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Technical appendix

The power of one: How standout firms grow national productivity

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Technical appendix

This technical appendix outlines the data, methodology, key assumptions, limitations, and metrics behind this research. It covers:

1. Calculating productivity growth contributions
2. The decomposition methodology with productivity and employment effects
3. Scaling productivity contributions from sector to country and the sector mix effect
4. Scope: Countries, sectors, and period covered
5. Data sources, estimations, and adjustments
6. Robustness checks
7. Supplementary analyses

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1. Calculating productivity growth contributions

This research focuses on firm-level contributions to productivity growth at the subsector, sector, and national sample levels. Each country sample is treated separately, and all calculations are done in local currency.

We define productivity growth as the change in real gross value added (GVA) per worker. We calculate real GVA by adding EBITDA and personnel cost (that is, labor compensation), adjusting for changes in prices using sector-level deflators. We include contributions as firms raise their productivity levels as well as those that come from the movement of employees into more productive firms.

Step-by-step calculations with an example

Step 1: Computing firm-level productivity

Let us illustrate 2011–19 productivity growth in real value per worker using Apple as an example, as we do in the body of our report. Exhibit A1 shows the following:

— First, we add nominal EBITDA and nominal personnel costs to obtain nominal GVA for 2011 and 2019. Comparing 2019 and 2011 figures, we see that Apple's nominal GVA grew at 10.6 percent per year over this period (derived from its 10 percent annual increase in nominal EBITDA and 14 percent annual increase in nominal personnel costs between the two years).

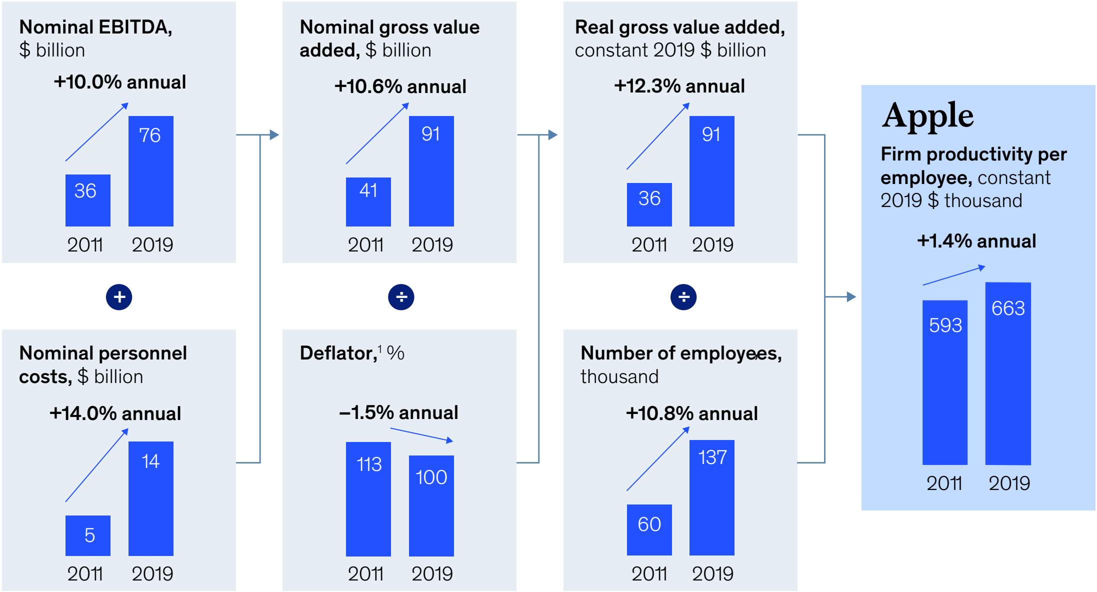
— Second, we apply a so-called double-sided deflator to nominal GVA to obtain real GVA in 2019 prices.[1] Because Apple is part of the US computers and electronics sector, we apply the deflator for that sector. This deflator allows us to discount changes in the prices of output and input in the sector and thus eliminate any potential for apparent growth in GVA that is explained by increasing sector prices. The double-sided deflator's growth was a negative figure of 1.5 percent annually—that is, the sector's products dropped in price on a quality-adjusted basis—hence Apple's real GVA grew 12.3 percent annually.

— Third, we divide real GVA by the number of employees to obtain Apple's productivity per employee. For Apple, that figure was a positive 10.8 percent annually.

— Finally, because Apple's real GVA grew faster than its head count over the same period, the company achieved a productivity increase of 1.4 percent annually per employee (Exhibit A1).

Exhibit A1

Illustration: Apple's growth in productivity per employee, 2011–19.



Note: Figures may not sum to 100 percent because of rounding.
[1] EU KLEMS country sector deflator; double-sided deflator.
Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; McKinsey Global Institute analysis

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Step 2: Computing firm-level contribution to productivity growth

Apple's total productivity contribution is calculated by adding its "firm productivity effect" and its "reallocation effect." We use the "shift-share" decomposition method and compare it with other formulas in section 2, "The decomposition methodology with productivity and employment effects."

To calculate the firm productivity effect, we multiply:

(A) How much the firm improved its own productivity level from 2011 to 2019 (for Apple, by $69,800 per employee in constant 2019 prices).

by

(B) How large the firm is relative to the sector, measured by its average employment share across 2011 and 2019 (for Apple, 4.1 percent of the employment in the computers and electronics sector).

To calculate the reallocation effect, we multiply:

(C) How much more productive the firm is relative to its sector, on average over the period (for Apple, it was $456,000 per employee more productive on average between 2011 and 2019, in constant 2019 prices, than the average firm in the US computers and electronics sector sample).

by

(D) How much the firm grew its employment share (for Apple, by 3.2 percentage points).

After adding the productivity effect to the relocation effect, we also calculate:

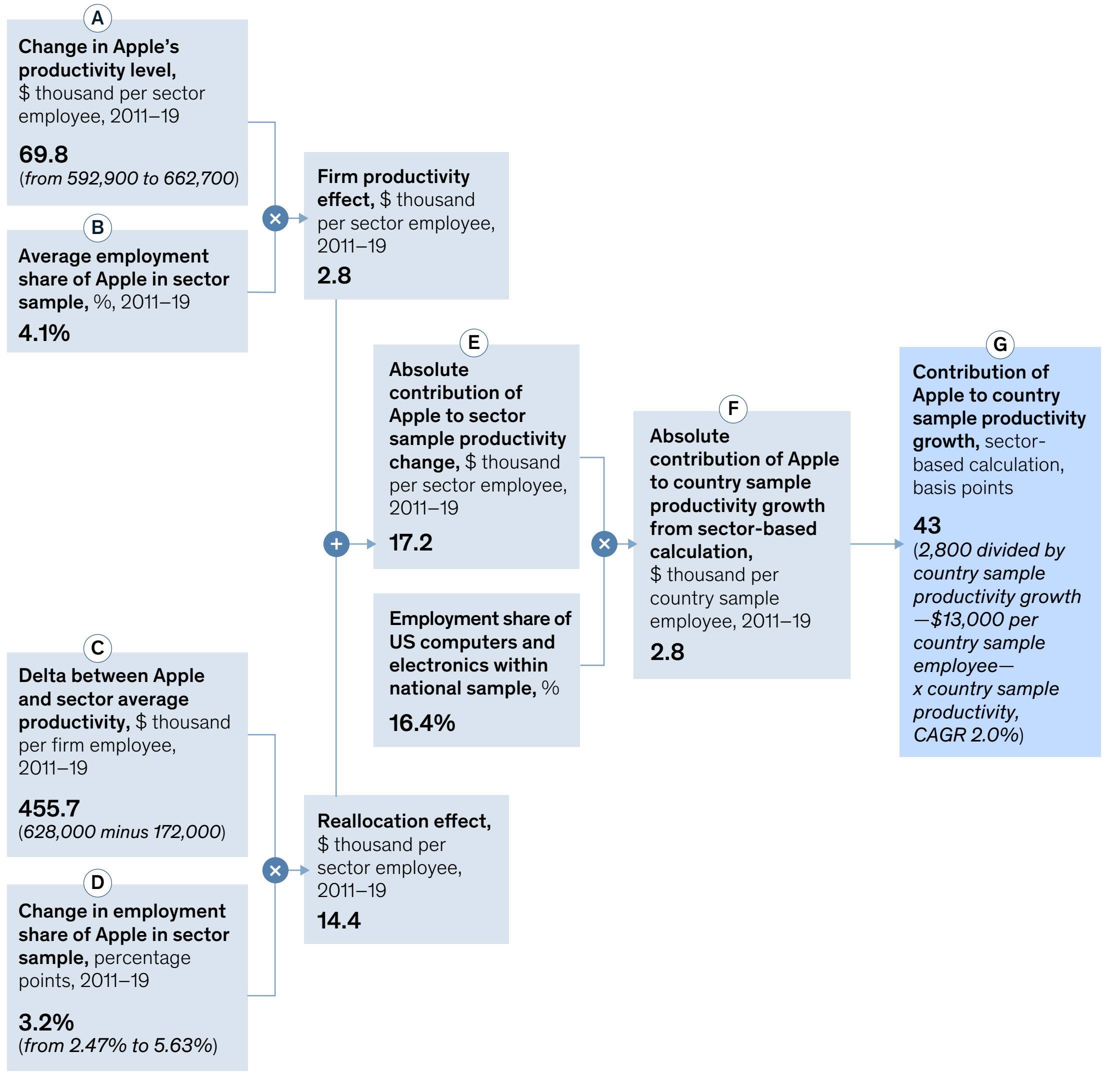
(E) Sector contribution. Adding the productivity and reallocation effects gives us the total contribution of Apple to productivity growth in its sector sample: $17,200 per employee in computers and electronics.

