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Corporate Reporting in the Era of Artificial Intelligence

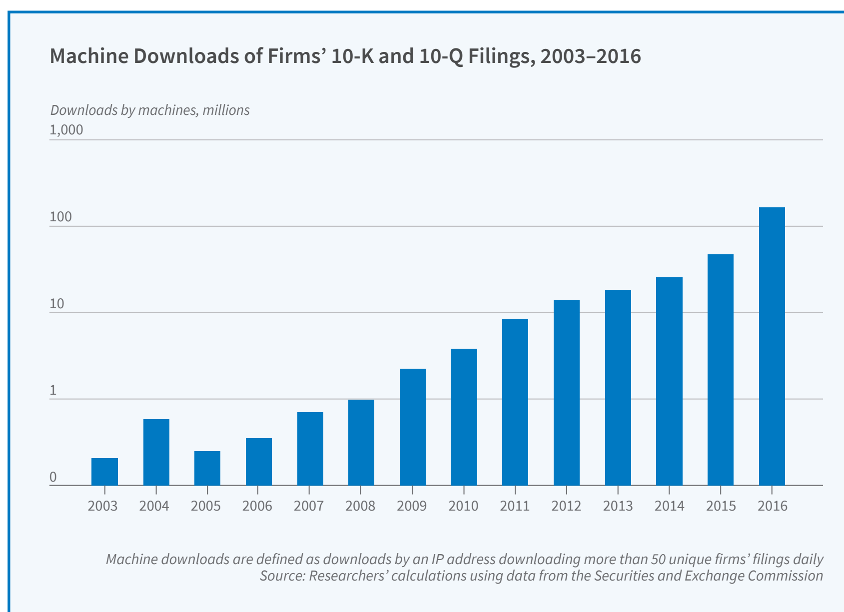
Companies have long seen annual reports and other corporate disclosures as opportunities to portray their business health in a positive light. Increasingly, the audience for these disclosures is not just humans, but also machine readers that process the information as an input to investment recommendations.

In **How to Talk When a Machine Is Listening: Corporate Disclosure in the Age of AI** (NBER Working Paper 27950), Sean Cao, Wei Jiang, Baozhong Yang and Alan L. Zhang explore some of the implications of this trend. Rather than focusing on how investors and researchers apply machine learning to extract information, this study examines how companies adjust their language and reporting in order to achieve maximum impact with algorithms that are processing corporate disclosures.

To gauge the extent of a company's expected machine readership, the researchers use a proxy: the number of machine downloads of the company's filings from the US Securities and Exchange Commission's electronic retrieval system. Mechanical downloads of corporate 10-K and 10-Q filings have increased exponentially, from 360,861 in 2003 to around 165 million in 2016. Machine downloads have become the dominant mode during this time — increasing from 39 percent of all downloads in 2003 to 78 percent in 2016.

> Mechanical downloads of corporate 10-K and 10-Q filings increased from 360,861 in 2003 to around 165 million in 2016.

The researchers find that companies expecting higher levels of machine readership prepare their disclosures in ways that are more readable by this audience. "Machine readability" is measured in terms of how easily the information can be processed and parsed, with a one standard deviation increase in expected machine downloads corresponding to a 0.24 standard deviation increase in machine readability. For example, a table in a disclosure document might receive a low readability score because its formatting makes it difficult for a machine to recognize it as a table. A table in a disclosure document would receive a high readability score if it made effective use of tagging so that a machine could easily identify and analyze the content.



Companies also go beyond machine readability and manage the sentiment and tone of their disclosures to induce algorithmic readers to draw favorable conclusions about the content. For example, companies avoid words that are listed as negative in the directions given to algorithms.

