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## Demand-Side Determinants of Wage Inequality

Corey Lorenzen

**ABSTRACT.** Since 1979, there has been an increasing gap in earnings between skilled and unskilled workers. Supply-side factors were shown to offset the demand shifts in the 1970's, but the supply of college graduates stabilized during the 1980's. As the wage inequality began to grow, focus turned to demand-side factors that contributed to the wage inequality. Three main factors were highlighted: changes in the industrial structure, international trade, and increased investment in technology. These factors expanded the relative demand for skilled workers, increasing the wage gap between skilled and unskilled workers. Increased educational subsidies is recommended as the best policy response.

### Introduction

Since the late 1970's there has been growing wage inequality between unskilled and skilled workers. In 1980 college graduates earned 41 percent more than high school graduates. However, in 1995 college graduates earned 62 percent more [Acemoglu, 1998, 1055]. This phenomenon can be explained with a basic supply and demand model. Demand for skilled workers has risen relative to the demand for unskilled workers, while the supply of each of these groups has stayed relatively stable. Therefore, wages for skilled workers have increased relative to those of unskilled workers.

The major effects of the wage differentials are social. Inequality in earnings may undermine the ideals of political and legal equality, and may affect public health [Burtless, 1999, 32]. Burtless [1999, 32] argues that inequality has produced wider discrepancies in political influence and legal bargaining power. In 1979, the 95th percentile of income distribution earned three times the median income, and thirteen times the income of those in the 5th percentile. In 1996, the 95th percentile made four times the median income and twenty-three times the 5th percentile [Burtless, 1999, 32]. If nothing else, increased wage inequality has contributed to Americans' dwindling confidence that elected officials care about the ordinary citizen, and has contributed to some of the apathy in the political process. As people at the high end of the income scale continue to make more than even those with a median income, people with low-to-upper middle class incomes increasingly feel they do not have a say in the political or legal system. For example, in 1960, 25 percent of Americans agreed with the statement "I don't think public officials care

much about what people like me think.” By 1996, 60 percent agreed with this statement [Burtless, 1999, 32]. On the other hand, one could argue that the conditions of public apathy towards the political and legal process are even present in people at the higher-end of the income scale. The argument presented in this paper is that as the gap in earnings among workers with the highest and lowest income grows, the power in the legal and political process becomes increasingly concentrated in the hands of a few. Therefore, wage inequality has helped contribute to the feelings of apathy in the U.S. In addition, inequality may also affect public health. According to Burtless [1999,33], “low-income Americans have death rates comparable to those in Bangladesh, one of the world’s poorest countries.” These problems with social inequality and public health should lead people to be concerned with the negative side-effects and causes of wage inequality. This paper will examine the demand-side causes of the wage inequality between skilled and unskilled workers.

## **Background**

As Levy and Murnane [1992, 1333] state, “1979 marked the beginning of a sharp acceleration in the growth of earnings inequality.” Until 1973, income inequality was generating little interest because real earnings were growing for all segments of society. In 1973, the official poverty rate was at a post-war low of 11.1 percent, and median income for 25-34 year-old men with a high school education was at a post-war high of \$24,500 [Levy and Murnane, 1992, 1341-1342]. From 1973 to 1979, the difference between the incomes of college graduates and high school graduates fell. In 1970, college graduates earned 55 percent more than high school graduates, but in 1980 this figure had fallen to 41 percent [Acemoglu, 1998, 1055]. However, by 1982, interest in the wage inequality had risen. In addition, civilian unemployment averaged 9.7 percent and manufacturing employment was 11 percent below its 1979 level [Levy and Murnane, 1992, 1346]. Also, real wages were growing very slowly during this period, so that workers were not only worse off in relative terms, but in absolute terms as well [Levy and Murnane, 1992, 1351]. As Levy and Murnane [1992, 1346] state, “the rich were getting richer and the poor were getting poorer, the type of inequality that would attract general interest.” Much of the literature of the period focused on demand side factors, most notably the loss of the middle class due to “deindustrialization.” This theory stated that labor was forced from the

