Human Capital and the Future of Work:

Implications for Investors and ESG integration

Sakis Kotsantonis and George Serafeim*

Abstract

Human capital development (HCD) is a key consideration for most companies, but only recently investors have focused on understanding the risks and opportunities related to human capital with the emergence of environmental, social and governance (ESG) investment frameworks and impact investing. We argue that the importance of human capital is likely to be magnified in an environment of rapid technological change where the future of work is uncertain and that existing frameworks to measure and evaluate human capital development might not be fit for purpose. Against this backdrop, we derive a human capital development metric that focuses on outcomes rather than inputs; show that even in the current disclosure landscape one could measure with reasonable accuracy this human capital development metric for thousands of companies; and provide exploratory evidence on its relationship with employee productivity. Moreover, we develop an estimate of probability of automation of job tasks for each sub-industry and show the relation of this probability to elements of our HCD metric and other human capital characteristics. Finally, we outline an investor engagement framework to improve the disclosure landscape related to HCD and to empower effective investment stewardship.

* Sakis Kotsantonis is the managing partner of KKS Advisors. George Serafeim is the Charles M. Williams of Business Administration at Harvard Business School. We are grateful to the Ford Foundation for financial support in developing practical solutions for measurement and integration of human capital considerations in investment decisions. Contact details: Kotsantonis (sakis@kksadvisors.com), Serafeim (gserafeim@hbs.edu).

Contents

Introduction

Human capital development is a key consideration for most companies around the world. While human capital has been a key consideration for businesses, it has only been more recently that investors have paid attention to it. With the emergence of environmental, social and governance (ESG) investment frameworks and impact investing activities human capital has propelled to an important pillar of investment analysis both from a financial and a social impact perspective. This is because human capital is now recognized as one of the most important drivers of competitiveness, value creation and sustainable competitive advantage. Moreover, human capital development (HCD) through strong workplace practices is linked to positive societal impacts as manifested by better health outcomes and well-being.

The importance of human capital is magnified in an environment of rapid technological change where the future of work is uncertain. How are organizations investing to develop their human capital to adapt to these changes? Are those investments effective? Will technological driven automation of job tasks bring prosperity, and if so, how quickly and to who? Or will it negatively impact workforces and have profound and adverse effects on society?

In this evolving landscape, existing frameworks to measure and evaluate human capital development might not be fit for purpose. For example, many metrics that represent proxies for human capital development measure inputs, such as dollars spent in training, rather than outcomes, such as improved wages over time. Moreover, they do not yet incorporate the profound and increasingly visible effects of automation on human capital issues.

Against this backdrop, this paper has several goals. The first group of goals relate to the development of a HCD metric that is actionable and cost-effective. Within this context our aims are to propose a HCD metric that focuses on outcomes; show that even in the current disclosure landscape one could measure with reasonable accuracy this HCD metric for thousands of companies; and provide some exploratory evidence on its relationship with employee productivity.

The second group of goals relate to creating the infrastructure to understand the impact of automation of job tasks at the sub-industry level. We focus on sub-industries as investors analyze sub-industries to understand competitive dynamics and therefore our data might fit seamlessly within the existing tools and models. Within this context our aims are to develop an estimate of probability of automation of job tasks for each sub-industry and show the relation of this probability to elements of our HCD metric and other human capital characteristics.

Our key results are as follows:

- First, even though companies have not disclosed the necessary data to exactly measure our HCD metric, investors have the data to calculate now a proxy for thousands of companies around the world.
- Second, the HCD metric exhibits meaningful relations to key measures of productivity raising the possibility that it could be relevant to business valuation and investment analyses.
- Third, most sub-industries exhibit relatively high degrees of job task automation. This is because most occupations with low probability of automation tend to be occupations that do not fall under the corporate sector or they are very small percentage of the occupations in most subindustries.
- Fourth, sub-industries with higher probability of automation have higher training expenditures per employee and employee turnover.

- Fifth, investors need to engage in a constructive way with companies to improve the disclosure landscape and be effective stewards of their investments as human capital development will become a key consideration in an environment of rapid technological change.

Human capital development metrics

Recently there have been several efforts to increase disclosure of human capital development metrics. Below we review a few of them:

Europe

The UK requires companies to consider their impact on a range of stakeholders and broader society. For example, the 2006 Companies Act states that under their duty to promote the success of the company, a director must consider the best interests of their employees.[1] While not directly related to human capital reporting, this legally binding duty indicates the direction that the government is moving towards. More recently the UK's Corporate Governance code, which applies to all companies operating in the UK with a premium listing on a comply or explain basis, promotes company reporting on human capital data.[2] However, it offers little guidance on measurement methodology to companies resulting in data that is inconsistent and incomparable.

Denmark has been identified as a pioneer when it comes to mandating company reporting on human capital metrics. The government requires companies to report on the formation of intellectual capital in their annual reports and many companies additionally will report on human capital metrics alongside this.[3]

Case study: Workforce disclosure initiative

In the UK, The Workforce Disclosure Initiative (WDI) launched in 2017 in response to investor demand for more meaningful and consistent company reporting on workforce data. The initiative, led by ShareAction, is supported by more than 120 investors with assets under management in excess of $13 trillion[4]. In 2018, 90 companies, including Adidas, Microsoft and BHP, responded to the WDI survey; an increase of more than 100% from 2017. Among 34 categories relating to metrics on direct operations and supply chain workforces, companies are asked to report on their turnover and training by employee age, gender and seniority[5].

United States

In the US there are no laws around reporting on human capital metrics. However, investors in the US are increasingly interested in understanding how companies manage human capital. In 2017 a group of US investors called The Human Capital Management Coalition, representing $2.8 trillion in assets under management, created a petition for the SEC to mandate issuer disclosure on human capital policies, practices and performance[6]. The coalition sought additional mandated disclosure to enable investors to evaluate company performance on human capital management - motivated by the understanding that human capital related information can be financially material.

Global

In January 2019 the International Organization for Standardization introduced a new standard for human capital reporting.[7] It comprises guidelines and metrics on diversity, leadership, culture, turnover and skills among other areas. It aims to standardize key metrics, ensuring they are internationally recognizable and useful to a wide range of stakeholders.

A new human capital development metric

When it comes to employee data, most companies measure inputs rather than outcomes.[8] Therefore, companies are not providing investors with a view of how their efforts to develop human capital are impacting the workforce. As a result, organizations may spend time and effort on improving metrics and key performance indicators, while often receiving minimal outcomes.

We propose a new way of measuring the outcome of a firm's investments in human capital. Overall, the aim of the HCD metric is to enable the continuous assessment of the effectiveness of a firm's investments:

$$HCD = median\ of\ [(\frac{Change\ in\ Employee\ Wage}{Starting\ Employee\ wage + Training\ Expenditures})$$

$$x\ (1/\ Employee\ turnover\ rate)]$$

There are three core components of the Human Capital Development (HCD) metric:

1. **Employee Wage Change:** determines how employees' wages change over time, allowing companies and investors to see if training programs are enabling employees to increase their wages and improve their livelihoods.

2. **Training Dollars:** demonstrates how much a company spends on training its employees per year. Company spend on training should be indicative of their investment in reskilling and retraining employees.

3. **Employee Turnover:** shows the percentage of employees that leave a company over a set period. This demonstrates whether companies can retain employees, which in the long run will determine if they are able to retain the skills required within the firm.

The HCD metric reflects the ability of management to train employees on issues that improve their earnings potential and livelihoods, while at the same time creating a work environment where employees want to stay. We propose median instead of average change to avoid the metric reflecting the impact of a few outlier observations. Another attractive aspect of this metric is also its inherent verifiability, making it possible subject to assurance by auditors.

What is the sample from which a company could generate data for this metric? The set of people that generate the data for the metric could be a randomly drawn set of employees within certain levels of seniority, tenure, wage level, gender, ethnicity or other individual characteristics of interest. The number of people in the sample could be a function of the number of employees in the organization. Companies with more employees could construct a sample where the median estimate is calculated across a larger set of employees.

Constructing a proxy for the HCD metric

Unfortunately, companies are not providing currently the necessary data to construct such a metric making it impossible to understand its exact properties and relation to other measures of interest. Here we provide the first attempt at constructing such a metric with the available data to us.

We collect data from Bloomberg on total salaries and wages and total employees, each year between 2005 and 2017, for a global sample of companies that disclose these data items. Moreover, we collect data on employee turnover and employee training expenditures. We keep only firms that disclose data on salaries and wages, number of employees and employee turnover while for employee training we assume that if the information is missing then it is zero.[1] The tables showing the distribution of observations across years, industries and countries are presented in the Appendix. Our sample increases over time as disclosure of turnover has improved. It represents a wide variety of industries and countries. A somewhat interesting fact is that we have relatively few observations for US firms. However, this is not surprising because most US firms do not separately disclose employee wages.

