How Have Automation and Trade Affected the Taxable Share of Covered Earnings?

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Introduction

Over the last two decades, income inequality in the U.S. has increased, causing the share of earnings taxable by Social Security to decrease, with significant implications for the program’s finances. At the same time, dramatic changes in the U.S. labor market have occurred, with a sharp increase in automation and increasing competition from abroad. How much has the unequal distribution of these changes’ impacts contributed to earnings inequality and the decline in the taxable share?

To measure the impact of these two factors on the increase in the top share of earnings, this paper uses: 1) industrial automation (from Acemoglu and Restrepo 2017, henceforth “AR”); and 2) imports from China (following Autor, Dorn, and Hanson 2013, henceforth “ADH”). The focus on Chinese imports is due to the large and exogenous change in trade driven by China’s entry into world markets around the turn of the century, which may have adversely affected competing U.S. producers. The analysis relies on data from the Social Security Administration’s Continuous Work History Sample (CWHS) for wage and salary earners to calculate the earnings distributions in 1994 and in 2015 and to estimate the association between the two factors and earnings at different points in the distribution.

The analysis shows that automation and trade had negative effects throughout the earnings distribution. Trade’s effect was decreasing (in absolute value) with earnings percentile. Automation, in contrast, displays a U-shaped pattern consistent with labor-market polarization. Despite these divergent patterns, both factors impacted the lower part of the earnings distribution more negatively than the upper part. The two factors, particularly trade, accounted for 15 percent of the increase in the top 1-percent share of earnings, and 11 percent of the decline in the taxable share (0.4 percentage points of the 3.4 percentage point decline) between 1994 and 2015. The remainder of the differences between the two years is likely due to other harder-to-measure factors, such as increasing market concentration, the erosion of norms surrounding managerial compensation, and an increasing share of compensation paid as untaxable benefits.

Data and Empirical Approach

The empirical analysis in this paper relies on four main datasets which are combined to estimate the effects of automation and trade on the earnings distribution. As a measure of automation, the analysis uses an operationalization developed by AR, based on the number of
robots per 1,000 workers. Trade is proxied by imports from China as described in ADH. Other control variables are taken from the Census Bureau’s Current Population Survey Annual Social and Economic Supplement. Finally, earnings for wage and salary earners are from the CWHS.

Using these data, the paper estimates the impact of automation and trade at different points in the earnings distribution. The analysis then takes those estimates and adjusts the 2015 earnings distribution to construct counterfactual earnings distributions assuming one or both of the factors had remained at their 1994 levels. These counterfactual distributions are used to calculate counterfactual taxable shares.

**Results**

Figures 1 and 2, respectively, show the estimated effects of automation and trade on the earnings distribution between 1994 and 2015. Both factors have had negative effects on the vast majority of wage and salary earners. However, the patterns vary between the two factors in how they hit different parts of the distribution.

**Figure 1. Percent Change in Earnings by Quantile Due to Automation, 1994-2015**

Note: Coefficients from quantile-regression estimates.
Source: Authors’ calculations based on the Continuous Work History Sample, 1994 and 2015.
Automation had essentially no effect on the lowest earners. However, its effect turns negative rapidly further up the distribution, reaching a nadir of -3.7 percent at the 90th percentile. The effect then diminishes in absolute value, but remains negative even for the highest earners. The U-shaped impact is consistent with the known polarizing effect of automation on the labor market (Autor, Katz, and Kearney 2006), and the overall negative effect on earnings is consistent with automation reducing the labor share of national income (Karabarbounis and Neiman 2014).

The pattern of impacts of trade is different, with a strong deleterious effect at the bottom of the distribution that declines in absolute value, essentially disappearing around the 70th percentile. As with automation, the effect of trade grows less negative at the top of the earnings distribution. However, trade has a slightly positive impact on the top 1-percent of earners. The negative impact on the bottom of the distribution is in line with the kinds of goods imported from abroad, which mostly require low-skill labor to produce.

Figure 2. Percent Change in Earnings by Quantile Due to Imports, 1994-2015

Note: Coefficients from quantile-regression estimates.
Source: Authors’ calculations based on the Continuous Work History Sample, 1994 and 2015.

In total, automation and trade have lowered earnings throughout the distribution, but their joint impact declines with earnings percentile. The disproportionately negative impacts at the
bottom of the distribution have contributed to the growing share of earnings going to those above the taxable maximum, and to the top 1-percent of earners.

