AEA Papers and Proceedings 2021, 111: 587–592
https://doi.org/10.1257/pandp.20211121

The Life Cycle of Businesses and Their Internal Organization†

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Existing research has established that businesses tend to start small and grow as they become older (e.g., Dunne, Roberts, and Samuelson 1989; Haltiwanger, Jarmin, and Miranda 2013). The emergence of detailed datasets of US employers has allowed economists to make significant advances in better understanding the underlying mechanisms of the relationship between business size and age. Despite these advances, we know far less about the occupational structure of employers.

We document new stylized facts on the occupational mix of businesses in the United States and on how their internal organization evolves over their life cycles. The analysis is based on a large establishment-level dataset combining high-quality survey data on the occupational mix of employers with administrative data on their longitudinal dynamics. Previous research studying the internal organization of businesses mostly uses specialized datasets of a few businesses or the manufacturing sector (Garicano and Rossi-Hansberg 2015). Our data are representative of the US economy (including the service and retail sectors) and cover businesses over the past two decades.

Our main empirical finding is that younger businesses have fewer hierarchical layers and lower span of control than comparable older businesses. Our results suggest that businesses become more hierarchical and increase their managerial span of control over their life cycles. We show that this pattern is not entirely driven by selection and is pervasive across sectors and cohorts.

Our results help shed light on the underlying mechanisms driving the life cycle dynamics of businesses (such as the role of organizational capital proposed by Atkeson and Kehoe 2005) and organizational economics (Calvo and Wellisz 1978, Lucas 1978, Garicano and Rossi-Hansberg 2015). We show that the association between internal organization and business age is not entirely driven by businesses' tendency to grow, suggesting that the ability of businesses to communicate, coordinate, and adjust to shocks changes as they age, irrespective of their size.

I. Data

We assemble a unique dataset by combining the confidential microdata of the Occupational Employment Statistics (OES) semiannual surveys from November 2002 through May 2017 with the administrative employment and wage records of the Quarterly Census of Employment and Wages (QCEW) for private sector establishments from 1992 through the first quarter of 2020. The OES survey provides high-quality information on detailed occupation and wage distributions for a large sample of establishments at one or more times during their life cycles. The QCEW records contain the geographic location, industry, and quarterly total employment and wages for the near universe of private sector establishments operating in the United States. This combination of data allows us to observe the occupations and wages of workers at least once for about 1.8 million establishments with known ages.[1]

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† Go to https://doi.org/10.1257/pandp.20211121 to visit the article page for additional materials and author disclosure statement(s).

[1] From the QCEW we identify the "birth cohort" for establishments that make a first appearance in the data after 1992, and thus we can determine their age at any point in their life cycle. The combined data allows us to observe occupation and wage distributions at some "age" at least a year after "birth" and follow the survival and growth of these establishments over time.

Table 1—Descriptive Statistics

	All				Age $\leq$ 3			
	Observations	Mean	SD	[P25, P75]	Observations	Mean	SD	[P25, P75]
Total employment	3,043,742	11.43	54.24	[1, 9]	626,518	7.05	23.51	[1, 6]
Layers	3,043,742	1.44	0.65	[1, 2]	626,518	1.33	0.57	[1, 2]
Span of control	1,794,551	7.51	12.36	[3, 9]	300,115	6.59	10.00	[2, 8]

Notes: The first set of columns summarize descriptive statistics for the entire dataset used in our analysis, covering about 1.8 million unique establishments. The second set of columns reports statistics for about half a million establishments that answered the OES survey at least once during their first three years. The table reports number of observations, the average, the standard deviation, and the percentiles 25 and 75. All statistics are weighted.

Our baseline analysis is conducted at the establishment level because the unit of observation in the OES is the establishment. Throughout the analysis, we use benchmarked weights and detailed imputations to account for the complex stratified sample design and differential patterns of nonresponse of the OES.[2]

We summarize the internal organization of establishments using two variables that capture the number of hierarchical *layers* and the *span of control*. We follow Caliendo, Monte, and Rossi-Hansberg (2015) and Forsythe (2019) in classifying workers into managers, supervisors, and "other workers." Using this information, we count the number of distinct *layers* of employment (ranging from one to three) and compute the *span of control* as the ratio of the number of other workers to the number of managers and supervisors in each establishment.[3]

Table 1 presents statistics on the number of establishments and the (weighted) distribution of occupational measures in our data. Our statistics show that the majority of establishments have a very flat hierarchical structure, and conditional on having at least a manager or supervisor, establishments have on average 7.5 workers per manager (or supervisor).

