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Decomposing the Education Wage Gap: Everything but the Kitchen Sink

Julie L. Hotchkiss
Georgia State University, julie.l.hotchkiss@atl.frb.org

Menbere Shiferaw
Federal Reserve Bank of Atlanta, menbere.shiferaw@atl.frb.org

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Julie L. Hotchkiss
Georgia State University

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Federal Reserve Bank of Atlanta

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Abstract: This paper contributes to a large literature concerned with identifying the source of the widening wage gap between high school and college graduates by providing a comprehensive, multidimensional decomposition of wages across both time and educational status. Data from a multitude of sources are brought to bear on the question of the relative importance of labor market supply and demand factors in the determination of those wage differences. The results confirm the importance of investments in and use of technology, which has been the focus of most of the previous literature, but are also able to show that demand and supply factors played very different roles in the growing wage gaps of the 1980s and 1990s.

JEL classification: J200, J310, J240

Key words: education wage gap, skill wage gap, skill-biased technological change, skill-based wage differentials

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Please address questions regarding content to Julie Hotchkiss (contact author), Research Department, Federal Reserve Bank of Atlanta, 1000 Peachtree Street, N.E., Atlanta, GA 30309-4470, 404-498-8198, julie.l.hotchkiss@atl.frb.org or Menbere Shiferaw, Research Department, Federal Reserve Bank of Atlanta, 1000 Peachtree Street, N.E., Atlanta, GA 30309-4470, 404-498-8875, menbere.shiferaw@atl.frb.org.

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I. Introduction and Background

Much attention has been given to the widely documented growth in the gap in earnings between the highly educated and the not-so-highly educated that occurred during the 1980s and 1990s. The implication of this widening gap for income inequality is a concern to some policy makers for moral, economic, and political reasons. Paul Krugman (2002) summed up the potential economic concerns in a New York Times editorial column: "...inequality in the United States has arguably reached levels where it is counterproductive. That is, you can make a case that our society would be richer if its richest members didn't get quite so much." A sample of political warnings about rising inequality is found in Kevin Phillips's book, *Wealth and Democracy*:

> "As the twenty-first century gets underway, the imbalance of wealth and democracy in the United States is unsustainable, at least by traditional yardsticks. Market theology and unelected leadership have been displacing politics and elections. Either democracy must be renewed, with politics brought back to life, or wealth is likely to cement a new and less democratic regime-plutocracy by some other name." (Phillips 2002: 421)

While the debate over whether income inequality serves as an engine of economic growth by providing powerful incentives, or whether it acts as a hindrance to economic potential (or lead to the end of democracy) rages on, it is essential to have a clear picture of the driving forces behind one of the most important culprits: earnings inequality. And since one of the single most important determinants of earnings differences across groups of workers is their education status, the goal of this paper is to provide a comprehensive, multi-dimensional investigation of the evidence as to the source(s) of the widening earnings gap across educational groups.

There is a clear consensus in the economics literature that wage inequality (and more specifically, skills wage inequality) has been increasing. Moreover, there is also agreement that the inequality is most pronounced in the upper portion of the earnings distribution (for example, see Lemieux 2006, Ginther and Rassier 2006, Autor et al. 2006). Research on this topic also agrees on the timing of changes in wage inequality. Most researchers trace the beginning of the increase in the skills wage gap to the mid-1970s (for example, see Piketty and Saez 2003). In addition, much of the literature places the blame for the growing skills wage gap on increasing returns to post-secondary education. Ingram and Neuman (2006), however, argue that years of education is a weak measure of skill in the analysis of wage distribution and that there is a lot more skill heterogeneity among workers. They find that the return to years of education remains constant after controlling for skills. However, given the high degree of correlation between education and skill and the fact that education is typically the mechanism through which one achieves a higher skill level, this paper will focus on educational wage differentials, rather than skill differentials, and will often refer to those with more education as being of higher skill, while those with less education being of lower skill.

Using the data employed for the analysis in this paper, Figure 1 illustrates how the wage gap between education groups has changed across the decades. Guvenen and Karuscu (2007) find that the overall wage inequality between college versus high school rose only modestly during the 1970s because the between-group inequality was actually falling as within-group inequality was rising. This is consistent with the means plotted in Figure 1: the gap between high school and college and the gap between college and more and less than college (between-group) fell fairly dramatically, but the gap between high school and less than high school and the gap between graduate and college (both could be considered more within-group comparisons) were rising.

[Figure 1 here]

If the labor market can be thought of as two sectors, one that employs skilled workers and one that employs less-skilled workers, the literature suggests multiple supply and demand reasons for why the earnings gap has grown. The most widely hypothesized reason for the growing skills wage gap is an increase in demand for skilled workers resulting from technological change, or skilled-biased technological change (SBTC). As industries/firms increase the adoption of computer-based technologies into their production processes, in response, for example, to the decline in the price of technology or the abundance of relatively cheap skilled labor, their demand for skilled workers increases. The "skilled worker" in this case includes those who know how to use the technology and those whose productivity is enhanced with the addition of computers. Autor et al. (2006) find that not only has computerization increased the demand of high-skilled workers (those with abstract-thinking type jobs to which computers would serve as a complement), it has also decreased the demand for intermediate-skilled workers (those with routine-task type jobs to which computers serve as substitutes). This increase in demand for skilled workers, either *ceteris paribus* or accompanied by a decline in demand for intermediate-skilled, less-educated workers, will increase the educational wage gap.

As the demand for skilled labor increases, the returns to a college education should also increase, which, in turn, should lead to an increase in the supply of educated workers, which should put downward pressure on the skill wage gap. However, the wage gap has continued to increase. Consistent with this observation, Crifo (2008) argues that the increased demand for skill among educated workers results in fewer workers with ordinary skills seeking higher education. The net result is a reduction in the supply of educated workers available to meet the growing demand, thus contributing an additional force increasing the wage gap.[1]

Card and Lemieux (2001) analyze the wage gap between college and high school graduates for younger and older men and find that the college wage gap for older workers has remained relatively stable while the gap among younger workers has risen sharply since the mid-1970s. Their explanation, also consistent with analysis in Topel (1997), is that the relative supply of young college educated workers has slowed down, while that of older workers has remained steady. Thus, because the current demand for college labor is increasing faster than the supply, inequality continues to increase. Lemieux (2006) provides additional documentation that increasing returns to post-secondary education has accounted for most of the growth in wage inequality.

SBTC as the source for the growing wage gap (especially since 1980) does have its critics (for example, Card and DiNardo 2002). The primary basis for this criticism is that although technology continued to advance dramatically through the 1990s, the growth in skill-based earnings inequality was much slower than in the 1980s. In addition, researchers have identified a number of alternative potential contributors to the growing wage gap. Some examples include declining unionization (which would result in lower wages among workers more likely to be unionized--the lower-skilled, see Card and DiNardo 2002), increased labor force participation of women (which would increase the supply of workers to traditionally lower-paying occupations, see Topel 1997), import penetration decreasing demand for workers in manufacturing (an industry that heavily employs the lower-skilled, see Brauer and Hickok 1995), shifts in immigration source countries (increasing the supply of lower-skilled workers from Latin

[1] Goldin and Katz (2008, esp. Chapter 3) also share in the view that supply of educated workers has not recently kept up with the demand.

America, see Topel 1997), and shifts in product demand which will change the composition of worker demand (see Autor et al. 2006). Piketty and Saez (2003) cite a trend in reporting stock options as wages and changing social norms regarding what is an acceptably high wage as contributors to the measured growth in the wage gap. Topel (1997) explores a number of potential supply-side contributors and finds that the weight of evidence falls on increasing returns to education for explaining the growth in earnings inequality.

This paper joins this vast literature in an attempt to contribute an even better understanding of the relative contributions of different supply and demand factors in explaining the growing earnings inequality between education levels. The contribution of the analysis in this paper includes bringing a multitude of data sources in an attempt to capture more of the variation across demand and supply factors that affect workers' wages across educational groups. As Krantz (2006) identified, many of the studies that have come before either focus on demand or supply factors. While Krantz's (2006) goal was to exhaust both supply and demand factors in the aggregate, comparing changes in the wage gap across countries, this paper's goal is to do so in an analysis at the individual worker level.

In addition, contributions of the composition of groups of workers and the way in which their characteristics translate into wages will be decomposed not only across groups, but also across time in a fairly straight-forward way in order to get directly at the question of the relative importance of different contributors to the changing wage gap. The analysis will be at an individual level, but will incorporate local labor market variations through regressors, such as immigration, mobility, and unemployment rates, at the Commuting Zone (CZ) level. The advantages of using regressors at the CZ level, as opposed to the MSA or county level, is that this area measure better characterizes the actual labor market in which a worker's wages are determined (see Autor and Dorn 2008). For example, in addition to the possibility that immigration status may affect a worker's wage, it is well known that immigrants tend to be geographically concentrated, thus capturing this labor market specific concentration, and changes in concentration, might be important in explaining wage differences across education groups.

II. Methodology and Data

The strategy that is employed to examine changes in the education wage gap over time is a straight-forward, reduced-form approach that relates numerous supply and demand factors to the measured change in the wage gap between workers with varying levels of educational attainment. The analysis is at the individual level which allows for a truly marginal analysis of the impact of the change in each of the factors on the observed change in the wage gap between two periods.

A. Methodology

The determinants of the measured wage of two education groups (A and B) are estimated in three time periods (1980, 1990, and 2000). The change in the wage gap (WG) between the two education groups between two time periods (*j* and *k*) can be expressed as:

$$WG_{A,B}^{k} - WG_{A,B}^{j} = \left[lnW_A^k - lnW_B^k\right] - \left[lnW_A^j - lnW_B^j\right] \ . \tag{1}$$

Where log wages of worker *i* in time period *t* are described as:

$$lnW_i^t = X_i^t\beta^t + Y_i^t\alpha^t + Z_i^t\delta^t + \varepsilon_i^t \ . \tag{2}$$

X_i^t is a vector of demand factors in time *t* that would be expected to affect the wage of this worker and will typically be measured at the industry, occupation, or CZ (commuting zone) level; Y_i^t is a vector of supply factors (mostly measured at the individual or CZ level); and Z_i^t is a vector of CZ institutional and other characteristics expected to affect the labor market environment in which wages are being determined.

Full descriptions of the regressors, and their expected contribution to wage determination, can be found in Table A1 of the data appendix. Worker demand regressors include characteristics that describe or are brought to the labor market by employers. Specifically, these include industry level investment in computers and computer software, individual level expected use of computers at work, industry level import penetration ratios (only in selected specifications), industry level value added, and industry and occupation CZ employment shares.

