# Who Built the Service Economy?*

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August 5, 2026

**Abstract**

We show empirically that the reallocation of employment from manufacturing to services in the U.S. between 1978 and 2023 was driven by large incumbent service firms, which expanded mainly by opening additional establishments. Guided by these facts, we develop a two-sector general equilibrium model of firm dynamics in which incumbent firms can scale by operating multiple establishments. An increase in manufacturing productivity relative to services accounts for a significant share of the decline in the manufacturing employment share but leaves the firm-size distribution unchanged. Adding a decline in replication costs—the cost of opening and coordinating additional establishments—reproduces the shift toward large, multi-establishment service firms, and the two forces together account for more than half of the observed sectoral reallocation. The replication-cost channel alone accounts for one third of the sectoral employment reallocation that the model explains. Thus, the firm dynamics margin played an important role in structural transformation.

**Keywords:** Firm dynamics; structural transformation; multi-establishment firms; entry

**JEL Codes:** L11, L16, O41

*We thank Gian Luca Clementi, Ryan Decker, Joseph Kaboski, Igor Livshits, Toshihiko Mukoyama, Hannah Rubinton, Eric Sager, and Todd Schoellman for useful comments. We thank Veronika Penciakova for an excellent discussion.

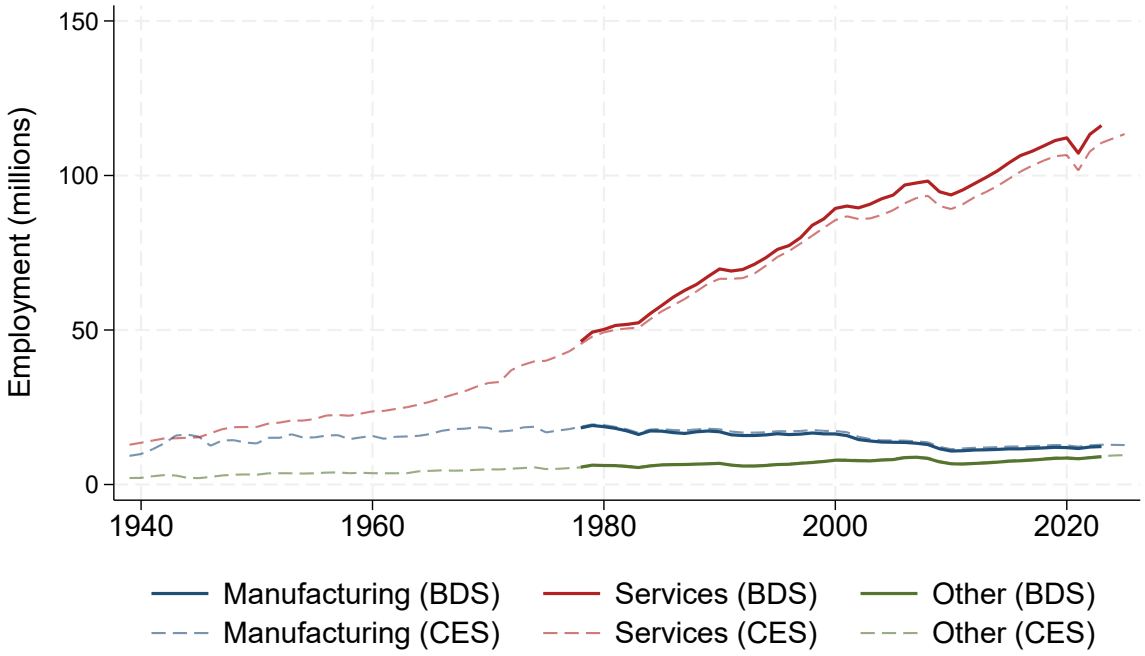
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# 1 Introduction

Structural transformation is a defining feature of modern growth. Figure 1 shows a steady reallocation of labor from the manufacturing sector toward the service sector, which accelerated around the 1980s. Since 1939, service employment has increased by a factor of nine, while manufacturing employment has increased by only about 50 percent. As a result, the service sector's share of total employment has risen from 50 to over 80 percent, while the manufacturing share has fallen from 40 to 10 percent.[1]

FIGURE 1: SECTORAL EMPLOYMENT




*Notes:* Figure 1 plots the time series of manufacturing and service employment. Table A.1 in the Appendix provides the mapping from industries to broad sector groups. Data source: BDS, BLS-CES.

How did this large reallocation of labor come about? Did it primarily reflect the rise of new service firms or the expansion of large, established incumbents? And if incumbent firms drove the growth of the service sector, did they expand existing establishments or open new ones? In this paper, we take a firm-dynamics perspective to answer these questions, focusing on

[1] We decompose the service-sector employment gains by subsector in Appendix A. The 'Health Care and Social Assistance' subsector accounts for the largest share of the gains (about 23 percent). Administrative and support services, accommodation and food services, and professional and technical services also expanded substantially, each accounting for more than 10 percent of the total employment growth.

how incumbent scaling—and in particular expansion through additional establishments—shaped structural transformation.

The trends shown in Figure 1 are well documented. However, much of the structural transformation literature treats sectors as aggregates—often implicitly as collections of representative firms—and therefore abstracts from the underlying firm dynamics. As a result, it is silent about whether sectoral reallocation reflects changes in the number of firms or the scaling of incumbents, nor whether incumbents grow within existing establishments or by opening new ones. The firm dynamics margin is important because a large empirical literature shows that firm turnover, heterogeneous firm growth, and reallocation across firms account for a large share of aggregate employment dynamics (e.g., Davis et al., 1996; Haltiwanger et al., 2013).

Using data from the U.S. Census Bureau's Business Dynamics Statistics (BDS), we find that structural transformation is primarily an incumbent scaling phenomenon. Specifically, we make four findings. First, service-sector growth is driven by incumbent expansion rather than net firm entry: gross entry and exit flows are sizable, but they largely offset each other. Second, manufacturing employment declines predominantly through the contraction of incumbent firms rather than through a collapse in the number of firms. Third, both the expansion of service incumbents and the contraction of manufacturing incumbents are concentrated among large, mature firms. Finally, we distinguish extensive-margin scaling (more establishments per firm) from intensive-margin scaling (employment per establishment) and find that large service-sector incumbents expand primarily through the extensive margin.

Guided by these facts, we develop a two-sector general-equilibrium model of firm dynamics in which incumbent firms can scale by operating multiple establishments. Adding establishments lets a firm grow without running into establishment-level decreasing returns, thereby raising its effective returns to scale. Expansion requires paying a convex replication cost, which captures the managerial and organizational resources needed to open and coordinate additional locations—standardizing procedures, training managers, and monitoring establishments from a distance. The convexity of the cost function reflects span-of-control limits: each additional establishment is harder to manage than the last, which governs how far incumbents can profitably scale. Our model extends the canonical framework of Hopenhayn and Rogerson (1993) by allowing incumbent firms to operate multiple establishments. This feature of the model allows us to account for our key

empirical finding that large service firms grew primarily by opening additional establishments.

The household side features non-homothetic preferences and complementarity between manufactured goods and services, both in the tradition of the structural transformation literature (e.g., Kongsamut et al., 2001; Herrendorf et al., 2014). These preferences introduce the two standard forces behind structural transformation: rising income shifts expenditure toward services, while faster productivity growth in manufacturing lowers the relative price of manufactured goods and reallocates employment toward services (Ngai and Pissarides, 2007). The model provides intuition for why an increase in manufacturing productivity alone cannot reproduce the firm-level facts. In an analytically tractable benchmark, free entry induces an offsetting price response, leaving firm policies—and hence the within-sector firm-size distribution—unchanged. Lower replication costs operate differently. Although the cost falls by the same proportion in both sectors, its effects are asymmetric: a firm's propensity to add establishments is increasing in its existing scale, and large service firms operate far more establishments than manufacturing firms. The same cost decline therefore generates a disproportionate expansion among large service incumbents, shifting employment toward large, multi-establishment firms and reallocating aggregate employment toward services.

We calibrate the model to 1979, the first year for which all of our calibration moments are available in the BDS data. In each sector, we target a rich set of moments including firm size distribution, establishments per firm across firm size groups, as well as sizes of entrants and young firms. Our main experiment combines an increase in manufacturing productivity relative to services with a decline in the convexity of replication costs. We discipline the increase in manufacturing productivity with the observed decline in the relative price of manufactured goods between 1979 and 2023 and the decline in replication costs with the increase in the number of establishments per firm among large service firms in 2023. We interpret cheaper replication as reflecting advances in information technology and logistics, as well as the standardization of business processes (e.g., Hsieh and Rossi-Hansberg, 2023; Lashkari et al., 2024; Brynjolfsson et al., 2023). Together, the two channels account for 52 percent of the observed sectoral employment reallocation and reproduce the shift toward large, multi-establishment service firms.

We then use counterfactuals to assess the role of each force. On its own, the increase in manufacturing productivity accounts for 44 percent of the observed reallocation but leaves the

service firm-size and establishment distributions essentially unchanged. On its own, the decline in replication costs reproduces the establishment expansion of large service firms and accounts for 17 percent of the observed reallocation—roughly one third of what the model explains. The firm dynamics margin is thus a quantitatively important driver of structural transformation in its own right, and one that the prior literature has overlooked.

We then provide suggestive evidence linking falling replication costs to various margins of industry growth and find support for the model's implications. Our evidence is based on two industry-level proxies for replication costs: IT capital per worker and the employment share of office and administrative support occupations. The former captures technologies—centralized inventory, payroll, and accounting systems—that require an up-front investment but lower the cost of operating each additional establishment. The latter captures back-office tasks that standardized software increasingly allows firms to centralize, so its decline signals cheaper replication. We relate changes in these proxies to three margins of industry growth: the number of firms, establishments per firm, and employment per establishment. Industries in which IT capital grew more rapidly, and in which back-office employment shares fell more rapidly, saw larger increases in establishments per firm, with the effect concentrated among large firms; we find no comparable association with the number of firms or with the average establishment size. In sum, the evidence corroborates the key mechanism of the paper: a fall in replication costs leads to an increase in the number of establishments per firm, concentrated among large firms.

**Related literature.** This paper contributes to three strands of the literature. First, it is related to work on structural transformation and multisector growth. This literature explains the reallocation of employment toward services through uneven sectoral productivity growth and nonhomothetic demand (e.g., Kongsamut et al., 2001; Ngai and Pissarides, 2007; Buera and Kaboski, 2012; Herrendorf et al., 2015; Comin et al., 2021). These papers explain the allocation of employment across sectors while typically abstracting from the firm dynamics through which that allocation occurred.[2] We show that this distinction matters: the expansion of services is concentrated among large incumbents and occurs primarily through additional establishments. Our model preserves the standard demand and productivity channels while making the organizational margin of incumbent

[2] Ding et al. (2022) study a distinct within-firm margin of structural transformation, whereby manufacturing firms create nonmanufacturing employment.

growth explicit.

Second, the paper relates to work on firms' spatial expansion and multi-establishment organization. Hsieh and Rossi-Hansberg (2023) document that productive service firms increasingly scale across local markets and study the implications for industry growth, national and local concentration, and measured productivity.[3] We take this service-replication mechanism as our starting point and connect it to structural transformation in a dynamic two-sector general-equilibrium model. Relatedly, Kleinman (2025) studies a decline in spatial expansion frictions for multi-location service firms and focuses on wage inequality and spatial disparities. Cao et al. (2022) decompose firm growth into employment per establishment and establishments per firm. They document fat tails along both margins and show that the recent increase in average U.S. firm size was driven primarily by firms adding establishments. Their model attributes the rise in establishments per firm to lower innovation costs, lower establishment exit, and slower aggregate productivity growth.

Third, the paper relates to the literature on firm dynamics. Canonical models study how entry, exit, and incumbent growth shape the firm-size distribution (Hopenhayn, 1992; Hopenhayn and Rogerson, 1993; Luttmer, 2007). Recent work connects demographic change to firm entry and aging (Karahan et al., 2024; Hopenhayn et al., 2022; Peters and Walsh, 2026), while Hopenhayn et al. (2025) extend this idea to structural transformation in a multisector model. These papers emphasize entry and firm aging; we instead focus on incumbent growth through additional establishments. Our contribution to this literature is to make establishment scope an endogenous margin of incumbent growth. This separates firm growth into changes in establishments per firm and employment per establishment and allows us to study how changes in organization reshape both the firm-size distribution and the sectoral allocation of employment.[4]

While we model falling replication costs in a parsimonious way, a large literature studies the technological and organizational forces that determine firms' costs of expanding across establishments. These include information technology, which raises returns to scale and facilitates

[3] Oberfield et al. (2024) model firms' endogenous choice of the number, size, and location of plants, emphasizing spatial sorting. We instead use a reduced-form replication cost to study changes in firms' establishment scope and their consequences for sectoral reallocation.

[4] Related models view firms as collections of products and emphasize scope expansion as a margin of incumbent growth (Klette and Kortum, 2004; Bernard et al., 2010). Aghion et al. (2023) consider a decline in firms' cost of operating multiple product lines, allowing efficient incumbents to expand across more markets. We apply this scope logic to establishments. Xi (2023) also develops a dynamic multi-establishment firm model and studies establishment-level distortions, misallocation, and cross-country productivity.

the replication of efficient routines across establishments and markets (Brynjolfsson et al., 2023; Lashkari et al., 2024), standardization, which lowers the cost of expanding scope (Argente et al., 2025), and the costs of managing establishments at a distance (Gumpert et al., 2022).[5] We interpret lower replication costs as a summary of these forces.

The rest of the paper is organized as follows. Section 2 describes the data and documents our main empirical facts. In Section 3, we develop a two-sector firm dynamics model with multi-establishment firms. Section 4 shows analytically that, in the workhorse firm dynamics model, an increase in manufacturing productivity relative to services cannot generate the micro facts behind structural transformation, whereas a decline in replication costs raises the number of establishments per firm, especially among the most productive firms. We calibrate the model and present quantitative results in Section 5. In Section 6, we interpret the estimated decline in replication costs and provide suggestive empirical evidence that corroborates the workings of the replication-cost channel. Section 7 concludes.

