EFFECT OF VOLATILITY CHANGE ON PRODUCT DIVERSIFICATION

by

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ABSTRACT

Studies of the volatility of the U.S. economy suggest a noticeable change in mid 1980s. There is some empirical evidence that the aggregate volatility of the U.S. economy has been decreasing over time. The response of firms to the change of economic volatility and economic fluctuation has been studied in terms of many margins a firm can adjust –capital, labor, capacity, material, etc. However, we have not studied the most important margin – the product.

This paper studies the effect of profit volatility on the firm/plant level product diversification. Section 2 profiles diversification and shows that there is a downward trend of aggregate diversification in many industries. Cyclicality of diversification is not clear at the aggregate or industry level. Firms change their diversification very frequently and very differently from one another. Section 3 verifies the trend of volatility at the aggregate, sectoral, and firm level and studies the relationship between diversification and volatility at the firm level. Firm level diversification decreases as the aggregate, sectoral and idiosyncratic volatility decreases.

Keywords: Diversification, Volatility, Business Cycle, Firm Level Adjustment

1. Introduction

Studies of the volatility of the U.S. economy suggest a noticeable change in the mid 1980s. There is some empirical evidence that the aggregate volatility of the U.S. economy has decreased over time.[2] The volatility of real GDP growth in the United States has fallen by half since the early 1980s relative to the prior postwar experience. Not only output, but many other economic indicators show less volatility. Inflation also stabilized after the mid 1980s. Some studies have argued that an improvement in U.S. monetary policy can explain both the lower output and inflation volatility.[3] Others have attributed the decreased volatility of GDP to a reduction in the size of shocks hitting the U.S. economy-in other words, 'good luck'.[4] Recent studies argue that both policy and good-luck played a role and that changes in inventory behavior stemming from improvements in information technology have played a role in reducing real output volatility.[5] The causes of change in volatility have been studied, although a consensus has yet to be reached.

Research on the effects of the volatility change has accumulated as well. The response of firms to changing economic volatility or economic fluctuations has been studied along many margins –capital, labor, capacity, material, etc.[6] However, the most important margin – the product – has not been studied thoroughly.

Throughout the history of 20th century U.S. business, diversification was a strategic option pursued by corporate entities. High diversification was a virtue, and big conglomerates were regarded as the engine of fast growing economies. In the late 20th century, many big companies were split either by antitrust lawsuits or for strategic purposes, but we still observe

[2] Blanchard and Simon (2001), McConnell and Perez-Quiros (2000)
[3] Clarida, Gali, and Gertler (2000)
[4] Ahmed, Levin, and Wilson (2001), Blanchard and Simon (2001)
[5] Stock and Watson (2002), Kahn et al (2002)
[6] See Sakellaris (2000) for a survey.

massive mergers and acquisitions toward horizontal and/or vertical integration in many industries, such as petroleum, telecommunications, printing, and so on.[7]

Economists have followed the trend of multi-output production of manufacturing plants and firms, but despite theoretical advances, the variation in diversification across industry and time still remains a mystery. Although there are thousands of papers on corporate diversification, most of them focus on the diversification in the financial portfolio of the firm and its effect on productivity or the value of the firm.[8] A comprehensive empirical study on product diversification is long overdue. Except for some anecdotal evidence, there are few publicly available statistics measuring the extent of establishment, firm, or industry diversification at a short-term frequency over the long run. Because of this lack of data, it was not possible to study diversification along with business activity, although product diversification is one of the most important aspects of a firm's behavior over time.

In this paper, I study the cause and effect of the volatility change related to the firm level product diversification and government investment. First, I establish a detailed profile of firm/plant level product diversification in manufacturing sector. Second, I study the relationship between the firm level diversification and volatility of the U.S. manufacturing sector.

Section 2 discusses the quality and limitations of the datasets as well as the measure of diversification, provides a conceptual discussion of diversification and describes stylized facts regarding the long-term and short-term dynamics of diversification. Section 3 provides a conceptual discussion of the relationship between diversification and profit volatility, describes stylized facts regarding volatility change, and estimates the relationship between firm level

[7] Federal Trade Commission(2004, 1999), Samli (2004), Kirkpatrick (2002), and Wilcox et al (2001)

[8] More than 3,000 papers are found by a keyword "firm-level diversification" by Google-scholar. See Schoar(2002) and Lins and Servaes(1999) for example.

diversification and aggregate, industrial and idiosyncratic profit volatility. Section 4 concludes the paper.