Supply regressors include characteristics that describe or are brought to the labor market by workers. Specifically, these include lagged values of immigrant penetration; demographics, such as race, gender, and marital status; human capital measures which include age and expected home computer use; an indicator for whether the CZ has at least one post-secondary institution offering a bachelor's degree; the share of the CZ workforce that is female; and lagged values of CZ population and share of the population with the worker's same level of education.

Institutional characteristics are factors not specifically brought by either the employer or worker, but yet describe the environment of the labor market. These include the degree of unionization within a worker's industry, the CZ unemployment rate, mobility of the population in a worker's CZ, and industry and occupational dummies,

The wage gap estimated for each pair of skill groups and years will be decomposed as follows:

$$\begin{aligned} WG_{A,B}^{k} - WG_{A,B}^{j} &= \left[lnW_A^k - lnW_B^k\right] - \left[lnW_A^j - lnW_B^j\right] \\ &= \left[T_A^k\Omega_A^k - T_B^k\Omega_B^k\right] - \left[T_A^j\Omega_A^j - T_B^j\Omega_B^j\right] \\ &= \Omega_A^k\left(T_A^k - T_A^j\right) + T_A^j\left(\Omega_A^k - \Omega_A^j\right) + \left[-\Omega_B^k\left(T_B^k - T_B^j\right)\right] + \left[-T_B^j\left(\Omega_B^k - \Omega_B^j\right)\right] \quad . \qquad (3) \end{aligned}$$

$T = [X\ Y\ Z]$ and $\Omega = [\beta\ \alpha\ \delta\ ]'$.[2] This decomposition is structured to determine how much of the wage gap growth between years *j* and *k* can be explained by changes in the endowments of skill-groups (e.g., use of a computer at home, import penetration, mobility) and how much can be explained by changes in how the respective labor markets value those endowments (differences in estimated coefficients across time). If a term is estimated to be positive, that difference (in college or high school graduate characteristics between the two years or in estimated valuation of those characteristics) contributes positively to the growing skill wage gap. If a term is estimated to be negative, it has the effect of reducing the measured skill wage gap.

There are four pieces to the decomposition. The first term, $\Omega_A^k\left(T_A^k - T_A^j\right)$, indicates the contribution of changes in endowments of workers in skill group *A* between years *j* and *k*. The second term, $T_A^j\left(\Omega_A^k - \Omega_A^j\right)$, indicates the contribution of the change in valuation of endowments of workers in skill group *A* between years *j* and *k* to the wage gap growth. The third term, $\left[-\Omega_B^k\left(T_B^k - T_B^j\right)\right]$, indicates the contribution of changes in endowments of workers in skill group *B* between years *j* and *k*. And, the fourth term, $\left[-T_B^j\left(\Omega_B^k - \Omega_B^j\right)\right]$, indicates the contribution of the change in valuation of endowments of workers in skill group *B*.

B. Data

The data for the wage gap analysis come from a multitude of sources. Details about data sources, as well as variable descriptions can be found in Appendix A. Major data sources include the Integrated Public Use Microdata Series (IPUMS), National Income and Product Accounts (NIPA), Department of Commerce, National Bureau of Economic Analysis (NBER), and the Current Population Survey (CPS). The main data source is the IPUMS from which

[2] Also see Wellington (1993) who uses this same decomposition to explore changes in the Male/Female wage gap.

individual level data on wages, human capital, demographics, and institutional factors were extracted. In addition to providing the individual level wage, education, and other demographic characteristics, these data also provide the CZ level characteristics included in the regression (construction of commuting zones is also described in Appendix A). CZ level characteristics are expected to capture the importance of changing local labor market characteristics in determining changes in the skills wage gap. This level of aggregation is preferred to metropolitan statistical areas (MSAs), which excludes individuals not located in a metropolitan area, and to counties, which reflect artificial geographic boundaries (see Autor and Dorn 2008).

Consistent with most of the literature that is concerned with skill wage gaps or income inequality, we make several decisions regarding top-coded (in hours or earnings) observations (for example, see Lemieux 2006). We drop all observations with reported hours top-coded at 99 hours per week; this amounts to 0.21 percent of the sample in 1980, 0.38 percent of the sample in 1990, and 0.06 percent of the sample in 2000. In addition, we drop observations from the 1980 sample if their earnings were top-coded; this was 0.30 percent of the sample. In 1990 and 2000, top-coded earnings were reported as state median (1990) or state mean (2000) values above a certain level. These observations were left in the data; 0.45 percent of the sample in 1990 and 0.75 percent of the sample in 2000 had top-coded earnings. Lastly, we dropped observations with extreme outlier observations for hourly wage. In 2000 dollars, these were observations earning less than one dollar or more than one thousand dollars per hour.

Regressors are separated into groups based on the mechanism through which they are expected to affect wages. For example, demand for more skilled workers is expected to be related to the increase in employer investment in computer hardware and software; if employment in a worker's industry represents a relatively smaller share of overall employment in the worker's local labor market, it is expected that demand for workers, thus wages, will be lower in that industry. In addition, increases in immigration to a local labor market that competes with a skill type is expected to put downward pressure on the wages of workers of that skill type. Table 1 presents sample means for the regressors used in the analysis, separated by whether the regressor is expected to capture demand, supply and institutional, or human capital and demographic influences on wages.

[Table 1 here]

Clearly, the classification of regressors as supply or demand influences is somewhat arbitrary. Generally, we classify factors that come to the labor market through the worker as supply factors and those factors that come to the labor market through the employer as demand factors. The number of observations ranges from roughly 1.5m high school graduates and 375,000 college graduates in 1980 to 1.8m high school graduates and 922,000 college graduates in 2000. The characteristics of workers, employers, and CZs have changed over time as one might have expected. For example, the amount of money firms have invested in computer hardware and software has increased almost four times and twelve times, respectively, between 1980 and 2000, with the probability of workers using computers at work has more than doubled over the time period. In addition, computer use at home has increased one and a half times; educational levels overall have increased; the share of the CZ born in Latin America has increased more than the share born in other parts of the world; the population has aged; marriage and unionization rates have declined; and the shares of workers employed in financial activities, information, leisure and hospitality, and professional and business services occupations have all increased as expected.

Recent investigations of the growth in real wages have found the greatest growth occurring in the upper portion of the earnings distribution (for example, see Guvenen and Duruscu 2007, Lemieux 2006, Ginther and Rassier 2006, Autor et al. 2006, Piketty and Saez 2003, and Topel 1997). Only Lemieux (2006) makes a direct link between the upper portion of the earnings distribution and the highest levels of education. Figures 2 and 3 plot normalized hourly wages by percentile and by education level, respectively, to compare the data being used in this analysis with that used in previous analyses. Figure 2 confirms that the most dramatic growth in wage between 1980 and 2000 (especially between 1990 and 2000) occurred in the upper portion of the earnings distribution, among workers in the 99th percentile of the wage distribution. Figure 3 illustrates how this growth across the wage distribution translates into growth across education levels. While the growth among workers with a postgraduate degree outpaced growth for workers of lower education levels, the wage gap between the highest and next highest education level (postgraduate versus college) shrunk slightly, while the gap between college grads and high school grads continued to grow through 2000.

[Figures 2 and 3 here]

III. Results

Tables 2 and 3 contain the decompositions of changes in the wage gap between college and high school graduates from 1980 to 1990 (Table 2) and from 1990 to 2000 (Table 3). Figures 4 and 5 reproduce these results graphically to more easily visualize the relative contributions of changes in endowments of each educational group, contributions of changes in how those endowments translate into wages, and how different groups of regressors (e.g., supply vs. demand) compare to each other. Appendix B contains the estimated parameter coefficients for each year and each education level.

[Tables 2 and 3 here]

[Figures 4 and 5 here]

A. Relative Contributions of Changes in Endowments and Changes in Coefficients

Considering the endowments of workers with different educational levels and how those endowments translate into wages, the relative contributions are fairly consistent across the two decades (see Figure 4). Changes in college graduates' endowments and the value placed by the labor market on high school graduates' endowments (the coefficient effect) both worked to increase the wage gap during both decades. However, changes in high school graduates' endowments and the changes in the labor market valuation of college graduates' endowments both put downward pressure on the wage gap in both decades. The implication is that, overall, both high school and college graduate workers were increasing their wage-enhancing characteristics (both individual and job-related) during both decades. The increasing endowments among college graduates, however, exceeded the increase experienced by high school graduates. As will be discussed in the next section, technology investments and increased computer use were the driving forces behind this greater endowment effect for college graduates.

The degree to which labor markets were valuing those characteristics (the coefficient effect) was declining in both labor markets, which also put opposing pressures on the wage gap. The decline in valuation was greater among college graduates, particularly in the 1990s, which helps to explain the slowdown in the growth of the wage gap during that decade. As will be discussed in more detail in the next section, the driving force behind this large negative coefficient effect in the 1990s among college graduates was the significant decline in labor market return to occupational employment share.

B. Relative Contributions of Demand, Supply, and Institutional Factors

Figure 5 graphically illustrates the relative contributions of demand and supply factors in the changing wage gap between high school and college graduates across the 1980s and 1990s. There are some striking differences across the two decades. But first, the significant contribution of unexplained factors in the determination of wage gap across both decades is apparent through the size of the contribution of the constant term. An important potential component of the constant term is the change in the quality of a college and high school graduate over time. Hendricks and Schoellman (2009) present evidence that a fair amount of the growth in the college wage premium can be attributed to the growth in the relative ability or "quality" of college graduates compared to high school graduates. Such a change in quality is unmeasured and will, thus, be captured only by the constant term.

Of arguably greater interest here than the role of unmeasurables, however, is the completely opposite effect changes in supply, demand, and institutional factors have had on the wage gap determination across the two decades. During the 1980s, demand and institutional factors acted to increase the wage gap, while supply factors, as a whole, put downward pressure on the wage gap. The opposite was true for the 1990s -- supply factors increased the wage gap, while demand and institutional factors worked to decrease it. The most dramatic reversal was among demand factors. Tables 2 and 3 provide details of the relative contributions.

Demand Factors. Consistent with the SBTC literature, the largest single contributor to the wage-gap-enhancing change in college graduates' endowments was the investment by their employers in technology and their use of computers at work, both in the 1980s and the 1990s.[3] At the same time, employers of high school graduates were investing in technology and those workers were also increasingly likely to use computers at work, but these changes were not nearly large enough to offset the growth along this dimension among college graduates, particularly in the 1990s. During the 1990s, however, the change in the use of computers at home (a supply factor) by high school graduates was the single largest contributing endowment factor putting downward pressure on the wage gap (-0.1240). And this downward pressure slightly exceeded the upward pressure of the growing use of home computers by college graduates (0.1118). Perhaps this reflects a catching up of computer use human capital by high school graduates, especially since the contribution of home computer use by high school graduates was essentially non-existent in the 1980s.

