

Trends in the Adoption of Corporate Child Labor Policies: An Analysis with Bloomberg Terminal ESG Data

Vedran Sekara
UNICEF Office of Innovation
New York, NY

Alex Rutherford
UNICEF Office of Innovation
New York, NY

Gideon Mann
Bloomberg LP
New York, NY

Mark Dredze
Bloomberg LP, New York, NY
Johns Hopkins University,
Baltimore, MD

Natalia Adler
UNICEF Data Research and
Policy
New York, NY

Manuel Garcia-Herranz
UNICEF Office of Innovation
New York City, NY
mgarciaherranz@unicef.org

ABSTRACT

Over 150 million children worldwide are estimated to be engaged in some form of child labor, with nearly one in every four children between the ages of 5 and 14 engaged in potentially harmful work in the world's poorest countries. Child labor compromises children's physical, mental, social and educational development. It also reinforces cycles of poverty, negatively affecting the ecosystem necessary for business to thrive in a sustainable manner. Against a backdrop of multiple international and national laws against child labor, corporations also adopt policies on child labor. However, new methods of globally dispersed production have made this commitment to sustainability issues across supply chains more challenging. In this work we examine, through the lens of Bloomberg's environmental, social and governance (ESG) and financial data, trends in corporate child labor policies and their relationship to classic economic variables as a first step in understanding sustainability issues across global supply networks.

1. INTRODUCTION

As of 2012, 168 million children, accounting for 11% of the overall child population, are estimated to be engaged in some form of child labor [1]. Child labor goes beyond "child work"—understood by many as something legitimate and formative to the child—to include forms of work that are harmful: damaging their health, exploiting them physically or sexually, and preventing them from getting an education [2]. Child labor also perpetuates a vicious circle of poverty through generations. By forcing children to work at a young age one denies them access to education, in turn lowering their chances to achieve future higher incomes that would make child labor obsolete for future generations [3]. Therefore, in addition to protecting children from labor, they must also be given the opportunity to get an education [4].

The widespread adoption of multiple international and national human rights laws and instruments has led to progress in reducing the prevalence of child labor. However, global-

ization has brought additional complexity to these efforts [5] with the proliferation of value chains of global buyer-supplier networks that cut across different legal jurisdictions. To navigate this uneven legal landscape, and to respond to growing public pressure, companies have increasingly adopted corporate codes of conduct and self-reporting mechanisms to uphold human rights and transparency norms across their supply chain [6].

The shift towards practices in global supply networks is not only altruistic. Compelling commercial reasons encourage global organizations to manage the risk of child labor, fighting to reduce the practice within the supply chain in a sustainable way [7]. If child labor is found within a company's supply chain, it can have a negative financial impact in the form of diminished reputation, often called "supply chain sustainability risk" [8]. Studies suggest that potential negative impact from a supplier with poor management practices can lead to an average 12% loss in market capitalization [9]. On the positive side, a sustainable supply chain can ease the retention and attraction of talent [10].

The first step in understanding this evolving view of sustainable Corporate Social Responsibility (CSR) is to look at the existing state of adoption of child labor policies by corporations worldwide. Thanks to both the increased attention from market investors interested in knowing which companies adopt sustainable supply chain practices [9, 10] and the growing socially responsible investment (SRI) movements that favor the Triple Bottom Line (i.e. financial, social, environmental outcomes), financial data vendors, such as Bloomberg L.P., increasingly explore, gather, and offer environmental, social and governance (ESG) data about companies observance or consideration of sustainability practices, including child labor [11].

Building on a public-private "data for good" agreement between UNICEF and Bloomberg L.P., this paper provides an analysis of trends in the adoption of corporate child labor policies as a first step towards a holistic understanding of sustainability concerns across global supply networks. We present an exploratory analysis of child labor policy adoption trends based on ESG data available through the Bloomberg Terminal.

2. CHILD LABOR POLICIES

Advocacy efforts to fight child labor, and more generally improve working conditions as part of human rights efforts, take several different approaches. Significant efforts focus on working with governments to pass new legislation that establishes new protections for workers. Additionally, these efforts coordinate with enforcement authorities to ensure that existing protections are enforced. However, principles of national sovereignty and the proliferation of a global supply networks create an uneven playing field for the protection of children against child labor [6]. Therefore, advocates also work directly with companies to translate international human rights tenets into corporate practices and behaviors that condemn child labor policies in their own activities as well as their supply chain. While adoption of a corporate child labor policy may not have as broad an impact as new legislation, it can be easier to achieve and cross international boundaries. While corporate codes have strengths and weakness [6], when combined with sustainability issues, they are still an attractive option for dealing with new models of global sourcing practices.