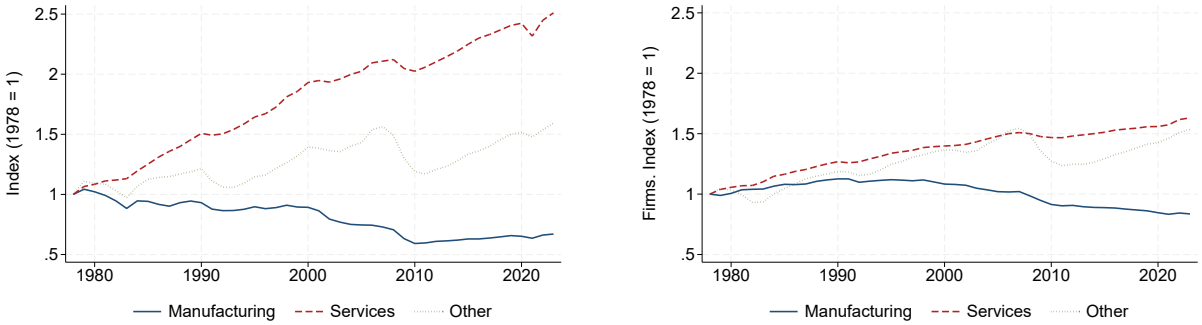
## 2 Empirical Results

In this section, we document the firm dynamics behind the shift toward the service sector shown in Figure 1. In particular, we make four findings. First, net entry contributes very little to overall employment growth, especially in the service sector. Second, incumbent firms drive employment changes in both sectors: they expand in the service sector and contract in the manufacturing sector. Third, both the expansion in the service sector and the contraction in the manufacturing sector are concentrated among large, mature firms. Finally, in the service sector, a key channel is the extensive-margin scaling: large incumbent firms expand by opening new establishments.

**Data and measurement.** Our empirical analysis draws on the BDS, housed by the U.S. Census Bureau. The Census Bureau constructs the BDS from the Longitudinal Business Database (LBD), the most comprehensive longitudinally linked dataset covering the universe of U.S. establishments with at least one paid employee. The BDS span the time period 1978–2023 and report a wide range of establishment- and firm-level statistics across industries, sectors, and geographic regions,

[5] Work on retail firms emphasizes related roles for chain expansion, technology, and density economies (e.g., Foster et al., 2006; Jarmin et al., 2009; Holmes, 2011; Basker, 2012).

FIGURE 2: SECTORAL EMPLOYMENT AND THE NUMBER OF FIRMS




(A) Employment

(B) Number of firms

*Notes:* Figure 2 shows the evolution of employment (Panel (A)) and the number of firms (Panel (B)) in the manufacturing and service sectors. All series are normalized to one in 1978. Data source: BDS.

including annual measures of job creation and destruction and of firm startups and shutdowns. Aggregate employment trends in the BDS closely mirror those in the Bureau of Labor Statistics (BLS) data, which extend back to 1939 and appear as the dashed lines in Figure 1.

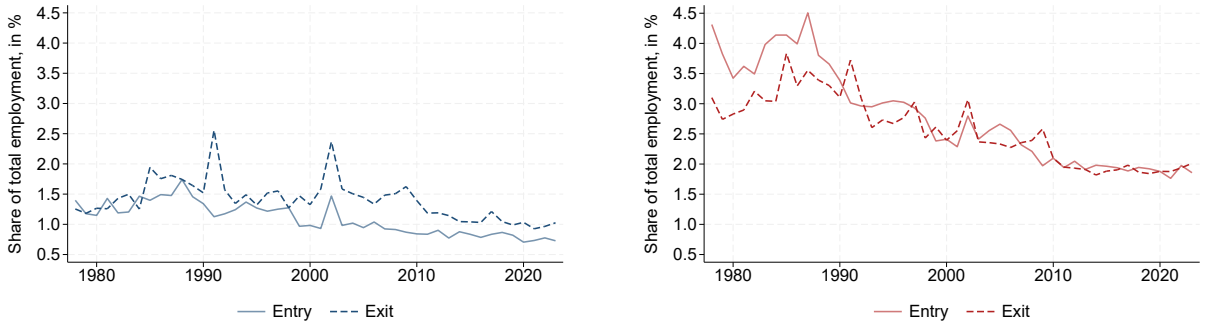
Throughout the paper, we adopt the BDS definitions of establishments and firms. An establishment is a single physical location at which business is conducted; a firm is a collection of establishments under common ownership. The BDS record a firm entry when a new firm consists entirely of age-0 establishments, and a firm exit when all of a firm's establishments—regardless of changes in ownership over time—cease operations.

The manufacturing sector spans NAICS industries 31–33. The service sector comprises wholesale and retail trade, transportation, information, FIRE (finance, insurance, and real estate), professional services, and educational services, among other industries. We classify the remaining industries—such as agriculture, mining, and construction—as "other". Table A.1 in the Appendix provides the mapping between NAICS two-digit industries and these broad sector categories.

## 2.1 Muted Sectoral Transformation in the Number of Firms

Panel (A) of Figure 2 plots sectoral employment relative to 1978: employment in the service sector has grown by a factor of 2.5, so one might expect a comparable increase in the number of service firms. Panel (B) shows that this is not the case: the number of service firms increased by only 63 percent. The manufacturing sector displays the same disconnect. While total manufacturing

FIGURE 3: THE ROLE OF ENTRY AND EXIT




(A) Manufacturing (B) Services

*Notes:* Figure 3 plots the employment share of entrants (defined as total employment of entering firms as a fraction of total sectoral employment) and the employment share of exiting firms (defined as total employment of exiting firms as a fraction of total lagged sectoral employment). Data source: BDS.

employment declined by over 30 percent over this period, the number of manufacturing firms follows a hump-shaped path, with an eventual decline of only 16 percent.[6]

In both sectors, the number of firms moves far less than employment, which points to important changes in the firm-size distribution—especially in the service sector. Viewing sectors as collections of representative firms can therefore be misleading: aggregate employment reallocation may reflect firm selection through entry and exit, changes in the firm-size distribution, or both. In the remainder of this section, we examine which of these margins matter quantitatively.

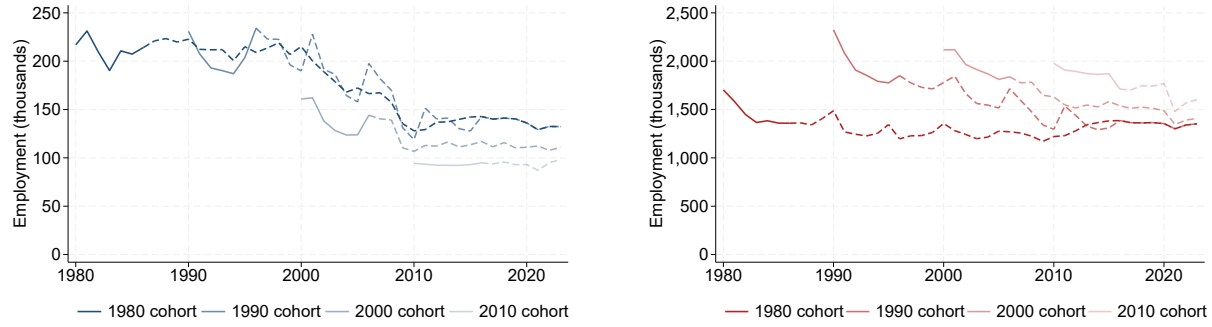
## 2.2 Entry and Exit Play a Minor Role

A natural starting point is the employment contribution of entry and exit. Stable firm counts do not rule out an important role for this margin: if many firms enter and a similar number exit each period, the number of firms changes little even though entry may create substantial employment at birth. We therefore measure the contribution of entry and exit directly. Figure 3 plots the share of total sectoral employment accounted for by entering and exiting firms.

Panel (A) reports results for the manufacturing sector and Panel (B) for the service sector. The figure delivers three takeaways. First, in both sectors, the share of employment accounted for by

[6] In absolute terms, the number of service firms increased from 2.9 million to 4.7 million, while the number of manufacturing firms decreased from .26 million to .22 million. The results for the number of establishments are very similar. Figure A.1 in the Appendix shows the evolution of average firm sizes.

FIGURE 4: COHORT EMPLOYMENT OVER TIME




(A) Manufacturing (B) Services

*Notes:* Figure 4 shows total employment for selected entry cohorts in the manufacturing and service sectors. For ages 0–5, the BDS reports employment by exact firm age (solid segments). At older ages, the BDS reports employment only in multi-year age bins, so we approximate cohort employment with the bin average (dashed segments). Data source: BDS.

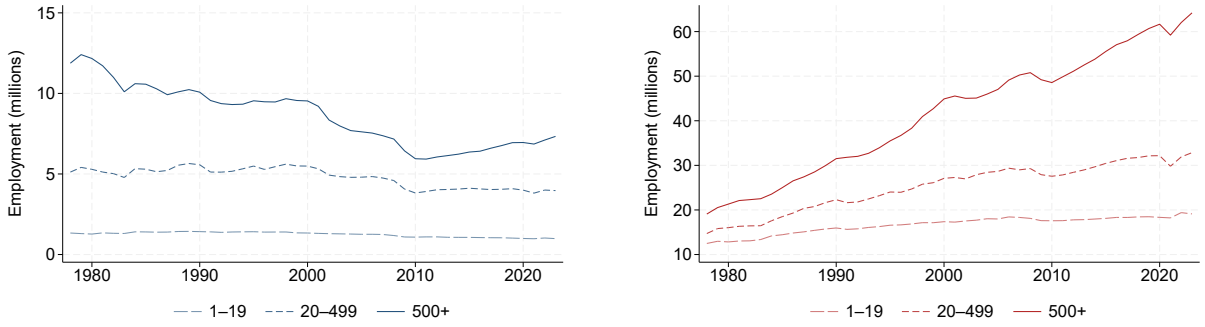
entering and exiting firms has declined throughout the sample period. Second, gross entry and exit matter considerably less for employment in the manufacturing sector than in the service sector. Third, in the manufacturing sector, net entry has reduced employment by about 0.3 percent per year on average. In the service sector, by contrast, entry has typically created more jobs than exit has destroyed.[7]

A large literature documents a secular decline in firm entry rates. Our evidence adds a sectoral dimension to this fact: service employment expanded substantially even as the employment contribution of entrants steadily declined, while in the manufacturing sector exit contributed meaningfully to the employment decline. Taken together, these patterns indicate that contemporaneous net entry cannot, by itself, account for the expansion of service employment.

**Post-entry dynamics.** Measuring employment at the time of entry may understate the role of entry if firms enter small and expand afterward. To address this concern, we track entering cohorts over time: for each sector and entry cohort $c$, we measure the total employment at time $t \geq c$ of the firms that entered in year $c$. Figure 4 shows results for $c = \{1980, 1990, 2000, 2010\}$; other cohorts display similar patterns.

[7]The sectoral entry and exit rates (as fractions of all firms) are shown in Figure A.2 in the Appendix. Both in the manufacturing and service sectors, firm entry rates have fallen over most of the sample period, while starting to increase again since around 2010. Exit rates show no discernible pattern. The service sector exhibits higher gross turnover than manufacturing.

FIGURE 5: SECTORAL EMPLOYMENT BY SIZE GROUP




(A) Manufacturing (B) Services

*Notes:* Figure 5 shows the evolution of the employment by size group in the manufacturing and service sectors. Every group's employment level is normalized to one at the beginning of the sample. Data source: BDS.

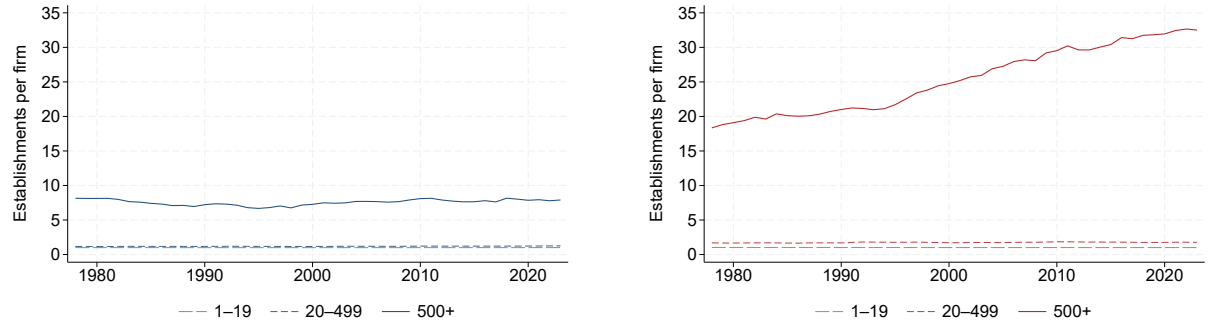
In the manufacturing sector, entering cohorts have become smaller over time, and cohort employment declines as the cohort ages, driven by firm exit. In the service sector, cohort size shows no clear trend, and cohort employment remains roughly stable as cohorts age. Since service entrants account for only about 3 percent of sectoral employment at birth (*cf.* Figure 3), post-entry growth does not overturn our conclusion: entrants contribute only marginally to aggregate employment growth, even at longer horizons.

The limited role of entry cohorts shifts attention to continuing firms: service-sector growth must primarily reflect scaling by incumbents rather than the cumulative impact of successive waves of entrants. We examine this margin next.

## 2.3 Incumbent Firms Explain the Bulk of Sectoral Transformation

Since firm entry plays a limited role, understanding structural transformation requires a closer look at continuing firms. Employment reallocation among these firms can occur along three dimensions. First, employment may shift across firms of different sizes. Second, size dynamics may reflect life-cycle differences, making it important to distinguish size effects from age effects. Third, employment may adjust within existing establishments or through the opening and closing of establishments by multi-unit firms. We examine each dimension in turn.

FIGURE 6: ESTABLISHMENTS PER FIRM




(A) Manufacturing (B) Services

*Notes:* Figure 6 shows the average number of establishments per firm in the manufacturing and service sectors, broken down by firm size. Data source: BDS.

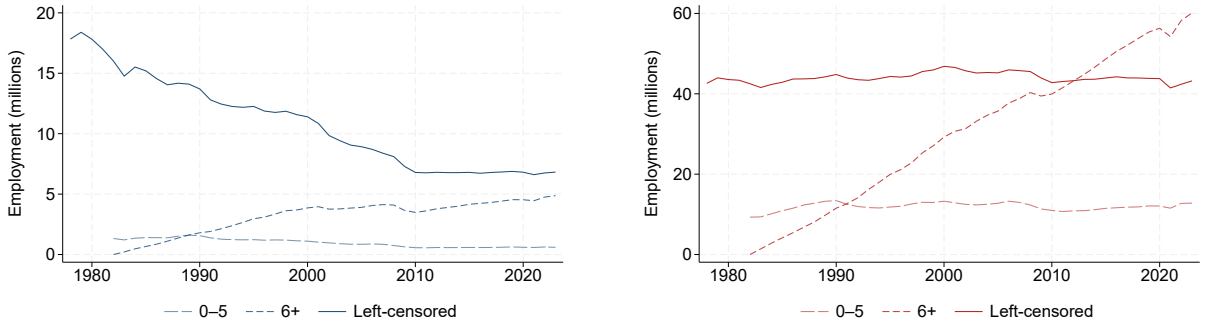
**The growing role of large firms.** We define small firms as those with 1–19 employees, medium firms as those with 20–499 employees, and large firms as those with 500 or more employees. Figure 5 shows each sector's employment by firm size group.[8] In the manufacturing sector, employment in large firms accounts for a vast majority of the secular decline, having fallen by about five million employees, or about 40 percent. Employment in small and medium firms is comparatively stable. In the service sector, large firms drive the expansion: their total employment has more than tripled, while growth is more muted among medium-sized firms and weakest among small firms. As a result, the share of service-sector employment concentrated in the largest firms rose from close to 40 percent at the beginning of the sample to more than 55 percent at the end.