manufacturing sector, where there are many jobs that pay middle class wages, into the service sector with a few high paying jobs, and many low earnings jobs [Levy and Murnane, 1992, 1347]. By 1988, most studies concluded that earnings inequality was growing and that it was being driven more by growing wage rate inequality among both men and women, than by cyclical movement in hours worked [Levy and Murnane, 1992, 1351]. Also, the studies were beginning to look at the causes of inward demand shifts, such as deindustrialization, international trade, and technology [Levy and Murnane, 1992, 1352-1353].

### **Supply-Side Effects on Wage Inequality**

Supply-side factors had a major impact in the 1970's. The number of 25-34 year old male college graduates increased by 85 percent, from 1.196 million in 1971 to 2.212 million in 1979. In comparison, 25-34 year old male high school graduates increased by 13 percent, from 4.151 million to 4.695 million. In comparison, women in the same age groups increased by 151 percent for college graduates and 66 percent for high school graduates [Levy and Murnane, 1992, 1358]. This increase in the number of college graduates was due mainly to demographics, as most of the "baby-boom" generation came of age [Kodrzycki, 1996, 13]. The dramatic increase in the supply of educated workers was the single most important factor contributing to the reduction in earnings inequality [Levy and Murnane, 1992, 1358]. In the 1980's, the influx of college educated workers slowed relative to the 1970's, boosting the returns to schooling [Kodrzycki, 1996, 13]. Between 1979 and 1987, the 25-34 year-old male college graduates labor force grew by 32 percent, compared to 40 percent for male high school graduates [Levy and Murnane, 1992, 1359]. Levy and Murnane [1992, 1359] state two reasons for the decline in the relative supply of college graduates: the decline in the returns to education in the 1970's, and a move to a volunteer army which made it unnecessary to go to college to avoid the draft. The effects of supply-side determinants had its major influence in the seventies by offsetting the effects of increased relative demand of college graduates. As Autor, Katz, and Krueger state,

...the increased rate of growth of relative demand for college graduates beginning in the 1970's did not lead to an increase in the college/high school wage differential until the 1980's because

the growth in the supply of college graduates increased even more sharply in the 1970's before returning to historical levels in the 1980's. [1998, 1169]

Hence, the supply-side determinants had a major impact on the wage inequality in the 1970's, but the overall effect that supply-side factors had on the acceleration of inequality that occurred from 1979 on was minimal.

### **Demand-Side Effects on Wage Inequality**

There are two general demand effects on wage inequality. There has been an increase in the demand for skilled workers, and a decrease in the demand for unskilled workers. Many causes of these demand shifts have been examined, such as unions, dollar exchange rates, technological changes, shifts within and between industries, and international trade. For this paper, we will focus on the three major demand effects: shifts within and between industries, international trade, and technological change.

#### **INDUSTRIAL MIX**

Two changes in the industrial mix have had an impact on wage inequality. First, there are changes "between industries." Manufacturing industries, which employ more less-educated workers, have become less important in the economy, and service industries, which employ more college graduates, have become more important [Kodrzycki, 1996, 14]. Second, changes within industries to more highly educated workers have increased the demand for skilled workers [Kodrzycki, 1996, 14]. These changes in the structure of industries will be shown to have a major impact in the demand for workers.

Changes in the importance of different industries have had a significant effect on the increased relative demand for highly skilled workers. As Kodrzycki [1996, 14] states, "19 percent of the increased demand for highly educated workers is due to the importance in the growth of service industries." The decline in the manufacturing sector has an impact on the wage inequality because this is where many of the less-educated workers have traditionally worked [Kodrzycki, 1996, 14]. Therefore, the importance of industries in the U.S. economy has shifted from a low-skilled sector to a high-skilled sector, increasing the relative

demand of highly skilled (college educated) workers. In a supply-demand model, this will result in an outward shift in the demand of skilled workers, increasing the wages of these workers relative to unskilled workers.