There is large variation in the types of child labor policies companies can adopt. Bernstein and Greenwald [12] conducted a survey of such policies and found that they vary in the level of specificity and coverage. Some policies are short boiler plate material, while others include a detailed enforcement mechanism. For example, few policies endorse specific labor standards. Our goal in this paper is to record the presence of such a policy, as a explicit signal of a company's commitment to condemn child labor. As new methods of global production become the norm, these corporate signals are critical to address sustainability concerns across globally dispersed networks of buyers and suppliers.

Large organizations with a mandate to protect vulnerable children, such as UNICEF [13] and UN Global Compact, have undertaken CSR approaches to engagement with businesses to incentivize responsible policies and behavior. A holistic understanding of how companies' child labor policies are adopted and changed based on horizontal and network influence is very appealing. In addition multinational corporations and markets have compelling commercial reasons to respectively manage and monitor sustainability and protection from child labor in the supply chain. For example, UNICEF's children's rights and business agenda promotes corporate responsibility to support children's rights in the workplace.¹ UNICEF works directly with companies around the world to develop good practice, set precedents, and craft model child labor policies for companies to adopt and enforce. Stopping child labor in a company's supply chain can be complex [14], but these types of efforts can aid the process. Specially with engaging strategies that do not only look for the company not to be in contact with child labor but to actively work in tackling the child labor as an issue [5].

3. DATA

The Bloomberg Terminal is the leading financial information platform, widely used in the financial industry. The Terminal collects, organizes and disseminates many diverse

streams of data relevant for financial decision making. These data sources include market price data, news, economic indicators, and financial disclosures from tens of thousands of companies.

The Bloomberg Terminal provides ESG information on thousands of companies on a yearly basis [11]. Central to our analysis, this information includes whether the company has a child labor policy. Additionally, the terminal provides data about supply chains, mapping relations between companies and their financial dependencies. We use these two datasets as the main drivers of our child labor analysis.

Under a data philanthropy agreement, we collected data regarding yearly revenue, market capitalization, industry sector, number of employees, country of domicile, and presence of child labor policies, as well as information regarding whether a company is privately or publicly held and whether a company is a subsidiary. We only include publicly held companies, since Bloomberg rarely includes ESG data for private companies. Additionally, Bloomberg does not collect ESG data on every publicly held company. The data collection effort focuses on companies listed on major global indices, or with market capitalization over \$30 million. Furthermore, only companies that report quantitative ESG data are included in Bloomberg's data collection. This leaves us with data for 25,508 globally distributed companies in the period 2010-2015.

Bloomberg records one of three values for a company's child labor policy in each year: *Yes*, *No*, and *Not Available*. A value of "Yes" is recorded for a company in a given year if a policy is referenced in a financial disclosure document, or another document released by the company in the given year. If no evidence exists in released documents for a company in the given year, Bloomberg records a "No". If Bloomberg does not cover ESG values for a company, then they record a value of "Not Available." Note that this field only records a binary presence of a policy.

4. CHILD LABOR POLICY ANALYSIS

Policy Adoption. Table 1 summarizes the number of companies with a child labor policy each year between 2010 and 2015. Out of those companies for which there is data for 2015 on their child labor policies, only around 30% have a child labor policy, indicating that the majority of the market does not mention child labor whatsoever. However, the trend is positive; the percentage of companies has risen each year, and nearly doubled since 2010. It is important to remember the sample being considered in this data; those companies for which Bloomberg collects ESG data. These companies are large companies or traded on major exchanges, which may be companies that have a higher likelihood of having such a policy in general.

Country/Region. Figure 1A shows the number of companies in the data by region with and without a child labor policy. Europe has the most companies overall, and Latin America the least. India, China and the United States stand out as countries with the most companies. Of areas with large coverage, European countries are the most likely to

¹<https://www.unicef.org/csr/>

Year	2010	2011	2012	2013	2014	2015
Y	432	629	819	1,014	1,136	1,058
N	2,058	2,283	2,813	2,803	2,855	2,381
N/A	23,018	22,596	21,876	21,691	21,517	22,069
$\frac{Y}{Y+N}$	17.3%	21.6%	22.5%	26.7%	28.5%	30.8%

Table 1: Overview of child labor policy data. Number of companies per year with Y , N , and N/A tags.

