Creative Destruction and Aggregate Productivity Growth*

BY SHIGERU FUJITA

Productivity growth is the engine of economic growth and is responsible for rising standards of living. But all firms do not partake equally in the nation's productivity growth. Rather, according to economist Joseph Schumpeter's theory, firms undergo a process of "creative destruction": New firms that adapt to new knowledge cause the decline and eventual demise of incumbent firms. In this article, Shigeru Fujita surveys recent studies that examine the role of creative destruction in aggregate productivity growth.

Productivity growth is the engine of economic growth. Firms constantly discover and implement new technologies, making it possible for them to produce new products and services or to produce existing products and services more efficiently. Productivity growth is responsible for rising living standards in the world.

The figure on page 13, which plots a common measure of productivity — labor productivity — for the U.S., shows that productivity has grown steadily in the postwar U.S.[1] economy, indicating that the economy has become wealthier over time.

The smooth rise of productivity shown in the figure might suggest that all firms partake equally in the nation's productivity growth. Joseph Schumpeter (1883-1950), one of the most influential economists of the 20th century, observed that anyone who thought so would completely miss the "essential fact about capitalism,"[2] which, he argued, is the process of "creative destruction." In his famous book, *Capitalism, Socialism, and Democracy*, he summarized this process as one that "incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." Of course, many other economists have deeply appreciated the importance of creative destruction in capitalism. Former Federal Reserve Chairman Alan Greenspan, for instance, argues in his latest book that creative destruction is the only way to increase productivity and therefore the only way to raise average living standards on a sustained basis. These readings suggest that the turbulent process of creation and destruction lurks beneath the smooth rise in aggregate productivity.

Underlying Schumpeter's astute observation is the fact that firms are very different from each other: They differ in terms of their managerial abilities, their location, their organization, and their know-how. These differences mean that some firms take better advantage of new knowledge and ideas than others. New and existing firms that adapt to new knowledge cause the decline and eventual demise of other firms. Schumpeter emphasized that this process of creative destruction is an "evolutionary process" whereby "every element of it takes considerable time in revealing its true features and ultimate effects," and thus "we must judge its performance over time."

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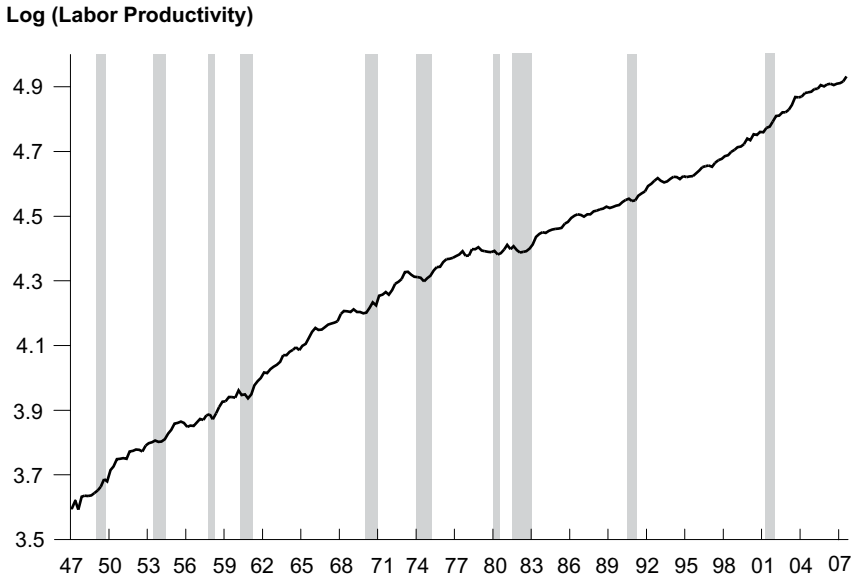
[1] Labor productivity is defined as the value of output less intermediate inputs (both values adjusted for inflation) produced per unit of labor input (measured as man-hours).

[2] The first view is consistent with Adam Smith's view of economic growth. See Leonard Nakamura's article for detailed characterizations of the differences between Smith's and Schumpeter's views.

*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

FIGURE

Labor Productivity
(output per hour)



Note: Shaded areas indicate recessions.

