

An Analysis of Job and Wage Growth in the Tech/Telecom Sector

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This paper examines job growth at leading tech/telecom firms. We compare them to leading industrial firms, both in the first half of the 20th century and in the post-war era, and show that they have similar employment trajectories. Then we consider wage and industrial structure trends. We find that real wages in the tech/telecom sector are higher and rising faster than in the physical sector. To correct for composition effects, we examine detailed occupational categories and find that, for middle-skill occupations such as sales and office support, the tech/telecom sector has significantly higher wages than the physical sector.

This paper incorporates and updates portions of earlier reports and blog posts, including: “A Historical Perspective on Tech Job Growth” (January 2017); “The Creation of a New Middle Class?: A Historical and Analytic Perspective on Job and Wage Growth in the Digital Sector, Part I” (March 2017); and “Do today’s tech/telecom companies employ too few workers?” (June 2017).



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INTRODUCTION

These days, technology is generally viewed as job-destroying rather than job-creating.

In 2017 one journalist wrote a short piece entitled “Big companies, fewer workers,” which went on to say that

The five most valuable companies in the U.S. are all technology firms that employ far fewer workers than their industrial predecessors.... These companies symbolize the central issue of employment in a new age of technology, automation and artificial intelligence.¹

Certainly, emerging technologies such as autonomous vehicles and robots offer interesting questions about the future evolution of productivity and employment.²

This paper, however, stays away from speculation about the future, which has regularly defied prediction. Instead, our goal is to establish some key facts about the employment and wage performance of the tech/telecom sector, which includes not only giants such as Apple and AT&T, but also many smaller companies and startups as well.

The historical context for this report is the rapid expansion of high-productivity industrial companies in the first half of the 20th century. Economists have conclusively demonstrated there are large and persistent productivity differences between companies in the same industry. In other words, some companies are simply much better at using the same inputs. A recent OECD report called these high performers “frontier firms.”⁴

Recent research also suggests that aggregate gains in productivity are driven by the shift of workers and market share from low-productivity laggards to high-productivity frontier firms.⁵ It would be great if every company could up their game, but existing businesses often have a tough time adopting new technologies and ways of doing things.⁶ Expecting a donkey to suddenly become a racehorse is unreasonable. If you want to travel faster, you are better off shifting your saddle.

Looking back, we can see this process at work in the first half of the 20th century with companies such as General Motors, General Electric, DuPont, and other great industrial companies. These firms were able to adopt new production and distribution techniques more quickly and successfully than their rivals. As a result, these “frontier firms” were able to accomplish what had seemed impossible at the time: create hundreds of thousands of jobs while paying good wages and offering consumers lower prices than their rivals.

The key to this win-win situation was productivity. High-productivity firms would be able to cut prices, which would expand demand and benefit consumers. Expanded demand would create more jobs at higher pay. The result was the creation of a new middle class of factory workers who could afford to buy the products they made.

Yet, today, skeptics worry that digital-enabled productivity gains are not yielding the same virtuous circle as the productivity gains of the past.⁷ They point out that digital companies do not seem to be generating as many jobs as the big industrial companies of the past.

To tackle these questions, we do a direct comparison of the employment trajectory of leading tech/telecom and leading industrial companies such as General Motors and Bethlehem Steel, both pre-Great Depression and post-World War II. Adjusting for company age, we find a surprisingly large number of similarities.

Then we examine wage growth in the tech/telecom and digital sectors, compared to the physical sector. A key insight is that the boundaries of the tech/telecom and digital sectors are not static. For example, careful examination of county-level data shows that much of Amazon’s employment growth in recent years is being reported in the warehouse industry, as the company staffs up its high-tech fulfillment centers.⁸ In other words, as ecommerce expands, the tech/telecom workforce expands to include fulfillment center workers, who earn significantly more than brick-and-mortar retail workers.

Here are our main findings:

- Adjusting for age of company, today's tech leaders are following the same employment growth path as General Motors and Bethlehem Steel did.
- Today's 10 most valuable tech/telecom companies employ roughly 1.5 million people, up 63 percent over the past 10 years.
- In 1979, at the peak of manufacturing employment, the 10 most valuable industrial companies employed 2.2 million workers, 48 percent more than employment at 2017 tech/telecom leaders. However, the difference is mainly due to General Motors.
- The revenue of the top 10 tech/telecom companies in 2016 was 5.5 percent of U.S. GDP, compared to 5.7 percent of GDP for the top 10 industrial companies in 1979.
- Real wages for production and nonsupervisory workers in tech/telecom, digital nontech, and health have been steadily rising since 1990. However, real wages in the physical nonhealth sector have been flat since 1990.
- Workers in mid-skill occupations such as office and administrative support; sales; and installation, maintenance, and repair get paid significantly more in the tech/telecom sector.
- We examine the shift of industries from the physical sector into the digital sector.

THE HISTORICAL PARADIGM FOR MIDDLE-CLASS JOB GROWTH

From 1919 to 1955, manufacturing productivity more than tripled, while real earnings for factory workers soared.⁹ The jumping off point, of course, was Henry Ford's 1914 move to double the daily wage for workers at his Highland Park factory to \$5 per day, accompanied by his introduction of new production techniques that dramatically increased production and reduced the cost of producing the Model T. The price of a Model T Touring Car fell from \$950 in 1908 to \$360 in 1916.¹⁰

Ford's combination of high productivity, high wages, and low prices attracted both workers and customers and enabled Ford to create jobs at a spectacular rate. He went from 14,000 workers in his Highland Park factory in 1914 to 36,000 workers in 1917. By 1955, when the economy was starting to settle into normalcy after the Great Depression, World War II, and the Korean War, Ford Motor employed more than 180,000 workers.

At the same time, William Durant, an entrepreneur and salesman in Flint, Michigan, was creating General Motors. Unlike Ford, however, Durant did not start from scratch.¹¹ Durant rolled up 13 car companies and 10 parts-and-accessories manufacturers into one huge multi-brand manufacturer, employing 14,250 employees in 1909, GM's first year of existence. This number quickly grew. By 1929, General Motors had more than 233,000 workers in the United States and other countries, including assembly plants located in London, Copenhagen, Stockholm, Warsaw, Antwerp, Berlin, Buenos Aires, Sao Paulo, Osaka, Bombay, Wellington (New Zealand), Port Elizabeth (South Africa), and multiple cities in Australia.¹²

But, despite the company's global reach—or perhaps because of it—General Motors became the largest private sector employer in the United States. In 1955, for example, GM employed more than 400,000 hourly workers in the United States alone, with a total of 624,000 workers worldwide.¹³ In 1979, GM's U.S. employment hit its peak at over 600,000, with more than 800,000 employees worldwide.¹⁴

Other high-productivity “frontier firms,” to use the OECD terminology, were showing equally dramatic gains in employment over that same period. IBM's workforce went from 3,000 workers to 56,000, while DuPont went from 32,000 to 87,000 workers. Meanwhile, General Electric went from roughly 50,000 workers in 1914 to 215,000 in 1955.¹⁵

On average, these five frontier firms alone more than quintupled their employment between 1919 and 1955. That growth far exceeded overall manufacturing employment, which increased by 50 percent over the same stretch.¹⁶ As these firms expanded their workforce, the net effect was to replace low-wage jobs with jobs that offered middle-class incomes, lifting real earnings and living standards for the country as a whole. By 1955, factory workers came to epitomize the American middle class.

