcing.

As noted above, we focus on the wage inequality between high-skilled and low-skilled workers. However, many recent studies reveal interesting new trends in wage inequality, such as the inequality among high-, middle-, and low-wage workers (job polarization) or the inequality within the top 10 percent of the income distribution (within-group inequality). Thus we also survey these new trends and attempt to link them to the trade and wage inequality literature.

Of course, there are many papers that also survey trade and wage inequality (e.g., Burtless, 1995; Richardson, 1995; Cline, 1997; Williamson, 1997; Wolff, 2000; Feenstra and Hanson, 2003; Kremer and Maskin, 2006; Drews, 2007; Goldberg and Pavcnik, 2007; Chusseau et al., 2008; Harrison et al., 2011; Chusseau and Dumont, 2012). Our survey paper adds value as follows. First, our paper is not a mere chronological survey but focuses on the anomalies and their resolutions. Second, it also discusses new trends in inequality and attempts to link them to the trade and wage inequality literature.

The rest of this paper is as follows. In Section 2, we first survey some trade-based explanations of wage inequality and then discuss three major criticisms based on the trade-wage inequality anomaly, the price-wage anomaly, and the small volume of trade. In Section 3, we describe some technology-based explanations. Section 4 reviews a few trade models weakening the above criticisms. Our alternative trade models are introduced in Section 5. In Section 6, we discuss new trends in inequality, such as job polarization and within-group inequality. Finally, Section 7 concludes the paper.

2 Trade-Based Explanations

What is the cause of the recent increase in wage inequality in the U.S. and developing countries such as Mexico? Some studies argue that by using different assumptions and by examining different data, it is possible to find a significant effect of trade on wage inequality.

2.1 Theoretical and Empirical Arguments by Wood (1994)

Among these studies, Wood (1994) is one of the first economists to systematically examine wage inequality trends across developed and developing countries.[5] He argues that the labor-market effects of North-South trade in manufactured goods can be analyzed in the standard H-O model, with North and South countries as the two countries, and high-skilled and low-skilled workers as the two factors.[6] The H-O model predicts that after trade liberalization, the relative wage of high-skilled to low-skilled workers will rise in the high-skill abundant North, as production shifts toward high-skill intensive goods, raising the relative demand and thus the relative wage of high-skilled workers. In the low-skill abundant South, on the other hand, the relative wage of high-skilled workers will fall, as production shifts toward low-skill intensive goods, raising the relative demand and thus the relative wage of low-skilled workers.

In the H-O model, this rise in the relative wage of high-skilled to low-skilled workers in the North should be driven by the rise in the relative price of high-skill to low-skill intensive goods. This price-wage linkage is known as the Stolper-Samuelson theorem of the H-O model.

Wood next estimates the degree to which trade with the South can account for the decreased demand for low-skilled workers in manufacturing in the North in 1990. Primarily using OECD sources, he develops the factor content approach to calculate the numbers of high-skilled and low-skilled workers used to produce the goods that are exported and the numbers that would have been used to produce the goods that are imported. The

[5] We note that Leamer (1993) is also notable and makes a similar argument.

[6] In Wood (1994), the "North" usually approximates most closely what the World Bank calls "high-income OECD-member economies" (before 1989 called "industrial market economies"), and the "South" is usually the UN's "developing market economies," plus China.

difference between these values is used to determine the effect of trade on the demand for high-skilled and low-skilled workers. He finds that trade with the South reduced the demand for low-skilled workers in manufacturing in the North by 22 percent.

His theoretical and empirical arguments thus indicate a significant effect of trade on wage inequality. However Wolff (2000) notes that one strong assumption used by Wood is that goods imported from the South are "non-competing" imports—most of the manufactured goods imported from the South are types that are not produced in the North. It might be probable that, due to this assumption, the effects on low-skilled employment of trade expansion are overestimated. This is because under this assumption, competition can occur on the price differences between imported and domestic goods; for example, one 50 dollar pair of domestic pants is substituted by one 20 dollar pair of imported pants. By the standard factor content approach, however, one 20 dollar pair of domestic pants is substituted by one 20 dollar pair of imported pants. Thus the former effect is 2.5 times as large as the latter. However, as noted by Burtless (1995), Wood himself suggests that even his estimate presented above understates the impact of North-South trade on the relative demand for low-skilled Northern workers because it ignores unskilled labor saving technology that Northern firms are forced to adopt to remain competitive with firms based in the South.

2.2 Other Empirical Studies on Trade and the Skill Premium

Although they use different models and examine different data, there are many empirical studies that also find a significant effect of trade on wage inequality as in Wood (1994). For the U.S., Borjas and Ramey (1994), for example, show how trade volumes can be linked to wage inequality in the U.S. By using time series analysis, they conclude that the only variable that consistently shares the same long-run trend with their wage-inequality series is the durable-goods deficit as a percentage of GDP. Harrigan and Balaban (1999) estimate an econometric general equilibrium model of U.S. wages as a function of prices, technology, and factor supplies. They find that capital accumulation and the fall in the price of traded goods increased returns to education.

For Mexico, Revenga (1997) and Hanson and Harrison (1999), for example, link changes in Mexican wage inequality to changes in trade policy. Revenga (1997) argues that trade reform had a negative effect on firm-level employment and wages in the Mexican manufacturing sector both by shifting down industry product and labor demand and by reducing the rents available to be captured by firms and workers. Hanson and Harrison (1999) find that the reduction in tariff protection in 1985 disproportionately affected low-skilled industries and that the goods from that sector may have fallen in price and wage because of competition from economies with reserves of less expensive low-skilled labor than that available in Mexico. Verhoogen (2008) also focuses on Mexico, linking quality upgrading for export to the skill premium. He shows that only the most productive plants in Mexico enter the export market and produce higher-quality goods for export than for the domestic market, thus requiring the payment of high wages to both white-collar and blue-collar employees, but especially to white-collar employees.[7]

There are also many empirical studies for countries other than the U.S. and Mexico, particularly for Latin America.[8] For Chile, Robbins (1996), for example, finds that, although the content of high-skilled labor in imports exceeds the content in exports, the returns to high-skilled labor grew after trade liberalization. Using a time series approach, Beyer et al. (1999) also find a long-term correlation between openness and wage inequality in Chile. For Costa Rica, Gindling and Robbins (1999) find that the skill premium rose after liberalization as a result of changes in the structure of labor demand. For Brazil, Green et al. (2001) find an increase in the returns to college education following trade liberalization. For Argentina, Galiani and Sanguinetti (2003) find that import penetration explains a small part of the skill premium in Argentina. For Colombia, Attanasio et al. (2004) show that trade liberalization increases inequality through technology, and the growing informal sector. Goldberg and Pavcnik (2005) show that tariff cuts decreased low-skilled wages in Colombia because the most protected workers were low-skilled.

2.3 Criticisms of Trade-Based Explanations

As was discussed in the previous sections, increased trade might have contributed to the recent increase in skill premiums. However, trade-based explanations for increased wage inequality have been criticized. The major criticisms lie not in the theories but in the data.

2.3.1 "Trade-Wage Inequality Anomaly"

One criticism is based on a "trade-wage inequality anomaly"—a discrepancy between the standard H-O model and the data. As we discussed in Section 2.1, according to the H-O model, the relative wage of high-skilled to low-skilled workers should increase in the high-skill abundant U.S. but decrease in low-skill abundant Mexico after trade liberalization. The H-O model thus generates a positive relationship between trade and wage inequality in the U.S. but generates a negative relationship in Mexico. However, as we have seen in Figures 1 and 2, the data generated a positive relationship between trade and wage inequality in both countries in the late 1980s and early 1990s. This is the "trade-wage inequality anomaly."

Note, however, that this anomaly is not particular to the U.S. and Mexico during the 1980s and 1990s. As pointed out by Williamson (1997), the anomaly was actually found by Krueger (1978), who studied ten developing countries covering the period through 1972. As

[7] Cragg and Epelbaum (1996), Feliciano (2001), and Robertson (2004) also highlight trade and wage inequality in Mexico.