II. Relationship between Internal Organization and Business Age

We evaluate whether and how internal organization varies systematically between young and older employers. We begin by estimating the following specification separately for each measure of internal organization of business j in year t:

$$(1) \quad W_{jt} = \alpha + \sum_{a=a1}^{A} \beta_a D_{a,jt} + \delta_t + \boldsymbol{\gamma}\mathbf{X}_{jt} + u_{jt},$$

where $D_{a,jt}$ are dummies for age bins 1–3, 3–6, 6–9, 9–12, 12–15, and 15+ years old, and δ_t are date-of-observation fixed effects. The universe of establishments encompasses substantial heterogeneity that can affect these age profiles. Thus in $\mathbf{X}_{jt}$ we control for six-digit industry (NAICS) fixed effects, state fixed effects, and a dummy for multiunit establishments.[4] We are interested in the series of coefficients, β_a, that collectively capture average changes in organizational structure as establishments age.

Figure 1 shows the estimated conditional age effects for hierarchical layers and span of control. Both measures display clear life cycle patterns. Our results indicate that older establishments are more hierarchical than younger establishments: establishments that have been in operation more than 15 years have, on average, 15 percent more

[2] To produce detailed estimates of employment by industry and occupation for each geographic area in the United States in each time period, the OES program oversamples large employers, small industries, industries with high occupational variability, and geographic areas with small employment levels. Thus, survey weights and nonresponse imputations from nearest-neighbor observations are a key part of creating any estimates based on these data. Building on Handwerker, Piccone, and Cross (2020), we use population-level information from the QCEW to adjust standard OES imputation and weighting procedures, prioritizing imputations from donors of the same birth cohort and age in each time period, and adjusting weights similarly. Baseline results are qualitatively robust without weights.

[3] We ensure robustness by computing various other related measures capturing the internal organization of businesses and found qualitatively similar patterns.

[4] To assuage concerns that our empirical findings may be different at the firm level, we use information from the QCEW on the employer tax ID number to identify establishments in each period that are part of a multiestablishment, and we control for the multiunit status and explore heterogeneity across this dimension.

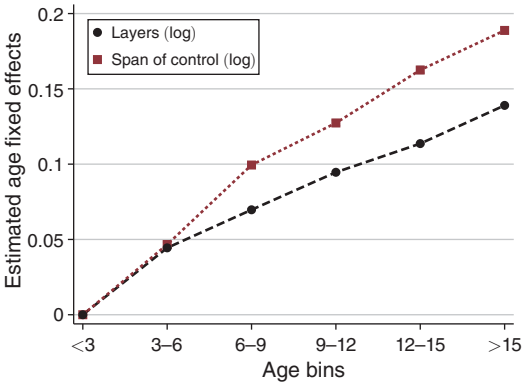

FIGURE 1. INTERNAL ORGANIZATION OVER THE LIFE CYCLE

Note: The figure shows the estimated age fixed effects of the number of layers of organization (log) and the span of control (log) according to equation (1), estimated by OLS with sampling weights.

layers than the youngest comparable establishments (about half a standard deviation). For many small establishments, this is the difference between having no one whose primary occupation is management or supervision to having one worker in these categories. Our results for the span of control indicate that older establishments have more workers per manager than younger firms: establishments that have been in operation more than 15 years have, on average, 20 percent more workers per manager than comparable younger business (about one-third of a standard deviation), suggesting that the span of control grows over the life cycle.

Our results suggest that over the life cycle businesses become more hierarchical by adding layers but also attain a wider span of management and supervision. While the number of layers and span of control are closely related, the two measures can evolve in opposite directions or at very distinct paces. For example, Calvo and Wellisz (1978) present a monitoring hierarchy model where businesses may exhibit a slowdown in the increase in the number of workers per manager when adding new layers. Additionally, Rajan and Zingales (2001) propose a model that predicts that businesses will begin operations with few layers to minimize expropriation risk, adding more layers over time once workers have made firm-specific investments. This model, however, predicts that businesses should have a high span of control when young and a reduced span of control as workers become more attached to the firm.