Taken together, Figure 5 implies that the key firm-dynamics margin behind structural transformation is the changing scale of large incumbents.

**Intensive vs. extensive margin within incumbents.** An important margin for the expansion of incumbent firms is the number of establishments they operate. Figure 6 shows the average number of establishments for firms of different size groups in the manufacturing and service sectors. In both sectors, firms with fewer than 500 employees essentially consist of a single establishment. Among large manufacturing firms, the average number of establishments is about eight and has been stable over time. In contrast, establishments per large service firm have risen steadily, reaching

[8]Using initial firm size, rather than current firm size, leads to virtually identical results (see Figure A.3 in the Appendix).

FIGURE 7: SECTORAL EMPLOYMENT BY FIRM AGE




(A) Manufacturing (B) Services

*Notes:* Figure 7 shows the evolution of the employment by age group in the manufacturing and service sectors. Data source: BDS.

33 on average by the end of the sample period. Since employment per establishment has been stable (see Figure A.4 in the Appendix), this points to extensive-margin growth—the opening of new establishments by incumbent firms—as a key growth margin in the service sector. In the manufacturing sector, where the number of establishments per firm has stayed constant, employment declines mainly through falling employment per establishment.

**The role of firm age.** The size-based patterns raise a natural question about the role of firm age. Size and age are closely related but conceptually distinct: large firms tend to be older on average, yet firms of similar size can be at very different stages of the life cycle. Reallocation attributed to firm size may therefore reflect life-cycle dynamics rather than size per se. Examining employment by firm age disentangles these effects and reveals whether expansion occurs through the maturation of young firms or through the continued growth of mature incumbents.

To analyze firm-age dynamics, we classify firms into three groups. Young firms are defined as firms aged 0–5 years. Old firms are defined as firms aged 6 years or older that enter after the beginning of the sample. Firms that were already present prior to the start of the sample are left-censored and cannot be assigned an exact age.[9] We report results for young and old firms starting in 1982, the first year in which firms aged 0–5 can be observed in the data. The employment patterns are shown in Figure 7.

[9] At the end of the sample, 13.4 percent of manufacturing firms are classified as left-censored, as compared to 6 percent in the service sector.

In the manufacturing sector, young firms play a minor role, employing fewer than one million workers in a typical year, with little change over time. Employment among old firms—those aged six years or older—rises as cohorts age into this category, but stabilizes around the year 2000 at approximately five million workers. By contrast, the secular decline in manufacturing employment is concentrated among left-censored firms. Employment in this group falls by more than 11 million workers over the sample period, with the pace of decline moderating somewhat after 2010. This pattern is not unexpected: the group of left-censored firms only shrinks over time, as its members mature and eventually exit.

In the service sector, employment among young firms also plays a relatively minor role and plateaus at around twelve million workers. However, the age profiles of old and left-censored firms differ sharply from those in the manufacturing sector. Employment among old service firms continues to grow throughout the sample period, reaching roughly 60 million workers by the end of the sample. Strikingly, employment in left-censored service firms is stable over time, even though the number of such firms shrinks from 2.2 million at the beginning of the sample to 280,000 at the end.

Taken together, the age patterns reinforce the conclusions from the firm-size analysis. Employment among young firms remains quantitatively small and largely stable in both sectors, indicating that the expansion of large firms does not primarily reflect the maturation of initially small entrants. Instead, reallocation occurs predominantly among mature firms. In the manufacturing sector, the secular employment decline is concentrated among firms that were already operating before the start of the sample, consistent with contraction among long-established, presumably larger, incumbents. In the service sector, by contrast, employment growth is driven by continued expansion among firms that are already mature, including left-censored ones. Structural transformation thus operates mainly through the expansion and contraction of mature firms, rather than through the life-cycle dynamics associated with entry and early growth.

## 2.4 Employment Accounting Decomposition

To summarize our results, we decompose the sectoral employment change from year $t-1$ to $t$ into three components—net firm entry, net expansion of continuing establishments, and net

TABLE 1: DECOMPOSITION OF EMPLOYMENT CHANGES BY SECTOR, 1978–2023

| Component | Δ Employment (millions) | Share of Total Change (%) |
|---|---|---|
| *Panel A: Manufacturing* | | |
| Net entry | −2.065 | 37.7 |
| Entry (startups) | 7.642 | |
| Exit (firm deaths) | −9.709 | |
| Net expansion | −0.603 | 11.0 |
| Job creation (continuers) | 52.666 | |
| Job destruction (continuers) | −53.269 | |
| Net establishment expansion of incumbent firms | −2.815 | 51.3 |
| **Total change** | −5.483 | **100.0** |
| *Panel B: Services* | | |
| Net entry | 4.883 | 6.8 |
| Entry (startups) | 98.407 | |
| Exit (firm deaths) | −93.524 | |
| Net expansion | 37.600 | 52.6 |
| Job creation (continuers) | 381.400 | |
| Job destruction (continuers) | −343.900 | |
| Net establishment expansion of incumbent firms | 29.000 | 40.6 |
| **Total change** | 71.483 | **100.0** |
| *Panel C: Other* | | |
| Net entry | 0.306 | 7.4 |
| Entry (startups) | 12.455 | |
| Exit (firm deaths) | −12.148 | |
| Net expansion | 3.387 | 81.6 |
| Job creation (continuers) | 46.834 | |
| Job destruction (continuers) | −43.447 | |
| Net establishment expansion of incumbent firms | 0.456 | 11.0 |
| **Total change** | 4.149 | **100.0** |

*Notes:* Table 1 decomposes employment changes in the manufacturing, service, and other sectors into three components: net firm entry, net expansion of continuing establishments, and net establishment expansion within incumbent firms (see Equation 1). Data source: BDS.

establishment expansion within incumbent firms—using the identity:

$$\Delta E_{s,t} = \underbrace{\left(JC_{s,t}^{\text{birth},f=0} - \text{FirmDeathEmp}_{s,t}\right)}_{\textbf{Net firm entry}} + \underbrace{\left(JC_{s,t}^{\text{cont}} - JD_{s,t}^{\text{cont}}\right)}_{\textbf{Net within-establishment expansion of incumbents}} + \underbrace{\left(JC_{s,t}^{\text{birth},f\geq 1} - \left(JD_{s,t}^{\text{death}} - \text{FirmDeathEmp}_{s,t}\right)\right)}_{\textbf{Net establishment expansion within incumbent firms}}, \quad (1)$$

where $JC_{s,t}^{\text{birth},f=0}$ denotes job creation by age-0 firms in sector $s$ at time $t$, and $\text{FirmDeathEmp}_{s,t}$ denotes job destruction due to firm exit. $JC_{s,t}^{\text{cont}}$ and $JD_{s,t}^{\text{cont}}$ denote job creation and job destruction

by continuing establishments. Finally, $JC_{s,t}^{\text{birth},f\geq 1}$ denotes job creation from establishment entry within incumbent firms, and $JD_{s,t}^{\text{death}}$ denotes job destruction by exiting establishments.

Table 1 reports the decomposition for the period 1978–2023. Net entry accounts for about 40 percent of the decline in manufacturing employment, but only about 7 percent of the employment change in the service and other sectors. The small net entry component in these sectors masks large gross entry and exit flows that largely offset each other. In the service sector, the bulk of employment growth comes instead from the net expansion of continuing establishments (53 percent) and from net establishment creation within incumbent firms (41 percent).

The decomposition is consistent with the evidence presented in the preceding subsections. In the service sector, net entry contributes little to employment growth, in line with the small employment share of entrants. The dominant component is instead establishment creation within incumbent firms, the same extensive margin that drives the growth of large service firms. In the manufacturing sector, net entry plays a larger role, consistent with the contribution of exit to the sector's employment decline; even there, however, about half of the total change occurs through the establishment margin of incumbent firms.

Overall, the empirical evidence assigns the leading role in structural transformation to large incumbents that expand through establishments rather than to firm entry. The next section develops a two-sector firm dynamics model with multi-establishment firms designed to confront these facts. We use the model to evaluate whether the standard driver of structural transformation—an increase in manufacturing productivity relative to services—can reproduce both the sectoral employment shares and the distributional moments documented in this section. As we show, this productivity increase captures about a half of the sectoral employment reallocation but leaves the firm-level facts unexplained. A decline in the cost of replicating establishments fills this gap: it reproduces the reallocation toward large, multi-establishment service firms and itself accounts for a significant share of structural transformation.

# 3 Model

Time is discrete and runs forever: $t = 0, 1, 2, \ldots$ A representative household supplies $\bar{L}$ units of labor inelastically and owns all firms. Production takes place in two sectors, manufacturing

$(M)$ and services $(S)$, indexed by $j \in \{M, S\}$. Each sector is comprised of incumbent firms and potential entrants. Incumbent firms are heterogeneous in idiosyncratic productivity $z$ and can operate multiple establishments. Each establishment uses the same decreasing-returns technology, and expanding the number of establishments requires paying a convex replication cost.

## 3.1 Household

The representative household maximizes the expected discounted sum of flow utilities:

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln(C_t), \tag{2}$$

where $\beta \in (0, 1)$ is the discount factor and $C_t$ is a composite of the two sectoral goods. Preferences are non-homothetic: the household must purchase a subsistence quantity $\bar{c}_M > 0$ of the manufacturing good each period. Household income is $I_t = W_t \bar{L} + \Pi_t$, where $W_t$ is the wage and $\Pi_t$ denotes aggregate firm profits rebated to the household. The budget constraint is:

$$p_{Mt} C_{Mt} + p_{St} C_{St} = I_t. \tag{3}$$

The household first purchases the subsistence quantity $\bar{c}_M$ of the manufacturing good. The remaining supernumerary expenditure is $X_t \equiv I_t - p_{Mt} \bar{c}_M$. We restrict attention to equilibria with $X_t > 0$. The household allocates supernumerary expenditure across the two sectoral goods according to CES expenditure shares. The associated price index is $P_t = \left[\mu p_{Mt}^{1-\varepsilon} + (1-\mu)\, p_{St}^{1-\varepsilon}\right]^{1/(1-\varepsilon)}$, where $\varepsilon > 0$ is the elasticity of substitution across sectoral goods and $\mu \in (0, 1)$ governs the allocation of supernumerary spending. The resulting expenditure shares are $\phi_{Mt} = \mu\, (p_{Mt}/P_t)^{1-\varepsilon}$ and $\phi_{St} = (1-\mu)\, (p_{St}/P_t)^{1-\varepsilon}$, with $\phi_{Mt} + \phi_{St} = 1$. Household sectoral demands are therefore $C_{Mt} = \bar{c}_M + (\phi_{Mt}/p_{Mt})\, X_t$ and $C_{St} = (\phi_{St}/p_{St})\, X_t$.

## 3.2 Heterogeneous Firms

Our setup extends the framework of Hopenhayn and Rogerson (1993) by allowing firms to operate multiple establishments: an incumbent in sector $j$ with idiosyncratic productivity $z$ runs $m \geq 1$ identical establishments. To streamline the exposition, in what follows we drop time and firm

subscripts.

**Establishments.** Each establishment hires $\ell$ workers and produces output according to $q = a_j\, z\, \ell^{\alpha_j}$, where $a_j$ denotes sector-level TFP and $\alpha_j \in (0,1)$ governs diminishing returns at the establishment level.

**Firms.** Firm productivity $z$ evolves according to a sector-specific AR(1) process:

$$\log z' = (1-\rho_j)\,\mu_j^z + \rho_j\,\log z + \sigma_j\,\varepsilon', \quad \varepsilon' \sim \mathcal{N}(0,1), \tag{4}$$

where $\varepsilon'$ is i.i.d. across firms and time. We write the process in mean-deviation form, so that $\mu_j^z$ is the unconditional mean of $\log z$ and $\sigma_j/\sqrt{1-\rho_j^2}$ its unconditional standard deviation.

Operating $m$ establishments requires paying the replication cost:

$$G(m) = c_{m,j}\,\frac{m^{1+\eta_j}-1}{1+\eta_j}, \tag{5}$$

where $c_{m,j}$ is a sector-specific scale parameter and $\eta_j > 0$ governs the convexity of the span-of-control friction. The cost is zero for single-unit firms ($m = 1$).

Given prices $(W, p_j)$, each period the firm chooses labor per establishment $\ell$ and the number of establishments $m \geq 1$ to maximize flow profit:

$$\max_{m\geq 1,\ \ell\geq 0} \quad m\left[p_j\, a_j\, z\, \ell^{\alpha_j} - W\,\ell\right] - x\,G(m) - x\,f_j. \tag{6}$$

Here $f_j$ is a fixed operating cost, and $x$ denotes the unit in which the fixed cost, the replication cost, and (below) the entry cost are denominated. We consider two cases: $x = P$, where costs are denominated in units of the final consumption bundle, and $x = W$, where they are denominated in labor units.[10,11]

[10] Hopenhayn and Rogerson (1993) assume $x = P$ and we use the same assumption in our quantitative results. Deriving some of our analytical results is facilitated by assuming $x = W$.

[11] In this section, we focus on the case where all exit is exogenous, so the fixed cost $f_j = 0$. We find that an extension with endogenous exit delivers largely the same results.

The first-order condition for labor per establishment yields:

$$\ell^*(z) = \left(\frac{p_j\,\alpha_j\,a_j\,z}{W}\right)^{\frac{1}{1-\alpha_j}}, \tag{7}$$

so that, at the optimum, variable profit per establishment is:

$$\pi_v(z) = (1-\alpha_j)\left(p_j\,a_j\,z\right)^{\frac{1}{1-\alpha_j}}\left(\frac{\alpha_j}{W}\right)^{\frac{\alpha_j}{1-\alpha_j}}. \tag{8}$$

Given $\ell^*$, the optimal number of establishments is:

$$m^*(z) = \max\left\{1,\ \left(\frac{\pi_v(z)}{x\,c_{m,j}}\right)^{1/\eta_j}\right\}. \tag{9}$$

Every active firm operates at least one establishment; the unconstrained optimum exceeds one when variable profit surpasses the marginal cost of replication at $m = 1$.[12]

Let $V_j(z)$ denote the value of an incumbent firm in sector $j$. Each period, the firm earns flow profits, faces exogenous exit with probability $\delta_j$, and, conditional on surviving, decides whether to continue operating. The value function satisfies:

$$V_j(z) = \Pi_j(z) + \beta\,(1-\delta_j)\max\left\{0,\ \mathbb{E}\left[V_j(z') \mid z\right]\right\}, \tag{10}$$

where flow profit is $\Pi_j(z) = m^*(z)\,\pi_v(z) - x\,G(m^*(z)) - x\,f_j$, and a firm exits endogenously when $\mathbb{E}[V_j(z') \mid z] < 0$.