Higher relative demand for college educated workers versus less educated workers across all industries has had a major impact on the wages for skilled workers. As Kodrzycki [1996, 14] states, "81 percent of the increased relative demand for skilled workers can be explained by changes within industries." These "within industry" changes in demand have been correlated with industry investment in computers and research and development [Kodrzycki, 1996, 14]. Technological change has increased the value of highly skilled workers because workers are needed who can operate these new technologies. As a result, the demand of skilled workers shifts outward and results in a growing inequality between the wages of skilled and unskilled workers.

This section has showed that the industrial structure in the United States has shifted from a manufacturing sector to a service sector, and technology has changed the focus to a more skilled labor force. These two occurrences have resulted in an increase in the demand for skilled workers relative to unskilled workers. Later these shifts in the industrial structure will be shown to be a result of international trade and technological change.

#### INTERNATIONAL TRADE

Many economists argue that trade with less-developed countries has resulted in decreasing the demand for unskilled workers domestically by reducing demand for domestically manufactured goods. Freeman [1995,21] provides a good summary of the theory behind this argument. The economy of a developed country, in this case the U.S., will shift toward the production of commodities made by skilled workers. As a result, the U.S. will then import the commodities that are made by less-skilled workers from a less-developed country (LDC). This assumes that the U.S. has a high concentration of skilled workers, and the less-developed country has relatively more less-skilled workers. The result of this trade is that the demand for less-skilled labor in the U.S. and skilled labor in the LDCs falls, and their wages will be reduced. Also, the demand for skilled labor in the U.S. and unskilled labor in the LDC's increases, and their wages will increase. Therefore, trade would result in

widening wage inequality within the U.S.

There has been some debate about the impact of trade on wage inequality. However, as Wood [1995, 58] states, there are five points that most economists agree upon. First, the demand for unskilled labor has fallen relative to the demand for skilled labor in the U.S., and this has increased the wage inequality. Second, employment in manufacturing has fallen faster than expected. Third, these changes in labor markets have coincided with the rapid growth of imports from “low-skill-intensive” manufacturers from developing countries. Fourth, the other major alternative explanation to the wage inequality is technological change, since the diffusion of computers has also coincided with the growth in inequality. Finally, most empirical studies show that trade has some impact on the wage inequality. These points should lead one to believe trade has had an impact on wage inequality.

Trade is now opening up between countries as a result of many factors. First, there has been a substantial reduction in trade barriers, as seen in such international treaties as NAFTA, and GATT [Freeman, 1995, 20]. Also, developing countries have switched their development strategies to a more export-oriented trade policy [Wood, 1995, 61]. In addition, investment by developed countries in the manufacturing sectors of developing countries has helped the ability of developing countries to compete on the global market [Freeman, 1995, 20]. Diffusion of technology has also put developing countries on the same production frontier as developed countries [Freeman, 1995, 20]. Finally, as Wood [1995, 61] states, “international transport and telecommunications have become much cheaper, quicker, and of better quality.” Therefore, the growing wage inequality has coincided with the opening up of trade.

The most common indicator that is used to measure increased trade, or globalization of trade, is the ratio of exports plus imports to the gross domestic product (GDP) [Freeman, 1995, 19]. The rise in U.S. globalization can be seen by using this indicator. In 1970, this ratio was 0.11, or 11 percent of GDP. In 1990, the ratio was 0.22, or 22 percent of GDP [Freeman, 1995, 19]. In addition, the ratio of U.S. imports from less-developed countries rose from 14 percent in 1970, to 35 percent in 1990 [Freeman, 1995, 19]. These measures show that the U.S. is trading more, and a higher proportion of this trade is with developing countries. Now the question is what is the impact of this increased trade with developing countries on wage inequality. Wood [1995, 64] provides the strongest argument for the impact of trade. Wood uses factor content