This article surveys recent studies that examine the role of creative destruction in aggregate productivity growth. These studies seek to understand the link between the productivity of individual business units and aggregate productivity, paying particular attention to the role that the birth and death of firms plays in the growth of aggregate productivity. Although Schumpeter's idea of creative destruction has been around for more than 60 years, it is only in the last 20 years or so that economists have had access to data that make it possible to quantify — and establish beyond doubt — this "essential fact about capitalism."

LINKING INDIVIDUAL AND AGGREGATE PRODUCTIVITY

To understand how growth in aggregate productivity depends on the process of creative destruction, we need a way to link individual productivities to aggregate productivity. Although there are various ways to make this link, I will focus on the one proposed by Lucia Foster, John Haltiwanger, and C.J. Krizan. Their method is to take a weighted average of individual establishment productivities and it allows us to express aggregate productivity as the sum of four components, each of which has intuitive economic meaning.[3]

The first component represents the productivity growth of establishments that continuously exist between two dates. Obviously, if the productivity of these continuing establishments grows, aggregate productivity will grow. This first component is called the "within component," reflecting the fact that this term captures the productivity gains that occur within each continuing establishment.

A second component takes into account the changes in aggregate productivity that result from changes in the relative size of establishments with different productivity levels. Even if the productivity of continuing establishments were to remain constant, aggregate productivity could change because of changes in the size of the establishments with different productivity levels. For instance, if more productive establishments were to expand employment over time and less productive establishments were to shrink, aggregate productivity (which is a weighted average of individual productivities) will grow. This component is called the "between component."

The two components above measure the effects of changes in individual productivities or changes in employment shares. Because these two components are calculated by fixing either the shares or the level of individual productivities, they do not capture the effects of how the changes in the individual productivities and the changes in shares are correlated. The "cross component" measures this correlation. The positive correlation shows up as a positive contribution. Similarly, the negative correlation shows up as a negative contribution. More specifically, if the establishments with faster-growing productivity are also the ones that are increasing their shares of employment, it shows a positive contribution. Again, similarly, if the establishments with slower-growing productivity are also the ones that are decreasing their shares of employment, it shows a positive contribution. The case of the positive correlation sounds reasonable in that one may think that establishments that have higher productivity growth expand their em-

[3] Note that in the literature I review in this article, an individual unit is a business establishment (or plant) that may be part of a larger firm. For this reason, I refer to an individual unit as an establishment rather than as a firm.

ployment shares over time, while those that have lower productivity growth shrink their shares. However, it is also possible that those that are reducing employment faster than others (for example, more aggressively restructuring) are more rapidly improving their productivity. When the two are negatively correlated, the cross component shows the negative contribution to aggregate productivity growth.

The last component measures the effects of the births and deaths of establishments. If new establishments have higher-than-average productivity, their presence will contribute to growth in aggregate productivity. If exiting establishments have lower-than-average productivity, that, too, contributes to productivity growth. The sum of these two subcomponents is called the "net entry component." Clearly, this term is directly related to Schumpeter's notion of creative destruction.

The Process of Creative Destruction and the Accounting Framework. While the net entry component has a direct connection to the notion of creative destruction, it is important to recognize that the other components are also influenced by it. For instance, invention of a superior technology by a new entrant may encourage incumbent firms to improve their own technologies. In the accounting framework above, this effect will show up in the within component. Another possibility is that the invention of new technologies induces resource reallocation (for example, workers change jobs) across incumbent establishments. This reallocation will clearly affect the between component.

Of course, the actual effects of creative destruction are likely to be more varied and subtle than any accounting framework can fully reveal.[4] Nevertheless, this simple framework can shed considerable light on what actually happens in each establishment as new technologies emerge and old technologies die out.

CREATIVE DESTRUCTION AND PRODUCTIVITY GROWTH IN MANUFACTURING

Net Entry Accounts for 30 Percent of Productivity Growth over a 10-Year Period. Table 1 reports the contribution to productivity growth in the manufacturing sector.[5] The first row shows the breakdown over a 10-year period between 1977 and 1987. The first column of the row shows that aggregate labor productivity, defined as real output divided by total hours (number of workers times hours worked per worker), grew 21 percent over this period. The four columns next to the aggregate growth rate are the shares of contributions of the four terms explained above.

