NBER WORKING PAPER SERIES

MULTI-PRODUCT FIRMS AND PRODUCT SWITCHING

Andrew B. Bernard
Stephen J. Redding
Peter K. Schott

Working Paper 12293
http://www.nber.org/papers/w12293

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2006

Bernard and Schott thank the National Science Foundation (SES-0241474), and Redding thanks the Leverhulme Trust and Princeton University, for research support. This paper is a combination of papers previously circulated under the titles "Multi-product Firms and the Dynamics of Product Mix" and "Product Choice and Product Switching." We are especially grateful to Esteban Rossi-Hansberg for helpful comments and suggestions. We are also grateful to Marc Melitz, Sharon Oster, Peter Neary, John Sutton, John Van Reenen, Stephen Yeaple and seminar participants at CEPR, Dartmouth, LSE, Princeton and Yale for helpful comments. The research in this paper was conducted while Bernard and Schott were Special Sworn Status researchers of the U.S. Census Bureau at the Boston Research Data Center. Research results and conclusions expressed are those of the authors and do not necessarily reflect the views of the Census Bureau or the NBER. The paper has been screened to insure that no confidential data are revealed. Bernard: 100 Tuck Hall, Hanover, NH 03755, tel: (603) 646-0302, fax: (603) 646-0995, email: andrew.b.bernard@dartmouth.edu. Redding: Houghton Street, London, WC2A 2AE, tel: (44 20) 7955-7483, fax: (44 20) 7831-1840, email: s.j.redding@lse.ac.uk. Schott: 135 Prospect Street, New Haven, CT 06520, tel: (203) 436-4260, fax: (203) 432-6974, email: peter.schott@yale.edu.

Multi-Product Firms and Product Switching
Andrew B. Bernard, Stephen J. Redding and Peter K. Schott
NBER Working Paper No. 12293
June 2006
JEL No. D21, E23, L11, L60

ABSTRACT

This paper examines the frequency, pervasiveness and determinants of product switching among U.S. manufacturing firms. We find that two-thirds of firms alter their mix of five-digit SIC products every five years, that one-third of the increase in real U.S. manufacturing shipments between 1972 and 1997 is due to the net adding and dropping of products by survivors, and that firms are more likely to drop products which are younger and have smaller production volumes relative to other firms producing the same product. The product-switching behavior we observe is consistent with an extended model of industry dynamics emphasizing firm heterogeneity and self-selection into individual product markets. Our findings suggest that product switching contributes towards a reallocation of economic activity within firms towards more productive uses.

Andrew B. Bernard
Tuck School of Business at Dartmouth
100 Tuck Hall
Hanover, NH 03755
and NBER
andrew.b.bernard@dartmouth.edu

Stephen J. Redding
London School for Economics
Houghton Street
London WC2A 2AE
UNITED KINGDOM
s.j.redding@lse.ac.uk

Peter K. Schott
Yale School of Management
135 Prospect Street
New Haven, CT 06520-8200
and NBER
peter.schott@yale.edu

1. Introduction

The extent to which resources are allocated to their most efficient use is a core issue of economics. Until now, research into industry dynamics has addressed this issue by focusing almost exclusively on the contribution of firm entry to resource reallocation, i.e., whether newly created firms or plants are more productive than the dying firms and plants they replace.[1] This paper examines a new, "extensive" margin of firm adjustment, the reassignment of resources that takes place within surviving firms as they add and drop, i.e. "switch", products.

Our analysis of product switching is made possible by our construction of a unique new longitudinal dataset that tracks U.S. manufacturing output at the firm-product level across quinquennial U.S. Manufacturing Censuses from 1972 to 1997. In this dataset, a "product" is defined as one of approximately 1,800 five-digit Standard Industrial Classification (SIC) codes, e.g., "Passenger Cars".[2] We observe the full set of products each manufacturing firm produces in each year and analyze how incumbent firms' product mix evolves for the more than 140,000 firms that survive on average from one Census year to the next. To our knowledge, these are the most comprehensive data on multi-product production yet assembled; they are more detailed than the data contained in typical manufacturing censuses, which record only the primary industry of firms or plants.

We find product switching to be frequent, widespread and influential in determining both firm and aggregate outcomes. Nearly one-third of the increase in real U.S. manufacturing shipments between 1972 and 1997 is due to the net adding and dropping of products by continuing firms, a contribution to aggregate growth that dwarfs that of firm net entry, which accounted for a five percent decline. On average, two-thirds of U.S. manufacturing firms alter their mix of products between Censuses, and two-thirds of those firms change their product mix by *both* adding and dropping at least one product. Switched products account for a considerable fraction of individual firms' activity, with added and dropped products each representing roughly half of a switching firm's total output. Adding and dropping also exert considerable influence on the scope of firms, with an average of 47 percent of firms

[1] There is a large empirical literature in macroeconomics on firm creation and destruction and their implications for industry dynamics and the firm-size distribution. See, for example, Albuquerque and Hopenhayn (2002), Baily et al. (1992), Cooley and Quadini (2001), Dunne et al. (1989a,b), Foster et al. (2001, 2006), and Rossi-Hansberg and Wright (2005) among others.

[2] Throughout the paper we use the terms "product" and "good" to denote a five-digit SIC category. We reserve the terms "sector" and "industry" to refer to two- and four-digit SIC categories, respectively. Examples of industries and sectors are given in Section 2..

adding products outside their existing set of four-digit SIC industries between Census years.

Further analysis of how firms switch products reveals a surprisingly small role for mergers and acquisitions. Fewer than 1 percent of firms' product additions between 1972 and 1997, for example, occur because of the acquisition of another firm's plant. In fact, 94 per cent of product additions occur within a firm's existing production facilities. On the other hand, while product switching does not imply ownership changes, ownership changes are often associated with product switching: on average, 95 percent of firms engaging in M&A concomitantly adjust their mix of products.

The trends we document are all the more striking given that our definition of a product, though substantially narrower than the industries usually employed in panel microdata, remains relatively coarse. The five-digit SIC category "Passenger Cars", for example, does not distinguish the station wagons, sports cars or other types of vehicles contained within that product category. Indeed, given the unobserved changes firms presumably make to their products within five-digit SIC product categories, our findings likely underestimate the true importance of firms' adjustments to their extensive margins.

In the second half of the paper we consider different classes of explanations for the product-switching behavior we observe and highlight features of the data that successful future theories of the firm must incorporate. The first group of explanations we examine focuses on factors that are product-specific but common across firms, such as demand or supply shocks. Demand shocks might induce product switching by leading firms to add "hot" products for which demand is rising and drop "cold" products for which it is falling. Similarly, supply shocks associated with technological progress or international trade and outsourcing might push firms to drop uncompetitive products in favor of goods more consistent with U.S. comparative advantage.[3] If demand or supply shocks were the dominant forces accounting for product switching, products' add and drop rates would exhibit a negative correlation as all firms systematically add ascending products and drop declining ones. In fact, we find products' add and drop rates to be positively rather than negatively correlated, indicating that while some firms are dropping a particular product, others are adding it. This positive correlation is hard to reconcile with explanations of product switching that are based purely on a net reallocation of activity from one group of products to another.

A more compelling explanation of product switching is provided by a natural extension

[3]Bernard, Jensen and Schott (2006), for example, find that U.S. manufacturing firms are more likely to switch out of industries where exposure to imports from low-wage countries is high.

of existing models of industry dynamics (e.g. Jovanovic 1982, Hopenhayn 1992 and Ericson and Pakes 1995) that receive support from empirical studies of firm creation and destruction (e.g., Baily et al. 1992, Dunne et al. 1989a,b, and Foster et al. 2001, 2006). In these models firms produce a single product, rendering firm creation and destruction equivalent to product-market entry and exit. Here, we imagine a more general model where firms are permitted to add new goods to their product mix over time by incurring product-specific sunk costs of entry. Firms discover their initial productivity in a product after paying its sunk cost of entry, with productivity being imperfectly correlated across product markets. Firms drawing a sufficiently high productivity become producers while firms drawing a low productivity exit immediately, i.e., without ever commencing production. Once a firm begins production of a new product, its actual or perceived productivity in that product evolves over time as stochastic shocks to productivity or learning take place. Firms drop a product when its productivity falls below the level needed for zero profitability. Dropping a product does not necessarily end the life of a firm, however, because it may remain active in other product markets where its productivity remains relatively high.[4]

This generalized model of firm (and industry) dynamics accords well with the stylized product-switching facts noted above. In its steady-state equilibrium, the flow of firms that add a product each period must equal the flow of firms that drop the product. As a result, the model features equilibrium product adding and dropping that is consistent with the frequency and pervasiveness of product switching observed in the data. Furthermore, products' equilibrium add and drop rates in the model are positively correlated, as in the data. In the model, these rates depend upon products' sunk costs of entry: products with low sunk costs of entry exhibit high entry and high exit rates, and *vice versa*.

Additional aspects of firms' extensive-margin adjustments suggest that product switching contributes towards a within-firm reallocation of resources to their best use. A key implication of the firm dynamics model we describe is that firms add and drop products on the basis of their relative productivity across products. In the model, firm-product productivity is correlated positively with firm-product output and firm-product tenure, i.e., the length of time the firm has produced a product. In the data, the probability that a firm drops a product does indeed vary negatively with firm-product output and tenure. We also find evidence that a firm's productivity is correlated positively across its products: single-

[4] See Dunne et al. (1988, 1989b) for an empirical analysis of diversification as a form of market entry distinct from plant birth. Dunne et al. (2005) investigate the relationship between the form of product-market entry and plant death.

product firms with relatively high productivity in their existing product are more likely to add a new product to their mix of goods than a relatively low-productivity firm producing the same initial product.

Though the generalization of existing theory we envision is consistent with many aspects of product switching, it is challenged by other features of the data that relate to broader questions about the boundaries of the firm and the determinants of firm dynamics. First, though the model treats firms as bundles of products, it is silent on which products should be co-produced within firms versus separately produced across firms. Our examination of firms' product portfolios reveals that firms are most likely to co-manufacture products within the same industry or within similar industries (e.g., lumber and furniture or electronics and instruments). Second, the relative contributions of firms' intensive (output per product) and extensive (number of products) margins in determining firm growth and the firm-size distribution are not well understood. Finally, while the extended model predicts a positive correlation between products' add and drop rates, it is not clear why adding and dropping frequently occurs within the same firm across Census years, and why the majority of this reallocation occurs not only within firms but within their surviving production facilities.