2. Product Diversification: Profile

2.1. Measurement and Data

Gollop and Monahan(1991) is the one of a few existing studies of micro level diversification for the whole manufacturing sector in the long run. They showed that manufacturing firms specialized within plants, while they diversified among plants, until 1982 (see Figure 1). However, there are no empirical studies on diversification covering the last two decades, and it still remains unclear why firms change their product portfolios and how they change diversification over time.

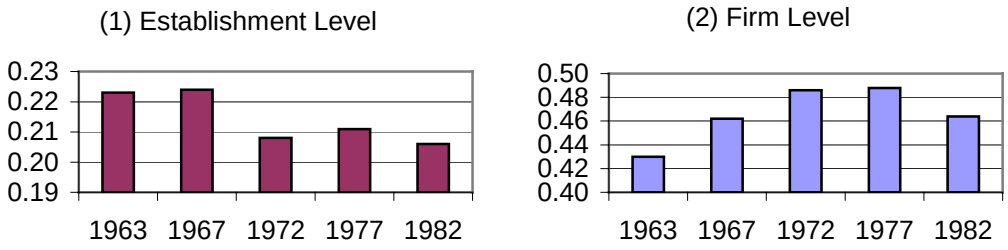
There are quite a few researches on the cyclicality of product diversification. Many of them suggest the diversification moves pro-cyclically, while a few others suggest counter-cyclical diversification.[9] One of the goals of this section is to verify whether the diversification is pro- or counter-cyclical over the long time period.

The three datasets I use are the Census of Manufactures (CM), Annual Survey of Manufactures (ASM) and Longitudinal Business Database (LBD) from 1974 to 1998.[10] CM and ASM compose the Longitudinal Research Database (LRD). LRD is a time series of economic variables collected from manufacturing establishments in CM and ASM programs. LRD contains establishment level identifying information; information on the factors of production (inputs, such

[9] See Axaloglou (2003), Keuschnigg (2001), Jovanovic (1993), for instance.

[10] CM is available in 1977, 1982, 1987, 1992, and 1997. ASM is available annually, 1973-76, 1978-81, 1983-86, 1988-91, 1993-96, and 1998-2000. LBD is currently available 1975 to 1999. ASMs in 1999 and 2000 are not used because the product codification was changed from SIC to NAICS in 1998. See Appendix A for a discussion.

Figure 1 Diversification Indexes



Note: Shipment weighted aggregate series
Source: Gollop and Monahan(1991), Table 4, pp.328

as levels of capital, labor, energy and materials) and the products produced (outputs); as well as other basic economic information used to define the operations of a manufacturing plant.[11]

LBD provides longitudinally linked data for all employer establishments (i.e., those with paid employees) contained in the Census Bureau's business register, the Standard Statistical Establishment List (SSEL). Basic data items, such as payroll, employment, location, industrial activity and firm affiliation are included in LBD. LBD is used to get data on firm age, total employment, and the number of plants of multi-unit firms.

Using LRD product files, I use a Herfindahl-type index as a measure of establishment and firm level diversification.[12] My diversification index satisfies the following requirements: it varies directly with the number of different products produced; it varies inversely with the increasingly unequal distribution of products across product lines; and it is bounded between zero and unity.

[11] Some product data that are imputed by Census Bureau are excluded from the sample.
[12] This measure has been widely used in the literature. See Gollop and Monahan(1991)

$$D1 \equiv 1 - \sum s_i^2, \quad where\ s_i = \text{share of product i that is identified by 5 digit SIC code}$$

$$D2 \equiv 1 - \sum \left(\frac{\sigma_{ij} + 1}{2} \right) s_j^2, \quad where\ s_j = \text{share of product j that is identified by 5 digit SIC code}$$

$$\sigma_{ij} = \text{correlation of shipments between product j and Firm i's primary product i by 4 digit SIC}$$

$$D3 \equiv 1 - \sum s_i^2, \quad where\ s_i = \text{share of product i that is identified by 3 digit SIC code}$$

$$D4 \equiv 1 - \sum s_i^2, \quad where\ s_i = \text{share of product i that is identified by 4 digit SIC code}$$

D1 is the simplest diversification index which incorporates the number of products and share of the products' shipments. Since it is simple, we can apply this method to any years in LRD data. D1 can show a very consistent time series of diversification and accounts the most detailed product information collected in ASM.