COMPARISON OF TECH COMPANIES WITH PRE-WAR INDUSTRIAL GIANTS

Clearly, no U.S. tech firm today can compare in employment to GM at its peak. But, in 1979, GM had been around for seven decades, going through two world wars, a Great Depression, and several decades of American prosperity. By comparison, companies such as Google and Amazon are far younger.

Or take another industrial giant of the past, U.S. Steel. That company was formed in 1901 as a giant roll-up of existing steel companies, including the Carnegie Steel Company, which had been in operation since 1872. As a result, U.S. Steel started corporate life with 168,000 employees and a huge share of the domestic steel market.

General Electric was founded in 1892 as a merger of the Edison General Electric Company and the Thomson-Houston Electric Company.¹⁷ American Telephone and Telegraph (the original incarnation) had an even more complicated corporate history. It was originally incorporated in 1885 as the long-distance subsidiary of the Bell System. But, for various reasons, in 1899 the assets of the local exchanges were transferred into AT&T, and the subsidiary became the parent company.

We remember the giant corporate employers of the post-World War II period. But we fail to remember how they had generally been in existence for many decades before they reached that mammoth size. And just like it takes many years for an oak tree to grow from an acorn, it turns out that employment growth simply takes time.

We also forget that today's tech firms are genuine startups. By comparison, most of the big job producers of the past started as mergers or roll-ups of companies that had existed for years or decades before.

When we compare today's tech leaders with the employment leaders of the past at a similar stage of development, it turns out that the job creation performance of the tech sector looks quite good (see the methodology appendix for an explanation of how the start date was identified).

TABLE 1: Employment at Year 5

COMPANY	EMPLOYMENT, YEAR 5*
GOOGLE	30,222
GM	20,042
FACEBOOK	17,048
FEDEX	10,092
BETHLEHEM STEEL	8,615

* Based on IPO or corporate formation. See methodology.
Data: Annual reports, company histories

As Table 1 shows, even Facebook, the poster child for companies with high market values and low employment, looks better in historical context. Facebook had 17,048 employees in 2016, its fifth year as a public company. That doesn't seem like much, but General Motors had only 20,000 in its fifth year of being incorporated as GM. FedEx, one of the great job stories of all time, averaged 10,000 full-time equivalent employees in 1982, its fifth year as a public company.

Before going on, let's point out that we have not scaled these numbers for the size of the economy or the national labor force. In 1914, the fifth year of GM's corporate existence, the

U.S. workforce totaled about 40 million, including the farm sector.¹⁸ Today the workforce is roughly 160 million, four times as big. Still, it's not obvious that scaling for the size of the economy is the right metric.

Table 2 looks at employment in year 20 for many of the most important companies of the past 100 years. Note that Microsoft and Google had employed more workers at year 20 (year 13 in the case of Google) than did General Electric or IBM. Facebook in year 5 employs almost as many people as IBM did at year 20. Apple in year 20 employed more people than FedEx in year 20. And Amazon in year 20 employs more workers than General Motors did in year 20.

TABLE 2: How Tech Companies Compare to the Big Job Creators of the Past

COMPANY	START DATE*	YEAR 1	YEAR 20**	
AMAZON	1997	614	34,1400	
GENERAL MOTORS	1909	14,250	20,8981	
AT&T (OLD)	1899	25,741	199,914	
U.S. STEEL	1901	168,000	191,700	
APPLE	1997	8,437	116,000	
FEDEX	1978	3,224	107,827	
GOOGLE	2004	3,021	72,053	
BETHLEHEM STEEL	1904	9,461	62,350	YEAR 13
MICROSOFT	1985	998	57,000	
GENERAL ELECTRIC	1892	NA	41,300	
IBM	1924	3,384	21,251	
FACEBOOK	2012	4,619	17,048	YEAR 5

Data: Annual reports, company histories.

*Based on date of IPO or corporate formation, except Apple. See methodology.

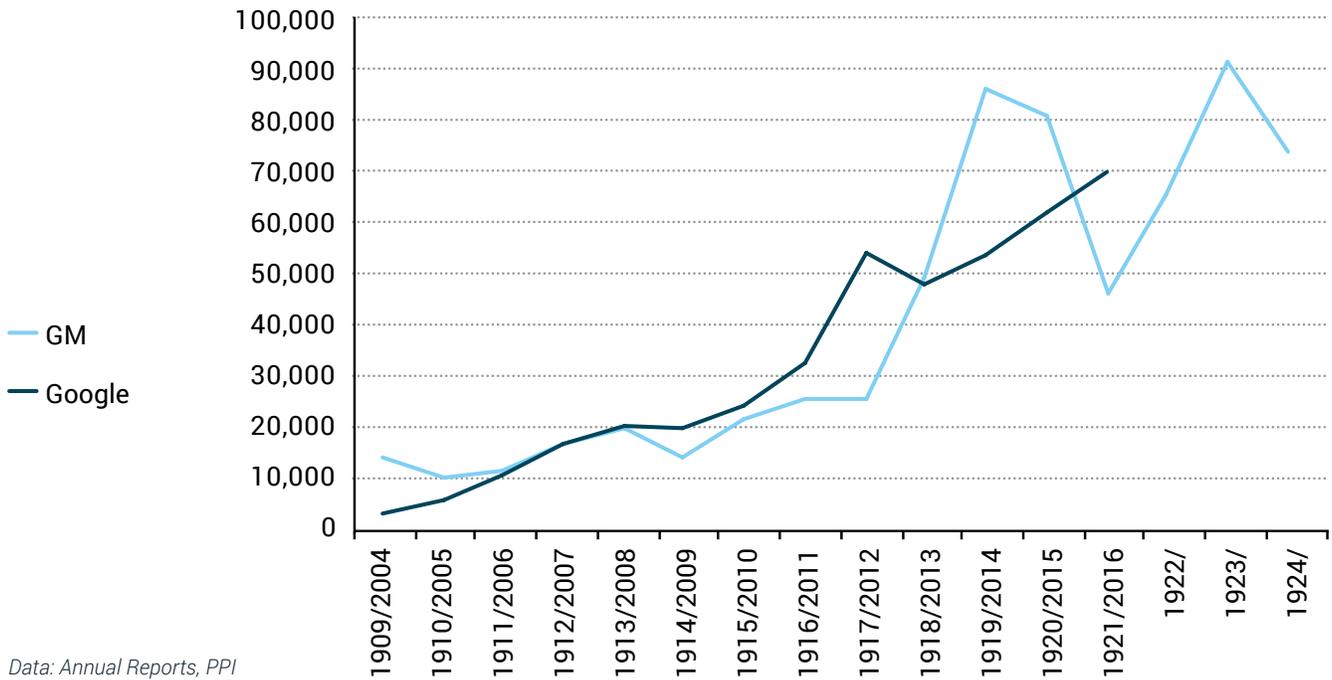
**Counting from first year.