[8] Gourdon (2011) surveys empirical studies on trade and wage inequality in developing countries. There are also theoretical studies for Latin America. For example, Atolia (2007) shows, using numerical simulations, that the rise in wage inequality in Latin America can be rationalized as a short-run response to trade liberalization.

we noted in Section 2.2, many studies for Latin America also find that wage inequality rose following trade liberalization. Moreover, a review by Davis (1996) reports a study of seven countries in Latin America and East Asia that shows that wage inequality typically did not decrease after trade liberalization but rather increased (Robbins, 1996). More recently, Berman et al. (1998) and Goldberg and Pavcnik (2007) present evidence of rising wage inequality in developing countries. These results are again at odds with the H-O prediction.

2.3.2 "Price-Wage Anomaly"

A second criticism is based on a "price-wage anomaly"—another discrepancy between the standard H-O model and the data. As we mentioned in Section 2.1, the Stolper-Samuelson theorem of the H-O model predicts the same direction of movement in the relative price of high-skill to low-skill intensive goods and the relative wage of high-skilled to low-skilled workers because the rise in the relative wage of high-skilled workers should be driven by the rise in the relative price of high-skill intensive goods in the high-skill abundant U.S. However, the data show that the relative prices of high-skill intensive goods were declining or constant during the 1980s, while the relative wage of high-skilled workers was increasing in the U.S.

Lawrence and Slaughter (1993), the most cited work on this criticism, find little effect of changes in output prices on wages during the 1980s. The measured wage inequality between high-skilled and low-skilled workers (non-production and production workers) increased by 10 percent during the period 1979-1989. Thus they argue that, according to the Stolper-Samuelson theorem, the rising relative wage of high-skilled to low-skilled workers after trade liberalization must have been accompanied by the rising relative price of high-skill to low-skill intensive goods.

However, using data on prices and quantities of inputs and outputs from the Trade and Immigration Data Base of the National Bureau of Economic Research (NBER) and data on U.S. terms of trade from the export and import price indices produced by the Bureau of Labor Statistics (BLS), they find no evidence that the price of low-skill intensive manufactured goods fell relative to that of high-skill intensive manufactured goods in U.S. manufacturing industries during the period 1979-1989. They examine percent changes during the 1980s in the import and export prices of industries against the ratio of high-skilled (non-production) to low-skilled (production) workers employed in these industries during the same period. In each unit, these industries are disaggregated at the two- and three-digit Standard Industrial Classification (SIC) levels. Regardless of the level of disaggregation, however, they find that these price changes do not indicate that the international prices of high-skill intensive goods increased relative to the international prices of low-skill intensive goods. In fact, the relative prices of high-skill to low-skill intensive goods declined.

To corroborate their conclusion, Lawrence and Slaughter (1993) also calculate the percent changes in U.S. import and export prices during the period 1980-1989 as a weighted sum of the 3-digit SIC price changes using the employment of either high-skilled (non-production) or low-skilled (production) workers as weights. They find that the average import price change using high-skilled workers as weights is 26.0 percent, while the change using low-skilled workers as weights is 28.1 percent. However, the average export price change using high-skilled workers as weights is 26.3 percent, while the change using low-skilled workers as weights is 30.0 percent. Thus, in both cases of import and export prices, the average price change using high-skilled workers as weights is lower than the change using low-skilled workers as weights. This result again indicates that the international prices of low-skill intensive goods slightly increased relative to the international prices of high-skill intensive goods.

This decrease in the relative international prices of high-skill intensive goods allowed the authors to conclude with confidence that the Stolper-Samuelson mechanism did not have much influence on U.S. relative wages during the 1980s and that no regression analysis is necessary for this conclusion. Needless to say, a regression analysis would have been necessary if the relative international prices of high-skill intensive goods had instead increased, to determine the degree to which the Stolper-Samuelson mechanism contributed to the increased U.S. skill premium compared to other possible factors.

It should be noted that some economists disagree with Lawrence and Slaughter's finding that imports have not contributed much to rising wage inequality in the U.S. Davis and Topel comment on in Lawrence and Slaughter (1993) as follows: "Those disagreeing with the authors' results suggested that their treatment of technological change in the U.S. economy as exogenous may be hiding the effects of trade on wages. Paul Romer, John Helliwell, and Martin Baily all argued that technological change cannot be considered exogenous because some portion of apparent technological change in the United States is driven by the globalization of production, as low-skilled, labor-intensive manufacturing tasks gradually move from the United States to low-wage countries, such as Mexico, while the most skill-intensive jobs continue to be performed in the United States." (Lawrence and Slaughter, 1993, p. 221)

2.3.3 The Small Volume of Trade

A third criticism is based on the volume of trade. As we have seen in Section 2.1, Wood (1994) empirically argues that there is a significant effect of trade on wage inequality. Trade-based explanations for increased wage inequality, however, have often been criticized due to the small volume of trade, as shown in Figure 2.

Krugman (1995) provides numerical examples to explain why the small volume of trade in the U.S. makes it unlikely that trade can account for the change in wages. He develops a computable general equilibrium model of world trade to determine the degree to which the growing exports of newly industrializing economies (NIEs) affect OECD labor markets. The model has the two countries (the aggregate OECD and the aggregate NIEs), two goods (high-skill intensive good 1 and low-skill intensive good 2), and two factors (high- and low-skilled workers). The markets are perfectly competitive. The production and utility functions are Cobb-Douglas.

The effects of opening trade between the OECD and the NIEs can be represented by Figure 3. Point A shows OECD autarky. After opening to trade, the relative price of high-skill intensive good 1 to low-skill intensive good 2 increases, and, as a result, production moves to Q while consumption moves to C. In world equilibrium, the NIEs' offer curve (drawn backward with its origin at Q) passes through C—OECD exports are equal to NIEs imports, and vice versa.

To make the model computable, he uses past empirical results to set parameter values, and by using the Cobb-Douglas production and utility functions he also specifies elasticities (unitary elasticities for simplicity) in production and consumption. He then asks what changes in relative wages and prices would be consistent with the observed NIEs trade.

His answer is that NIEs trade on the scale actually seen should be associated with a fairly small change in the relative wage of high-skilled to low-skilled workers and a very small change in the relative price of high-skill to low-skill intensive goods. In fact, his exercise shows that a 3 percent increase in the relative wage of high-skilled workers from its autarky level is large enough to imply NIEs exports of 2.2 percent of OECD gross product, which is greater than the actual share of NIEs manufactures in OECD spending. It is also shown that this wage increase is associated with a rise of only 1 percent in the relative price of the high-skill intensive good. He thus concludes that for plausible parameters, the change in relative prices associated with the size of NIEs trade should be well within measurement error. In other words, actual changes in relative prices should reflect a whole host of characteristics besides trade.[9]

In summary, as commented on by Cooper in Krugman (1995), Krugman's results nicely show the effects of import competition on the basis of simple traditional trade theory and then identify why the plausible effects are small. It seems that the simplicity of his theory makes his research more notable. As will be shown in Section 5, the model by Kurokawa (2011a) shares this simplicity with Krugman's model. Contrary to Krugman's simple model, however, Kurokawa's simple model will show the theoretical possibility that trade, even when small in volume, significantly contributes to an increase in the skill premium.

Here, it should be noted that Krugman (2008) recently argues that, due to the increase in U.S. trade with low income countries and the growing fragmentation of production, it is no longer safe to assume that the effect of trade on wage inequality is miniscule, although he admits that it is hard to prove the actual effect.

It should also be noted that trade seems small in volume in terms of U.S. GDP; however, it is not small from the Mexican perspective. U.S.-Mexican trade as a fraction of Mexican GDP, for example, was 23.9 percent in 1994 and 42.6 percent in 2000, although it was 1.4

[9] We note that, for alternative views, see Deardorff (2000), Leamer (2000), and Panagariya (2000).

percent in 1994 and 2.5 percent in 2000 as a percentage of U.S. GDP. It thus seems that people tend to look at the volume of trade only in terms of U.S. national income.