One disadvantage of D1 is that it equally accounts products no matter how different they are: how they are related in terms of sales or production. In order to include the information on how the industries in which the firm diversifies are related, D2 uses the correlation coefficient of shipments of the industries as a distance weight between diversified products. Example 2 shows the difference between D1 and D2.

Example 1: Firm I produces A and B (5 digit SIC) in two different industries (4 digit SIC) with equal share

Diversification Measure	Case	Index
D1		D1=1-(.25+.25)=.5
D2	corr(A,B)=1	D2=1-(.25+.25)=.5
	corr(A,B)=0	D2=1-(.25+.5*.25)=.625
	corr(A,B)=-1	D2=1-(.25+0*.25)=.75

Example 2: Firm I produces A, B, C and D (5-digit SIC) with equal share

	5-digit SIC	4-digit SIC	3-digit SIC	Shipment share
Product A	28124	2812	281	.25
Product B	28331	2833	283	.25
Product C	28332	2833	283	.25
Product D	28343	2834	283	.25

D1=1-(.0625-.0625-.0625-.0625)=.75
D4=1-(.0625-.25-.0625)=.625
D3=1-(.0625-.5625)=.375

Therefore, D2 will be generally higher than D1 unless the firm diversifies all its products in same 4 digit industry. A comparison of D1 and D2 will shed light on how different industries firms diversify with their products.

One may ask a question: Is diversification in different 5-digit SIC products a real diversification? There are cases where those products are so similar and ordinary people would not distinguish them easily. In such cases, it is better to use less detailed product classification to construct diversification index. D3 and D4 are additional measures of diversification to show only across-industry not within-industry diversification. Example 2 shows the difference across D1, D3 and D4. In this example, D4 is 17% lower than D1, suggesting that 17% of this firm's diversification came from within-4-digit-industry diversification. The fact that D3 is 50% lower than D1 shows a half of its diversification is due to within-industry diversification by 3-digit SIC. By showing D3 and D4 along with D1, we can see that Firm I is a highly diversified firm by 5-digit SIC, but a rather specialized firm by 3-digit. By comparing these indexes with D1, it will be clear how much the within-industry diversification contributes to the total diversification.

For the long-term trend analysis, I focus on the quinquennial CMs. The number of observations in CM is quite stable around 300,000 establishments. For a multi-unit firm level diversification index, the value of shipments of seven or five digit Standard Industrial

Classification System (SIC) products is aggregated across the establishments of the firm and divided by the total value of shipments of the firm to get the share of each product. [13] The detailed calculation method is described in Appendix A.[14]

For the short-term analysis, I produce annual diversification indices at the establishment and firm levels using ASM and CM. The annual number of observations is stable around 70,000 establishments. I can use up to 5-digit SIC product codes to construct the annual diversification index because only 5-digit product codes are consistently available in ASM.

With the same logic behind D1, D3 and D4, it is not clear which of the 5-digit or 7-digit SIC product code is better for the analysis of diversification. When the 7-digit code is used to construct the diversification index, I get higher index values, and we can study product variety in detail. However, the 7-digit code is very detailed and 7-digit products in the same 5-digit product code are often very similar to the each other.[15] If we are interested in product diversification across a variety of "different" products, the 5-digit, 4-digit or even 3-digit code would be better. In this section, all 7-digit, 5-digit, 4-digit and 3-digit are reported, if available.

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[13] A single-unit firm is defined as a firm with only one location. A multi-unit firm is defined as a firm that owns multiple establishments. See Appendix A for detail of SIC.