The researchers show this by contrasting the occurrence of positive and negative words from the *Harvard Psychosocial*

Dictionary—which has long been used by human readers—with those from an alternative, finance-specific dictionary that was published in 2011 and is now used extensively to train machine readers. After 2011, companies expecting high machine readership significantly reduced their use of words labelled as negatives in the finance-specific dictionary, relative to words that might be close synonyms in the Harvard dictionary but were not included in the finance publication. A one standard deviation increase in the share of machine downloads for a company is associated with a 0.1 percentage point drop in negative-sentiment words based on the finance-specific dictionary, as a percentage of total word count.

Companies also appear to adjust their use of words associated with potential stock market reactions, such as those that the alternative dictionary labels as litigation-related, uncertain, or demonstrating too little or too much confidence. In contrast, no relationship emerges between high machine readership and the sentiment of words as specified by the Harvard dictionary.

Both results demonstrate that company managers specifically consider machine readers, as well as humans, when preparing disclosures.

Machines have become an important part of the audience not just for written documents but also for earnings calls and other conversations with investors. Managers who know that their disclosure documents are being parsed by machines may also recognize that voice analyzers may be used to identify vocal patterns and emotions in their commentary. Using machine learning software trained on a sample of conference call audio from 2010 to 2016, the researchers show that the vocal tones of managers at companies with higher expected machine readership are measurably more positive and excited.

—Dylan Parry

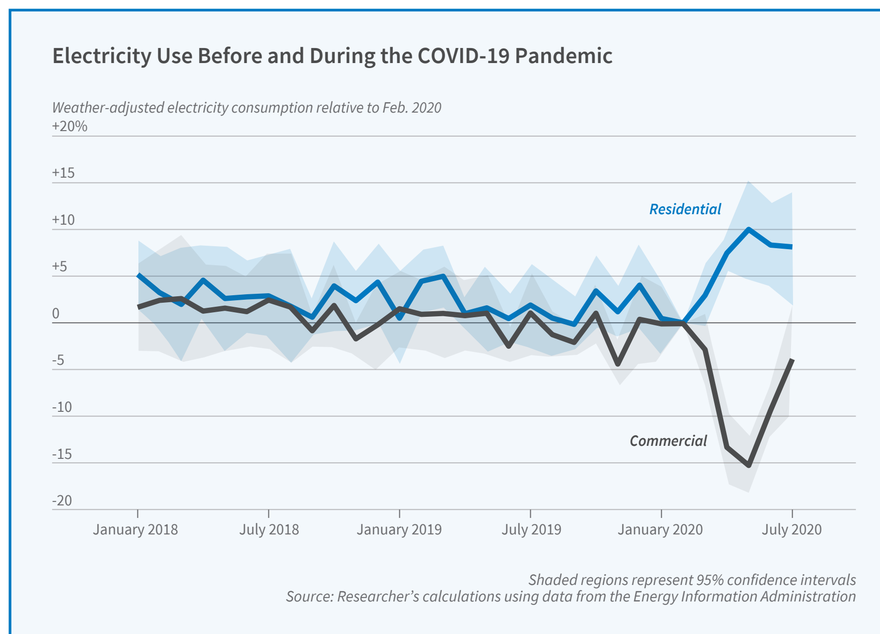
Working from Home's Impact on Electricity Use in the Pandemic

With Zoom sessions, greater use of heating and cooling systems, and lamps and printers running all day, Americans working from home, combined with an increase in the number of unemployed workers who are home because they have lost jobs at shuttered businesses, have driven a surge in residential electricity consumption since the onset of the COVID-19 pandemic in the United States.

Americans spent $6 billion more on at-home power consumption from April to July 2020 than during normal times, nearly offsetting a decline in business and industrial demand.

Compared with the same months from 2016–19 and adjusted for weather differences, the second quarter of 2020 saw a 10 percent increase in residential electricity usage, a 12 percent drop in commercial usage, and a 14 percent drop in industrial usage, according to **Powering Work from Home** (NBER Working Paper 27937) by Steve Cicala.

Based on weather-adjusted hourly usage data from Texas, the study documents stark changes in at-home electricity consumption patterns. Pre-pandemic, electricity use rose sharply early in the morning as people prepared for work, dropped off during the day, and peaked in the evening. During the pandemic, this pattern has largely disappeared: residential consumption rises later in the morning, and is 16 percent higher during work hours than it was before the pandemic struck.