(F) Country contribution. Weighting by the employment share of the sector in the country yields a $2,800 contribution to productivity growth across the country sample (for Apple, the computers and electronics sector made up 16.4 percent of US sample employment share on average between 2011 and 2019).

(G) Annual growth rate contributions. Annualizing this contribution in compound annual growth rate (CAGR) terms, Apple contributed 43 basis points of the 2.0 percent annual growth rate of the US sample (Exhibit A2).

Exhibit A2

Illustration: Apple’s contribution to country sample productivity growth.



Source: 2025 Moody’s Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; McKinsey Global Institute analysis

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Applying double-sided deflators

We use double-sided deflators from EU KLEMS to adjust nominal GVA and employment cost to changes in output and input prices. We apply these country-specific deflators directly to local currency figures.

Double deflation separately deflates output and intermediate consumption to arrive at the production measure of GVA in chained volume measures.[2] We apply the double-sided deflators in each sector (or subsector where available) because firm-level data regarding changes in prices was not available. These are different from some commonly used national statistics deflators. For example, the US Bureau of Labor Statistics (BLS) uses sector output prices rather than GVA prices.

For specific deflators used for our in-scope sectors, see section 5, “Data sources, estimations, and adjustments.”

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2. The decomposition methodology with productivity and employment effects

In the academic literature, there are many approaches to decompose productivity growth into two effects: productivity and employment effects, called firm productivity and reallocation effects in our research. We chose a shift-share method and compared it with two other approaches to test the robustness of our chosen approach. The differences between approaches mostly pertain to how they allocate productivity and employment effects to individual firms, where the shift-share method best reflects firms’ dynamic impacts for this research.

Approach 1: Shift-share method (used in calculation)

This approach has been used by a number of academics and the World Bank, which dubs it the shift-share method.[3] It decomposes as follows:

Productivity effect. Change in a firm’s productivity from 2011 to 2019, multiplied by its average employment share:

$$(p_f - p_i) \times \frac{w_f + w_i}{2}$$

Where p_i is the firm’s initial productivity in 2011, p_f is the firm’s final productivity in 2019, w_i is the firm’s initial employment share in 2011, and w_f is the firm’s final employment share in 2019.

Employment effect. Change in a firm’s employment share from 2011 to 2019, multiplied by the difference between firm and sector average productivity:

$$(w_f - w_i) \times \left(\frac{p_f + p_i}{2} - \frac{p_f^s + p_i^s}{2}\right)$$

Where p_i^s is the sector’s initial productivity in 2011 and p_f^s is the sector’s final productivity in 2019.

Approach 2: CSLS method

This is a well-established approach used by the Centre for the Study of Living Standards (CSLS), among others.[4] It decomposes as follows:

Productivity effect. Change in a firm’s productivity from 2011 to 2019, multiplied by its 2011 employment share:

$$(p_f - p_i) \times w_i$$

Level effect. Change in a firm's employment share from 2011 to 2019, multiplied by its 2011 productivity relative to the sector's average 2011 productivity:

$$\left(w_f - w_i\right) \times \left(p_i - \ p_i^s\right)$$

Growth effect. Change in a firm's employment share from 2011 to 2019, multiplied by the difference between the firm's change in productivity from 2011 to 2019 minus the overall sector's change in productivity from 2011 to 2019:

$$\left(w_f - w_i\right) \times (\left(p_f - p_i\right) - \left(p_f^s - p_i^s\right))$$

The level and growth effects can be summarized into an aggregate employment effect:

$$\left(w_f - w_i\right) \times \left(p_f - p_f^s\right)$$

Compared with the shift-share decomposition, CSLS thus anchors productivity effects on starting employment share rather than average, and it anchors employment effects on end-year productivity differences from sector average rather than average over the years. This underweights the impact on productivity growth of fast-growing firms. Looking at Zalando, for instance, its employment share rose sharply, from 0.1 to 1.0 percent, from 2011 to 2019, and weighting productivity growth only by its tiny starting share would not be a good representation of effects for this research.

Approach 3: Canonical method

The canonical approach decomposes as follows:[5]

Productivity effect. Change in a firm's productivity from 2011 to 2019, multiplied by its 2011 employment share (this term is identical to CSLS):

$$\left(p_f - p_i\right) \times w_i$$

Static reallocation effect. Change in a firm's employment share from 2011 to 2019, multiplied by its 2011 productivity:

$$\left(w_f - w_i\right) \times p_i$$

Dynamic reallocation effect. Change in a firm's productivity from 2011 to 2019, multiplied by the change in the firm's employment share over the same period:

$$\left(p_f - p_i\right) \times \left(w_f - w_i\right)$$

Static and dynamic reallocation effects can be summarized into an aggregate employment effect: change in a firm's employment share from 2011 to 2019, multiplied by its productivity in 2019:

$$\left(w_f - w_i\right) \times p_f$$

Compared with the shift-share method, it uses just the firm's final productivity level rather than the difference between the averages of firm and sector productivity. Accordingly, this shows employment share gains as positive for productivity even when those gains are made by an unproductive firm. It also treats employment share losses or exits as negative even if applied to firms below the sector average in productivity. This is not what we want to assess in this research.[6]

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3. Scaling productivity contributions from sector to country and the sector mix effect

In our research, we calculate the contribution of a firm to its country sample productivity growth. To do so, we proceed in two steps. First, we calculate the contribution of a firm to its sector's productivity growth, applying the shift-share method explained above. Second, we scale that result to the country level, multiplying by the employment share of the sector in the country. This gives us the firm's contribution to the country's productivity growth.

We choose to calculate the contribution this way—going from sector to country instead of directly calculating the contribution to the country—because, in our view, it has some advantages that outweigh its limitations.

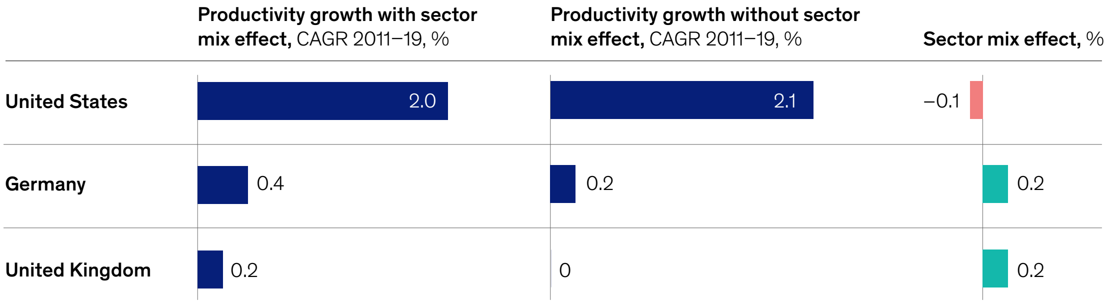
- The main advantage is that it allows for a better understanding of sector dynamics. By defining the contribution at the sector level, we put the focus on employment changes between firms in the same sector. For example, if a new, high-productivity retailer absorbed employment from incumbent retailers, the new firm would have positively contributed to the productivity growth of its country, because it contributed to more efficient factor allocation. This dynamic may help explain, for instance, the change in the UK retail landscape experienced in the period encompassing the entrance of discounters and digital players and the competitive reaction of incumbent firms. If we had defined the reallocation effect at the country level, this effect would presumably have been negligible or even negative, because tech companies would have pushed up average productivity and hence would have made any reallocation of employment to retail firms seem unproductive.
- The main limitation is that we do not account for changes in the employment between sectors—a phenomenon known as the sector mix effect. However, we chose to exclude this component from the analysis. The primary reason is that intersectoral labor mobility tends to be limited; workers rarely transition among the four sectors in our sample (from electronics manufacturing to retail, for example). As such, changes in sector composition are largely driven by external structural factors—such as demand shocks, globalization, and technological trends—rather than by employment reallocation between them. We therefore treat the sector mix effect as exogenous to the dynamics we aim to study and focus instead on within-sector firm performance as the primary driver of productivity growth. We have calculated the sector mix effect and found that it accounts for up to 0.2 percentage point of the variations in the countries' productivity growth (Exhibit A3).

Rescaling contribution from country sample to total economy

To illustrate the significance of Standouts—firms contributing more than one basis point to national productivity growth—we also estimated how much individual Standouts contributed to national productivity growth overall, not just within our sample. For this exercise, we use GVA and employment data from national statistical agencies: the Bureau of Economic Analysis (United States), Eurostat (Germany), and the Office for National Statistics (UK).[7] For instance, Apple contributed 43 basis points in the US sample, and this scaled to three basis points for the entire US economy.

Exhibit A3

Sector mix effect accounted for +/–0.2 percentage point of the countries' sample productivity growth.