3 Technology-Based Explanations

Mainly due to these three criticisms, as shown in Section 2.3, trade-based explanations for rising wage inequality have been limited among economists. Conversely, the primary explanations have been based on skill-biased technological change.[10]

3.1 Capital-Skill Complementarity

A variety of explanations for skill bias are possible. For instance, Krusell et al. (2000) consider the possibility of capital-skill complementarity and provide a technology-based explanation for increased wage inequality that fits the theory and data.

They develop the following four-factor aggregate production function that distinguishes among capital structures (k_{st}), capital equipment (k_{et}), low-skilled workers (u_t), and high-skilled workers (s_t) and allows for different elasticities of substitution among factors:

$$G\left(k_{st}, k_{et}, u_t, s_t\right) = k_{st}^{\alpha}\left[\mu u_t^{\sigma} + (1-\mu)\left(\lambda k_{et}^{\rho} + (1-\lambda)\, s_t^{\rho}\right)^{\sigma/\rho}\right]^{(1-\alpha)/\sigma}.$$

In this specification, the elasticity of substitution between equipment and low-skilled workers is given by $1/(1-\sigma)$, and the elasticity of substitution between equipment and high-skilled workers is given by $1/(1-\rho)$.[11]

To assess how the skill premium has been affected by changes in factor inputs, they estimate the parameters of their model using U.S. time series data during the period 1963-1992. They find that $\sigma = 0.401$ and $\rho = -0.495$: $\sigma > \rho$. Thus the elasticity of substitution between capital equipment and low-skilled workers, $1/(1-\sigma) = 1.67$, is higher than that between capital equipment and high-skilled workers, $1/(1-\rho) = 0.67$: capital-skill complementarity. With this empirically plausible difference in substitution elasticities, changes in observed factor inputs can account for most of the variation in the skill premium during the period.

They thus conclude that a sharp decrease in equipment prices in the 1980s led to an increase in the demand for high-skilled workers, who were complements for this equipment, and a decrease in the demand for low-skilled workers, who were substitutes. Hence, the relative demand for and thus the relative wage of high-skilled to low-skilled workers increased. This technology-based explanation is consistent with the decrease in the price of high-tech goods and the increase in wage inequality both in the U.S. and in Mexico. It is thus implied

[10] For example, see Katz and Autor (1999), Acemoglu (2002), and Acemoglu and Autor (2011) for a survey on technological change and wage inequality.

[11] See Saito (forthcoming) for the history of the constant elasticity of substitution (CES) function.

that the most significant competition that low-skilled workers in the U.S. face is not foreign workers but the combination of high-tech equipment and high-skilled workers in the U.S.[12]

It should be noted that the hypothesis of capital-skill complementarity was first formalized by Griliches (1969). As documented by Mendez (2002), there is now a vast literature on capital-skill complementarity initiated by Griliches. Most studies before the mid 1990s are skeptical about the empirical relevance at the aggregate level of this capital-skill complementarity. Using different methodologies, however, recent studies take the opposite view and explicitly link capital equipment to rising wage inequality. Goldin and Katz (1998), for example, document the importance of capital-skill complementarity during the period 1909-1929. This period has two features that make it comparable to the 1980s and the 1990s. The 1909-1929 period experienced both significant technological change and a substantial increase in wage inequality. Compared to these past studies, Krusell et al. (2000) go even further and find that most of the wage inequality shift during the 1960s-1980s in the U.S. can be accounted for by the capital-skill complementarity hypothesis. Their mechanism is straightforward, as we have seen in the above discussion. Lindquist (2005) is a Swedish version of the Krusell et al. (2000) study.

3.2 Other Technology-Based Explanations

Several other studies also relate skill-biased technological change to wage inequality (Katz and Murphy, 1992; Berman et al., 1994; Berndt and Morrison, 1995; Autor et al., 1998; Berman et al., 1998; Machin and van Reenen, 1998; Katz and Autor, 1999). For example, Berman et al. (1998) find strong evidence for pervasive skill-biased technological change in developed countries—the same manufacturing industries simultaneously increased demand for skills in different countries. They also show evidence consistent with skill-biased technological change in developing countries. Katz and Autor (1999) argue that the only explanation consistent with the increase in the relative wage and employment of high-skilled to low-skilled workers is that there has been an outward shift in the demand for high-skilled workers since the mid-1980s. Berman et al. (1994) and Krugman and Lawrence (1994) also document that the relative employment of high-skilled to low-skilled workers increased in U.S. manufacturing sectors during the 1980s.

Although technology-based explanations have been supported by most economists, there were also a few criticisms. Recall Wood (1994), who blamed growing trade for increased inequality, as we have seen in Section 2. As noted by Williamson (1997), Wood dismissed skill-biased technological change as a potential explanation for increased wage inequality because labor and total factor productivity growth both slowed during the 1980s. Wood also argued that the pattern of increasing wage inequality in the North favored a trade

[12] Alvalez-Cuadrado and Van Long (2011) focus on sectoral differences in the elasticity of substitution between capital and labor to provide an alternative source for technology-driven structural change consistent with balanced growth at the aggregate level.

explanation because there was no cross-country association between wage inequality trends and technological progress. That is, technological progress did not necessarily occur in every developed country in which wage inequality increased.

It should also be noted that many empirical studies have investigated skill-biased technological change at the worker-, firm-, and sector-level, but linkages across sectors have been ignored, despite the fact that more than half of a final product's value is embedded in intermediates. Voigtländer (2012) shows that skill upgrading in one sector goes hand-in-hand with increasing skill demand in many other sectors because of linkages that operate through the use of intermediate products (an intersectoral technology-skill complementarity).

4 Resolutions of the Anomalies

With very few exceptions, economists have tended to disagree with trade-based explanations for increased wage inequality on the basis of the anomalies—the gaps between the data and the standard H-O model—and thus blame skill-biased technological change. A few economists, however, have been successful in resolving the anomalies on the basis of trade models.

4.1 Foreign Direct Investment and Outsourcing

One of the notable resolutions of the anomalies is based on foreign direct investment and outsourcing. Feenstra and Hanson (1996) show that foreign direct investment shifts production activities from the North to the South and thus increases the North's outsourcing of low-skill intensive goods to the South, and these goods are high-skill intensive goods by the South's standards. Thus the skill intensity of production rises in both the North and the South. This globalization, interpreted as foreign direct investment from the North to the South, increases the relative demand and thus the relative wage of high-skilled to low-skilled workers in both the North and the South.[13]

To explain this mechanism, they provide a model with a continuum of intermediate goods indexed by $z \in [0, 1]$. Higher z reflects higher skill intensity of production. Capital is complementary with high-skilled workers, and the North has more capital and more high-skilled workers than the South. Figure 4 shows the locus of minimum costs for intermediate goods produced in the North and South denoted $C_N C_N$ and $C_S C_S$, respectively. It can be shown that in equilibrium there is a cutoff z^* such that the South produces intermediate goods in $[0, z^*]$ while the North produces intermediate goods in $[z^*, 1]$.

Consider a capital flow—foreign direct investment—from the North to the South. This capital flow lowers the return to capital in the South and raises it in the North. This will

[13] We note that, by introducing southern technological catch-up, Zhu and Trefler (2005) also employ a mechanism closely related to the mechanism developed by Feenstra and Hanson (1996). There are more recent papers that focus on the role of outsourcing/offshoring. For example, see Blinder (2006, 2009), Sayek and Sener (2006), Grossman and Rossi-Hansberg (2008), and Liu and Trefler (2008).

lower the Southern costs locus C_SC_S in Figure 4, and raise the Northern locus C_NC_N, thus increasing the cutoff value of z^* to $z^{'}$. Thus the activities in $[z^*, z^{'}]$ now take place in the South rather than in the North. The activities in $[z^*, z^{'}]$ are more high-skill intensive than any previously performed in the South. They are, however, less high-skill intensive than any that now occur in the North. As a result, this increases the average skill intensiveness of production in both countries, which raises the relative demand and thus the relative wage of high-skilled to low-skilled workers in both countries.

In the North, this increase in the relative wage of high-skilled workers is accompanied by the increase in the relative price of domestic production to imports. Feenstra and Hanson (1996) empirically confirm that domestic prices actually rose by more than import prices in the U.S. during the 1980s.