Our unanswered questions about product switching mirror a lack of a theoretical consensus on the boundaries of the firm and the determinants of firm dynamics. Both topics are areas of active research and one of the key contributions of the paper is to identify a new dimension of firm behavior for emerging theories of the firm to explain. Empirical research to date has concentrated either on product diversification at a point in time (e.g. Gollop and Monahan 1991 and Baldwin and Gu 2005) or on the more discrete margin of firm entry and exit (e.g. Baily et al. 1992, Dunne et al. 1989a,b and Foster et al. 2001, 2006). Existing theoretical work on multi-product firms, by contrast, focuses on issues associated with managing a firm's range of products at a particular point in time rather than changes in product mix over time (e.g. Baumol 1977, Panzar and Willig 1977, Brander and Eaton 1984, Shaked and Sutton 1990 and Eaton and Schmidt 1994).

The remainder of the paper is structured as follows. Section 2 describes our dataset. Section 3 documents the contribution of product switching to aggregate U.S. manufacturing growth. Section 4 provides evidence on the prevalence and firm-level consequences of product switching among U.S. manufacturing firms. Sections 5 and 6 discusses potential explanations for the trends observed in the data. Section 7 explores the implications of the results for work on the boundary of the firm. Section 8 concludes.

2. Data Description

Our dataset is derived from the U.S. Census of Manufactures of the Longitudinal Research Database (LRD) maintained by the U.S. Census Bureau. Manufacturing Censuses are conducted every five years and we examine data from 1972 to 1997. The sampling unit for each Census is a manufacturing "establishment", or plant, and the sampling frame in each Census year includes information on the mix of products produced by the plant. Very small manufacturing plants (referred to as Administrative Records) are excluded from the analysis unless otherwise noted because data on their mix of products are unavailable. Because product-mix decisions are made at the level of the firm, we aggregate the LRD to that level for our analysis.

Our definitions of "sector", "industry" and "product" are based upon 1987 Standard Industrial Classification (SIC) categories, which segment manufacturing output generally according to its end use.[5] We refer to two-digit SIC categories as sectors, four-digit SIC categories as industries and five-digit SIC categories as products or goods.[6] In the LRD, aggregate manufacturing contains 20 sectors, 459 industries and 1848 products.

For each firm in each Census year, we record the set of products and therefore the set of industries and sectors in which the firm produces. We also observe firms' total and product-level output, as well as their total input usage and wage bills. Output, capital stocks, employment of production and non-production workers and wagebills are also observable for individual plants within firms and can be aggregated up to the level of the firm. For surviving firms, we track the products that firms add and subtract from their product mix across Censuses. There are an average of 141,561 surviving firms in each Census year for which such extensive-margin adjustments can be observed.[7] The Data Appendix provides further details concerning construction of the data.

Table 1 provides a sense of the relative level of detail between products and industries.

[5] The SIC classification scheme was revised substantially in 1977 and again in 1987. Industry identifiers from Censuses prior to 1987 have been concorded to the 1987 scheme. Our results are not sensitive to this concordance: we get substantially similar results if we focus exclusively on the 1987 to 1997 portion of the LRD.

[6] Our terminology differs from that of the Census Bureau. The Census refers to an five-digit SIC categories as "product lines" and reserves the term "product" for seven-digit SIC categories. For a complete list of five-digit products see U.S. Census (1996).

[7] Roughly one-third of manufacturing firms exit between Census years. Our focus on surviving firms excludes the product-changing activities of exiting and entering firms (i.e. we do not record an exiting firm as a firm that drops all of its existing products). However, the theoretical model discussed below allows for endogenous firm exit as well as product switching.

The table lists the products captured by SIC industry 3357, "Nonferrous Wiredrawing and Insulating", which is one of the industries in SIC sector 33, "Primary Metal Industries". The thirteen products in this industry range from copper wire (33571) to fiber optic cable (33579). Though these products share a grossly similar end use, they can differ substantially in terms of the materials and technologies required to manufacture them.

As indicated in Table 2, the typical two-digit manufacturing sector has 24 four-digit industries and 76 five-digit products.[8] The number of products per sector ranges from a low of 12 in Leather (SIC 31) to a high of 187 in Industrial Machinery (SIC 35). Similarly, the average number of products per industry within sectors ranges from a low of 1.1 in Leather to a high of 5.1 in Printing & Publishing (SIC 27).[9] Nonferrous Wiredrawing and Insulating (SIC 3357), the industry highlighted in Table 1, is just one of 26 Primary Metal Industries, and its products represent 14 percent (13/89) of the total number of products in that sector.

Products vary substantially in terms of how they are produced both within and across sectors. This variation is documented in the last four columns of Table 2, which report products' mean and standard deviation capital and skill intensity, by sector.[10] Across sectors, capital intensity varies from $15,000 per worker in Leather (SIC 31) to $494,000 per worker in Petroleum (SIC 29) while skill intensity ranges from 0.05 in Primary Metal (SIC 33) to 0.26 in Printing & Publishing (SIC 27). Within-sector variation in products' input intensities is demonstrated by the standard deviations reported in columns six and eight. Coefficients of variation for capital intensity are relatively high for Lumber (SIC 24), Apparel (SIC 23) and Chemicals (SIC 28). For skill intensity, they are highest for Printing & Publishing (SIC 27), Transportation (SIC 37) and Apparel (SIC 23).

We find that firms producing multiple products, industries and sectors dominate U.S. manufacturing. This dominance is demonstrated in Table 3, which reports the share of U.S. manufacturing firms and output accounted for by multi-product firms. Though the majority

[8] Results for SIC 21, Tobacco, are excluded from Table 2 to conform with U.S. Census Bureau disclosure guidelines.

[9] There is a substantial amount of variation in the precision of industry and product classification. For example, Passenger Cars (SIC 37111) and Combat Vehicles (SIC 37114) are examples of products in the Motor Vehicle industry (SIC 3711), while Textbook Binding and Printing (SIC 27323) and Religious Books, Binding and Printing (SIC 27323) are examples of products in the Book Printing industry (SIC 2732).

[10] Capital and skill intensity are defined as the real book value of buildings and equipment per worker ($000), and the share of non-production workers in total employment, respectively. We do not observe input usage (or wages) for individual products. Means and standard deviations for products are computed as the average input intensity of all plants producing the product within the relevant sector. Means are weighted by plant-product output. Results for Tobacco (SIC 21) are excluded due to Census disclosure guidelines.

of firms (59 percent) produce just a single product, firms that produce multiple products represent 91 percent of output, while firms present in multiple industries and sectors are responsible for 87 percent and 76 percent of output, respectively.[11] Table 3 also reveals that the average multi-product firm produces 4.0 goods, that the average multi-industry firm manufactures in 3.1 industries and that the average multi-sector firm is present in 2.5 sectors. Multi-industry and multiple-sector firms represent 70 percent and 30 percent of all multi-product firms, respectively.

As indicated in Table 4, when firms do produce multiple products, output across them is highly skewed. Each column of the table reports the average output share of each product, in descending order, across all firms producing the noted number of products, up to ten.[12] The average share of the largest product declines from 81 to 45 percent as the number of products firms produce increases from two to ten. For firms manufacturing five or more products, each product ranges from 1.5 to 2.5 times as big as the next largest product.[13]

Finally, Table 5 compares the characteristics of firms producing multiple products, industries and sectors versus those producing only a single product, industry or sector, respectively. Comparisons are for 1997 and are obtained by regressing the log of the noted firm characteristic on a dummy variable indicating the firms' status after controlling for industry fixed effects. As indicated in the table, multi-product firm shipments are on average 77 percent higher than those of single-product firms. Multi-product firms also exhibit higher employment, wages, labor productivity (i.e., shipments per worker) and total factor productivity than single-product firms.[14] Similar differences are found with respect to firms producing multiple industries and sectors. All of the differences displayed in the table are statistically significant at the 1 percent level.

3. Product Switching and Aggregate U.S. Manufacturing

In this section we demonstrate that product adding and dropping by surviving firms accounts for a large share – nearly one-third – of the aggregate growth in real U.S. manu-

[11] Multi-product firms represent more than 80 percent of output in all two-digit SIC sectors. As a share of firms, they range from 28 percent in Leather (SIC 31) to 54 percent in Food (SIC 20).

[12] Firms producing at most ten products represent roughly 45 percent of all manufacturing value in the pooled 1972 to 1997 sample.

[13] If the distribution of product size within firms followed a power law, the ratio of each good's output share to the next-ranked product would be a constant. See the further discussion in Section 7.

[14] For TFP, we use the multi-factor superlative index number of Caves et al. (1982) to construct the percentage difference in firm productivity from the mean of all firms in the same primary four-digit SIC industry in each Census year t.

facturing output between 1972 and 1997.

It is straightforward to decompose the aggregate change in U.S. manufacturing output from Census years $t-5$ to t, ΔY_t into the sum of the output changes due to new (N), exiting (X), and continuing (C) firms,

$$\Delta Y_t = \sum_{j \in N} \Delta Y_{jt} + \sum_{j \in X} \Delta Y_{jt} + \sum_{j \in C} \Delta Y_{jt}, \tag{1}$$

where j indexes firms. At each continuing firm, output growth can be decomposed further into the contributions of added (A), dropped (D) and continuing (B) products,

$$\Delta Y_{jt} = \sum_{i \in A} \Delta Y_{ijt} + \sum_{i \in D} \Delta Y_{ijt} + \sum_{i \in B} \Delta Y_{ijt}, \tag{2}$$

where i indexes products. Finally, the output of goods produced in both periods can be broken down into products that grow (G) and shrink (S),

$$\sum_{i \in B} \Delta Y_{ijt} = \sum_{i \in G} \Delta Y_{ijt} + \sum_{i \in S} \Delta Y_{ijt}. \tag{3}$$

Substituting, we can write the aggregate change in U.S. manufacturing output as

$$\Delta Y_t = \sum_{j \in N} \Delta Y_{jt} + \sum_{j \in X} \Delta Y_{jt} + \sum_{j \in C} \left[\sum_{i \in A} \Delta Y_{ijt} + \sum_{i \in D} \Delta Y_{ijt} + \sum_{i \in G} \Delta Y_{ijt} + \sum_{i \in S} \Delta Y_{ijt} \right]. \tag{4}$$

The first two terms account for the contribution of firm entry and exit. Terms three and four represent the change due to product adding and dropping by surviving firms, i.e., adjustments to firms' extensive margins. The last two terms symbolize the growth and decline of continuing firms' continuing products, i.e., their intensive margins. Since aggregate output in equation (4) is an unweighted sum of the individual terms, the percentage contribution of each component is not sensitive to the choice of units of measurement or to the choice of a particular theoretical framework.

