FIRM DYNAMICS AND GROWTH MEASUREMENT IN FRANCE

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Abstract
In this paper we use the same methodology as Aghion et al. (2017a) to compute missing growth estimates from creative destruction in France. We find that from 2004 to 2015, about 0.5 percentage point of real output growth per year is missed by the statistical office, which is about the same as what was found in the United States. We look at how missing growth varies across French sectors and regions, and we look at the underlying establishment and firm dynamics. In particular we show that the similar missing growth estimates between France and the United States hide noticeable differences in plant dynamics between the two countries. (JEL: O4)

1. Introduction

In 1938, economist Alvin Hansen explained in his Presidential Address before the American Economic Association that in his opinion, the United States faced inexorable weak growth in the long term that he denoted "secular stagnation" (Hansen 1939). The nation was just emerging from the Great Depression, and Hansen did not anticipate another World War that would stimulate a rebound in public spending and thereby of aggregate demand. Since then, the world has experienced remarkable growth but also another major crisis in 2007. This "Great Recession" led some economists to revive the expression "secular stagnation" to characterize a situation that they assimilated to

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TABLE 1. Average TFP growth rate for different subperiods. Euro Area and the United States.

	1890–1913	1913–1950	1950–1975	1975–1995	1995–2005	2005–2016
U.S.	1.0	2.5	1.7	1.0	1.7	0.5
Euro Area	1.3	1.0	3.2	1.6	0.6	0.3

Notes: Average TFP growth rate are taken from Bergeaud et al. (2016). Euro Area is the aggregate of France, Germany, Italy, Spain, Netherlands, Finland, Portugal, and Belgium.

the one described by Hansen in 1938 (see Summers 2014; Teulings and Baldwin 2014 for an overview).

In particular for Gordon (2012) the risk of secular stagnation reflects a supply problem, and the age of great innovations is past. Gordon uses the metaphor of a fruit tree to describe the evolution of productivity for the past 150 years: in the same way as low-hanging fruits are easier to catch and more juicy than high-hanging fruits, the second industrial revolution—that of electricity and chemistry—produced a higher productivity wave than the third revolution—the ICT wave. This is illustrated in Table 1, taken from Bergeaud et al. (2016). A similar argument is made by Bloom et al. (2017) who push the view that the secular decline in productivity growth has to do with the fact that in any sector new ideas get harder and harder to find over time.

Schumpeterian economists are more optimistic about the future. A first argument (e.g., see Aghion 2016) is that the ICT revolution has radically and durably improved IT-producing technology; meanwhile globalization (which was concomitant with the ICT revolution) has substantially increased the potential returns on innovation—hence generating a scale effect—as well as the potential downside of not innovating—hence inducing a competition effect.

A second argument, is that innovation may not be properly reflected in actual measures of productivity growth. Already in 1996, the Boskin Commission (Boskin et al. 1996) would describe how bias could arise in the measure of inflation from the direct quality adjustment done when incumbents upgrade their products. This report was widely discussed in France at the time (see, e.g., Lequiller 1997) and a main conclusion was that the bias associated with incumbent innovation should be significantly lower in France.[1]

In this paper, however, we focus on a different source of bias associated with creative destruction, that is, with quality improvements by new producers who replace incumbent producers. The following Figure 1 helps motivate the idea that creative destruction could partly explain missing growth. Figure 1 depicts over time for U.S. manufacturing industries the relationship between the level of creative destruction and the correlation between TFP growth and the intensity of innovation, as measured by the number of patents on the other hand. More precisely we did the following: each year

1. One reason for this is that in France the weights of the various products in the CPI are readjusted every year. This in turn helps reduce the "substitution bias" emphasized by the Boskin Commission. In the future the French Statistical Office (INSEE) plans to rely more systematically on high frequency scanner data that should reduce this bias even further at least for nondurable goods (see Léonard et al. 2017).

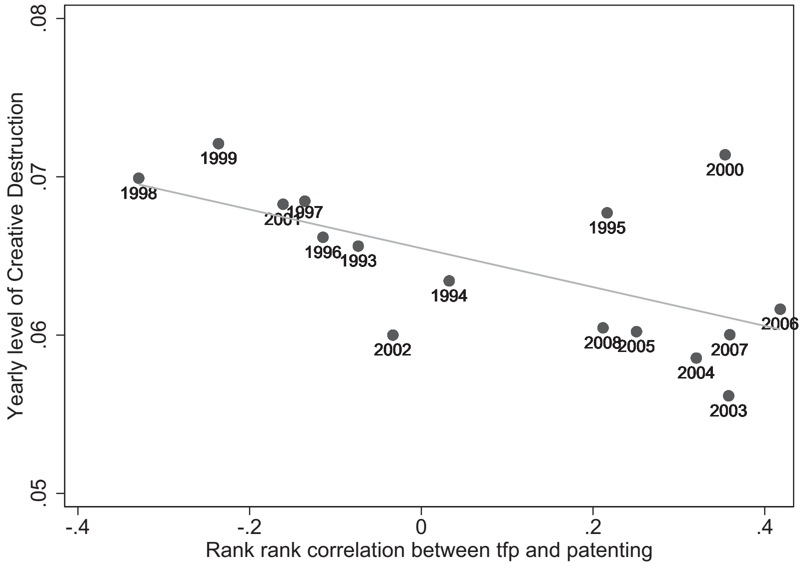

FIGURE 1. Creative destruction and correlation between TFP and patenting. Rank–rank correlation between TFP growth rate and number of patents per employees has been calculated each year among a set of 26 manufacturing industries using Spearman's formula. Patents correspond to granted application filed by U.S. companies or inventors and are distributed by the year of application. Creative destruction has been computed as half the sum of job creation and job destruction flow. Data are for 1993–2008.

over the period from 1993 to 2008, we computed the rank–rank correlation between TFP growth and the number of patents per employee, for 26 manufacturing industries. TFP growth has been computed using the NBER-CES manufacturing industry database and patents have been taken directly from the USPTO and correspond to granted patent filed by U.S. companies and inventors. We then measured the level of creative destruction in each year and for each sector by half the sum of job creation and job destruction rates taken from the Quarterly Workforce Indicators series from the Census. Figure 1 shows that the correlation between TFP growth and patenting, is lower in year when creative destruction is higher.[2]

Why should creative destruction make it harder to fully measure the contribution of innovation to productivity growth? Aghion et al. (2017a), henceforth ABBKL, argue that in sectors where new products replace old ones, the statistical office does not correctly assess how much of the increase in monetary value from the sector is due to inflation versus real productivity growth. The standard procedure in such cases is to assume that the quality-adjusted inflation rate is the same as for other items in the same category that the statistical office can follow over time, that is, products that are

2. Note that a similar figure could be obtained by plotting the average level of creative destruction for each sector over the period against the rank–rank correlation between patents and TFP growth for each *sector* (instead of doing it for each year).

not subject to creative destruction. This procedure is referred to as "imputation" in the United States.