These estimates of the relationship between age and measures of internal organization are based on repeated cross-sectional variation in data pooled across multiple survey dates. This source of variation conflates *life cycle changes* within cohorts with differences between *cohorts* at birth and the differential *selection* of surviving employers. We evaluate the impact of selection by estimating equation (1) using a sample of long-lasting businesses. Table 2 (columns 2 and 6) presents the results of estimating age fixed effects (up to age nine) within the subsample of establishments surviving at least nine years.[5] The estimated coefficients show that the qualitative relationship between both our measures of internal organization and age does not change in the sample of long-lasting establishments. There is an attenuation of age effects that is consistent with exit being more likely to occur among those with fewer layers and a lower span of control. Table 2 (columns 3 and 7) extends our baseline specification by adding additional controls for cohort fixed effects, following Deaton's (1997) normalization. Our results indicate that there are cohort effects, but these have little impact on the estimated age fixed effects. Overall, the stability of the results after incorporating survival and cohort controls make us confident that these estimates capture systematic patterns occurring over the life cycle of establishments.

III. The Role of Business Size

Next, we evaluate potential mechanisms underlying the systematic relationship between internal organization and age by exploring the role of establishment size. Through the lenses of models of "knowledge hierarchies," the number of layers should increase as businesses grow because large organizations solve more complex problems (or work on new ideas).[6] Because

[5] This condition ensures that we include a selective group of establishments. Exit rates for young businesses are quite high in the United States. In our data, less than 40 percent of establishments survive beyond 9 years.

[6] Models of internal organization largely emphasize systematic changes as firms grow rather than as they age (Garicano and Rossi-Hansberg 2015). Caliendo, Monte, and Rossi-Hansberg (2015) use data for French manufacturing firms, and Caliendo et al. (2020) use data for Portuguese manufacturing firms; both show that, indeed, businesses

Table 2—Internal Organization over the Life Cycle: Alternative Specifications and Additional Controls

	Layers (log)				Span of control (log)			
	Baseline (1)	Survival (2)	Cohort (3)	Size (4)	Baseline (5)	Survival (6)	Cohort (7)	Size (8)
$\mathbf{1}[3 < \text{age} \leq 6]$	0.044	0.029	0.044	0.012	0.047	0.027	0.046	0.002
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)
$\mathbf{1}[6 < \text{age} \leq 9]$	0.070	0.034	0.071	0.016	0.099	0.042	0.099	0.005
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)
$\mathbf{1}[9 < \text{age} \leq 12]$	0.095		0.095	0.023	0.127		0.130	0.010
	(0.000)		(0.000)	(0.000)	(0.001)		(0.001)	(0.001)
$\mathbf{1}[12 < \text{age} \leq 15]$	0.114		0.113	0.028	0.163		0.165	0.020
	(0.000)		(0.000)	(0.000)	(0.001)		(0.001)	(0.001)
$\mathbf{1}[\text{age} > 15]$	0.139		0.138	0.034	0.189		0.195	0.022
	(0.000)		(0.000)	(0.000)	(0.001)		(0.001)	(0.001)
R^2	0.212	0.186	0.212	0.482	0.209	0.222	0.209	0.492
Cohort	No	No	Yes	No	No	No	Yes	No
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiunit status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents the coefficients for the age fixed effects of layers (log) and span of control (log) of weighted OLS regressions. $\mathbf{1}[a < \text{age} \leq b]$ represents an indicator variable that equals one if the establishment is between a and b years old. Columns 1 and 5 use the baseline specification and sample. Columns 2 and 6 use the baseline specification but restrict the sample to observations up to nine years old from establishments surviving more than nine years. Columns 3 and 7 use the baseline sample and include a set of cohort variables using Deaton's normalization (which constrains the average of the cohort dummies to zero over the sample period). Columns 4 and 8 use the baseline sample and includes nine fixed effects for size: 1–4, 5–9, 10–19, 20–49, 50–99, 100–249, 250–499, 500–999, and more than 1,000 employees. The baseline sample used in this table comprises all establishments in the OES for which an exact quarter of birth can be determined from QCEW data.

young employers are also more likely to be small (Haltiwanger, Jarmin, and Miranda 2013), the relationship between internal organization and age may be capturing differences in internal organization related to the size of a business rather than its age. Table 2 (columns 4 and 8) extends our baseline specification by introducing detailed size fixed effects. There is still a significant relationship between internal organization and age conditional on size, although controlling for size substantially attenuates this relationship. This suggests that to a large extent, the systematic relationship between internal organization and age takes effect through size: as businesses age, they also grow and adjust their internal organization accordingly. The additional explanatory effect of age suggests age also has a direct effect on organizational structure beyond the effect of size.