[14] Gollop and Monahan(1991) included a product heterogeneity component in their index construction, available only in CM. Their index is as follows:

$$Diversification\ Index\ (D) \equiv 1/2\left[1 - \sum_i s_i^2 - \sum_i \sum_{k \neq i} s_i s_k (z_{ik} - \sigma_{ik})\right]$$

where

s_i = *share of a seven – digit product*

$$z_{ik} = \begin{cases} 1 & \text{if the } i^{th} \text{ and } k^{th} \text{ products are identical} \\ 0 & \text{if the } i^{th} \text{ and } k^{th} \text{ products are not identical} \end{cases}$$

$$\sigma_{ik} \equiv \left(\sum_j \frac{|w_{kj} - w_{ij}|}{2}\right)^{1/2}$$

$w_{kj} \equiv$ *input cost share of the* j^{th} *input in the* k^{th} *product*

[15] An example of product classification in the chemical industry is given in Appendix A.

2.2. Why Diversify?

Diversification has been treated as a firm characteristic in numerous studies. Many empirical studies on Total Factor Productivity (TFP) include the firm's diversification level as a control variable.[16] Studies of the performance of the q-theory of investment also include multi-product dummy variables.[17] Multi-product dummy variables are also used to proxy financial constraints in some studies.[18] Some have conjectured that diversified firms have different investment and entry/exit decisions, yet these empirical studies did not examine the firm's diversification directly.[19] Many studies find that multi-product firms behave differently from single-product firms, but the diversification decision has not been incorporated endogenously in the empirical literature.[20] The adjustment of a firm's product portfolio has only recently drawn attention from researchers.[21]

There are many important studies on diversification in the area of strategic behavior studies and corporate finances. Campa and Kedia (2002) focuses on the relationship between the decision of diversification and firm value. When they use panel data and instrumental variables to control for the exogenous characteristics that predict the decision to diversity, the evidence in favor of the assertion that diversification destroys value is weaker. When they jointly estimate the decision of a firm to diversify and its firm value, diversification seems a value-enhancing strategy. The diversification discount is more likely to be a premium in this case. They also find that firms

[16] Giandrea(2002), Gemba and Kodama(2001)
[17] Bond and Cummins(2000), Fazzari, Hubbard and Petersen(1988), Abel and Blanchard(1986), Hayashi and Inoue(1991), Dwyer(2001).
[18] Abel and Eberly(2001a and 2001b), Barnett and Sakellaris(1999), Gilchrist and Himmelberg(1995), Gross(1994)
[19] Caballero, Engel and Haltiwanger(1995), Chatterjee and Cooper(1993), Dunne, Roberts and Samuelson(1989). Firm's exit and investment decisions are combined with financial constraints in Whited(1992) and Winter(1999).
[20] The product portfolio decision has been considered in I/O literature in terms of business management. For example, Anderson, de Palma and Nesterov(1995), Ottaviano and Thisse(1999), Pepall and Norman(2001).
[21] Cooper and Haltiwanger(2000), Sakellaris(2000)

that refocus their operations would have suffered a significant decreased in value if they had remained diversified, suggesting that the observed correlation between diversification and firm value is rather the outcome of actions by profit-maximizing firms reacting to shocks in their environments. In their estimation, they include a dummy variable for diversification, firm size, proxied by the log of total assets, profitability, investment, lagged variables and organizational aspects of industry (fraction of firms that are conglomerates, fraction of industry sales accounted for by conglomerates), economic environment (number of M&A, GDP, business cycle) and other firm publicity (listed on Nasdaq, NYSE, AMEX or part of S&P index, incorporated outside US).

Villalonga (2004) also estimates the value effect of diversification by matching diversifying and single-segment firms on their propensity score – the predicted values from a probit model of the propensity to diversify. He also finds that on average, diversification does not destroy value. These papers suggest that the decision of diversification is consistent with profit-maximization and that it is a reaction to exogenous environment.

Maksimovic and Phillips (2002) develop a model where the firm optimally chooses the number of segments in which it operates depending on its comparative advantage and industry demand shocks. Their model predicts firm-size distributions and investment and growth decisions of focused single-industry and multiple-segment firms. Plants of conglomerates are found less productive than plants of single-segment firms of a similar size, but this is consistent with the fact that conglomerates are value-maximizing, supporting the hypopaper that firms invest in industries in which they have a comparative advantage. Conglomerate firms also grow less in an industry if their other plants in other industries are more productive and if their other industries have a larger positive demand shock.