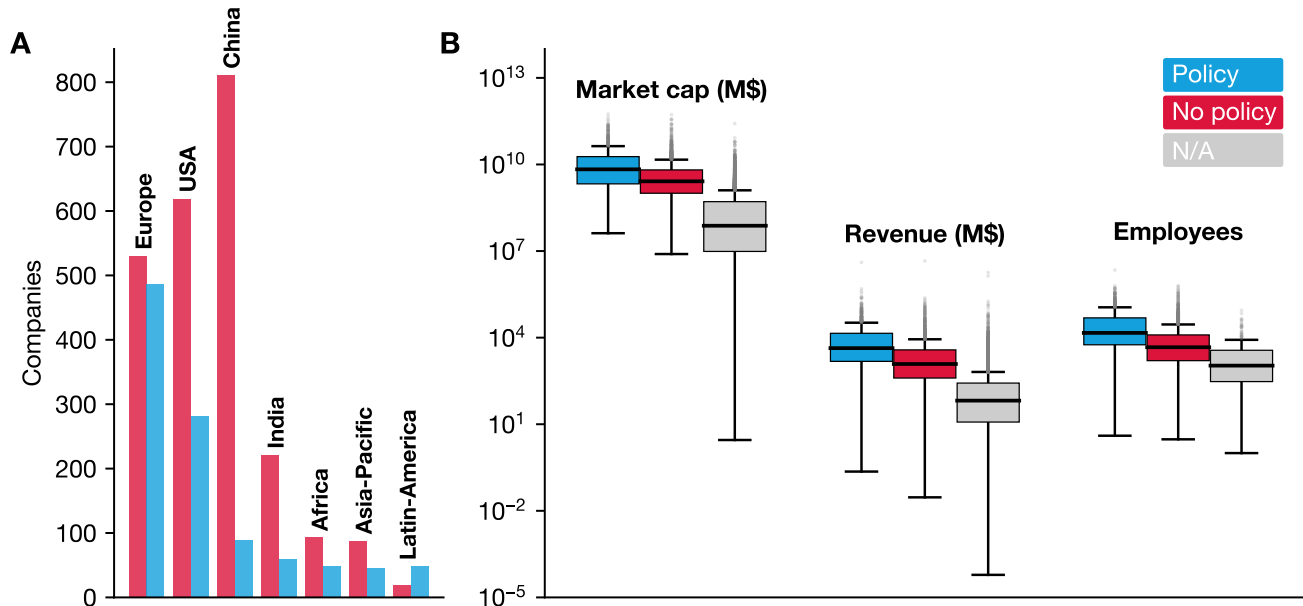


Figure 1: Overview of financial data. A, Geographic distribution of tracked companies with and without policies on child labor in 2015. China and India are treated as separate regions due to their size. As such the designation ‘Asia-Pacific’ covers all countries in the region excluding China and India. Left bar (red) indicates no policy, right bar (blue) indicates policy. B, Distributions of market capitalization (million USD), revenue (million USD), and number of employees for 2015 split on whether companies make reference to policies on child labor (blue), do not mention child labor (red), or if there is no available data in the Bloomberg Terminal (gray).

have (or report on) child labor policies while Chinese companies rarely have (or report on) a policy.

Company Financials. How is having a child labor policy correlated with other company financial information? Figure 1B shows the distribution over market cap, revenue and number of employees by child labor policy value as a box plot. Companies with child labor policies in place have on average larger market capitalizations, higher yearly revenue, and employ more people. This visualization also shows how Bloomberg focuses its efforts on gathering ESG data for the largest, biggest and most profitable companies (compare “policy” or “no policy” values to N/A). While this indicates a positive correlation between these factors and companies that are cognizant of child labor issues, we cannot identify the nature of this relationship. Adoption of child labor policies may be more prevalent in larger companies, or larger companies may be in industries that tend to have such policies.

Temporal Trends. The year over year trend shows positive growth, but we want to understand how individual companies may be changing. Additionally, we want to understand whether these increases are coming from companies who previously did not have a policy ($N \rightarrow Y$) or whether this reflects an increase in coverage ($N/A \rightarrow Y$). Figure 2 shows the number of transitions each year: how many companies adopt a policy and how many abandon their policy. This seems to depict a dynamic environment in which companies continuously change whether they have a child labor policy. We observe that many companies are in fact adopting policies, and that increases are not just due to coverage changes. However, the number of companies abandoning policies is worrisome. This may be due to how Bloomberg collects their data. Bloomberg records a Y for child labor in a given year only if the company releases documentation affirming the policy in that year. If a company highlights its policy one year but does not mention it the next, this will be registered as N , even though this may actually not indicate a change in policy—there is no way to distinguish this with currently available data. Still, this trend is concerning as it points to a potential future in which the number of

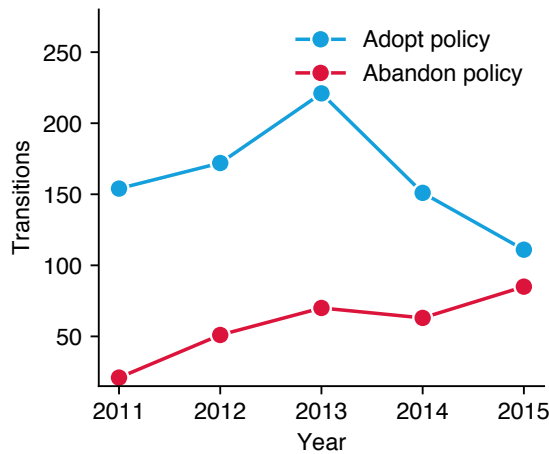


Figure 2: Temporal trends in policy adoption. Number of transitions per year. Transitions in which companies do not change their stance on child labor, or companies from whom there is no data are not shown.