Note: Sector mix effect reflects the contribution of employment reallocation between sectors in a country, not captured in the productivity growth calculated as the sum of the contribution of firms using the shift-share method (second column).
Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; OECD; McKinsey Global Institute analysis

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4. Scope: Countries, sectors, and period covered

In this section, we define the scope of our analysis, covering selected countries, sectors, and subsectors as well as the period studied. We also explain the rationale behind these choices and their relevance to our findings.

Countries, sectors, and subsectors

The countries and sectors for this research were chosen to represent a meaningful share of the economy and a diversity of productivity growth trends. We first focus our research on the top five economies by GDP and then narrowed the set down to just three based on which offered the best data coverage for the short-listed sectors.

To narrow down our short list of sectors, we use the following criteria:

— *Criterion 1:* Does Orbis, our main data source, cover more than 50 percent of the sector's total GVA and number of firms?

— *Criterion 2:* Is the sector meaningful in its home economy, defined as accounting for more than 5 percent of GVA and 5 percent of employment for nonmanufacturing sectors? For manufacturing sectors, which are highly fragmented, which ones have the highest shares?

— *Criterion 3:* Is the sector GVA influenced mainly by private-sector dynamics rather than by macro parameters or the public sector? We chose sectors that were mostly in the private sector, excluding, for instance, human health and social work. We wanted to ensure that the sector was represented well by data on large firms and, on that basis, excluded accommodation and food services. We opted to exclude sectors that were highly heterogenous, such as professional scientific and technical activities. We wanted to avoid sectors in which the labor productivity metric was highly biased by the macroeconomic context and was very sensitive to the period chosen, and therefore we excluded financial services and basic metals.

From these criteria, we selected the United States, Germany, and the United Kingdom as the countries in scope, operating in four sectors and their 12 subsectors. The following sectors cover 10 to 15 percent of total private GVA and employment in the three countries:

- *Computers and electronics* including computers, semiconductors, and electronic equipment manufacturing.
- *Retail* including apparel, grocers and nonspecialized retail, and other retail.
- *Automotive and aerospace* including automotive manufacturing, aerospace manufacturing, and other transportation manufacturing.
- *Travel and logistics* including travel, logistics, and postal.

Linking our classifications and macroeconomic sources
The sectors map to OECD STAN industry list and ISIC Rev. 4 codes (Exhibit A4).

Exhibit A4

MGI sector	OECD STAN industry list	ISIC Rev. 4 code
Computers and electronics	Manufacturing of computer, electronic, and optical products	26
Retail	Retail trade, except motor vehicles and motorcycles	47
Automotive and aerospace	Manufacturing of transport equipment	29–30
Travel and logistics	Transportation and storage	49–53

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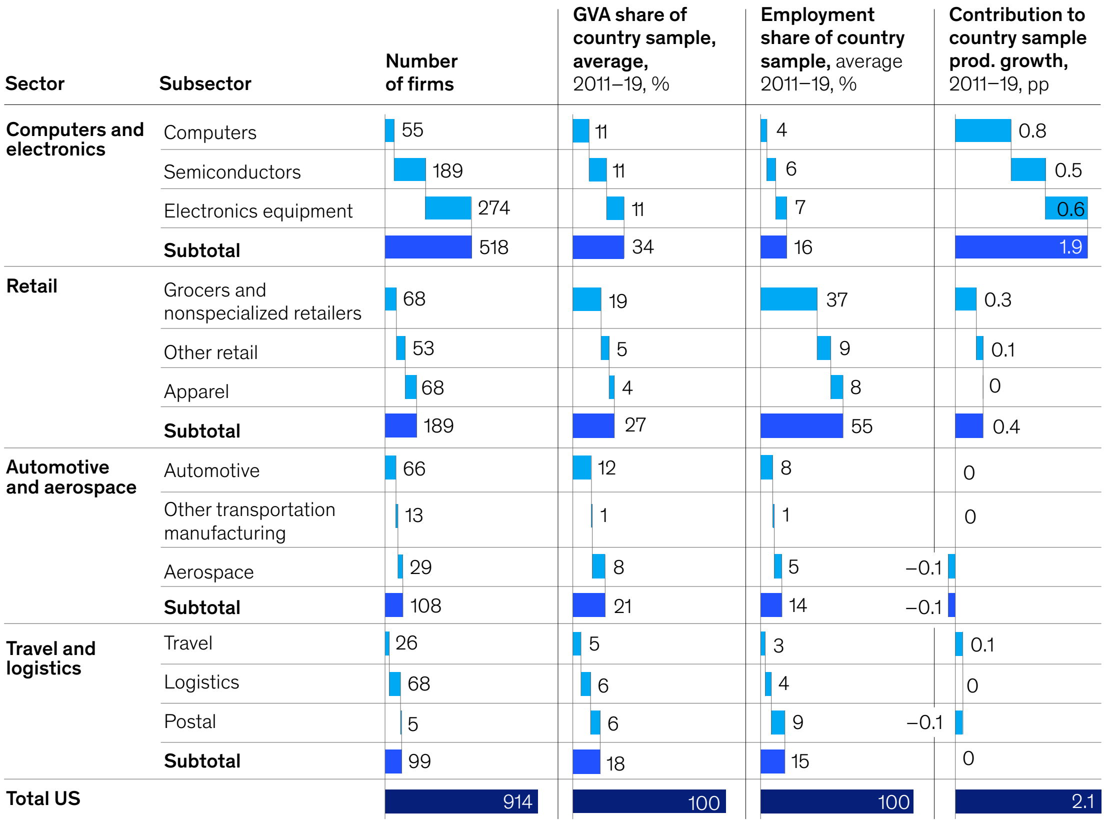
Sectors were classified into subsectors based on their classification in the Orbis database. ISIC Rev. 4 subsectors are good matches for some of those—for instance, splitting travel into travel, logistics, and postal, which are subsectors with separate double-sided deflators—while others are not further disaggregated in national accounts. Here, we take reasonable classifications from Orbis and other McKinsey databases. For example, retail includes grocers and nonspecialized retail, apparel, and other retail.

Sample composition by sector and subsector
Each country sample consists of varying sector shares and mix due to varying sample coverage as well as differences in actual sector mix across countries (Exhibits A5 through A7).

Exhibit A5

The US sample.



Sector	Subsector	Number of firms	GVA share of country sample, average, 2011–19, %	Employment share of country sample, average 2011–19, %	Contribution to country sample prod. growth, 2011–19, pp
Computers and electronics	Computers	55	11	4	0.8
	Semiconductors	189	11	6	0.5
	Electronics equipment	274	11	7	0.6
	Subtotal	518	34	16	1.9
Retail	Grocers and nonspecialized retailers	68	19	37	0.3
	Other retail	53	5	9	0.1
	Apparel	68	4	8	0
	Subtotal	189	27	55	0.4
Automotive and aerospace	Automotive	66	12	8	0
	Other transportation manufacturing	13	1	1	0
	Aerospace	29	8	5	–0.1
	Subtotal	108	21	14	–0.1
Travel and logistics	Travel	26	5	3	0.1
	Logistics	68	6	4	0
	Postal	5	6	9	–0.1
	Subtotal	99	18	15	0
Total US		914	100	100	2.1

Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; OECD; McKinsey Global Institute analysis

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Exhibit A6

The German sample.

Sector	Subsector	Number of firms	GVA share of country sample, average, 2011–19, %	Employment share of country sample, average 2011–19, %	Contribution to country sample prod. growth, 2011–19, pp
Computers and electronics	Computers	56	0	0	0
	Semiconductors	203	3	3	0
	Electronics equipment	337	5	5	0.1
	Subtotal	596	8	8	0.1
Retail	Grocers and nonspecialized retailers	168	12	22	0.2
	Other retail	409	2	3	0
	Apparel	254	2	3	0
	Subtotal	831	15	27	0.1
Automotive and aerospace	Automotive	240	45	32	0.3
	Other transportation manufacturing	67	1	1	0
	Aerospace	28	2	1	0.1
	Subtotal	335	48	33	0.4
Travel and logistics	Travel	527	14	13	–0.4
	Logistics	644	7	7	0
	Postal	37	8	11	0
	Subtotal	1,208	29	31	–0.4
Total Germany		2,970	100	100	0.2

Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; OECD; McKinsey Global Institute analysis

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Exhibit A7

The UK sample.

Sector	Subsector	Number of firms	GVA share of country sample, average, 2011–19, %	Employment share of country sample, average 2011–19, %	Contribution to country sample prod. growth, 2011–19, pp
Computers and electronics	Computers	52	0	0	0
	Semiconductors	142	2	1	0.1
	Electronics equipment	232	5	2	0.1
	Subtotal	426	8	4	0.2
Retail	Grocers and nonspecialized retailers	402	24	38	0.2
	Other retail	542	6	9	0
	Apparel	770	8	13	0
	Subtotal	1,714	38	61	0.2
Automotive and aerospace	Automotive	275	7	4	−0.2
	Other transportation manufacturing	107	1	1	−0.1
	Aerospace	71	10	4	−0.3
	Subtotal	453	18	9	−0.5
Travel and logistics	Travel	1,240	25	17	0.2
	Logistics	538	7	5	−0.1
	Postal	37	4	4	0
	Subtotal	1,815	36	26	0.1
Total UK		4,408	100	100	0

Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; OECD; McKinsey Global Institute analysis

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Period of analysis: 2011 to 2019

We analyze the period from 2011 to 2019, a relatively stable time between the 2008 financial crisis and the COVID-19 pandemic. To minimize pandemic effects, we prioritized 2011–19 calendar year data, occasionally using fiscal year 2018 reports instead of fiscal year 2019. For the United Kingdom in particular, fiscal year 2019 ended in April 2020, which experienced pandemic effects.