Because we do not have the exact data to construct the proposed metric, we attempt to approximate it. In an ideal state we would like to be able to observe the evolution of wages of a random group of employees to understand human capital development. Instead we can observe the total compensation allocated to the total number of employees in the organization. Therefore, we construct this proxy for HCD as:

$$Proxy\ for\ HCD\ = \left\{ \frac{\left[\left(\frac{Employee\ Wage_t}{\text{Employees}_t}\right) - \left(\frac{Employee\ Wage_{t-3}}{\text{Employees}_{t-3}}\right)\right]}{\left[\left(\frac{Employee\ Wage_{t-3} + Training\ \text{Expenditures}_{t-3}}{\text{Employees}_{t-3}}\right)\right]} \right\}$$

$$x\ (1/\ Employee\ turnover\ rate_t)$$

To increase the likelihood that we measure meaningful human capital development we measure changes in employee wages over three-year periods rather than one-year periods as investments in training and workplace practices might take time to have an impact on employees.

An obvious problem with this approximation of our metric is that it might favor companies that experience low or even negative employee growth and penalize companies that are growing their workforce. To account for that effect, we estimate for every year cross-sectional models where the dependent variable is our HCD metric and the independent variables are 3-year employee growth, country indicator variables and industry indicator variables. Indeed, we find that the HCD metric exhibits a strong negative relation with employee growth.[2] Therefore, we use the unexpected (residual) component of the HCD metric to ensure that our metric is uncorrelated to employee growth.

The table below presents all industries with more than 50 observations and how the average HCD metric for the industry would classify them. In the low category we find many of the industries in the energy and utilities sectors but also the airlines and the hospitality industries. In contrast, in the high category we find industries in the financial services sector but also in the food and beverages sector and in the transportation services sector such as auto parts, air freight and logistics, and transportation infrastructure.

[1] This assumption makes no difference for our results. Excluding firms with missing employee training expenditures does not change any of our conclusions.

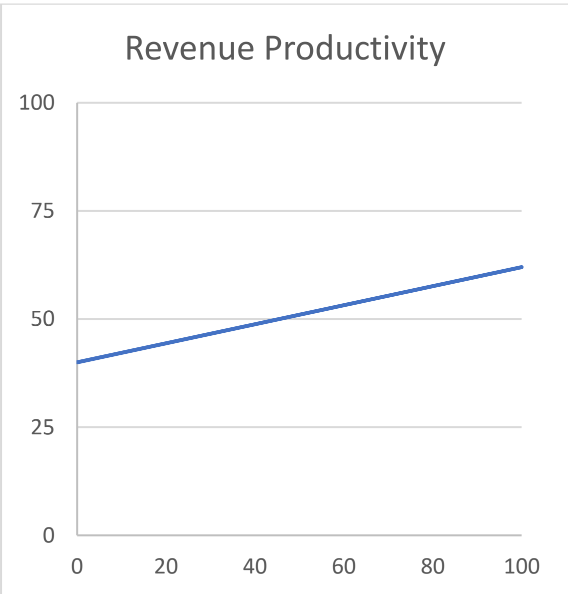
[2] The overall model explains anywhere between 20 and 40% of the variation in the HCD metric in any given year.

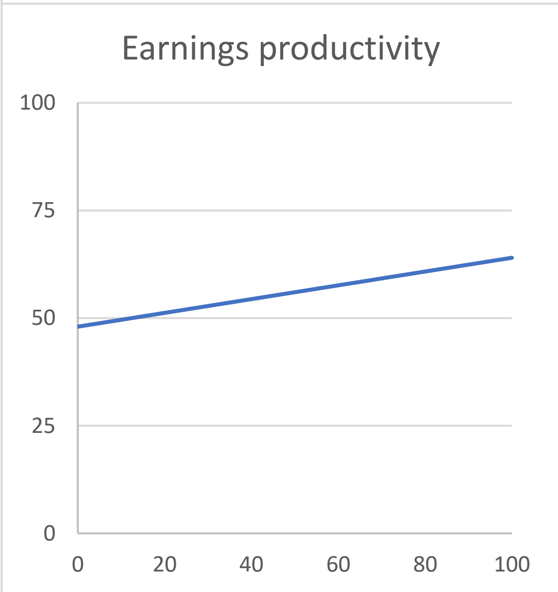
Human Capital Development Metric		
Low	Medium	High
Gas Utilities	Machinery	Capital Markets
IT Services	Water Utilities	Chemicals
Household Durables	Industrial Conglomerates	Construction Materials
Diversified Telecommunication Services	Pharmaceuticals	Real Estate Management & Development
Multi-Utilities	Electrical Equipment	Diversified Financial Services
Metals & Mining	Electric Utilities	Electronic Equipment, Instruments & Components
Hotels, Restaurants & Leisure	Commercial Services & Supplies	Auto Components
Independent Power and Renewable Electricity Producers	Food & Staples Retailing	Specialty Retail
Airlines	Health Care Equipment & Supplies	Beverages
Energy Equipment & Services	Professional Services	Building Products
Paper & Forest Products	Banks	Equity Real Estate Investment Trusts (REITs)
Semiconductors & Semiconductor Equipment	Textiles, Apparel & Luxury Goods	Food Products
Oil, Gas & Consumable Fuels	Media	Transportation Infrastructure
Insurance	Trading Companies & Distributors	Road & Rail
Construction & Engineering	Automobiles	Air Freight & Logistics
	Aerospace & Defense	Wireless Telecommunication Services

HCD metric and its relationship to productivity

Notwithstanding these industry statistics we are interested at the firm-level on how the metric might be related to the output produced by employees. Therefore, we estimate the relation between the HCD metric and changes in revenue and earnings productivity (revenue or EBITDA per employee) for the firms in our sample. In all the models we include controls for the industry, country and size of the company. To make inferences easier we transform both the HCD metric and the productivity metrics to ranked measures that reflect the percentile that each firm falls in. Therefore, each variable ranges from 0 to 100.

In the two graphs below, we observe a positive relation between the HCD metric and the productivity metrics, both for revenue and earnings productivity. Moving from the 20th percentile of the HCD metric to the 80th percentile is associated with a move from the 43rd percentile to the 60th percentile for revenues productivity and from the 45th percentile to the 58th percentile for earnings productivity. The lower increase for earnings productivity makes sense given that higher labor compensation is accounted as an expense in the income statement.





The Appendix presents the econometric models using the raw variables (before the rank transformation to percentiles) for the interested reader. We estimate models using both changes in productivity and the levels of productivity as the dependent variable including and excluding controls for starting level productivity for each firm. Across all models the HCD metric is positively associated with productivity.

Our key conclusions from this empirical exercise are two-fold:

- First, although companies have not disclosed the necessary data to exactly measure the HCD metric investors could calculate now a proxy for it for thousands of companies around the world.
- Second, the HCD metric exhibits meaningful relations to key measures of productivity raising the possibility that it could be relevant to business valuation and investment analyses.

Investing in human capital: shaping the future of work

The HCD metric described in the previous section outlines a new way of measuring the outcome of a firm's investments in human capital. A key component of the HCD is the training spend per employee. A key question is not only how much money is spent but more importantly, for what reason. In order to remain competitive, companies need to invest in the right mix of skills, knowledge and capabilities both in terms of their employee's training but also in terms of their recruitment practices.

Advances in artificial intelligence (AI), machine learning and big data can have a significant impact in the mix of skills, knowledge and capabilities required to perform different tasks. These include evolving jobs that reduce physical strain on workers, improved safety, increases in productivity, and more meaningful work that ultimately leads to higher rates of job satisfaction.

At the same time, new capabilities brought by these technologies evoke widespread fear of diminishing worker rights, mass job losses and unequal access to opportunities due to the lack of relevant skills and education needed for the jobs of the future. While technological advancement is not a new phenomenon, the current pace at which technology spreads and disrupts industries is incomparable to previous waves of automation.[9] A recent report from OECD highlighted the impact of automation by estimating the share of workers in occupations at high risk of automation by income class.[10] The difference in the percentage of occupations at high risk of automation between upper income and lower income workers was about 10% in OECD countries.

Disruptions arising from new technologies have the potential to polarise workforces and the broader society. Carefully managing the development and dissemination of automation and AI as well as the impact on the workforce will be particularly important to ensure disadvantaged populations and minorities are not disproportionately affected in the transition.

We identify two equally important reasons why investors should consider the impact of automation on the future of work:

- the risk-return case of better understanding how different businesses identify the skills that will become more important than others as AI and automation are adopted (re-skilling and upskilling current employees, changing recruitment practices for future employees)
- the impact case of supporting a transition to more automated tasks through a process that does not have a destabilizing systemic impact on society.

The risk-return case

Human capital is a key element of ESG frameworks and impact investing activities. Recent research has shown that among multiple Environmental and Social metrics, Diversity and Employee turnover are two out of the four metrics that have shown the strongest and most consistent relationship with financial performance.[11] At the same time such frameworks have not yet updated to incorporate the profound and increasingly visible effects of automation on human capital issues. For example, employee satisfaction and wellbeing could decrease if there is a risk of mass automation and mass layoffs, which in turn could lead to mitigating any productivity benefits from the adoption of new technologies and even to a reduction in overall productivity.

At a societal scale, inequality due to loss of jobs and a lack of reskilling opportunities could have a significant impact for investors. Increased inequality can destabilize the financial and social systems that investors operate in, increasing uncertainty and leading to declines in economic activity.[12] This could occur through a lack of jobs contributing to decreases in consumption, declines in net worth and the ability to access capital, all of which inhibit a country's Gross Domestic Product (GDP). This can have a negative impact on long-term investment performance, especially for large investors and asset owners that depend on long-term economic growth.