Nonetheless, like Krueger (1993), we find that computer use at work is rewarded more than computer use at home. For college graduates, a ten percentage point increase in the probability of using a computer at work translated into a three percent, seven percent, and nine percent increase in wages in 1980, 1990, and 2000, respectively (see estimation results in Appendix B). Analogous rewards were five percent, six percent, and three percent among high school graduates. These relative valuations of computer use at work (along with the returns workers experiences from their employer's technology investments) explains why the coefficient effect for technology demand factors are positive for both high school and college graduates in both decades, and illustrates what others have found -- it was not only the increased use of technology among college graduates that translated into faster wage growth, but also the greater

[3] Like Autor, et al. (2003), we measure employers' investments in technology as the total spent on all computer and peripheral equipment and software. Even if new devices were introduced between the 1980s and 1990s, this aggregated measure should be reflective of total investment.

translation of that technology investment and use into higher wages (for college graduates) that expanded the wage gap.

The boost to the wage gap from increased technology use and investment between 1980 and 1990 (0.2486) was almost completely offset by downward pressure imposed by changing occupational demand (-0.2340). Between 1990 and 2000, this downward pressure of changing occupational demand is three times larger than the continued upward pressure on the wage gap imposed by changing technology investment and use. This accounts for the bulk of the flip between the 1980s and 1990s in the direction of contribution of demand factors. Like Autor, et al. (2006), we measure occupational demand as the share of employment accounted for by each occupation. Generally, the empirical results presented here are consistent with the theoretical conclusions drawn by Autor, et al. (2006) that market forces likely played an important role in the determination of the wage gap, especially during the 1990s. The downward pressure on the wage gap of changing occupational demand between 1990 and 2000 came from the reduced rewards to being employed in occupations dominated by college graduates (even more so than during the 1980s), and the increased rewards to being employed in occupations dominated by high school graduates. While the share of jobs populated by high school and college graduates did not substantially change between 1990 and 2000, the labor market rewards of being in those occupations did, *ceteris paribus*. Specifically, a one percentage point increase in the CZ share of employment in a worker's occupation increased wages among high school graduates by 0.05 percent in 1990, but by 0.53 percent in 2000, thus the relatively large negative coefficient effect in the Occupational Demand category in Table 3 (-0.3927). At the same time, the analogous coefficient among college graduates decreased from 0.17 to -0.51, putting further downward pressure on the wage gap (-0.5857).

Autor, et al. (2003) conclude that technological change caused relative demand shifts favoring educated labor (also see Katz and Murphy 1992). The results from the analysis in this paper suggest that the rewards to that shift in demand toward educated labor were primarily flowing to college graduates through the increased use of and investment by employers in technology. This is consistent with Autor et al.'s (2003) conclusions that technological change caused, rather than reflected, the demand shift toward educated labor (this is seen here as evident in both the 1980s and 1990s).

Alternatively, the growing rewards to high school graduates through increasing occupational share in the 1990s (as opposed to primarily through technological change) is consistent with Autor, et al.'s (2006) evidence for a polarization of the labor market in the 1990s; the marginal productivity of manual task input (supplied by less-educated workers) is complementary with a rise in routine task input (supplied primarily by lower cost computer capital). There is very little evidence here of this effect in the 1980s, which is, again, consistent with Autor, et al.'s (2006) monotonic shift in occupational demand during that decade.

The relatively innocuous impact of the changing industrial employment share is consistent with the findings of Wheeler (2005) and Katz and Murphy (1992) who found that rising inequality within industries to be more important than rising inequality between industries in explaining the growing education gap in both decades.

Supply Factors. During the 1980's, supply factors, as a whole, put a downward pressure on the wage gap. The most significant driver of the change during the 1980s in the contribution of supply factors to the growing educational wage gap was the valuation of demographics (-0.3137), most notably the valuation of age among college graduates (-0.2476). Between 1980 and 1990, the oldest of the baby boomers were entering their forties, with the youngest baby boomers graduating from college and entering their twenties. In addition, a greater and greater number of workers were entering the work force with a college degree (although at a decreasing rate; see Card and Lemieux 2001). The net result, it appears, was earlier college educated boomers facing a significant amount of competition as the younger of their cohort began graduating from college, putting downward pressure on college wages, thus the wage gap.

The largest supply factor contributing to the wage gap change during the 1990s was computer use at home (0.1438). Even though high school graduates increased their use slightly more than college graduates during this decade, the increased use had a much larger boost to college graduate wages (0.3045 of the wage gap change) than it did to high school graduate wages (-0.1485 of the wage gap change), making for a net positive contribution to the wage gap. This may be because high school graduates were increasingly less likely to apply their newly acquired computer skills on the job. This accounts for the bulk of the flip between the 1980s and 1990s in the direction of contribution of supply factors.

Another significant supply factor change is found in the lagged share of the worker's CZ with the same education level.[4] Changes in this factor were relatively unimportant in the 1980s, but contributed a relatively significant share to the wage gap growth in the 1990s. Changes in both the endowment and coefficient effects related to this factor contributed to its sizable contribution. First, college educated workers became more geographically concentrated and high school graduates became less geographically concentrated (changes in endowments). Second, being located in a CZ with a large share of workers with the same skill level was increasingly a bonus for college graduates, but became a penalty for high school graduates -- a continuation of the decline in return to this characteristic that was also seen between 1980 and

[4] Details that follow relating to the categories of "Other Supply" and "Institutional Factors" are not reported individually in Table 2 and 3, but can be easily constructed using the means in Table 1 and the parameter estimates found in Appendix B.

1990. This result is consistent with the finding of others that once a workforce has a large enough concentration of high-skilled workers, the workers themselves benefit from the rents generated by skill complementarities (Giannetti 2001 and Hotchkiss et al. 2008). This finding also suggests that the supply effects found at an aggregate level by Card and Lemieux (2001) (less supply of college educated workers boosted their wages) do not necessarily trickle down to the individual level; an individual college graduate captures rents from locating in a labor market with others of the same education level, *ceteris paribus*.

While Topel (1997) found that the percent of the labor force that is female did not have much impact on growing wage inequality, decomposing that supply factor into endowment and coefficient effects highlights a notable shift from the 1980s to the 1990s. Between 1980 and 1990, the coefficients on the share of the workforce that is female changed from negative (more females in the labor force put downward pressure on wages) to positive. This had the effect of pushing up both college and high school graduate average wages (making the college graduate coefficient effect for this regressor positive and the high school graduate coefficient effect negative). In contrast, between 1990 and 2000, the coefficients on the percent of the CZ labor force that is female declined for both the college and high school graduates, making the impact of the change just the opposite of what was seen during the previous decade. Much has been made of highly educated women "opting out" of the labor force during the 1990s (Hotchkiss et al., 2010). If this took the form of women working fewer hours or in jobs requiring less skill, this opt out phenomenon could be contributing to the dramatic downward pressure on the wage gap from percent of the CZ labor force that is female.

Topel (1997) also investigated and found that immigration was not particularly important for explaining growing wage inequality during the 1980s. We also found this to be the case for both the 1980s and the 1990s, likely because of the small fraction of the workforce made up by immigrants.

Institutional Factors. Changes in factors that we categorize as institutional increased the wage gap between 1980 and 1990, but worked to decrease the wage gap during the 1990s. Institutional factors are those characteristics that define the labor market, rather than being brought to the labor market as characteristics of the employer or worker. Card and DiNardo (2002) point to declining unionization as a major contributor to the growing wage gap between educational groups. However, in addition to being a relatively minor contributor in this analysis, controlling for other wage determining factors at the individual level results in changes in unionization and changes in the return to unionization, overall, actually putting *downward* pressure on the wage gap during both decades, although the impact of that downward pressure was much smaller in the 1990s.

Changes in mobility worked in the favor of high school graduate wages in the 1990s, but barely had any impact on the changing wage gap in the 1980s. In 1990, there appears to have been a wage penalty for working in a CZ with high levels of mobility, for both college and high school graduates, although the penalty was greater among college graduates. In 2000, that penalty became larger for college graduates, but became a bonus for high school graduates, thus the fairly significant downward pressure on the wage gap from that piece of the decomposition. It was also in 2000 that the return to being employed in an occupation with a high employment share increased significantly for high school graduates. The increasing return to mobility may be reflecting a degree of flexibility among high school graduates that allowed them to take advantage of increased demand for the occupations in which they are employed.

One might expect that in CZs where there is a lot of slack labor, we would also observe lower average wages. The positive coefficient on the unemployment rate, however, are consistent with the presence of sticky wages (for example, see Gottschalk 2004). For any given equilibrium level of wages (characterized by all of the other regressors included in the estimation), the higher the unemployment rate, the higher the observed wage in that labor market is likely to be (the higher the observed wage is above the equilibrium wage). This is not an estimated causal relationship between unemployment and the wage level, but, rather, merely a cross-sectional correlation holding all other labor market characteristics constant. The result does not invalidate the frequently replicated negative relationship between wage growth and the unemployment rate (e.g., see Aaronson and Sullivan 2001).

IV. Sensitivity Analysis

One of the main points of the analysis contained in this paper is that focusing just on one potential contributor to the change in the education wage gap over time runs the risk of biasing the conclusions. The purpose of this section of the paper is to illustrate just how sensitive the decomposition is to exclusions of various regressors. Three alternative specifications are estimated: (1) excluding the industry and occupation dummy variables; (2) excluding the technology demand variables; and (3) excluding all CZ-level regressors. The main impacts of the specification changes were similar across years, so they will be discussed in general terms.

With only one exception, none of the different specifications altered the relative contributions of the endowment and coefficient effects. Although the different parts of the decomposition differed in size from the base specification, the relative contributions reflected in Figure 4 remained unchanged. The exception was the relative contributions of endowments and coefficients to the observed change in the wage gap between 1990 and 2000 when CZ level variables are excluded from the analysis. The overwhelming source of the difference is the increase in the unexplained portion of the valuation of endowments among college graduates when CZ level variables are excluded -- as reflected in the estimate of the intercept term.

Removing the industry and occupation dummy variables primarily affected the contribution of the industry and occupation CZ employment shares. This change in contribution manifested itself through an increase in the relative contribution of CZ occupation employment share to a growing wage gap. And this, in turn, operated through a reduction in the measured growing advantage high school graduates enjoyed over college graduates in demand for the occupations in which they were employed. This pattern of change was the same across both decades. The implication is that excluding occupation and industry fixed effects would have resulted in underestimating the complimentary role that demand for high school graduate skills (as measured by demand for occupational shares of high school grads) played as the demand for technological skills increased.