analysis, which involves figuring how much skilled and unskilled labor is used in producing a country's exports, and how much would have been used to produce its imports. The difference is interpreted as the impact of trade on demand. Wood's [1995, 66] results show that the relative demand for unskilled workers is reduced by 22 percent. The demand for skilled workers is shown to increase by 0.3 percent, while the demand for unskilled workers decreased by 21.5 percent. Wood's results imply that the wage gap between skilled and unskilled workers in the U.S. has widened because the demand for skilled workers has remained fairly constant, while the demand for unskilled workers has fallen. While this contradicts Freeman's theory that as a result of international trade, domestic wages for skilled and unskilled workers will move in opposite directions, the result is still that trade causes the wage gap to widen. As Richardson [1995, 51] states, "trade is a moderate contributing source of income inequality, it may not overshadow other sources, but it cannot be shrugged away."

Several arguments have been made against the impact of trade on wage inequality. First, the manufacturing sector is relatively small, accounting for less than 20 percent of U.S. employment, which limits the number of jobs affected by trade. Also, some of the trade has been with developed countries, limiting how much U.S. wages would adjust downward for unskilled workers [Kodrzycki, 1996, 15-16]. Finally, if trade has an impact, prices of goods produced by unskilled workers domestically would be expected to fall. However, despite the criticism, the evidence previously presented is too significant to discard. Freeman [1995, 30] concludes that "trade matters, but it is neither all that matters nor the primary cause of the observed changes." This paper comes to the same conclusion, that trade does have an impact on wage inequality, but this impact is limited and other factors, like technology, can also be attributed as causes of wage inequality.

#### TECHNOLOGICAL CHANGE

The third and final demand-side determinant of wage inequality is technological change. As Kodrzycki [1996, 16] states, "there has been a general shift in demand in favor of workers with relatively high intellectual ability, opposed to manual ability." The conclusion that technology is a determinant of the wage inequality is based on the fact that the earnings gap has widened, and investment in technology across



industries appears correlated to this earnings gap. According to Kodrzycki [1996,16], industry investment in high-tech capital may be able to account for as much as 60 percent of the explained variation in the wage gap. Doms, Dunne, and Troske [1997, 259-260] explain the theory behind the technology argument quite well. The technologies they examine are “primarily used in the design and fabrication of products and the control of machinery and information on the factory floor” [Doms, Dunne, and Troske, 1997, 259-260]. These technologies increase the level of automation in the factory. Workers use the new technologies through computers, keyboards, pointing devices, and video display terminals. Therefore, workers should have at a minimum, reasonable language skills, reading skills, some math skills, and reasonable skills to run the automated capital. As a result, firms with more automated technology will employ more educated, and thus, more-skilled workers. In addition, introduction of the new technology will affect the organization of the workforce. For example, with the new technology, employees may be able to perform tasks that previously took many people to perform. Therefore, skilled workers are replacing less-skilled workers like assemblers and operators. In addition, with the increased technology, a significant skilled support staff must be employed to install and maintain the technology. Therefore, the introduction of new technologies in a firm has resulted in the replacement of less skilled workers with skilled engineers and support staff. These changes increase both the relative demand for skilled workers, and the wage inequality.