The impact case

The impact investing market has expanded fivefold between 2013 and 2017, reaching $228 billion globally.[13] This market could grow even further and bring considerable benefits as investors are increasingly looking for ways to generate benefits for society alongside financial returns. For investors that care about social impact, a better understanding of how automation will affect jobs is valuable. For example, large-scale automation could lead to increasing inequality between highly skilled high-paid workers and low skilled low-paid workers.[14] Research also indicates that technology enabled changes to work tend to affect lower-paid and less qualified workers more than others.[15] These challenges can provide opportunities for impact investments, both in businesses that manage the transition better but also in supply chain solutions and initiatives that offer support through training and education programs.

Developing a sub-industry automation score database

While it is becoming increasingly apparent that the role of technology in reshaping the future of work is an important topic to understand, we currently lack the infrastructure and tools to accurately model and predict these trends. To fill this void we have developed a new database that provides an industry outlook on the future of work. To build the database we adopted the probability of occupation automation scores calculated by Frey and Osbourne to calculate probability of automation scores for Global Industry Classification Standards (GICS) sub-industries[16].

Frey and Osbourne (2017) have calculated the probability of automation of 702 occupations by assessing the extent of automation of non-routine cognitive tasks across occupations. In order to do so, the authors identified some inhibiting bottlenecks to automation that persist across occupations. These were broken into the following categories: perception and manipulation tasks, creative intelligence tasks, social intelligence tasks. Beyond these bottlenecks, it is already technologically possible to automate almost any task, provided that sufficient amounts of data are gathered, and computer resources are allocated. As a result, their model predicts the pace at which these bottlenecks can be overcome, which in turn can determine the extent of automation across occupations.

Figure 2 shows the distribution of the 702 occupation automation scores calculated by Frey and Osbourne. We observe that approximately 13% of the occupations in the sample have a probability of automation score below 0.02. Similarly, we see that the same percentage of occupations have a high score above 0.94. Overall, we note that while there is some agreement in the literature about the relative probability of automation across professions and industries, there is significant disagreement about the outcome of automation, as it might not necessarily lead to job losses.[17] We do not assume the latter, only the former. Therefore, our analysis demonstrates the relative propensity across subindustries that jobs will be automated.

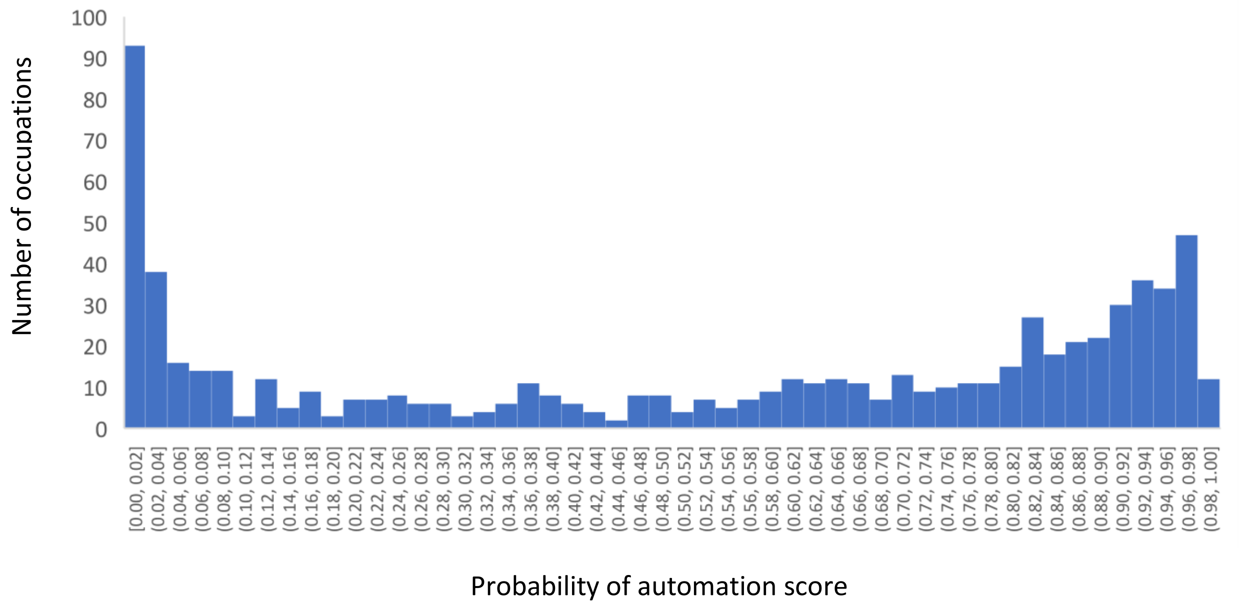


Figure 1. Distribution of occupation probability of automation scores

Probability of automation scores at the occupation level are useful, but to make them more relevant to an investor audience, we developed a methodology to aggregate these scores at the subindustry level. For each occupation we took the top five industries with the highest level of employment from the U.S. Bureau of Labour Statistics.[18] We mapped these five industries to their corresponding GICS sub-industries. Where it was not possible to map the occupations and the industries to GICS sub-industries, due to lack of representation in GICS (e.g. public sector or no clear match), we have marked these in our underlying dataset and excluded the occupations from our analysis.

Table 2 below shows an example for the occupation of *Computer Programmers*:

Industry	Employment	Percent of industry employment
Computer systems design and related services	99,370	4.46
Software publishers	16,510	4.19
Management of companies and enterprises	9,910	0.42
State Government, excluding schools and hospitals	6,640	0.30
Colleges, universities and professional schools	6,480	0.21

Figure 3 illustrates how we combine the probability of automation scores for the different occupations within a subindustry to calculate a total subindustry probability of automation score. The example also shows how we group the subindustries according to whether they have low (0-0.4), medium (0.4-0.8) or high (0.8-1) probability of automation. Note that each occupation is weighted depending on its relative presence within a subindustry measured as the number of jobs within the subindustry associated with that occupation. A table with all the sub-industries and their automation probability can be found in the Appendix.

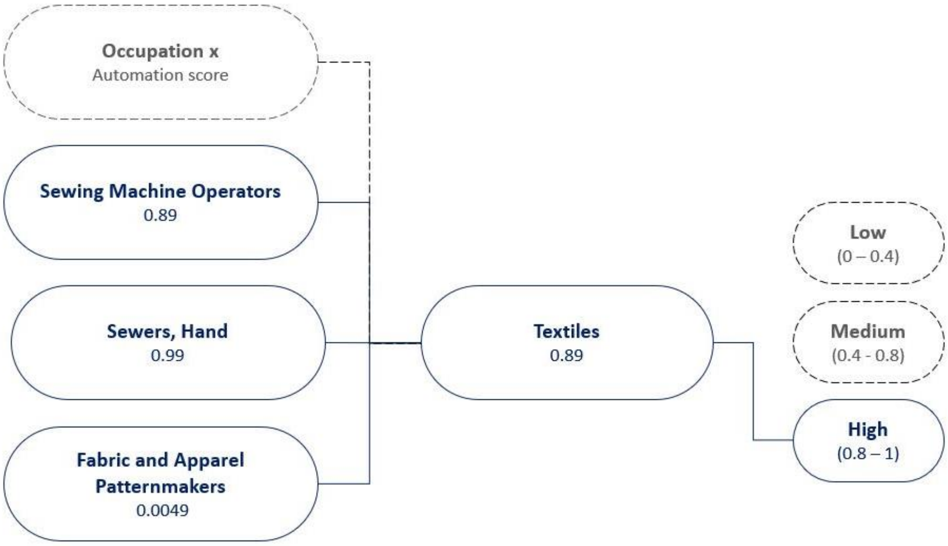


Figure 2. Occupation to subindustry mapping – including low, medium and high probability of automation categorization

Once we calculate the subindustry probability of automation scores the distribution of our data changes, with more subindustries having a medium and high probability of automation. Figure 4 represents the distribution of subindustry probabilities of automation after combining the probability of automation scores for the different occupations within each subindustry.

There are several explanations for this change in the distribution. First, many of the occupations with low probability of automation scores, such as Choreographers and Podiatrists, are niche occupations that do not comprise large parts of the employee population for corporations. Although these occupations are present in certain subindustries their relative presence is low and therefore do not significantly influence the overall subindustry scores. Second, there are several occupations with low probability of automation scores that could not be mapped to GICS, such as Elementary School Teachers and Healthcare and Social Workers. Most individuals within these professions are employed by the public sector, which is not accounted for in GICS. Additionally, in some cases it was not possible to map specific occupations to GICS using our mapping methodology e.g. Lodging Managers.