EMPLOYMENT TRAJECTORIES

How do the employment trajectories of large tech firms such as Google and Amazon compare to the early years of GM and other big job creators? Take a look at Figure 1, which shows

the actual employment figures for the first 13 years of Google as a public company, starting with 2004, and the first 15 years of corporate existence for General Motors, starting with 1909.

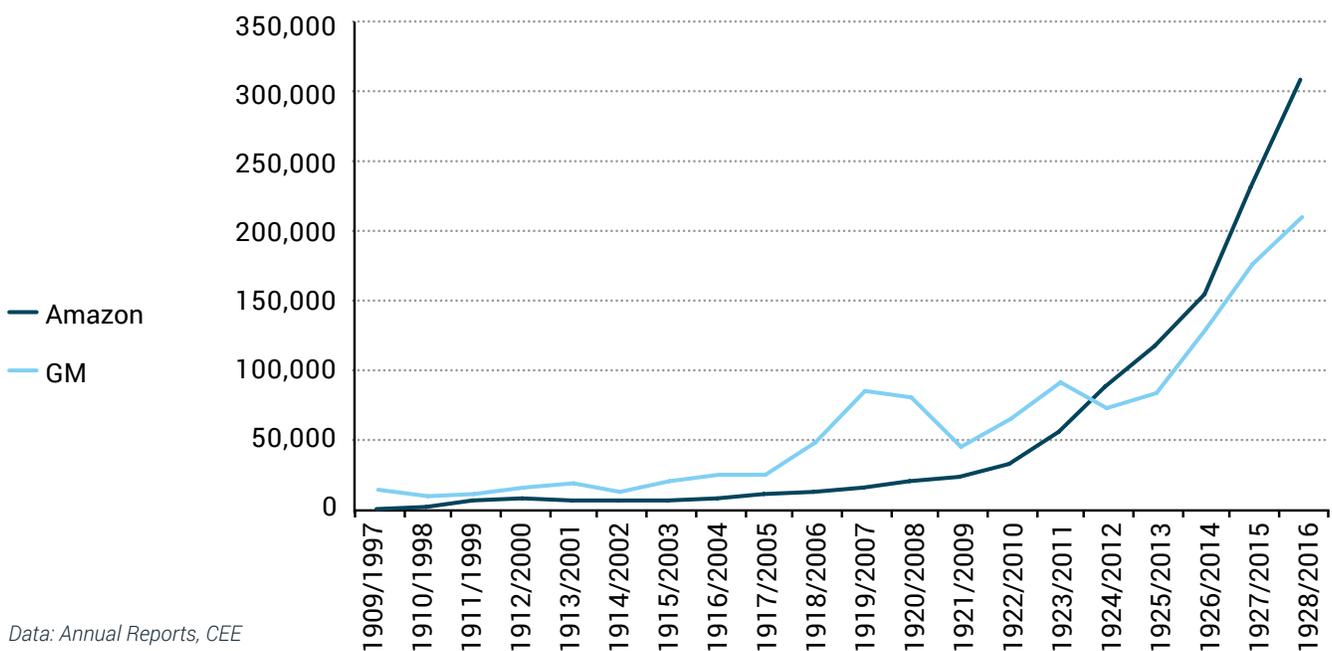
FIGURE 1: GM Jobs vs. Google Jobs: The First 13 Years



We can see that Google is almost exactly paralleling GM's early employment growth, with far fewer ups and downs. Note also that GM had an extensive global presence almost from the beginning, so a substantial share of its employment was overseas.

We can make a similar comparison between GM and Amazon (Figure 2).