companies that stop referencing child labor policies grows bigger than the new adopters. This is specially worrisome given that most companies in 2015 did not reference a child labor policy. Highlighting policies in disclosures could be due to specific moments of attention in their CSR agenda. For example, a company might make a big announcement and release a strict code of conduct about child labor one year, followed by years in which, while the code of conduct is enforced, no further references are added to new documents. It is nevertheless a worrisome trend that should be further investigated, if only for the impact it can have on the much needed global awareness, advocacy and pressure that still has to be made around the necessity to protect children from child labor. With the growth of globally dispersed supply networks, these explicit and formalized means of communication about a company’s policy on child labor are critical to provide a ‘holistic picture of value creation overtime’ across the supply chain [15].

Sectors. Figure 3 shows the percentage of companies with child labor policies versus not for the 30 largest sectors measured by number of companies. The percentage by sector varies quite a bit, from Telecom (54%) to Asset Management (13%). However, the rank ordering does not reflect actual child labor risk by industry. Asset Management as an industry likely has little risk of child labor, as compared to Metals & Mining, an industry with a known problem of exploiting child labor. Our future analyses will pair this sector breakdown with sector risk profiles, such as with the analysis by the Sustainability Accounting Standards Board (SASB) in their Materiality Map.²

We also looked at which sectors show the largest negative trend: companies that abandoned references to child labor policies in the last 6 years. Entities within *Banking*, *Chemicals*,

Oil, Gas & Coal sectors were the most likely to abandon policies, whereas companies within the *Consumer Products*, *Chemicals*, and *Oil, Gas & Coal* sectors are frequent adopters of child labor policies. This demonstrates a great deal of variation within companies belonging to similar industries, and especially within *Consumer Products* and *Chemicals*.

Change in Revenue. One of the core questions of ESG investing is whether adoption of sustainable policies has long term impact on the company. We investigated correlations between child labor policy adoption and the year over year change in revenue. We compare companies that adopt a child labor policy ($N \rightarrow Y$) versus companies that abandon their policy ($Y \rightarrow N$). Figure 4B illustrates these effects by showing the effective change in yearly revenue, where effect is calculated as the difference in revenue between the two years. The distributions show that companies who adopt a child labor policy on average have a lower probability of experiencing a decline in revenue and in turn exhibit a higher probability of higher earnings, compared to companies who abandon their policy. Rescaling the change in revenue to a percentage change (with respect to the previous year revenue) reveals similar effects (Figure 4B, inset). A two-sample Kolmogorov-Smirnov test confirms that the probability distribution for adaptation and abandonment of child labor policies differ ($p < 10^{-6}$).

Figure 4A presents another view of the data. We compute the median year over year revenue change of companies organized by the type of policy transition between 2010 and 2015. To account for overall market performance we normalize the revenue changes in each year by the average revenue change for all companies in our analysis. We find that companies that adopt a policy or keep their policy do better than companies that abandon their policy or continue not to have a policy.

These findings are in line with previous work that suggests implementing a child labor policy can have an overall positive effect on revenue [9, 10]. These results suggest the value of a further causal analysis of these factors.

5. CHILD LABOR AND THE SUPPLY CHAIN

One of the primary challenges for companies in addressing child labor is their supply chain. Large multinational companies often do not themselves employ child labor, but they may purchase materials from smaller, regional companies that do. The problem of child labor cannot be solved without considering the supply chain and the necessity for multinational companies to manage and monitor sustainable practices down the chain. This goes beyond implementing fair business practices within an organization, but it is about influencing the behavior of others [17].

In this sense, similar to how the influence of peer pressure between individuals has been seen to propagate through a social network e.g. [18, 19, 20], we hypothesize the same process through a *supply chain network* describing the value of the flow of goods and/or services between organizations. Additionally, major international companies can exert considerable influence on legislative practices [5]. This is of spe-