This paper extends these studies to build a more detailed profile of diversification and to examine its relationship to exogenous environment. The segment, the traditional definition of industry in which firms diversify, is 3-digit SIC in most of the papers mentioned above. The

decision of diversification is often captured by dummy variable that takes value of 1 when firms diversify into multiple segments. Summary statistics in this paper will show diversification indexes measured by various definitions, including 2-digit, 3-digit, 4-digit, 5-digit and 7-digit SIC and also distance measure between industries. These results will shed light on various aspects of diversification, depending on how we define "diversification".

Papers mentioned above focus on the relationship between diversification and firm performance (value or productivity). They show that diversification is a rational choice of profit maximization as a reaction to the exogenous environment, including GDP, demand shock by industry, other firms' performance. This paper will focus on the effect of exogenous factor, that is, what affects the decision of diversification, especially changes in economic volatility at the aggregate, industry and firm level. The variables in my estimation are similar to those in previous studies, including firm size proxy, profitability, age or organizational aspects. However, because I explicitly use various measures of degree of diversification and volatility, it will show not only whether to diversify or how many segments to diversify, but also how much to diversify as a response to economic volatility.

Only a few papers pay attention to the short-term dynamics of product diversification. Chatterjee and Cooper(1993) link product diversity with the business cycle, but only at the aggregate level.[22] Product choice is determined by the production technology and technology is usually regarded as something that changes only in the long run. This explains why short-run dynamics of diversification have seldom been studied in the short run.

There are several potential motives for diversification. Jovanovic(1993) lists: (1) *Gaining Market Power*: A firm with market power in two substitute products can have higher profits than two single-product monopolies. (2) *Avoiding Risk*: With liquidity constraints, firms' investment,

[22] Chatterjee and Cooper (1993) analyzed the product diversity fluctuation with a firm exit/entry model.

especially for small firms, depends on cash flows. Firms may diversify over the products to smooth their sales. (3) *Having Access to Funds*: In an imperfect capital market, funds tend to go to the large firms, not necessarily to the efficient ones. Firms may want to diversify across products to keep their size big. (4) *Making Products Compatible*: A set of products may be produced more efficiently together than individually. The optimal set of products is determined by the technology. (5) *Reaping Efficiency Gains*: By making several products, a firm can exploit cost synergies in producing, selling, promoting, and advertising. The diversified firm can also have a richer internal labor market to meet the demand of various production tasks. (6) *Pursuing Managerial Goals*: The manager may have a motive other than profit maximization. A diversified firm can reduce unemployment fluctuations, increase the volume of sales (though not necessarily profit), and discourage shareholder monitoring through complicated financial statements.

Among these potential motives, risk-avoidance dominates the literature. To verify the effect of risk on diversification, stylized facts of diversification are profiled in the next section. The relationship between risk and diversification is analyzed in Section 3.

2.3 Stylized Facts of Diversification

2.3.1. Long-term Trend

The Census of Manufactures surveys all establishments in the US manufacturing sector every five years. This allows us to study the long run behavior of diversification at the firm and establishment level. In CM, basic data obtained for all establishments include kind of business, geographic location, type of ownership, total revenue, annual and first quarter payroll, and

number of employees in the pay period. For some establishments, much less data detail is requested and no information on materials consumed is collected.[23]

Product diversification is regarded as a firm level decision. However, it is important to study the establishment level diversification because a multi-unit firm can diversify not only within the firm but also within plants. This analysis allows us to see the trend of diversification within plants.[24]