FIGURE 2: GM Jobs vs. Amazon Jobs: The First 20 Years

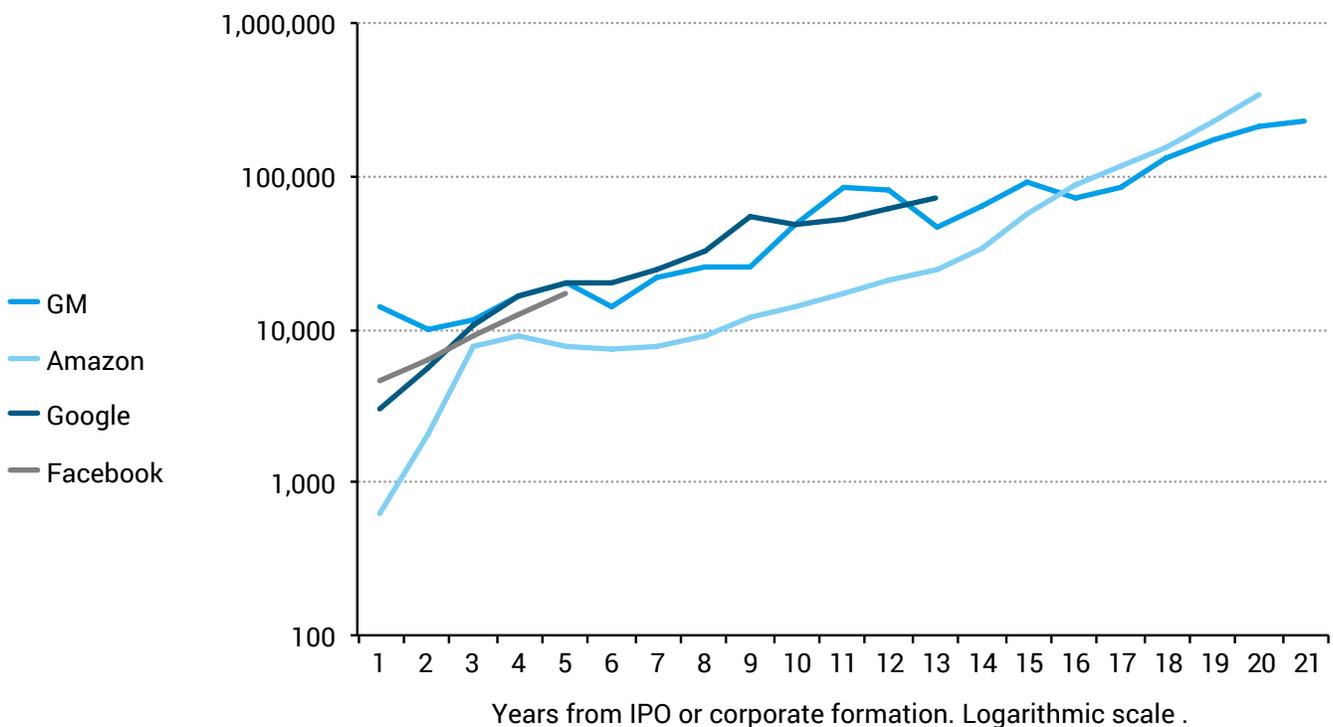


We can see that Amazon’s employment for its first 20 years parallels GM’s, before actually jumping ahead.

Indeed, in 2016, Amazon became the fastest American company to reach 300,000 workers, hitting that mark in its 20th year as a public company.¹⁹ This figure, which does not include

contractors or temporary workers, represents an average employment growth rate of roughly 30 percent per year. That figure was before Amazon’s January 2017 promise to add more than 100,000 full-time jobs in the United States over the next 18 months.

FIGURE 3: Employment: GM vs Tech Firms



Data: Corporate Reports, CEE

Now let’s plot employment at GM, Amazon, Google and Facebook on the same graph, aligning them by years from corporate formation or initial public offering. Basically, there’s no difference. Facebook, Amazon, and Google are following the same employment path as General Motors did in its first 20 years.

Apple is following a different employment path. Apple originally went public in 1980 (FY 1981). But we can identify a second starting point, FY

1997, when Apple bought Next Software and Steve Jobs returned to the company he founded. In Table 2 above, we used 1997 for the start date.

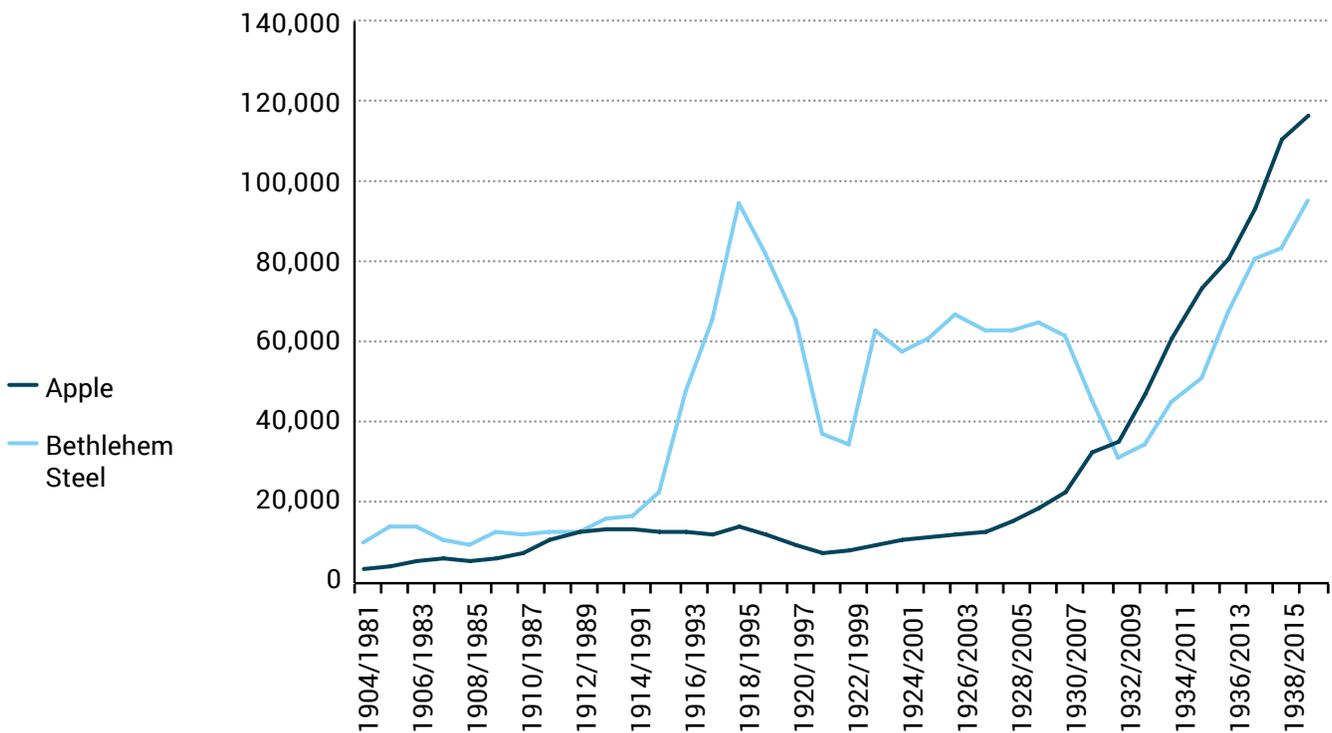
But, as we also noted at the beginning of the paper, we can compare Apple to Bethlehem Steel, using the earlier start date of FY 1981. Or let’s match Apple’s job growth up against that of Bethlehem Steel, which was the second largest steel maker and the biggest shipbuilder during World War II. Apple hit 116,000 full-

time equivalent employees in 2016, 35 years after its fiscal year 1981 initial public offering. By comparison, Bethlehem Steel averaged roughly 95,000 employees on payroll in 1939, 35 years after its 1904 incorporation.²⁰ (Indeed, Bethlehem Steel could trace its lineage much

further back to the founding of the Bethlehem Iron Company in 1861).

That's shown in Figure 4, below.

FIGURE 4: Bethlehem Steel vs. Apple: The First 35 Years of Employment



Data: Annual Reports

Note that Bethlehem changed its method of calculating employment several times over this period.