Table 6 decomposes U.S. manufacturing growth according to these contributions for each Census interval as well as for the entire 1972 to 1997 sample period. The decomposition is shown in percentage terms by dividing year-to-year changes by initial manufacturing shipments. Census years are listed in column one and overall growth rates for the noted periods are reported in column two. The remaining columns document the net and gross contributions of firm entry and exit (columns three to five), firms' extensive-margin adjustments (columns six to eight), and firms' intensive-margin adjustments (columns nine to eleven). The final row of the table reports the share of 1972 to 1997 growth accounted for by each gross and net contribution over that period. Note that in each row of the table, the net contributions sum to the overall change noted in column two.

From 1972 to 1997, real U.S. manufacturing output grew 65 percent, with increases in each five year period except 1977 to 1982. As indicated in the second-to-last row of the table, this 65 percentage point increase is the sum of a 3 percentage point decline due to net firm entry, a 19 percentage point increase due to net product additions by continuing firms, and a 50 percentage point increase due to the net growth of continuing products at continuing firms. Thus, firms' extensive-margin adjustments accounted for nearly one-third – 29 percent – of the change in real U.S. manufacturing shipments over the sample period.[15]

Table 6 also demonstrates the substantial "excess" reallocation of economic resources associated with product switching.[16] Between 1972 and 1997 gross product additions raised aggregate manufacturing output by 189 percent while gross product deletions reduced it by 170 percent. These gross contributions are quite large compared to the increase of 19 percent from net product adding, indicating that firms altered their productive capacity far more substantially than was needed to amass their net contribution to overall growth. They are also larger than the gross intensive-margin adjustments, which were 127 percent and -77 percent, respectively. While a substantial literature examines excess reallocation of resources due to entry and exit of firms, the causes and consequences of such reallocation within surviving firms has received scant attention.

4. Product Switching

This section documents the prevalence and impact of product adding and dropping by U.S. manufacturing firms from 1972 to 1997. It also examines the extent to which firms adjust their extensive margins at existing facilities rather than via merger and acquisition.

4.1. The Frequency of Product Switching

We document the prevalence of product switching by dividing firms into four exhaustive and mutually exclusive groups based on the manner in which they alter their product mix

[15] A similar decomposition (not shown but available upon request) performed according to plants rather than firms indicates that extensive-margin adjustments at the plant level account for 34 percent of real shipment growth.

[16] The use of the term "excess reallocation" originates in the literature on job creation and destruction in Davis and Haltiwanger (1992).

between Census years. Possible actions are: (1) *None* - the firm does not change its mix of products; (2) *Drop* - the firm only drops products; (3) *Add* - the firm only adds products; and (4) *Both* - the firm both adds and drops (i.e., "churns") products.

Table 7 reports firm activity across these dimensions for the pooled 1972 to 1997 dataset. Cells in the top panel of the Table report the average percent of firms reporting each activity across five-year Census intervals, while cells in the bottom panel report percentages weighted by firm output. Figures in the table are computed for surviving firms only.[17] The three columns in each panel report results for all firms, single-product firms and multi-product firms, respectively.

As indicated in the upper panel of the table, 68 percent of all surviving firms alter their product mix every five years, 12 percent by dropping at least one product, 11 percent by adding at least one product and 45 percent by both adding and dropping at least one product.[18] Comparison of these results with those in the two adjacent columns indicates that single-product firms are more likely to leave their product mix unchanged than multi-product firms (46 percent versus 11 percent). Note that single-product firms cannot *Drop* and survive.

Product switching is even more frequent when weighted by firm output, indicating that large firms are relatively more likely to add and drop products than small firms. As indicated in the bottom panel of the Table 7, an average of 93 percent of all manufacturing output is produced by firms that change their product mix across Census years. Firms that churn products account for the largest share of output, at 81 percent.[19]

4.2. The Impact of Product Switching

We quantify the firm-level impact of product switching along three dimensions. First, we show that product adding frequently pushes firms into new industries and sectors. Second, we demonstrate that newly added and dropped products represent a sizeable portion of firm

[17] Firms that enter and exit are by definition "adders" and "droppers" respectively. We exclude them to focus on product turnover at incumbents.

[18] The statistics in Table 7 exhibit no systematic variation over time: the share of firms engaging in each activity was 30, 12, 14, and 44 percent for *None*, *Add*, *Drop*, and *Switch* during the 1972 to 1977 interval and 33, 14, 12, and 41 percent, respectively, over the 1992 to 1997 interval. Firms also do not appear to be switching into and out of the same products over time. Re-adding a formerly dropped product represents less than 7 percent of all product switches observed in the data.

[19] Product switching pervades all sectors of U.S. manufacturing. The average share of firms reporting any product-switching activity ranges from a high of 78 percent in Printing & Publishing (SIC 27) to a low of 43 percent in Leather (SIC 31), confirming that the prevalence of product switching is not driven by high levels of activity in a small number of sectors.

activity. Finally, we report significant relationships between product switching and changes in firm performance.

Product switching frequently induces firms to extend or contract the range of industries and sectors they produce. Table 8 compares extensive-margin adjustments across three levels of aggregation – products (column 2; reproduced from Table 7), industries (column three) and sectors (column four) – using the same typology of activities introduced above. Industry or sector adding refers to firms adding at least one product outside its existing set of industries or sectors. Likewise, industry or sector dropping indicates that firms have dropped all products in a given industry or sector.

The first row of the Table records the average share of firms making no adjustments between Census years. As indicated, firms generally switch products within industries: product switching (68 percent) is more prevalent than industry switching (47 percent), while industry switching is more frequent than sector switching (21 percent). This relative ordering is intuitive given that jumps between two-digit sectors are likely to be more extreme than shifts within four-digit industries. Nevertheless, product adding does induce an average of 34 percent of firms to enter at least one new industry between Census years, and 14 percent of firms to break into at least one new sector. To the extent that adding industries and sectors requires adopting unfamiliar production and distribution technologies, these percentages suggest that product switching often involve substantial changes in the nature and scope of the firm.

Table 9 reveals that a substantial fraction of multi-product firm output is accounted for by recently added or about-to-be dropped products. The first row of the table reports the average share of output in year t comprised by products added between Census years $t-5$ and t among firms that do any adding. The second row of the table reports a similar share with respect to products dropped between Census years t and $t+5$. Column two reports averages across all added and dropped products, while columns three and four are restricted to adds and drops that extend or contract the set of industries and sectors firms produce, respectively. As indicated in the second column of the table, recently added products represent an average of 49 percent of output across multi-product firms, while about-to-be dropped products account for an average of 46 percent of output. The remaining columns demonstrate that 26 percent (8 percent) of current period output is due to industries (sectors) that are new to the firm, while 23 percent (9 percent) percent of current period output is in industries (sectors) that the firm will have abandoned by the next Census year. These results reinforce the message of Table 8, which is that extensive-margin adjustments entail relatively large changes in firm activity.

To provide some descriptive statistics on the relationship between product switching and firm outcomes we consider simple OLS regressions of changes in firm characteristics between Census years on dummy variables capturing contemporaneous product switching behavior,

$$\Delta Z_{jt} = \alpha_t + \alpha_n + \beta_1 Drop_{jt} + \beta_2 Add_{jt} + \beta_2 Both_{jt} + \varepsilon_{jt}. \tag{5}$$

where ΔZ_{jt} represents the annualized log difference in a firm outcome between Census years $t-5$ and t, α_t and α_n represent year t and industry n fixed effects and *Drop*, *Add* and *Both* are defined as above.[20] The firm characteristics we consider are output, employment, average wage per worker, labor productivity and total factor productivity.[21]

Regression results, reported in Table 10, include all firms over the pooled 1972 to 1997 sample period. Each row of the table reports results for a different firm-outcome regression. Standard errors adjusted for clustering at the industry level are reported in parentheses below coefficients. The number of firm-year observations included in each regression as well as each regression's R^2 are reported in the final two columns of the table.

As indicated in the table, firm performance as well as input use are significantly correlated with firms' extensive-margin adjustments. Predictably, output and employment growth increases with product adding and declines with product dropping. Firms that both add and drop products across Census years exhibit both increasing employment and output. Wages, on the other hand, rise with all extensive-margin adjustments.

The last two rows of the table report results for two measures of productivity. Labor productivity is positively correlated with all extensive-margin adjustments, which is understandable given the coefficients reported separately for output and employment. Total factor productivity, in contrast, rises with product adding as well as with product switching, but declines with product dropping. The decline in TFP at firms that drop products is consistent with a decline in capital productivity that is more precipitous than the rise in labor productivity, i.e. output falls following product dropping and it takes time for the capital stock to adjust.

[20] Firms are assigned to the industry which represents the largest share of their output. The results are not sensitive to this assignment.

[21] As noted in footnote 14 above, we use the multi-factor superlative index number of Caves et al. (1982) to construct the percentage difference in firm productivity from the mean of all firms in the same primary four-digit SIC industry in each Census year t. Computing TFP for multiple-product firms is problematic because the grouping of firms into appropriate industries is imprecise. See, for example, Bernard, Redding and Schott (2005) and De Loecker (2005). We include here for comparison purposes.

We caution that these results are merely intended to provide descriptive statistics on the correlation between firm outcomes and the decision to add and drop products. They show that adjustments to product mix are associated with changes in observed firm characteristics. Because the determination of product mix is itself endogenous, the regression coefficients capture both the correlation between changes in firm outcomes and the non-random decision to add or drop products, as well as the impact of product-mix adjustments on firm outcomes conditional on the decision to add or drop products.

We now examine the method by which firms switch products over time before moving on in Section 5 to concentrate on the issue of how extensive-margin adjustments themselves can be modeled.

4.3. How Product Switching Occurs

There are a variety of ways in which firms change products. They can add goods at existing plants, at newly constructed facilities, or by acquiring an existing plant from another firm. Similarly firms can drop products at continuing plants, by closing plants or by selling plants to another firm. Surprisingly, we find that very few product-mix changes occur because of mergers and acquisitions; the vast majority take place within firms' existing facilities.