According to the first row, the within component (77 percent) and the net entry component (29 percent) are the main contributors to productivity growth over this 10-year period. This latter finding is consistent with creative destruction. The next three rows in Table 1 present the contribution of the four components for three five-year periods: 1977-1982, 1982-1987, and 1987-1992. Overall, it is somewhat difficult to clearly characterize the results. However, we can make two observations. First, the contribution of net entry is always around 20 percent, regardless of time period. Note that relative to the result for 10-year productivity growth, the contribution of net entry is smaller. This is consistent with the idea that the effects of creative destruction are more apparent over a longer horizon.

Invention of a superior technology by a new entrant may encourage incumbent firms to improve their own technologies.

The second observation we can make from Table 1 is that the contribution of the between component is higher when overall productivity growth is lower (and vice versa). Specifically, it is highest during 1977-1982, when productivity growth is low compared with the other two periods. This result in Table 1 is based on coarse data observations, that is, only three observations of five-year productivity growth. However, a recent study by Yoonsoo Lee, which breaks down the annual productivity growth in manufacturing from 1973 through 1997 using a similar method, also finds that the between component is higher when aggregate productivity growth is slower. To put this observation into perspective, we can note that aggregate productivity tends to move together with the business cycle, which implies that reallocation of workers from less productive establishments to more productive ones intensifies during the cyclical downturns.

New and More Productive Establishments Displace Old and Less Productive Ones. Now, let's look

[4] Deeper understanding of the creative destruction process requires development of the appropriate theoretical framework. Readers who are interested in such attempts can refer to a recent paper by Markus Poschke and the references therein.

[5] The data in Table 1 are based on tables in the article by Lucia Foster, John Haltiwanger, and C.J. Krizan.

TABLE 1

Productivity Decomposition
(Manufacturing Sector)

	Overall Growth Rate	Within Component	Between Component	Cross Component	Net Entry Component
1977 - 1987	21.32	16.42 (77)	-1.71 (8)	-2.98 (-14)	6.18 (29)
1977 - 1982	2.54	3.10 (122)	2.16 (85)	-3.23 (-127)	0.51 (20)
1982 - 1987	18.67	15.50 (83)	2.43 (13)	-2.80 (-15)	3.55 (19)
1987 - 1992	7.17	6.74 (94)	2.37 (33)	-3.51 (-49)	1.51 (21)

Source: Foster, Haltiwanger, and Krizan, 2001, Tables 8.4 and 8.7. Sum of the four components equals the overall growth rate. Numbers in parentheses indicate the share of overall productivity growth explained by each component, calculated by dividing the contribution of each component by the overall growth rate (expressed as percent). The share is negative when the component contributes negatively to overall growth.

more closely at the role of net entry in 10-year productivity growth. The four columns in Table 2 report productivity levels of the following three types of establishments: (i) those that existed in 1977 but disappeared 10 years later, (ii) those that did not exist in 1977 and appeared 10 years later, and (iii) those that continued to exist throughout the 10-year period. All numbers are expressed relative to the average productivity level in 1977 of the establishments that existed throughout the 10-year period.

The table shows an interesting pattern. The first column (0.83) indicates that the average productivity of the establishments that failed to survive the 10-year period was 17 percent lower in 1977 than that of the establishments that successfully survived the same 10-year period. One can think of these displaced establishments being replaced by new establishments, which first appeared in 1987. The average productivity level of these new establishments in 1987 is given in the second column of the table. Observe that these new establishments on average had much higher productivity than that of the displaced establishments (1.11 vs. 0.83). This pattern is clearly consistent with Schumpeter's creative destruction insight that new and more productive firms push out old and less productive ones.