The motivation for removing the technology demand factors was to see which other factors would take up the slack of this dominant influence on the change in the wage gap. The primary effect of removing technology demand factors was an increase in the relative contribution of supply factors to the growing wage gap. This occurred primarily through an increased contribution of technology supply.

Excluding CZ-level regressors had a differential effect in the 1980s and 1990s. In the absence of CZ regressors in the 1980s, the contribution of demand factors to the wage gap increase was reduced significantly, primarily through the importance of industry and occupation employment shares. In the 1990s, the contribution of supply factors to the wage gap increase was significantly reduced, mainly through the valuation of home computer use. The increase in the contribution of the intercept was largest in this specification, across both decades.

For the most part, with the exception of excluding CZ-level regressors, the relative contributions of endowment and coefficient effects do not change across different specifications. However, the relative contributions of supply and demand factors do change in fairly significant ways. Of course, those changes are partially dependent on the categorization of regressors into supply and demand influences, but once there is agreement on that point, it's clearly important to include as many measures as possible of potential influence. It is particularly important to include measures of geographic differences across education groups and time when trying to identify sources in the changing wage gap.[5]

V. Summary and Implications

The analysis in this paper provides a thorough and exhaustive reduced-form investigation of the relative contributions of supply and demand factors to the growing wage gap between high school and college graduates during the 1980s and the 1990s. Most importantly, the analysis is able to identify the mechanism through which technological change boosted wages of both groups of workers in each decade. Specifically, wage gains from increased demand for college graduates, in both decades, flowed through their increased use of technology (and technological investments by their employers), rather than from merely an increase in demand for educated workers. However, the main rewards from technology to high school graduates flowed through increased demand for their particular skills (which are theorized to be complementary to technological advancements), rather than through the use of technology itself. These results

[5] Others have documented the importance of geography on wage differences and wage growth. For example, see Bartik (1991), Dumond et al. (1999), Hirsch (2005), Easton (2006), Hirsch et al. (2009), and Black et al. (2009).

provide empirical evidence in support of the theoretical arguments of Autor et al. (2006) that the labor market of the 1990s experienced a polarization; the marginal productivity of manual task input (supplied by less-educated workers) is complementary with a rise in routine task input (primarily by lower cost computer capital).

In general, the results are mostly consistent with what is found in the previous literature, however the individual level analysis in this paper provides an advantage over some aggregate analyses. For example, whereas Card and Lemieux (2001) found that reduced aggregate supply boosted wages of college graduates, the results here indicate that the marginal effect of a *growing* concentration of college graduates (increased supply in a geographic area) had an increasingly positive impact on college wages over the two decades, consistent with evidence of rents generated by skill complementarities (Giannetti 2001).

The analysis also demonstrated that supply and demand wage determining factors had opposite effects in growing the wage gap during the 1980s and 1990s, however changes in endowments of workers with college degrees were largely responsible for the increasing wage gap in both decades. Consistent with the SBTC literature, increased investments in technology and computer use by workers (both college and high school graduates) was the single largest contributing endowment change that impacted the wage gap across both decades, even after controlling for as many other demand, supply, and institutional factors as possible.

Besides contributing to our overall understanding of the dynamics of the wage gap between workers of different education levels during the 1980s and 1990s and the roles that supply and demand factors in each decade played in the determination of the wage gap, the analysis in this paper provides an even more general lesson. Focusing on only one factor in a complicated market process runs the risk of losing perspective of that factor's relative importance in the determination process or missing the impact of that factor's interaction with other market forces. The sensitivity analysis demonstrated the importance of including as many measures as possible of potential influence when trying to identify sources in the changing wage gap, particularly measures of geographic differences across education groups.

References

Aaronson, Daniel and Daniel Sullivan. "Cross-state Evidence on the Reltionship between Unemployment and Wage Growth." *Chicago Fed Letter* 165 (May 2001).

Autor, David. and David Dorn. "Inequality and Specialization: The Growth of Low-Skill Service Jobs in the United States." *Mimeo*, Department of Economics, Massachusetts Institute of Technology (20 July 2008).

Autor, David H.; Lawrence F. Katz; and Melissa S. Kearney. "The Polarization of the U.S. Labor Market." *NBER Working Paper #11986* (January 2006).

Autor, David H.; Frank Levy; and Richard J. Murnane. "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics* 118(4) (November 2003): 1279-1333.

Bartik, Timothy J. *Who benefits from State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute (1991).Brauer, DA and S. Hickok. "Explaining the growing inequality in wages across skill levels". *Economic Policy Review* (January 1995), 61:75.

Black, Dan; Natalia Kolesnikova; and Lowell Taylor. "Earnings Functions When Wages and Prices Vary by Location." *Journal of Labor Economics* 27(1) (January 2009): 21-47.

Card, David and Thomas Lemieux. "Can Falling Supply Explain the Rising Return to College for Younger men? A Cohort-based Analysis." *Quarterly Journal of Economics* 116 (May 2001): 705-46.

Card, David and John E. DiNardo. "Skill-based Technological Change and Rising Wage Inequality: Some Problems and Puzzles." *Journal of Labor Economics* 20 (October 2002): 733-83.

Crifo, Patricia. "Skill Supply and Biased Technical Change." *Labour Economics* 15 (2008): 812-30.

Dumond, J. Michael; Barry T. Hirsch; and David A. Macpherson. "Wage Differentials across Labor Markets and Worekrs: Does Cost of Living Matter?" *Economic Inquiry* 37(4) (1999): 577-98.

Easton, Todd. "Metropolitan Wage Levels of Less-Educated Workers: 1986-1999." *Industrial Relations* 45 (2) (April 2006): 119-46.

Giannetti, Marissunta. "Skill Complementarities and Migration Decisions." *Labour* 15 (2001): 1-31.

Ginther, Donna K. and Dylan G. Rassier. "Do Specific Skills Expalin Inequality at the Top of the Wage Distribution." *Mimeo* Department of Economics, University of Kansas (27 April 2006).

Goldin, Claudia and Lawrence F. Katz. *The Race Between Education and Technology*. Cambridge, MA: Harvard University Press, 2008.

Gottschalk, Peter. "Downward Nominal Wage Flexibility: Real or Measurement Error?" *IZA Discussion Paper* No. 1327 (October 2004).

Guvenen, Fatih and Burhanettin Karuscu. "A Quantitative Analysis of the Evolution of the U.S. Wage Distribution: 1970-2000." *Mimeo*, Department of Economics, University of Texas at Austin (September 2007).

Hendricks, Lutz and Todd Schoellman. "Student Abilities During the Expansion of U.S. Education, 1950-2000." *Mimeo*, Department of Economics, University of North Carolina, Chapel Hill (4 February 2009).

Hirsch, Barry T. "Why do Part-time Workers Earn Less? The Role of Worker and Job Skills." *Industrial and Labor Relations Review* 58(4) (July2005): 525-51.

Hirsch, Boris; Marion Keonig; and Joachim Moeller. "Is There a Gap in the Gap? Regional Differences in the Gender pay Gap." *IZA Discussion Paper No. 4231*(2009).

Hotchkiss, Julie L.; M. Melinda Pitts; and John C. Robertson. "The Push-pull Effects of the Information Technology Boom and Bust: Insight from Matched Employer-employee Data." *Economic Development Quarterly* 22(3) (August 2008): 200-12.

Hotchkiss, Julie L.; M. Melinda Pitts; and Mary Beth Walker. "Assessing the Impact of Education and Marriage on Labor Market Exit Decisions of Women." *Federal Reserve Bank of Atlanta Working Paper #2010-XX (January 2010).*

Ingram, Beth and George R. Neumann. "The Returns to Skill." *Labour Economics* 13 (2006): 35-59.

Jann, Ben. "A Stata Implementation of the Blinder-Oaxaca Decomposition." *Mimeo* (May 2008).

Katz , Lawrence and Kevin Murphy. Changes in Relative Wages, 1963-1987: Supply and Demand Factors", *The Quarterly Journal of Economics*, Vol. 107 No. 1 (February 1992): 35-78.

Kranz, Daniel Fernandez. "Why has wage inequality increased more in the USA than in Europe? An empirical investigation of the demand and supply of skill". *Applied Economics,* Vol. 37 *(2006): 771-788.*

Kueger, Alan B. “How Computers Have Changed the Wage Structure: Evidence from Microdata: 1984-1989”. *The Quarterly Journal of Economics,* Vol. 108, No. 1 (February 1993): 33-60.

Krugman, Paul. "For Richer." *New York Times* (nytimes.com). <http://www.nytimes.com/2002/10/20/magazine/20INEQUALITY.html?ex=1178769600&en=871bdfc17e98714c&ei=5070>, accessed 8 May 2007 (20 October 2002).

Lemieux, Thomas. "Post-Secondary Education and Increasing Wage Inequality." *NBER Working Paper #12077* (March 2006).

Oehlert, Gary W. "A Note on the Delta Method." *American Statistician* 46 (1992): 27-9.

Phillips, Kevin. *Wealth and Democracy: A Political History of the American Rich*. New York: Broadway Books, 2002.

Phillips, P.C.B. and Joon Y Park. "On the Formulation of Wald Tests of Nonlinear Restrictions." *Econometrica* 56(5) (September 1988): 1065-83.

Piketty, Thomas and Emmanuel Saez. "Income Inequality in the United States, 1913-1998." *Quarterly Journal of Economics* 68 (February 2003): 1-39.

Topel, Robert. “Factor Proportions and Relative Wages: The Supply-Side Determinants of Wage Inequality”. *Journal of Economic perspectives.* Vol. 11, (Spring 1997): 55-74.

Wellington, Alison J. "Changes in the Male/Female Wage Gap, 1976-1985." *Journal of Human Resources* 29(2) (Spring 1993): 383-411.

Wheeler, Christopher. “Evidence on Wage inequality, Worker Education, and Technology”, *Federal Reserve Bank of St. Louis Review,* Vol. 87, No. 3 (May/June 2005): 375-93.

Figure 1. Education wage gap over time.