**Entry.** In each sector, a prospective entrant pays a sector-specific entry cost $c_{e,j}$ before learning its idiosyncratic productivity draw. Upon entry, the firm draws productivity from a sector-specific entrant distribution $\pi_{e,j}$, which is log-normal:

$$\log z \sim \mathcal{N}\left(\mu^z_{e,j},\ \sigma^2_{e,j}\right). \tag{11}$$

[12] As $\eta_j \to \infty$ replication becomes prohibitively costly and all firms operate a single establishment. As $\eta_j \to 0$ the replication cost becomes linear and firms face constant returns to scale.

Entrants are thus not drawn from the invariant distribution of the incumbent productivity process (4), which corresponds to the special case $\mu^z_{e,j} = \mu^z_j$ and $\sigma_{e,j} = \sigma_j/\sqrt{1-\rho_j^2}$. Allowing the entry distribution to differ serves two purposes. First, entrants are much smaller than incumbents in the data, and $\left(\mu^z_{e,j}, \sigma_{e,j}\right)$ allow the model to reproduce the size distribution at birth. Second, entering cohorts start away from the stationary distribution and converge to it at a rate governed by $\rho_j$, generating post-entry firm growth. Section 5.1 exploits this convergence to identify $\rho_j$.

Free entry requires that the expected value of entry equal its cost:

$$\mathbb{E}_{\pi_{e,j}}[V_j(z)] = xc_{e,j}. \tag{12}$$

## 3.3 Stationary Recursive Competitive Equilibrium

For the remainder of this section, we assume that $x = P$.[13] We normalize the stationary measures by the entrant flow: $\mu_j$ is the measure generated by a unit mass of entrants, so that $\int \mathrm{d}\mu_j$ equals the mass of active firms sustained by a unit flow of entrants. Accordingly, $M_j$ denotes the mass of entrants per period, and $M_j \int \mathrm{d}\mu_j$ is the mass of active firms in sector $j$. The stationary recursive competitive equilibrium consists of value functions $\{V_j\}$, firms' decision rules $\{\ell^*_j(z), m^*_j(z), \mathrm{exit}_j(z)\}$, stationary measures $\{\mu_j\}$, aggregate dividends $\Pi$, prices $\{W, p_M, p_S, P\}$, household consumption $\{C_M, C_S\}$, the final-good expenditure shares $\{\phi_M, \phi_S\}$, the sectoral entrant masses $\{M_M, M_S\}$, and total final-good demand from firms' cost payments $B$ such that:

1. given prices $\{W, p_M, p_S, P\}$ and aggregate profits $\Pi$, household consumption $\{C_M, C_S\}$ satisfies the non-homothetic demand system implied by (2) and (3), with manufacturing subsistence demand $\bar{c}_M$ purchased first and supernumerary expenditure allocated using the shares $\phi_M$ and $\phi_S$;

2. given prices $\{W, p_M, p_S, P\}$, value functions $\{V_j\}$ and decision rules $\{\ell^*_j, m^*_j, \mathrm{exit}_j\}$ solve (6)–(10);

[13] When fixed operating costs, replication costs, and entry costs are denominated in units of the final good, firms must purchase final output to pay these costs. This creates demand for sectoral goods that is distinct from household consumption and must therefore appear separately in goods-market clearing. Under CES aggregation, this demand is allocated across manufacturing and services using the same expenditure shares that govern household demand. Appendix B.1 states the equilibrium conditions for the alternative case $x = W$, in which fixed, entry, and replication costs are denominated in labor units.

3. free entry holds in each sector as in (12);

4. the final-good expenditure shares are $\phi_M = \mu \left(\frac{p_M}{P}\right)^{1-\varepsilon}$, and $\phi_S = (1-\mu)\left(\frac{p_S}{P}\right)^{1-\varepsilon}$;

5. total final-good demand from firms' cost payments is

$$B = \sum_{j \in \{M,S\}} M_j \left( \int \left[ f_j + G(m_j(z)) \right] \mathrm{d}\mu_j(z) + c_{e,j} \right);$$

6. goods markets clear, where $C_M$ already includes subsistence manufacturing demand and firms' cost payments $B$ (denominated in final-good units) are converted into sectoral quantities at the relative prices $P/p_j$:

$$M_M \int Y_M(z)\,\mathrm{d}\mu_M(z) = C_M + \phi_M \frac{P}{p_M} B, \qquad M_S \int Y_S(z)\,\mathrm{d}\mu_S(z) = C_S + \phi_S \frac{P}{p_S} B;$$

7. the labor market clears:

$$M_M \int \ell_M(z) m_M(z)\,\mathrm{d}\mu_M(z) + M_S \int \ell_S(z) m_S(z)\,\mathrm{d}\mu_S(z) = \bar{L};$$

8. aggregate dividends equal net payouts from both sectors:

$$\Pi = \sum_{j \in \{M,S\}} M_j \left( \int \Pi_j(z)\,\mathrm{d}\mu_j(z) - P\, c_{e,j} \right);$$

9. stationary measures $\{\mu_j\}$ are consistent with the productivity process (4), firms' exit decisions, and a unit entrant inflow drawn from $\pi_{e,j}$.

Computational details are relegated to Appendix B.2.

# 4 Growth Through Establishments

This section presents two analytical results. The first explains why, in the workhorse firm dynamics model extended to two sectors, an increase in manufacturing productivity relative to services fails to generate the firm-level facts behind structural transformation. The second shows that a decrease

in the convexity of the service sector's replication cost—the parameter $\eta$ in the establishment cost function (5)—raises the number of establishments per firm, especially among large, high-productivity firms.

To develop analytical intuition, we temporarily abstract from non-homothetic demand by setting subsistence consumption $\bar{c}_M = 0$, and we denominate costs in labor units by setting $x = W$. Under these assumptions, the model allows for a transparent characterization of firm behavior.

**Proposition 1** (Invariance of firm policies to sectoral productivity)**.** *Consider a sector $j \in \{M, S\}$ with production technology $q = a_j z \ell^{\alpha_j}$, output price $p_j$, and wage normalized to $W = 1$. Assume $x = W$. Then optimal labor per establishment $\ell^*(z)$, maximized per-establishment profits $\pi_v(z)$, and the optimal number of establishments $m^*(z)$ depend on $(p_j, a_j)$ only through the composite term $p_j a_j$. Moreover, under free entry, any change in $a_j$ is offset in equilibrium by a proportional adjustment of $p_j$ that leaves $p_j a_j$—and hence all firm policies and the firm-size distribution—unchanged.*

*Proof.* Under $x = W$, the fixed, replication, and entry costs are all denominated in wage units. By free entry, (12), the expected value of entry must remain equal to $c_{e,j}$. Equations (7) and (8) show that establishment-level labor demand and variable profits depend on sectoral conditions only through the composite term $p_j a_j$. By (9), $m^*(z)$ is a function of $\pi_v(z)$ alone, so flow profits $\Pi_j(z)$ also depend on sectoral conditions only through $p_j a_j$. Thus, the value function (10) depends on $(p_j, a_j)$ only through their product, and the expected value of entry is strictly increasing in it. Since free entry requires the value of entry to remain constant, the equilibrium must adjust so that $p_j$ proportionally offsets any change in $a_j$, leaving $p_j a_j$ unchanged. It then follows from (7), (8), and (9) that $\ell^*(z)$, $\pi_v(z)$, and $m^*(z)$ are unchanged. Finally, the productivity process and the exogenous exit rate do not depend on $a_j$, and the endogenous exit rule depends on $(p_j, a_j)$ only through the value function—and hence only through the unchanged composite term $p_j a_j$—so the stationary firm-size distribution is unchanged as well, which proves the proposition. □

Proposition 1 states that an increase in manufacturing productivity is perfectly offset by a decline in the price of the manufacturing good, leaving all firm policies—and hence the firm-size distribution—unchanged. This productivity increase alone therefore cannot generate the

employment growth at large service firms or the rise in establishments per large service firm that we document in the data.

**Proposition 2** (Replication costs and effective firm-level returns to scale)**.** *Consider a sector $j \in \{M, S\}$ with production technology $q = a_j z \ell^{\alpha_j}$, output price $p_j$, wage normalized to $W = 1$, and replication costs $G(m) = c_{m,j} \frac{m^{1+\eta_j}-1}{1+\eta_j}$, with $c_{m,j} > 0$ and $\eta_j > 0$. Assume $x = W$. Then:*

*(i) the optimal establishment choice is given by (9), reprinted here for convenience:*

$$m^*(z) = \max\left\{1, \left(\frac{\pi_v(z)}{c_{m,j}}\right)^{1/\eta_j}\right\}.$$

*This implies that lowering $\eta_j$ strictly increases $m^*(z)$ for firms with $\pi_v(z) > c_{m,j}$, while leaving $m^*(z) = 1$ for firms with $\pi_v(z) \leq c_{m,j}$. Moreover, among firms with an interior solution, the proportional increase in $m^*(z)$ is larger for firms with higher productivity $z$;*

*(ii) for firms with an interior solution for the number of establishments, total firm employment $L(z) = m^*(z)\ell^*(z)$ scales with productivity as*

$$L(z) \propto z^{\frac{1+\eta_j}{\eta_j(1-\alpha_j)}} = z^{\frac{1}{1-\alpha_{\text{eff},j}}},$$

*where the implied effective firm-level returns-to-scale parameter is:*

$$\alpha_{\text{eff},j} = \frac{1+\eta_j\,\alpha_j}{1+\eta_j} \in (\alpha_j, 1). \tag{13}$$

*Therefore $\alpha_{\text{eff},j} > \alpha_j$ for any finite $\eta_j$, $\alpha_{\text{eff},j} \to \alpha_j$ as $\eta_j \to \infty$, and $\alpha_{\text{eff},j} \to 1$ as $\eta_j \to 0$.*

*Proof.* For part (i), using (9) for firms in the interior region, it must be that $\pi_v(z) > c_{m,j}$ and therefore

$$\ln m^*(z) = \frac{1}{\eta_j}\ln\left(\frac{\pi_v(z)}{c_{m,j}}\right), \qquad \frac{\partial \ln m^*(z)}{\partial \eta_j} = -\frac{1}{\eta_j^2}\ln\left(\frac{\pi_v(z)}{c_{m,j}}\right) = -\frac{1}{\eta_j}\ln m^*(z) < 0.$$

Lowering $\eta_j$ raises the number of establishments for firms with $\pi_v(z) > c_{m,j}$, while firms with $\pi_v(z) \leq c_{m,j}$ remain at the corner $m^*(z) = 1$. Moreover, for a given reduction in $\eta_j$, the proportional response is larger the larger is $\ln m^*(z)$, that is, the larger is initial firm size on the establishment

margin. Since $\pi_v(z)$ is increasing in $z$, it follows that higher-productivity firms respond more strongly.

For part (ii), (7) and (8) imply $\ell^*(z) \propto z^{1/(1-\alpha_j)}$ and $\pi_v(z) \propto z^{1/(1-\alpha_j)}$. Combining this with part (i) yields

$$m^*(z) \propto z^{\frac{1}{\eta_j(1-\alpha_j)}}$$

in the interior region. Therefore

$$L(z) = m^*(z)\ell^*(z) \propto z^{\frac{1}{\eta_j(1-\alpha_j)}} z^{\frac{1}{1-\alpha_j}} = z^{\frac{1+\eta_j}{\eta_j(1-\alpha_j)}}.$$

Defining $\alpha_{\text{eff},j}$ by

$$\frac{1}{1-\alpha_{\text{eff},j}} = \frac{1+\eta_j}{\eta_j(1-\alpha_j)}$$

and solving for $\alpha_{\text{eff},j}$ gives:

$$\alpha_{\text{eff},j} = 1 - \frac{\eta_j(1-\alpha_j)}{1+\eta_j} = \frac{1+\eta_j\,\alpha_j}{1+\eta_j},$$

which is (13).

Finally, since

$$\frac{\partial \alpha_{\text{eff},j}}{\partial \eta_j} = \frac{\alpha_j - 1}{(1+\eta_j)^2} < 0,$$

lower $\eta_j$ implies higher effective firm-level returns to scale. □

Proposition 2 shows that a reduction in $\eta_j$—the convexity of the replication cost—acts like an increase in effective firm-level returns to scale: it leaves small firms at the corner $m = 1$, raises $m$ among multi-establishment firms, and does so most strongly for the most productive firms. Employment therefore shifts toward the upper tail of the firm-size distribution. This mechanism is central to our quantitative results.

The mechanism highlighted here does not rely on homothetic demand. Reintroducing subsistence consumption affects equilibrium prices and sectoral demand, but leaves the firm-level mapping from profits to establishment choices unchanged. As a result, the scaling forces described in this section carry over to the full model.