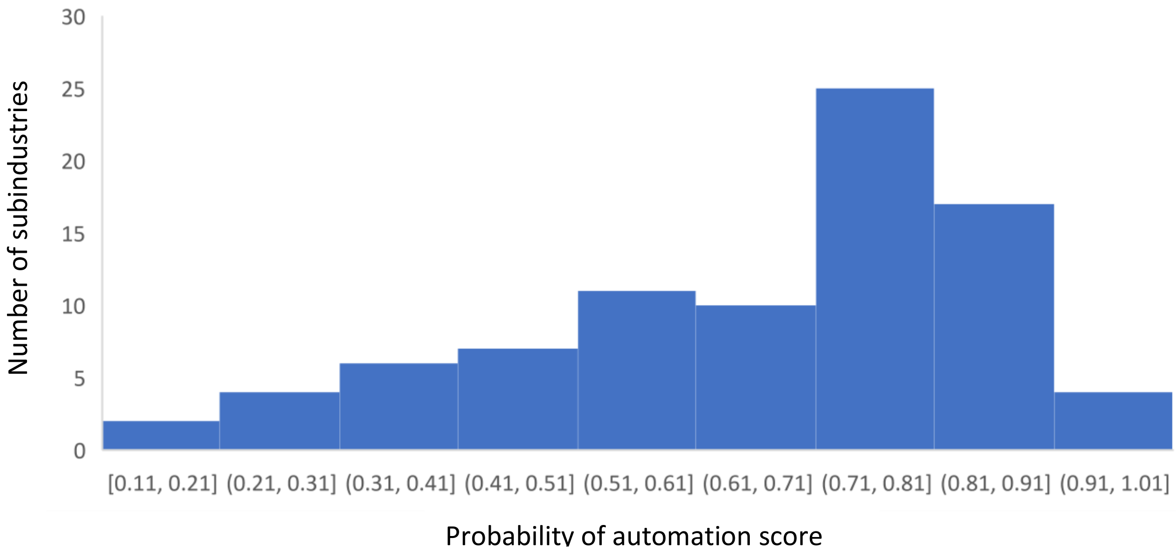


Figure 3. Distribution of subindustry probabilities of automation

Analysis of subindustry characteristics by probability of automation

We conducted our analysis in two parts:

First, using the subindustry automation score database and a global sample of large companies that report data on elements of our HCD metric, we examined the association between our probability of automation and HCD metric elements (training, employee turnover and wages over sales) as well as some other key variables of interest i.e. wage gap, and employee diversity (% of women employees, % of women managers). Because our data are coming from a global sample of companies and these characteristics might differ across countries, we estimated models that account for country differences and isolate the difference that could be attributed to sub-industries.[3]

Second, we used occupation level data to generate over 9,700 data points that demonstrate the makeup of skills, knowledge and abilities in each subindustry. This is calculated using the proportions of occupations within a subindustry**.** An illustrative example is shown in figure 5 below.

- *Abilities* refer to enduring attributes of the individual that influence performance. These are split into the following categories: cognitive abilities, physical abilities, psychomotor abilities, sensory abilities.[19]
- *Knowledge* refers to organized sets of principles and facts applying in general domains.[20]
- *Skills* refer to developed capabilities that facilitate learning or the more rapid acquisition of

[3] Specifically, we estimated ordinary least square panel regressions with country, sub-industry and year fixed effects. The baseline sub-industry was automobile manufacturers and the estimated coefficients on each sub-industry effect was the incremental effect of being in that sub-industry relative to a firm belonging in the automobile manufacturer sub-industry.

knowledge. These are split into the following categories: basic skills, complex problem solving skills, resource management skills, social skills, systems skills, technical skills.[21]

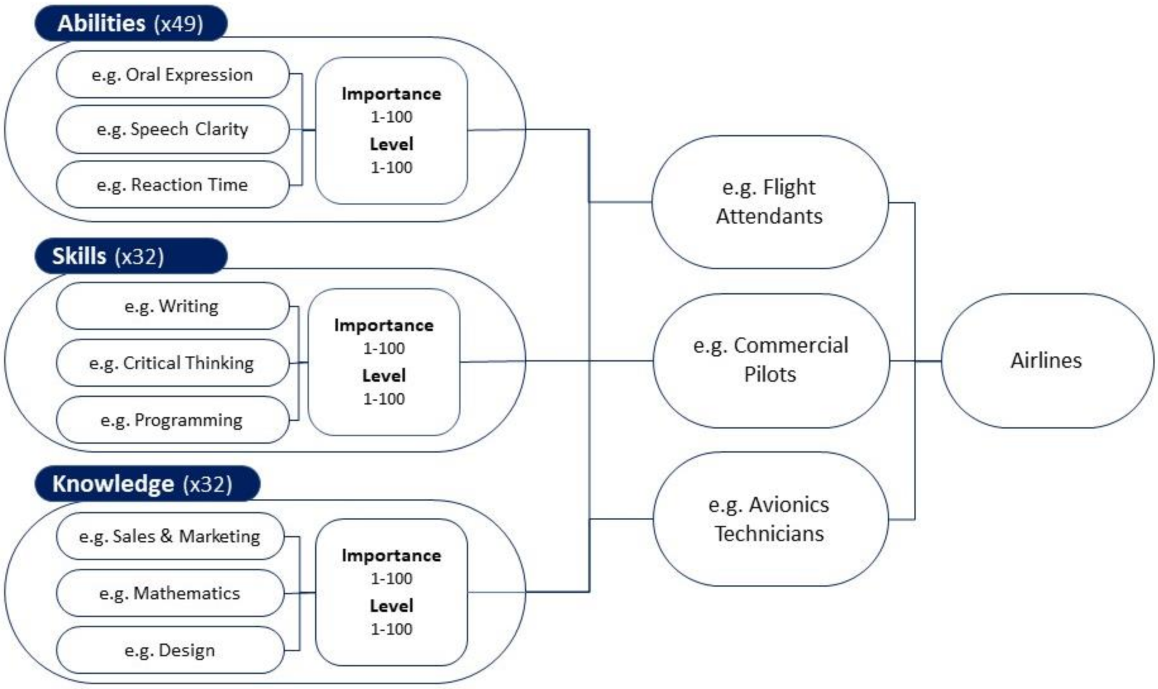


Figure 4. Importance and level of abilities, skills and knowledge mapped to subindustries

Using this dataset, we analysed trends in the level of skills, knowledge and abilities for subindustries with low and high probability of automation (see section Looking ahead: skills necessary for the future)

Training

Key finding: *the average training spend per employee is higher in sub-industries with high probability of automation.*

In an era of automation retraining and reskilling is increasingly important; the lack of skills needed to embrace emerging technologies is already creating a widespread talent shortage.[22] Lifelong learning is crucial, and employers need to emphasize the importance of continuous training, development and adaptability to their employees.[23] Companies need to be prepared to invest in training and development; an Accenture survey found that although 74% of executives at US companies anticipate significant task automation over the next 3 years, only 3% plan to increase their spending on employee training.[24] A few examples of these efforts might be helpful in understanding these programs:

In the **Integrated Telecommunications Services** sub-industry, AT&T is investing $200 to $250 million a year to identify where every job function is heading and provide workers with the training they need to prepare for future roles. Management has implemented a Future Ready reskilling program that offers ‘nanodegrees’ in collaboration with an educational organization called Udacity; this enables existing employees to take hands-on courses in subjects like data science and machine learning.

In the Systems Software sub-industry, SAP launched a large-scale program to upgrade their workforce’s skills. One of the company’s main divisions, the 20,000-employee digital-business-services (DBS), implemented a comprehensive workforce skills upgrade to support shifts in its product portfolio toward more digital innovation and cloud-based products. The upgrade is taking place over multiple years and will include a boot camps, shadowing experienced colleagues, peer coaching, and digital learning.

In the Industrial Conglomerates sub-industry, Siemens invests more than €500 million (~$580 million) a year in the training, reskilling, and upskilling employees. In the United States the company is investing $50 million annually in the continuing education of employees and is increasingly introducing the German model of apprenticeships in their U.S. operations. Currently, the apprenticeship program operates in nine states. In addition, the company has provided $3 billion worth of industrial software to academic and training institutions.

Currently, companies use training cost per employee as a metric to demonstrate their investment in human capital. Our analysis of average training cost per employee across subindustry groups (classified as low to high probability of automation) seeks to understand this relationship and is shown in Figure 6. We find that sub-industries with high probability of automation spend approximately $318 per employee, which is $50 more per employee than sub-industries with low probability of automation.

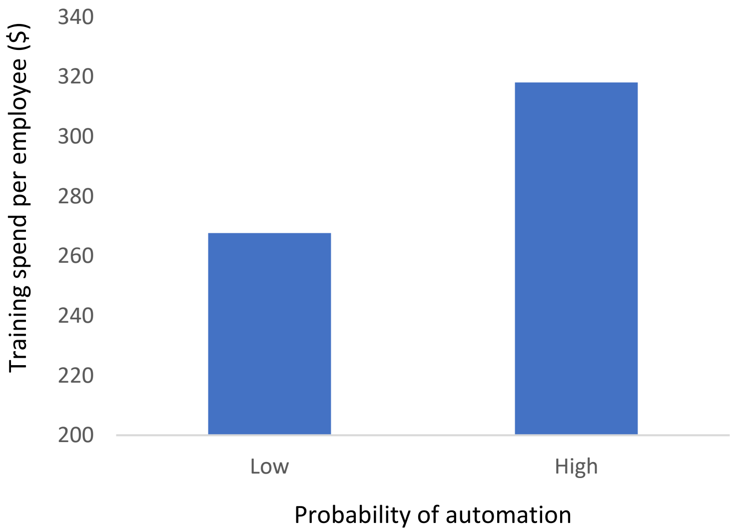


Figure 5. Average training cost per employee across low and high probability of automation sub-industry groups

Home Improvement Retail and Restaurants are subindustries with significantly lower per employee spend compared to the rest of the high probability of automation subindustries. While Electrical Components & Equipment and Apparel, Accessories & Luxury Goods spend the most. Among the low probability of automation subindustries Advertising spends the most per employee and Education Services spend the least.