Finally, let's compare Microsoft's time path of employment to that of IBM, two companies that have a long history together. IBM, which had more than 380,000 workers globally as of 2016, is one of the largest corporate employers in the world. By comparison, Microsoft, with 114,000 employees, is a much smaller job creator.

But that comparison fails to take into account the difference in the age of the two firms. IBM started in 1911 as the Computing-Tabulating-Recording Company (C-T-R), which was a merger of the Tabulating Machine Company with the International Time Recording Company and the Computing Scale Company of America, both of which had been started a decade earlier.²¹ The new company had 1,300 employees and offices and plants in New York, Michigan, Washington, D.C., and Canada.²² In 1924, more than 90 years

ago, IBM changed its name from the Computing-Tabulating-Recording Company (C-T-R) and became International Business Machines. By contrast, it's been only 31 years since Microsoft's 1985 IPO.

In fact, Microsoft's job growth over its three decades as a public company far exceeds IBM's first three decades of job growth. Since 1985, Microsoft has averaged a 16.5 percent annual employment growth rate. By contrast, IBM grew from roughly 3,000 to 56,000 workers in the 31-year stretch from 1924 to 1955. That's a strong 9.5 percent annual employment growth rate, but still slower than Microsoft's.²³ We note that Microsoft's domestic employment of 63,000 in 2016 substantially exceeds IBM's 1955 domestic employment of 39,000.

COMPARISON OF TECH/TELECOM COMPANIES WITH POST-WAR INDUSTRIAL COMPANIES

What about a more recent comparison? As noted earlier, journalists have consistently complained that the leading tech/telecom companies don't employ many workers compared to the big industrial companies of the past. However, as far as I know, no one has actually done the comparison.

Table 3 identifies the top 10 tech/telecom companies by market cap as of June 2017, and reports their global workforce figure as of the latest annual report of that date, and then 10 years earlier. We made no attempt to correct for different workforce concepts (some companies use full-time equivalents, while others use headcounts).

TABLE 3: Ten Most Valuable Tech/Telecom Companies as of June 2017

COMPANY	EMPLOYMENT (THOUSANDS)	
	2006/07	JUNE 2017*
APPLE	18	116
ALPHABET	11	72
MICROSOFT	71	114
AMAZON	14	341
FACEBOOK	1	17
AT&T	303	269
VERIZON	242	161
COMCAST	90	159
ORACLE	75	138
INTEL	94	106
TOTAL	918	1,491
10-YEAR PERCENTAGE INCREASE IN JOBS		63%

*Based on most recent annual report available as of June 2017, and annual report 10 years earlier. Data: Annual reports, PPI

TABLE 4: Ten Most Valuable Industrial Companies as of December 1979

COMPANY	EMPLOYMENT (THOUSANDS)		
	1959	1969	1979
IBM	95	259	337
GENERAL MOTORS	557	794	853
GENERAL ELECTRIC	247	318	405
EASTMAN KODAK	71	110	126
DUPONT	86	118	134
3M	25	66	88
DOW CHEMICAL	27	47	56
MERCK	12	21	31
XEROX	2	55	116
JOHNSON & JOHNSON	14	21	72
TOTAL	1,136	1,810	2,218
PERCENTAGE INCREASE		59%	23%

Based on annual report for that year.
Data: Sibilis Research, annual reports, PPI

Table 4 identifies the top 10 industrial companies, by market cap, as of December 1979. We picked that year because it was the all-time peak for manufacturing employment in the United States. All the names on the list are familiar ones, and the list encompasses a wide range of industries within manufacturing.

Comparing the 2017-vintage tech/telecom leaders and the 1979-vintage industrial leaders

leads to several observations. First, it's true that the 1979-vintage industrial leaders employed 49 percent more workers (2.2 million) than the 2017-vintage tech/telecom leaders (1.5 million). Extending the list to 15 companies wouldn't change things much. Ford and Caterpillar would join the industrial leaders, while IBM and Hewlett-Packard Enterprise would join the tech/telecom leaders.

The average employment of the vintage-2017 tech/telecom leaders is 149,000, compared to a 222,000 average for the vintage-1979 industrial leaders. However, the industrial average is heavily influenced by General Motors, which is an outlier. Surprisingly, if we omit General Motors, the employment average of the other industrial companies is 152,000, very close to the tech/telecom average.

To put it another way, without General Motors, the industrial list has a couple of large companies (IBM, GE); several mid-size companies (Kodak, DuPont, Xerox) that are just over 100,000 employment; and at least one smallish company in terms of employment (Merck). Similarly, the

tech/telecom list contains a couple of companies over 200,000, while Microsoft, Oracle, and Apple are roughly the same size as Xerox, Kodak, and larger than 3M. Meanwhile, Facebook is only a bit smaller than GM.

Note that these are global employment numbers. However, the domestic share of employment is roughly 65-70 percent for both vintages, as far as we can tell, based on available data (Table 5). Seven out of 10 companies in both 1979 and 2017 provided enough information to closely estimate domestic employment. For the other companies, we used proxy measures such as domestic share of assets or long-lived assets.

TABLE 5: Globalization comparison between 1979-vintage industrial leaders and 2017-vintage tech/telecom leaders

	DOMESTIC SHARE OF EMPLOYMENT, EXACT NUMBERS AND CLOSE ESTIMATES*	DOMESTIC SHARE OF EMPLOYMENT, INCLUDING PROXY MEASURES
1979-VINTAGE INDUSTRIAL LEADERS	67%	66%
2017-VINTAGE TECH/TELECOM LEADERS	70%	71%

*For both 1979-vintage and 2017-vintage leaders, seven companies out of 10 provided enough information to generate an accurate estimate.
 **Proxy measures include domestic share of assets and long-lived assets.
 Data: Annual reports, PPI

TABLE 6: Revenue comparison between 1979-vintage industrial leaders and 2017-vintage tech/telecom leaders

	TOTAL REVENUES (BILLIONS)	RATIO TO CURRENT-YEAR GDP
1979-VINTAGE INDUSTRIAL LEADERS	\$149.8	5.7%
2017-VINTAGE TECH/TELECOM LEADERS	\$1021.5	5.5%

Data: BEA, annual reports

The revenues of the 1979-vintage industrial leaders totaled \$149.8 billion, which equates to 5.7 percent of United States gross domestic product in 1979. The revenues of the 2017 top tech/telecom companies totaled \$1021.5 billion, based on their latest annual reports. That equates to 5.5 percent of United States gross domestic product in 2016 (which represents the most current fiscal year for most of the companies). In other words, the 2017-vintage tech/telecom leaders are roughly the same size, relative to the whole economy, as were the 1979-vintage industrial leaders (Table 6).