TABLE 2: MODEL PARAMETERS

| Parameter | Description | Value | Target | Data | Model |
|---|---|---|---|---|---|
| | | *Parameters assigned outside the model* | | | |
| $\beta$ | Discount factor | 0.96 | | | |
| $\varepsilon$ | Substitution elasticity | 0.40 | Desmet and Rossi-Hansberg (2014) | | |
| $a_M$, $a_S$ | Sectoral TFP | 1.00 | Normalization | | |
| $\delta_M$ | Exogenous exit rate | 0.08 | Average firm entry and exit rate | | |
| $\delta_S$ | Exogenous exit rate | 0.11 | Average firm entry and exit rate | | |
| $p_S/p_M$ | Relative price of services | 0.64 | BEA value-added price indexes | | |
| | | *Household* | | | |
| $\bar{c}_M$ | Manufacturing subsistence | 0.32 | Goods-share slope wrt log PCE per capita | −0.23 | −0.23 |
| $\mu$ | CES preference weight | 0.09 | Manufacturing employment share | 0.28 | 0.28 |
| | | *Manufacturing* | | | |
| $\mu_M^z$ | Mean log productivity | 1.81 | Average firm size | 73.21 | 74.16 |
| $\sigma_M$ | Productivity volatility | 0.44 | Employment share, firms with 500+ | 0.65 | 0.67 |
| $\mu_{e,M}^z$ | Mean log entrant productivity | 0.27 | Average entrant size | 9.04 | 9.03 |
| $\sigma_{e,M}$ | Entrant productivity dispersion | 0.88 | Entrant firm share with 20+ | 0.03 | 0.03 |
| $\rho_M$ | Productivity persistence | 0.69 | Age 1–5 firm share with 20+ | 0.15 | 0.15 |
| $\alpha_M$ | Establishment returns to scale | 0.53 | Average establishment size | 61.72 | 60.21 |
| $c_{m,M}$ | Replication-cost level | 52.87 | Average establishments per firm | 1.19 | 1.23 |
| $\eta_M$ | Replication-cost convexity | 0.87 | Estab./firm: 500+ relative to <20 | 8.10 | 8.00 |
| $c_{e,M}$ | Entry cost | 386.56 | Free-entry condition | — | — |
| | | *Services* | | | |
| $\mu_S^z$ | Mean log productivity | 0.14 | Average firm size | 16.43 | 16.43 |
| $\sigma_S$ | Productivity volatility | 0.18 | Employment share, firms with 500+ | 0.42 | 0.42 |
| $\mu_{e,S}^z$ | Mean log entrant productivity | 1.95 | Average entrant size | 4.90 | 4.90 |
| $\sigma_{e,S}$ | Entrant productivity dispersion | 0.24 | Entrant firm share with 20+ | 0.01 | 0.01 |
| $\rho_S$ | Productivity persistence | 0.99 | Age 1–5 firm share with 20+ | 0.06 | 0.06 |
| $\alpha_S$ | Establishment returns to scale | 0.47 | Average establishment size | 13.46 | 13.46 |
| $c_{m,S}$ | Replication-cost level | 14.12 | Average establishments per firm | 1.22 | 1.22 |
| $\eta_S$ | Replication-cost convexity | 0.85 | Estab./firm: 500+ relative to <20 | 18.44 | 18.44 |
| $c_{e,S}$ | Entry cost | 94.86 | Free-entry condition | — | — |

# 5 Quantitative Results

This section describes our quantitative results. We first solve the steady state of the model, which we calibrate primarily to BDS moments from 1979, supplemented by a 1982 moment for firms aged one to five. We then present our main experiment, which combines an increase in manufacturing productivity relative to services with a decline in the convexity of replication costs. This experiment reproduces the shift toward large, multi-establishment service firms and accounts for 51.5 percent of the aggregate employment reallocation. We then decompose the results, study counterfactuals, and show robustness to a variety of extensions.

## 5.1 Parameterization

We partition the parameter set into two groups. Those in the first group are assigned outside the model, while parameters in the second group are calibrated to match empirical moments. Table 2 summarizes all parameter values and, for calibrated parameters, the corresponding empirical targets.

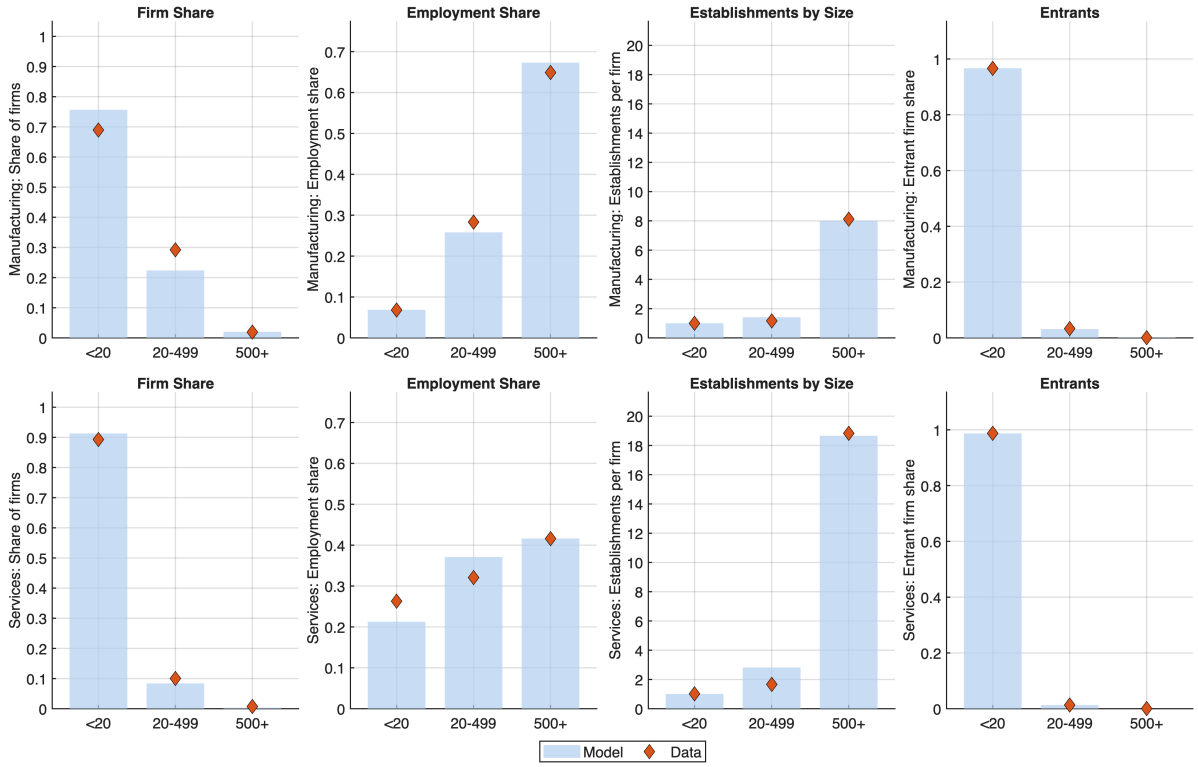
**Fixed parameters.** The model period is one year. We set the discount factor $\beta = 0.96$. The elasticity of substitution between manufacturing and services is set to $\varepsilon = 0.40$, consistent with the structural transformation literature (e.g., Desmet and Rossi-Hansberg, 2014). The sectoral TFP levels $a_M = a_S = 1$ are normalized in the initial steady state. Each sector's exogenous exit is chosen to match the 1979 BDS data. We set the initial relative price of services, $p_S/p_M = 0.64$, equal to the ratio of the BEA value-added price indexes for private service-producing industries and manufacturing.

**Calibrated parameters.** We proceed in two steps. First, we discipline the two remaining preference parameters. The manufacturing subsistence term $\bar{c}_M$ governs how strongly the household's expenditure share on goods declines as expenditure rises. The CES preference weight $\mu$ determines the allocation of spending across manufacturing and services. We pin down the subsistence term using U.S. Personal Consumption Expenditures data.[14] We choose $\mu$ to match the manufacturing employment share in 1979.

Second, we estimate the firm side parameters for manufacturing and services by minimizing the distance between model moments and the corresponding sector-specific BDS targets. Although each targeted firm-level moment is jointly affected by all parameters, we provide a heuristic identification argument that motivates the choice of empirical targets. The mean of log productivity, $\mu_j^z$, shifts the level of firm employment and is therefore pinned down by average firm size. The dispersion of the stationary productivity distribution, $\sigma_j/\sqrt{1-\rho_j^2}$, governs the thickness of the right tail of the firm-size distribution and is disciplined by the employment share of firms with 500 or more employees. The entrant-distribution parameters $(\mu_{e,j}^z, \sigma_{e,j})$ pin down the size distribution at birth, targeted by

[14] Specifically, we estimate a reduced-form time-series relationship between the goods expenditure share, real expenditure per capita, and the relative price of goods to services using annual data from 1970 to 2025. The coefficient of interest is the slope of the goods expenditure share with respect to log real expenditure per capita, holding relative prices fixed. We choose the subsistence term so that the model reproduces the estimated slope of $-0.227$ in the initial steady state. Appendix B.3.2 describes the data construction and reports alternative samples and specifications.

FIGURE 8: INITIAL STEADY-STATE FIT (1979)

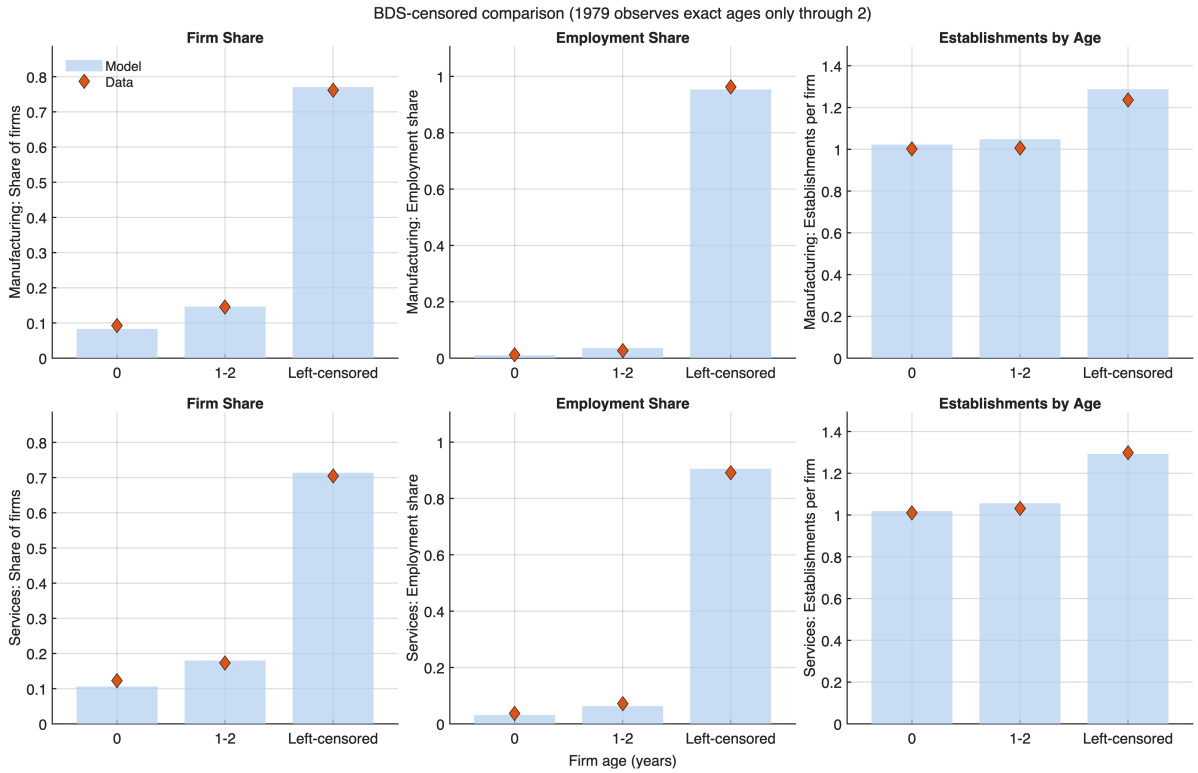



*Notes:* Figure 8 compares the model's initial steady state (1979) to the data for manufacturing and services. The columns show, from left to right, the share of firms by size bin, the employment share by size bin, establishments per firm by size bin, and the entrant firm share by size bin. Diamonds denote the data and bars denote the model.

the average entrant size and the share of entrants with 20 or more employees. The persistence $\rho_j$ governs how quickly entering cohorts converge toward the incumbent distribution; it is identified by the share of firms aged one to five with 20 or more employees.[15] The returns-to-scale parameter $\alpha_j$ is identified by the average establishment size. The replication-cost level $c_{m,j}$ sets the productivity threshold at which operating a second establishment becomes profitable and is therefore disciplined by the average number of establishments per firm, while the convexity $\eta_j$ controls how steeply the establishment count rises with productivity and is identified by establishments per firm among large (500+) relative to small (<20) firms. Finally, the entry costs $c_{e,j}$ are backed out from the free-entry conditions.

[15] We measure this moment in 1982, the first year in which the BDS fully tracks the age 1–5 group.

FIGURE 9: INITIAL STEADY-STATE AGE FIT UNDER BDS CENSORING (1979)

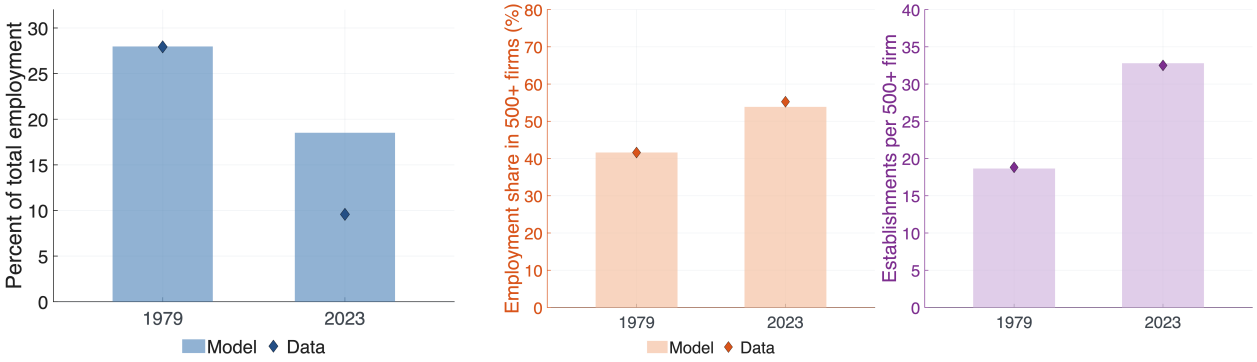



*Notes:* Figure 9 compares the model's initial steady state (1979) to the BDS by firm-age group, for manufacturing (top row) and services (bottom row). The columns show the share of firms, the employment share, and establishments per firm. Bars denote the model and diamonds denote the data. Because the BDS firm-age panel starts in 1977, exact ages in 1979 are observed only for age 0 and ages 1–2; firms aged three and above are pooled into a single left-censored group on both the model and the data side. None of these moments is targeted in the calibration.

**Model fit.** Figure 8 compares the model's 1979 steady state to the data across the three firm-size bins, for manufacturing (top row) and services (bottom row). The four columns show the share of firms in each size bin, the corresponding employment share, establishments per firm, and the entrant firm share by size bin. The model reproduces the high concentration of service firms in the smallest size bin, the much larger employment share of large firms in the manufacturing sector, the steep increase in establishments per firm with firm size in both sectors, and the concentration of entrants in the smallest size bin. Given that only four of the data points shown in Figure 8 were targeted, we see the very good fit between the model and the data as a success of the model.[16]

[16]The targeted moments are the employment share of firms with 500+ employees, the average establishments per firm, the establishments per firm among 500+ firms relative to firms with fewer than 20 employees, and the entrant firm share with 20+ employees.