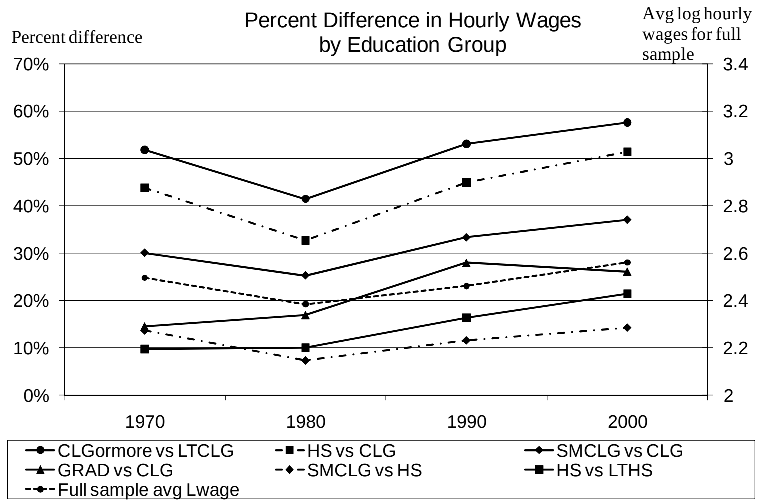


Figure 2. Indexed hourly wages across worker percentiles.

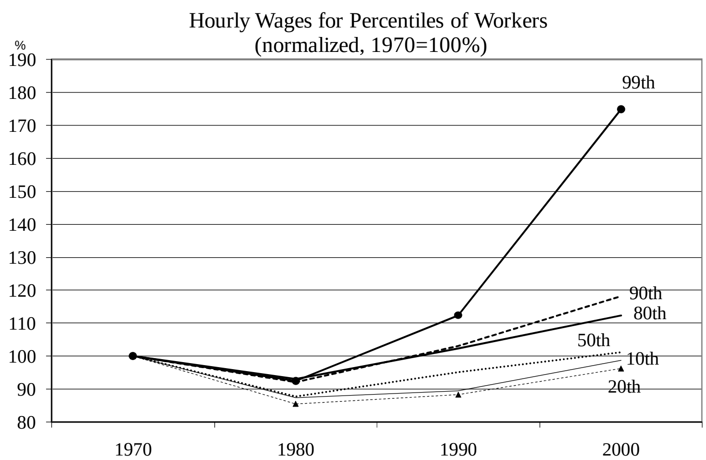


Figure 3. Indexed hourly wages across education levels.

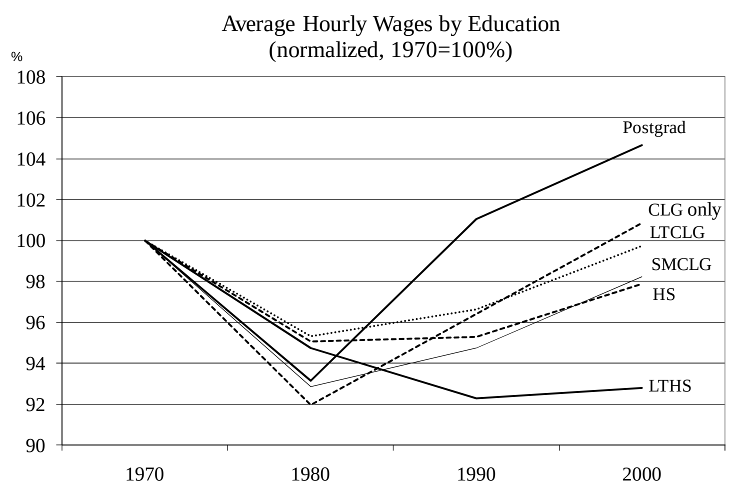


Figure 4. Relative contributions of changes in endowments and changes in valuation of endowments to the changing wage gap between high school and college graduates.

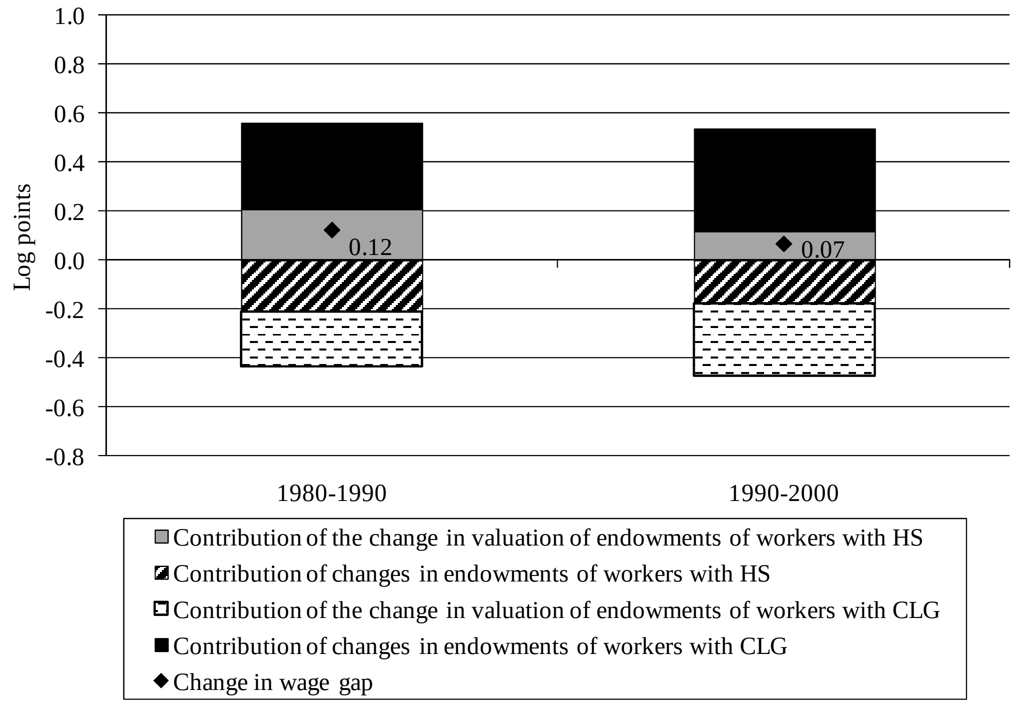


Figure 5. Relative contributions of changes in supply and demand (and other) factors to the changing wage gap between high school and college graduates.

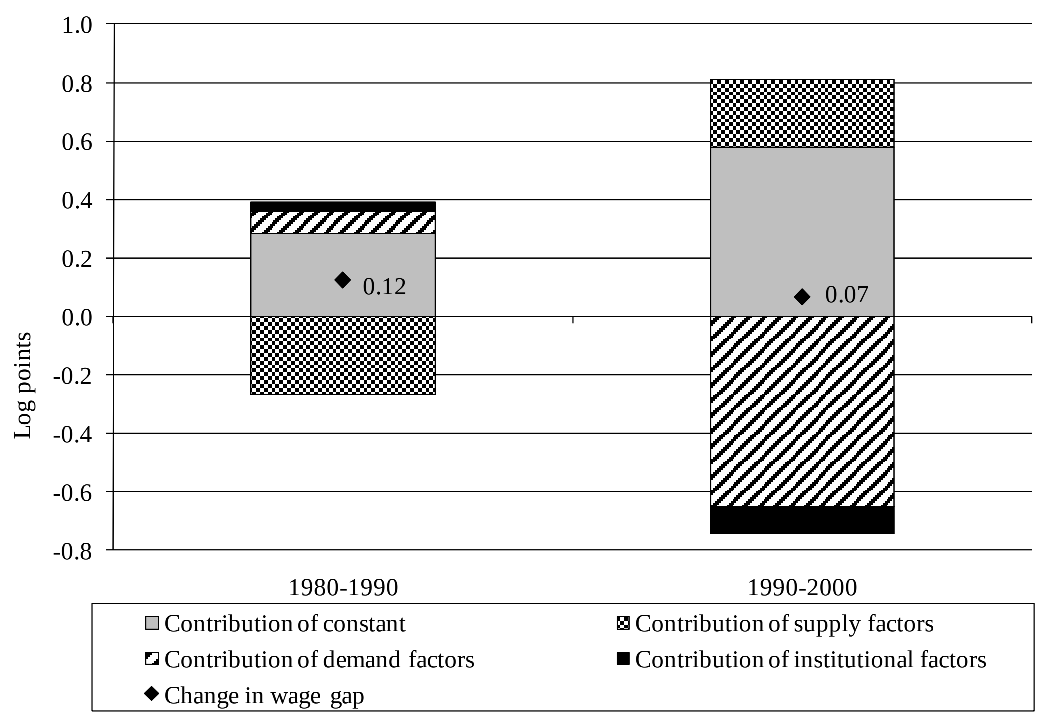


Table 1. Sample means by year.

Regressors	1970	1980	1990	2000
Demand Factors				
computer investment (billions $)	0.193 (0.221)	0.529 (0.639)	1.082 (1.252)	2.000 (2.650)
software investment (billions $)	0.126 (0.147)	0.291 (0.320)	1.065 (0.994)	3.456 (3.399)
prob. of computer use at work	--	0.228 (0.138)	0.378 (0.180)	0.513 (0.206)
import penetration	0.569 (0.363)	0.367 (1.107)	0.119 (0.225)	0.271 (0.804)
industry value added (trillions $)	0.193 (0.114)	0.159 (0.140)	(0.207) (0.180)	(0.280) (0.231)
industry empl share	0.783 (0.069)	0.811 (0.056)	0.829 (0.047)	0.813 (0.049)
occupation empl share	0.784 (0.081)	0.813 (0.061)	0.831 (0.053)	0.816 (0.054)
Supply Factors				
prob. of computer use at home	--	0.523 (0.166)	0.566 (0.147)	0.809 (0.096)
female share of cz's labor force	0.381 (0.023)	0.427 (0.019)	0.454 (0.015)	0.466 (0.013)
share of cz with less than hs degree	0.383 (0.077)	0.261 (0.067)	0.163 (0.054)	0.133 (0.047)
share of cz with hs degree	0.367 (0.050)	0.391 (0.052)	0.349 (0.060)	0.323 (0.061)
share of cz with clg degree	0.068 (0.016)	0.089 (0.020)	0.135 (0.038)	0.157 (0.043)
share of cz with postgraduate degree	0.047 (0.016)	0.073 (0.024)	0.067 (0.024)	0.081 (0.030)
share of cz born in North Am. (excluded)	0.939 (0.056)	0.921 (0.077)	0.897 (0.107)	0.857 (0.127)
share of cz born in Latin Am. or Caribb.	0.013 (0.018)	0.027 (0.043)	0.043 (0.066)	0.071 (0.080)
share of cz born in Europe or Asia	0.038 (0.030)	0.040 (0.031)	0.047 (0.040)	0.061 (0.052)
share of cz born in other non-North Am. country	0.010 (0.017)	0.013 (0.016)	0.013 (0.016)	0.011 (0.012)
presence of university or college in cz = 1	0.998	0.982	0.968	0.961