ABBKL develop a methodology to quantify the bias that arises from relying on imputation to measure U.S. productivity growth in cases of creative destruction. Using the Schumpeterian growth paradigm, ABBKL provide explicit expressions for missing growth from creative destruction and estimate this missing growth to lie between 0.4 and 0.8 percentage point on average per year over the past thirty years in the aggregate U.S. economy. This corresponds to about one fourth to one third of "true" productivity growth that has been missed. Furthermore, ABBKL find no evidence for a clear time trend in this "missing growth" in the United States.

This growth mismeasurement from creative destruction and imputation is not specific to the United States, however.[3] In this paper we use the same methodology as in ABBKL to compute missing growth from creative destruction and imputation in France. We find missing growth estimates that are remarkably similar between France and the United States. That missing growth from creative destruction should not be too different between the two countries, is hinted at by Guédès (2004) which looks at the 1998–2003 period. During this period, the monthly rate of item substitutions in the CPI ranges between 4.1% and 4.5% and the average monthly frequency of "noncomparable" substitutions (those from which it is not possible to find a replacement item of comparable quality) ranges between 2.5% and 3.1% in the French CPI. These numbers are quantitatively very similar to their counterparts in the United States as reported by ABBKL (e.g., roughly 50% of substitutions are judged to be comparable and substitution happens at similar monthly frequency, see Aghion et al. 2017a, Online Appendix A).[4]

But what is more surprising is that we obtain similar estimates of missing growth from creative destruction in France and the United States despite the fact that, as we shall see in what follows, the underlying plant dynamics are markedly different between the two countries.

After thirty years (from 1945 until 1975) over which France was growing faster than the United States in terms of per capita GDP capita (3.8% annual growth on average in France versus 2.1% for the United States when the 1945–1950 period is excluded), convergence stopped in the mid-1970s; and from 1995 onward the U.S. economy has grown faster than the French economy (1.4% annual growth in the United States versus 0.9% in France) as shown in Figure 2. What happens to this comparison between France and the United States when we factor in missing growth from creative destruction in the two countries? Is the gap between U.S. and French GDP growth

3. For details on PPI and CPI in Europe, see Eurostat (2012), OECD (2002), Ahnert and Kenny (2004), and the ILO and IMF guidelines (http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm).

4. And both the BLS and the INSEE rely mostly to imputation to deal with noncomparable substitutions: "*In France, we generally estimate the evolution of prices by the evolution of the average price observed among products that are followed and are considered to be in the same variety. The remaining changes are considered to be a quality effect.*" (translated from Guédès 2004)

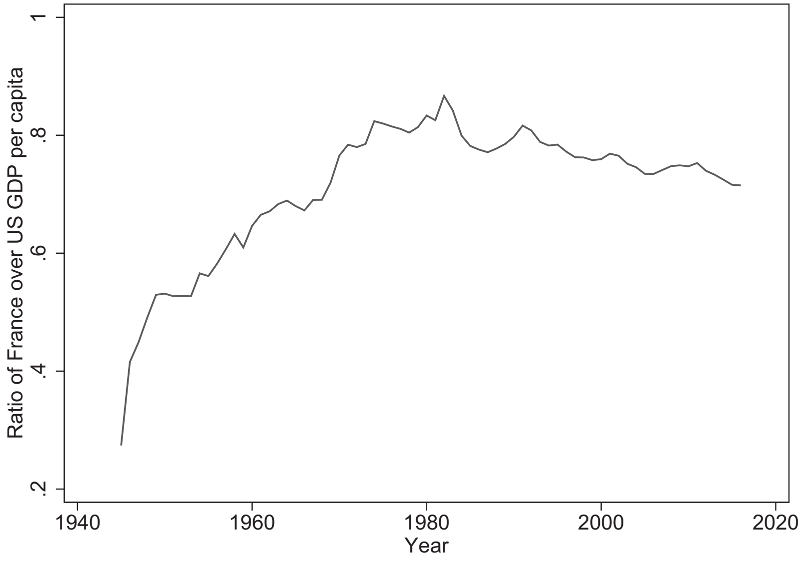

FIGURE 2. Ratio of GDP per capita between France and the United States since 1945. This figure plots the value of GDP per capita for France divided by the one of the United States since 1945. GDP has been converted in 2010 U.S. dollars. See Bergeaud et al. (2016) for sources and computation.

increased or reduced when adding missing growth? These are among the questions we address in this paper.[5]

The remaining part of the paper is organized as follows. Section 2 summarizes the methodology in ABBKL to compute missing growth from creative destruction for the whole economy. Section 3 presents the data and descriptive statistics and derives the missing growth estimates for France. Section 4 looks at the extent to which the comparison between missing growth estimates in France and the United States is mirrored by the comparison between the firm and plant dynamics in the two countries. Finally, Section 5 concludes.

2. The ABBKL Methodology in a Nutshell

In this section we summarize the ABBKL methodology to compute aggregate missing growth from creative destruction. Imputation means that the statistical office uses the average price change on all products with a surviving producer to compute the inflation

5. Some recent literature has documented on firm dynamics in France: Picart (2006) shows that a small share of firms are responsible for most of job creations (see also Cette et al. 2017); Picart (2008b) considers the low dynamism of French SMEs and Bacheré (2017) shows that firms with size of between 250 and 5,000 employees, account for most job creations in the period from 2009 to 2015. We contribute to this literature by showing new evidence on the creation, destruction and growth of French establishments in comparison with their U.S. counterparts.

rate from innovation for the overall economy: that is, it computes the aggregate quality-adjusted price growth for the entire economy as being equal to the average price growth over all products that are not subject to creative destruction (i.e., products that are unchanged or products that are subject to incumbent own innovation).

To estimate missing growth from imputation, ABBKL propose to use information on the market shares of entrant establishments (plants), of surviving plants that stay in the market, and of exiters throughout the time period we consider. This method is quite attractive as it allows us to abstract from the details of the innovation process, in particular we do not have to compute the arrival rates and step size of the various types of innovations.

In a nutshell, let L_t denote total employment (or payroll) at date t, X_t denote the employment of *continuers* at date t, that is, of the set of plants operating in both periods t and $t+1$, and E_t denote the employment of exiting plants at date t. We have by definition

$$L_t = X_t + E_t.$$

Similarly, if L_{t+1} denotes total employment at date $t+1$, X_{t+1} denotes the employment or payroll of *continuers* from date t at date $t+1$, and F_{t+1} denotes the employment or payroll of new entrants (i.e., of new entering plants) at date $t+1$, we have

$$L_{t+1} = X_{t+1} + F_{t+1}.$$

Then, under the assumption of a constant number of products per plant, ABBKL derive from their model that aggregate missing growth from imputation between periods t and $t+1$, is simply expressed as a function of the growth in market share of continuers between t and $t+1$, namely,[6]

$$MG_{t+1} = \frac{1}{\sigma - 1}\left[\ln\left(\frac{X_t}{L_t}\right) - \ln\left(\frac{X_{t+1}}{L_{t+1}}\right)\right], \tag{1}$$

where X_t/L_t is the market share of continuers at date t and X_{t+1}/L_{t+1} is the market share of those same continuers at date $t+1$.