Learning and Selection Play Important Roles in the Evolution of Aggregate Productivity. However, another important insight from this table is that these new establishments do not necessarily enjoy the highest productivity when they appear in the market. This is reflected in the fact that the average productivity of these entering establishments is *lower* than the productivity of establishments that continue to exist throughout the 10-year period (1.11 vs. 1.20). This observation is consistent with the idea that "selection" and "learning" play important roles in the evolution of establishment-level productivity. Note first that those establishments that continue to exist throughout the period (that is, survive) do so because they are able to achieve high productivity. One can view this as the "selection" process over time. Further, even though new entrants presumably have some advantages (especially over old, exiting firms) — for example, because they can take advantage of new

TABLE 2

Relative Labor Productivity for Exiting, Entering, and Continuing Establishments
(Manufacturing Sector, 1977-1987)

Exiting Establishments in 1977	Entering Establishments in 1987	Continuing Establishments in 1977	Continuing Establishments in 1987
0.83	1.11	1.00	1.20

Source: Foster, Haltiwanger, and Krizan, 2001, Table 8.9. Each column gives the average productivity level of each type of establishment, relative to the average productivity level of establishments in 1977 that existed throughout the 10-year period 1977-1987. Existing establishments: establishments that existed in 1977 but disappeared in 1987. Entering establishments: establishments that did not exist in 1977 but appeared in 1987. Continuing establishments: establishments that existed in both 1977 and 1987.

technology or a good location — their observed productivity is not necessarily higher than the pre-existing "selected" establishments, since it takes time for these new entrants to "learn" the new technology and building organizational capability also takes time. Of course, some of these new entrants may disappear, failing to survive the competition, and only productive establishments will again be selected over time.

These facts are consistent with Schumpeter's assertion that creative destruction is an evolutionary process. As Schumpeter suspected, the facts point to the presence of rich micro-level dynamics, whereby the gradual process of learning and selection plays a key role in diffusing and propagating technological improvements.

CREATIVE DESTRUCTION AND PRODUCTIVITY GROWTH IN RETAIL TRADE

So far we have looked at the role of creative destruction in the manufacturing sector. But the service sector employs the bulk of the U.S. workforce. For example, in 2007, 84 percent of nonfarm business employees were employed in service-providing industries. Unfortunately, data limitations prevent us from carrying out a similar analysis for the entire service sector. But Foster, Haltiwanger, and Krizan have made an important attempt to look at a key segment of the service industry, namely, the retail trade sector. While the analysis covers only one service industry, it is of particular interest given that the retail trade sector is large, employing more than 15 million workers (2007), which amounts to 11 percent of total nonfarm business employment. Moreover, it has undergone massive restructuring and reallocation since the late 1980s. In particular, it has changed its ways of doing business, mostly because of the adoption of advanced information technology (for example, improved inventory and sales tracking).

Productivity Growth in Retail Trade Is Mostly Driven by Net Entry. Table 3 considers aggregate productivity growth in the retail trade sector over the 10-year period and the contributions of the four components. According to the table, the net entry component accounts for virtually all (98 percent) of the productivity growth over the 10-year period. Compared with the corresponding figure for the manufacturing sector, it is much larger, indicating the importance of net entry in the retail trade industry. This finding is consistent with the fact that job creation and destruction in this industry are explained mostly by the entry and exit of establishments.

Another interesting finding in Table 3 is the large negative contribution of the cross term. As I discussed before, the cross component contributes positively if establishments with higher productivity growth also have higher employment growth or if establishments with lower productivity growth have lower employment growth. Thus, a negative contribution of this term implies that higher productivity growth at the establishment level is associated with lower employment growth and lower productivity growth is associated with higher employment growth. This appears counterintuitive if one expects more productive establishments to expand employment over time and less productive establishments to shrink employment over time. However, causality can go in the other direction as well: Downsizing of employment may have enhanced productivity growth for some establishments over the period.

Establishment Births Are Driven by Expansion of Continuing Firms, While Establishment Deaths Come from Firms' Deaths. Table 4 presents the breakdown of net entry's contribution. The entry and exit columns of the table indicate that entry and exit account equally for net entry's

large, positive contribution.[6] Foster, Haltiwanger, and Krizan's analysis does not stop there; the authors explicitly consider how much of the entry and exit of establishments reflects the entry and exit of firms as opposed to the entry and exit of establishments. Remember that the unit of observation in the analysis so far has been an "establishment," which is defined by the physical production site (whether a manufacturing plant or a retail store). This definition leaves ownership of the establishments out of the analysis. However, bringing the notion of firms into the analysis, especially for the retail trade sector, provides a richer picture of creative destruction. Table 4 indicates that the positive contribution of entry comes mostly from entering establishments of *continuing* firms, whereas the large contribution of exit comes from exiting establishments of *exiting* firms. The authors further distinguish firms depending on whether the parent firm is a single-unit or a multi-unit firm that operates locally (one state), regionally (two to five states), or nationally (more than five states). The findings can be summarized as follows:

- *For continuing establishments,* multi-unit firms have a large productivity advantage over single-unit firms. Establishments operating locally, regionally, and nationally are, on average, 10.9 percent, 18.3 percent, and 24.1 percent more productive than single units.
- *Among exiting establishments,* the least productive are the single units. These units are 20.9 percent less

[6] As in the case of the manufacturing sector, the pattern of reallocation is consistent with the idea that less productive plants are replaced by more productive plants (selection effects) and those new plants experience more rapid productivity growth than more mature incumbents (post-entry learning effects).

TABLE 3

Productivity Decomposition (Retail-Trade Sector)

	Overall Growth Rate	Within Component	Between Component	Cross Component	Net Entry Component
1987-1997	11.43	1.83 (16)	2.74 (24)	-4.46 (-39)	11.20 (98)

Source: Foster, Haltiwanger, and Krizan, 2006, Table 3. Sum of the four components equals the overall growth rate. Numbers in parentheses indicate the fraction of overall productivity growth explained by each component, calculated by dividing the contribution of each component by the overall growth rate (expressed as percent). The fraction is negative when the component contributes negatively to overall growth.

TABLE 4

Productivity Decomposition: Contributions of Firm Entry and Exit (Retail-Trade Sector 1987-1997)

Net Entry of Establishments						
	Entering Establishments			Exiting Establishments		
		Continuing Firms	Entering Firms		Continuing Firms	Exiting Firms
98	54	37	17	45	3	42

Source: Foster, Haltiwanger, and Krizan, 2006, Table 3. The numbers indicate the fraction of overall productivity growth explained by each component, calculated by dividing the contribution of each component by the overall growth rate (expressed as percent). The number in the first column (98) corresponds to that in parentheses in the last column of Table 3. Entering establishments (firms): establishments (firms) that did not exist in 1987 and appeared in 1997. Existing establishments (firms): establishments (firms) that existed in 1987 but disappeared in 1997. Continuing firms: firms that existed in both 1987 and 1997.

productive relative to the continuing single units, on average. The most productive among the exiting establishments are those affiliated with a national chain. These establishments are actually slightly more productive than the continuing single-unit establishments (+1.9 percent).

- *Among entering establishments,* those associated with a national chain have a very large productivity advantage over single-unit incumbents (+24.7 percent).

Clearly, these findings are consistent with views in the popular press that describe the demise of "mom and pop" stores and the increasing presence of large national chains. The creative destruction process has played a crucial role in the productivity gains in the retail trade industry.

SUMMARY

The availability of rich establishment-level data over the last 15 years or so has made it possible for researchers to assess Schumpeter's assertion regarding the importance of creative destruction in aggregate productivity growth.

Recent empirical studies indeed find that creative destruction plays a significant role in shaping the evolution of aggregate productivity: The evidence shows that new and relatively more productive establishments displace older and relatively less productive ones. However, new establishments are not necessarily the most productive: While new entrants have some advantages over existing establishments — for example, they can take advantage of new technology or a good location — it takes time for them to fully exploit these advantages.

The facts reviewed in this article point to the importance of creative destruction but only hint at how creative destruction actually works. To fully appreciate these facts, economists have begun to build models that explicitly connect establishment-level decisions to aggregate outcomes. These models, together with the accumulating empirical evidence on establishment-level dynamics, promise to further enrich our understanding of creative destruction. BR

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APPENDIX

Example of Productivity Decomposition

This appendix provides a simple example to better understand the four components of aggregate productivity growth discussed in the text.