FIGURE 10: MAIN EXPERIMENT: AGGREGATE REALLOCATION AND LARGE SERVICE FIRMS




(A) Manufacturing employment share

(B) Large service firms

*Notes:* Figure 10 compares the model and the data in 1979 and 2023. Panel (A) reports the manufacturing employment share. Panel (B) reports the two key service-sector distributional moments: the employment share of firms with 500 or more employees (left axis) and establishments per firm among those firms (right axis). Bars denote the model and diamonds denote the data.

Relatedly, Figure 9 reports the model's fit to the firm-age distribution. Because the BDS firm-age panel begins in 1977, in 1979 exact ages are only observed for age 0 and ages 1–2; all older firms are left-censored. We impose the same censoring on the model by pooling firms aged three and above into a single left-censored group. The model reproduces the untargeted age profile remarkably well in both sectors. Because these moments played no role in the calibration, their close fit provides a strong independent validation of the model's firm-dynamics mechanism.[17]

## 5.2 Main Experiment: Structural Transformation and the Expansion of Large Service Firms

The empirical evidence in Section 2 highlighted that a defining feature of structural transformation was that employment increasingly became concentrated in large incumbent service firms that expanded by operating more establishments. Our main experiment asks whether the model can account simultaneously for these aggregate and firm-level dimensions of structural transformation.

We consider two forces. First, we increase manufacturing productivity relative to services, the standard mechanism emphasized in the structural-transformation literature. This force raises the

[17] The only targeted age moment is the share of firms aged one to five with 20 or more employees used to discipline productivity persistence.

relative price of services and reallocates employment toward that sector. By Proposition 1, however, its reach is limited: the equilibrium price adjustment absorbs the productivity change, leaving firm policies—and hence the firm-size distribution—unchanged. Second, motivated by Proposition 2, we lower the convexity of establishment-replication costs. This raises effective firm-level returns to scale and disproportionately expands establishments among high-productivity firms.

We compare the calibrated 1979 steady state with a counterfactual 2023 steady state. We choose the increase in manufacturing productivity to match the change in the relative price of services and choose the replication-cost change to match the rise in establishments per firm among large relative to small service firms. All other primitives remain fixed.

Figure 10 summarizes the main result. In the data, the manufacturing employment share fell from 27.93 percent in 1979 to 9.57 percent in 2023; the two forces together account for 51.5 percent of this decline. At the same time, establishments per firm among large service firms rise from 18.7 to 32.8, matching the data. As a consequence, the employment share of large service firms rises from 41.6 percent to 53.9 percent, very close to the observed increase in the data, although untargeted. The main experiment therefore matches both the aggregate reallocation of employment and the firm-level mechanism that underlies it. Appendix Figure B.1 reports the full fit across firm-size bins.

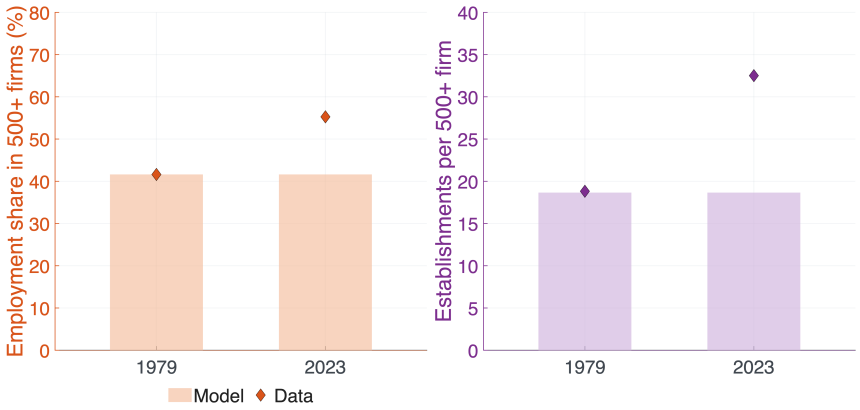
## 5.3 Counterfactual Decomposition

We next assess the roles of manufacturing productivity and replication costs using counterfactuals in which each force changes in isolation. The two counterfactuals are disciplined independently, and each triggers its own equilibrium price adjustment. Thus, the results should not be interpreted as an additive decomposition of the main experiment.

**Manufacturing productivity only.** We first let manufacturing productivity be the only parameter that changes between 1979 and 2023. Targeting the relative price of services delivers an increase in $A_M$ by a factor of 1.55.[18]

[18]BLS data show that manufacturing labor productivity grew substantially faster than in most service industries over this period. A simple growth-accounting calculation based on these data implies that manufacturing productivity increased by about 2.3–2.7 times since 1980. However, part of this gap likely reflects measurement differences across sectors, as service output is more difficult to quantify and quality improvements are imperfectly captured. In addition,

FIGURE 11: MANUFACTURING PRODUCTIVITY ONLY: LARGE SERVICE FIRMS



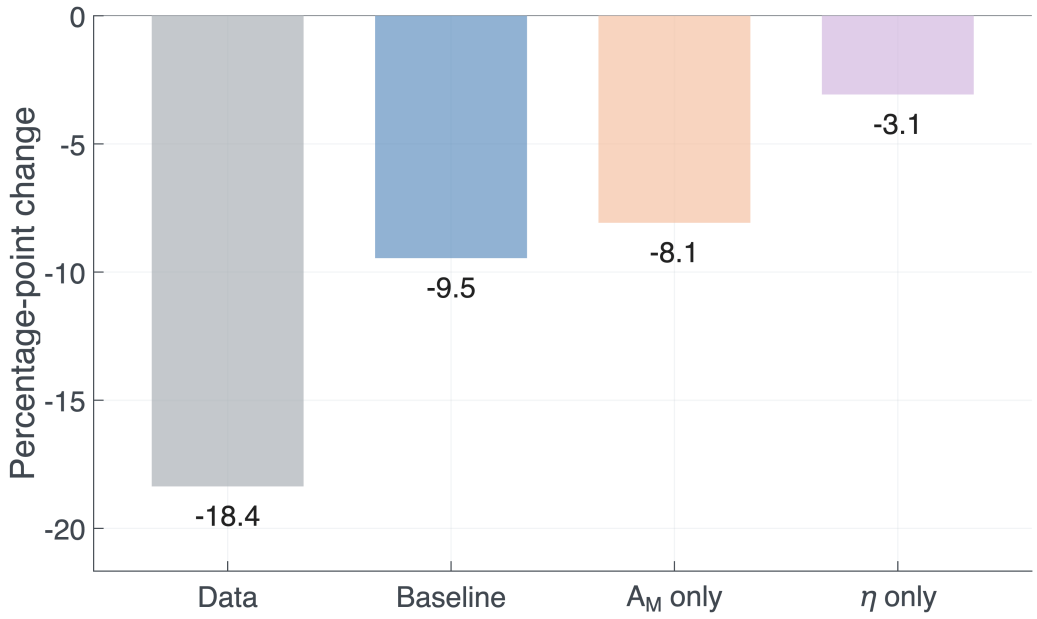

*Notes:* Figure 11 compares the employment share of service firms with 500 or more employees (left axis) and establishments per firm among those firms (right axis) in 1979 and 2023. Bars denote the model and diamonds denote the data.

Although this counterfactual reallocates aggregate employment toward the service sector, it does not replicate the key microeconomic patterns highlighted in the data. The manufacturing employment share falls from 27.97 percent to 19.89 percent, so the increase in manufacturing productivity relative to services on its own accounts for 44.0 percent of the observed decline. On the service side, however, the counterfactual produces essentially nothing. As Figure 11 shows, the employment share of large service firms is unchanged at 41.6 percent, against 55.3 percent in the data, and establishments per firm among large service firms remain at 18.7 rather than rising to the 32.5 observed in 2023. This force alone thus misses the underlying margin through which structural transformation takes place in the data.

The ability of firms to choose their number of establishments plays an important role. In a version of the model where one firm consists of one establishment ($m = 1$), an increase in manufacturing productivity relative to services results in a more than one-for-one offset of the manufacturing price $p_M$ and the service price $p_S$. The reason is that free entry is pinned down in final-good units. While firm-level labor demand depends on the composite term $p_j a_j$, the free-entry condition equates the value of entry to $Pc_{e,j}$, where $P$ is the final-good price index. A fall in $p_M$ lowers $P$ only partially, since $P$ is a CES aggregate of both sectoral prices. Without multi-

evidence based on long-run movements in relative prices suggests a somewhat smaller differential: the relative price of manufactured goods has declined persistently over time, consistent with faster productivity growth in the manufacturing sector, but at a rate that implies a cumulative increase closer to a factor of about two.

FIGURE 12: MANUFACTURING EMPLOYMENT-SHARE DECLINE ACROSS EXPERIMENTS




*Notes:* Figure 12 reports the percentage-point decline in the manufacturing employment share between 1979 and 2023 in the data, the main experiment (baseline), the manufacturing-productivity-only counterfactual ($A_M$ only), and the replication-cost-only counterfactual ($\eta$ only).

establishment firms, this results in smaller firms throughout the size distribution, including lower employment by large firms, because the composite term $p_j a_j$ declines. With multi-establishment firms, the drop in $P$ lowers the cost of having many establishments. Especially for large firms that are above the $m = 1$ threshold, this increases their number of establishments and offsets the negative effects on their employment share.

**Replication costs only.** The second counterfactual holds manufacturing productivity fixed at its 1979 level and lets only the convexity of the replication cost fall. The decline is proportionally the same in both sectors, and its size is disciplined by establishments per firm among large (500+) relative to small (<20) service firms in 2023. This delivers a scaling factor of 0.70, so that $\eta_M$ falls from 0.87 to 0.60 and $\eta_S$ from 0.85 to 0.59.

This counterfactual reproduces the service-sector margins that the increase in manufacturing productivity relative to services could not: establishments per firm among large service firms rise from 18.7 to 32.6, essentially matching the 32.5 in the data, and average establishments per service firm rise from 1.22 to 1.33, against 1.37 in the data. The employment share of large service firms

rises from 41.6 percent to 68.9 percent, now overshooting the 55.3 percent observed in 2023. The counterfactual also generates aggregate reallocation: the manufacturing employment share falls from 27.97 percent to 24.90 percent, accounting for 16.7 percent of the observed decline (see the $\eta$-only bar in Figure 12).

The two counterfactuals thus play complementary roles. Manufacturing productivity moves employment across sectors but does not affect the firm-size distribution. Lower replication costs reshape the service firm-size and establishment distributions and, in doing so, shift employment toward services. Neither force alone reproduces both the aggregate reallocation and the firm-level facts.

Figure 12 summarizes the aggregate implications of the three experiments on a common scale. Manufacturing productivity accounts for most of the decline generated by the main experiment. The replication-cost channel, however, matters in the aggregate as well: on its own it accounts for 16.7 percent of the observed decline—roughly one third of the reallocation explained by the model—in addition to reshaping the service-firm distribution.

## 5.4 Adding Labor Force Growth

The experiments considered in Sections 5.2 and 5.3 hold aggregate labor supply fixed, thereby isolating the compositional effect of the two forces. In the data, however, total employment grew substantially over this period. Recent work shows that changes in aggregate employment can be an important source of service-sector growth (Duarte and Restuccia, 2026). Our final experiment repeats the main experiment while scaling aggregate labor supply by the BDS total employment growth between 1979 and 2023, a factor of 1.88.

The estimated parameters are unchanged: $A_M$ still rises by a factor of 1.57, and the replication-cost scaling factor is still 0.70. This is because both parameters are identified from the relative service price and from establishments per firm among large relative to small service firms, and neither moment depends materially on the level of aggregate labor supply. The service-sector margins are correspondingly unchanged: the employment share of large service firms reaches 53.9 percent, and establishments per firm among large service firms reach 32.8.

By contrast, the aggregate implications of the model change substantially. With a growing

TABLE 3: SUMMARY OF QUANTITATIVE EXPERIMENTS

| | Experiment | | | | |
|---|---|---|---|---|---|
| | (1) $A_M, \eta$ | (2) $A_M$ | (3) $\eta$ | (4) $+\bar{L}$ | Data 2023 |
| *Parameters* | | | | | |
| $A_M$ (factor, 1979 = 1) | 1.57 | 1.55 | 1.00 | 1.57 | |
| Replication-cost scaling | 0.80 | 1.00 | 0.70 | 0.80 | |
| $\eta_S$ | 0.67 | 0.85 | 0.59 | 0.67 | |
| Labor supply $\bar{L}$ | 1.00 | 1.00 | 1.00 | 1.88 | |
| *Aggregate* | | | | | |
| Manuf. emp. share (%) | 18.52 | 19.89 | 24.90 | 14.79 | 9.57 |
| Share of decline explained (%) | 51.5 | 44.0 | 16.7 | 71.8 | |
| *Service sector* | | | | | |
| Emp. share, large firms (%) | 53.9 | 41.6 | 68.9 | 53.9 | 55.3 |
| Estabs./firm, 500+ | 32.8 | 18.7 | 32.6 | 32.8 | 32.5 |
| Avg. estabs./firm | 1.28 | 1.22 | 1.33 | 1.28 | 1.37 |

*Notes:* Table 3 summarizes the four experiments. All experiments start from the common 1979 steady state, in which the manufacturing employment share is 27.97 percent, the employment share of large service firms is 41.6 percent, establishments per firm among large service firms is 18.7, and average establishments per service firm is 1.22. Column (1) is the paper's main experiment and varies both manufacturing productivity and the convexity of replication costs. Columns (2) and (3) vary each force in isolation. Column (4) repeats the main experiment while scaling aggregate labor supply by BDS total employment growth between 1979 and 2023. Free parameters are disciplined by the relative price of services and by establishments per firm among large (500+) relative to small (<20) service firms. "Share of decline explained" is the model's fall in the manufacturing employment share as a fraction of the 27.97-to-9.57 percent decline in the data.

labor force, the manufacturing employment share falls from 27.97 percent to 14.79 percent rather than to 18.52 percent, so the model now accounts for 71.8 percent of the observed decline instead of 51.5 percent. Table 3 collects the results of all four experiments. Labor force growth is thus quantitatively important for the aggregate reallocation while being irrelevant for the firm-level moments: the micro margins the paper emphasizes are identified independently of how much the labor force grew.

# 6 Interpreting the Decrease in $\eta$

We view the decrease in $\eta$ in the service sector as a parsimonious stand-in for a broader set of historical changes that reduced the cost of replicating and managing service production across establishments. Examples include ICT adoption, inventory and logistics technologies, standardization of operating procedures, improved knowledge transfer within chains and franchises, and organizational innovations that widened spans of control. A small literature documents each of these channels, even if it does not estimate our exact structural parameter.