Thus true growth exceeds measured growth (i.e., missing growth is positive) whenever the market share of continuing incumbents shrinks over time. The imputation done by the statistical office is based on information of the continuers. So intuitively, the difference between true growth and measured growth is equal to the difference between true growth and continuers' average productivity growth. This relative productivity growth cannot directly be observed, but the dynamics in market share reflects information about it. The market share of continuers shrinks between t and $t+1$ precisely when the average productivity of continuers grows more slowly than the average productivity of the overall economy. Together with an estimate for the

6. We refer the reader to ABBKL for details.

elasticity of substitution, σ, data on market share dynamics can be used to back out the underlying difference in productivity growth.

For our analysis in Section 4 it will be useful to reexpress the previous missing growth expression as

$$MG_{t+1} = \frac{1}{\sigma - 1}\left[\ln\left(1 - \frac{E_t}{L_t}\right) - \ln\left(1 - \frac{F_{t+1}}{L_{t+1}}\right)\right].$$

For E_t/L_t and F_{t+1}/L_{t+1} small, we can approximate MG_{t+1} as

$$MG_{t+1} \approx \frac{1}{\sigma - 1}\left[\frac{F_{t+1}}{L_{t+1}} - \frac{E_t}{L_t}\right]. \quad (2)$$

3. Missing Growth in France

In this section, we implement the approach developed in ABBKL and presented above on French plant data to derive aggregate missing growth estimates for France.

3.1. Data Source

Our data are based on administrative sources and cover all French establishments (plants) from 1993 to 2015. Our main source is the CLAP ("Connaissance Locale de l'Appareil Productif") dataset from 2003 that we augment with information from the matched employer–employees dataset, namely the DADS ("Declaration Annuelle des Donnees Sociales") dataset that goes back to 1993. CLAP is constructed using various administrative sources (social security, business registry, etc.). It provides firm-level and plant-level information on employment and wage remuneration for the various types of activities across the commercial and noncommercial sectors of the French economy as long as those activities generate a labor income. CLAP also reports the date of creation of the plant. It is arguably the most reliable and broadest source of information on establishments in France, however it starts in 2003. Prior to that year, we rely on aggregate matched employer–employees data at the plant level from the DADS. Although DADS provides accurate worker level information, it is less comprehensive than CLAP when it comes to plant level information. In particular DADS only reports employment measured by total headcount at the end of the year.[7] This in turns leads us to focus on the period 2004–2015 for our baseline analysis.

We restrict attention to establishments from nonfarm business sectors for consistency with the U.S. Census's Longitudinal Business Database (LBD). For each establishment in our data sample and each year, we have information on the precise location of the establishment, its date of registration, the size of its workforce (i.e., employment by the plant), its total payroll and the firm's value

7. Note that the U.S. Census's Longitudinal Business Database (LBD) also measures employment by headcount.

TABLE 2. Descriptive statistics of plants.

	Number of establishments	Average employment	
		FTE	Headcount
2003	1,446,125	8.10	9.01
2004	1,477,876	8.10	8.97
2005	1,481,967	8.04	8.85
2006	1,409,612	8.44	9.48
2007	1,462,781	8.31	9.43
2008	1,461,577	8.41	9.47
2009	1,441,992	8.42	9.40
2010	1,549,487	7.95	8.93
2011	1,460,265	8.25	9.39
2012	1,472,624	8.38	9.45
2013	1,479,463	8.36	9.37
2014	1,477,047	8.32	9.35
2015	1,484,932	8.32	9.36

Notes: This table presents the number of plants per year. Plants are included in our dataset only if it has positive and nonmissing employment, either measured by total headcount at the end of the year or by full time equivalent (FTE).

added. We do not consider individual firms,[8] except when they involve some kind of labor income and the results are therefore unaffected by the numerous changes in regulation and incentives since 2008 associated with the introduction of a new self-employment ("auto-entrepreneur") status (see, e.g., Aghion et al. 2017b for more details on individual firms). We delete plants that are subject to specific legal or administrative constraints, such as bailiffs, transportation companies, water supply, university refectory, and mutual funds.

We also drop from the sample plants that reports zero employment both in terms of full time equivalents and in terms of total headcount. Table 2 shows the number of plants in our final sample each year, along with plants' average employment size.[9]

3.2. Measuring the Market Share Growth of Continuers

From this database, we can infer E_t and F_{t+1} as well as L_t and L_{t+1} from information on plants' employment shares.[10] More precisely, let B denote the first period of operation and D denote the last year of operation of a plant. Then, let $L(t, B \leq b, D \geq d)$ denote

8. Individual firms ("entreprises individuelles") are firms that are owned by individuals that bear all the legal responsibilities associated with the business. Individual firms typically includes craftsmanship. Such firms can have employees but they remain typically small to escape extra taxation.

9. On average 61% of French establishments in the nonfarm business sector have an employment equals to zero over the period 2003–2015. This high proportion is mainly attributable to nonsalaried individuals owning their companies.

10. We will also explore alternative proxies for the market share of plants based on payroll and value added.

the total employment or payroll in period t of plants who were born before or in period b and die in period d or after. Using previous notations, we therefore have

$$\begin{aligned} E_t &= L(t, B \leq t, D = t), \\ F_{t+1} &= L(t+1, B = t+1, D \geq t+1), \\ L_t &= L(t, B \leq t, D > t). \end{aligned} \tag{3}$$

Estimating these variables is sufficient for us to estimate missing growth through equation (2). How do we measure these quantities? A natural way is to map t to the data year, B to the first year the plant appears in the dataset and D to the last year the plant appears in the dataset. This would implicitly assume that entry and exit in our data correspond to entry and exit in the market. However, in practice entering the database does not necessarily mean fully entering the market, for example, because it may take time for firms to accumulate customers and market share and recruit workers. Also, some establishments may appear in the database even during the development phase of their products. Hence, the mapping between the model and the data is likely to be more accurate if we consider a plant to be an entrant a few years after the firm has appeared in the database.

This in turn calls for mapping B into a year in the dataset plus k years of lag, where $k > 0$. Concretely, as in ABBKL we remove from the database all plants that are less than k year old. An entrant is therefore defined as a firm of k years old. Another assumption is that when a plant stops its activity, it immediately exits the dataset. This is not always true in practice and some plants can survive in the data for many years with 0 employment. In that case, we consider D to be the last year with positive employment for the plant. Because of the truncation of our data, we have to assume that these plants do not reenter after showing 0 employment. Reentry is a relatively rare event in French data, just like in the U.S. LBD, and whenever this happens, we delete the establishment from the database.[11]

3.3. Results

Figure 3 shows the evolution of mean employment growth as a function of the plant's age, based on our full data sample. We see that employment growth is high for young plants but stabilizes rapidly after about 5 years. This in turn justifies our focus on the market share dynamics of mature plants and our choice of setting k equal to 5 years

11. More generally, entry and exit in the database do not necessarily correspond to actual creation and destruction of plants. Alternative reasons include relocation and acquisition both of which generate a change in the establishment identifier. This issue is inherent to all establishment data where an establishment is usually defined as the combination of a firm identifier and an address. Thus over the 2003–2004 period, more than 60% of entries in our database correspond to actual creations. Note however that each relocation and acquisition simply adds one entry and one exit. Thus from equation (2) this does not affect our missing growth estimate, provided that the employment growth of affected plants is not systematically above or below average.