	(0.044)	(0.133)	(0.177)	(0.193)
Demographics				
age	38.84 (12.92)	36.22 (12.85)	37.58 (11.94)	39.27 (12.17)
female = 1	0.384 (0.486)	0.446 (0.497)	0.459 (0.498)	0.491 (0.500)
white (excluded) = 1	0.892 (0.310)	0.873 (0.333)	0.879 (0.326)	0.783 (0.412)
black = 1	0.095 (0.293)	0.101 (0.301)	0.087 (0.281)	0.097 (0.296)
asian = 1	0.009 (0.096)	0.018 (0.135)	0.026 (0.159)	0.038 (0.190)
other race = 1	0.003 (0.059)	0.008 (0.091)	0.008 (0.090)	0.082 (0.274)
hispanic = 1	0.037 (0.189)	0.063 (0.242)	0.077 (0.267)	0.113 (0.317)
married w/ spouse = 1	0.720 (0.449)	0.622 (0.485)	0.613 (0.487)	0.576 (0.494)
Institutional Factors				
cz unemployment rate	0.040 (0.014)	0.061 (0.020)	0.059 (0.016)	0.050 (0.015)
% of workers covered by union in industry	0.230 (0.172)	0.201 (0.148)	0.160 (0.128)	0.119 (0.119)
mobility rate of cz population	0.103 (0.051)	0.120 (0.060)	0.122 (0.054)	0.124 (0.051)
Industries 1-12				
Natural Resources & Mining	0.026 (0.158)	0.030 (0.171)	0.030 (0.170)	0.025 (0.156)
Construction	0.060 (0.238)	0.066 (0.248)	0.077 (0.266)	0.076 (0.265)
Manufacturing	0.296 (0.457)	0.259 (0.438)	0.215 (0.411)	0.158 (0.365)
Transportation & Utilities	0.063 (0.242)	0.058 (0.233)	0.059 (0.235)	0.055 (0.228)
Wholesale Trade	0.048 (0.214)	0.048 (0.214)	0.052 (0.223)	0.037 (0.188)
Retail Trade	0.151 (0.358)	0.169 (0.375)	0.141 (0.348)	0.123 (0.328)
Financial Activities	0.060 (0.238)	0.047 (0.212)	0.056 (0.230)	0.067 (0.251)

Information	0.021 (0.142)	0.019 (0.138)	0.026 (0.160)	0.030 (0.170)
Professional and Business Service	0.051 (0.220)	0.062 (0.241)	0.067 (0.251)	0.094 (0.291)
Education and Health Services	0.157 (0.364)	0.176 (0.381)	0.202 (0.402)	0.207 (0.405)
Leisure and Hospitality	0.016 (0.127)	0.023 (0.150)	0.027 (0.162)	0.083 (0.276)
Other Services (excluded)	0.050 (0.219)	0.043 (0.202)	0.047 (0.212)	0.045 (0.208)
Occupations 1-6				
Managerial and prof. specialty (excluded)	0.213 (0.409)	0.216 (0.412)	0.253 (0.435)	0.264 (0.441)
Technical sales, and administrative support	0.291 (0.454)	0.300 (0.458)	0.322 (0.467)	0.302 (0.459)
Service	0.102 (0.302)	0.114 (0.318)	0.079 (0.270)	0.137 (0.344)
Farming, forestry, and fishing	0.016 (0.127)	0.017 (0.128)	0.023 (0.151)	0.028 (0.165)
Precision production, craft, and repair	0.141 (0.348)	0.135 (0.342)	0.129 (0.335)	0.117 (0.321)
Operators, fabricators, and laborers	0.237 (0.425)	0.217 (0.412)	0.194 (0.395)	0.153 (0.360)
Wage and Education Variables				
hourly wage	15.370 (15.225)	14.113 (17.937)	15.47 (20.266)	17.86 (26.443)
less than hs	0.348 (0.476)	0.228 (0.419)	0.134 (0.340)	0.121 (0.326)
hs	0.371 (0.483)	0.393 (0.489)	0.348 (0.476)	0.328 (0.470)
clg	0.080 (0.272)	0.098 (0.297)	0.148 (0.355)	0.158 (0.365)
postgraduate	0.061 (0.240)	0.084 (0.277)	0.079 (0.269)	0.084 (0.277)

Notes: Standard errors are in parentheses.

Table 2. Decomposition of the change in the wage gap between college and high school graduates, 1980 to 1990.

	College Graduates		High School Graduates		
	Contribution of changes in endowments	Contribution of changes in coefficients	Contribution of changes in endowments	Contribution of changes in coefficients	TOTAL (row sum)
TOTAL (column sum)	**0.3528*** **(0.0041)**	**-0.2241*** **(0.0044)**	**-0.2108*** **(0.0020)**	**0.2049*** **(0.0022)**	**0.1229*** **(0.0067)**
DEMAND FACTORS	**0.2614*** **(0.0041)**	**-0.0274** **(0.0630)**	**-0.1479*** **(0.0015)**	**-0.0103** **(0.0255)**	**0.0759** **(0.0681)**
Technology Demand (industry hardware and software investment, probability worker uses computer at work)	0.2171* (0.0039)	0.1323* (0.0161)	-0.1192* (0.0014)	0.0184* (0.0045)	0.2486* (0.0173)
Industry Demand (industry value added, CZ empl. share in wrkr's industry)	0.0423* (0.0008)	0.1234* (0.0436)	-0.0279* (0.0004)	-0.0766* (0.0196)	0.0612 (0.0478)
Occupation Demand (CZ empl. share in wrkr's occupation)	0.0020* (0.0006)	-0.2831* (0.0625)	-0.0007^ (0.0003)	0.0479+ (0.0253)	-0.2340* (0.0674)
SUPPLY FACTORS	**0.1005*** **(0.0024)**	**0.2114*** **(0.0493)**	**-0.0767*** **(0.0012)**	**-0.5043*** **(0.0242)**	**-0.2692*** **(0.0550)**
Low-skill Immigrant Supply (Percent of CZ population born in Central America, Caribbean, or South America)	-0.0054* (0.0004)	-0.0005 (0.0010)	0.0067* (0.0002)	-0.0047* (0.0004)	-0.0040* (0.0012)
High-skill Immigrant Supply (Percent of CZ population born in non-Latin foreign countries)	0.0128* (0.0003)	0.0534* (0.0025)	0.0006* (0.0001)	-0.0644* (0.0013)	0.0024 (0.0029)
Technology Supply (Probability that worker uses computer at home)	0.0120* (0.0008)	-0.0405* (0.0143)	-0.0001* (0.0000)	0.0568* (0.0045)	0.0282^ (0.0150)
Other Supply (Percent of the CZ population that is of worker's skill group, lagged a decade; CZ population, lagged a decade; presence of college or university in CZ; percent of CZ labor force that is female)	0.0572* (0.0021)	0.4465* (0.0397)	-0.0409* (0.0012)	-0.4448* (0.0217)	0.0179 (0.0453)
Demographics (age, gender, race, ethnicity, marital)	0.0239* (0.0004)	-0.2476* (0.0202)	-0.0429* (0.0001)	-0.0472* (0.0092)	-0.3137* (0.0222)
INSTITUTIONAL (CZ unemployment rate, industry degree of unionization, mobility rate of population in CZ, worker's industry and occupation dummy variables)	**-0.0091*** **(0.0004)**	**-0.1283*** **(0.0118)**	**0.0138*** **(0.0003)**	**0.1586*** **(0.0072)**	**0.0350^** **(0.0138)**
CONSTANT	**0.0000**	**-0.2798*** **(0.0755)**	**0.0000**	**0.5610*** **(0.0355)**	**0.2811*** **(0.0835)**

Notes. Standard deviation in parentheses; these have been estimated using the delta method (Phillips and Park 1988), abstracting from the sampling variation in the regressors (see Jann 2008). * indicates significant at the 99 percent confidence level. ^ indicates significant at the 95 percent confidence level. + indicates significant at the 90 percent confidence level.

Table 3. Decomposition of the change in the wage gap between college and high school graduates, 1990 to 2000.

	College Graduates		High School Graduates		
	Contribution of changes in endowments	Contribution of changes in coefficients	Contribution of changes in endowments	Contribution of changes in coefficients	TOTAL (row sum)
TOTAL (column sum)	**0.4195*** **(0.0082)**	**-0.2960*** **(0.0084)**	**-0.1755*** **(0.0040)**	**0.1181*** **(0.0043)**	**0.0661*** **(0.0131)**
DEMAND FACTORS	**0.2191*** **(0.0049)**	**-0.6962*** **(0.0606)**	**-0.0469*** **(0.0017)**	**-0.1261*** **(0.0266)**	**-0.6502*** **(0.0663)**
Technology Demand (industry hardware and software investment, probability worker uses computer at work)	0.2184* (0.0049)	0.0397+ (0.0208)	-0.0613* (0.0016)	0.1526* (0.0060)	0.3493* (0.0223)
Industry Demand (industry value added, CZ empl. share in wrkr's industry)	-0.0073* (0.0007)	-0.1502* (0.0403)	0.0065* (0.0004)	0.1140* (0.0204)	-0.0370 (0.0451)
Occupation Demand (CZ empl. share in wrkr's occupation)	0.0080* (0.0008)	-0.5857* (0.0593)	0.0079* (0.0004)	-0.3927* (0.0270)	-0.9626* (0.0652)
SUPPLY FACTORS	**0.2227*** **(0.0079)**	**-0.0533** **(0.0592)**	**-0.1717*** **(0.0041)**	**0.2334*** **(0.0294)**	**0.2310*** **(0.0667)**
Low-skill Immigrant Supply (Percent of CZ population born in Central America, Caribbean, or South America)	-0.0033* (0.0003)	0.0049* (0.0009)	0.0072* (0.0002)	-0.0027* (0.0005)	0.00608* (0.0011)
High-skill Immigrant Supply (Percent of CZ population born in non-Latin foreign countries)	0.0182* (0.0004)	-0.0106* (0.0021)	-0.0157* (0.0002)	0.0332* (0.0011)	0.0251* (0.0024)
Technology Supply (Probability that worker uses computer at home)	0.1118* (0.0073)	0.3045* (0.0327)	-0.1240* (0.0039)	-0.1485* (0.0074)	0.1438* (0.0346)
Other Supply (Percent of the CZ population that is of worker's skill group, lagged a decade; CZ population, lagged a decade; presence of college or university in CZ; percent of CZ labor force that is female)	0.0776* (0.0018)	-0.3672* (0.0411)	-0.0281* (0.0008)	0.3534* (0.0258)	0.0357 (0.0486)
Demographics (Age, gender, race, ethnicity, marital)	0.0184* (0.0004)	0.0151 (0.0187)	-0.0111* (0.0002)	-0.0019 (0.0105)	0.0204 (0.0215)
INSTITUTIONAL (CZ unemployment rate, industry degree of unionization, mobility rate of population in CZ, worker's industry and occupation dummy variables)	**-0.0223*** **(0.0008)**	**-0.0201+** **(0.0107)**	**0.0432*** **(0.0005)**	**-0.0960*** **(0.0073)**	**-0.0952*** **(0.0130)**
CONSTANT	**0.0000**	**0.4736*** **(0.0798)**	**0.0000**	**0.1068*** **(0.0397)**	**0.5804*** **(0.0891)**

Notes. Standard deviation in parentheses; hese have been estimated using the delta method (Phillips and Park 1988), abstracting from the sampling variation in the regressors (see Jann 2008). * indicates significant at the 99 percent confidence level. ^ indicates significant at the 95 percent confidence level. + indicates significant at the 90 percent confidence level.