IV. Industry Heterogeneity and Changes over Time

Different industries have different production processes and include establishments with different workforce compositions. Moreover, changes in internal organization induced by accumulation of organizational capital may be more predominant in manufacturing industries than in some types of retail businesses. Figure 2 (panel A) shows the results of estimating equation (1) for hierarchical layers by allowing age fixed effects to vary between broad industrial sectors. Although the average number of layers differs substantially by sector, all sectors show a positive association between hierarchical layers and age. The relationship is especially steep among manufacturing establishments.

Changing technologies over time may also affect the internal organization. For

with more layers are larger. Kueng, Yang, and Hong (2020) analyze multiple aspects of firm organization and firm age and size for Canadian firms and find that changes in internal organization are associated with size but not age.

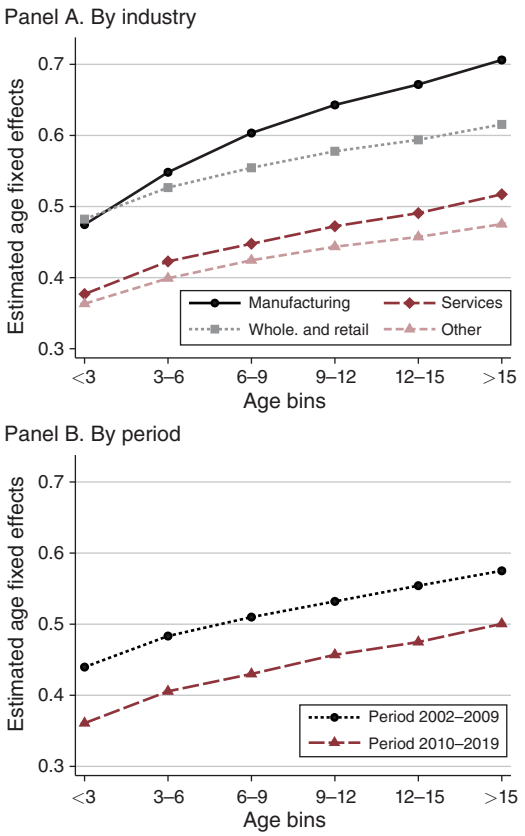

FIGURE 2. LAYERS OVER THE LIFE CYCLE: HETEROGENEITY AND CHANGES OVER TIME

Notes: Panel A shows the estimated age fixed effects of the number of layers of organization (log) according to equation (1) estimated by OLS with sampling weights, separately for broad industrial groups. Panel B estimates the same equation separably for two distinct periods. All regressions include time effects, industry, location, and multiunit status fixed effects. We normalize the the number of layers for the age group up to three years old according to the unconditional average.

example, information and communication technology affects monitoring and the acquisition and communication of knowledge. One key advantage of our dataset is that it covers cohorts of businesses over an extensive period. In Figure 2 (panel B), we explore the relationship between hierarchical layers and age using repeated cross-sectional variation from surveys pooled separately for 2002–2009 and 2010–2017. Our results indicate that recent start-ups have relatively fewer layers, which leads us to conjecture that information and communication technology allows businesses to have relatively flatter structures.[7]

V. Conclusion

Our results suggest that there are systematic patterns in internal organization over the life cycle of businesses. This empirical evidence is relevant for the literature on the mechanisms of the life cycle dynamics of businesses. Atkeson and Kehoe (2005) suggest that life cycle patterns are driven by the accumulation of business-specific organizational capital. Our results suggest that as organizational capital is accumulated through the learning process, employers may be adjusting their internal organization, and these adjustments can ultimately shape their growth and survival. Knowledge-based theories, as in Garicano and Rossi-Hansberg (2015), explore the role that hierarchical structures play in shaping business growth. These theories predict larger organizations will have more layers. We show that while a large fraction of the association between internal organization and business age is driven by businesses' tendency to grow as they age, there is also room for mechanisms of learning or time to build.

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[7] We find similar qualitative patterns for the measure of span of control. Another relevant source of heterogeneity is the multiunit status of an establishment. We explore heterogeneity in age fixed-effects between independent establishments and those that are part of multiunit organizations. Both types exhibit a significant positive association between layers (and span of control) and age.

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