Investment in new technologies has risen over the last few decades. In 1979, computer investment per worker was around \$100. In 1992, the computer investment per worker was around \$1000 [Howell, 1995, 28]. Most of this investment has been directed toward college graduates, or skilled workers. In 1993, only 34.6 percent of high school graduates used computers, contrasted to 70.2 percent of college graduates [Acemoglu, 1998, 1076]. In addition, as the number of new technologies in a firm increase, the percent of college educated workers rises. For example, only 9.4 percent of workers in firms that use less than four technologies have college degrees. In comparison, 33.1 percent of the workers in plants with thirteen or more technologies have college degrees [Doms et al., 1997, 261]. Doms, Dunne, and Troske [1997, 263] show that more nonproduction and production workers in firms have a college education when more technology is used, and the number of workers in skilled occupations rises significantly when the number of technologies

employed by a firm increases. The percent of nonproduction workers with at least a college degree increases from 24.1 percent with four technologies used, to 53.9 percent when 13 or more technologies are used. Similarly, the percent of production workers with at least some college education increases from 21.2 percent when only four technologies are used, to 34.9 percent when more than 13 technologies are used. Their research also shows that industry-level investment in “high technology” capital goods, such as computers, is positively correlated with the educational attainment of production and nonproduction workers in the industry. Firms that have 10 or more technologies employ 11.7 percent more nonproduction workers with college degrees than firms that use zero to three technologies. In comparison, firms with more than 10 technologies employ 9.9 percent more production workers with some college education than firms with zero to three technologies. These numbers show that technological investment is on the rise, and with this increase comes an increase in the demand for workers with the skills to operate the new technology.

There are two main theories that link the increased investment in technology to the differences in wages between skilled and unskilled labor. One focus is on the complementarity between skills and firm production choices. For example, Doms, Dunne, and Troske [1997,268,281-282] argue that operations with more educated workers adopt new technologies sooner and the decision to adopt new systems then increases further the demand for skilled workers. In other words, the most technologically advanced firms paid their workers higher wages prior to adopting the new technologies, and these firms had high productivity before and after adopting the new technology. Therefore, firms with high concentrations of technology will remain at the forefront, and will continue to demand the most skilled workers. This will maintain the high wages (demand) of the skilled workers relative to the unskilled. The other argument is that the direction of technical change is determined by the size of the market for different innovations [Acemoglu, 1998, 1076]. As Acemoglu [1998, 1076] argues, with more skilled workers, the market for technologies that complement the skills of these workers is large. As a result, more technologies will be invented, and they will be complementary to skills. In other words, as the concentration of skilled workers increases, research and development will become more intense, pushing up the relative demand for skills [Machin and Van Reenen, 1998]. Therefore, wages for the skilled workers will increase relative to

that of the unskilled worker.

Two qualifications on the technological change argument need to be addressed. Some economists argue that the demand for high-skilled workers rose before computer usage became widespread, and that institutional changes explain the differences in earnings [Kodrzycki, 1996, 16]. The data identified in this paper show a correlation between firms with numerous technologies implemented and an educated workforce, which would refute this argument. However, this argument does show that other explanations for wage inequality, like international trade, are likely to exist. In addition, the argument that an increase in demand before computers became widespread did not result in the wage inequality, would back up the theory that increases in the supply of college-educated workers in the 1970's offset the increases in demand. A more general criticism is that more research is needed that looks at the impacts of specific types of technological change. The studies in this paper examine only general measures of technology. More specific studies may give a better understanding of the effects of technological change.

#### LINKS BETWEEN INDUSTRIAL MIX, INTERNATIONAL TRADE, AND TECHNOLOGICAL CHANGE

The determinants mentioned have had the largest impact on the demand for workers in the U.S., and are interconnected to have one major impact on wage inequality. The structure of the industrial mix is connected to both international trade and technological change. International trade shifts the focus of the economy "between" industries, from the manufacturing industry to the service industry, where skilled employees are concentrated. Technological change shifts the focus "within" industries to nonproduction occupations that take advantage of skilled workers. As Richardson [1995, 49] states, "Technological investment explains some of the shift toward nonproduction workers within plants, but exporting explains the shifts between plants." In addition, international trade with less-developed countries will focus the direction of technical change. If the U.S. is able to import the goods that are produced by unskilled workers, research and development can be focused in the production of goods and services that are produced by skilled workers [Acemoglu, 1998,1074]. Therefore, the effects of technological change, international trade, and the structure of the

industrial mix all contribute together to increase the demand of the skilled worker relative to the unskilled worker. As a result, demand-side factors have created an increasing gap in earnings between the skilled and unskilled worker.