Appendix A: Data Sources and Variable Descriptions

A.I. Variable Description and Data Sources Overview

The data used for the analysis in this paper come from a number of different sources. The primary data source is the Integrated Public Use Microdata Series (IPUMS) and was obtained from The Minnesota Population Center at The University of Minnesota. CZ-level regressors are constructed using the individual-level data in the IPUMS. In particular, average demographics and labor market characteristics are constructed based on commuting zones with data from the IPUMS.

Industry-level investment in technology is obtained from the National Income and Product accounts (NIPA). Industry value added, designed to capture overall demand for product demand, thus worker demand, also comes from NIPA.

Trade penetration ratios are constructed using data from the Department of Commerce (Trade Statistics Express), for 1990 and 2000, and the National Bureau of Economic Research (NBER), for 1972 and 1980. GDP used to construct trade penetration ratios is obtain by industry for each year from the Bureau of Economic Analysis (BEA).

Computer use at work and home and unionization by industry are obtained from the Current Population Survey (CPS).

Detailed descriptions and sources of all variables used in the analysis are provided in Table A1.

Table A1: Variable Description & Construction and Data Sources

Dependent Variable: Individual log hourly wage. All dollar values are deflated to 2000 values using the PCE chain-type price deflator. All regressors, even if CZ (k) or industry (j) specific, are measured at the individual level (i). See the next section for information related to construction of commuting zones (CZ).

Regressors	Description	Data Source
Demand Factors		
$computer_j$ $software_j$	Industry specific (3-digit NAICS) dollar investment in high-tech equipment and software; millions of dollars. Expected to capture industry demand for technologically astute workers.	**National Income and Product Accounts (NIPA)**
$comwork_i$	Measures an individual's use of a computer at work. A reduced-form OLS model is estimated using the CPS to determine a person's propensity to use a computer at work. The parameter estimates are then applied to the IPUMS to obtain a predicted probability of an individual using a computer at work. Not available for 1970.	**Current Population Survey (CPS)**
$ImportPen_j$	Industry specific import penetration ratios. Variable available for manufacturing industry in all years, available for manufacturing and service industries in 1990 and 2000 only. Import Penetration = value of imports/(gross output of industry plus value of exports minus value of imports). The denominator is referred to as "apparent consumption." Expected to capture displacement of workers by trade or international competition. *** excl. from initial 1980, 1990, 2000 analyses ***	1990 and 2000 trade in goods data from the **U.S. Department of Commerce (Trade Statistics Express**). Trade in services from **Dep. of Commerce (BEA).** 1972 and 1980 trade in goods data from **National Bureau of Economic Research** (**NBER).** Industry GDP from **BEA.**
VA_j	Industry specific value added, measured as the dollar value of output minus the value of intermediate inputs. Expected to capture total derived demand for workers. Not available for 1970.	**National Income and Product Accounts (NIPA)**
$EmplShare_{kj}$ $EmplShare_{ki}$	Share of total employment in CZ *k* that is employed in the worker's industry *j* (occupation *i*). Expected to capture local labor market demand for employment across industries.	**IPUMS**
Supply Factors		
$comhome_i$	Measures an individual's use of a computer at home. A reduced-form OLS model is estimated using the CPS to determine a person's propensity to use a computer at work. The parameter estimates are then applied to the IPUMS to obtain a predicted probability of an individual using a computer at home (comhome). Not available for 1970.	**Current Population Survey (CPS)**
$flfper_k$	This is a measure of the percent of the CZ labor force that is female. Others have concluded that female workers are lower-paid substitutes for low-skilled	**IPUMS**

	men, and their presence could drive down low-skilled wages.	
perskillX_k	Percent of the CZ population that is of skill group X (e.g., high school only, college grad, etc.) Because of potential endogeneity of migration decisions, this variables is lagged a decade (e.g., the 1990 value is used in the 2000 regression).	**IPUMS**
mNAm_k (excluded)	Percent of CZ population that is from north America. Expected to capture effect of immigration on local wage determination. Because of potential endogeneity of migration decisions, all the immigration variables are lagged a decade (e.g., the 1990 value is used in the 2000 regression).	**IPUMS**
$\text{mCenCaribbSouthAm}_k$	Percent of CZ population born in Central America, Caribbean, or South America. Expected to capture effect of immigration on local wage determination.	**IPUMS**
EuropeAsia_k	Percent of CZ population born in Europe or Asia. Expected to capture effect of immigration on local wage determination. Expected to capture effect of immigration on local wage determination.	**IPUMS**
mothernonNAm_k	Percent of CZ population born in other non-North American regions (ex. Africa, Arctic…). Expected to capture effect of immigration on local wage determination.	**IPUMS**
schldummy_k	Dummy variable set equal to one if CZ has at least one college or university that offers a bachelor's degree. Zip code of schools (obtained from NCES) was mapped onto the CZ. Other work has used a dummy indicating the presence of a land grand university only (Mervis 1962 and Moretti 2002: 20).	**U.S. Department of Education, National Center for Education Statistics (NCES)**
Demographics		
age_i	Age of individual (and it's squared value).	**IPUMS**
female_i	Dummy variable set equal to one if individual is female.	**IPUMS**
white_i (excluded)	Dummy variable set equal to one if white. All race variables are constructed from IPUMS variable *race.*	**IPUMS**
hispanic_i	Dummy variable set equal to one if individual is Hispanic.	**IPUMS**
black_i	Dummy variable set equal to one if black	**IPUMS**
asian_i	Dummy variable set equal to one if Asian (Chinese, Japanese, or other Asian or Pacific Islander).	**IPUMS**
otherrace_i	Dummy variable set equal to one if any other race or two or more of the races above.	**IPUMS**
marriedsp_i	Dummy variable set equal to one if married with a spouse present.	**IPUMS**
Institutional Factors		
urate_k	CZ level unemployment rate; constructed using individual labor force data from the IPUMS. Expected to capture current local labor market	**IPUMS**

	conditions.	
$union_j$	Industry specific percent unionization. Expected to measure the degree of non-competitive wage setting mechanisms present in worker's industry.	**Current Population Survey (CPS)**
$mfluidity_k$	Percent of the CZ that lived in a different state five years ago. Expected to capture mobility of workers in the local labor market; greater degree of mobility makes a labor market more competitive.	**IPUMS**
ind_j occ_m	Dummy variables for broad industry (*j*) and occupation (*m*) classifications. Expected to capture occupation and industry specific determinants of wages not otherwise controlled for.	**IPUMS**

A.II. Construction of Import Penetration Ratios for Service Industries

All of the import and export data for services come from the International Economic Accounts of the Bureau of Economic Analysis (BEA). The actual data is published annually in the Survey of Current Business. (The data comes from the Balance of Payments Division.)

Service data are available for 1990 and 2000. For 2000 the data is clearly broken into affiliated and unaffiliated transactions (all definitions are from the BEA http://www.itdu.org/file_download/6):

Affiliated transaction: trade within multinational companies

- Trade between U.S. parent companies and their foreign affiliates
- Trade between foreign-owned U.S. affiliates and their foreign parent groups (so this would be like Honda in the U.S. traded with its' foreign parent groups in Japan).

Unaffiliated transaction: no direct investment relationship between the transacting parties.

We are using import and export values for unaffiliated services only by type for both 1990 and 2000. We are using unaffiliated, versus affiliated or total, for a number of reasons: (1) Data on services by type/industry for affiliated services are not available for 1990 (and neither is total aggregated trade data); (2) In 2000, for many service types (such as insurance, telecommunications, travel, and education) services are deemed to be unaffiliated (all transactions are unaffiliated); (3) For the years 1990 and 2000, there is a value for imports and exports in unaffiliated services for all of the services BEA lists in the tables. The bottom line is that using unaffiliated transactions allows the data for services to be comparable across years in the analysis.

Import penetration ratios for the service types are calculated in the same manner that they were constructed for the manufacturing industries. Note that GDP by industry is available for all industries and services. As of right now, import penetration ratios will be missing for service industries in 1970 and 1980.

A.III. Method for Assigning Commuting Zones to Individuals

Data on commuting zones are extracted from the IPUMS. The original data was constructed by C. Tolbert and M. Sizer who used 1990 Census data on journey-to-work county commuting flows to construct 741 commuting zones (CZ) (clusters of counties with strong commuting ties). We use the same (1990) definition of commuting zones for all analysis years (1980, 1990, & 2000) for a consistent definition of a labor market area throughout our analysis.

A commuting zone is assigned to an individual in the sample by matching commuting zones to either a *public use micro data* (PUMA) for 1990 and 2000 or a similarly defined *county group* (CNTYGRP) for 1980. Because each PUMA or CNTYGRP can contain multiple CZs, we use the following method to assign each observation in a PUMA or CNTYGRP to a CZ (similar to the method used by Autor and Dorn 2007):

(1) The CZ dataset is merged into the IPUMS dataset that contains PUMA/CNTYGRP by county fips codes.

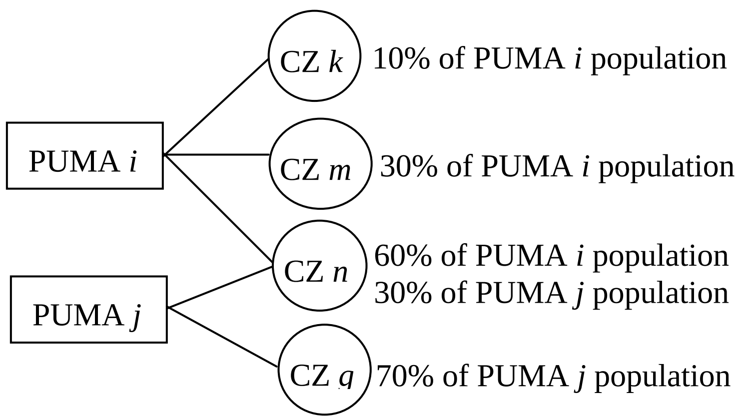
(2) Depending on the year, between 68 and 82 percent of CZs are matched exclusively to one PUMA or CNTYGRP. In 2000, 1677 out of the 2052 pumas (82%) match to a single CZ. In 1990, 1348 of the 1726 pumas (78%) match to single CZ. In 1980, 788 of the 1154 county groups (68%) match to single CZ.