If we assume that high probability of automation subindustries will need to retrain many employees, then we can take these results as a positive signal; on average these subindustries are already spending more on training. However, among our sample of subindustries, Home Improvement Retail, Restaurants and Real Estate Operating Companies are all high probability of automation subindustries with a lower training spend per employee between $121 - $167 per employee. Inadequate training could pose a challenge for companies and employees; if many occupations are automated then reskilling and retraining will be necessary. First, to ensure there are enough workers equipped to support in technical roles, and secondly to help displaced workers find opportunities to be redeployed elsewhere. As previously discussed, we do not assume that automation will necessarily lead to job losses. However, investors should know which industries are more likely to be affected by automation in order to engage with companies on the potential impact on their human capital.

Automation and technological advances can also be used to improve training processes; companies recognize that automation technologies can be most impactful when utilized to complement and support humans[25]. For example, in 2016 Amazon introduced robots and reduced holiday worker training time to 2 days compared to the six weeks of training that is often required[26], and similarly in 2017 Walmart introduced virtual reality technology to optimize training for workers in-store.[27]

After implementation, streamlining training or adopting online programs can significantly reduce training hours and costs. This calls into question the relevance of traditional metrics like training spend per employee, which only capture inputs rather than the output of the training program. If we take the example of Amazon, without context we might perceive the reduction of training time and spend as a negative, when in fact it is a sign of increased efficiency and cost savings. Overall, new technologies require companies and investors to redesign metrics that better capture training outcomes rather than training inputs.

Turnover

Key finding: *The average employee turnover rate is higher in sub-industries with a high probability of automation.*

Employee retention is moving up the ranks of importance for investors, especially considering shortages of highly skilled workers in tech-based roles.[28] Currently, turnover rates are used to understand employee retention. While turnover rates are known to vary across industries, they can be used as a proxy to gauge employee engagement; for example, a high turnover rate is often an indicator of poor company culture or inadequate opportunities.

As we move into an era of automation, employees will have new concerns which could impact their fulfilment and engagement at work e.g., is my job safe, am I qualified for this role, and will I have to work alongside technology? Companies that can appease employee concerns on these topics will ultimately fair better in attracting and retaining the best human capital. In the Multi-line Insurance sub-industry, in 2017 Aviva asked their 16,000 UK employees whether their job could be automated and offered to retrain any employees for a new role within the firm if they thought it could. Overall, the program sought to reassure employees of their job security despite increasing automation within the insurance sector.[29]

As discussed in 'Training', one factor that will impact employees is whether they have access to training and reskilling programs. Ultimately, companies that offer relevant and reputable training programs will attract and retain the best talent. Considering this, we foresee that well-designed company training programs will become increasingly important; not only to support companies to fill internal skills gaps, but also to offer a competitive advantage in the war for talent.[30]

In the Trading Companies & Distributors sub-industry Symbia logistics – a privately held US company focused on warehousing and logistics – used to experience high turnover rates. When a new CEO took over, she aimed to build a sustainable team and increase retention rates. To achieve this the company invested over $350,000 in retraining and implemented automation training for mechanics to teach them how to troubleshoot and service robots. Since these changes the company has experienced a 20-30% improvement in their retention rates.

Our analysis of average employee turnover rates across sub-industry groups is shown in Figure 7. We find that the turnover rate of high probability of automation subindustries is 1.6% higher than low probability subindustries. Among the high probability of automation group, Security and Alarm Services and Specialized Finance exhibit the highest turnover rates between 18-24%, while Automobile manufacturers and Steel have the lowest turnover rates at approximately 5.5%. In the low group, Education Services have a high turnover rate of nearly 20%, which is double the group's average. And Health Care Services, Application Software and Electric Utilities have the lowest turnover rates between 5-6%.

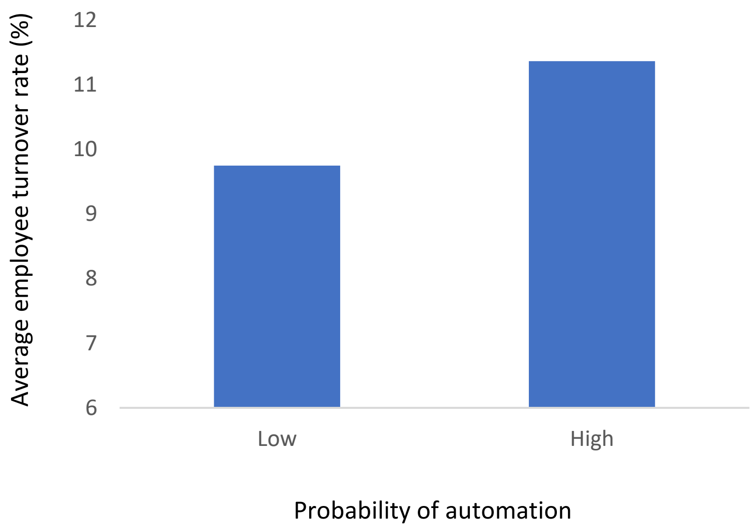


Figure 6. Average turnover of employees across low and high probability of automation sub-industry groups

Employee turnover rate could signal a variety of issues relating to company performance and preparedness for the future of work. On the one hand, high employee turnover might be associated with a bad company culture. On the other hand, low employee turnover could be the result of a lack of opportunities within an industry, exacerbated by a lack of retraining opportunities for employees. For example, if company retraining efforts are unable to meet the workforce's reskilling needs, then low skilled workers could face reduced opportunities for employment. In this scenario there is a significant risk of workers losing jobs or remaining in low paid jobs with limited opportunities for career progression. Low turnover rates could signify higher rates of unemployment, or potentially higher rates of exploitation among low-skilled workers who have insufficient employment opportunities and reduced bargaining power in the workplace.

Alternatively, low turnover rates in high probability of automation industries e.g., Steel and Automobile Manufacturers, could also be a sign that automation is improving employee satisfaction. It is widely anticipated that automation of tasks will augment employee experiences at work, as workers will no longer be required to perform repetitive routine tasks freeing up time to work on tasks requiring a higher level of skill.[4,5] Similarly, increased use of robotics can improve job safety in many sectors such as mining.

Wage gap

Key finding: sub-industries that are less likely to be automated exhibit a higher wage gap than subindustries with high probability of automation.

In Figure 10 we observe that subindustries with low probability of automation have a higher wage gap, defined as the CEO to median salary. This means that within subindustries that are less likely to be automated, companies pay CEOs approximately 72 times their median employee salary. In comparison, in subindustries that are highly likely to be automated top earners earn 60 times the median employee salary.

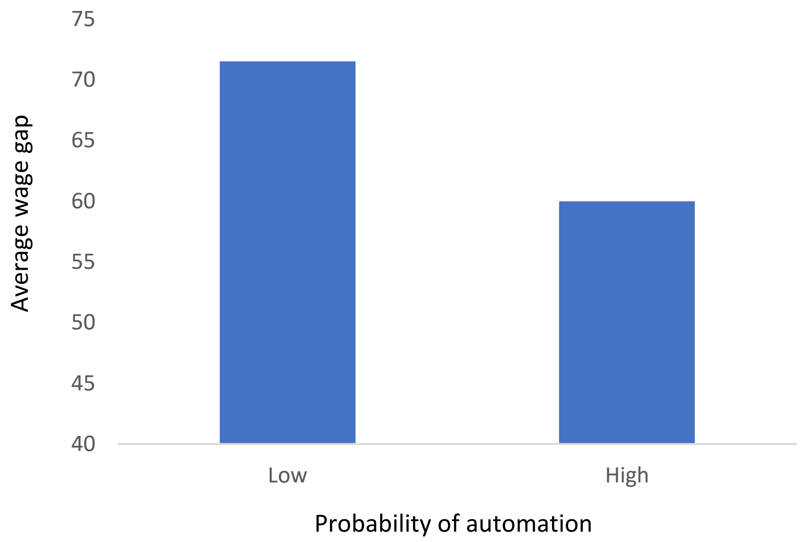


Figure 7. Average wage gap between the median and highest paid employee salary, across low and high probability of automation sub-industry groups

Within the low probability of automation subindustries Health Care Services, Technology Hardware, Storage & Peripherals, and Systems Software exhibit the highest wage gaps, ranging from 105 to 132. Among our sample several of the sub-industries that are least likely to be automated are technology related, which often have notoriously high CEO-to-worker pay ratios.[6] An additional factor that contributes to higher ratios - and can skew wage gap data - is the level of outsourced contract work versus full time employment overseas. While 2018 SEC rulings mandate disclosure on pay, this is only for employee pay.[7] Therefore, if a company outsources a significant proportion of its low paid work overseas, they might report a comparatively low wage gap, despite paying CEOs much more than those overseas workers. Ultimately this highlights a shortcoming of current wage gap measures, when used as a proxy for understanding levels of inequality.