²<http://materiality.sasb.org/>

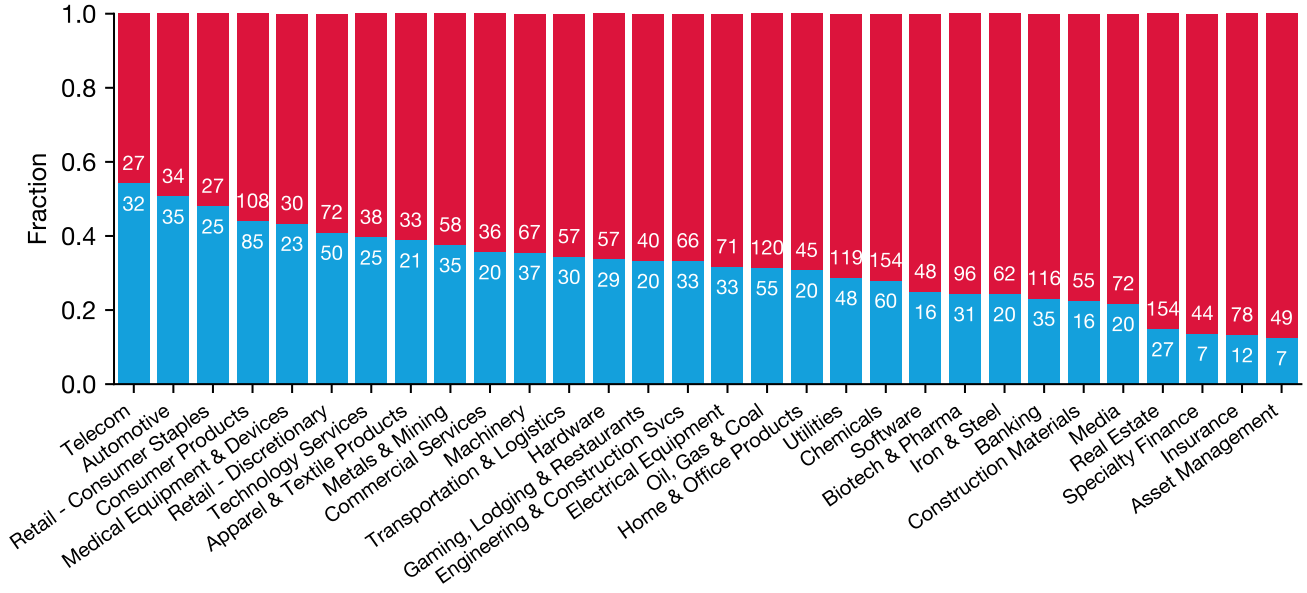


Figure 3: Sector Analysis. The percentage of companies for the 30 biggest industries (measured by number of companies) that have a child labor policy. Top bars (red) are the percent of companies without a child labor policy. Bottom bars (blue) have a policy. White numbers show counts.

cial importance as it can trigger secondary processes on a legislative level, as provisions in national constitutions concerning social rights, including protection of children from exploitation, are adopted both through influence between other countries as well as the influence of temporal trends in policy advocacy [21]. Furthermore, work by Rutherford et al. [21] found a hierarchical structure in provisions concerning specific topics such that advanced rights tend to be adopted only after basic and fundamental rights. For example, the protection of children from child labor is generally preceded by the right to form a trade union; labor rights of children come after labor rights for adults.

To understand the “peer pressure” effect of companies through their supply chains, we analyzed supply chain data made available through the Bloomberg Terminal. Bloomberg analyzes corporate disclosures and other available information to infer supply chain relations between tens of thousands of companies. The data is designed for small-scale analyses of specific companies and their competitors, so the data is not available for bulk download. Therefore, we conducted a proof of concept analysis by considering the network of one company with its 20 biggest suppliers, and in turn their 20 biggest suppliers, leading to an overall network of 250 unique nodes (21 of which have a complete ego network) and 405 edges. In total, 168 nodes in the network have data for child labor in 2015.

Figure 5A shows the resulting network, with node color indicating child labor policy and node size indicating company size. Given that the supply chain was queried starting with a high capitalization company, it is not surprising that there is a general prevalence of companies with a child labor policy. Using this network, we analyzed the tendency of companies with child labor policies to be supplied by companies with

similar stances on child labor. In doing so we analyzed the 168 nodes network for which there is data on child labor policies, calculating the ratio of Y suppliers (R_Y) for both Y nodes and N nodes. Figure 5B clearly shows a tendency for Y companies to have a higher R_Y than N companies, and also higher than the expected ratio in a random scenario (smaller than the expected R_Y in a random scenario for N companies). There is a persistent general assortativity³ on the supply chain around referencing child labor policies (of 0.166 [16]), despite the limited size of our sample. Whether this is an homophily effect, an influence one, or related to regions of the network with higher capitalization can change advocacy efforts of companies, governments and international organizations. We plan to pursue this further on a large sample of the supply chain network.

6. DISCUSSION

This paper provides an analysis on corporate trends around child labor policies adoption. With the emergence of global supply networks, understanding the level of adoptions of child labor policies by corporations is a first step towards establishing supply chain sustainability.

Our findings suggest that implementing a policy may have an overall positive effect on revenue. Nevertheless the complex relationship between a company’s economical performance and its social policies, and the many confounding factors, require further analysis to measure causal effects. Further analysis can confirm these findings, and illuminate the mechanism by which child labor policies are impacting corporate behavior and profit. Additionally, the small sample of supply chain data already noted at dependencies between network structure and the adoption of child labor policies.

³When a network’s nodes attach to others that are similar.