(3) When there is not an exclusive match between CZ and PUMA/CNTYGRP, a random assignment strategy is employed to distribute the PUMA/CNTYGRP population across the appropriate CZs.

a) Population weights are created for each CZ within a PUMA or CNTYGRP. The weights are equal to the share of the PUMA or CNTYGRP population in each CZ.

b) Each IPUMS observation within a PUMA or CNTYGRP is assigned a value from a uniform random variable distribution.

c) Each person is then assigned a CZ based on the CZs population share weight and the person's uniform distribution value. For example (see diagram below), if PUMA *i*'s population is distributed across CZ *k* (10 percent), CZ *m* (30 percent), and CZ *n* (60 percent), then individuals from PUMA *i* with a uniform draw between 0 and 0.10 will be assigned to CZ *k*, individuals with a draw between 0.10 and 0.40 will be assigned to CZ *m*, and the remaining population is assigned to CZ *n*.



Appendix B: Parameter Estimates

Table 1. OLS parameter estimates of log wage equations by education and by year.

	1980		1990		2000	
Regressors	**High School**	**College**	**High School**	**College**	**High School**	**College**
Demand Factors						
computer investment (billions $)	0.0064*	0.0155*	-0.0410*	-0.0521*	-0.0054*	-0.0071*
	(0.002)	(0.003)	(0.001)	(0.001)	(0.000)	(0.000)
software investment (billions $)	0.1336*	0.1847*	0.1262*	0.1469*	0.0169*	0.0182*
	(0.002)	(0.005)	(0.001)	(0.002)	(0.000)	(0.000)
prob. of computer use at work	0.5058*	0.2708*	0.5629*	0.6902*	0.2806*	0.9438*
	(0.017)	(0.030)	(0.014)	(0.023)	(0.015)	(0.027)
industry value added (trillions $)	0.2848*	0.3761*	0.3976*	0.4947*	0.0309*	0.0775*
	(0.010)	(0.019)	(0.006)	(0.009)	(0.005)	(0.006)
industry empl share	0.5047*	0.7450*	0.5758*	0.8754*	0.5337*	0.7913*
	(0.017)	(0.040)	(0.017)	(0.035)	(0.018)	(0.033)
occupation empl share	0.1071*	0.5031*	0.0477$^{\wedge}$	0.1705*	0.5281*	-0.5083*
	(0.022)	(0.054)	(0.023)	(0.049)	(0.024)	(0.048)
Supply Factors						
prob. of computer use at home	0.2569*	0.2889*	0.1344*	0.2287*	0.4537*	0.6486*
	(0.006)	(0.014)	(0.008)	(0.016)	(0.014)	(0.042)
female share of cz's labor force	-0.4929*	-0.7329*	0.7022*	0.4925*	0.3309*	-0.3157*
	(0.031)	(0.066)	(0.036)	(0.066)	(0.039)	(0.063)
cz population (lagged, millions)	2.1561*	1.7968*	0.3476*	0.4070*	0.0097*	0.0105*
	(0.050)	(0.099)	(0.009)	(0.013)	(0.000)	(0.001)
share of cz with hs degree (lagged)	0.1485*	--	0.1168*	--	-0.2650*	--
	(0.009)		(0.009)		(0.011)	
share of cz with clg degree (lagged)	--	1.5064*	--	0.7076*	--	1.1516*
		(0.080)		(0.051)		(0.031)
share of cz born in Latin Am. or Caribb.	-1.0993*	-0.3310*	-0.6587*	-0.3697*	-0.5268*	-0.1895*
	(0.038)	(0.075)	(0.017)	(0.028)	(0.013)	(0.020)
share of cz born in Europe or Asia	1.5807*	0.5972*	3.1575*	1.7684*	1.8391*	1.3050*
	(0.034)	(0.067)	(0.031)	(0.044)	(0.025)	(0.033)
share of cz born in other non-North Am. country	-1.5441*	0.0038	0.1026^{+}	1.1482*	1.0670*	1.8213*
	(0.060)	(0.117)	(0.057)	(0.084)	(0.053)	(0.069)

presence of university or college in cz	0.0521* (0.003)	0.0236* (0.009)	0.0241* (0.002)	0.0227* (0.005)	0.0143* (0.002)	0.0173* (0.005)
Demographics						
age	0.0378* (0.000)	0.0595* (0.001)	0.0386* (0.000)	0.0462* (0.001)	0.0363* (0.000)	0.0498* (0.001)
age squared	-0.0003* (0.000)	-0.0005* (0.000)	-0.0003* (0.000)	-0.0004* (0.000)	-0.0003* (0.000)	-0.0005* (0.000)
female	-0.3478* (0.002)	-0.2489* (0.005)	-0.3615* (0.002)	-0.3038* (0.004)	-0.2961* (0.002)	-0.3064* (0.003)
black	-0.0083* (0.002)	0.0360* (0.004)	-0.0098* (0.002)	0.0530* (0.004)	0.0132* (0.002)	0.0625* (0.004)
asian	-0.0330* (0.004)	-0.0710* (0.006)	-0.0891* (0.004)	-0.0546* (0.004)	-0.0778* (0.003)	-0.0283* (0.004)
other race	-0.0122$^{\wedge}$ (0.005)	-0.0559* (0.015)	-0.0014 (0.005)	-0.0256$^{\wedge}$ (0.012)	-0.0501* (0.002)	-0.0696* (0.004)
married w/ spouse	0.0621* (0.001)	0.0773* (0.002)	0.0882* (0.001)	0.1066* (0.002)	0.1022* (0.002)	0.0951* (0.002)
Institutional Factors						
cz unemployment rate	1.6755* (0.039)	1.9837* (0.079)	0.4808* (0.046)	1.6019* (0.077)	1.2773* (0.051)	1.4432* (0.083)
unionization	0.3190* (0.005)	0.2478* (0.011)	0.3788* (0.005)	0.0914* (0.009)	0.3080* (0.005)	-0.2073* (0.008)
mobility rate of cz population	0.2707* (0.010)	0.1205* (0.022)	-0.0130 (0.010)	-0.0836* (0.018)	0.1233* (0.011)	-0.2159* (0.018)
Industries 1-12						
Natural Resources & Mining	0.2234* (0.004)	0.3976* (0.010)	0.2513* (0.004)	0.4682* (0.007)	0.1216* (0.004)	0.3037* (0.009)
Construction	0.1631* (0.003)	0.3168* (0.008)	0.0912* (0.003)	0.2777* (0.006)	0.0569* (0.003)	0.2745* (0.006)
Manufacturing	0.1711* (0.003)	0.3838* (0.007)	0.1904* (0.003)	0.4394* (0.005)	0.1399* (0.002)	0.4362* (0.005)
Transportation & Utilities	0.2098* (0.004)	0.3789* (0.009)	0.2132* (0.003)	0.4274* (0.006)	0.1261* (0.003)	0.4730* (0.006)
Wholesale Trade	0.0125$^{\wedge}$ (0.005)	0.1855* (0.011)	-0.0018 (0.005)	0.2669* (0.007)	0.0411* (0.004)	0.3399* (0.006)
Retail Trade	-0.0577*	0.0473*	-0.1532*	0.0105^{+}	-0.0473*	0.1941*

	(0.004)	(0.008)	(0.003)	(0.006)	(0.003)	(0.006)
Financial Activities	-0.0062	0.0898*	-0.1528*	-0.0249*	0.1255*	0.3701*
	(0.004)	(0.009)	(0.004)	(0.007)	(0.004)	(0.005)
Information	0.2319*	0.2340*	0.0809*	0.2947*	0.0197*	0.2444*
	(0.005)	(0.010)	(0.004)	(0.006)	(0.004)	(0.006)
Professional and Business Service	0.1079*	0.2565*	-0.0607*	0.0331*	-0.0032	0.2176*
	(0.003)	(0.007)	(0.003)	(0.006)	(0.003)	(0.005)
Education and Health Services	0.0561*	0.2219*	0.0057^	0.1961*	-0.0355*	0.2039*
	(0.003)	(0.007)	(0.003)	(0.005)	(0.003)	(0.005)
Leisure and Hospitality	0.0836*	0.2187*	0.1184*	0.2656*	0.0108*	0.1771*
	(0.004)	(0.010)	(0.004)	(0.007)	(0.003)	(0.006)
Occupations 1-6						
Technical sales, and administrative support	-0.1218*	-0.1379*	-0.1353*	-0.1834*	-0.0907*	-0.2108*
	(0.002)	(0.005)	(0.002)	(0.004)	(0.002)	(0.004)
Service	-0.2730*	-0.2806*	-0.3066*	-0.3621*	-0.2094*	-0.4460*
	(0.004)	(0.010)	(0.004)	(0.008)	(0.004)	(0.007)
Farming, forestry, and fishing	-0.4395*	-0.4745*	-0.4565*	-0.6334*	-0.3228*	-0.6094*
	(0.006)	(0.014)	(0.004)	(0.010)	(0.004)	(0.010)
Precision production, craft, and repair	-0.0820*	-0.1667*	-0.0976*	-0.2608*	-0.0784*	-0.3255*
	(0.002)	(0.005)	(0.002)	(0.004)	(0.002)	(0.004)
Operators, fabricators, and laborers	-0.1796*	-0.3232*	-0.2115*	-0.4465*	-0.1664*	-0.5683*
	(0.003)	(0.008)	(0.003)	(0.006)	(0.003)	(0.006)
Constant	0.6925*	-0.3260*	0.1315*	-0.6058*	0.0247	-0.1322^
	(0.024)	(0.056)	(0.026)	(0.051)	(0.030)	(0.062)
Observations	1506546	375090	1610134	684110	1822896	922376
Adjusted R-squared	0.2530	0.2548	0.2589	0.2418	0.2043	0.2045

Notes. Standard deviation in parentheses. * indicates significant at the 99 percent confidence level. ^ indicates significant at the 95 percent confidence level. + indicates significant at the 90 percent confidence level. Excluded race group is white. Excluded immigration share in cz is North American. Excluded industry is other services. Excluded occupation is managerial & profession specialty.