---

[4] http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf
[5] https://ifr.org/ifr-press-releases/news/position-paper
[6] https://www.vox.com/recode/2019/5/2/18522927/ceo-pay-ratio-tech-employee-salary-2018
[7] https://www.nytimes.com/2018/05/25/business/highest-paid-ceos-2017.html

The potential discrepancy in wage gap, caused by a company's choice to outsource work, also highlights another side effect of automation. Due to the cost savings associated with automation and risks of offshoring, some companies are bringing certain production processes back in-house.[31] A recent study in Australia found that on average companies could save $30,000 (AUD) / year / resource by automating and migrating processes in-house.[32] As a result, many Australian companies have scaled back their offshoring and returned processes to Australia.[33] Overall this highlights a global phenomenon associated with automation and the future of work; countries that are dependent on work provided by overseas companies could be negatively impacted in the short-term.

Gender Diversity ***Key finding:*** *Subindustries with low probability of automation have more female employees and more female managers.*

Discussions about automation have started to consider whether the future of work will be different for men and women. A World Economic Forum study used data from LinkedIn to determine that globally only 22% of Artificial Intelligence (AI) professionals are women.[34] AI is an in-demand skill but even beyond tech-based roles, automation is affecting job opportunities differently for men and women. Women tend to have jobs that are both the most and least likely to be automated.[35] And when factoring in ethnicity research from the Institute for Women's Policy Research finds that in the US women are always more at risk of automation than their male counterparts.[36] They also find that although women are more likely to work in digital roles than men, they are notably underrepresented in the highest-paying tech jobs.

Our analysis of employee diversity across sub-industries finds that subindustries that are less likely to be automated employ a higher percentage of females (see figure 8) and have more female managers (see figure 9).

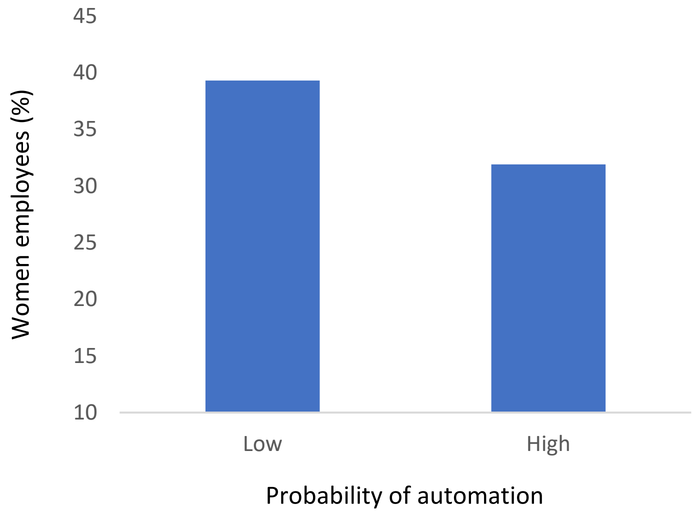


Figure 8. Average % of female employees across low and high probability of automation subindustry groups

Among the subindustries with low probability of automation, Education Services and Health Care Services employ the highest percentage of female employees, with both at approximately 58% of the workforce. High rates of female employment in the Education and Health sectors is positive as both subindustries contain occupations that are projected to grow.[37] Overall, male employees dominate most high probability of automation subindustries. However, the subindustry with the highest percentage of female employees - Apparel, Accessories & Luxury Goods - is a high probability of automation subindustry.

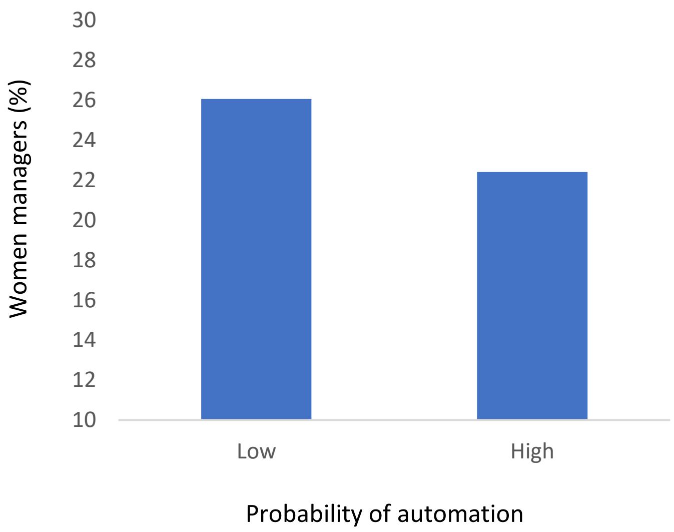


Figure 9. Average % of female managers across low and high probability of automation sub-industry groups

When it comes to the percentage of female managers, we see the same trend in the low probability of automation group; Health Care Services and Education Services have the highest percentage of female managers as well as Broadcasting. Women managers are underrepresented in industries with high probability of automation, such as Diversified Metals & Mining, Steel and Tires & Rubber. These subindustries are historically dominated by male employees as they have required manual labour. However, with increased automation we will see more females entering these sectors and taking on managerial roles.[38] For example, in the Diversified Metals & Mining**,** BHP Billiton credits the increasing use of technology and automation on mining sites for boosting diversity in the sector. The Chief People Officer, Athalie Williams, stated that this allowed the firm to broaden its hiring pool to outside the sector. The company is now on track to achieve its target of having a 50% female workforce by 2025.[39]

Looking ahead: skills necessary for the future

Most of the current research around the future of work and the impact of automation concludes that almost no occupation will be unaffected by technological changes. Similarly, the most common recommendation is for businesses to take the necessary actions in promoting a learning mindset, to invest in reskilling and upskilling employees, and to expand learning opportunities and support for workers that carry out tasks particularly susceptible to automation. The critical question then becomes, what are the new skills that companies should focus on developing? A recent report by the World Economic Forum attempted to introduce an approach to identify reskilling and job transition opportunities.[40] The point of reference of the report was at the occupation rather than the industry level.

We expect that as technological advances transform the composition of tasks required to perform jobs within the high probability of automation sub-industries, these sub-industries will increasingly start resembling the low probability of automation sub-industries in terms of the skills, abilities and knowledge requirements. For example, if data processing and manual tasks that are prevalent in the high probability of automation sub-industries end up being automated, workers will then be required to perform well in high-value tasks such as reasoning and decision-making.

For the purpose of providing insights at the industry level, we compared the average makeup of skills, abilities and knowledge in the two sub-industry groups (low and high probability of automation). The results below show the highest differences in terms of skills, abilities and knowledge:

Skills	Knowledge	Abilities
Operations analysis	Computers and electronics	Fluency of ideas
Systems evaluation	Telecommunications	Written expression and comprehension
Systems analysis	Communications & Media	Inductive reasoning
Science	Engineering & Technology	Mathematical reasoning
Programming	Mathematics	

This information is particularly relevant to both investors and companies. Investors not only need to understand and model potential risks and opportunities of automation, but they also need to gain more insights on how their investee companies are changing their recruitment and training practices to prepare for this transition. HR departments should consider these transformational changes as a guide to review and if needed revise their practices. HR departments in sub-industries with high probability of automation might soon realize that they require individuals with skills that are not yet part of the core skill set of their current functions.

Investor Engagement on the future of work

While traditionally most investors have been passive rarely exercising their 'voice' we have seen this changing in the past few years and we expect this trend to continue. Investor engagement is an important aspect of stewardship. In a 2017 survey 73% of 475 investors said they considered active ownership and engagement an integral aspect of ESG investing[41]. And human capital management is increasingly significant to investors; Blackrock identifies it as an engagement priority for 2019, citing shortages of skilled labor, uneven wage growth, and technology as key motivations[42]. With this in mind, understanding the risks and opportunities of automation, what questions to ask management and what data to examine is of major importance to investors.

Theme	Questions
Implementing technology	How does your organization make decisions about if and how to implement automation and artificial intelligence?
	If you are implementing automation or artificial intelligence, have you considered employee experience, skills and other human capital factors?
	What is the intended outcome of implementing automation and/or AI?

Retraining and reskilling employees	Does your organization have a strategy for accessing which skills are required to work with emerging technologies?
	Have you considered how to develop your employees' skills in line with shifting demands?
	Are you offering new opportunities to employees with changing roles?
	Are you ensuring training opportunities are available to male and female employees?
	Are you ensuring training opportunities are available to employees from diverse backgrounds, and in particular to ethnic minorities?
	Are you ensuring training opportunities are available to low and high skilled workers?
	Do you have policies to formalise your commitments to equitable retraining and reskilling opportunities?
	Do you assess the effectiveness of your training programs? If yes, how?
Employee satisfaction	What actions have you taken to improve employee loyalty and reduce turnover rates?
	How effective have these efforts been?
	Do you measure employee satisfaction? If so, do you look beyond turnover and tenure metrics?
Recruitment	Are you recruiting with future skills requirements in mind?
	Have you adapted your recruitment process to ensure you can assess candidates on skills you will require in the future?
Human resources	Is your human resources department aware of how automation and AI could impact human capital management?
	Are relevant resources about the risks and opportunities available to the HR department?