Table 11 reports the distribution of product adds (top panel) and drops (bottom panel) according to how they are accomplished. As indicated in the first columns of each panel, 94 percent of added and dropped products, respectively, are added and dropped by existing plants. The role of mergers and acquisitions (M&A), in particular, is exceedingly small: less than 1 percent of both adds and drops are the result of plant acquisitions or divestitures. M&A activity possesses a relatively more pronounced – though still small – association with sector switching. On average, 1.9 and 1.4 percent of firms add and drop sectors via M&A, respectively.

Though product switching is not synonymous with M&A, M&A is tightly linked with product switching. Table 12 compares product- and sector-switching activity according to whether or not firms concomitantly acquire or divest a plant. As indicated in the table, firms involved in an ownership change are relatively more likely to change their product mix. An average of 95 percent of firms that engage in M&A also alter their product mix, compared with an average of 68 percent for firms that do not participate in an acquisition or divestiture. For sector switching the importance of M&A is even more stark: the analogous percentages are 60 and 21 percent.

Taken together, the results in this section establish that virtually all product switching is done at firms' existing plants while very little of it is the result of M&A. However, firms that undergo ownership changes are much more likely to alter their mix of products and industries than firms with no ownership changes.

5. Why Do Firms Switch Products?

In the preceding sections we have shown that product switching by U.S. manufacturing firms is frequent, often occurs within firms' existing plants, may span diverse activities, involves a substantial proportion of firm output, and makes a notable contribution to firm and aggregate growth. In this section we examine alternative explanations for this behavior, distinguishing between those that are product-specific, firm-specific, and firm-product-specific. Our empirical results suggest that firm-product-specific explanations are the most compelling, and we provide evidence that a natural extension of existing models of industry dynamics is able to explain a number of aspects of product switching.

5.1. Product- or Firm-Specific Explanations

One class of explanations for product switching emphasizes forces that are product-specific but common to all firms, for example shocks to products' relative demand or supply. While demand shocks might be driven by consumers' jumping from unfashionable to fashionable products over time, supply shocks might result from changes in production technologies or trade liberalization. Because both of these explanations emphasize a net reallocation of economic activity between groups of products, they imply a negative correlation between products' add and drop rates: "hot" products should be added but not dropped while the reverse should be true of "cold" products.

Figure 1 displays the mean rate at which five-digit SIC manufacturing products are added and dropped by U.S. manufacturing firms over the 1972 to 1997 sample period. A product's add and drop rates in year t are computed as the number of firms adding and dropping the product, respectively, between Census years $t-5$ and t divided by the average number of firms producing the product in both years.

As shown in the figure, there is a clear positive correlation between the rates at which U.S. manufacturing products are added and dropped. This correlation, which is statistically significant at conventional levels, indicates that the extensive-margin adjustments we observe in the data cannot be explained solely in terms of a net reallocation of economic activity from one group of products to another. Although the fact that add and drop rates do not lie perfectly along a 45 degree line indicates that there is some net transfer of output across products in the data, other forces are also clearly at work.

A second class of explanations for product switching focuses on factors that are specific to firms but common to all products. A positive productivity shock to all of a particular firm's manufacturing facilities, for example, might increase the profitability of all of the firm's products and thereby induce the firm to add a marginal product that it previously did not find it profitable to produce.[22] Such explanations, however, are hard to reconcile with the fact, reported in Table 7, that firms frequently add and drop products simultaneously across Census years. That stylized fact suggests that firm-specific shocks differentially affect products; we refer to such explanations as firm-product-specific in the next section.[23]

A more fundamental difficulty for both firm- and product-specific explanations of product switching is that firm-product characteristics are found to be influential determinants of product switching even after controlling for the characteristics of both firms and products. In Section 6, below, we show that firms are more likely to drop products when firm-product output is relatively small and when firm-product tenure is relatively short.

One remaining possibility is to think of firm- and product-specific explanations working in tandem. Suppose, for example, that there is both a positive shock to a firm's productivity that is symmetric to all of its products and, at the same time, a negative, economy-wide shock to the profitability of just one the firm's products. In this case, the positive firm-specific shock may induce the firm to add one or more new products while the negative product-specific shock may drive the firm to drop that particular product. This explanation is consistent with simultaneous product adding and dropping across Census years noted above, but it imposes the strong assumption that there are no idiosyncratic factors that affect the profitability of a firm-product pair.

A simple empirical inquiry indicates that this assumption is both implausible and rejected by the data. Regressing a dummy for whether firms drop products between Census years on a full set of firm fixed effects in addition to a full set of product fixed effects, we find

[22] See Chandler (1920) for one of the classic early discussions of a firm's trade-off between scale and scope.

[23] One way of reconciling simultaneous adding and dropping with a firm-specific model of product switching is to argue that the "simultaneity" observed in Table 7 is entirely due to time aggregation, i.e., the fact that we observe firms across five-year intervals rather than annually. Concurrent adding and dropping observed across five-year intervals could be driven by annual productivity shocks that are exclusively firm specific and either uncorrelated or negatively correlated over time. One or two years of positive shocks followed by one or two years of negative shocks, for example, could push the firm to add one set of goods and drop another.

R^2s of just roughly 50 percent.[24] These results imply an important role for idiosyncratic factors that are specific to individual firm-product pairs.

5.2. The Interactions of Firms and Products

An alternative class of explanations for the product switching we observe among U.S. manufacturing firms emphasizes the interactions of firm and product attributes. Firm shocks, such as the accumulation of R&D knowledge or the substitution of one management team for another, may have uneven effects across products. As a result, the profitability of products not currently manufactured by the firm may rise relative to those that are. If some factors of production (e.g. managerial time) are in limited supply, the firm may find it profitable to add a new product whose relative profitability has risen and drop an existing product whose relative profitability has fallen. Lucas (1978), for example, emphasizes the inelastic supply of managerial talent in a model explaining relative firm size. Klette and Kortum (2004), on the other hand, explore the role of innovation in determining a firm's scope across product markets.

Firm-product-specific explanations of product switching also encompass the existence of product shocks that have asymmetric effects across firms. Rossi-Hansberg and Wright (2005), for example, emphasize product-specific shocks to human capital accumulation in influencing the distribution of firm size. Alternatively, skill-biased technological change that raises the skill intensity of a good's production may induce skill-abundant firms to add the product while driving skill-scarce firms to drop it.[25]

More generally, firm-product-specific accounts of product switching emphasize factors that are idiosyncratic to individual firm-product pairs. One set of such explanations focuses on product sunk costs of entry and producer heterogeneity within and across product markets. As noted above, theoretical models incorporating these elements already are employed to explain firm creation and destruction. Our empirical analysis of product switching, however, indicates that the insights of these models possess much wider relevance as they can be applied to surviving firms' adjustments to their extensive margins.

In existing models, firms generally pay an up-front sunk cost to create the firm, after which *ex ante* uncertainty concerning firm productivity is resolved. This uncertainty either takes the form of stochastic shocks to firm productivity (as in Hopenhayn 1992, Ericson

[24] These OLS regressions take the form described in equation (6) of Section 6. below.

[25] The substitution of products that are skill-intensive for those that are less intensive within firms and industries may help explain the within-firm and within-industry skill-upgrading observed in U.S. manufacturing since the early 1980s (see Riggs and Zarotiadis 2005).

and Pakes 1995, Melitz 2003 and Bernard, Redding and Schott 2006) or learning about an uncertain value of true firm productivity (as in Jovanovic 1982).[26] In both classes of models, if productivity falls below some threshold value, firms endogenously exit. Steady-state equilibria feature a constant mass of active firms, with the result that the flow of new firms incurring the sunk cost and starting production must equal the flow of existing firms choosing to exit. High rates of firm entry and exit are associated with high sunk costs, while low rates are associated with low sunk costs.[27]

In a similar way, a compelling explanation of product switching has surviving firms facing *ex ante* uncertainty about their productivity in new (to the firm) product markets. To enter a new product market, the firm must incur a product-market-specific sunk cost of entry. The firm begins production after paying the sunk entry cost for the new market (i.e., adds the new product) if the productivity draw for the new product is above the threshold at which production is profitable. Firm-product productivity evolves over time as stochastic shocks to productivity occur or learning takes place. The firm exits a product market (i.e., drops a product) if actual or revealed firm-product productivity falls below the zero profitability threshold. In equilibrium, the flow of firms adding the product equals the flow of existing firms that drop it, yielding a positive correlation between products' add and drop rates.

Several of the stylized facts we document are consistent with this framework. In particular, the frequency and pervasiveness of product adding and dropping by U.S. manufacturing firms in our sample are highly suggestive of product switching occurring *in equilibrium*. This feature of the data accords with sunk entry cost models, where the steady-state flow of firms that add a new product would equal the steady-state flow of firms that drop the product.

6. Empirical Implications of Firm-Product Explanations

In this section we examine additional implications of models featuring product sunk costs of entry and stochastic firm-product productivity.

6.1. Covariation Between Product Adding and Dropping

Product sunk cost of entry models imply a positive correlation between the rate at which surviving firms add and drop products. This correlation further implies that gross product

[26] For models of endogenous sunk costs, see Sutton (1991).

[27] Plant entry and exit rates are strongly positively correlated across industries in many countries. See for example Dunne et al. (1988) for the United States and Disney et al. (2003) for the U.K..

adding and dropping in each product be large relative to their net effect: at the limit, if product add and drop rates lined up along the 45 degree line, the net contribution of adds and drops would be zero while absolute value of each gross contribution would exceed zero for all products. As noted above we find a positive correlation between products' add and drop rates in Figure 1. This finding accords with the results of the decomposition of aggregate manufacturing growth reported in Table 6, where the gross contributions of firms' extensive-margin adjustments to output growth are large relative to their net contribution in every year of the sample.

6.2. Selection Within Firms and Product Markets

Another implication of product sunk costs of entry models is that firms retaining production of a particular product should be systematically more productive in manufacturing that product than firms choosing to drop it. In the models of Hopenhayn (1992) and Jovanovic (1982), firm productivity is positively correlated with firm output as well as the age of the firm. Application of this relationship to product market entry suggests that firms opting to drop a product should have relatively low output of the product and should have produced the product for a relatively short period of time compared with other firms electing to continue manufacturing the product.[28]

Both of these implications are consistent with the data. Table 13 reports OLS[29] regression results of a dummy indicating that a firm drops a product between Census years 1992 and 1997 on firms' 1992 relative product size ($Size_{jit}$) and tenure in the product market ($Tenure_{jit}$) as well as relative firm size ($Size_{jt}$) and firm age (Age_{jt}) and the number of products the firm produces ($Products_{jt}$),

$$Drop_{jit} = \alpha_i + \beta_1 Size_{jit} + \beta_2 Tenure_{jit} + \beta_3 Size_{jt} + \beta_4 Age_{jt} + \beta_5 Products_{jt} + \varepsilon_{jit}, \quad (6)$$

where, as above, j and i index firms and products, respectively.[30] Very similar results hold for other years in the data.