This period saw slower productivity growth in Europe and the United States due to factors like reduced investment following the crisis, the end of offshoring, and slower gains in electronics productivity following exceptionally rapid advances linked to Moore's law.[8] Further research into periods of rapid growth could yield additional insights.

Other limitations of our chosen period include the fact that the eight-year span may not be long enough for transformative technological change or for new firms entering the market to achieve mature productivity levels or become large enough to move the needle. Firms that performed well on productivity during this period may have experienced different outcomes later, and vice versa.

However, when we tested our findings against a more recent period—from 2019 to 2023, for a smaller sample—we saw that the patterns of asymmetrical contributions held true. (See section 6, "Robustness checks.")

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5. Data sources, estimations, and adjustments

In this section, we detail the data sources used for a number of elements of this research, notably for the sample of firms compiled.

Company data: 8,300 firms from Moody's

For the short-listed countries and sectors, we extracted data from the Orbis database from 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors. Firms are classified into geographies based on where they are incorporated. Data was extracted using SQL queries for the short-listed countries and sectors for the three variables of the productivity calculation in 2011 and 2019: EBITDA, personnel costs, and number of employees.

Moody's compiles its data sets through a combination of more than 200 information providers, proprietary databases updated from hundreds of sources, and a live registry connection solution (Kompany) with direct API access to more than 200 global registries. We performed data cleaning in Orbis (see below sections on treatments of missing data, subsidiaries, or M&A) and also adjusted firms after the Orbis extraction (see "Further manual adjustments to extracted data," below).

Moody's generally had greater coverage of the United Kingdom and Germany than of the United States, which explains why our US sample has only about 900 firms compared with approximately 3,000 in the German sample and roughly 4,400 in the UK sample.

Using total number of employees

National statistics typically measure productivity in per-hour terms (for example, GDP per hour), but hours are not available at the company level. We use the number of employees instead. Using OECD data, we cross-checked that there were minimal differences in productivity growth using employees instead of hours for national statistics data.

Using total employees instead of full-time equivalents can skew productivity and employment share calculations, especially in sectors like retail that have more part-time workers. However, part-time employment remained stable (accounting for a change of no more than two percentage points) from 2011 to 2019, so the impact on our results is likely small (Exhibit A8).

Exhibit A8

Share of part- and full-time employees remained stable over the period, with variations of less than +/–2 pp.

	Share of part-time employees in country, %			**Share of full-time employees in country,** %		
	2011	**2019**	**Change,** pp	**2011**	**2019**	**Change,** pp
United States	13	11	–2	87	89	+2
Germany	21	21	—	79	79	—
United Kingdom	23	22	–1	77	78	+1

Source: OECD; McKinsey Global Institute analysis

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Using sector-average labor compensation for US firms

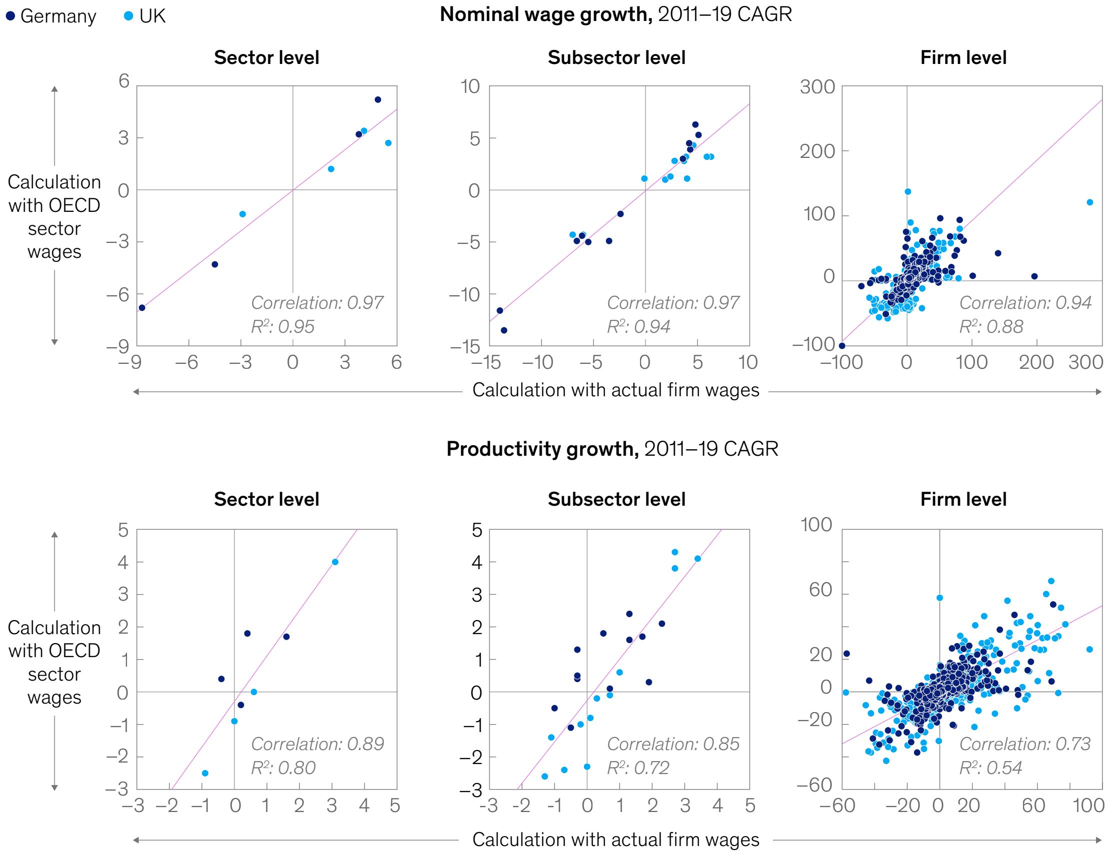
Due to limited data availability on personnel costs for US firms, we estimated them using average salaries from the US Bureau of Labor Statistics for the specific subsector and firm size category.[9] For example, Apple's personnel costs grew from $5 billion in 2011 to $14 billion in 2019 in our estimate. This was calculated by multiplying Apple's employee numbers (60,000 in 2011 and 137,000 in 2019) by BLS average salaries for the relevant subsector (NAICS code 334) and employee size category (about $83,000 in 2011 and $104,000 in 2019).

To validate this approach, we tested it on German and UK firms, where actual compensation data is available, and found it to be a reliable proxy. A correlation analysis of productivity growth using firm salaries versus industry-average salaries showed a strong correlation of 0.73. Wage growth correlation was even higher, at 0.94 (Exhibit A9).

Exhibit A9

Using firm data or OECD sector average data leads to very similar results on wages and productivity growth.

Correlation between firm wage data and OECD sector average wage data, calculating nominal wage growth and productivity growth, Germany and UK



Note: N=6,860 for nominal wage growth correlation. N=6,392 for productivity growth correlation.
Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; OECD; EU KLEMS; Capital IQ; McKinsey Global Institute analysis

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A bias toward larger firms

Orbis does not cover the whole population of firms in a given sector and region, and it generally has more coverage of larger firms. In particular, it has less US coverage, and so our US sample is smaller than our German and UK samples, and it consists mainly of US public companies. Firms with fewer than 50 employees in 2011 and 2019 were excluded due to poor data quality. See the subsection on coverage of micro-, small, and medium-size enterprises (MSMEs) for more information. See section 6, “Robustness checks,” which shows that our results hold with lower MSME coverage and varying sample sizes across countries.

Treating missing data and identifying and correcting entries and exits

If data for 2011 or 2019 was unavailable for a given firm, we checked the firm’s legal status to determine whether there was a legitimate entry or exit during this period by consulting the Orbis legal table for its status of incorporation. Where there were simply data gaps, we use data from the closest year. For German and UK companies, deflators were applied to adjust for 2011 and 2019 price levels, while no deflators were applied for US companies.

We cross-checked firms against the legal tables in Orbis and corrected cases of fake or misleading entries or exits, imputing financial data using the closest available year and applying deflators. We also deleted fields for firms that entered or exited but had inaccurate financial data for 2011 or 2019. We manually checked incorporation dates for a subset of the largest firms.

Treatment of subsidiaries

If a firm’s consolidated accounts were unavailable but data for several subsidiaries covered the firm’s full activities in a sector and region, we combined the subsidiaries’ data into a single entity. Where we had only one or a subset of subsidiaries, we kept them in the sample for smaller companies but removed them for major ones to avoid misrepresenting their size and impact.

Treatment of M&A

A merger into a parent company is counted as the acquired firm’s exit, while spin-offs are counted as new entries. This approach avoids double-counting GVA and employment. Additionally, we ensured that these effects were confined to the same sector and country as the parent company. Given the small number of such cases and their minimal impact on productivity, we believe this method does not significantly distort results.