Conclusion

Human capital development is essential for hiring, training, managing and retaining high performing employees who are one of the key drivers of corporate success and sustained competitive advantage. From both corporate and investor perspectives, assessing human capital development is challenging. Because human capital development is an intangible asset, there are no generally accepted standards for both measuring the value of people and quantifying return on investment. Particularly on the latter without an understanding of how for example employee training can yield long term benefits, investments in human capital can be perceived as costly. In an era where automation and rapid technological change will potentially impact every industry, creating an infrastructure where human capital development can be better measured is essential.

To address some of these challenges, we derived a human capital development metric by focusing on outcomes rather than inputs and by exploring the relationship of the metric with employee productivity, and therefore long-term benefits. The three components of our metric include employee wage change, training dollars spent and employee turnover. When these three components are combined, they reflect the ability of a company to train employees on tasks that improve their earnings potential and livelihoods, while at the same time create a work environment where employee want to stay. Our results showed that there is a positive relation between the human capital development metric and productivity metrics (both for revenue and earnings productivity), making the metric particularly relevant to business valuation and investment analyses.

Moreover, to help investors better understand the potential impact of automation across sub-industries, we developed a new database that provides an industry outlook on the future of work. Through a combination of probability of automation scores for over 700 occupations and employment data from the U.S. Bureau of Labour statistics, we calculated subindustry probability of automation scores and provided insights relevant to our human capital development metric. We found that the average training spend per employee and the average employee turnover are higher in subindustries with high probability of automation. Subindustries that are less likely to be automated exhibit a higher wage gap than subindustries with high probability of automation.

Although it is hard to precisely predict how automation will impact the future of work, we expect with a high degree of certainty that technological advances will transform the composition of tasks required to perform jobs. Our future of work database provides a tool for investors to better understand potential risks and opportunities across subindustries and to prioritize and frame engagement efforts. Our human capital development metric provides a new way to measure outcomes and link these with long term benefits.

Appendix

Table A1: Frequency by Year

Year	Number	% of sample
2005	142	1.55
2006	175	1.91
2007	288	3.14
2008	376	4.10
2009	452	4.93
2010	666	7.26
2011	795	8.66
2012	863	9.40
2013	953	10.38
2014	1,039	11.32
2015	1,092	11.90
2016	1,155	12.59
2017	1,181	12.87

Table A2: Frequency table by country/region

Country/region	Number	% of sample
ARGENTINA	3	0.03
AUSTRALIA	354	3.86
AUSTRIA	70	0.76
BELGIUM	110	1.20
BERMUDA	9	0.10
BRAZIL	380	4.14
CANADA	271	2.95
CHILE	78	0.85
CHINA	194	2.11
COLOMBIA	42	0.46
CYPRUS	10	0.11
CZECH REPUBLIC	12	0.13
DENMARK	120	1.31
EGYPT	1	0.01
FINLAND	210	2.29
FRANCE	868	9.46
GERMANY	539	5.87
GIBRALTAR	8	0.09
GREECE	84	0.92
GUERNSEY	2	0.02
HONG KONG	283	3.08
HUNGARY	19	0.21
ICELAND	3	0.03
INDIA	283	3.08
INDONESIA	146	1.59
IRELAND	35	0.38

ISLE OF MAN	1	0.01
ISRAEL	26	0.28
ITALY	330	3.60
JAPAN	185	2.02
JERSEY	27	0.29
JORDAN	3	0.03
KOREA (SOUTH)	271	2.95
KUWAIT	6	0.07
LUXEMBOURG	13	0.14
MACAU	2	0.02
MALAYSIA	112	1.22
MALTA	1	0.01
MEXICO	64	0.70
MOROCCO	8	0.09
NETHERLANDS	218	2.38
NEW ZEALAND	17	0.19
NORWAY	79	0.86
OMAN	5	0.05
PAPUA NEW GUINEA	4	0.04
PERU	28	0.31
PHILIPPINES	49	0.53
POLAND	84	0.92
PORTUGAL	69	0.75
QATAR	1	0.01
RUSSIAN FEDERATION	80	0.87
SAUDI ARABIA	5	0.05
SINGAPORE	63	0.69
SOUTH AFRICA	433	4.72
SPAIN	358	3.90
SWEDEN	282	3.07
SWITZERLAND	264	2.88
TAIWAN	304	3.31
THAILAND	132	1.44
TURKEY	109	1.19
UNITED ARAB EMIRATES	9	0.10
UNITED KINGDOM	1088	11.86
UNITED STATES	313	3.41

Table A3: Frequency table by industry

Country	Number	% of sample
Aerospace & Defense	90	0.98
Air Freight & Logistics	85	0.93
Airlines	134	1.46
Auto Components	103	1.12
Automobiles	132	1.44
Banks	1072	11.68
Beverages	102	1.11
Biotechnology	21	0.23

Building Products	63	0.69
Capital Markets	308	3.36
Chemicals	397	4.33
Commercial Services & Supplies	154	1.68
Communications Equipment	39	0.42
Construction & Engineering	222	2.42
Construction Materials	183	1.99
Consumer Finance	30	0.33
Containers & Packaging	31	0.34
Distributors	5	0.05
Diversified Consumer Services	10	0.11
Diversified Financial Services	81	0.88
Diversified Telecommunication Services	239	2.60
Electric Utilities	312	3.40
Electrical Equipment	85	0.93
Electronic Equipment, Instruments & Components	92	1.00
Energy Equipment & Services	126	1.37
Entertainment	17	0.19
Equity Real Estate Investment Trusts (REITs)	192	2.09
Food & Staples Retailing	135	1.47
Food Products	162	1.77
Gas Utilities	55	0.60
Health Care Equipment & Supplies	64	0.70
Health Care Providers & Services	44	0.48
Health Care Technology	5	0.05
Hotels, Restaurants & Leisure	140	1.53
Household Durables	131	1.43
Household Products	32	0.35
IT Services	149	1.62
Independent Power and Renewable Electricity Producers	137	1.49
Industrial Conglomerates	109	1.19
Insurance	298	3.25
Interactive Media & Services	14	0.15
Internet & Direct Marketing Retail	3	0.03
Leisure Products	1	0.01
Life Sciences Tools & Services	6	0.07
Machinery	216	2.35
Marine	33	0.36
Media	221	2.41
Metals & Mining	563	6.13
Multi-Utilities	127	1.38
Multiline Retail	38	0.41
Office Electronics	4	0.04
Oil, Gas & Consumable Fuels	532	5.80
Paper & Forest Products	90	0.98
Personal Products	28	0.31
Pharmaceuticals	173	1.89
Professional Services	79	0.86
Real Estate Investment Trusts (REITs)	7	0.08

Real Estate Management & Development	244	2.66
Road & Rail	123	1.34
Semiconductors & Semiconductor Equipment	116	1.26
Software	35	0.38
Specialty Retail	87	0.95
Technology Hardware, Storage & Peripherals	44	0.48
Textiles, Apparel & Luxury Goods	125	1.36
Thrifts & Mortgage Finance	16	0.17
Tobacco	37	0.40
Trading Companies & Distributors	67	0.73
Transportation Infrastructure	153	1.67
Water Utilities	55	0.60
Wireless Telecommunication Services	154	1.68

Table A4: Relationship between HCD Metric and Revenue Productivity

	Δ Revenue Productivity		Revenue Productivity			
Parameter	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	-0.159	-1.31	5.410	18.44	1.512	7.89
HCD	1.496	6.83	0.962	4.00	1.333	6.95
Firm size	0.007	0.95	0.078	4.93	0.027	3.50
Lagged Revenue Productivity					0.703	33.313
N	9,113		9,129		9,113	
Adj R-squared	8.9%		46.8%		76.3%	

Table A5: Relationship between HCD Metric and Earnings Productivity

	Δ Earnings Productivity		Earnings Productivity			
Parameter	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	0.110	0.62	4.870	13.12	1.639	7.12
HCD	1.393	5.11	1.489	5.33	1.405	5.92
Firm size	0.000	0.03	0.031	1.56	0.011	0.95
Lagged Earnings Productivity					0.671	34.244
N	8,288		8,643		8,288	
Adj R-squared	6.0%		50.5%		73.4%	

Table. List of all subindustries for which automation probability was calculated

High Probability of automation

Automobile Manufacturers	0.954199
Electrical Components & Equipment	0.924584
Specialty Stores	0.915481
Tires & Rubber	0.914706
Specialized Finance	0.903578
Internet & Direct Marketing Retail	0.896281
Textiles	0.887613
Steel	0.878991
Forest Products	0.875655
Railroads	0.875103
Restaurants	0.869845
Home Furnishings	0.846658
Insurance Brokers	0.844810
Construction Materials	0.840897
Real Estate Operating Companies	0.839779
Security & Alarm Services	0.828218
Apparel, Accessories & Luxury Goods	0.826140
Home Improvement Retail	0.819860
Diversified Metals & Mining	0.819453
Real Estate Services	0.816951
Human Resource & Employment Services	0.814978