The study uses weather-adjusted monthly data on electricity consumption nationwide to disentangle the impact of the enlarged home-based workforce from other factors that have pumped up residential usage. In the top 10 metropolitan areas, for example, the portion of the labor force that is working from home is estimated to be 10 percentage points above the national average. That differential corresponds to a 3 percent increase in residential consumption in those metro areas in the second quarter of 2020, compared with the same months from 2016–19. Residential consumption has increased nationwide, but the sharpest rises have been in New England, Illinois, and California. The smallest increases

have been in Appalachia and the south-central states.

Traditionally, business consumption of electricity has been a signal of the economy's direction. The 2008 economic crisis was accompanied by a 10 to 15 percent drop in industrial and commercial electricity use, but no significant change in residential usage. In contrast, the surge in residential use during the pandemic has nearly offset the decline in commercial and industrial consumption. Electricity use across all sectors declined just 3.5 percent in the second quarter of 2020, compared with the same period the year before.

From an environmental standpoint, working and studying from home comes with a cost, especially for those living in large suburban houses. These homes are not as energy efficient, on average, as schools and offices. This reduction in daytime energy efficiency is a partial counterbalance to the energy savings associated with reduced commuting.

— Steve Maas

Debt is Supported by Firms' Value as Going Concerns

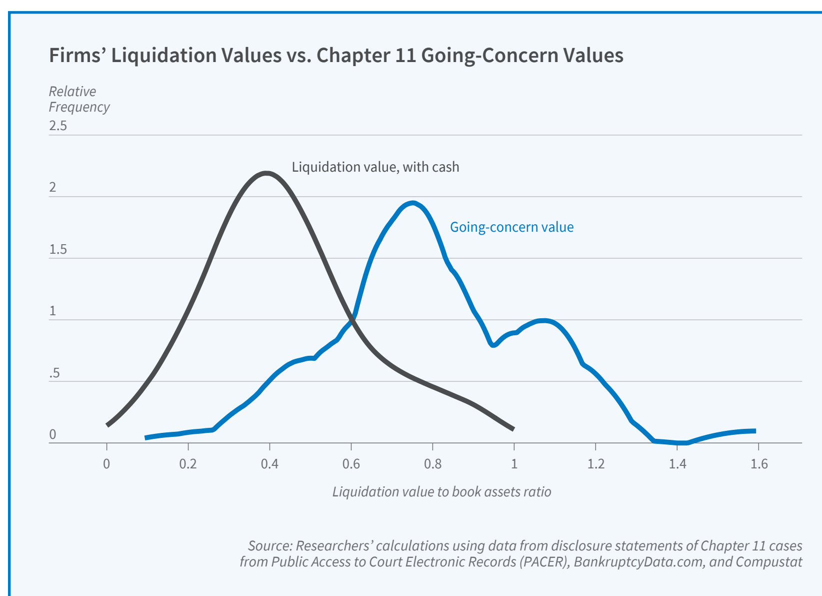
Roughly three-quarters of noninvestment-grade firms in nonfinancial industries carry debt that exceeds the estimated liquidation value of their property, plant, equipment, and working capital. This suggests that a substantial amount of corporate debt takes the form of cash flow-based lending, where creditors have payoffs backed by firm value as an operating business and place more emphasis on monitoring firms' operating performance. Even for secured debt, at least one third is secured by the firm as an operating business rather than by discrete assets.

In **Two Tales of Debt** (NBER Working Paper 27641), Amir Kermani and Yueran Ma examine the determinants of firms' debt capacity. They discuss three kinds of debt: asset-based debt that gives creditors claims against the liquidation value of discrete assets, cash flow-based debt with weak control rights that gives lenders claims against a firm as a whole but typically does not allow them to intervene in business decisions, and cash flow-based debt with strong control that gives creditors claims against the firm as a whole and allows them to engage in active monitoring of a firm's business decisions. Active monitoring may include imposing restrictive financial covenants designed to ensure managerial effort.