Further manual adjustments to extracted data

We manually adjusted the financials of about 50 firms in two ways, as follows:

- First, we identified 30 potential duplicates of firms, based on firm names, and removed 21 confirmed as genuine duplicates.
- Second, we carried out financial checks in priority areas. We examined 260 firms, including Standouts, Stragglers, and the top ten largest employers in each sector. Their financials were compared with the Capital IQ database, and 40 firms with deviating data were prioritized for detailed checks using financial reports and press searches. This prioritization was based on four criteria: (1) EBITDA differences of over 50 percent between Orbis and Capital IQ in 2011 or 2019; (2) EBITDA CAGR differences of more than 15 percent between the two; (3) a reversal in EBITDA CAGR direction (positive to negative or vice versa) between 2011 and 2019; and (4) sensitivity to the effects of the global financial crisis or the pandemic, based on reporting dates. Ultimately, we adjusted 27 firms—eight for EBITDA and 19 others on number of employees or personnel costs.

EU KLEMS for deflators at the sector and subsector levels

As described above, we chose to use EU KLEMS as our source to retrieve double- sided deflators, partially at the sector level and partially at the subsector level.

For the retail and computers and electronics sectors in our sample, we applied their respective sector-level deflators, because subsector deflators—for example, at the level of grocers versus specialized retailers—were not available. We use ISIC classifications “Retail trade, except of motor vehicles and motorcycles" for retail and "Manufacture of computer, electronic and optical products" for computers and electronics.

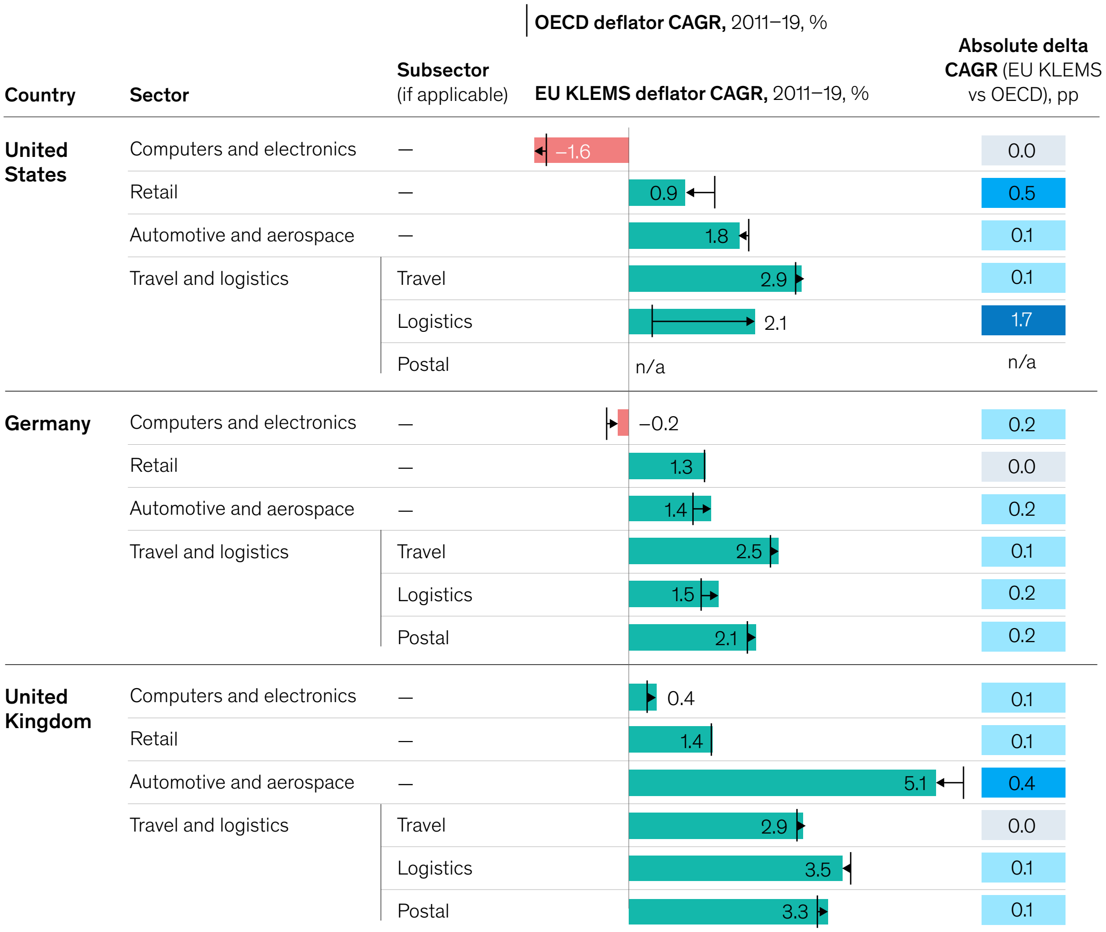
For the automotive and aerospace sector, we use the deflator for "Manufacture of motor vehicles, trailers, semi-trailers, and other transport equipment" without subsector differentiation. More granular deflators were available but not suitable in the context of the Moody's database classifications. For instance, there was a specific deflator for "Spacecraft and other transport manufacturing," but the Moody's data was split into "Aerospace" and "Other transportation manufacturing" subsectors.

In contrast, for the travel and logistics sector, we applied deflators specific to each subsector. For the travel subsector, we use the deflator for "Transportation and storage"; for the logistics subsector, the deflator for "Warehousing and support activities for transportation"; and for the postal subsector, the deflator for "Postal and courier activities."

We also tested our results using double-sided deflators from OECD. This changed some of the results but did not produce a closer match with national statistics in sector productivity growth (Exhibit A10).[10]

Exhibit A10

EU KLEMS and OECD deflators were largely similar.



Source: EU KLEMS; OECD; McKinsey Global Institute analysis

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6

6. Robustness checks

In this section, we summarize key robustness checks of the sample and testing the 2019–23 period.

Robustness checks of the sample

Testing sensitivity of sample size

The US sample is smaller than the other countries' in number of firms (about 900 firms in the United States, compared with approximately 3,000 in Germany and roughly 4,400 in the United Kingdom); GVA coverage of the sectors (68 percent in the United States, 94 percent in Germany, and 106 percent in the United Kingdom); and employment share represented (72 percent in the United States, 81 percent in Germany, and 115 percent in the United Kingdom), due to data-availability constraints for US firms.

To ensure that sample size does not affect our finding that a small number of firms disproportionately drive productivity growth, we conducted robustness checks. We reduced the German and UK samples to match the US sample size in firm count, GVA share, and employment share. Regardless of the method used to downsize, the results were consistent: a small number of firms still contributed disproportionately to productivity growth, and the overall productivity growth rate remained similar. Therefore, we chose to use the full sample for our analysis (Exhibit A11).

Exhibit A11

The UK and German samples had a long tail of firms; cutting this tail did not affect the robustness of the productivity results.

		Full sample	Fixed firm count to 914	Fixed GVA % to 68%	Fixed employment % to 72%
United States	Sample size	914 firms	914 firms	914 firms	914 firms
	Delta to macro productivity CAGR, 2011–19, %	+1.0%	+1.0%	+1.0%	+1.0%
	Sample productivity CAGR, 2011–19, %	2.0	2.0	2.0	2.0
	Sample % macro GVA	68	68	68	68
	Sample % macro employment	72	72	72	72
	Number of Standouts	**44**	**44**	**44**	**44**
Germany	Sample size	2,970 firms	914 firms	18 firms	302 firms
	Delta to macro productivity CAGR, 2011–19, %	–0.5%	–0.5%	–0.4%	–0.6%
	Sample productivity CAGR, 2011–19, %	0.4	0.4	0.5	0.3
	Sample % macro GVA	94	91	68	86
	Sample % macro employment	81	75	52	72
	Number of Standouts	**13**	**13**	**8**	**13**
United Kingdom	Sample size	4,408 firms	914 firms	88 firms	90 firms
	Delta to macro productivity CAGR, 2011–19, %	–0.1%	+0.1%	+0.2%	–0.2%
	Sample productivity CAGR, 2011–19, %	0.2	0.4	0.5	0.1
	Sample % macro GVA	106	97	68	62
	Sample % macro employment	115	101	67	72
	Number of Standouts	**30**	**29**	**30**	**20**

Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; McKinsey Global Institute analysis