### **Policies**

As stated in the introduction, inequalities in earnings may undermine the ideals of political and legal equality, and may have a negative effect on public health. Defenders of the U.S. economic and political system point out that inequality plays a crucial role in creating incentives for people to improve their situations through saving, hard work, and additional schooling [Burtless, 1999, 33]. These defenders argue that wage inequalities must widen in order for people to realize they need to save, work more, change jobs, or acquire more education. Therefore, the poor may be able to earn higher absolute earnings in a society that allows the wage gap to widen, rather than one where laws keep the wage gap very small [Burtless, 1999, 33]. However, for low-income residents of the United States this higher absolute income theory has not come true because their absolute real incomes have actually fallen. Since low-income residents are not enjoying increases in their situation, either in relative or absolute terms, policy makers are beginning to look at the social, legal, and health consequences of wage inequalities that were discussed in the introduction. As a result, policy responses need to be examined.

In almost every piece of literature cited in this paper, a section on policy responses is available. One option would be to raise trade barriers so as to protect unskilled workers. However, every piece of literature regards this as a bad idea. As Richardson [1995, 51] states, restricting trade is a bad idea because “trade is also a stimulus to growth, and the incomes of both poor and rich can rise (in absolute terms) because of it.” The other response ignore the demand-side determinants and looks at increasing the supply of skilled workers through increased education and training [Wood, 1995, 78]. However, as Wood [1995, 78] points out, this strategy will take years or even a decade or two for the results to show up. My opinion is that this is the best response because there can be little objection. I would argue these policies would need to be implemented with the youth. Few could argue against the idea that children of equal abilities should be offered the same educational opportunities. This

should be done by expanding the availability of loans, grants, and scholarships to low-income students. As Bishop [1996, 133] states,

it would not be a tragedy if a major increase in college completion rates lowered the wage premium paid business B.A.s over high school graduates to only 100 percent rather than 200 percent. Indeed competitiveness would improve and income inequality would decline.

Wood [1995, 78] argues that while we wait for these measures to be implemented, other measures are needed. Wood [1995, 78] continues that “subsidies are needed to boost the living standards of workers who take low-paying jobs, in the form of tax cuts, cash supplements to wages, and better public services.” However, subsidies to low-income people is more controversial than the idea of subsidies for education. Those against this policy would argue that over time, with the increasing returns to education, people will educate themselves on their own in order to improve their situation. Also, economists argue that subsidies will ease the situation of the unskilled worker, slowing the supply response [Wood, 1995, 78]. As a result, these subsidies are unlikely to make it through the political process. Hence, the most plausible option available would be increasing educational opportunities through increased subsidies to students. In the meantime, society has to hope that the economy will adjust for the wage gap on its own through residents seeking more education because of the increased returns to capital.

## **Conclusion**

Since 1979, there has been an increasing gap in earnings between skilled and unskilled workers. The basic explanation for the wage inequality has been that the relative demand for skilled workers has risen, while the relative supply of skilled workers has remained constant. Supply-side factors were shown to offset increased demand in the 1970’s. Therefore, the differential in earnings actually fell during this period. However, due to decreasing returns to education, and a move to a volunteer army, the supply of college graduates stabilized during the 1980’s. As the wage inequality began to grow in the eighties, focus turned to the demand-side factors that contributed to the wage inequality. Three main factors were

highlighted. International trade and technological change, and their impact on the structure of industries were shown to have the major impacts on wage inequality. These factors expanded the relative demand for skilled workers, causing the wage gap between skilled and unskilled workers to rise. The policy response that has been recommended would be increased subsidies to students wishing to further their education so each student has the same educational opportunities, no matter what their income or the income of their parents is.

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