They next ask whether outsourcing due to growth in the South's relative capital stock can explain a significant part of the shift towards high-skilled workers in the U.S. To answer this question, using a panel data of 450 four-digit SIC U.S. industries, they perform regressions in which the share of high-skilled workers in the total wage bill should be explained on the basis of various industry variables including the change in the import share. They find that 15-33 percent of shifts towards high-skilled workers within U.S. manufacturing industries during the period 1979-1985 can be explained by the increasing import share.

4.2 Role of Non-Traded Goods

Kremer and Maskin (2006) note that the model of Feenstra and Hanson (1996) shares with the other standard trade models the prediction that trade should be greatest between countries with the most different factor endowments; this is not observed. Related to this point, Xu (2003), for example, shows that in a model with endogenously determined non-traded goods, tariff rates in the South can have a U-shaped relationship with inequality, reducing wage inequality when tariff rates start at a high level and increasing it when they are initially lower.

To demonstrate this relationship, he formulates a model with two countries (North and South countries), two factors (high-skilled and low-skilled workers), a continuum of manufactured goods indexed by $z \in [0, 1]$ that both countries produce using high-skilled workers, and an agricultural good that only the South produces using low-skilled workers. The South has a relative productivity advantage in low-index manufactures, and the North has such an advantage in high-index manufactures. In equilibrium, there will be cutoff indices $0 < z^x < z^m < 1$ such that southern export goods in $[0, z^x]$ are produced only in the South, southern import goods in $[z^m, 1]$ are produced only in the North, and goods in $[z^x, z^m]$ are produced in both countries and are not traded. Southern trade liberalization due to a tariff reduction in this model decreases the range of non-traded goods through the import expansion effect and the export expansion effect. The import expansion effect decreases z^m, thus decreasing the demand for high-skilled workers in the South. The export expansion effect, however, increases z^x, thus increasing the demand for high-skilled workers in the South as in the model of Feenstra and Hanson (1996). He shows that the export expansion effect dominates for low initial tariff rates, while the import expansion effect dominates for high initial tariff rates. Trade liberalization due to a tariff reduction thus produces a U-shaped effect on inequality in the South. A similar argument shows that the same is true for the North.

It should also be noted that Feenstra and Hanson (1996) resolve the anomalies on the basis of a "skill intensity reversal": intermediate goods that are produced in the South and relatively high-skill intensive within the South are relatively low-skill intensive within the North.[14] As will be discussed in Section 5.3, however, this assumption poses an empirical challenge, as past research has found little evidence for the so-called "factor intensity reversal." In fact, as documented by Kurokawa (2011b), we could not observe any clear-cut skill intensity reversal in the late 1980s when the skill premiums in the U.S. and Mexico actually began to rise. Kurokawa (2011a), however, successfully provides a simple resolution of the anomalies observed in the late 1980s and early 1990s without assuming this skill intensity reversal, unlike Feenstra and Hanson (1996).

4.3 Schumpeterian Mechanism

Another notable resolution of the anomalies is based on the Schumpeterian mechanism. Dinopoulos and Segerstrom (1999) show that trade increases the relative price of innovation (the reward for innovation relative to the current level of R&D difficulty), thus encouraging high-skill intensive R&D investment in each country. They also show that a contemporaneous correlation between an index of the relative price of innovation and an index of the U.S. skill premium was 0.80 during the period 1963-1989. Acemoglu (2003) shows that trade "induces" skill-biased technological change in the U.S., and this improved technology can be transferred to other countries by spillover effects.[15] Thus these explanations also demonstrate the rise in relative demand and, hence, the relative wage of high-skilled to low-skilled workers in each of the trading countries. This can occur without a rise in the relative price of high-skill to low-skill intensive goods.

We, however, note that Acemoglu (2003) might not be successful in explaining the fact that the U.S. and Mexico exhibited surprisingly similar timing in the increase in the skill premium. This is because the increase in the skill premium in Mexico should be driven by the spillover effects in his model, but this spillover process usually takes many years.

We also note that, while emphasizing that trade can increase the skill premium in each

[14] We note that, even if a good has the same skill intensity in both the North and the South, this good can be relatively low-skill intensive compared to other goods within the North but relatively high-skill intensive within the South. In the following discussion, the word "skill intensity reversal" refers to the reversal of relative skill intensities between the two countries.

[15] Using a heterogeneous-firm trade model a la Melitz (2003), Bas (2012) links firms' export to skill-biased technology to show a within-industry increase in the skill premium. Burstein et al. (2012) link trade to the skill premium through capital-skill complementarity (skill-biased technology).

of the trading countries, all the studies presented above do not disagree that technological change has played an important role.

5 Our Alternative Resolutions

5.1 Variety-Skill Complementarity

Compared to the previous studies discussed in Section 4, Kurokawa (2011a) provides a simpler resolution of the anomalies. The resolution is based on a straightforward application of the well-known model of variety trade in intermediate goods developed by Ethier (1982).[16] The variety trade in differentiated intermediate goods increases the variety of intermediate goods used by the final good in both countries. The increased variety of intermediate goods then can increase the variety of tasks to be handled and thus corresponds to higher demand for high-skilled workers. Through this variety-skill complementarity, the relative demand and thus the relative wage of high-skilled to low-skilled workers—the skill premium—rises in both countries.[17] This can occur without a rise in the relative price of high-skill to low-skill intensive goods. Using the data from the period prior to the implementation of NAFTA, he also provides several numerical examples that illustrate that small amounts of variety trade can produce a significant increase in the relative wage.

This linking of imports of new foreign varieties—increases in the extensive margin of imports—to wage inequality is compatible with available empirical evidence. Figure 5 plots the 1980–2000 data on growth in what Kehoe and Ruhl (2009) call the "least traded goods" in U.S. manufacturing imports from Mexico for 1980 and on the growth in the relative wage of high-skilled to low-skilled workers in U.S. manufacturing industries. Figure 6, however, plots the growth in the "least traded goods" in Mexican manufacturing imports from the U.S. for 1980 and the growth in the relative wage in Mexican manufacturing industries during the same period.

Kehoe and Ruhl (2009) classify the set of goods that accounts for only 10 percent of trade as the "least traded goods." Here, the growth in the least traded goods is employed to measure the increase in the extensive margin of trade. The data for the growth in least traded goods are the Standard International Trade Classification (SITC) (revision 2) 3-digit manufacturing data from the OECD International Trade by Commodities Statistics (ITCS).[18] The source of data for the U.S. and Mexican relative wages is the same as for

[16] Ethier's (1982) model is an intermediate-goods version of Krugman's (1979) model of variety trade in final goods.

[17] Dinopoulos et al. (2011) also link variety trade to wage inequality. Their model, however, modifies the one-sector Krugman (1979) model of variety trade in final goods by introducing quasi-homothetic preferences for varieties and non-homothetic technology in the production of each variety, thus relating an increase in the output of each variety—not an increase in the number of variety—to an increase in the relative demand for high-skilled workers by each variety (output-skill complementarity). Sato and Yamamoto (forthcoming) also link variety trade in final goods to the skill premium. Zhang (2012) links variety trade in services to the skill premium.

[18] See Kehoe and Ruhl (2009) for the detailed procedure used to construct figures 5 and 6. Note that the

Figure 1.

As can be seen in figures 5 and 6, the least traded goods that account for 10 percent of U.S. manufacturing imports from Mexico in 1980 account for 42.5 percent in 2000, and the least traded goods that account for 10 percent of Mexican manufacturing imports from the U.S. in 1980 account for 17.5 percent in 2000. This indicates that each country started importing goods that it had not imported previously or had only imported in small quantities, thus indicating that the variety of manufactured imports increased in each country. Moreover, these figures reveal that this growth in the least traded goods was highly correlated with the growth in the relative wage in each country over 1980–2000. In fact, the correlation between these two series was high in each country: it was 0.932 and 0.947 in the U.S. and Mexico, respectively. Thus linking the extensive margin of imports to the skill premium is compatible with this evidence in both countries.

Here, it is worth noting that the method developed by Kehoe and Ruhl (2009) used in Kurokawa (2011a) for measuring the extensive margin is different from methods used in the few previous studies of the extensive margin.