The common theme in these papers is that service production became easier to codify, coordinate, and roll out across locations. Hsieh and Rossi-Hansberg (2023) are the closest to our interpretation: they argue that new ICT-type technologies enabled service firms to replicate the same production process across many local markets, helping top firms expand geographically. In our framework, this is naturally captured as a decline in the convexity of establishment replication costs.

The literature on retail firms provides more concrete examples of the underlying channels. Holmes (2001) shows that barcode technology and modern inventory systems complemented frequent deliveries and supported the rise of large-scale retail formats, while Basker (2012) documents substantial productivity gains from barcode scanners. Both findings point to lower operating and coordination costs at the establishment level. Holmes (2011) adds that multi-store chains benefit from economies of density, so that running additional nearby establishments becomes cheaper as the network expands. This is exactly the type of force that would make the cost of adding establishments less convex.

Finally, Bloom et al. (2014) show that information and communication technologies changed internal firm organization by increasing decentralization and widening spans of control. That evidence speaks directly to the managerial side of our mechanism: if firms can monitor, coordinate, and transfer knowledge across units more effectively, then multi-establishment expansion becomes easier. Taken together, these papers suggest that the estimated decline in $\eta$ should be interpreted as a reduced-form summary of several technological and organizational changes that increased the scalability of large service firms. This interpretation is also consistent with the broader evidence in Cao et al. (2022), Foster et al. (2006), and Jarmin et al. (2009) that U.S. firm growth has increasingly

occurred through the addition of establishments, especially among large chains.

Prior work documents that replication costs have fallen over recent decades. The remainder of this section shows which margin this decline is associated with: growth in establishments per firm, concentrated among large firms.

**Suggestive evidence.** We use two proxies for replication costs.[19] The first is IT capital per worker, computed as BEA nonresidential IT capital (computers, communications equipment, and software) per employee. The intuition is that information technology—centralized inventory, payroll, and accounting systems—requires a large up-front investment at the firm level but, once installed, sharply lowers the cost of operating each additional establishment, enabling firms to expand across many local markets.

The second proxy is the share of employment in office and administrative support occupations (bookkeepers, payroll clerks, data entry operators), measured at the 2-digit NAICS level using BLS data. These tasks are arguably easy to codify and centralize: a single back office running standardized software can replace clerks who previously sat in each location. As this codification progresses, the office and administrative support share of employment declines.

Figure 13 plots both series. IT capital per worker rises sharply over 1990–2023 in both manufacturing and services, while the office and administrative support share declines over 2002–2023 in both broad sectors.

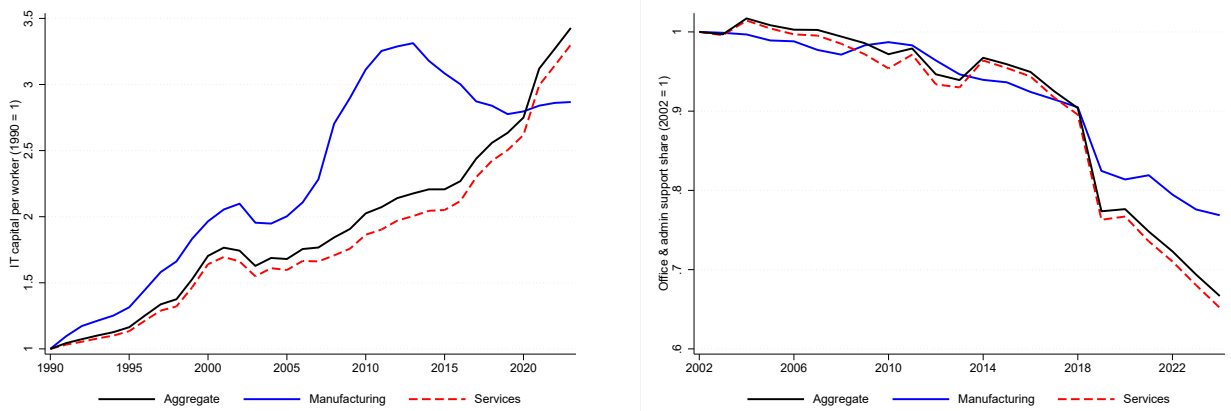
We study the association between these proxies and several margins of industry-level growth by estimating:

$$\ln Y_{ist} \;=\; \beta\, X_{it} \;+\; \gamma\, X_{it}\cdot \mathbf{1}\{s = L\} \;+\; \alpha_i + \alpha_s + \delta_t + \varepsilon_{ist}, \tag{14}$$

where $Y$ is either firm count, establishments per firm, or employment per establishment; $i$ indexes 3-digit NAICS industries; $s \in \{S, L\}$ denotes firm-size bins (small: fewer than 500 employees, large: 500 or more); $t$ indexes years. $X$ is the first difference of the proxy. To facilitate interpretation, we standardize $X$ to have mean zero and standard deviation of one, so that coefficients represent the effect of a one-standard-deviation change in the proxy. We include industry, size, and year fixed effects and weight observations by employment.

[19] We use BEA IT capital data starting from 1990, when establishments per firm began growing rapidly in the services sector. BLS occupational employment data by NAICS industry are available starting in 2002.

FIGURE 13: REPLICATION COST PROXIES: AGGREGATE TRENDS




(A) IT capital per worker

(B) Office and admin. support share

*Notes:* Figure 13 plots the two replication-cost proxies. Panel (A): BEA nonresidential IT capital (computers, communications equipment, and software) divided by BDS employment, normalized to 1 in 1990 (1990–2023). Panel (B): BLS employment in office and administrative support occupations as a share of total employment, normalized to 1 in 2002 (2002–2023). Both panels plot manufacturing, services, and the aggregate. Data source: BEA, BLS, BDS.

Table 4 reports the results. For each margin we show an industry-level specification (odd columns) and one with a firm-size interaction (even columns). The data reveals that the link between the proxies and growth through establishments is special. A one-standard-deviation increase in IT intensity growth is associated with a 0.088 log-point increase in establishments per firm for large firms relative to small firms (Panel A, column 4). Similarly, a one-standard-deviation decline in office and administrative support share is associated with a 0.088 log-point increase in establishments per firm for large firms relative to small firms (Panel B, column 4). We do not find robust support for an association between the two proxies and firm count growth or average establishment size.

These findings corroborate the key mechanism in the paper: a fall in replication costs leads to an increase in the number of establishments per firm, concentrated among large firms. We note that empirical results reported in this section are purely descriptive and should be interpreted as suggestive evidence.

TABLE 4: REPLICATION-COST PROXIES AND MARGINS OF INDUSTRY GROWTH

| | ln(firms) | | ln(estab/firm) | | ln(emp/estab) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Panel A:* $X = \Delta \log(IT/emp)$ | | | | | | |
| $X$ | 0.010 | 0.017 | 0.017*** | -0.037 | 0.000 | -0.030* |
| | (0.006) | (0.033) | (0.004) | (0.026) | (0.004) | (0.016) |
| $X\times$ large | | 0.009 | | 0.088** | | 0.055*** |
| | | (0.043) | | (0.035) | | (0.021) |
| Industry FE | Y | Y | Y | Y | Y | Y |
| Size FE | | Y | | Y | | Y |
| Year FE | Y | Y | Y | Y | Y | Y |
| Observations | 1782 | 3539 | 1782 | 3539 | 1782 | 3539 |
| *Panel B:* $X = \Delta$(*office & admin share*) | | | | | | |
| $X$ | 0.007** | 0.020 | -0.004*** | 0.043** | 0.003 | 0.012 |
| | (0.003) | (0.021) | (0.002) | (0.017) | (0.002) | (0.010) |
| $X\times$ large | | -0.027 | | -0.088*** | | -0.021 |
| | | (0.028) | | (0.023) | | (0.013) |
| Industry FE | Y | Y | Y | Y | Y | Y |
| Size FE | | Y | | Y | | Y |
| Year FE | Y | Y | Y | Y | Y | Y |
| Observations | 1565 | 3118 | 1565 | 3118 | 1565 | 3118 |

*Notes:* Table 4 reports OLS estimates of equation (14). Odd columns pool across firm sizes; even columns interact $X$ with a large-firm indicator (small size category is omitted). Panel A: 3-digit NAICS industries matched to BEA IT data, 1990–2023. IT capital includes computers, communications equipment, and software. Panel B: 3-digit NAICS industries matched to BLS office and administrative support share, 2002–2023. Industry, size, and year fixed effects are included. Standard errors are reported in parentheses. Observations are weighted by employment. *, **, ***: significance at the 10, 5, and 1 percent levels.

# 7 Conclusion

In this paper, we study structural transformation through the lens of firm dynamics. Using the BDS data, we show that the long-run reallocation of employment from the manufacturing sector to the service sector is not primarily an entry phenomenon. Instead, it is driven by the expansion of large incumbent service firms, which grow primarily by opening additional establishments. The decline of manufacturing employment mirrors this pattern: it is concentrated among large incumbents, which shrink over time.

Guided by these facts, we develop a two-sector general equilibrium model in which firms grow both by expanding existing establishments and by adding new ones. The model clarifies why the standard productivity channel cannot generate the firm-level facts: under free entry, sectoral productivity growth is absorbed by equilibrium price adjustment and leaves the firm-size distribution unchanged. A decline in replication costs, by contrast, is scale-biased and expands large incumbents through new establishments.

Quantitatively, the two forces together account for more than half of the observed decline in the manufacturing employment share and reproduce the rise in the employment share of large service firms as well as the increase in establishments per firm among them. Lower replication costs alone account for about 17 percent of the sectoral reallocation—roughly one third of what the model explains. Structural transformation thus reflects not only sectoral forces but also a microeconomic mechanism: the ability of incumbent firms to replicate production across establishments.

More broadly, our results suggest that long-run changes in the sectoral composition of employment reflect changes in the organization of production within firms. The rise of services is not simply a story of more service firms; it is a story of existing firms replicating themselves across locations. Bringing this margin into models of structural change is essential for explaining who built the service economy.

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# A Additional Figures and Tables

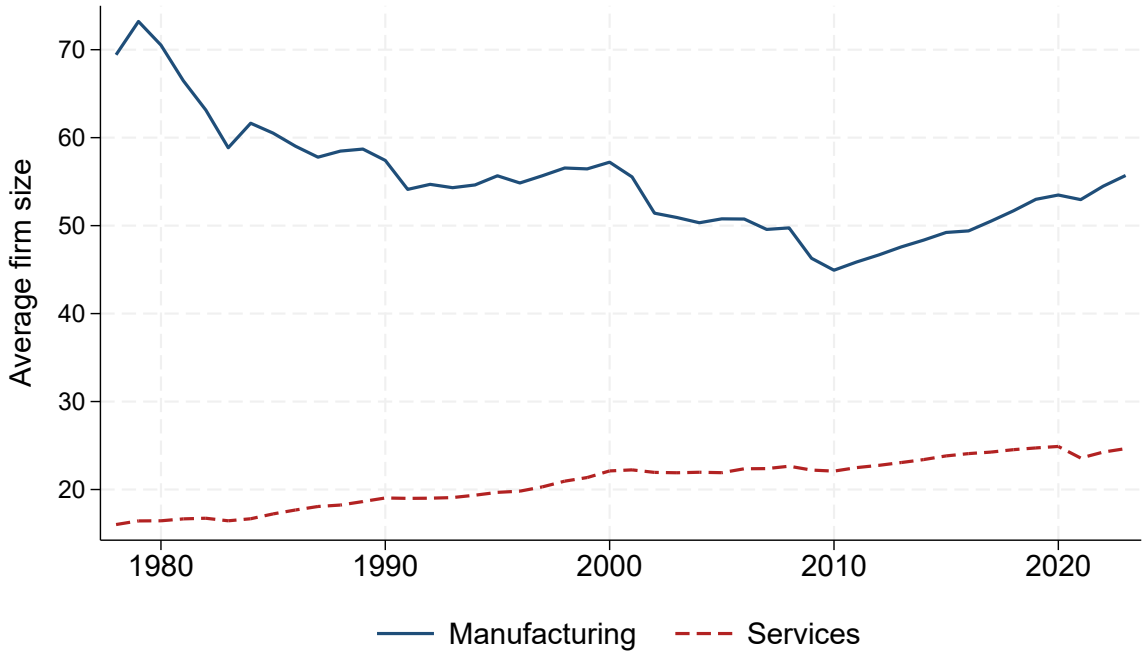
Table A.1 shows our baseline definition of service, manufacturing, and other sectors.

TABLE A.1: SECTOR CLASSIFICATION

| Code | Sector Name | Category |
|---|---|---|
| 11 | Agriculture, Forestry, Fishing and Hunting | Other |
| 21 | Mining, Quarrying, and Oil and Gas Extraction | Other |
| 22 | Utilities | Other |
| 23 | Construction | Other |
| 31–33 | Manufacturing | Manufacturing |
| 42 | Wholesale Trade | Services |
| 44–45 | Retail Trade | Services |
| 48–49 | Transportation and Warehousing | Services |
| 51 | Information | Services |
| 52 | Finance and Insurance | Services |
| 53 | Real Estate and Rental and Leasing | Services |
| 54 | Professional, Scientific, and Technical Services | Services |
| 55 | Management of Companies and Enterprises | Services |
| 56 | Administrative and Support and Waste Management Services | Services |
| 61 | Educational Services | Services |
| 62 | Health Care and Social Assistance | Services |
| 71 | Arts, Entertainment, and Recreation | Services |
| 72 | Accommodation and Food Services | Services |
| 81 | Other Services (except Public Administration) | Services |

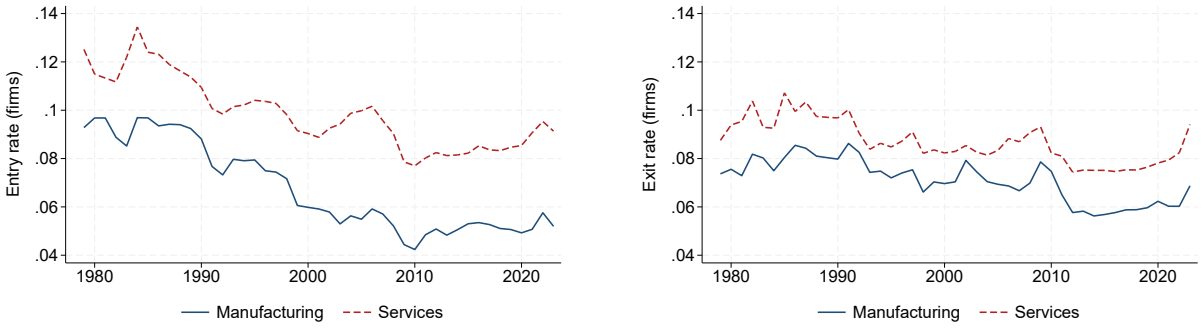
*Notes:* Table A.1 shows how sectors in BDS data map into manufacturing, services and other groups.