Firm-product size and firm-product tenure are measured relative to their averages for the product via log differencing in each Census year. As a result, they control for differences

[28] It is not possible to directly measure productivity of a product within a firm in the data.

[29] We use an OLS linear probability model here in order to include firm and product fixed effects. Inclusion of these fixed effects in a logistic regression is impractical given the size of our sample.

[30] We examine these implications in the context of product dropping because construction of an analogous product-adding sample is impractical given the size of our dataset. In each year, there are on average 140,000 firms, each of whom can add one or more of over 1848 products.

across products in output and tenure, both at a point in time and over time. Similarly, firm size and age are measured relative to the average of firms producing the same mix of products, by year.[31] Additional specifications include firm fixed effects, product fixed effects, and both sets of fixed effects together.

The first column of Table 13 reports regression results when fixed effects are excluded. As shown in the first two rows, firms are less likely to drop a product if their shipments and tenure are larger than other firms producing the same product. In contrast, results in the third and fourth rows of the column reveal that firms are more likely to drop a product if their total shipments across all products are larger and if they are older than other firms producing the same product mix.[32]

The statistical significance of the firm-product variables, after controlling for the analogous characteristics of the firm, provides support for firm-product-based explanations that emphasize factors idiosyncratic to firm-product pairs. In particular, the negative coefficients on firm-product relative size and age directly support the predictions of product sunk cost models and suggest that purely firm-based explanations for product switching that neglect factors idiosyncratic to the firm-product are incomplete. Since the firm-product variables are measured relative to the average of all firms in the product market, the results also cast doubt on exclusively product-specific explanations of product switching.

The remaining columns of Table 13 bolster this conclusion by demonstrating that the regression results are robust to the inclusion of a full set of firm fixed effects, a full set of product fixed effects, as well as full sets of both firm and product fixed effects. These fixed effects control for all unobserved firm- or product-specific considerations that may influence the probability with which a product is dropped. We note that firm-specific covariates are dropped in the last two columns of the table due to the inclusion of firm fixed effects.

The finding that firm relative size and age are positively correlated with product dropping is at first surprising given that the literature on firm entry and exit finds these variables to be negatively correlated with the probability of firm death. However, the distinction between a firm's exit from individual product markets and the destruction of the firm is important in resolving this tension. Our finding that firm-product relative size and tenure are negatively correlated with product dropping exactly parallels the finding for firm death.

[31] The correlation of $Size_{jit}$ and $Size_{jt}$ is 0.12 while the correlation of Age_{jit} and Age_{jt} is 0.26. Both correlations are statistically significant at the 1 percent level.

[32] While measuring productivity for multi-product firms is problematic (see Bernard et al. 2005 and De Loecker 2005), a similar pattern of results (available upon request) is found in analogous regressions that also control for firm labor productivity or TFP.

Interestingly, our results suggest that large and old firms may be more likely to survive precisely because they of their ability to move in and out of individual product markets.[33]

The results in Table 13 have broader implications as well. Above, we find that firms' extensive-margin adjustments are an important component of aggregate U.S. manufacturing growth. Here, we demonstrate that firm-product drops exhibit systematically lower relative size and tenure than surviving firm-product pairs. To the extent that relative size and tenure are positively correlated with firm-product productivity, our findings provide evidence of systematic reallocation of economic activity towards higher productivity output both across products within firms as well as across firms within manufacturing. These findings suggest that existing studies of industry dynamics likely underestimate the role of reallocation in overall economic growth: by focusing almost exclusively on the birth-death margin, they neglect surviving firms' extensive margin.

6.3. Firm Productivity and Product Switching

Models with product sunk costs of entry allow for the possibility that a firm's productivity in one product market is correlated with its productivity in other markets. If this correlation is positive, another implication of the product sunk cost models is that, among firms with the same product mix, the firms with the higher productivity should be more likely to add a new product. The intuition for this implication is straightforward: with productivity positively correlated across product markets, high productivity firms are more likely to draw a productivity above the threshold needed to sustain entry.

This implication is also consistent with the data. To examine it, we focus on single-product firms because this restriction enables us to abstract from problems of measuring productivity in multi-product firms (see Bernard et al. 2005 and De Loecker 2005). Table 14 reports OLS[34] regression results of a dummy indicating product adding by a single-product firm between Census years t and $t+5$ on firm productivity in year t,

$$Add_{jt} = \alpha_t + \alpha_i + \beta_1 Productivity_{jt} + \varepsilon_{jt}, \tag{7}$$

where α_t and α_i are year and product fixed effects, respectively, and the productivity of

[33] Indeed, the ability to enter and exit individual product markets flexibly may be itself a capability of firms, as discussed for example by Helfat and Raubitschek (2000), Sutton (2005) and Teece at al. (1997). Our results are also consistent with Bernard and Jensen (2007), who find that the production of multiple products is associated with a significantly lower probability of plant death.

[34] Here, as above, we use an OLS linear probability model so that product fixed effects can be included. Inclusion of these fixed effects in a logistic regression is impractical given the size of our sample.

firm j is measured in terms of either labor productivity or total factor productivity (TFP). We include product fixed effects to compare the actions of firms producing the same initial product. Productivity is compared before a product is added and hence before the firm becomes multi-product.

As shown in Table 14, product adding by single-product firms is positively and statistically significantly correlated with both TFP and labor productivity. This positive correlation remains even when controlling for firm size (i.e., employment) and age. These findings are consistent with the predictions of product sunk entry costs models with stochastic productivity if, as seems plausible, firm productivity is positively correlated across products.

The results in Table 14 are also consistent with the idea that the productivity advantage of multi-product firms noted in Table 5 is not simply caused by their production of a larger number of products. In part, it appears to capture a selection effect: single-product firms who subsequently become multi-product firms are on average more productive than other single-product firms even before they become multi-product.

7. Discussion

In the preceding two sections, we showed that a natural extension of existing models of industry dynamics is consistent with many aspects of product switching, and that several of its theoretical predictions receive direct empirical support. There are other features of the firm-product data, however, that are not well explained by the extended model and that raise broader questions about the boundaries of multiple-product firms and the determinants of firm dynamics. These features, interesting in their own right, also provide guidance for future theories of the firm.

The first set of questions relates to the breadth of firms' product mix. In existing models of industry dynamics, the firm is implicitly identified with a single product. In the extended model we describe above, firms are allowed to produce multiple products. Factors governing the equilibrium number and types of products co-produced by the firm, however, are not specified. In Table 15, we report the frequency with which firms co-produce products within and across two-digit SIC sectors from 1972 to 1997. The dark (light) shading indicates co-production that is significantly more (less) frequent than expected based on the individual probabilities of producing each product.[35] As shown in the table, the probability that a firm

[35] We assess statistical significance by comparing the observed co-production frequencies to those that would be expected under a null hypothesis that the decisions to produce row and column products are

produces a product in the row sector conditional on production of a product in the column sector is relatively high within two-digit sectors as well as between two-digit sectors that appear related (e.g. Electronics and Instruments or Lumber and Furniture). Furthermore, the matrix of data as a whole rejects the null hypothesis that the probability a firm produces a product is independent of the firm's existing product mix (p-value = 0.000).

The results in Table 15 pose a variety of questions for further theoretical research. Why are some pairs of products produced within firms and others across firms? Does co-production reflect complementarities between products or common firm capabilities that are shared across the products? If there are complementarities or shared capabilities, what constrains equilibrium firm scope? Why do some firms become multi-product while others remain single-product? How is the decision to become a multi-product firm related to the systematic differences in performance observed between single and multi-product firms?[36]

A second set of questions concerns how firms grow. Existing empirical research on this issue examines whether firm growth is independent of firm size (i.e., Gibrat's Law) or whether it exhibits age or scale dependence (see for example Sutton 1997, Cooley and Quadini 2001, Albuquerque and Hopenhayn 2002 and Rossi-Hansberg and Wright 2005). One of the key findings of our paper is that, just as industry dynamics are shaped by the endogenous selection of firms, so firm dynamics are influenced by the endogenous selection of products. In particular, product adding and dropping are systematically correlated with changes in firm size and productivity, and multi-product firms are larger and more productive than single-product firms. Further research is needed into the respective roles of firms' intensive (how much of each product is produced) and extensive (how many products are produced) margins in firm growth.

A third and related set of questions focuses on the distribution of product sizes within firms. An active research agenda currently seeks to explain the observed distribution of firm sizes within industries and to determine whether it is well-approximated by a Pareto distribution (see for example Axtell 2001, Cabral and Mata 2003, Luttmer 2004 and Rossi-Hansberg and Wright 2005). Here, we find skewness in the distribution of output across

independent. Under this null, the expected frequency with which a particular pair of sectors is co-produced follows an independent Poisson distribution. An individual cell's deviation from random co-production therefore follows a standard normal distribution, $\frac{o_{rc}-e_{rc}}{\sqrt{e_{rc}}} \sim N(0,1)$, where o_{rc} and e_{rc} are the observed and expected frequencies in row r and column c, respectively. Summing across cells, the statistic for testing whether the entire matrix of frequencies is generated by random co-production, $\sum_{r,c} \frac{(o_{rc}-e_{rc})^2}{e_{rc}}$, is distributed chi-squared (Cochran 1952).

[36] See Sutton (2005) for further discussion of firm capabilities and Gibbons (2004) for a survey of recent research on the boundaries of the firm.

firms as well as in the distribution of products within firms. A commonly used benchmark for size distributions is Zipf's law, which would predict a constant ratio of output shares between the top two products regardless of the number of products produced.[37] Instead, in Table 4, we find that the ratio of output shares between the top two products is falling from 3.2 to 2.2 as the number of products at the firm increases from 2 to 10, i.e. that the distribution of output shares is shifting more than proportionately towards the smaller products as the number of products increases at the firm.