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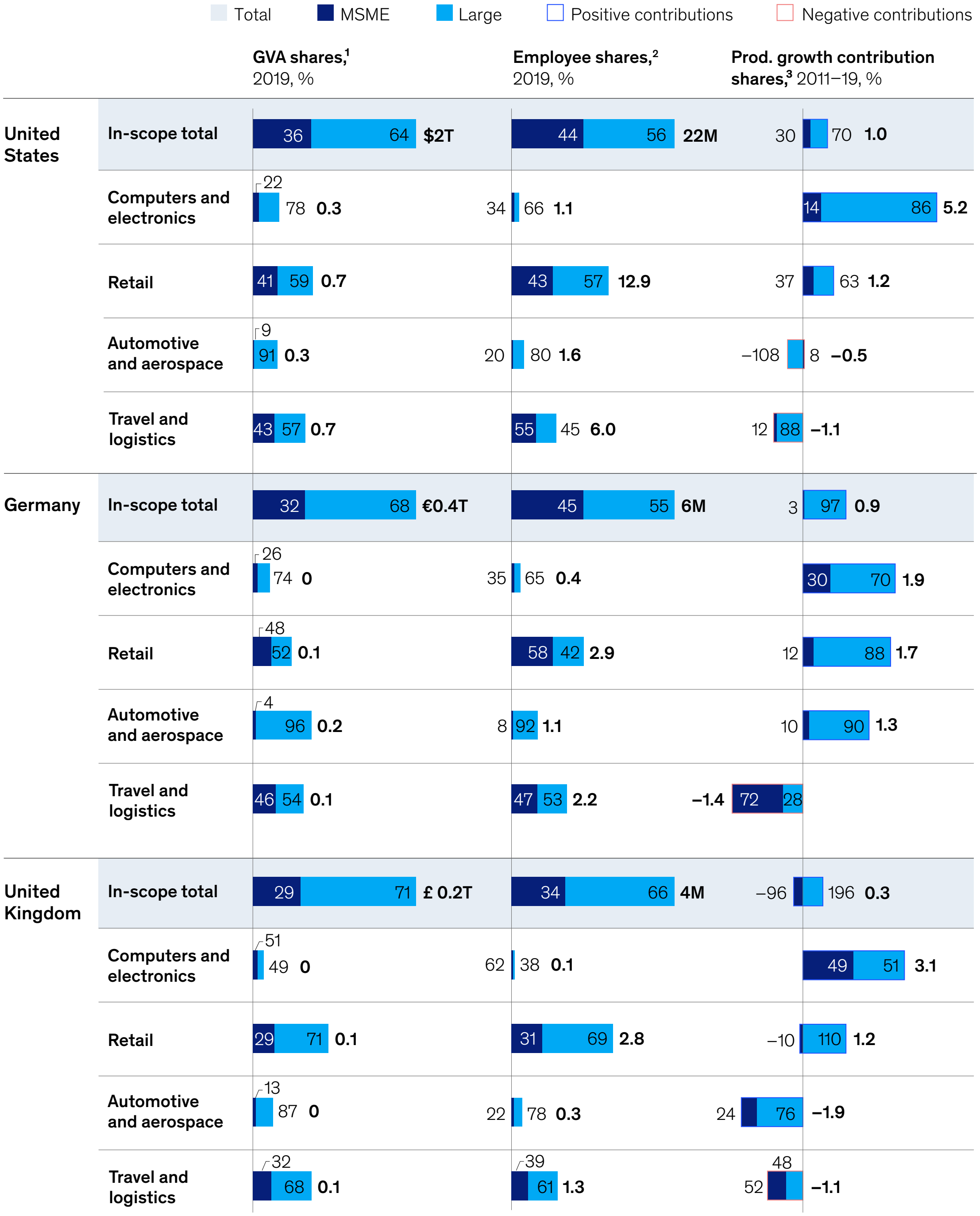
MSME coverage

According to national statistics for the sectors analyzed, large firms contributed about two-thirds of GVA and at least 70 percent of productivity growth, with some exceptions. Large firms drove 70 percent of productivity growth in the United States (positive) and United Kingdom (negative), and nearly 100 percent in Germany. Notable contributions from MSMEs are seen in UK retail and computers as well as travel and logistics in Germany and the United Kingdom, where MSMEs have a higher GVA share (Exhibit A12).

Exhibit A12

For in-scope sectors, large firms accounted for two—thirds of GVA and at least 70 percent of productivity growth, with some exceptions.



[1] Totals expressed in trillions, local currency. GVA shares by firm size calculated using revenue as proxy for the US and nominal GVA as proxy for Germany and the UK due to low availability of macro data split by sector and firm size. When using revenue for Germany to test for consistency, shares by firm size held similar. For the US, companies with 500 or more employees are considered large; for Germany and the UK, the cutoff is set at 250 or more employees.

[2] Totals expressed in millions of employees. Employee shares by firm size calculated based on national employment statistics split by firm size, following similar rationale as above.

[3] Totals expressed as sector's total productivity CAGR between 2011 and 2019 based on countries' national statistics. Shares calculated based on MSMEs' and large firms' contributions to sector and country productivity growth in basis points.

Source: US Census Bureau; OECD; EU KLEMS; McKinsey Global Institute analysis

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These calculations are based on OECD and national statistics. Firms were categorized as large (more than 500 employees in the United States, more than 250 in Germany and the United Kingdom) or MSMEs (below these thresholds). GVA shares were calculated using revenue as a proxy for the United States (due to data limitations) and nominal GVA for Germany and the United Kingdom. Employee shares were calculated using national statistics. Productivity contributions were determined by representing each sector as one large firm corresponding to the large firm aggregated data and one MSME corresponding to the respective aggregate of small firms and calculating their respective contributions.

While our sample has limited coverage of MSMEs and startups, it aligns well with national productivity growth trends in many sectors. Exceptions include German and UK retail, where MSMEs have higher value-added shares. Additionally, the German sample reflects the growth of German discounters in the UK, and both German and UK retail sectors miss the impact of global e-commerce players like Amazon, which are not headquartered in these countries.

International exposure

Large multinational corporations play a key role in local and global economies, so we analyzed them as whole entities rather than separating their national and international operations. This approach explains why our sample's GVA coverage exceeds 100 percent in some sectors.

We estimate that 10 to 30 percent of our sample firms' revenue is generated internationally, with the GVA share likely even lower since higher-value activities often occur near headquarters. This aligns with US national statistics, which show that 20 percent of GVA for multinationals in the sectors we analyzed is international.

Standouts and Stragglers tend to have more international revenue (and likely GVA) than other firms, but they still make significant contributions to domestic productivity growth. For example, in 2019, about 50 percent of Apple's revenue came from international activities, yet nearly 70 percent of its employees were based in the United States. Between 2011 and 2019, Apple doubled its US head count, contributing to domestic productivity growth through the reallocation effect.

Adjusted EBITDA sensitivity

The introduction of International Financial Reporting Standards (IFRS 16) in January 2019 changed how leases are accounted for in financial statements. This affected asset-heavy firms and sectors, like travel and logistics, potentially altering 2011–2019 EBITDA due to differences in how operating leases were treated.

Our analysis uses standard EBITDA, but we tested using leases-adjusted EBITDA (applying 2011 accounting criteria to 2019 using the standard McKinsey Value Intelligence Platform accounting principles) for most Standouts, Stragglers, and major firms in travel and logistics, a sector making ample use of operating leases. This adjustment had no significant impact on our results. Overall productivity growth and the identification of Standouts and Stragglers remained nearly unchanged across countries, with only minor differences (for example, a change of one to three basis points in sample productivity growth and one new Straggler in the UK).[11]

Given the limited impact on even the most extremely affected firms, we chose to continue to use EBITDA as reported in Orbis to maximize data availability and coverage.

Testing the robustness of our findings in the post-COVID period (2019–23)

To test the persistence of our findings, we replicated the 2011–19 analysis for Standouts and Stragglers for a more recent period, 2019–23. Data availability for this period is lower due to the lack of continuous financial data for many firms through 2023 as well as gaps in macroeconomic indicators such as deflators. We therefore make key methodological choices in representing these results.

Limited sample of 114 firms

We were able to include only 114 firms in our 2019–23 analysis for two reasons. First, financial data was not available in Capital IQ for most firms in the later period, and we opted to replicate the analysis for only those firms whose financial data could be compared between different databases (for instance, Orbis and Capital IQ). Out of 8,300 firms in our sample, only 135 had available data for EBITDA and on employees for both 2019 and 2023. Second, there were significant discrepancies between Orbis and Capital IQ data for some of the firms, which we cross-checked manually, resulting in a final sample of 114 firms.

Key assumptions

We calculated the contribution of firms to 2019–23 productivity growth using the same methodology as in our 2011–19 sample. However, some of the figures required for such calculations were estimated using assumptions due to lack of data for the more recent years. Assumptions include the following:

- *Firm personnel costs in 2023.* Data on personnel costs was not available for 2023 for most firms. We therefore estimated it using 2019 data and growth assumptions. For each firm, we calculated 2023 personnel costs as the number of employees in 2023 (extracted from Capital IQ) multiplied by an estimated 2023 wage. The estimated 2023 wage was calculated by multiplying each firm's average wage in 2019 (using real data from the 2011–19 model) and a country-level average wage 2019–23 CAGR obtained from OECD. This assumption may alter results because not all firms in a country experienced similar growth, and the results will be enriched by greater data availability in the future.
- *Adjusting for reduced firm sample size.* Even though our firm sample shrank significantly in the 2019–23 period, we wanted to ensure that the results remained comparable to those from 2011–19. To do so, we kept the total size of each sector in our "lab economy" consistent with the earlier period, essentially creating a pro forma baseline. Specifically, we extrapolated total sectoral GVA and employment in 2023 based on 2019 values from the 2011–19 model, using CAGRs from external sources. GVA growth rates were sourced from country- and sector-level data provided by S&P IHS Markit, while employment growth rates came from the International Labour Organization.
- *Deflators.* No EU KLEMS double-sided deflators were available for 2019–23. As a substitute, we use sector-level single-sided 2019–23 deflators from each country's national statistics: the US Bureau of Economic Analysis for the United States, the Statistisches Bundesamt (Destatis) for Germany, and the Office for National Statistics for the United Kingdom. This may distort results because this approach does not consider differences in the evolution of prices in final and intermediate goods. (After EU KLEMS' double-sided deflators become available, our analysis could be updated to eliminate these possible distortions.)