Hummels and Klenow (2005) and Broda and Weinstein (2006), for example, classify a good as not traded if the value of trade is zero, and Evenett and Venables (2002) classify a good as not traded if its yearly value of trade is less than or equal to 50,000 1985 U.S. dollars, regardless of the country being studied. In Kehoe and Ruhl's (2009) definition of a non-traded good, however, goods with very small but nonzero amounts of trade can also be considered, and the actual dollar value of the 10 percent cutoff can differ across countries. Hence, non-traded goods in a country are determined based on the relative importance of goods in the country's trade. This country-variant method developed by Kehoe and Ruhl has been widely used. Sandrey and van Seventer (2004), Mukerji (2009), Amarsanaa and Kurokawa (2012), and Atolia and Kurokawa (2012a), for example, use the method to measure the extensive margin of trade, as does Kurokawa (2011a).

5.2 A Quantitative Analysis of Import Variety and Skill Premium

As we discussed in Section 5.1, Kurokawa (2011a) has provided a simple resolution of the anomalies. However, this poses a quantitative challenge. This is because no past studies have quantified how much of the increase in the skill premium can be accounted for by the change in the extensive margin of imports. Atolia and Kurokawa (2012a) formulate a static applied general equilibrium model and then calibrate it to Mexican data for 1987.[19]

manufacturing imports in these figures include imports of both final and intermediate goods. Fortunately, however, much of the increase in trade has been in intermediate goods (Feenstra, 1998).

[19] Here, applied general equilibrium analysis is defined to be the numerical implementation of general equilibrium models calibrated to data (Kehoe and Kehoe, 1994; Kehoe and Prescott, 1995). Recently, Cho and Díaz (forthcoming) also apply applied general equilibrium analysis to trade and wage inequality in Slovenia. Note that some authors (e.g., Richardson, 1995; Bhagwati, 1998; Francois and Nelson, 1998) convincingly point out that a general equilibrium approach is the appropriate tool for analyzing the effects of trade on wage inequality.

In the calibrated model, their numerical experiments show how much of the increase in the Mexican skill premium can be accounted for by the extensive margin growth in Mexican manufactured imports from the U.S.

As in Kurokawa (2011a), Atolia and Kurokawa (2012a) also measure the growth in the extensive margin of imports by the growth in the share of the least traded goods in imports. Figure 7 plots the 1987-2000 data on the growth in the least traded goods in Mexican manufactured imports from the U.S. for 1987 and on the growth in the relative wage of high-skilled to low-skilled workers in Mexican manufacturing industries. The data for the share of the least traded goods are the SITC (revision 2) 4-digit manufacturing data from the OECD ITCS, and the data source for the relative wages is the same as that of Figure 1.

Figure 7 reveals that the least traded goods that account for 10 percent of Mexican manufactured imports from the U.S. in 1987 account for 19.5 percent in 1994. This indicates that over this period, Mexico started importing U.S. manufactured goods that it had not imported before or had only imported in small quantities, thus indicating that the variety of Mexican manufactured imports from the U.S. increased. The figure also reveals that the growth in the least traded goods was highly correlated with the growth in the relative wage in Mexico over 1987-2000. The correlation between these two series was high, 0.926, over the period. As can be seen, the extensive margin of manufactured imports was growing substantially before NAFTA was enacted in 1994, and it became stable thereafter. Similarly, the Mexican skill premium was also growing substantially before NAFTA and became stable (with a slight decrease) thereafter.

Their numerical experiments focus on the period 1987-1994, when both the extensive margin of manufactured imports and the skill premium were growing dramatically as shown in Figure 7. The numerical experiments show that the extensive margin growth in Mexican manufactured imports from the U.S. over 1987-1994 can raise Mexican skill premium by up to approximately 6.5 percent. However, the data show that the Mexican skill premium increased by 43.4 percent during the same period. Thus the results indicate that the growth in the extensive margin of manufactured imports can account for up to approximately 15 percent of the change in the Mexican skill premium over 1987-1994.

Atolia and Kurokawa (2012a), therefore, have quantitatively illustrated that the extensive margin of manufactured imports may be a channel that has a substantial effect on the increase in wage inequality in Mexico.

It should be noted that one of the most salient characteristics of the Mexican economy is *maquiladoras*. This export-processing sector imports intermediate inputs and then assembles them into final goods in a way that is similar to that modeled in Atolia and Kurokawa (2012a). Of course, low-skilled workers would be used more intensively than high-skilled workers in *maquiladoras* (intensity), but it is still possible that the demand for high-skilled workers increases more than that for low-skilled workers (complementarity). In fact, as emphasized by Feenstra and Hanson (1997), the demand for high-skilled workers increased along with the increase in imports from the U.S. in *maquiladoras*. Atolia and Kurokawa's experiments successfully capture both the intensity and the complementarity.

5.3 Skill Intensity Reversal

Using data from the period following the implementation of NAFTA, Kurokawa (2011b) also presents an alternative simple resolution of the trade-wage inequality anomaly. As also documented by Reshef (2007), a rising skill premium in two countries can be explained simply by the H-O model assuming a "skill intensity reversal."[20] That is, U.S. exports to Mexico of goods that are relatively high-skill intensive compared to other goods in the U.S. but relatively low-skill intensive in Mexico will increase demand for U.S. high-skilled workers but decrease demand for Mexican low-skilled workers. Conversely, U.S. imports from Mexico of goods that are relatively low-skill intensive in the U.S. but relatively high-skill intensive in Mexico will decrease demand for U.S. low-skilled workers but increase demand for Mexican high-skilled workers. Therefore, the relative demand and thus the relative wage of high-skilled to low-skilled workers will increase in both countries.

This assumption, however, poses a serious empirical challenge because little evidence for the so-called "factor intensity reversal" has been found in manufacturing industries in past empirical studies (Leontief, 1964; Ball, 1966; Moroney, 1967), thus supporting Samuelson's (1951-1952) impression that a factor intensity reversal has much less empirical importance than theoretical interest.

Should we thus conclude that the H-O explanation with factor intensity reversal is theoretically interesting but empirically unimportant? The answer is no. This is because the so-called factor intensity reversal has so far referred only to a capital/labor intensity reversal. However, our focus is now on a skill intensity reversal. Unfortunately, no serious empirical work on skill intensity reversal has been done until now. Thus it is time to revive the factor intensity reversal controversy of the 1960s with the fresh viewpoint of a skill division among labor.

Kurokawa (2011b) shows clear-cut evidence for the existence of skill intensity reversal. U.S. net exports to Mexico of electronics products increased from 1994 to 2000.[21] As shown in figures 8 and 9, the electronics products were relatively high-skill intensive compared to the non-electronics products in the U.S. but relatively low-skill intensive in Mexico both in 1994 and in 2000.[22] U.S. net imports from Mexico of non-electronics products also increased

[20] Using simulations, Reshef (2007) shows that tariff reductions can substantially increase the skill premium under the existence of skill intensity reversals.

[21] In Kurokawa (2011b), the electronics industry is defined by the 2-digit SITC (revision 3) category 77, and the non-electronics industry is defined by all the other 2-digit SITC categories of U.S. manufacturing industries.

[22] Kurokawa (2011b) defines the 2-digit SIC 1987 category 36 and the 3-digit International Standard Industrial Classification (ISIC) (revision 2) category 383 as the U.S. and Mexican electronics industries, respectively. These approximately correspond to the 2-digit SITC (revision 3) category 77. He defines skill

from 1994 to 2000. As shown in figures 8 and 9, non-electronics products were relatively low-skill intensive in the U.S. but relatively high-skill intensive in Mexico both in 1994 and in 2000. As shown in Figure 1, the skill premium also increased in both countries. Thus the two-good H-O model with the reversal of relative skill intensities can be compatible with the data presented above.

It is worth noting that the skill intensity reversal in the electronics industry displayed in these figures is compatible with the structure of technologies in Feenstra and Hanson (1996, 1999), whereby the low-skill abundant country specializes in the low-skill intensive operations within a given industry, and similarly the high-skill abundant country specializes in the high-skill intensive operations.