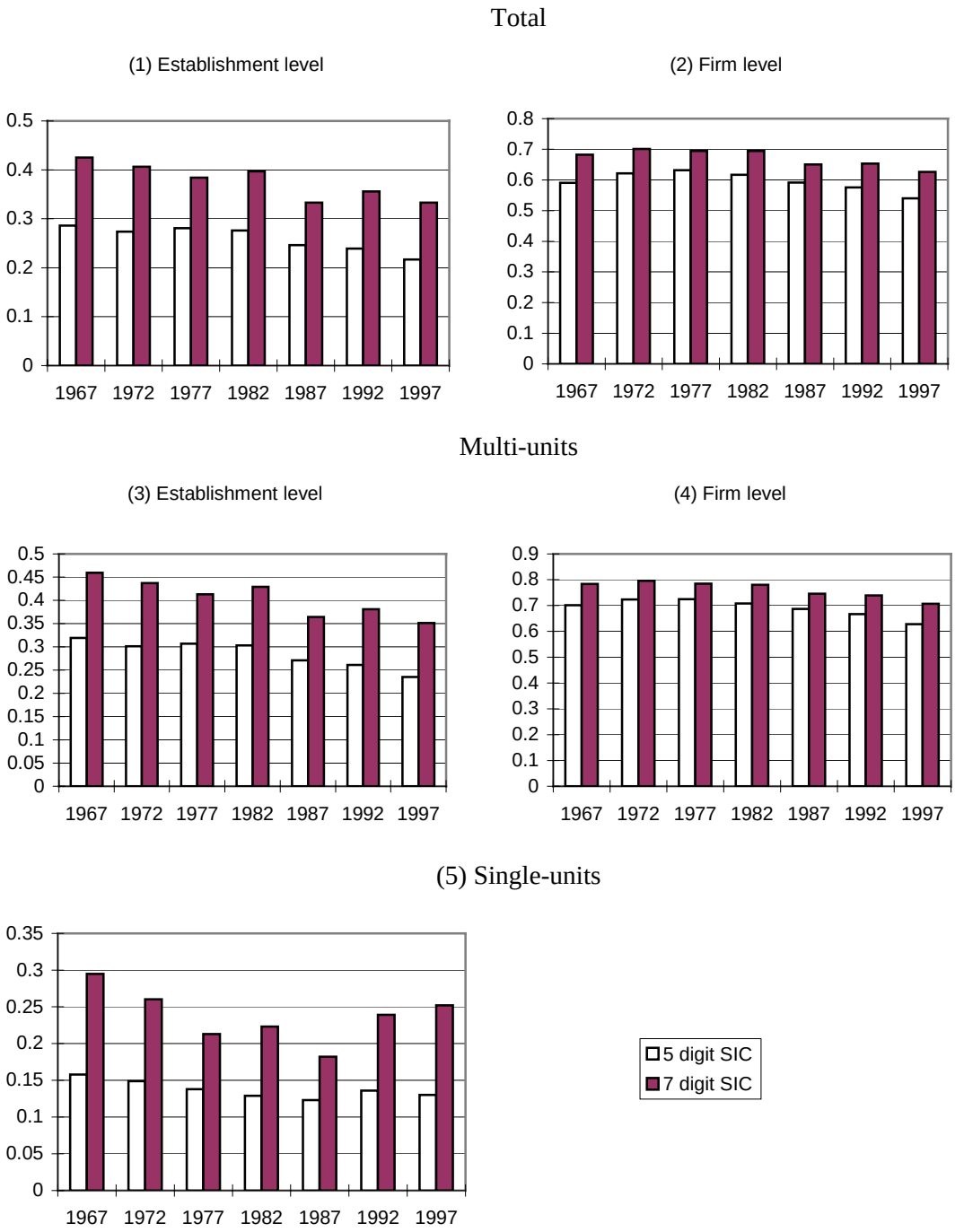
Average diversification indexes are generated by 5 digit and 7 digit SIC product codes. Figure 2 plots the trend of the average diversification index at the establishment level. Diversification has steadily decreased at the establishment level since 1967 as measured using by either 5 or 7 digit SIC product codes. At the firm level, diversification stayed high until 1982 and then started to decrease. As Gollop and Monahan(1990) argued, until early 1980s, firms were diversifying while plants were specializing. Since then, however, both firm and plant level diversification has declined.

The downward trend of aggregate diversification is surprising because many researchers have conjectured that firms should diversify more and more for various reasons. However, it is premature to conclude that every firm decreased its diversification, because there is heterogeneity in firm level diversification.

[23] CM is widely used in economic analysis and forecasting by many organizations, such as the Bureau of Economic Analysis, the Bureau of Labor Statistics, the Federal Reserve Board, state and local agencies, trade associations, companies, researchers, national and local news media.

[24] Additional statistics on firm level diversification is in Appendix B. Additional statistics on establishment level diversification is available from the author.