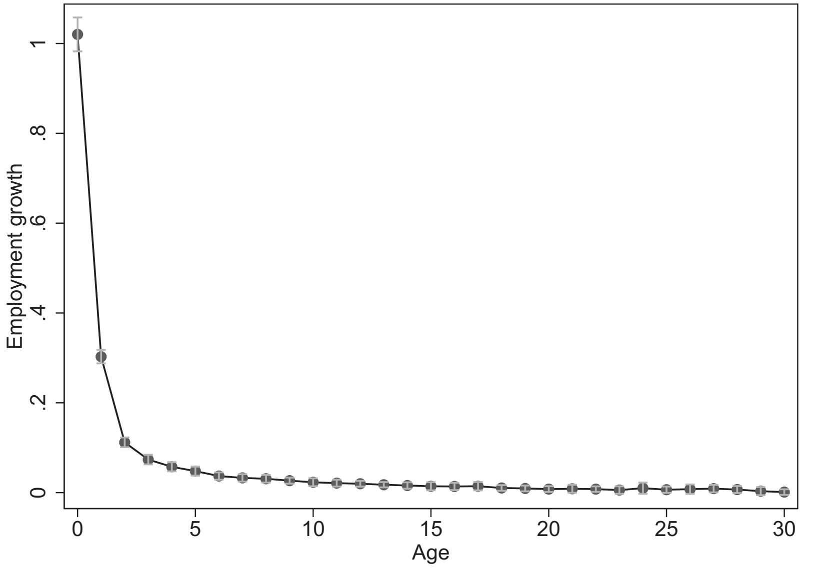

FIGURE 3. Average employment growth by age. Employment growth is computed by establishment's age groups, each year, using full-time equivalent employment. Results are then averaged over all years from 2004 to 2015.

TABLE 3. Missing growth at the plant level.

	Missing growth				
	FTE	Headcount	Payroll	Value Added	Hours
2004–2015	**0.46**	**0.64**	**0.70**	**0.47**	**0.48**
2006–2013	0.42	0.64	0.61	0.47	0.39

Notes: Entries are percentage points per year. $\sigma = 4$, $k = 5$. Data for total hours worked are not available in 2015 so column (5) stops in 2014. Numbers of the full sample period are boldfaced.

to compute missing growth, as ABBKL do when computing missing growth for the United States.

Table 3 shows the missing growth estimates using the employment share of continuing plants for our baseline period 2004–2015. We consider this period as our baseline since over that period we can directly use the CLAP database that we consider to be more accurate. We set $\sigma = 4$ in addition to taking $k = 5$. This choice of the elasticity of substitution is consistent with ABBKL and in line with the median value across producers within a same product category from Hottman et al. (2016). To measure market share, here we use employment at the plant level that we measure first using a full time equivalent count (column (1)) and then by using total headcount at the end of the year (column (2)). On average over the baseline period, yearly missing growth is around 0.5 percentage points, which is of the same order of magnitude as what ABBKL find for the United States. For a more precise comparison between

TABLE 4. Missing growth, at different values of k.

	Missing growth		
	$k = 3$	$k = 5$	$k = 7$
2004–2015	**0.23**	**0.46**	**0.66**
2006–2013	0.24	0.42	0.61

Notes: Entries are percentage points per year. $\sigma = 4$ and market share is measured using full-time equivalents. Numbers of the full sample period are boldfaced.

France and the United States, we refer the reader to the second row that focuses on the 2006–2013 period as in ABBKL, and on the second column that uses headcount as in ABBKL. In this case, missing growth in France is equal to 0.64 that is remarkably close to the corresponding missing growth estimate for the United States over the same period, namely 0.74 (see Aghion et al. 2017a, Table 1).

In the next columns of Table 3, we measure market share using alternative proxies. Column (3) uses total payroll to measure market share and doing so yields larger missing growth estimates than when using employment to measure market share. This result mirrors the findings in ABBKL (see Aghion et al. 2017a, Table 2). Then, in column (4), we measure market share using plants' value added (which in turn is computed by splitting the firm's total value added[12] across its establishments weighted by their employment size. For the vast majority of single-establishment firms (94% of firms on average, over 2003–2015), this is equivalent to considering the exact value added of the plant. For the remaining firms, this uses the assumption of a constant level of productivity across all its plants. Finally, in column (5), we measure the intensive margin of employment by hours worked, which we compute using the DADS dataset.[13] The resulting estimates of missing growth are very close to our baseline estimates shown in the first column of Table 3.

The results presented in Table 3 point to a missing growth estimate at around 0.5pp per year on average from 2004 to 2015. Over that period, measured TFP growth in France was on average 1% per year,[14] which means that missing growth represented about a third of total "true" growth. Next, in Tables 4 and 5, we explore the sensitivity of our baseline estimate to the choice of parameters k and σ. We let the values of k vary from 3 to 7 and the values of σ vary from 3 to 5. Although the effect of an increase in σ is clearly predictable from equation (1), the effect of an increase in k is somewhat harder to predict. Yet we see from Table 4 that missing growth increases slightly with

12. Value added at the firm level has been computed using the INSEE firm level balance sheet dataset: FICUS/FARE.

13. In theory, this should be equivalent to using full-time equivalent. The difference is that full-time equivalent weights employment by working time only up to 35 hours per week. Above that level, the weights are taken to be equal to one.

14. This estimation uses TFP data computed by the Bank of France. However these TFP series are not one to one comparable to the multifactor TFP series computed by the BLS and used in ABBKL.

TABLE 5. Missing growth, at different values of σ.

	Missing growth		
	$\sigma = 5$	$\sigma = 4$	$\sigma = 3$
2004–2015	**0.34**	**0.46**	**0.68**
2006–2013	0.32	0.42	0.64

Notes: Entries are percentage points per year. $k = 5$ and market share is measured using full-time equivalents. Numbers of the full sample period are boldfaced.

TABLE 6. Missing growth, long run.

	Missing growth
1994–2015	**0.50**
1996–2005	0.47
2006–2013	0.64

Notes: Entries are percentage points per year. $\sigma = 4$, $k = 5$ and market share is measured using total headcount. The period subdivision is reduced to 1996–2005 and 2006–2013 for the sake of comparison with U.S. estimates from Aghion et al. (2017a, Table 1). Numbers of the full sample period are boldfaced.

k and reaches 0.66 percentage points per year on average from 2004 to 2015 when k is set to 7.[15]

Next, we extend our results by moving back in time, using information drawn from the DADS, as explained previously. The DADS is matched employer employee dataset and is not originally dedicated to be a register of all the plants in France. Therefore we cannot consider the estimations over the period before 2004 to be as accurate as those for the 2004–2015 period. In any case, Table 6 presents average yearly missing growth in percentage point for the whole 1994–2015 period. We find an average yearly missing growth estimate of 0.50 using end of year headcount as the measure of market share.[16]

For the sake of comparison with ABBKL, we also average yearly missing growth estimates over the 1996–2005 time period: we find an average yearly missing growth estimate of 0.47pp, compared to 0.55 in the United States (see Aghion et al. 2017a, Table 1). Over that period, yearly TFP growth is roughly equal to 2% on average in France, which suggests that missing growth represents about a fifth of total "true" productivity growth.