A final group of questions relates to how product switching is accomplished. We find that firms frequently decide to both add and drop products between Census periods and that the vast majority of product switching occurs within firms' existing production facilities rather than via mergers and acquisitions. It is not directly apparent from an extended model of industry dynamics why firms would add and drop products "simultaneously". One potential explanation is an inelastic supply of factors of production such as managerial time, but this explanation provides little insight into why product switching often occurs within firms' surviving plants. Indeed, managerial time is arguably a firm rather than a plant-specific factor of production. Future models of firm dynamics must explain both firm scope at a point in time and provide insight into the factors governing reallocation between firms, within firms and within plants.

It is perhaps not surprising that a natural extension of existing models of industry dynamics offers an incomplete explanation of product switching. The questions of the boundaries of the firm and firm dynamics are areas of active research. One of the key contributions of our paper is to identify a new dimension of firm behavior for emerging theories of the firm to explain. The explanation of product switching is not only of interest in itself, but also because of the potential for this new dimension of firm behavior to discriminate between competing theories of the firm, and because we find product switching to have important microeconomic implications for firms and macroeconomic consequences for broader economic aggregates.

8. Conclusions

Of primary concern in economics is the extent to which resources are allocated to their most efficient use. Virtually all empirical research on reallocation as a source of output growth and productivity advancement has focused on the entry and exit of firms and plants

[37] See, for example, Zipf (1949).

or on changes in the composition of output across firms and plants. Here, we demonstrate the relative importance of looking within firms to the products added and dropped over time. Using a dataset that tracks U.S. manufacturing output at the firm-product level from 1972 to 1997, we find that firms add and drop five-digit SIC products with surprising intensity and frequency. On average, 68 percent of U.S. manufacturing firms alter their mix of products every five years, with 45 percent of firms both adding and dropping at least one product. These adjustments drive an average of 47 percent of firms to enter new or exit existing four-digit SIC industries, and 21 percent of firms to extend or contract their set of two-digit SIC sectors. Overall, we find that product switching accounts for a substantially larger share of aggregate U.S. manufacturing growth than net firm births and deaths.

Observed patterns of product switching do not match explanations that focus solely on the characteristics of products or solely on the attributes of firms. In particular, rationales for product switching based on a net reallocation of economic activity away from "cold" products to "hot" products are difficult to square with the positive correlation observed between the rate at which a product is added and dropped. Another feature of the data at odds with these exclusively firm- or product-specific explanations of product switching is that firm-product pairs that dissolve differ systematically within product markets from firm-product combinations that survive.

In contrast, many aspects of product switching are consistent with a natural extension of existing models of industry dynamics that have been used to explain firm creation and firm destruction following Jovanovic (1982) and Hopenhayn (1992). This natural extension allows firms to produce multiple products and features sunk entry costs and producer heterogeneity that are specific to individual products. Variation in sunk entry costs across product markets generates the observed positive correlation between the rate of product adding and dropping. It also suggests firms self-select into product markets on the basis of productivity, an implication that is consistent with our observation that more productive firms are more likely to add products.

More generally, our findings raise broader questions of the boundaries of the firm and the determinants of firm dynamics, areas where theoretical research is nascent and ongoing. A key contribution of our paper is the empirical evidence on a new dimension of firm behavior that can help guide future theoretical research. Our examination of surviving firms' extensive margin adjustments highlights the fact that even basic concepts, such as a firm's industry, become far more nuanced when firms produce sets of products that change over time. More generally, our analysis raises a host of questions about the scope of the firm and the influence of product, firm and market characteristics on this scope over time. To what extent do firms add and drop products in response to trade liberalization and other forms of deregulation? How does the recognition of multi-product firms and product switching change our understanding of the determinants of firm growth and the firm-size distribution? How is product switching related to the specialization of firms across products? Does product switching influence job creation and destruction? To what degree does product switching depend on national policies and institutions, such as barriers to entry and labor market regulation?

Not all of these questions can be answered with the data used in this paper and we have only scratched the surface of other possible topics for further research. The striking importance of firms' extensive margins in our data calls out for more empirical work creating even more finely detailed datasets, tracking firms' product mix across more disaggregate categories and at higher frequencies. The empirical findings that we report also suggest the need for more theoretical modelling of firm-product dynamics and their aggregate implications. Additional theoretical research will not only shed further light on the empirical findings in this paper, but also yield new predictions to serve as a guide for future empirical research.

References

Albuquerque, R. and Hopenhayn, H. (2002) "Optimal Lending Contracts and Firm Dynamics", *Center for Economic Research Working Paper*, 493, University of Rochester.

Axtell, R. L. (2001) "Zipf distribution of US Firm sizes", *Science*, 293, 1818-1820.

Baily, N., Hulten, C. and Campbell, D. (1992) "Productivity Dynamics in Manufacturing Plants", *Brookings Papers on Economic Activity*, Microeconomics, 187-267.

Baldwin, J. and Gu, W. (2005) "The Impact of Trade on Plant Scale, Production-Run Length and Diversification", Statistics Canada, mimeograph.

Baumol, W. (1977) "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry", *American Economic Review*, 67(5), 809-22.

Bernard, A. B., and J. B. Jensen. (2007). "Firm Structure, Multinationals and Manufacturing Plant Deaths", *Review of Economics and Statistics*, forthcoming.

Bernard, A. B , J. B. Jensen and P. K. Schott. (2006). "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plants", *Journal of International Economics*, forthcoming.

Bernard, A. B. , S. Redding, and P. K. Schott (2005) "Products and Productivity", *NBER Working Paper* #11575.

Bernard, A. B., S. Redding, and P. K. Schott (2006) "Comparative Advantage and Heterogeneous Firms", *Review of Economic Studies*, forthcoming.

Brander, J and Eaton, J (1984) "Product Line Rivalry", *American Economic Review*, 74(3), 323-34.

Cabral, L and Mata, J (2003) "On the Evolution of the Firm Size Distribution: Facts and Theory", *American Economic Review*, 93(4), 1075-1090.

Caves, D., Christensen, L. and Diewert, E. (1982) "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", *Econometrica*, 50, 6, 1393-1414.

Chandler, A. D. (1920) *Scale and Scope: the Dynamics of Insustrial Capitalism*, Cambridge: The Belknap Press.

Cochran, W. G. (1952) “The Chi-Squared – Test of Goodness and Fit”, *Annals of Mathematical Statistics*, 23, 315-45.

Cooley, T and Quadini, V (2001) “Financial Markets and Firm Dynamics”, *American Economic Review*, 91(5), 1286-1310.

Davis, S. J. and Haltiwanger, J. (1992) ‘Gross Job Creation, Gross Job Destruction, and Employment Reallocation’, *Quarterly Journal of Economics*, August, 819-63.

De Loecker, J. (2005) ‘Product Differentiation, Multi-Product Firms and Structural Estimation of Productivity’, K.U. Leuven, mimeograph.

Disney, R., Haskel, J., and Heden, Y. (2003) ‘Restructuring and Productivity Growth in UK Manufacturing’, *Economic Journal*, 113(489), 666-694.

Dunne, T., S. Klimek, and M. J. Roberts. (2005) “Exit from Regional Manufacturing Markets: The Role of Entrant Experience” *International Journal of Industrial Organization*,vol. 23, no. 5-6, June, 399-421.

Dunne, T. , M. J. Roberts, and L. Samuelson. (1988) “Patterns of firm entry and exit in U.S. manufacturing industries.” *Rand Journal of Economics*, vol. 19 No.4 Winter, 495-515.

Dunne, T. , M. J. Roberts, and L. Samuelson. (1989a) “The Growth and Failure of U.S. Manufacturing Plants”, *Quarterly Journal of Economics*, Vol. 104, No. 4 , pp. 671-698.

Dunne, T. , M. J. Roberts, and L. Samuelson. (1989b) “Plant Turnover and Gross Employment Flows in the U.S. Manufacturing Sector” *Journal of Labor Economics*, Vol. 7, No. 1. , pp. 48-71.

Eaton, C. and Schmidt, N. (1994) “Flexible Manufacturing and Market Structure”, *American Economic Review*, 84(4), 875-88.

Ericson, R. and Pakes, A. (1995) “Markov-Perfect Industry Dynamics: A Framework for Empirical Work”, *Review of Economic Studies*, 62, 53-82.

Foster, L., J. Haltiwanger, and C. Krizan, (2001) “Aggregate Productivity Growth: Lessons from Microeconomic Evidence.” in *New Developments in Productivity Analysis,* Hulten, Charles R; Dean, Edwin R; Harper, Michael J, eds, NBER Studies in Income and Wealth, vol. 63. Chicago and London: University of Chicago Press.

Foster, L., J. Haltiwanger, and C. Krizan, (2006) "Market Selection, Reallocation, and Restructuring in the U.S. Retail Trade Sector in the 1990s." *Review of Economics and Statistics*, forthcoming.

Gibbons, R. (2004) "Four Formal(izable) Theories of the Firm?", *MIT Department of Economics Working Paper*, 04-34.

Gollop, F. M. and J. L. Monahan (1991), "A Generalized Index of Diversification: Trends in U.S. Manufacturing." *Review of Economics and Statistics*, Vol. 73(2), 318-330.

Helfat, C. E. and R. S. Raubitschek. (2000) "Product Sequencing: Co-evolution of Knowledge, Capabilities and Products." *Strategic Management Journal*, Vol 21: 961-979.

Hopenhayn, H. (1992) "Entry, Exit, and Firm Dynamics in Long Run Equilibrium", *Econometrica*, 60(5), 1127-1150.

Jovanovic, B. (1982) "Selection and the Evolution of Industry", *Econometrica*, 50(3), 649-70.

Klette, T. and Kortum, S. (2004) 'Innovating Firms and Aggregate Innovation', *Journal of Political Economy*, 112(5), 986-1018.

Lucas, R. E. (1978) "On the Size Distribution of Business Firms", *The Bell Journal of Economics*, 9(2), 508-23.

Luttmer, E. G. J. (2004) "The Size Distribution of Firms in an Economy with Fixed and Entry Costs", Working Paper 633, Federal Reserve Bank of Minneapolis.

Melitz, M. J. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica,* 71, 1695-1725.

Panzar, J. and Willig, R. (1977) "Economies of Scale in Multi-output Production", *Quarterly Journal of Economics*, 91(3), 431-93.

Riggs, T. L. and G. Zarotiadis (2005) "Soft and Hard Within- and Between-Industry Changes of US Skill Intensity: Shedding Light on Worker's Inequality", U.S. Census Bureau, mimeograph.