Using these estimates, counterfactual 2015 earnings distributions are estimated. Table 1 presents statistics for the counterfactual 2015 earnings distributions holding each of the factors constant, and holding both constant simultaneously. The analysis shows that trade has little effect on average growth in earnings, while automation is actually a drag on average earnings. This ranking of the factors in terms of their effect on earnings is different when considering impacts at different points in the distribution. For example, the biggest drag on earnings at the 25th percentile is trade, while growth in automation had only a small effect on earnings at that percentile. The reverse is true at the 75th percentile.

Table 1. Characteristics of the Factual and the Counterfactual 2015 Earnings Distributions

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>1st quartile</th>
<th>Median</th>
<th>3rd quartile</th>
<th>99th percentile</th>
<th>1-percent share</th>
<th>Taxable share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual 2015</td>
<td>$45,412</td>
<td>$11,482</td>
<td>$28,946</td>
<td>$55,439</td>
<td>$515,065</td>
<td>11.3%</td>
<td>85.6%</td>
</tr>
<tr>
<td>Automation at 1994</td>
<td>46,993</td>
<td>11,748</td>
<td>29,866</td>
<td>57,428</td>
<td>531,733</td>
<td>11.3</td>
<td>85.6</td>
</tr>
<tr>
<td>Trade at 1994 level</td>
<td>45,881</td>
<td>12,119</td>
<td>29,712</td>
<td>55,628</td>
<td>509,674</td>
<td>11.1</td>
<td>85.9</td>
</tr>
<tr>
<td>Both at 1994 level</td>
<td>47,423</td>
<td>12,399</td>
<td>30,657</td>
<td>57,624</td>
<td>526,167</td>
<td>11.1</td>
<td>85.9</td>
</tr>
</tbody>
</table>

Notes: All numbers are in 2015 dollars. The 1994 taxable share is calculated using a tax-max equal to the actual cap in 1994 adjusted by CPI to 2015 dollars.
Source: Authors’ calculations based on the Continuous Work History Sample, 1994 and 2015.

Overall, the factor most responsible for the rise in the top 1-percent share of earnings is trade, whereas automation had a negligible effect on this share. These two factors combined account for 15 percent of the increase in the top 1-percent share.

How have these changes to the earnings distribution affected the taxable share? The estimates suggest that industrial robot proliferation has had a very small effect on the taxable share, contributing just 0.1 percentage points of the 3.4 percentage points’ decline in the taxable share in the 1994-2015 period. In contrast, trade with China alone is responsible for 0.3 percentage points of the decline in the taxable share, or 10 percent of the total decline. When both factors are combined, the estimates imply that automation and trade contributed 0.4
percentage points of the 3.4 percentage point decline in the taxable share over the last twenty years – or 11 percent of the decline.

Conclusion

This paper estimates the impact of the growth of automation and trade between 1994 and 2015 on the distribution of earnings and the share taxable by the Social Security payroll tax. These two factors alone explain 11 percent of the decline in the taxable share over the last 20 years, and 15 percent of the increasing concentration of earnings among the top 1-percent of earners. However, these estimates are likely lower bounds of the total effect of automation and trade, since they capture only the effects of proxies for these broader phenomena. In particular, the automation measure includes only industrial robots, and not the myriad effects of other forms of automation, such as advances in computing and information technology. Regarding trade, note that imports from China account for only one-fifth of imports to the U.S., so the effect of imports more broadly could be substantially higher than what is estimated here (although probably not five times larger, as some increase in imports is likely due to increased demand in the U.S., which does not necessarily crowd-out local production). Thus, these estimates should be considered indications of the general pattern of the effects of automation and trade, rather than a comprehensive account of their effects.

Bearing this qualification in mind, the estimates can inform projections of the taxable share going forward. Extrapolating the growth of the two factors suggests the 2026 taxable share will be 85.7 for wage and salary earners, and 82.5 for all workers, all else equal, consistent with projections by the Social Security Trustees (2018) and the Technical Panel on Assumptions and Methods (2015). Because the estimates provide a lower bound of the impact of automation and trade on the decline of the last 20 years, further declines beyond those predicted by these factors would be very much in line with historical precedent. If automation and trade continue to increase inequality, the taxable share is likely to decline further.
References