Note also that what Sampson (2011) recently calls an "assignment reversal" is analogous to a skill intensity reversal in the H-O model. Sampson considers an "assignment reversal" to exist whenever the ranking of sectors by skill level differs either over time or across countries.

As above, this section has focused on our alternative resolutions. However, it is worth noting that by modifying the H-O model and focusing on structural features within developing economies as in Marjit (2003), Razmi (2009) also successfully demonstrates an increase in wage inequality along with the informalization of the labor force observed in many developing countries.

6 New Trends

Thus far we have examined the wage inequality between high-skilled and low-skilled workers. However, many recent studies now reveal interesting new trends in wage inequality such as the inequality among high-, middle-, and low-wage workers (job polarization) or the inequality within the top 10 percent of the income distribution (within-group inequality). This section briefly surveys these new trends and attempts to link them to the trade and wage inequality literature.

6.1 Job Polarization

Recent work in labor economics analyzes the diverging development of different sectors of the labor market. Autor et al. (2003), Autor et al. (2006, 2008), Goldin and Katz (2007), Goos and Manning (2007), Falvay et al. (2008), and Goos et al. (2009), for example, document that employment growth has been non-monotonic across sectors in that it is positive at the low and high ends of the labor market, but negative in the middle. This employment shifts into high- and low-wage jobs at the expense of the middle is referred to as job polarization.

intensity by the number of non-production workers (NPD) relative to that of production workers (PD). The broken lines represent the averages of skill intensity within each country.

Increased trade might be a factor affecting this job polarization. In fact, Blanchard and Willmann (2011), for example, construct a model that captures the observed job polarization and then derive policy implications on the potential differential impacts of strengthening educational institutions versus trade protection. They find that targeted education subsidies are more effective than tariffs as a means to preserve middle-wage jobs, while uniform educational subsidies are less effective.

6.2 Within-group Inequality

Dew-Becker and Gordon (2005) document new findings on U.S. income inequality over 1966-2001 from Internal Revenue Service (IRS) micro data.[23] The mean real income has grown faster than the median real income. This is because half of the income gains went to the top 10 percent of the income distribution. Half of this inequality effect is attributable to the gains of the 90th percentile over the 10th percentile (between-group inequality); the other half is due to increased skewness within the top 10 percent (within-group inequality). These results cast doubt on past studies that have paid substantial attention to between-group inequality such as 90th/10th percentile ratio but little attention to within-group inequality such as inequality within the top 10 percent.

Of course, technological change would be a major source of this income distribution change. In fact, the hypothesis of skill-biased technological change is central to the labor economics literature on inequality. As Dew-Becker and Gordon (2005, 2008) argue, however, the evolution of the income distribution reflects multiple causes, not a single cause.

Thus increased trade might be also a cause. Atolia and Kurokawa (2012b), for example, formulate a simple model that can provide a unified explanation of the Dew-Becker and Gordon (2005) findings on both between- and within-group inequality. Using a numerical example, they show that under differences in the flexibility of skills, an increase in input/task variety due to technological change can be a source of these income changes. Their model also implies that trade and entry policy can also be catalysts for these income changes. Therefore, while technological change (which is similar everywhere) may increase income inequality similarly in all countries, cross-country differences in the top skewness can arise in the presence of cross-country differences in trade and entry policy. This could weaken an objection to the skill-biased technological change hypothesis. For example, Piketty and Saez (2006) object that technological changes have been similar everywhere while changes in top income shares have not.

7 Conclusion and Next Steps

This paper has primarily discussed anomalies (the gaps between the standard H-O model and the data) and their possible resolutions. It is true that the H-O model is confronted

[23] See also Dew-Becker and Gordon (2008) for a survey of several aspects of rising inequality.

with the anomalies, but the models that we have discussed in this paper are successful in resolving the anomalies, weakening the criticisms of trade-based explanations of wage inequality. An increasing number of economists now argue that the effect of trade, though relatively small compared to that of technological change, is more significant than generally believed.[24] Even Krugman (2008) argues that, due to the increase in U.S. trade with low income countries and the growing fragmentation of production, it is no longer safe to assume that the effect of trade on wage inequality is miniscule.

However, it should be noted that the result that trade can theoretically increase wage inequality is not necessarily negative. This is because Kurokawa's (2011a) model, for example, shows that the real wage of both high-skilled and low-skilled workers can rise. However, inequality increases because the former rises disproportionately more than the latter. In fact, the real wage of non-production workers has increased, and, furthermore, the real wage of production workers has slightly increased in the U.S. since the 1980s.

Finally, we suggest some additional steps for future research. A next step is to carefully monitor whether the wage effect of trade will become increasingly significant. To do so, it would be more convincing to analyze the relative influences of trade and technological change on wage inequality within a unified framework as in Feenstra and Hanson (1999), Esquivel and Rodríguez-López (2003), and Parro (2012).[25]

Another next step is to study trade and wage inequality on the new trends that we have briefly surveyed above. It would be interesting to theoretically and empirically investigate the possible effects of trade on the finer details of income distribution such as job polarization and within-group inequality.[26]

[24] For example, see Feenstra and Hanson (1996, 1999), Acemoglu (2003), Burstein and Vogel (2010), and Atolia and Kurokawa (2012a).

[25] Feenstra and Hanson (1999) find, using regression analysis, that computers explain approximately 35 percent of the increase in wage inequality in the U.S. during the period 1979-1990 while outsourcing explains approximately 15 percent. Esquivel and Rodríguez-López (2003) find, using regression analysis, that trade liberalization would have led to a reduction in the wage gap in Mexico during the period 1988-1994 but this effect was offset by the large impact of technological progress. They also find that during the period 1994-2000, the effect of trade liberalization on Mexican wage inequality was nil and thus the slight increase in wage inequality during this period was driven by technological progress. Using a general equilibrium trade model with capital-skill complementarity, Parro (2012) shows that the impacts of trade costs and technological change on the skill premium during 1990-2007 are comparable, especially in developing countries.

[26] On a different note, Caponi (2011) examines the inequality between generations of Mexican immigrants in the U.S., while Takahashi et al. (forthcoming) demonstrate the equivalence of spatial inequalities in income and in industrial location.

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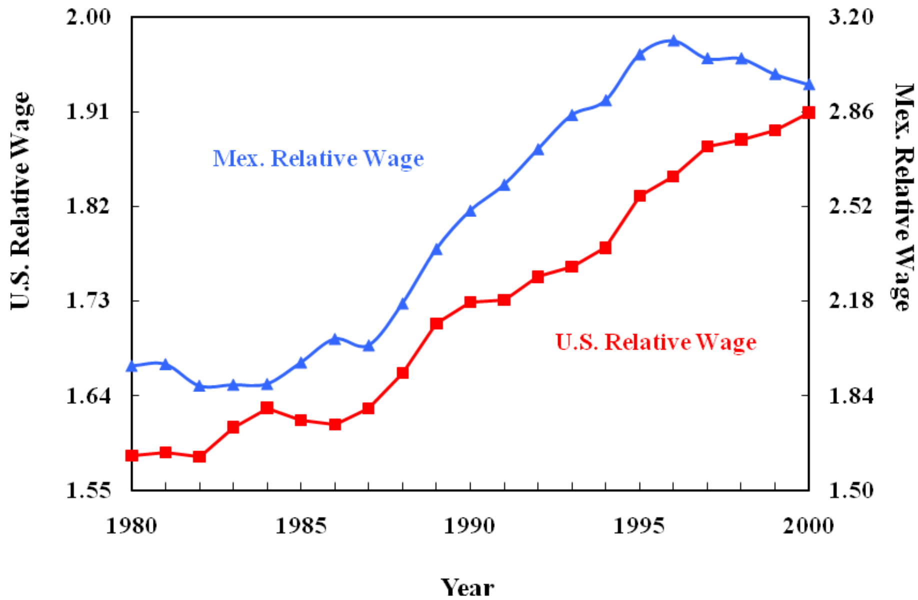

FIGURE 1. Relative Wage of High-Skilled to Low-Skilled Workers in U.S. and Mexican Manufacturing Industries, 1980-2000