The researchers collected data from liquidation analyses included in Chapter 11 filings for 387 public nonfinancial companies that filed for bankruptcy from 2000 to 2016. By combining liquidation recovery rates from this dataset with Compustat data, they estimated that nonfinancial firms' liquidation value of fixed assets and working capital is only 23 percent of book value on average, with an interquartile range of 12 percent to 33 percent. Using a variety of commercial databases, they also collected data on the composition and contractual provisions of public companies' outstanding debt. The data show that variations in firms' debt contracts are a function of their liquidation value, their value as an operating business, their indebtedness, and their size.

Debt backed by the value of the firm as a going concern, rather than asset-based debt, features prominently in corporate capital structures.

The share of asset-based debt is high when a firm's book leverage — the value of total debt divided by the book value of total assets — is below 10 percent, and falls as borrowing rises. Firms use more cash flow-based bonds with weak control for medium levels of borrowing, and eventually have a greater prevalence of cash flow-based loans with strong control for high levels of leverage. Companies with lower liquidation values have more cash flow-based debt and more intensive creditor monitoring of their performance. They also pay higher interest rates when they borrow through asset-based debt. Overall, total leverage does not depend on the liquidation value of discrete assets, except among small public firms and firms with negative earnings.



Source: Researchers' calculations using data from disclosure statements of Chapter 11 cases from Public Access to Court Electronic Records (PACER), BankruptcyData.com, and Compustat

Nonfinancial firms' assets are often specific to their business and have low liquidation values. Nonetheless, institutional arrangements in the United States, such as creditor monitoring, covenants, and Chapter 11 corporate restructuring, help firms borrow well beyond liquidation values. The researchers conclude that financial development requires not just secure property rights, but also institutional structures that enable creditors to monitor managerial actions and enforce control rights to maximize the value of a business as a going concern.

— Linda Gorman

The Return to Impact Investing in Developing Countries

The oldest and most diversified international impact investor has earned superior returns by deploying its funds in emerging-market and developing nations, according to findings reported in **Long-Run Returns to Impact Investing in Emerging Markets and Developing Economies** (NBER Working Paper 27870).

Over six decades, the International Finance Corporation (IFC) has invested in private equity and venture capital in 130 such countries. The portfolio has outperformed the US stock market over this period. At the end of 2019, an investor who had earned returns on the IFC's portfolio since 1961 would have 15 percent more wealth than one who invested the same initial amount in the S&P 500. While the IFC, as a member of the World Bank Group, may have certain investment advantages over other market participants, its record offers insights for international investors who want to achieve social and environmental goals while receiving a strong financial return.

The study by Shawn Cole, Martin Melecky, Florian Mölders, and Tristan Reed offers new data on the long-standing question of whether investors can have a social or environmental impact only if they accept lower risk-adjusted returns. The researchers find that imperfect integration of international capital markets creates attractive investment opportunities in countries with less-developed banking systems and capital controls, thereby creating scope for both financial profit and social impact. They define an impact investor as one who "provides capital to eligible projects that would not have otherwise received funding due to imperfectly integrated financial markets."

The IFC was founded in 1956 with a World Bank mandate to encourage growth in productive private enterprise, especially in less-developed areas. It made its first loan in 1957 and its first equity investment in 1961. Its portfolio includes investments in more countries than are included in the MSCI Emerging Markets index, which is heavily concentrated in large economies like China and Brazil. The IFC also has a higher share of investment in very poor nations. An investor holding the IFC's equity portfolio since 1988, the year the MSCI Emerging Markets Index was launched, would have 30 percent more wealth at the end of 2019 than an investor who started with an equal-sized investment in 1988, but who held the MSCI Index instead.