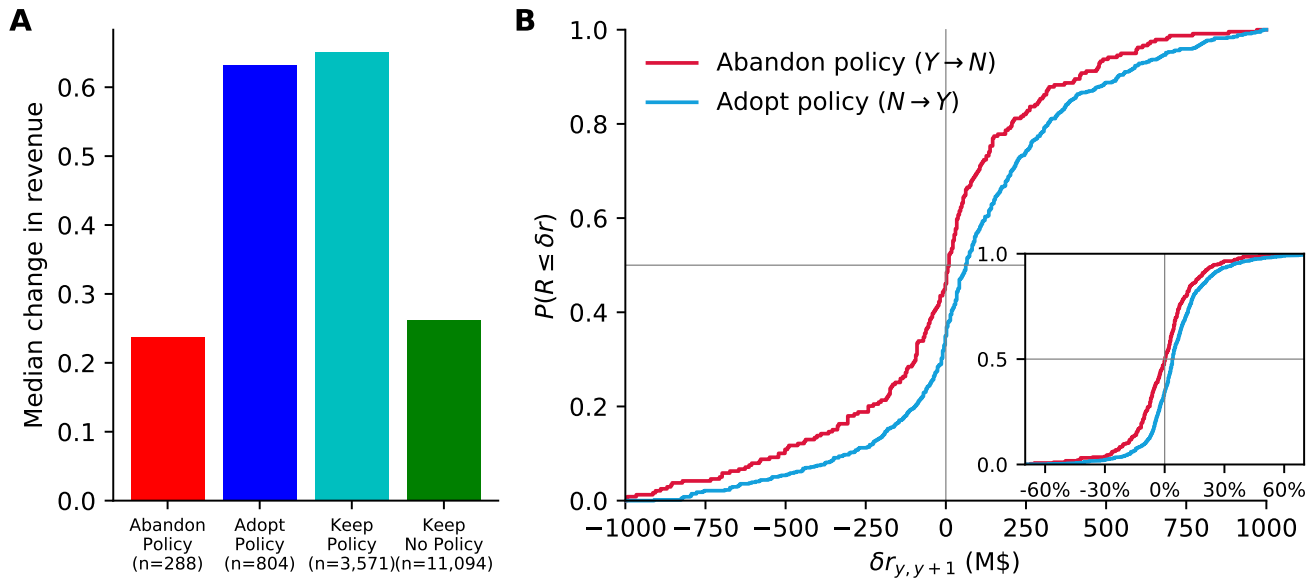


Figure 4: Quantifying the effect of child labor policies. A, Median year over year revenue of companies, normalized by market performance in the given year, organized by the type of policy transition. Companies that adopt a policy or keep their policy do better than companies that abandon their policy or continue not to have a policy. B, Cumulative probability distribution of effective change in yearly revenue for companies which implement a policy against child labor versus companies that abandon such policy. Between 2010-2015 804 companies implemented a policy, while 288 abandoned theirs. Effect is calculated as the difference in revenue between the two years ($y, y + 1$) where the change occurred ($\delta r_{y,y+1}$). Inset shows the change in percent, with differences being estimated from r_y . Two-sample Kolmogorov-Smirnov tests confirm that the probability distribution for adaptation and abandonment of child labor policies differ ($p < 10^{-6}$).

Nevertheless, larger availability of data on the supply chain and its evolution over time will be needed to understand further the implications of these dependencies.

Furthermore, these insights can shed new light both from an advocacy and programmatic point of view as well as from the point of view of better informing financial and investment decisions. The expanding efforts of Bloomberg and other financial data service providers to gather ESG data can benefit efforts to improve the global situation of the child. These types of data collaborations show how data originally intended to inform financial decision is now used to create public value for children, helping bridge the data and scientific gaps that currently separate them. At the same time, these new methods to analyze vulnerabilities can have significant spillovers for creating more robust and sustainable markets, as well as for making better informed investments with better returns. As such, these collaborations can go beyond pure *data for good* by showing that doing good is, actually, good business.