7

7. Supplementary analyses

In this section, we outline other analyses undertaken to strengthen the understanding of our results. It includes testing against other common metrics and using alternate calculation approaches.

Testing the overlap between Standout firms and economic profit–based 'superstars'

In the report, we clarify that productivity is distinct from economic profit. Economic profit refers to the difference between an investment's return on invested capital—the return generated for shareholders and lenders per unit of capital invested—and its weighted average cost of capital, which represents the average cost of capital from both equity and debt. This spread, multiplied by the amount of capital invested, measures value added for shareholders.[12]

Economic profit ties to productivity growth. The numerator of the productivity calculation includes EBITDA. Higher EBITDA boosts return on invested capital, assuming other factors remain constant. Firms failing to deliver sufficient returns risk resource reallocation to more profitable competitors, leading to reduced investment, operations, EBITDA, and productivity. Actually, returns and productivity can be related under the following formula, where P equals productivity or value added per worker in real terms, d is the deflator, k is invested capital per owner, $r + s$ is the pretax return on invested capital plus the depreciation rate, and w is the average wage:

$$P = d[k(r + s) + w]$$

Yet economic profit and productivity are distinct metrics. A firm can contribute to national productivity growth without delivering attractive returns on capital. For example, a shrinking firm with negative economic profit may enhance productivity by downsizing, though this likely offers little value to its shareholders. Similarly, a firm might disproportionately drive productivity by prioritizing value for employees—such as increasing wages—rather than returns to shareholders during a given period.[13]

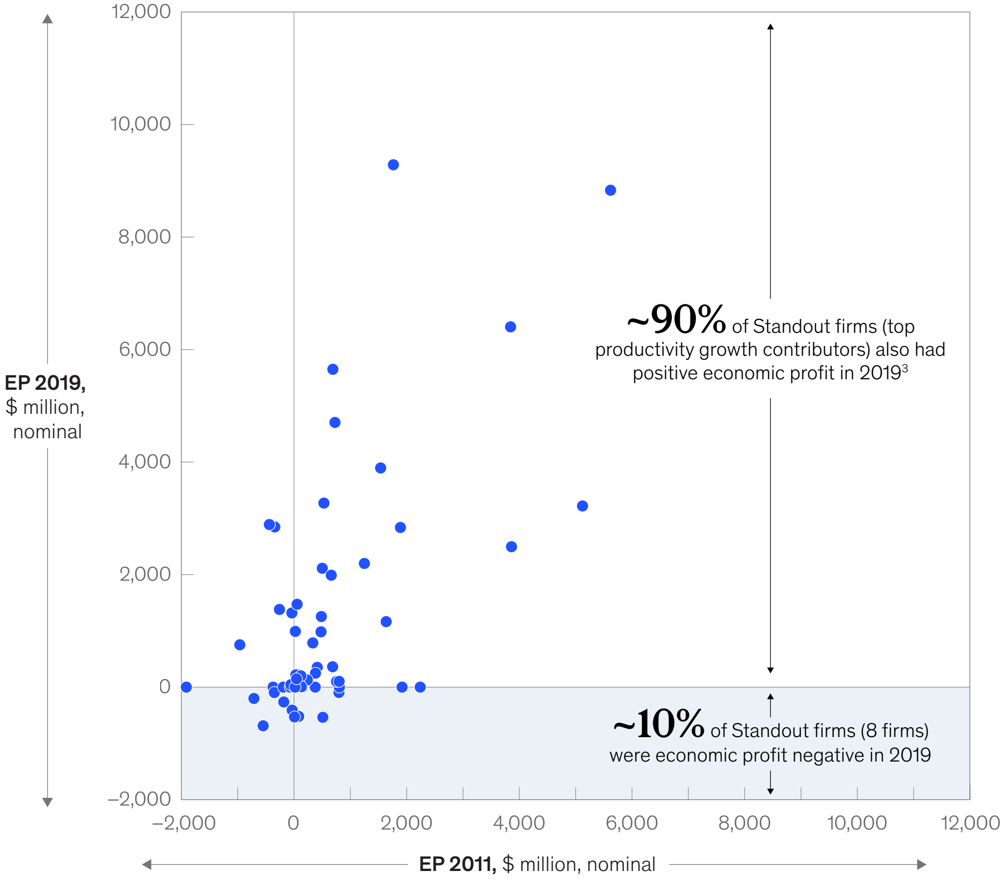
We analyzed the relationship between Standouts and economic profit to determine whether they generate value by contributing to shareholders and lenders beyond the cost of capital. We evaluated Standouts' economic profit performance over the snapshot period, finding that nearly 90 percent of Standouts achieved positive economic profit in 2019.[14] For the 10 percent (eight firms) of Standouts with negative economic profit, we can sort them into the following three groups (Exhibit A13):

- *Four firms that failed to create value from acquisitions during the period.* Half were firms with positive economic profit excluding goodwill, which turned negative when goodwill—reflecting the premium paid for acquired assets or intangibles like brands—was included. These firms made bold acquisitions but couldn't fully realize their value by 2019.
- *Three firms that may prioritize goals beyond economic profit.* Two Standouts with negative economic profit (losses) were worker-owned cooperatives, likely focusing equally on metrics like wages or environmental, social, and governance benchmarks. Another was a subsidiary of an international group, possibly financed to navigate a turbulent market, explaining its negative economic profit alongside high contributions.
- *One firm was a Shrinker.* This unproductive firm—also value destructive for capital—reduced size and thereby contributed positively.

Exhibit A13

Ninety percent of Standout firms were economic profit positive in 2019.

Economic profit[1] of Standout[2] firms, 2011–19, $ million



~90% of Standout firms (top productivity growth contributors) also had positive economic profit in 2019[3]

~10% of Standout firms (8 firms) were economic profit negative in 2019

Note: Productivity is defined as real GVA per employee. Real GVA = EBITDA + personnel costs, deflated. Plot shows N=63 out of 87 Standouts due to data availability.
[1] Including goodwill. Nominal figures.
[2] Firms that contributed the most to their country sample productivity growth in 2011–19 (+1 basis point of contribution to national productivity CAGR).
[3] Excluding outliers (=1).
Source: McKinsey Global Institute analysis

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Testing the overlap between Standout firms and frontier firms

We then tested the extent to which the group of Standout firms overlaps with the group of firms consistently in the top 20 percent of productivity levels across the period, commonly referred to in the literature as frontier firms. *The overlap is surprisingly limited: only one-third of Standout firms are frontier firms.* This relatively low share aligns with the archetypes outlined in our report. Indeed, many Standouts are not productivity leaders at the outset. Some are restructurers, turning around underperforming operations and rarely starting at the frontier. Others are disruptors, often emerging outside the frontier in 2011 and gaining ground over time. Improvers, typically large incumbents, drive gradual gains but tend to remain outside the top 20 percent. Only scalers—firms whose contribution comes primarily from expanding already-strong positions—are predominantly at the frontier. Exhibit A14 illustrates these dynamics.

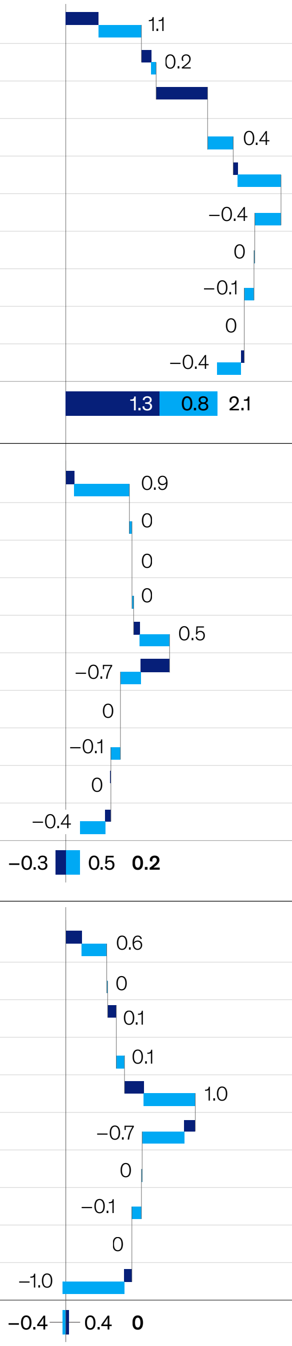
Exhibit A14

Standouts come from different places along the productivity curve.