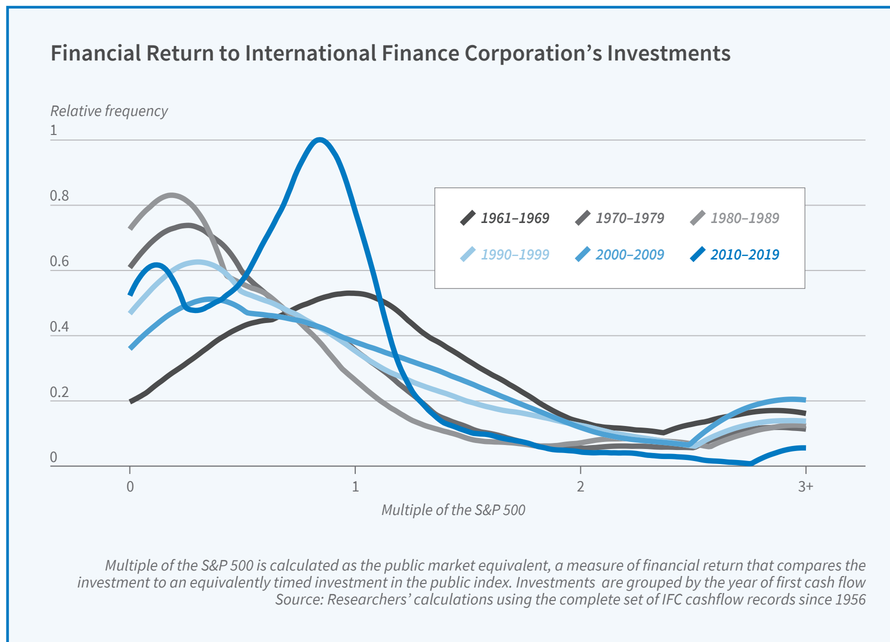
The researchers measure the performance of the IFC portfolio and each individual investment by computing its public market equivalent (PME), a measure of financial return that compares the investment to an equivalently timed investment in the public index. The PME is preferred to alternative measures of return — such as the internal rate of return and multiple of money — because the PME accounts for the value of payouts that are not perfectly correlated with the market. The researchers consider both the S&P 500 Index and the MSCI Emerging Markets Index as potential comparisons.

The study also examines the returns to individual IFC investments, and the factors that are associated with them. Conditions within particular countries, such as political risk, corruption, and ease of doing business, are weak predictors of future returns. Macroeconomic conditions over the course of the investment are positively associated with returns, as are changes in the host country's sovereign risk over the investment period. Each 1 percent rise in annual GDP growth over the life of a typical investment is associated with a 6.6 percentage point boost in the investment's return. The researchers conclude that predicting a nation's macroeconomic performance is therefore a key component of country risk assessment.

—Laurent Belsie

Over six decades, the International Finance Corporation has earned higher returns than the S&P 500 on its equity portfolio.

Financial Return to International Finance Corporation's Investments



Multiple of the S&P 500 is calculated as the public market equivalent, a measure of financial return that compares the investment to an equivalently timed investment in the public index. Investments are grouped by the year of first cash flow
Source: Researchers' calculations using the complete set of IFC cashflow records since 1956

Gang Culture and Economic Development: Evidence from El Salvador

How do armed, nonstate actors such as criminal organizations affect economic growth? Nikita Melnikov, Carlos Schmidt-Padilla, and Maria Micaela Sviatschi explore this question in **Gangs, Labor Mobility, and Development** (NBER Working Paper 27832), a study of how two of the world's largest gangs, MS-13 (also known as Mara Salvatrucha) and 18th Street (also known as Barrio 18) affect socioeconomic development in El Salvador.