7. REFERENCES

- [1] International Programme on the Elimination of Child Labour (IPEC), “World report on child labour 2015: Paving the way to decent work for young people,” 10 June 2015.
- [2] F. King and R. Marcus, *Big business, small hands: responsible approaches to child labour*. Save the Children Fund, 2000.
- [3] P. M. Emerson and A. P. Souza, “Is there a child labor trap? intergenerational persistence of child labor in Brazil,” *Economic development and cultural change*, vol. 51, no. 2, pp. 375–398, 2003.
- [4] International Labour Organization (ILO), “Child labour and education: Progress, challenges and future directions,” 31 March 2015.
- [5] D. Winstanley, J. Clark, and H. Leeson, “Approaches to child labour in the supply chain,” *Business Ethics: A European Review*, vol. 11, no. 3, pp. 210–223, 2002.
- [6] N. R. Jaffe and J. D. Weiss, “The self-regulating corporation: How corporate codes can save our children,” *Fordham J. Corp. & Fin. L.*, vol. 11, p. 893, 2005.
- [7] K.-H. Lee and S. Vachon, *Supply Chain Sustainability Risk*, pp. 245–280. London: Palgrave Macmillan UK, 2016.
- [8] S. Hajmohammad and S. Vachon, “Mitigation, avoidance, or acceptance? managing supplier sustainability risk,” *Journal of Supply Chain Management*, vol. 52, no. 2, pp. 48–65, 2016.
- [9] C. Lefevre, D. Pellé, S. Abedi, R. Martinez, and P. Thaler, “Value of sustainable procurement practices,” *Collaborative report from PwC, EcoVadis and INSEAD*, 2010.
- [10] M. S. Hopkins, K. Haanaes, B. Balagopal, I. Velken, N. Kruschwitz, and D. Arthur, “New sustainability study: The embracers seize advantage,” *MIT Sloan Management Review*, vol. 52, no. 3, p. 23, 2011.

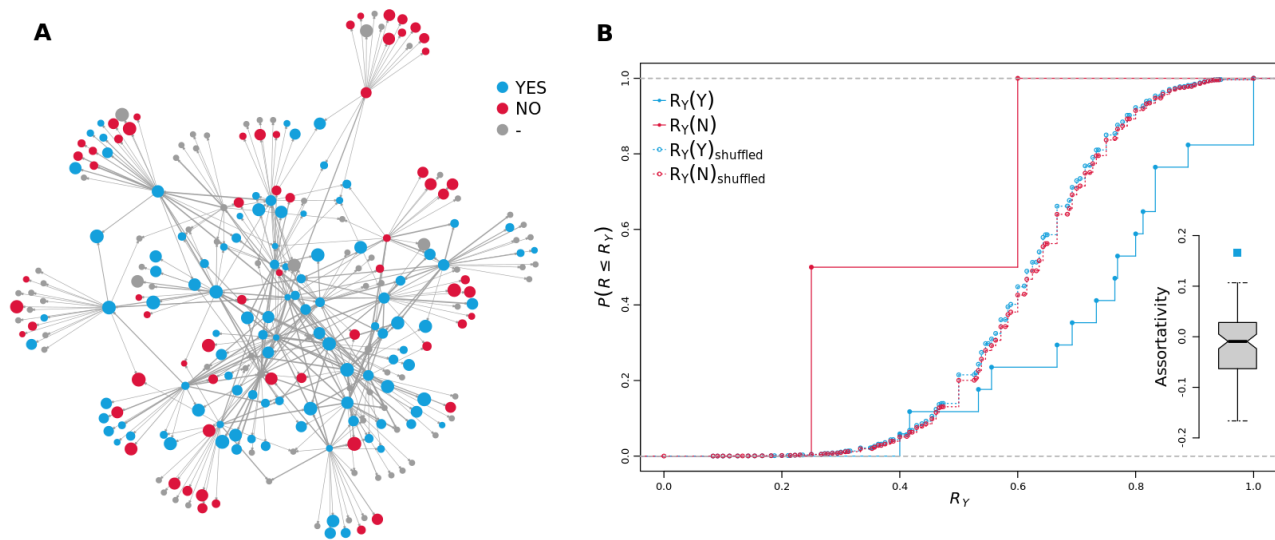


Figure 5: Child labor on the supply chain. A 2015 partial view of the supply chain as a network. Nodes represent companies, size is proportional to number of employees and color indicates whether they reference a child labor policy (blue), they do not (red) or there is no data available in the Bloomberg Terminal (grey). Arrows indicate a supplier-buyer relationship. B Empirical Cumulative Distribution Function (ECDF) of R_Y , meaning the ratio of Y supplier companies over the set of supplier companies that are tagged (i.e. either a Y or a N). Solid dots for the observed ratios on Y nodes (blue) and N nodes (red). Empty circles for 10,000 randomizations in which the network structure is preserved but the Child Labor property is shuffled between all nodes in the network. Two-sample Kolmogorov-Smirnov tests confirm that the probability distribution of $R_Y(Y)$ and $R_Y(Y)_{shuffled}$ differ ($p = 0.002$; $p = 0.001$ for the alternative that $R_Y(Y) < R_Y(Y)_{shuffled}$). Bottom right inset shows how the observed nominal assortativity [16] of the network (blue square) falls clearly outside the assortativity distribution of 100 randomized networks.

[11] C. Marquis, D. Beunza, F. Ferraro, and B. Thomason, "Driving sustainability at bloomberg lp," *Harvard Business School Organizational Behavior Unit Case No. 411-025.*, 2011.