Contribution to productivity growth by archetype and pathway, 2011–19

Contribution to national sample productivity growth, 2011–19, pp

■ *Frontier firms* ■ *Nonfrontier firms*



Pathway contribution to productivity growth, %

0–24 *25–49* *50–74* *75–100*

	Archetype	Contribute from frontier	Contribute from outside frontier	Transition to frontier	Transition from frontier	Entry	Exit
United States	Improver	43	44	13	0	0	0
	Disruptor	67	15	17	0	0	0
	Scaler	100	0	0	0	0	0
	Restructurer	0	25	0	0	0	75
	Rest of positive	10	41	4	7	2	36
	Anti-improver	0	47	0	53	0	0
	Anti-disruptor	0	0	0	0	0	100
	Anti-scaler	0	100	0	0	0	0
	Anti-restructurer	0	0	0	0	0	0
	Rest of negative	13	45	1	19	13	9
	Total	63	18	9	−10	−2	22
Germany	Improver	13	2	85	0	0	0
	Disruptor	0	0	100	0	0	0
	Scaler	0	0	0	0	0	0
	Restructurer	0	0	0	0	0	100
	Rest of positive	17	58	13	0	3	9
	Anti-improver	60	20	0	21	0	0
	Anti-disruptor	0	0	0	0	0	0
	Anti-scaler	0	91	0	0	9	0
	Anti-restructurer	100	0	0	0	0	0
	Rest of negative	16	42	0	24	14	5
	Total	−140	−65	427	−119	−27	24
United Kingdom	Improver	39	40	22	0	0	0
	Disruptor	0	0	100	0	0	0
	Scaler	100	0	0	0	0	0
	Restructurer	0	54	0	0	0	46
	Rest of positive	27	42	20	0	6	4
	Anti-improver	21	13	18	46	0	3
	Anti-disruptor	0	100	0	0	0	0
	Anti-scaler	0	84	0	0	16	0
	Anti-restructurer	0	0	0	0	0	0
	Rest of negative	11	50	0	24	14	1
	Total	−919	−13	−537	1482	241	−155

Source: 2025 Moody's Investors Service, Inc. and/or its affiliates and licensors; EU KLEMS; US Bureau of Labor Statistics; Capital IQ; OECD; McKinsey Global Institute analysis

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Testing whether convergence and divergence patterns in high-growth sectors depend on measurement method

To understand whether productivity growth in a subsector comes from leading firms pulling ahead (divergence) or lagging firms catching up (convergence), researchers use different methods to assess convergence and divergence. Each has distinct conceptual implications. Here are two of the most commonly used methods.

Group-level convergence.[15] This approach measures how the productivity gap between nonfrontier and frontier firms changes over time by comparing the ratio of their productivity at the end of the period to that at the beginning, as follows:

$$\frac{Prod._{Non-frontier\ in\ 2019}^{2019}}{Prod._{Frontier\ in\ 2019}^{2019}} - \frac{Prod._{Non-frontier\ in\ 2011}^{2011}}{Prod._{Frontier\ in\ 2011}^{2011}}$$

According to this definition, a subsector experienced convergence if the result of the formula is greater than zero—that is, if the ratio of productivity of nonfrontier firms to frontier firms increased between 2011 and 2019. This would mean that firms *not* in the frontier in 2019 are closer to the frontier than they were in 2011. Note that this does not mean that the same firms that were outside the frontier in 2011 were also outside it in 2019. In fact, this is highly unlikely. However, we are interested in the convergence of the nonfrontier to the frontier as a pattern that may hold over time, not in the behavior of a static cohort of firms.

Cohort-level convergence. Convergence can also be defined as the difference in productivity of firms that were originally outside the frontier and those that were in the frontier in 2011. This is a cohort-level definition that fixes the group of firms and assesses the evolution. This definition is also found in the literature and, in the context of this analysis, can be defined as follows:[16]

$$\frac{Prod._{Non-frontier\ in\ 2011}^{2019}}{Prod._{Non-frontier\ in\ 2011}^{2011}} - \frac{Prod._{Frontier\ in\ 2011}^{2019}}{Prod._{Frontier\ in\ 2011}^{2011}}$$

What is the difference between the two definitions in terms of their approaches? The first definition can be thought of as “firm equality.” The question it tries to answer is: “Has the overall productivity distribution become more equal (a flatter distribution) or unequal (a more skewed distribution)?” In case of the former, with more equality, the subsector experiences convergence (at the group level); in the latter, it experiences divergence. The second definition can be thought of as “firm mobility.” The question that approach attempts to answer is: “Did any of the firms that were outside the frontier in 2011 make it to the frontier in 2019?” If this is the case, then the subsector experiences convergence at the cohort level.

Note that one definition does not imply the other. A subsector can experience firm mobility while also becoming more unequal overall. To illustrate the point, consider the German computers subsector. The subsector experienced group-level divergence as productive firms transitioned into the frontier (abandoning the nonfrontier and pushing up inequality) and exits pushed down nonfrontier productivity. However, the same subsector displayed cohort-level convergence since firms that were outside the frontier in 2011 made it to the frontier in 2019 (the sector showed “firm mobility”).

In our research, we chose to use group-level convergence because we are primarily interested in whether the overall distribution of productivity is becoming more equal over time. This approach reflects aggregate dynamics.

However, we also tested our results using cohort-level convergence. This alternative definition showed stronger convergence patterns in high-growth subsectors, with seven high-growth subsectors showing convergence under the cohort method, compared with four high-growth subsectors under the group-level method.

Endnotes

[1] Double-sided deflators account for both quality-adjusted price changes that firms in a particular subsector make vis-à-vis their customers and those they experience from their suppliers.

[2] See *Double deflation: Update on progress*, UK Office for National Statistics, May 22, 2017.

[3] This is used, for instance, in Lucia Foster, John C. Haltiwanger, and C. J. Krizan, "Aggregate productivity growth: Lessons from microeconomic evidence," in *New developments in productivity analysis*, Charles R. Hulten, Edwin R. Dean, and Michael J. Harper, eds., University of Chicago Press, 2001. This approach is closely related to the one used in Zvi Griliches and Haim Regev, "Firm productivity in Israeli industry 1979–1988," *Journal of Econometrics*, volume 65, issue 1, January 1995. The World Bank uses what it calls the shift-share method in its Jobs Diagnostics JobStructure (JoGGs), too. See *Jobs diagnostics: Data, tools and guidance*, World Bank, accessed February 2025.

[4] This methodology was developed by the Centre for the Study of Living Standards, illustrated, for instance, in Andrew Sharpe, "Can sectoral reallocations of labour explain Canada's abysmal productivity performance?" *International Productivity Monitor*, volume 19, 2010; and *A detailed analysis of Canada's post-2000 productivity performance and pandemic-era productivity slowdown*, Centre for the Study of Living Standards, 2023.

[5] The nomenclature and approach are found in J. Gaaitzen de Vries, Marcel Timmer, and Klass de Vries, "Structural transformation in Africa," *Journal of Development Studies*, 2015.

[6] All three approaches confirm the message that a few firms account for most productivity growth. Standout firms' share of positive productivity contribution to their national sample shifts by only approximately ten percentage points between the three approaches.

We note that there are several other decomposition methodologies that we decided were not directly applicable to our research context and goal. Another potential approach might have been to use Domar weights, which relate to multifactor productivity growth and consider intermediate goods and the variation in output and value added. See, for instance, Evsey D. Domar, "On the measurement of technological change," *The Economic Journal*, volume 71, issue 284, December 1961. Another approach looks at the impact of relative price effects, like the Tornqvist method (see Diane Coyle and Jen-Chung Mei, *Diagnosing the UK productivity slowdown: Which sectors matter and why?*, The Productivity Institute, working paper number 018, March 2022, updated April 2022). Our data sources do not offer firm-specific relative price levels, and therefore we could not use this method. In any case, we adjust GVA using double-sided deflators.

[7] We decided to use national statistics instead of OECD data because in that data set, the productivity CAGR for the total national economies was sensitive to variations in the snapshot period (2011–19). It should also be noted that national statistics productivity calculations are not double deflated.

[8] *Investing in productivity growth*, McKinsey Global Institute, May 2024.

[9] For some sectors in which BLS granularity was higher than our subsector classification (for example, retail), we matched each firm with BLS activity classifications. For the remaining sectors, we matched subsectors with BLS activity classifications. For firm size, we used two cuts in 2011 (fewer than 500 and more than 500 employees) and eight cuts in 2019 (fewer than 500, 500–750, 750–1,000, 1,000–1,500, 1,500–2,000, 2,000–2,500, 2,500–5,000, and more than 5,000 employees), reflecting greater data availability.

[10] See more on comparing deflators in Reitze Gouma and Robert Inklaar, *Comparing productivity growth across databases*, World KLEMS, September 2022.

[11] Leases-adjusted EBITDA data was cross-checked against the McKinsey Value Intelligence Platform.

[12] For previous McKinsey work on economic profit, see, for instance, Marc de Jong, Tido Röder, Peter Stumpner, and Ilya Zaznov, "Working hard for the money: The crunch on global economic profit," *McKinsey Quarterly*, April 2023.

[13] In the longer term, it may not be possible to sustain wage growth without any return to shareholders, because the capital will be reallocated to other firms. However, there may be cases where shareholders and lenders don't mind about economic profit, which may happen under some special ownership structures like employee-owned firms or cooperatives.

[14] Nominal economic profit in 2011 and 2019 including goodwill in US dollars. We were able to map the economic profit of 63, or 72 percent, of 87 Standouts.

[15] This approach is in line with Min Zhu, Longmei Zhang, and Daoju Peng, *China's growth potential—A stocktaking and sectoral approach*, International Monetary Fund, November 2019. Group-level convergence can also be expressed by equivalent definitions, like the employment-weighted gap of firms to frontier productivity, or the subsector average productivity as a share of the frontier productivity in 2019 versus 2011.

[16] See Daron Acemoglu, Philippe Aghion, and Fabrizio Zilibotti, "Distance to frontier, selection and economic growth," *Journal of the European Economic Association*, volume 4, number 1, March 2006; and Michael Kremer, Jack Wills, and Yang You, *Converging to convergence*, National Bureau of Economic Research working paper number 29484, November 2021.

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