Taking globalization into account shifts the numbers a bit. The revenues of the 1979-vintage industrial leaders represented roughly 1.1 percent of world GDP at that time, as measured by the International Monetary Fund. The revenues of the 2017-vintage tech/telecom leaders represented 0.9 percent of 2016 world GDP.

Finally, let's consider employment growth. Employment by the 2017-vintage tech/telecom leaders rose by 63 percent from 2006 to 2016. That's a huge jump. But it's somewhat less impressive when we consider the number of people working in computer and mathematical occupations rose by 43 percent over the same stretch. So, on an annual basis, employment at the tech/telecom leaders grew at a 5 percent annual rate, while employment in computer and mathematical occupations grew at a 3.7 percent annual rate. That's a difference of 1.3 percentage points.

Employment by the 1979-vintage industrial leaders grew by 95 percent between 1959 and 1979. By comparison, the number of people working in production and nonsupervisory positions in U.S. manufacturing rose by 20 percent over the same stretch. In annual terms,

employment at the industrial leaders grew at a 3.4 percent annual rate, compared to 0.9 percent for production and nonsupervisory workers in U.S. manufacturing. That's a 2.5 percentage point difference.

TECH/TELECOM WAGES

Next we will tackle the question of wages in the tech/telecom sector. Unlike employment, we do not have direct data on wages by company. Instead, we have various databases from the Bureau of Labor Statistics on wages by industry and occupation, with some geographical information as well.

Sometimes that can be enough. For example, in a new paper on ecommerce jobs and wages, we were able to use QCEW data on wages and employment by county to analyze ecommerce fulfillment center wages. We concluded that, on average, workers in ecommerce fulfillment centers earned 31 percent more than workers in brick-and-mortar retailers in the same area.²⁴

In effect, the shift to ecommerce is "digitizing" retail. Retailers such as Walmart were early adopters of IT for their supply chains, but, in recent years, retail IT investment has lagged, putting them into the category of "medium" digitization, according to a 2015 analysis by the McKinsey Global Institute.²⁵ Indeed, brick-and-mortar salespeople were doing much the same thing—reshelving inventory and watching for pilferage—as they had been doing 20 years earlier.

The growth of ecommerce is based not just on the increased use of the Internet, but the construction of high-tech fulfillment centers, able to rapidly ship millions of orders per day on quick turnaround. In effect, ecommerce is now offering a new product/service combination that

didn't exist before—the ability to order a product from your home or desk, get it within a day, and return it easily if need be. To reliably provide consumers with this combination of product and time-saving convenience requires a lot more information technology, software, and use of broadband services than conventional retailing—but it also requires hundreds of thousands of workers, as it turns out, who are paid better than their brick-and-mortar counterparts precisely because of their higher productivity and usage of IT and telecom services. We estimate that, since 2007, the shift to ecommerce has created 400,000 new jobs in the warehouse and electronic shopping industries, while only reducing brick-and-mortar retail jobs by 140,000.

This is an example of a broader trend: Increased digitization of an industry can increase the productivity of workers in that industry and potentially create more jobs. So, when we consider wages in the tech/telecom sector, we have to examine two potential effects.

1. The rise in real wages in the tech telecom sector relative to the rest of the economy
2. The expansion of the tech/telecom and digital sector, as existing industries such as retail, motor vehicles, and construction are digitized.

The first step is to identify the industries that are currently in the tech/telecom sector. Let's acknowledge that the industrial classification scheme used by government statisticians is not designed to measure the crosscutting activities of the modern knowledge economy. For example, the BLS reports there are roughly 200,000 jobs in an industry called "Internet publishing and broadcasting and web search portals." It would be easy to assume this

industry category encompasses all of the jobs created by Google and Facebook.

However, the BLS assigns jobs by establishment, not by company, where an establishment is defined as a single location producing a single good or service. So a company such as Google—which provides search services, develops software, runs a network of data centers, sells advertising, lays fiber, and delivers an astonishing amount of video each day—may report its U.S. employees in multiple industries.

Similarly, Apple designs computers and smartphones, develops software, and runs retail and online stores, so its domestic employment may appear in multiple industries. Moreover, economists and government statisticians have been wrestling with the definition of manufacturing. Should a company that designs and sells products such as computers and smartphones, but contracts out for the actual production, be counted as a manufacturer?²⁶ The battle over whether to give "factoryless goods producers" a separate statistical category is paused for the moment, but it shows the difficulty of establishing clear industry or sector boundaries during times of structural change.

Amazon is known as an ecommerce site, but it also runs huge databases and operates fulfillment centers (which mainly are being reported in the industry category for warehousing).

Or consider customer service call centers. Call centers have their own industry category, so, if a telecom company opens up a standalone call center, those jobs might show up in the NAICS code for call centers rather than telecom (overall call center employment is up 38 percent over the past decade). Workers for online travel sites such as Expedia might be reported in the

Internet industry or in the industry for “Travel Arrangement and Reservation Services.” Etsy, the online marketplace, might be reporting its jobs under data hosting, electronic shopping, or any of a number of other industries.

Moreover, sometimes industry codes may stay the same but the activities in the industry may become more digitized. Ecommerce is one obvious example of that, but another one is publishing. Twenty years ago newspaper and magazine publishing was still mainly a physical industry. Today it’s mostly digital. Interestingly enough, BLS data shows that the number of fulltime reporters, correspondents, and news analysts is at the same level as in 2006, and median wages are 35 percent higher in nominal terms, and 15 percent in real terms.

Keeping all these issues in mind, we sketch out our current division of the economy into a tech/telecom sector, a digital sector, and a physical sector (Table 7). The digital sector includes those industries.²⁷ Digital industries tend to be

industries where the output is relatively easy to digitize. These include Internet, tech and software industries; telecom and broadcasting; ecommerce; content industries such as journalism and entertainment; and a variety of financial, professional, and technical activities.

The digital industries include roughly 70 percent of all private sector investment in information technology equipment and software, and roughly 70 percent of private sector employment of computer and mathematical occupations. In other words, the digital sector is driving the great majority of private sector investment in IT physical, intellectual, and human capital.

Within the digital sector, we can focus on a set of industries we call the tech/telecom sector. These focus on the core businesses that drive the information economy. The tech/telecom sector accounts for roughly half of private sector employment of computer and mathematical occupations, but only about 6 percent of employment.