So far, we have computed missing growth for the whole nonfarm business economy. We now take a look at missing growth at the sectoral level. We thus split the whole economy into 10 broad industry groups and compute missing growth within each of these groups. Table 7 reports the results for missing growth on average from 2004

15. Reducing the value of k below 3 will further reduce missing growth. With $k = 2$, over the period 2004–2015, the yearly average missing growth is of 0.07 percentage points.

16. Yearly missing growth estimates from 1994 to 2015 are plotted in Figure A.1 in the Appendix.

TABLE 7. Missing growth, by industry.

	Missing growth	Creative destruction
Extractive industry	0.09	8.1
Manufacturing	0.04	9.1
Construction	0.40	11.6
Retail	0.75	10.7
Hotels, restaurants	0.76	10.2
Logistic and communication	0.35	11.6
Finance	0.65	11.1
Real estate	0.73	14.6
Health	0.18	10.1
Social and personal services	0.74	11.8

Notes: Missing growth is given in percentage points per year and is measured using $k = 5$, $\sigma = 4$, and market share is measured using full-time equivalents. The period considered is 2004–2012 due to change in the definition of sectors. Over this period, the missing growth for the whole nonfarm business sector is 0.48 percentage point. Creative destruction is the average of entry and exit rate of plants.

to 2012 in column (1).[17] In particular, Table 7 shows that missing growth figures are lower for manufacturing than for other sectors, as this was also the case in the United States (see Aghion et al. 2017a, Table 5). It also shows that our results for the whole nonfarm business economy is not driven by one particular sector. Next, we compute an estimate of the average level of creative destruction in each of these sectors over the 2004–2012 period. Here creative destruction is measured as the sum of entry and exit rates of plants divided by 2. We see that missing growth tends to be higher in sectors with more creative destruction.[18]

Next, we look at how missing growth is geographically distributed across French regions. Indeed, CLAP reports the location of each plant and it is therefore straightforward to compute missing growth estimates locally. Figures 4(a) and (b) show how missing growth is geographically distributed across French regions and French "departments".[19] We find that missing growth is higher in the *Cote-D'Azur* region, along the northern Atlantic coast and around the Toulouse and Lyon urban areas. Interestingly, these are regions with higher rates of creative destruction compared to the French average (the correlation between creative destruction and missing growth at the "department" level is reported in Figure 5). In addition, these are regions in which measured productivity growth is higher than in the remaining part of France. This in turn suggests that the unevenness in economic development across French regions is worse than what measured growth suggests. One noticeable exception is

17. The reason we stop in 2012 is because of a change in the sectoral classification that occurred in 2008. The CLAP database continued to report the previous classification but only up to 2012. It would be possible to use a crosswalk to update the results up to 2015 but this would also add noise.

18. That our estimates of missing growth are positively correlated with the level of creative destruction is positively correlated is in line with our theory. Indeed our theory predicts that sectors with more churning like hotels and restaurants have higher rates of noncomparable item substitution in the PPI and therefore larger missing growth.

19. There are 22 regions in mainland France in the period we consider, and 96 departments.

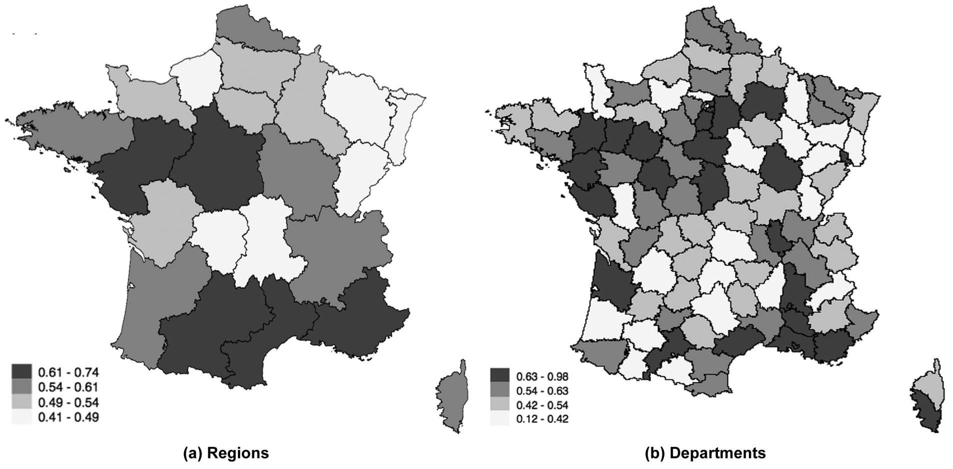

FIGURE 4. Missing growth by geographical areas. Missing growth is computed in percentage point per year. $\sigma = 4$ and $k = 5$. Market share is measured using full-time equivalent employment. The period considered is 2004–2015.

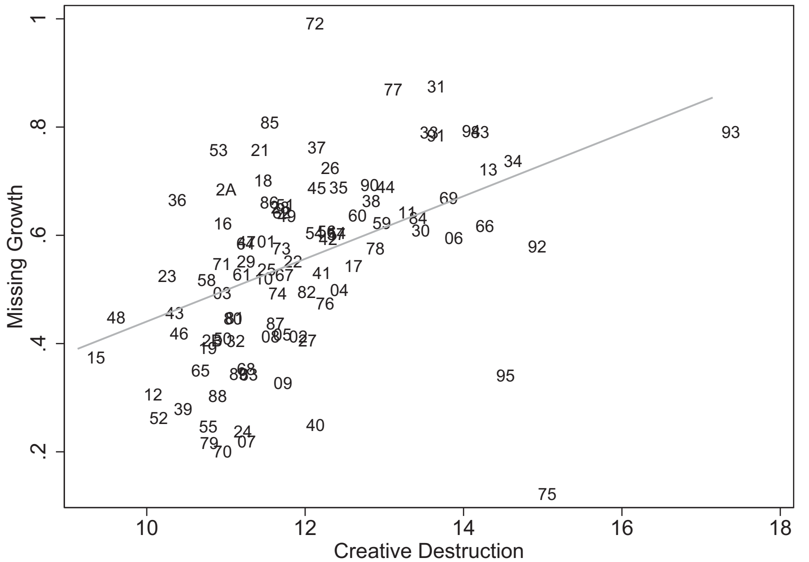

FIGURE 5. Correlation between missing growth and creative destruction. Missing growth has been computed at the department level and corresponds to value presented in Figure 4(b) whereas creative destruction is defined as half the sum of entry and exit rates of plants. Both are taken as average over the period 2004–2014. Paris is "department" number 75. A complete list of "departments" and their corresponding numbers can be found from the INSEE.

TABLE 8. Missing growth, firms versus plants.

	Firms		Plants	
	FTE	Headcount	FTE	Headcount
2004–2015	**0.17**	**0.14**	**0.46**	**0.64**
2006–2013	0.20	0.15	0.42	0.64

Note: Entries are percentage points per year. $\sigma = 4$ and $k = 5$. Numbers of the full sample period are boldfaced.

Paris that shows a very small amount of missing growth despite a high level of creative destruction. This is due to the fact that Paris is experiencing a high entry rate but also a high exit rate of plants, so that the market share of continuers remains relatively stable over time.