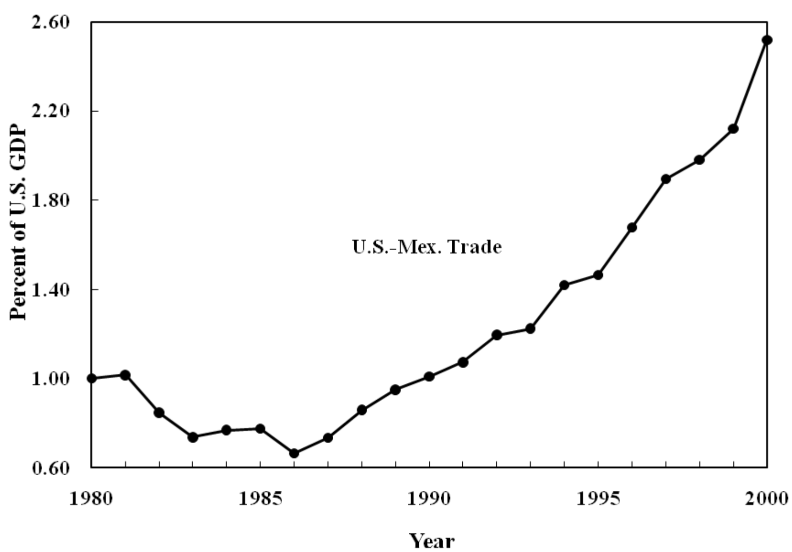

FIGURE 2. U.S.-Mexican Trade as Percent of U.S. GDP, 1980-2000

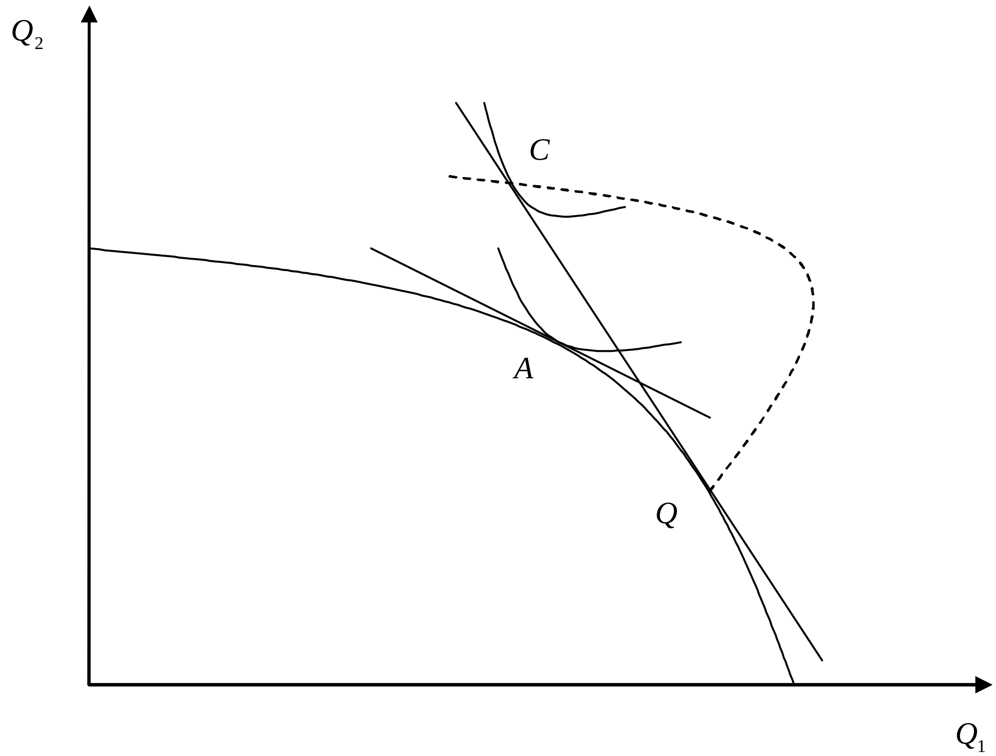

FIGURE 3. Adjustment of OECD Production and Consumption

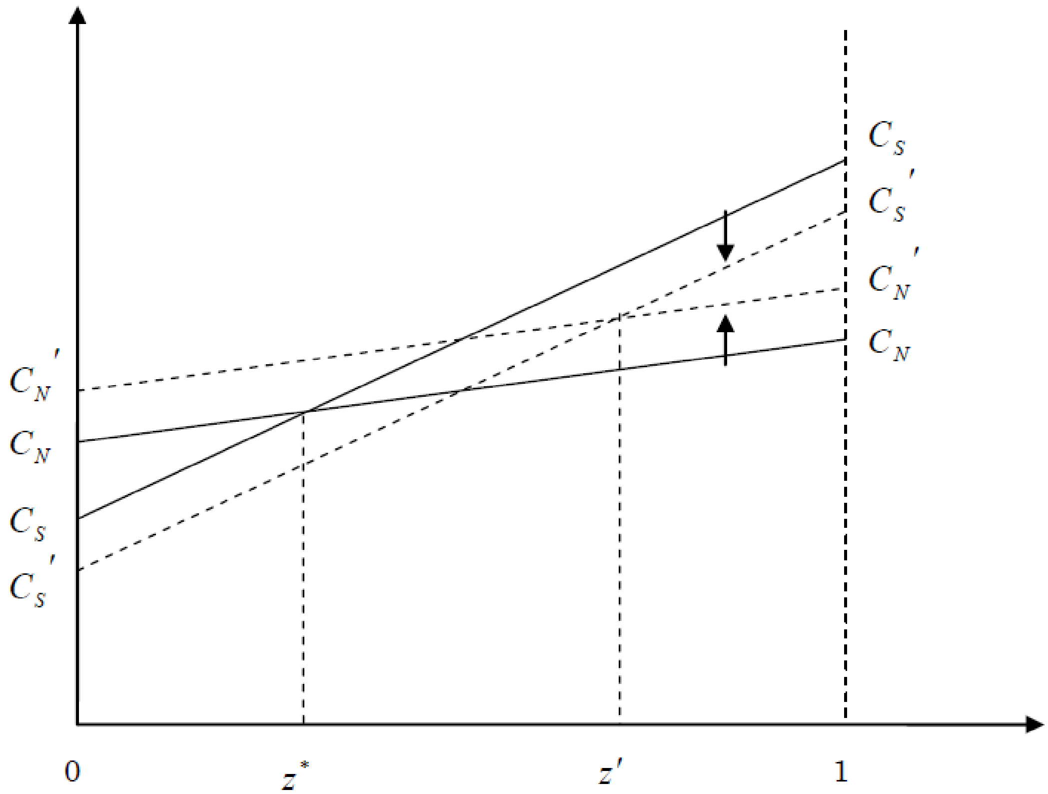

FIGURE 4. Feenstra and Hanson (1996)

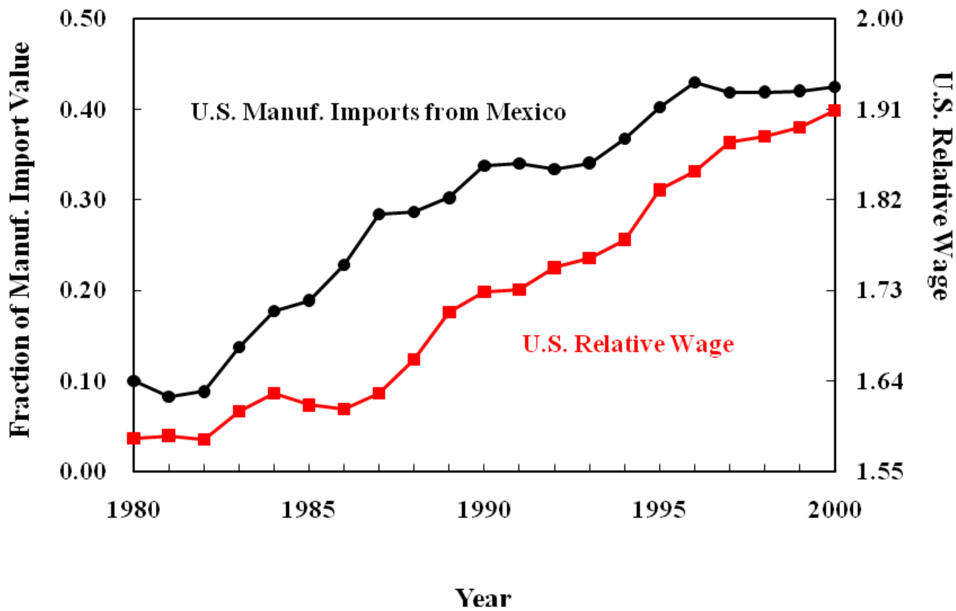

FIGURE 5. Least Traded Goods Growth: U.S. Manufacturing Imports from Mexico, 1980-2000