Rossi-Hansberg, E. and Wright, M. (2005) "Establishment Size Dynamics in the Aggregate Economy", Princeton University, mimeograph.

Shaked, A. and Sutton, J. (1990) "Multi-product Firms and Market Structure", *Rand Journal of Economics*, 21(1), 45-62.

Sutton, J. (1991) *Sunk Costs and Market Structure*, MIT Press: Cambirdge MA.

Sutton, J. (1997) "Gibrat's Legacy", *Journal of Economic Literature*, 35(1), 40-59.

Sutton, J. (2005) *Competing in Capabilities*, Clarendon Lectures, Oxford University Press: Oxford.

Teece, D., G. Pisano, and A. Shuen, (1997) "Dynamic Capabilities and Strategic Management", *Strategic Management Journal*, 18(7), 509-34.

United States Census (1996) "1992 Census of Manufactures and Census of Mineral Industries: Numerical List of Manufactured and Mineral Products", U.S. Government Printing Office, Washington DC 20402.

Zipf, G. K. (1949) *Human Behavior and the Principle of Least Effort*, Cambridge, MA: Addison-Wesley Press.

A Appendix: Collection of Product-Level Production Data in the Census of Manufactures

Information on the products that firms produce is collected at the plant level. In each of the Census years we analyze, plants received a form noting all of the seven-digit SIC categories contained within the industries in which they previously noted participation. (See http://www.census.gov/epcd/www/pdf/97mc/ for the forms used in the 1997 Census.) Firms use these forms to record the quantity and value of each seven-digit category in which they have positive production, adding new product codes and deleting outdated ones as necessary. Roughly 7,000 of the 15,000 seven-digit SIC categories are recorded directly in the LRD; the rest are recorded at the more aggregate five-digit SIC level. Thus, to obtain a complete and consistent set of five-digit SIC products for all manufacturing firms, we aggregate any seven-digit categories in the LRD up to the roughly 1,800 five-digit SIC products that are recorded for all firms. A complete list of the two-, four- and five-digit SIC categories are available from U.S. Census (1996) available online at www.census.gov.

Table 1: Five-Digit SIC Products in Four-Digit SIC Industry 3357

SIC		Description
33		Primary Metal Industries
3357		Nonferrous Wiredrawing and Insulating
33571	Products	Aluminum Wire
33572		Copper Wire
33573		Other Nonferrous Metal Wire
33575		Nonferrous Wire Cloth
33576		Apparatus Wire and Cord Sets
33577		Magnet Wire
33578		Power Wire
3357A		Electronic Wire
3357B		Telephone Wire
3357C		Control Wire
3357D		Building Wire
3357E		Other Wire NES
33579		Fiber Optic Cable

Source: U.S. Census Bureau (1996).

Table 2: Products per Industry and Product Characteristics, by Sector

Two-Digit SIC Sector	Industries	Products	Products/ Industry	Capital Intensity Mean	Capital Intensity Std Dev	Skill Intensity Mean	Skill Intensity Std Dev
20 Food	49	157	3.2	106	103	0.26	0.10
22 Textile	23	79	3.4	44	25	0.17	0.06
23 Apparel	31	75	2.4	16	36	0.22	0.10
24 Lumber	17	59	3.5	85	627	0.18	0.06
25 Furniture	13	36	2.8	23	10	0.23	0.06
26 Paper	17	55	3.2	147	154	0.23	0.06
27 Printing & Publishing	14	72	5.1	35	23	0.44	0.26
28 Chemicals	29	102	3.5	231	256	0.37	0.08
29 Petroleum	5	15	3.0	494	363	0.31	0.06
30 Rubber & Plastics	15	63	4.2	58	30	0.24	0.05
31 Leather	11	12	1.1	15	11	0.17	0.06
32 Stone & Concrete	26	47	1.8	84	73	0.22	0.05
33 Primary Metal	26	89	3.4	115	87	0.24	0.05
34 Fabricated Metal	38	135	3.6	45	27	0.27	0.07
35 Industrial Machinery	51	187	3.7	42	26	0.36	0.10
36 Electronic	37	111	3.0	39	26	0.29	0.10
37 Transportation	18	65	3.6	38	27	0.33	0.17
38 Instruments	17	44	2.6	39	36	0.39	0.10
39 Miscellaneous	18	53	2.9	26	20	0.26	0.08

Notes: Table reports the number of four-digit SIC industries and five-digit SIC products within the noted two-digit SIC sector, respectively. Capital and skill intensity are the real book value ($000) of buildings and equipment per worker, and non-production workers per total employment, respectively. Mean and standard deviation input intensities are computed across all plants producing a product within the relevant sector. Means are weighted by plant-product output. Results for Tobacco (SIC 21) are excluded due to Census disclosure guidelines.

Table 3: Prevalence of Firms Producing Multiple Products, Industries and Sectors

Type of Firm	Percent of Firms	Percent of Output	Mean Products, Industries or Sectors per Firm
Single-Product	59	9	1
Multiple-Product	41	91	4.0
Multiple-Industry	29	87	3.1
Multiple-Sector	13	76	2.5

Notes: Table displays a breakdown of firms according to whether they produce multiple products (five-digit SIC categories), multiple industries (four-digit SIC categories) and multiple sectors (two-digit SIC categories). Columns two and three summarize the distribution of firms and output, respectively. Column four reports the mean number of products for multiple-product firms, the mean number of industries for multiple-industry firms and the mean number sectors for multiple-sector firms. Results are based on the pooled 1972 to 1997 sample.

Table 4: Distribution of Within-Firm Output Shares, by Product

Average Share of Prodcut in Firm's Output (High to Low)	Number of Products Produced by the Firm: 1	2	3	4	5	6	7	8	9	10
1	100	81	71	64	59	55	52	50	48	45
2		19	22	23	22	22	21	21	21	20
3			7	10	11	11	12	12	12	12
4				4	6	6	7	7	8	8
5					2	4	4	5	5	5
6						2	2	3	3	4
7							1	2	2	2
8								1	1	2
9									1	1
10										1

Notes: Columns indicate the number of products produced by the firm. Rows indicate the share of the produce, in descending order of size. Each cell is the average across the relevant set of firm-products in the sample. Sample includes all firms producing at least ten products in the 1972 to 1997 Censuses.

Table 5: Mean Percentage-Point Differences Between Single- and Multiple-Product Firm Attributes

	Multiple Product	Multiple Industry	Multiple Sector
Output	0.77	0.77	0.92
Employment	0.66	0.68	0.83
Wages	0.08	0.06	0.05
Production Worker Wages	0.08	0.06	0.05
Non-Production Worker Wages	0.05	0.03	0.03
Probability of Export	0.13	0.13	0.15
Labor Productivity	0.10	0.08	0.09
TFP	0.01	0.04	0.00

Notes: Table summarizes mean percent differences in 1997 between firms that produce multiple products, industries and sectors versus those that produce a single product, industry and sector, respectively. Results are obtained by regressing the log of the noted firm characteristic on a dummy variable indicating the firms' status as well as industry fixed effects. All regressions are OLS except for probability of firm export, which is a probit. All differences are statistically significant at the 1 percent level. There are roughly 150,000 observations for each regression.

Table 6: Decomposition of Aggregate Real U.S. Manufacturing Output, 1972 to 1997

		Source of Growth								
		Firm Entry and Exit			Firms' Extensive Margins			Firms' Intensive Margins		
Period	Aggregate Growth	Net	Firm Births	Firm Deaths	Net	Added Products	Dropped Products	Net	Growing Products	Shrinking Products
1972-77	9	0	8	-9	-1	24	-24	10	22	-12
1977-82	-4	-3	10	-12	2	30	-28	-3	15	-19
1982-87	13	-2	16	-18	5	45	-40	10	24	-13
1987-92	10	0	15	-15	5	36	-31	5	18	-14
1992-97	27	2	16	-14	4	33	-29	21	32	-11
Total Change	65	-3	73	-76	19	189	-170	50	127	-77
% Total Change	100	-5	112	-118	29	291	-262	77	195	-119

Notes: Table decomposes the change in real U.S. manufacturing shipments across noted five-year intervals (rows one to five) as well as across the entire 1972 to 1997 sample period (row 6). Column two reports the change in aggregate manufacturing shipments. Columns three through five report the contributions of net and gross firm entry. Columns six through eight report the contributions of net and gross product adding by continuing firms. Final three columns report the contributions of net and gross output growth of continuing products by continuing firms. In each row, "net" columns sum to the aggregate change reported in column two. Totals are based on the sum of firms' product-level shipments. Administrative Records are excluded.

Table 7: Product Switching by U.S. Manufacturing Firms, 1972 to 1997

	Percent of Firms		
Firm Activity	All Firms	Single-Product Firms	Multiple-Product Firms
None	32	46	11
Drop Product(s) Only	12	na	30
Add Product(s) Only	11	13	8
Both Add and Drop Products	45	41	50

	Output-Weighted Percent of Firms		
Firm Activity	All Firms	Single-Product Firms	Multiple-Product Firms
None	7	49	3
Drop Product(s) Only	7	na	8
Add Product(s) Only	5	20	3
Both Add and Drop Products	81	31	86

Note: Top panel displays average percent of surviving U.S. manufacturing firms engaging in each type of product-changing activity across five-year intervals from 1972 to 1997. Bottom panel provides a similar breakdown but weighting each firm by its output. Products refer to five-digit SIC categories. The four firm activities are mutually exclusive. There are an average of 141,561 surviving firms in each Census year.

Table 8: Sector and Industry Switching by U.S. Manufacturing Firms, 1972 to 1997

	Percent of Firms		
Firm Activity	Product Activity	Industry Activity	Sector Actvivity
None	32	53	79
Drop Only	12	13	8
Add Only	11	13	7
Both Add and Drop	45	21	7

Note: Table displays average share of surviving firms who engage in product, industry and sector switching across five-year intervals from 1972 to 1997. Product, industry and sector activity refers to the adding and/or dropping of five-digit, four-digit and two-digit SIC categories, respectively. In each column, the four firm activities are mutually exclusive. There are an average of roughly 141,561 surviving firms in each Census year.