Finally, in Table 8 we compare missing growth figures using plants' employment shares with missing growth estimates using firms' employment shares (in each case we consider both, full-time employment equivalents and headcounts on December 31 to measure employment). We see that missing growth estimates using firms' employment shares are lower than when using plants' employment shares, as also found in ABBKL when looking at U.S. firms versus U.S. plants.

4. The Underlying Plant Dynamics in France versus the United States

In the previous section we showed that missing growth in France is large, at about 0.5 percentage point per year on average, and of comparable magnitude as missing growth in the United States. Recall that when restricting attention to $\sigma = 4$ and $k = 5$, the missing growth estimate we found for France based on headcount employment was equal to 0.64 on average between 2006 and 2013. Using the same methodology, ABBKL found a missing growth estimate only slightly higher and equal to 0.74. At the same time average yearly measured growth was lower in France than in the United States over that period (and this was also true for the longer 1996–2013 time period) so that missing growth represents a higher share of total GDP growth in France than in the United States. Yet it is remarkable to find missing growth estimates that are so similar between the two countries. Does that mean that the underlying plant dynamics is also similar across the two countries? In fact we will see in this section that the answer is no: namely, both the market share F_{t+1}/L_{t+1} of future entrants and the market share E_t/L_t of past exiters differ markedly between France and the United States, but these differences end up canceling each other out, thereby leading to similar missing growth estimates in the two countries (see equation (2)).

4.1. The Age-Size Nexus

Figure 6 depicts the employment share of plants by age on average over the period 2003–2015, respectively for France (in blue) and the United States (in red). Data for

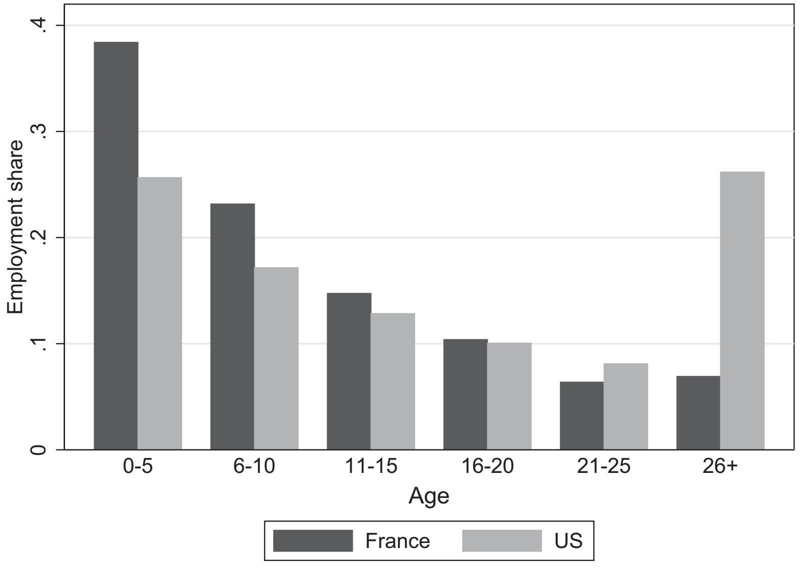

FIGURE 6. Employment share of plants by age. Employment share by age group of establishments is computed each year using total headcount. Results are then averaged over the period 2003–2015.

the United States have been directly drawn from the Census's Business Dynamics Statistics (BDS) and are based on the work of John Haltiwanger, Javier Miranda, and Ron Jarmin, among others (see, e.g., Haltiwanger et al. 2013). We see that young plants account for a higher share of employment in France, especially plants that are less than 5 years old. On the other hand, older plants account for a higher share of employment in the United States. This figure pools all establishments over all years and aggregate them by age groups. Figure 6 clearly shows that past a certain age the average plant size grows faster with age in the United States than in France, and that the U.S. economy has larger old plants than France.

Figure 7 provides additional supporting evidence of a higher growth rate of plant size in the United States than in France, by reproducing the same kind of exercise as in Hsieh and Klenow (2014).[20] More specifically, we plot the average size for establishment at different ages in the cross-section. We see that up to age 21–25, the life cycle of establishments is rather similar between the two countries. However, it differs quite dramatically for firms that are older than 26 years.[21] A more dynamic way of showing the link between plant size and plant age is displayed in Figure A.3 in the Appendix, where we only consider establishments born in 1993 that we follow over time up to year 2015.

20. Note that the analysis in Figure 1 in Hsieh and Klenow (2014) is done on manufacturing plants only.

21. Figure A.2 in the Appendix reproduces the same graph for France but extending up to 40 year old. We see that there is also a discontinuity for the older establishments, but these represent a small part of the total economy, especially compared to the United States.

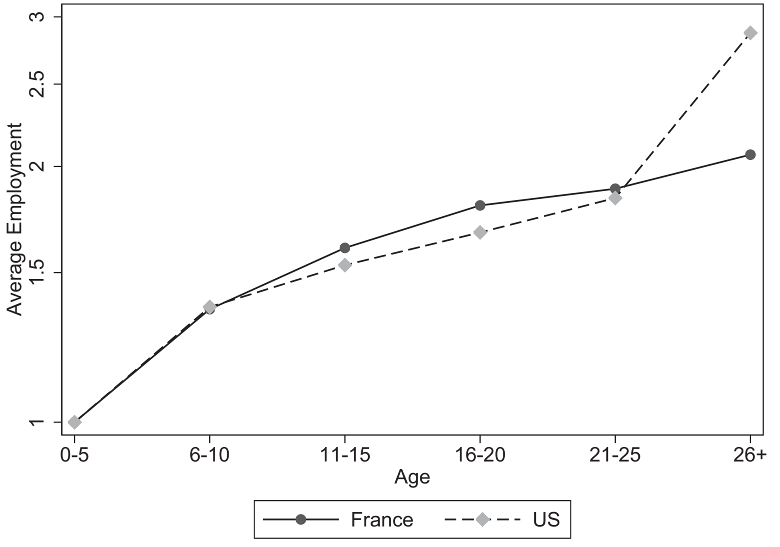

FIGURE 7. Average size of plants by age. Average Employment by age group of establishments is computed each year using total headcount and normalized to 1 for the youngest age group (similar to Hsieh and Klenow 2014, Figure 1). Results are then averaged over all years from 2003 to 2015.

The fact that average plants' employment grows faster with age in the United States than in France, is likely to reflect: (i) the fact that promising businesses have better investment and financing opportunities in the United States, and (ii) the fact that the selection process toward plants with high growth potential operates more efficiently in the United States than in France. All in all, this suggests that misallocation should be larger in France than in the United States (see Hsieh and Klenow 2009). This in turn could be due to a number of factors that have been widely documented: these include the higher degree of market frictions in France (as reflected in the OECD Indicators of Product Market Regulation), firm size regulation in France (Garicano et al. 2016), labor market adjustments (Ridder and Berg 2003; Picart 2008a), entry regulation (Bertrand and Kramarz 2002), and corporate real-estate frictions (Bergeaud and Ray 2017): these various sources of rigidity hinder firms and establishments dynamics in France.

4.2. Entry, Exit, and Missing Growth

The evidence shown previously suggests that the market share of entrants is higher in France than in the United States. However, missing growth figures are comparable between the two countries, which in turn suggests that the market share of exiters should also be higher in France.