	Date T		Date T+1	
Establishments	Output per worker	Number of workers	Output per worker	Number of workers
A	3	10	6	20
B	2	10	4	10
C	1	10	----	----
D	----	----	4	10
Total	2	30	5	40

In this example, I go through the decomposition of the productivity difference between the two dates T and T+1. At each point in time, there are only three establishments: at date T, they are establishments A, B, and C, and at date T+1, they are A, B, and D. That is, establishment C, which existed at date T, is replaced by a new establishment D, at T+1. The first two columns of the table summarize the information at date T. Each number in the first column gives the productivity (output per worker) of the three establishments, while the next column gives the total number of workers. The last row is economy-wide productivity, which can be calculated as a weighted average of the establishment-level productivities:

Productivity of A * (Employment share of A) + Productivity of B * (Employment share of B) + Productivity of C * (Employment share of C) = 3(10/30)+ 2(10/30)+ 1(10/30) = 2.

One can verify that aggregate productivity in period T+1 is 5 by doing the same calculation. Between the two dates, aggregate productivity goes up by 3 (=5-2), which amounts to a 150 percent increase in aggregate productivity. I now go over how to decompose overall improvement of productivity into four components.

1. **Within component:** This term measures the contribution of continuing establishments to productivity improvements. It is simply a weighted average of changes in the productivity of continuing establishments, namely, A and B, in this example. To measure the effect of productivity changes that occurred "within" those establishments, employment shares are fixed at the levels of date T:

   (Change in productivity at A) *(A's employment share at Date T)+ (Change in productivity at B) *(B's employment share at Date T) = (6-3)(10/30)+(4-2)(10/30)=5/3.

   In this example, establishments A and B experienced productivity gains of 3 and 2, respectively. They are averaged by using their employment shares at date T.
2. **Between component:** This term measures how much of the overall productivity gain comes from the shift of employment from less productive establishments to more productive establishments: Even if the productivity levels of the existing units do not change over time, overall productivity can change simply because reallocating workers to more productive units improves overall productivity. It is calculated as a weighted average of the changes in employment shares, where the weights are productivity at the initial date, T, relative to overall productivity.

APPENDIX *(continued)*

(Change in A's share)*(Productivity difference of A from overall productivity at Date T) + (Change in B's share)*(Productivity difference of B from overall productivity at Date T) = (20/40-10/30)(3-2)+(10/40-10/30)(2-2) = 1/6.

The calculation in the first set of parentheses shows that the employment share of establishment A increased from 1/3 to 1/2. Since establishment A had a productivity level of 3, which is higher than the average productivity level of 2, this term contributes positively. Similarly, the calculation in the second term captures the fact that the share of establishment B decreased, but it had the same productivity level as aggregate productivity and thus makes no contribution to aggregate productivity.

3. **Cross component:** This term is less intuitive, but it is simply computed by multiplying changes in shares and changes in productivity and summing them across all continuing establishments:

(Change in productivity at A)*(Change in A's share) + (Change in productivity at B)*(Change in B's share) = (6-3)(20/40-10/30)+(4-2)(10/40-10/30) = 1/3.

Establishment A increased both its employment share and its productivity, and thus the first term is positive. However, part of this positive contribution is offset by the second term, which is negative because the share of establishment B decreased.

4. **Net entry component:** This term represents the difference between the contributions of the entry and exit components. The contribution of entry is expressed as a weighted average of the productivity of entering establishments relative to overall productivity at the initial date, T. In this simple example, there is only one entering establishment, namely, D. It is therefore computed as:

(Productivity difference of D from overall productivity at Date T)*(D's share at Date T+1) = (4-2)10/40=1/2

Note that at the initial period, establishment D has a higher productivity level, 4, than the overall productivity level of 2, and this positive contribution is multiplied by the share of employment at date T+1. Similarly, the contribution of exits is expressed as a weighted average of the productivity of exiting establishments.

(Productivity difference of C from overall productivity at Date T)*(C's share at Date T) = (1-2)10/30=-1/3

The calculation in the parenthesis reflects the fact that the productivity level of establishment C is lower than the average level at date T. Relative productivity is weighted by the employment share: 1/3. The net entry term is calculated as a difference between the two terms:

(Contribution of entry) – (Contribution of exit) = 1/2-(-1/3) = 5/6.

The exit of establishment C contributes positively to changes in overall productivity because establishment C had lower-than-average productivity, while the entry of establishment D also makes a positive contribution because it has higher-than-average productivity. This pattern is consistent with creative destruction. Summing over all four components we find that 5/3+1/6+1/3+5/6=3, which indeed gives the aggregate productivity gain observed between the two dates.