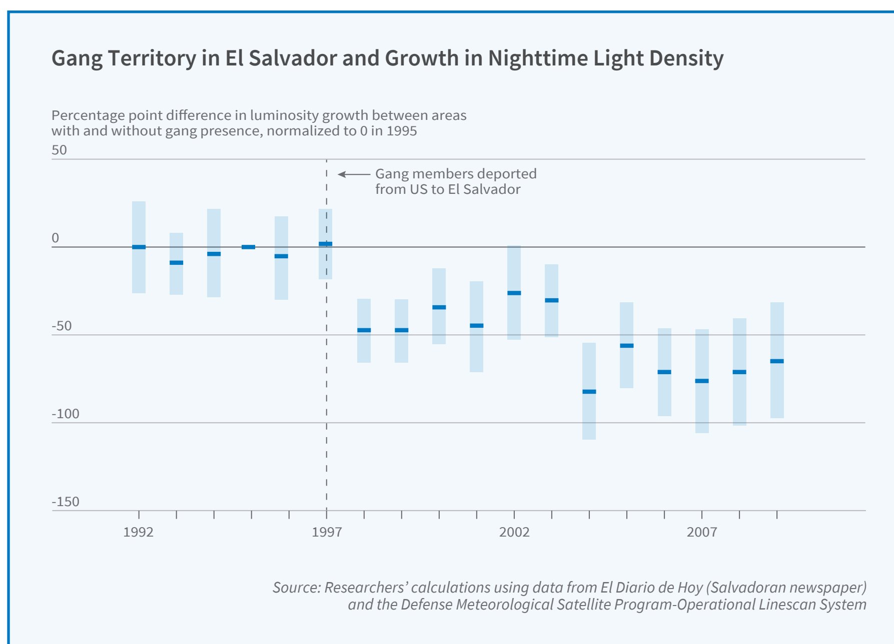
The researchers study a natural experiment that occurred in the 1990s. Before 1997, El Salvador did not have any powerful gangs. In that year, the United States began implementing an immigration policy that made it easier to deport individuals with criminal backgrounds to their countries of origin. As a result, many Salvadoran migrants who were members of California-based gangs, in particular MS-13 and 18th Street, were deported to El Salvador, where they established the gangs and gained control over parts of the country.

The researchers estimate the impact of gangs on socioeconomic development in two ways. First, they use the boundaries of gang-controlled neighborhoods in El Salvador's capital, San Salvador, to compare economic outcomes inside and outside these neighborhoods. They study outcomes using data from the 2007 census and a 2019 geocoded survey they conducted. Second, they compare the growth in nighttime light density in locations with high and low gang presence between 1992 and 2013.

The results indicate that residents of gang-controlled neighborhoods have worse dwelling conditions and are worse off than those living just 50 meters away but outside of gang territory. Residents of gang areas have $350 lower monthly income than individuals in neighboring nongang locations and are 12 percent less likely to work in a firm with at least 100 employees.

> Residents of gang-controlled neighborhoods in San Salvador have worse dwelling conditions, less income, and lower probability of working in a large firm than those living just outside gang territory.

These differences did not exist before the gangs arose. When the researchers replicate their calculations using data from the 1992 census, the results show that neighborhoods on both sides of what would become the gang-territory boundary had similar socioeconomic and geographic characteristics. The light density analysis confirms this. After the arrival of gang members from the US, areas with gang activity experienced lower growth in nighttime light density compared to places without gang presence, while before the deportations both these locations had similar rates of growth.



Source: Researchers' calculations using data from El Diario de Hoy (Salvadoran newspaper) and the Defense Meteorological Satellite Program-Operational Linescan System

A key mechanism through which gangs affect socioeconomic development is restrictions on nongang individuals' mobility in the neighborhoods they control. To maintain control over their territory and prevent the police and members of rival gangs from entering it, both MS-13 and 18th Street use a checkpoint system, stopping free movement into and out of their neighborhoods. The researchers suggest that as a result of these restrictions, residents of gang-controlled areas often cannot work outside of gang territory and therefore must settle for low-paying jobs in small firms in the neighborhoods where they live.