TABLE 7: A Moving Target: Dividing the Economy, August 2017

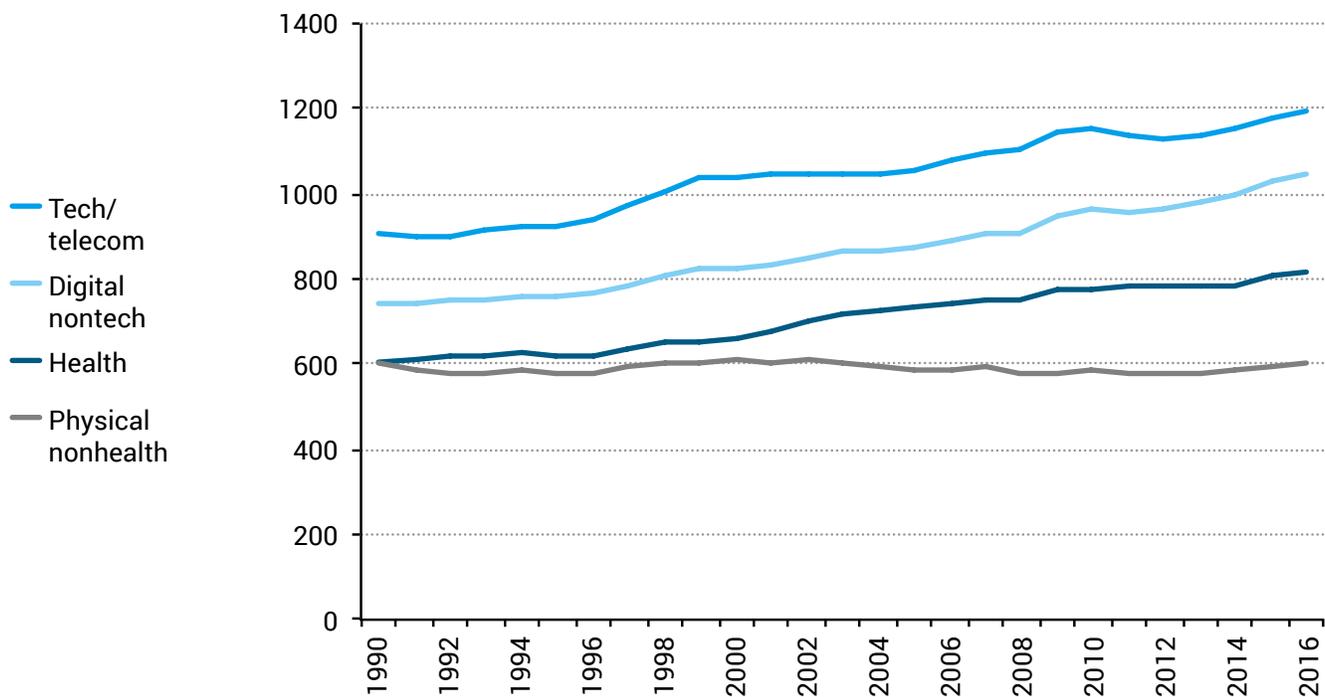
TECH/TELECOM SECTOR	DIGITAL SECTOR	PHYSICAL SECTOR
Tech	Tech	All other industries except healthcare
Computer and electronics manufacturing	Computer and electronics manufacturing	Manufacturing except computers and electronics
Computer and software wholesalers	Computer and software wholesalers	Wholesale and retail trade, except ecommerce
Software publishing	Software publishing	Mining
Data processing and hosting	Data processing and hosting	Construction
Internet publishing and search	Internet publishing and search	Agriculture
Computer systems design	Computer systems design	Utilities and transportation
Telecom and Broadcasting	Telecom and Broadcasting	Transportation
Wired and wireless telecom	Wired and wireless telecom	Social assistance
Satellite telecommunications	Satellite telecommunications	Temporary help
Television and cable	Television and cable	Waste management
Ecommerce	Ecommerce	Leisure and hospitality
B2B electronic markets	B2B electronic markets	Education
Electronic shopping /mail order	Electronic shopping/mail order	Healthcare
Warehousing*	Warehousing*	Hospitals
Content	Content	Ambulatory care
Print and Internet publishing	Print and Internet publishing	Nursing homes
Video, movies, and music production	Video, movies, and music production	
	Digital nontech	
	Professional and technical activities (including accounting, engineering, design, market research, advertising)	
	Finance and insurance	
	Management of enterprises	
	Office support, business support, and travel support	

*Increase since 2011
Source: PPI

This is not a static schema. In fact, the original version of this analysis, done a year ago, did not include ecommerce as part of the tech/telecom sector. But the rapid expansion of fulfillment centers has convincingly moved ecommerce into its new category.

We will now calculate real weekly wages for production and nonsupervisory workers in the tech/telecom sector, the digital sector outside of tech/telecom, the health sector, and the physical sector outside of health.

FIGURE 5: Tech/telecom workers have gained ground
Real weekly wages, 2016 dollars, production and nonsupervisory workers



Data: BLS, CEE

This chart is very clear. For the past 25 years, real wages for production and nonsupervisory workers in the physical sector have been completely flat, while real wages in the tech/telecom sector, digital nontech, and health sectors have risen significantly.

In 2016, the average weekly wage for production and nonsupervisory workers in the tech/telecom sector was \$1,193, which translates to a full-time annual salary of \$62,038. By comparison,

the average weekly wage in the physical sector is \$601, which translates to a full-time annual salary of \$31,262.

Now we look more closely at the pay differential by occupation, using data from the BLS Occupational Employment Statistics (OES), which gives national occupation pay by detailed industry. Table 8 compares tech/telecom wages with physical sector wages for selected mid-skill occupations.

For example, on average, customer service representatives get paid 16 percent more in the tech/telecom sector than in the physical sector. Installation, maintenance, and repair workers get paid 21 percent more in the tech/telecom sector,

while people working in business and financial operations occupations get paid 23 percent more on average. Designers get paid 38 percent more in the tech/telecom sector, but that may partly reflect the difference in the nature of the work.

TABLE 8: Tech/Telecom Wages for Selected Occupations

OCCUPATION	TECH/TELECOM	PHYSICAL	TECH/TELECOM PREMIUM*
DESIGNERS	\$27.46	\$19.85	38%
BUSINESS & FINANCIAL OPERATIONS	\$39.60	\$32.08	23%
INSTALLATION, MAINTENANCE & REPAIR	\$26.54	\$21.85	21%
COMPUTER & MATHEMATICAL	\$44.79	\$38.10	18%
OFFICE & ADMINISTRATIVE SUPPORT	\$19.51	\$16.80	16%
CUSTOMER SERVICE REPRESENTATIVES	\$18.93	\$16.32	16%
RETAIL SALESPEOPLE	\$15.06	\$13.04	15%
SALES REPRESENTATIVES, SERVICES	\$32.17	\$28.04	15%

*Pay differential between tech/telecom sector and physical sector
Data: BLS OES, PPI

DIGITIZATION OF PHYSICAL INDUSTRIES

The analysis of the previous section assumes a static industry and occupational structure. In fact, a key trend is the digitization of existing physical sectors, and their incorporation into the tech/telecom or digital sectors. We hypothesize that this shift is associated with changes in the job structure of industries toward higher wage jobs.