In Figure 8 we computed the average exit rate for all years between 2003 and 2014 at different age bins. First, we see that French plants exit more often at all age. See also Figure A.4 in the Appendix, which considers all firms that were born in 1993 and computes the exit rate of survivors every year in our sample period until 2014.

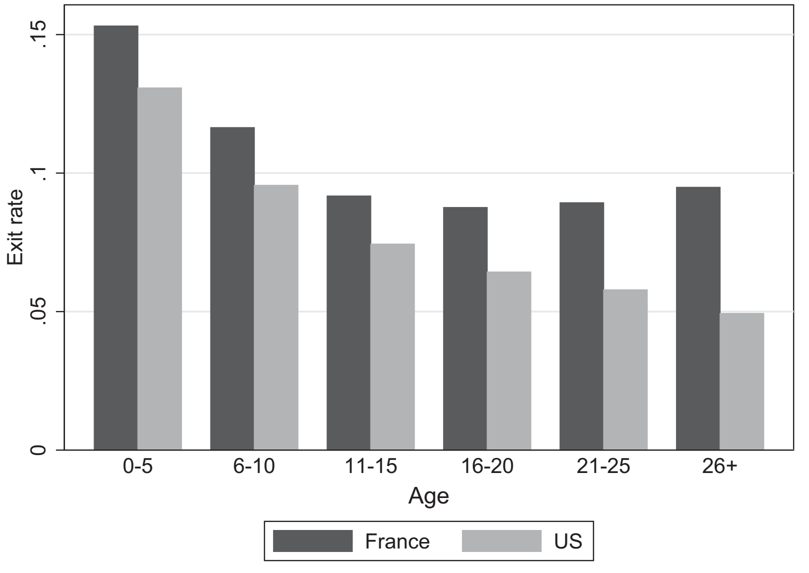

FIGURE 8. Exit rate of plants by age. Exit rate by age group of establishments is computed each year using total headcount. Results are taken indifferently all years from 2003 to 2014.

Next, one can compare the market share of exiters between France and the United States over the period 2006–2013. We find the following results

$$\left(\frac{E_t}{L_t}\right)_{FR} = 0.066 > \left(\frac{E_t}{L_t}\right)_{US} \approx 0.033.$$

What about entry rates? We can show that employment share F_{t+1}/L_{t+1} of very young firms is indeed higher in France than in the United States. More precisely, on average over the period 2006–2013 we have

$$\left(\frac{F_{t+1}}{L_{t+1}}\right)_{FR} = 0.083 > \left(\frac{F_{t+1}}{L_{t+1}}\right)_{US} \approx 0.051,$$

where the U.S. numbers are computed using the Census's BDS. Recall that entry is defined as an establishment reaching the age of 5. Thus overall, both the employment rate of new entrants and that of exiters are higher in France than in the United States, but the difference $F_{t+1}/L_{t+1} - E_t/L_t$ which by (2) translates into missing growth estimates is similar between France and the United States.

This similarity in missing growth estimates means that the relative market share of continuers decreases at a relatively similar pace in the two countries. Yet the employment share of entrants and exiters is larger in France than in the United States.

Note that these comparisons between France and the United States involve the relative *market share* of entrants versus exiters. It does not mean that entry and exit rates are necessarily larger in France than in the United States. In fact, entry and exit rates of plants in the two countries are of similar magnitude, as seen in Figures 9(a) and (b).

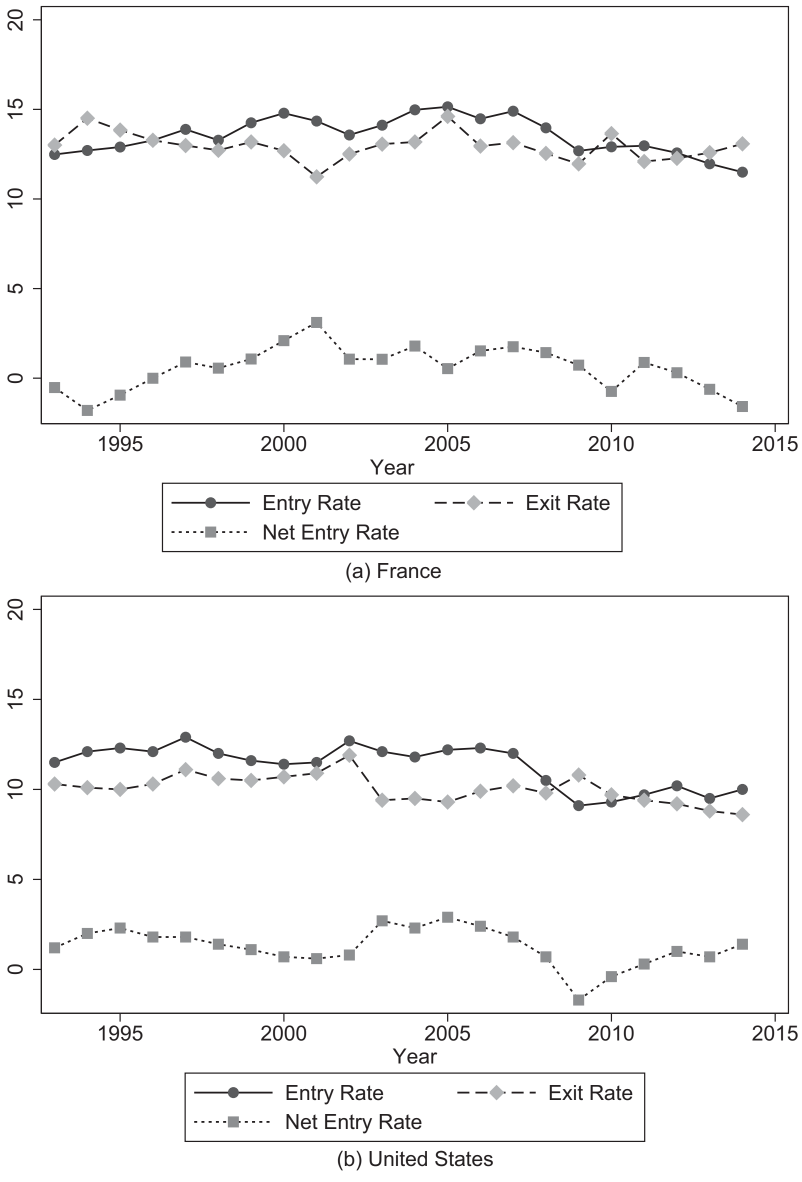

FIGURE 9. Entry/exit rate in France and the United States. Entry rate is defined as the number of new establishments at t divided by the stock of establishments at t. Exit rate is defined as the number of establishments that disappeared at t divided by the stock of establishments at t. Net Entry Rate is the difference between the two.