FIGURE A.1: AVERAGE FIRM SIZE




*Notes:* Figure A.1 shows the evolution of the average firm size in the manufacturing and service sectors. Data source: BDS.

FIGURE A.2: ENTRY AND EXIT RATES

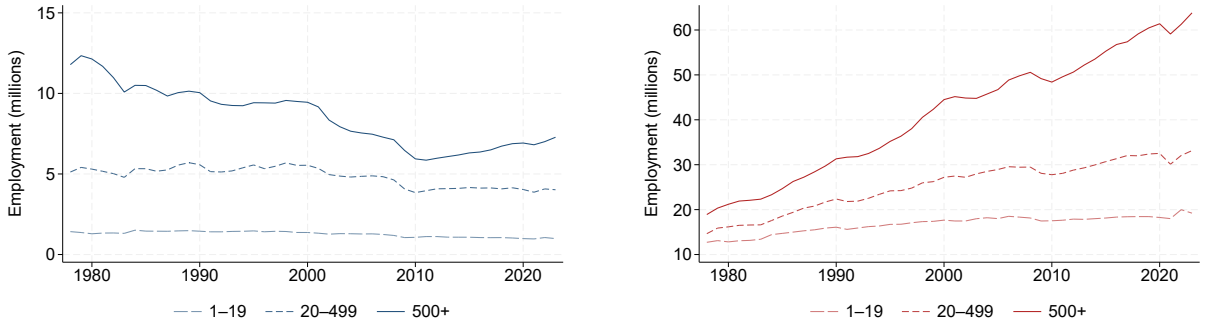



(A) Sectoral entry rates

(B) Sectoral exit rates

*Notes:* Figure A.2 plots entry and exit rates for manufacturing and services sectors. The entry rate is defined as the number of entrants in a sector as a fraction of all firms in a sector. The exit rate is defined as the number of exiting firms as a fraction of all firms that were active in the previous year. Data source: BDS.

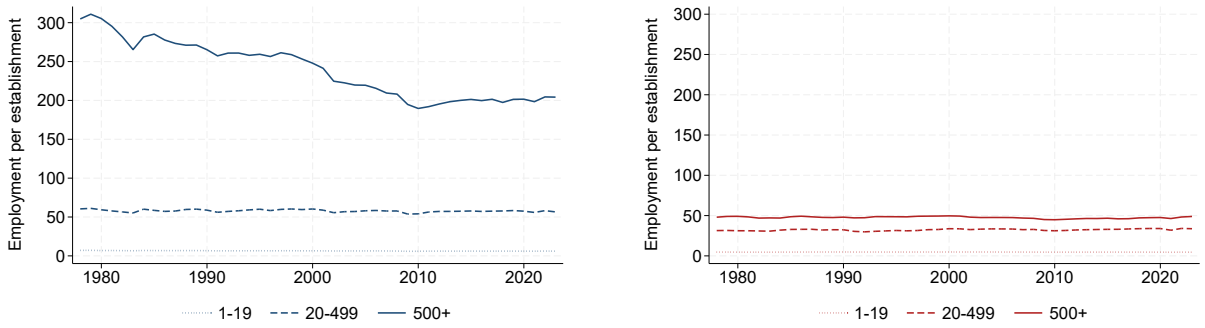
FIGURE A.3: SECTORAL EMPLOYMENT BY INITIAL SIZE GROUP




(A) Manufacturing (B) Services

*Notes:* Figure A.3 shows the evolution of the employment by initial size group in the manufacturing and service sectors. Data source: BDS.

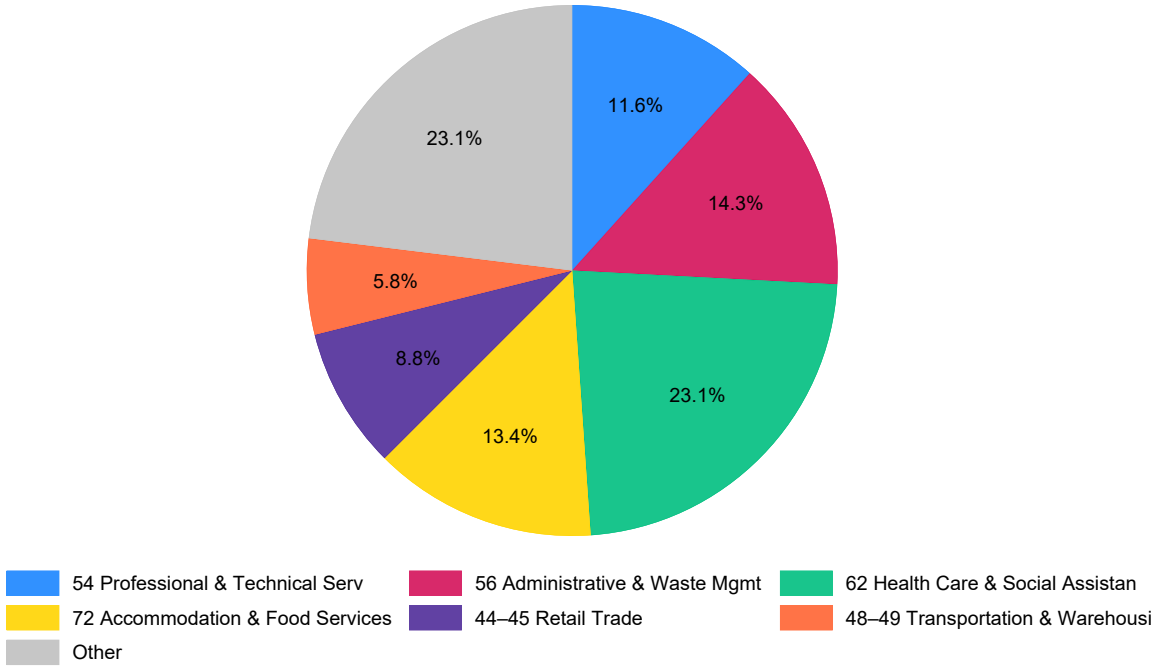
FIGURE A.4: EMPLOYMENT PER ESTABLISHMENT




(A) Emp. per establishment, manufacturing (B) Emp. per establishment, services

*Notes:* Figure A.4 plots the average number of employees per establishment by firm size group. Data source: BDS.

FIGURE A.5: SERVICE-SECTOR EMPLOYMENT GAINS BY SUBSECTOR




*Notes:* Figure A.5 shows the changes in total service-sector employment between 1978 and 2023 broken down by subsector. Slices show each subsector's share of total gains; slices below 5 percent are grouped as Other. Data source: BDS.

# B Model

## B.1 Equilibrium with Wage-Denominated Costs

This subsection states the stationary equilibrium conditions for the case $x = W$. The objects of equilibrium are the same as in the main text, except that there is no additional final-good demand from firms' cost payments. In particular, fixed, entry, and replication costs use labor directly rather than the final consumption bundle.

The household problem, firm decision rules, and free-entry condition are unchanged except that (12) becomes

$$\mathbb{E}_{\pi_{e,j}}[V_j(z)] = W c_{e,j}.$$

Goods markets therefore clear without an additional final-good-demand term:

$$M_M \int Y_M(z)\, \mathrm{d}\mu_M(z) = C_M, \qquad M_S \int Y_S(z)\, \mathrm{d}\mu_S(z) = C_S.$$

By contrast, labor market clearing includes labor used in production as well as the labor resources absorbed by fixed, replication, and entry costs:

$$\sum_{j\in\{M,S\}} M_j \left( \int \left[ \ell_j(z) m_j(z) + f_j + G(m_j(z)) \right] \mathrm{d}\mu_j(z) + c_{e,j} \right) = \bar{L}.$$

Finally, aggregate dividends equal flow profits net of entry costs, which are now denominated in labor units:

$$\Pi = \sum_{j\in\{M,S\}} M_j \left( \int \Pi_j(z)\, \mathrm{d}\mu_j(z) - W c_{e,j} \right).$$

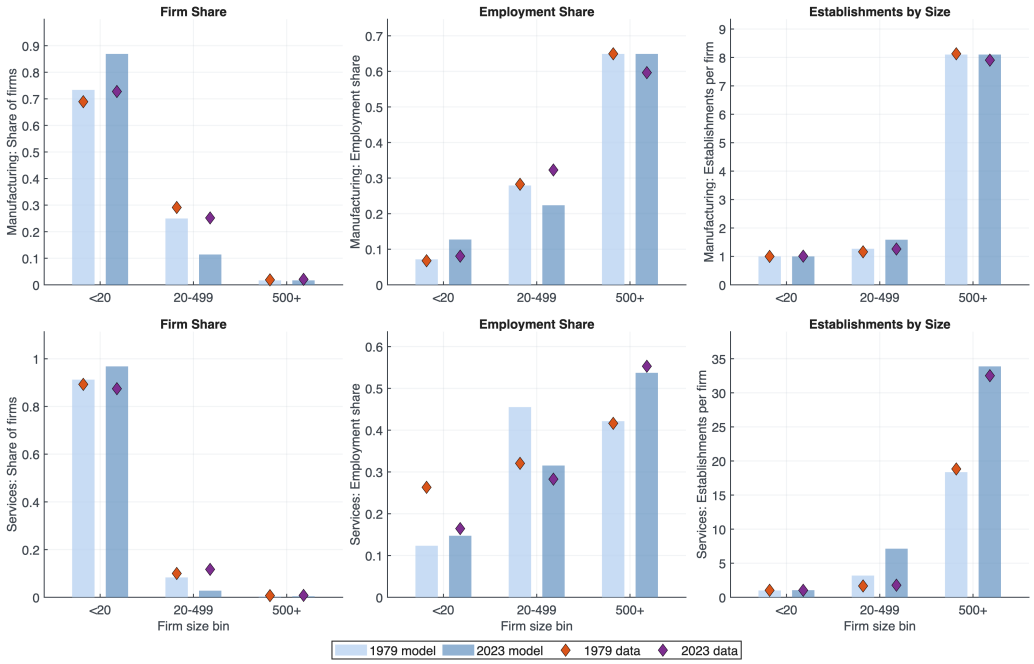
## B.2 Computational Details

### B.2.1 Outline of the Algorithm

The only state variable is idiosyncratic productivity. We discretize the AR(1) productivity process and then solve the static establishment and labor choices analytically at each grid point. For a given sector and a candidate output price, the algorithm proceeds as follows:

1. Compute optimal labor per establishment and variable profit for each productivity state.
2. Given variable profit, solve analytically for the optimal number of establishments $m^*(z)$.
3. Construct flow profits and solve the incumbent Bellman equation on the discretized Markov chain.
4. Under exogenous exit, the continuation operator is linear and the value function is obtained in closed form. Under endogenous exit, the code iterates on the Bellman equation until convergence.
5. Back out the sector-specific entry cost $c_{e,j}$ from the free-entry condition in the initial steady state.

FIGURE B.1: MAIN EXPERIMENT: FULL DISTRIBUTIONAL FIT




*Notes:* Figure B.1 compares the main experiment with the corresponding data for 1979 and 2023. The left column shows the share of firms by size bin, the middle column shows the employment share by size bin, and the right column shows establishments per firm by size bin. Bars denote the model and diamonds denote the data.

6. For counterfactual exercises, bisect over the sectoral output price until the free-entry condition holds at the previously backed-out entry cost.

The stationary distribution is then computed analytically from the transition matrix and the entrant distribution. The model solves each sector per unit mass of entrants and finally pins down the sectoral masses of firms from market-clearing conditions.

### B.2.2 Stationary Aggregation

Let $\mathbf{Q}_j$ denote the Markov transition matrix for sector $j$ after imposing exogenous survival or endogenous exit decisions, and let $\pi_{e,j}$ denote the entrant distribution over productivity states. For a unit entrant mass, the stationary distribution satisfies:

$$\mu_j = (\mathbf{I} - \mathbf{Q}_j')^{-1}\pi_{e,j}.$$

Aggregating over this distribution yields gross output, labor demand, dividends, and model moments per unit mass of firms in each sector. The overall sectoral masses are then chosen so that labor market clearing and the two goods-market conditions hold in general equilibrium. When costs are denominated in the final good, fixed, entry, and replication costs generate additional final-good demand from firms' cost payments, allocated across sectors using the same CES expenditure shares as household consumption. When costs are denominated in labor, these costs instead enter labor demand directly.

TABLE B.1: EXPENDITURE-SHARE REGRESSIONS

| Specification | Sample | Coefficient on log real expenditure per capita | Std. error |
|---|---|---|---|
| Full sample | 1959–2025 ($N = 67$) | −0.184 | (0.021) |
| Baseline | 1970–2025 ($N = 56$) | −0.227 | (0.045) |
| Restricted sample | 1979–2025 ($N = 47$) | −0.103 | (0.058) |
| With linear time trend | 1959–2025 ($N = 67$) | −0.171 | (0.040) |

## B.3 Additional Quantitative Results

### B.3.1 Full Distributional Fit of the Main Experiment

Figure B.1 reports the main experiment's fit across all three firm-size bins. It complements the distilled outcomes emphasized in the main text by showing the firm share, employment share, and establishments per firm in manufacturing and services.

### B.3.2 Calibration of Non-Homothetic Demand

This appendix explains how we discipline the manufacturing subsistence term in household demand. The goal is to measure how the expenditure share on goods changes as real expenditure per capita rises, after accounting for movements in relative prices.

We use annual U.S. Personal Consumption Expenditures data from the Bureau of Economic Analysis and population estimates from the Census Bureau. From BEA Table 2.4.5U we collect total personal consumption expenditures, goods expenditures, and services expenditures. From BEA Table 2.4.4U we collect the overall PCE price index, the goods price index, and the services price index. We then construct three objects: the expenditure share on goods, real expenditure per capita, and the relative price of goods to services. The baseline specification regresses the goods expenditure share on log real expenditure per capita and the log relative price of goods to services, using annual data from 1970 to 2025. We treat goods as an empirical proxy for manufacturing.

The estimate of interest is the coefficient on log real expenditure per capita. A more negative coefficient means that, conditional on relative prices, higher expenditure per capita is associated with a lower goods expenditure share and therefore stronger reallocation toward the service sector. In the model, the manufacturing subsistence term is chosen so that the initial steady state reproduces this local expenditure-share slope. We then use the manufacturing employment share to pin down the remaining demand-side weight on supernumerary expenditure.

Table B.1 reports the baseline estimate together with simple robustness checks. Our benchmark calibration uses the 1970–2025 specification, which yields a slope of −0.227. The results consistently imply a negative relationship between the goods expenditure share and real expenditure per capita.