Table 9: Average Output Share of Recently Added and Dropped Products, 1972 to 1997

	All Added or Dropped Products	Products that Result in Adding or Dropping Industries	Products that Result in Adding or Dropping Sectors
Products Added t-5:t	49	26	8
Products Dropped t:t+5	46	23	9

Notes: Table reports the mean share of multi-product firm year t output represented by products added between Census year t-5 and t and products dropped between Census years t and t+5. First column refers to all products adds and drops. Second and third columns refer to products that result in firms either adding or dropping industries and sectors, respectively. Means are across all years of sample, 1972 to 1997.

Table 10: Product Switching and Concomitant Changes in Firm Characteristics, 1972 to 1997

	Drop Only	Add Only	Both Add and Drop	Obs	R^2
Output	-0.0140 ***	0.0203 ***	0.0055 ***	447,399	0.05
	0.0007	0.0007	0.0005		
Employment	-0.0159 ***	0.0184 ***	0.0057 ***	447,399	0.02
	0.0006	0.0006	0.0005		
Wages	0.0009 ***	0.0017 ***	0.0011 ***	447,399	0.03
	0.0004	0.0004	0.0003		
Output/Worker	0.0014 **	0.0013 **	0.0006	273,927	0.03
	0.0006	0.0006	0.0004		
TFP	-0.0023 ***	0.0041 ***	0.0017 ***	273,927	0.02
	0.0005	0.0005	0.0034		

Notes: Table summarizes OLS regression results of log differences in firm characteristics from Census year t-5 to t on dummies indicating contemporaneous product switching activity. Each row summarizes the regression for a different firm characterisitc. Each cell reports the coefficient for the product-switching dummy variables noted at the top of the column. Standard errors adjusted for clustering at the industry level are noted below each coefficient. Regressions include year and industry fixed effects; coefficients for fixed effects and constant are suppressed. Sample sizes vary as a result of availability of data needed to compute right hand side variables. Regressions cover all firms during the pooled 1972 to 1997 sample period. ***, **, and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 11: Distribution of Added and Dropped, Products, By Method

Firm Adds Product(s) via:	All Product Additions	Product Adds That Result in Adding a Sector
Existing Plant(s) Only	94.3	88.7
Acquired Plant(s) Only	0.4	1.9
New Plant(s) Only	1.6	6.0
Combination	3.6	3.5

	Percent of Firms	
Firm Drops Product(s) via:	All Product Drops	Product Drops That Result in Dropping a Sector
Existing Plant(s) Only	94.1	89.1
Divested Plant(s) Only	0.2	1.4
Closing Plant(s) Only	2.0	5.8
Combination	3.7	3.6

Notes: Table reports the manner in which firms add (top panel) and drop (bottom panel) products. Second column of each panel focuses on all product adds or drops. Third column of each panel excludes product adds that occur within the firms' existing set of sectors and product drops that do not result in the firm exiting a sector. Figures shown are averages across the pooled 1972 to 1997 sample.

Table 12: Product Switching Activity and Concurrent Merger and Acquisition Activity

	Product Switching		Sector Switching	
Firm Activity	No M&A	With M&A	No M&A	With M&A
None	32	5	79	40
Drop Only	12	5	8	16
Add Only	11	17	6	26
Both Add and Drop	44	73	7	18

Notes: Table reports product and sector (two-digit SIC) switching activity for two types of firms: those without any ownership changes, denoted "No M&A" and those that acquire or divest a plant, referred to as "With M&A" firms.

Table 13: Firm-Product Drop OLS Regressions, 1972 to 1997

	Drop Product	Drop Product	Drop Product	Drop Product
Relative Product Size	-0.0384 ***	-0.0353 ***	-0.0665 ***	-0.0596 ***
	0.0005	0.0014	0.0009	0.0009
Relative Product Tenure	-0.1105 ***	-0.1248 ***	-0.1183 ***	-0.1313 ***
	0.0025	0.0040	0.0042	0.0041
Relative Firm Size	0.0717 ***	0.0573 ***		
	0.0037	0.0054		
Relative Firm Age	0.0377 ***	0.0354 ***		
	0.0019	0.0021		
Number of Products	0.0023 ***	0.0024 ***		
	0.0001	0.0001		
Firm Fixed Effects	No	No	Yes	Yes
Product Fixed Effects	No	Yes	No	Yes
R-Squared	0.05	0.17	0.51	0.53
Observations	174,303	174,303	174,303	174,303

Notes: Table summarizes OLS regression results of dummy variable indicating a firm-product drop between Census years 1992 and 1997 on firm-product and firm attributes in 1992. In each case, attributes are relative to firms with the same mix of products. Robust standard errors are noted below each coefficient; standard errors are adjusted for clustering at the product level. Coefficients for fixed effects and constant are suppressed. ***, **, and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 14: Product Adding and Firm Productivity, 1972 to 1997

	Add	Add	Add	Add
TFP	0.0541 ***	0.0592 ***		
	0.0065	0.0065		
ln(Output/Worker)			0.0294 ***	0.0369 ***
			0.0025	0.0027
ln(Employment)		0.0512 ***		0.0710 ***
		0.0023		0.0025
ln(Age)		0.0028 ***		0.0025 ***
		0.0004		0.0003
Year Fixed Effects	Yes	Yes	Yes	Yes
Product Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.06	0.08	0.16	0.16
Observations	331,431	331,431	503,348	503,348

Notes: Table summarizes OLS regression results of noted dummy variable indicating product adding by single-product firms between years t and t+5 on noted covariates. First two covariates are TFP (see text) and output per worker in year t. Second two covariates are firm employment and firm age, both for year t. Sample covers 1972 through 1992 panels. Robust standard errors are noted below each coefficient; standard errors are adjusted for clustering at the product level. Coefficients for fixed effects and constant are suppressed. ***, **, and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table 15: Product Co-Production Within Firms, 1972 to 1997

Sector	20	22	23	31	24	25	26	27	30	28	29	32	33	34	35	37	36	38	39
20 Food	2,439	25	210	19	30	22	51	46	75	178	23	41	32	75	79	27	36	35	37
22 Textile	25	512	249	25	32	38	62	38	132	85	19	41	42	80	77	35	46	49	59
23 Apparel	210	249	1,839	125	206	192	179	188	344	263	66	187	223	825	1,057	220	263	210	335
31 Leather	19	25	125	147	16	19	19	20	58	24	.	14	13	34	29	12	19	23	46
24 Lumber	30	32	206	16	2,846	429	87	47	157	75	20	91	59	213	118	68	68	48	86
25 Furniture	22	38	192	19	429	1,203	52	44	154	45	10	98	60	237	188	65	101	75	104
26 Paper	51	62	179	19	87	52	538	408	239	116	31	61	56	154	142	38	64	70	92
27 Printing & Publishing	46	38	188	20	47	44	408	6,510	134	92	35	48	52	187	152	57	90	69	253
30 Rubber & Plastic	75	132	344	58	157	154	239	134	1,187	319	59	209	215	572	910	187	271	221	243
28 Chemicals	178	85	263	24	75	45	116	92	319	1,297	160	159	139	235	288	88	146	165	150
29 Petroleum	23	19	66	.	20	10	31	35	59	160	128	146	39	57	63	27	36	27	21
32 Stone & Concrete	41	41	187	14	91	98	61	48	209	159	146	1,097	122	267	236	83	131	96	70
33 Primary Metal	32	42	223	13	59	60	56	52	215	139	39	122	847	615	789	162	225	127	78
34 Fabricated Metal	75	80	825	34	213	237	154	187	572	235	57	267	615	4,203	2,311	456	522	336	242
35 Industrial Machinery	79	77	1,057	29	118	188	142	152	910	288	63	236	789	2,311	4,887	571	688	464	226
37 Transportation	27	35	220	12	68	65	38	57	187	88	27	83	162	456	571	860	246	159	71
36 Electronic	36	46	263	19	68	101	64	90	271	146	36	131	225	522	688	246	1,254	511	135
38 Instruments	35	49	210	23	48	75	70	69	221	165	27	96	127	336	464	159	511	680	112
39 Miscellaneous	37	59	335	46	86	104	92	253	243	150	21	70	78	242	226	71	135	112	1,137

Notes: Table summarizes the extent of product co-production by sector across multiple-product firms. A firm is counted in a cell if it produces at least one product in both the row and column two-digit SIC sectors. Firms are counted in each cell only once, but they may appear in more than one cell if they have two or more products spanning two or more sectors. Firms are counted in a diagonal cell if they produce two products in the same sector. The counts displayed in each cell represent the average co-production observed in the six Census years from 1972 to 1997; the total number of firm-year-coproduction observations is 308,111 across all years. Dark grey and light grey shading indicate substantially higher and lower co-production than would be implied by a null hypothesis of random co-production (see text). The absence of shading indicates the absence of statistically significant differences from this null hypothesis. A "." denotes a cell where information has not been reported to due Census Bureau disclosure guidelines.

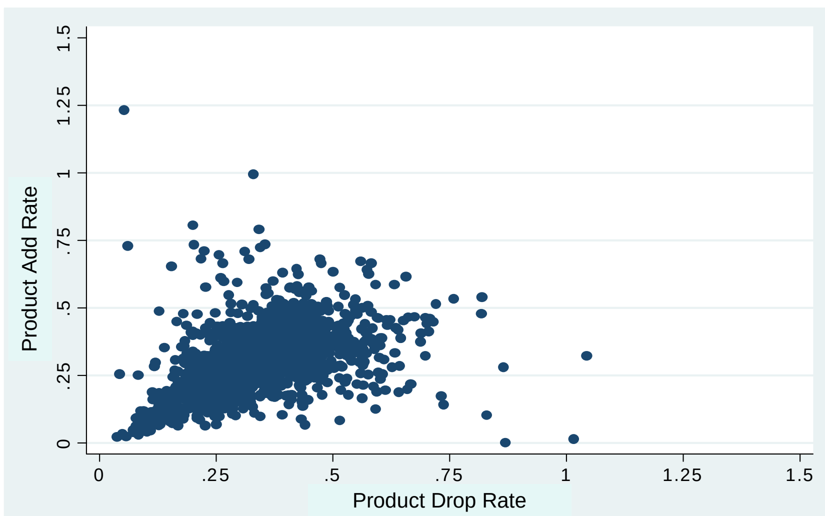

Figure reports the mean rate at which five-digit SIC manufacturing products are added and dropped by U.S. manufacturing firms over the 1972 to 1997 sample period. A product's add (drop) rate in year t is computed as the number of firms adding (dropping) the product between Census years t and t+5 divided by the average number of firms producing the product in years t and t+5.

Figure 1: Average Product Add and Drop Rates, 1972 to 1997