[12] A. Bernstein and C. Greenwald, "Benchmarking corporate policies on labor and human rights in global supply chains," *Pensions and Capital Stewardship Project, Labor and Worklife Program*, vol. 5, 2009.

[13] UNICEF, "Child labour and unicef in action: Children at the centre," May 2014.

[14] L. Compa and T. Hinchliffe-Darricarrere, "Enforcing international labor rights through corporate codes of conduct," *Colum. J. Transnat'l L.*, vol. 33, p. 663, 1995.

[15] R. Hahn and M. Kühnen, "Determinants of sustainability reporting: a review of results, trends, theory, and opportunities in an expanding field of research," *Journal of cleaner production*, vol. 59, pp. 5–21, 2013.

[16] M. Newman, *Networks: an introduction*. Oxford university press, 2010.

[17] Shift Project, "Using leverage in business relationships to reduce human rights risks," *New York*, 2013.

[18] L. Muchnik, S. Aral, and S. Taylor, "Social influence bias: A randomized experiment," *Science*, 2013.

[19] L. Coviello, Y. Sohn, A. D. I. Kramer, C. Marlow, M. Franceschetti, N. A. Christakis, and J. H. Fowler, "Detecting emotional contagion in massive social networks," *PLOS ONE*, vol. 9, pp. 1–6, 03 2014.

[20] S. Aral and D. Walker, "Identifying influential and susceptible members of social networks," *Science*, vol. 337, no. 6092, pp. 337–341, 2012.

[21] A. Rutherford, Y. Lupu, M. Cebrian, I. Rahwan, B. L. LeVeck, and M. Garcia-Herranz, "Inferring mechanisms for global constitutional progress," *Nature Human Behaviour*, vol. 2, no. 8, p. 592, 2018.

[22] R. Sparkes, *Socially responsible investment*. Wiley Online Library, 2008.

[23] International Labour Organization (ILO), "Economically active population 1950-2010," 2015.

[24] International Organization for Migration (IOM), "Global migration trends factsheet 2015," 2016.

[25] Norwegian Refugee Council (NRC), "Remittances to syria," 2017.

[26] UNICEF, "International convention on the rights of the child," 2017.

[27] K.-H. Lee and S. Vachon, "Supply chain sustainability risk," in *Business Value and Sustainability*, pp. 245–280, Springer, 2016.

[28] K. Legge, "The ethical context of hrm: the ethical organisation in the boundaryless world," *Ethical issues in contemporary human resource management*, pp. 23–40, 2000.

[29] United Nations, *Guiding principles on business and human rights*. Geneva, Switzerland: Office of the United Nations High Commissioner for Human Rights

(OHCHR), 2011.

- [30] J. Xu, T. L. Wickramaratne, N. V. Chawla, E. K. Grey, K. Steinhaeuser, R. P. Keller, J. M. Drake, and D. M. Lodge, “Improving management of aquatic invasions by integrating shipping network, ecological, and environmental data: Data mining for social good,” in *Proceedings of the 20th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, KDD '14, (New York, NY, USA), pp. 1699–1708, ACM, 2014.
- [31] K. Leetaru and P. A. Schrodtt, “Gdelt: Global data on events, location, and tone,” *ISA Annual Convention*, 2013.
- [32] D. Hristova, A. Rutherford, J. Anson, M. Luengo-Oroz, and C. Mascolo, “The international postal network and other global flows as proxies for national wellbeing,” *PLOS ONE*, vol. 11, pp. 1–19, 06 2016.
- [33] C. A. Hidalgo, B. Klinger, A.-L. Barabási, and R. Hausmann, “The product space conditions the development of nations,” *Science*, vol. 317, no. 5837, pp. 482–487, 2007.
- [34] A. Llorente, M. Garcia-Herranz, M. Cebrian, and E. Moro, “Social media fingerprints of unemployment,” *PloS one*, vol. 10, no. 5, p. e0128692, 2015.
- [35] N. Eagle, M. Macy, and R. Claxton, “Network diversity and economic development,” *Science*, vol. 328, no. 5981, pp. 1029–1031, 2010.
- [36] J. Blumenstock, G. Cadamuro, and R. On, “Predicting poverty and wealth from mobile phone metadata,” *Science*, vol. 350, no. 6264, pp. 1073–1076, 2015.
- [37] G. Magno and I. Weber, “International gender differences and gaps in online social networks,” in *International Conference on Social Informatics*, pp. 121–138, Springer, 2014.
- [38] Y. Kryvasheyeu, H. Chen, N. Obradovich, E. Moro, P. Van Hentenryck, J. Fowler, and M. Cebrian, “Rapid assessment of disaster damage using social media activity,” *Science advances*, vol. 2, no. 3, p. e1500779, 2016.
- [39] S. McQueen, S. Konopka, N. Palmer, G. Morgan, S. Bitrus, and L. Okoko, “mhealth compendium. edition one.,” 2012.