5. Conclusion

In this paper we used plant-level information to compute missing growth estimates for France. First, we found that in absolute terms missing growth from imputation is slightly lower in France than in the United States: this implies that, if anything, the growth differential between the United States and France over the past fifteen years has been (slightly) underestimated by the statistics. Second, although in the United States between a third and a fourth of true productivity growth was missed according to ABBKL, in France missing growth from imputation is closer to one third of total true productivity growth between 2004 and 2015. Third, we found that missing growth is higher in French sectors or regions with higher rates of creative destruction and with higher measured growth rates, suggesting that geographical differences in economic dynamism have been underestimated in France. Fourth, we found that the similarity between France and the United States in terms of missing growth hides differences in the market shares of new entrants and exiters between those two countries: both the employment share of new entrants and that of exiters are higher in France than in the United States, but these differences in employment shares of entrants and exiters between the two countries (almost) cancel each other out when computing missing growth estimates.

The analysis in this paper suggests several avenues for future work. A first avenue is to extend our analysis to more countries. Preliminary results in the United Kingdom and Japan show that missing growth seem to lie within the same range in these two countries, and similar computation exercises are being performed in ongoing work based on Italian and Swedish establishment data. Another extension would be to look at how the French Statistical Office can improve its measurement of productivity growth. Finally, our results have implications for growth, fiscal, and labor market policies and their impacts on growth. For example minimum wage policy uses estimates of the yearly level of inflation. Should the fact that inflation is overestimated, lead us to revisit minimum wage policy?

Appendix: Additional Figures

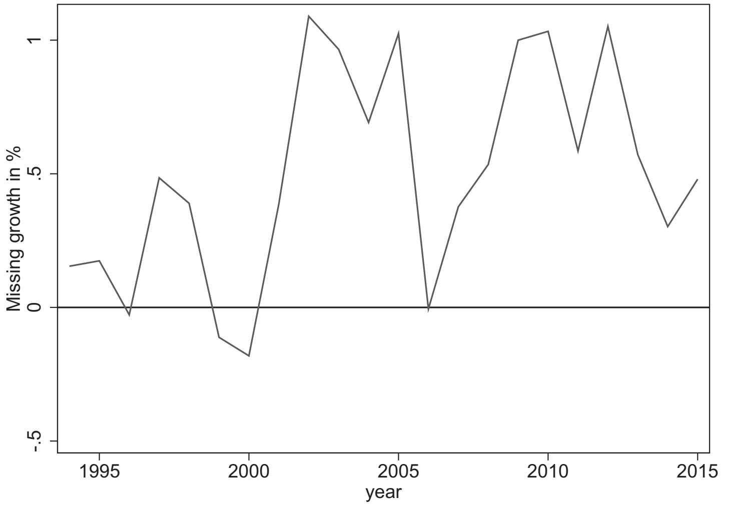

FIGURE A.1. Yearly missing growth results. Missing growth has been computed as described in Table 6 measuring market share using total headcount.

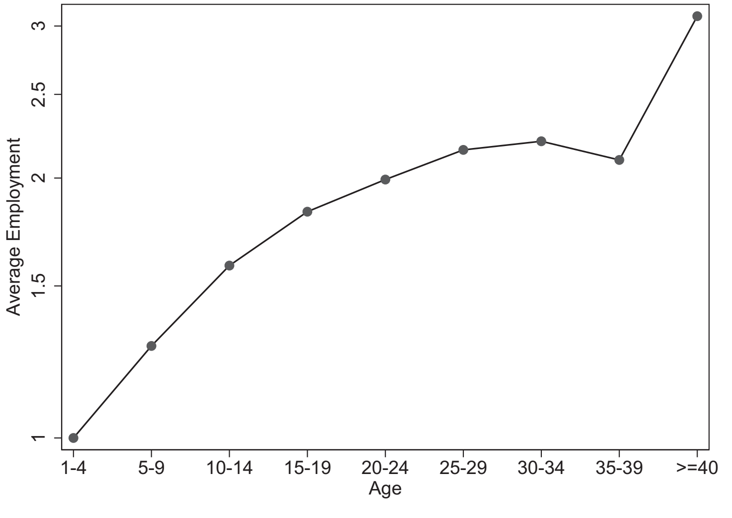

FIGURE A.2. Average size of plants by age—cross section. Average Employment by age group of establishments has been computed each year using total headcount and normalized to 1 for the youngest age group, as in Hsieh and Klenow (2014, Figure 1). Results are then averaged over the period 2011–2015.

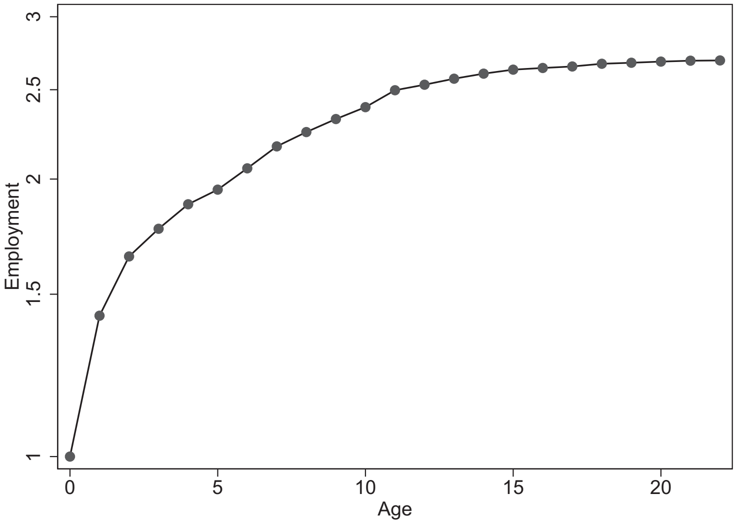

FIGURE A.3. Employment of plants by age. This Figure restricts on establishments born in 1993 and compute their employment each year standardized to 1 in 1993 using total headcount until 2015.

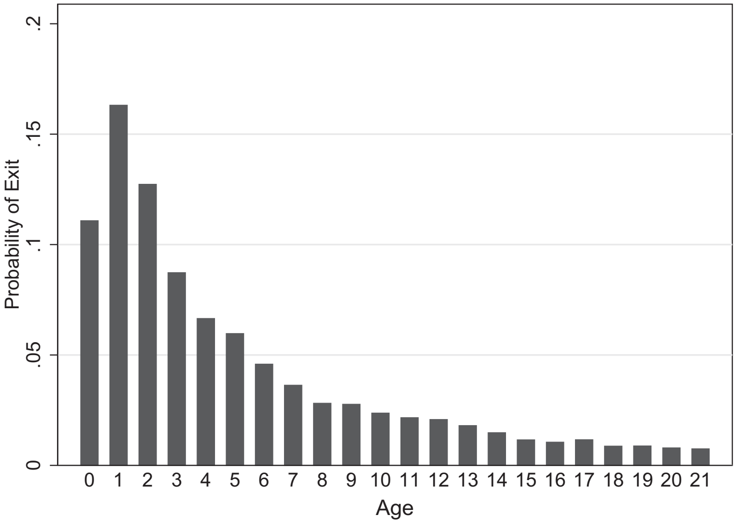

FIGURE A.4. Probability of exit of plants by age. This figure restricts on establishments born in 1993 and compute the exit rate each year until 2014 when they are aged 21. Exit rate is defined as the ratio of exiters at *t*, divided by the total number of firms born in 1993 that are still alive at *t*. At age 21, 8.16% of plants born in 1993 were still active.

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Supplementary Data

Supplementary data are available at *JEEA* online.