We have already mentioned how the digitization of retail is increasing the number of fulfillment center workers, who earn significantly more than brick-and-mortar retail workers in the same area.

In that case the shift to ecommerce increases the overall number of jobs while raising pay.

Similarly, the shift toward connected and autonomous or semi-autonomous cars will have the effect of bringing much of the motor vehicle ecosystem into the tech/telecom sector, which pays higher wages for more sophisticated work. That will make the pay structure of the auto repair industry (average wage of about \$18.26/hour) look more like the pay structure of the “Electronic and Precision Equipment Repair and Maintenance” industry (\$24.25/

hour) and “Commercial and Industrial Machinery Equipment Repair and Maintenance” (\$23.96/hour). As the skill levels rise, so will the pay.

The analogy here is the mechanization of transportation in the early part of the 20th century. The shift from horse-drawn vehicles to power-propelled trucks shifted the pay structure for drivers upward while increasing demand, as the trucks were able to transport more goods at a faster rate.²⁸ Indeed, the number of truck drivers soared as the price of transportation fell, because whole new markets appeared.

CONCLUSION

In this paper, we have drawn an explicit analogy between today's tech/telecom leaders and the industrial leaders of the past. Their early employment trajectories are surprisingly similar, and, while the industrial leaders in 1979 employed more workers than the tech/telecom leaders of 2017, most of the difference was due to one company, General Motors. We suggest that, as the tech/telecom sector expands to more industries such as ecommerce, we will see overall wages rise as well.

Appendix: Methodology

Our goal is to compare the employment growth among firms from different eras. The current tech firms are greenfield startups, in the sense that a new company was started from scratch and went public relatively soon afterward. For these companies the fiscal year of the IPO is the logical starting point.

By comparison, most of the earlier big job creators—such as U.S. Steel, General Motors, and General Electric—were formed by merging several smaller, existing companies. For these companies, we picked the date of corporate formation that the company itself would pick as its beginning date. For AT&T (old) and Bethlehem Steel, we picked the date of corporate restructuring into its “final” form.

The two exceptions are IBM and Apple. As noted earlier, Apple has two natural start dates: FY 1981 for its IPO and FY 1997 for the return of Steve Jobs and the absorption of Next Software. IBM has two logical start dates: 1911, when C-T-R was formed, and 1924, when the company first took the name IBM. We chose the second one, even though IBM itself celebrated its centennial in 2011.

We used employment data from annual reports when available, or corporate histories. In some cases, numbers from different sources or different years of annual reports were inconsistent.

References

- 1 <https://www.axios.com/how-silicon-valley-has-revolutionized-the-economy-in-1-chart-2413041113.html>
- 2 Michael Mandel and Bret Swanson. 2017. "The Coming Productivity Boom: Transforming the Physical Economy with Information."
- 3 Chad Syverson. 2011. "What Determines Productivity?" *Journal of Economic Literature* 49:2, 326–365
- 4 Dan Andrews, Chiara Criscuolo and Peter N. Gal. 2015 "Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries," OECD
- 5 Foster, Lucia, John Haltiwanger, and C. J. Krizan. 2006. "Market Selection, Reallocation, and Restructuring in the U.S. Retail Trade Sector in the 1990s." *Review of Economics and Statistics*, 88(4): 748–58.
- 6 That structural problem is the whole point of Clay Christenson's Innovator's Dilemma
- 7 <http://www.pewsocialtrends.org/2015/12/09/1-the-hollowing-of-the-american-middle-class/>
- 8 Michael Mandel. 2017. "How Ecommerce Creates Jobs and Reduces Income inequality," Progressive Policy Institute.
- 9 Census Bureau. 1975. *Historical Statistics of the United States*, Chapter D, page 162, 166.
- 10 <http://www.autonews.com/article/20030616/SUB/306160722>
- 11 <http://www.mackinac.org/article.aspx?ID=651>
- 12 1929 GM annual report
- 13 1955 GM annual report
- 14 http://www.mlive.com/business/index.ssf/2008/09/a_brief_history_of_general_mot.html
- 15 This data is mostly pulled from contemporary annual reports. We pick 1919 to avoid World War I and the downturn of 1920-21, and 1955 as the initial return to a normal economy after the Korean War, World War II, and the Great Depression.
- 16 An important caveat: The employment figures from the annual reports include overseas jobs as well as jobs outside of manufacturing, so we can't do a direct comparison.
- 17 <https://www.ge.com/about-us/fact-sheet>
- 18 Census Bureau. 1975. *Historical Statistics of the United States: Colonial Times to 1970*.
- 19 American Telephone & Telegraph hit the same milestone in 1926, 27 years after its 1899 absorption of the local Bell systems. Walmart went over 300,000 associates in its 1991 fiscal year, its 21st year as a public company.
- 20 This number is for U.S. workers, but Bethlehem had no plants or shipbuilding facilities outside of the country.
- 21 https://www-03.ibm.com/ibm/history/history/decade_1900.html

- 22 https://www-03.ibm.com/ibm/history/history/decade_1910.html
- 23 We could start the comparison at 1911 for IBM, when C-T-R was created out of three smaller companies, and 1975 for Microsoft, when the company was first founded. But that comparison is even more favorable for Microsoft.
- 24 Michael Mandel. 2017. "How Ecommerce Creates Jobs and Reduces Income inequality," Progressive Policy Institute.
- 25 McKinsey Global Institute, 2015. "Digital America: A Tale of the Haves and Have-Mores"
- 26 https://www.bls.gov/bls/factoryless_goods_producers.htm
- 27 Michael Mandel and Bret Swanson. 2017. "The Coming Productivity Boom: Transforming the Physical Economy with Information."
- 28 According to one source, pay for truck drivers in Cleveland in 1915 was 32.5 cents per hour for drivers of power-propelled vehicles, compared to a range of 19.2-29.2 cents per hour for drivers of horse-drawn vehicles. From Ralph Fleming. 1916. Labor Conditions and Wages in Street Railway, Motor and Wagon Transportation in Cleveland.



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