Medium probability of automation

Trucking	0.797613
Packaged Foods & Meats	0.793495
Casinos & Gaming	0.789888
Commercial Printing	0.785202
Environmental & Facilities Services	0.778164
Consumer Finance	0.777778
Automotive Retail	0.777583
Food Distributors	0.776314
Oil & Gas Storage & Transportation	0.771728
Diversified Chemicals	0.760556
Diversified Support Services	0.759362
Construction Machinery & Heavy Trucks	0.758107
Commodity Chemicals	0.752155
Health Care Equipment	0.750354
General Merchandise Stores	0.745404
Paper Products	0.742504
Apparel Retail	0.742470
Multi-line Insurance	0.741786
Food Retail	0.737620
Technology Distributors	0.737374
Hotels, Resorts & Cruise Lines	0.733417
Auto Parts & Equipment	0.723543
Gas Utilities	0.723324
Airport Services	0.718959

Building Products	0.714964
Computer & Electronics Retail	0.708003
Homebuilding	0.705572
Drug Retail	0.697559
Trading Companies & Distributors	0.692829
Air Freight & Logistics	0.685771
Distributors	0.684612
Oil & Gas Drilling	0.681990
Health Care Services	0.678421
Department Stores	0.663242
Agricultural Products	0.662370
Coal & Consumable Fuels	0.591987
Marine Ports & Services	0.586168
Industrial Machinery	0.581841
Semiconductors	0.573501
Health Care REITs	0.548806
Aerospace & Defense	0.548754
Pharmaceuticals	0.541168
Construction & Engineering	0.529619
Homefurnishing Retail	0.519040
Alternative Carriers	0.518621
Leisure Facilities	0.509975
Financial Exchanges & Data	0.481818
Movies & Entertainment	0.471687
Marine	0.471244
Electronic Components	0.471100
Specialized Consumer Services	0.468369
Airlines	0.441172
Health Care Facilities	0.440734

Low probability of automation

Electric Utilities	0.396976
Advertising	0.394147
Health Care Services	0.387777
Cable & Satellite	0.322422
Publishing	0.315177
Research & Consulting Services	0.310953
Education Services	0.308913
Broadcasting	0.301796
Integrated Telecommunication Services	0.285594
Technology Hardware, Storage & Peripherals	0.262093
Systems Software	0.136426
Application Software	0.108916

Reference list

[1] UK Government, *Companies Act 2006*. Available from: https://www.legislation.gov.uk/ukpga/2006/46/part/10/chapter/2/crossheading/the-general-duties

[2] Financial Reporting Council 2018, *The UK corporate governance code,* Available from: https://www.frc.org.uk/getattachment/88bd8c45-50ea-4841-95b0-d2f4f48069a2/2018-UK-Corporate-Governance-Code-FINAL.pdf

[3] CIPD 2017, *Human capital metrics and analytics: Assessing the evidence of the value and impact of people data.* available from: https://www.cipd.co.uk/Images/human-capital-metrics-and-analytics-assessing-the-evidence_tcm18-22291.pdf

[4] ShareAction 2019, *Workforce disclosure initiative - Report on 2018 company disclosures.* Available from: https://shareaction.org/wdi/2018-findings/

[5] ShareAction 2019, *Workforce disclosure initiative – Company resources.* Available from: https://shareaction.org/wdi/company-resources/

[6] SEC 2017, *Rulemaking petition to require issuers to disclose information about their human capital management policies, practices and performance.* Available from: https://www.sec.gov/rules/petitions/2017/petn4-711.pdf

[7] ISO 2019, *New ISO international standard for human capital reporting.* Available from: https://www.iso.org/news/ref2357.html

[8] IIRC 2016, *Creating value – The value of human capital reporting.* Available from: http://integratedreporting.org/wp-content/uploads/2017/05/CreatingValueHumanCapitalK1.pdf

[9] World Economic Forum 2016, *The fourth industrial revolution: what it means, how to respond.* Available from: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

[10] OECD 2019, *Under Pressure: The squeezed middle class*

[11] Goldman Sachs 2017, *The PM's guide to the ESG revolution – from article of faith to mainstream investment tool.*

[12] PRI 2018, *Why and how investors can respond to income inequality.* Available from: https://www.unpri.org/download?ac=5599

[13] GIIN 2018, *Annual Impact Investor Survey 2018.* Available from: https://thegiin.org/research/publication/annualsurvey2018

[14] McKinsey Global Institute 2017, *Jobs lost, jobs gained: Workforce transitions in a time of automation*. Available from: https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages

[15] British Academy and the Royal Society 2018, *The impact of artificial intelligence on work – An evidence synthesis on implications for individuals, communities and societies.* Available from: https://royalsociety.org/-/media/policy/projects/ai-and-work/summary-the-impact-of-AI-on-work.PDF

[16] Carl Benedikt Frey, Michael A. Osborne 2017, 'The future of employment: How susceptible are jobs to computerisation?', *Technological Forecasting & Social Change* 114 (2017) 254 - 280

[17] Arntz, M., T. Gregory and U. Zierahn 2016, 'The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis', *OECD Social, Employment and Migration Working Papers*, No. 189, OECD Publishing, Paris. Available from: http://dx.doi.org/10.1787/5jlz9h56dvq7-en

[18] United States Department of Labor, Bureau of Labor Statistics. Available from: https://www.bls.gov/

[19] ONet Online. Available from: https://www.onetonline.org/find/descriptor/browse/Abilities/

[20] ONet Online. Availabe from: https://www.onetonline.org/find/descriptor/browse/Knowledge/

[21] ONet Online. Available from: https://www.onetonline.org/find/descriptor/browse/Skills/

[22] Raconteur 2018, *Reskilling future workers: who's responsible?* Available from: https://www.raconteur.net/business-innovation/reskilling-workers-responsible

[23] Ibid

[24] Accenture Strategy 2018, *Reworking the revolution – are you ready to compete as intelligent technology meets human ingenuity to create the future workforce?* Available from: https://www.accenture.com/t20180613T062119Z__w__/us-en/_acnmedia/PDF-69/Accenture-Reworking-the-Revolution-Jan-2018-POV.pdf

[25] Deloitte Insights 2018, *The rise of the social enterprise – 2018 Deloitte Global Human Capital Trends.* Available from: https://www2.deloitte.com/content/dam/Deloitte/at/Documents/human-capital/at-2018-deloitte-human-capital-trends.pdf
[26] The Wall Street Journal 2016, *How Amazon gets its holiday hires up to speed in two days.* Available from: https://www.wsj.com/articles/amazon-leans-on-technology-to-speed-training-of-holiday-workers-1480329005
[27] Deloitte Insights 2018, *The rise of the social enterprise – 2018 Deloitte Global Human Capital Trends.* Available from: https://www2.deloitte.com/content/dam/Deloitte/at/Documents/human-capital/at-2018-deloitte-human-capital-trends.pdf
[28] CIPD 2019, *The intangible workforce – Investor perspectives on workforce data*. Available from: https://www.cipd.co.uk/Images/investor-perspectives-on-workforce-data_tcm18-55499.pdf
[29] Quartz 2017, *A UK company is offering new jobs to employees who admit they could be replaced by robots.* Available from: https://qz.com/919429/uk-insurance-company-aviva-is-offering-new-jobs-to-all-employees-who-admit-they-could-be-replaced-by-robots/
[30] Raconteur 2018, *Reskilling future workers: who's responsible.* Available from: https://www.raconteur.net/business-innovation/reskilling-workers-responsible
[31] A.T Kearney 2018, *Future of work and workers – Impact of robotics and artificial intelligence.* Available from: https://www.aph.gov.au/DocumentStore.ashx?id=7d8b730c-2349-4b35-ad62-4a86ab3d1439&subId=563759
[32] Ibid
[33] Ibid
[34] World Economic Forum 2018, *The global gender gap report 2018.* Available from: http://www3.weforum.org/docs/WEF_GGGR_2018.pdf
[35] Institute for Women's Policy Research 2019, *Women, automation and the future of work.* Available from: http://iwpr.org/wp-content/uploads/2019/03/C476_Automation-and-Future-of-Work.pdf
[36] Ibid
[37] Ibid
[38] Tim Treadgold 2018, *Australia's iron ladies are rocking the world's mining industry with tech.* Forbes Asia. Available from: https://www.forbes.com/sites/timtreadgold/2018/06/06/australias-iron-ladies-of-mining-tech/#1e91b5305d7c
[39] Henry Sanderson 2018, *BHP on track to achieve 50% female workforce by 2025.* Financial Times. Available from: https://www.ft.com/content/063eb6bc-d10f-11e8-a9f2-7574db66bcd5
[40] World Economic Forum 2018, *Towards a Reskilling Revolution – A future of jobs for all.*
[41] State Street Global Advisors 2018, *Performing for the future – ESG institutional investor survey.* Available from: https://www.ssga.com/investment-topics/environmental-social-governance/2018/04/esg-institutional-investor-survey.pdf
[42] BlackRock 2019, *BlackRock investment stewardship engagement priorities for 2019*. Available from: https://www.blackrock.com/corporate/literature/publication/blk-stewardship-priorities-final.pdf