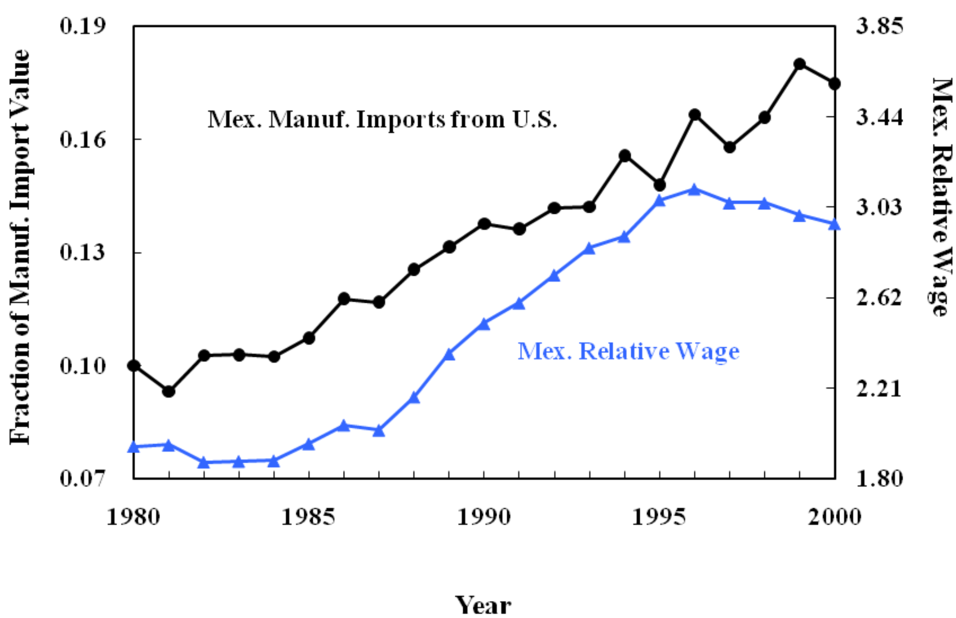

FIGURE 6. Least Traded Goods Growth: Mexican Manufacturing Imports from U.S., 1980-2000

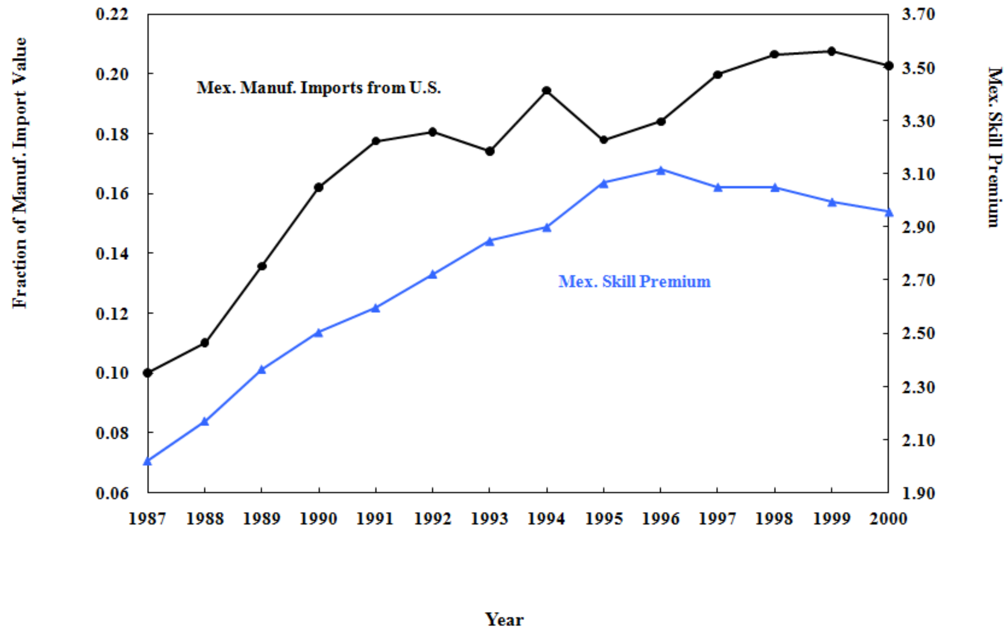

FIGURE 7. Least Traded Goods Growth in Mexican Manufactured Imports from U.S. and Mexican Skill Premium, 1987-2000

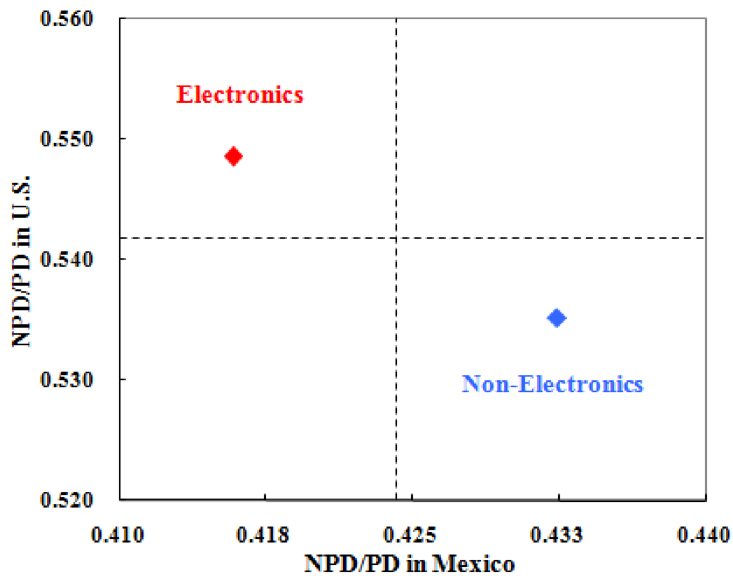

FIGURE 8. Skill Intensity in U.S. and Mexican Manufactures, 1994

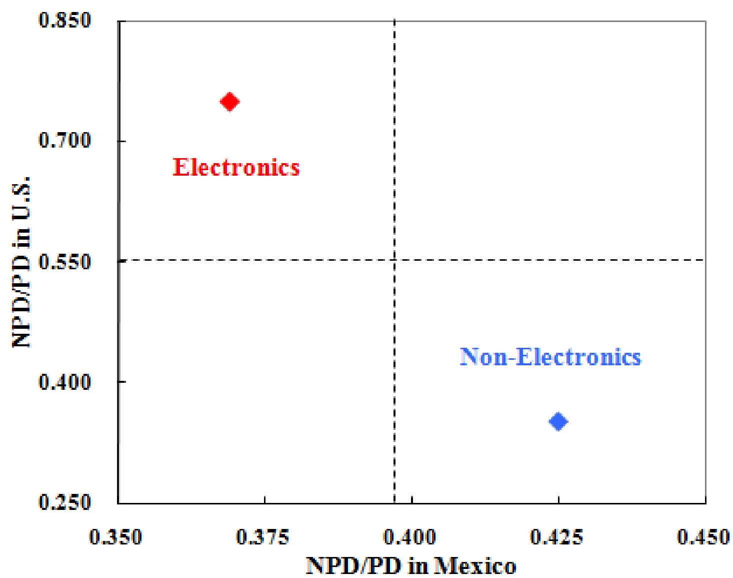

FIGURE 9. Skill Intensity in U.S. and Mexican Manufactures, 2000