Although restrictions on individual mobility may not be the sole mechanism behind the lower socioeconomic development of gang areas, the researchers are able to reject a number of other plausible explanations. They find no differences in the availability and quality of such public goods as schools and hospitals, which suggests that the government has been willing to provide public goods in gang-controlled areas in order to avoid ostracizing residents. They also show that the lower socioeconomic development of gang-controlled neighborhoods cannot be explained by selective migration of individuals across gang territory boundaries, differential exposure to violence, or higher levels of informal employment and unemployment in gang-controlled neighborhoods.

—Lauri Scherer

The Role of Multinationals in Propagating Economic Downturns

Nonfinancial multinational companies (MNCs) propagate economic downturns from one country to another through the network of their subsidiaries, according to an analysis of the experiences of more than 1,000 MNCs with over 10,000 subsidiaries in 23 countries during the 2008–12 period.

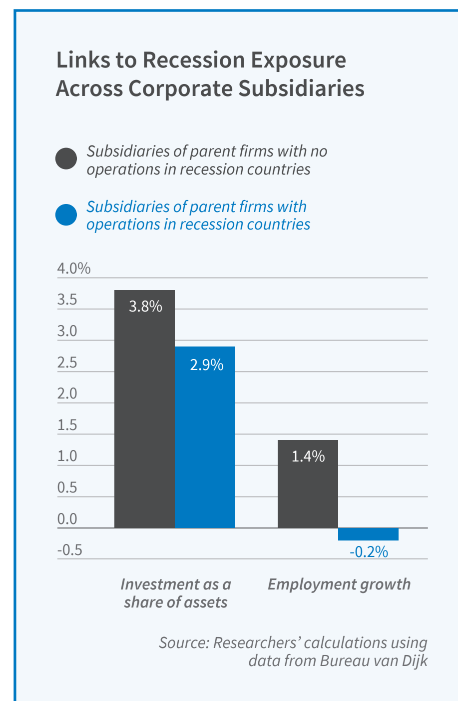
In **The International Propagation of Economic Downturns through Multinational Companies** (NBER Working Paper 27873), Jan Bena, Serdar Dinc and Isil Erel consider, for illustration, a hypothetical MNC headquartered in Germany with subsidiaries in both Spain and Finland. They ask how an economic downturn in Spain reverberates through the MNC to impact the subsidiary based in Finland.

The researchers find that if an MNC has a foreign subsidiary in a country that experiences a large downturn, the investment rate and employment growth in its subsidiaries in other countries are lower relative to similar subsidiaries of another MNC headquartered in the same country but without a subsidiary in the country experiencing the downturn.

Subsidiaries whose parent firms do not have subsidiaries in a country experiencing a downturn invest an average of 3.8 percent of their lagged assets, while those with parents with subsidiaries in a country experiencing a downturn invest 0.7 to 1.3 percentage points less on average. Similarly, the growth rate of employment for subsidiaries of recession-affected parent firms is 1.4 to 2.2 percentage points lower. This compares to a baseline average employment growth rate of 1.4 percent in the subsidiaries of unaffected parents.

Subsidiaries of parent firms that have other subsidiaries in a country experiencing a downturn invest less than subsidiaries of parents with no link to countries in recession.

The researchers offer two potential explanations for why economic downturns propagate via MNCs in this way.



First, foreign subsidiaries within a single MNC are often linked by a supply chain. For example, a German steel subsidiary may supply a subsidiary manufacturing automobiles in France. In these cases, the strength of the effect depends on the direction of the relationship. Specifically, if the subsidiary in the country experiencing a downturn is "downstream" — if it is a customer to other subsidiaries of the same parent firm — then the effect is greater than if the subsidiary in the affected country is an upstream supplier.

The second explanation relates to access to finance. In this case, the propagation effect is stronger when the parent MNC is financially constrained, thus offering relatively low internal access to capital. This suggests that an economic downturn in the country of one subsidiary can tighten the constraints on a financially constrained parent, making it more difficult for its subsidiaries in unaffected countries to obtain the capital needed to sustain investment and employment. The researchers find this effect even when there is no supply chain relationship between the subsidiaries of the parent MNC.

— Dylan Parry

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