Figure 2 Average Diversification Index(D1) 1967-1997, CM



Note: Diversification index is shipment weighted series
Source: Author's calculation

First, the trend is different for multi unit (MU) and single unit firms (SU). The diversification of MU firms and establishments is the driving force of the aggregate trend. Diversification decreased for the MU establishments, but increased for MU firms, up to 1982. Beginning in 1982, diversification decreased both at the establishment and firm level for multi-unit firms. Diversification of SU establishments (or firms) has had a completely different trend, decreasing until 1987 and then increasing.

Figure 4 explains why the overall trend of aggregate diversification is dominated by the movements due to multi-unit establishments or firms. Single-units firms comprise 30-50% of all establishments, but the share of economic activity attributable to single-units is a mere 5-7%. At the firm level, the non-weighted share of single-units is 50-70%.

The trend of diversification is also different by industry. In Table 1, eighteen of nineteen industries exhibit declining diversification at the establishment level. The one exception is Apparel (36% increase). The rate of increase in the SU index in Apparel (54%) far exceeds the corresponding rate for the MU index (15%). For the eighteen industries with declining diversification, the decline is more severe in MU establishments in thirteen cases.

At the firm level, twelve of nineteen industries exhibit declining diversification. The seven exceptions are Food, Lumber, Paper, Printing, Leather, Stone and Miscellaneous Manufacturing. The increase in firm-level diversification in these seven industries is driven largely by multi-unit firms. For the twelve industries with declining diversification, the decline is more severe in SU firms in six industries.

Table 1 Percentage change of Diversification (1967-1997)

Industry		Establishment			Firm		
		Total	SU	MU	Total	SU	MU
20	Food	-0.07	-0.24	-0.10	-0.00	-0.24	-0.00
22	Textile	-0.27	-0.18	-0.31	-0.25	-0.18	-0.26
23	Apparel	0.36	0.54	0.15	-0.21	0.54	-0.18
24	Lumber	-0.12	-0.20	-0.12	0.01	-0.20	0.04
25	Furniture	-0.19	-0.12	-0.29	-0.16	-0.12	-0.24
26	Paper	-0.30	-0.13	-0.31	0.03	-0.13	0.00
27	Printing	-0.23	-0.22	-0.26	0.06	-0.22	0.06
28	Chemical	-0.23	-0.43	-0.22	-0.05	-0.43	-0.06
29	Petroleum	-0.02	-0.55	-0.01	-0.08	-0.55	-0.09
30	Rubber	-0.42	-0.13	-0.46	-0.28	-0.13	-0.21
31	Leather	-0.19	0.21	-0.33	1.61	0.21	1.00
32	Stone	-0.16	-0.01	-0.20	0.14	-0.01	0.00
33	Metal	-0.37	-0.12	-0.38	-0.17	-0.12	-0.15
34	Fabricated Metal	-0.29	-0.03	-0.35	-0.36	-0.03	-0.23
35	Machinery	-0.17	-0.09	-0.21	-0.03	-0.09	-0.09
36	Electronic	-0.57	-0.49	-0.56	-0.28	-0.49	-0.25
37	Transportation	-0.41	-0.43	-0.41	-0.06	-0.43	-0.07
38	Instruments	-0.49	-0.41	-0.48	-0.09	-0.41	-0.10
39	Miscellaneous	-0.19	-0.09	-0.25	0.00	-0.09	-0.02

Note: Food (Industry 20) includes Tobacco due to the disclosure issue.

To summarize, the aggregate diversification index declined both at the establishment and firm level. However, there is great heterogeneity across MU/SU and by industry at the establishment and firm level. Diversification declined in the majority of industries both at the establishment and firm level. The decline is most severe in establishments that are part of MU firms. The evidence suggests that within-plant diversification of MU firms is decreasing. This will be verified in this paper.

2.3.2 Short-term dynamics

This section investigates short-run dynamics using the ASM sample. The number of observations decreases when we use only ASM plants in CM, and we lose some analytical power when we focus on ASM data. However, ASM enables us to construct an annual diversification index to study short-term variations, which has never been attempted in the literature.

Establishment level Analysis: Aggregate level

Figure 2 and 3 show the same aggregate trend of diversification at the establishment level. The difference between them is the sample size and frequency; Figure 2 uses quinquennial CM data with roughly 300,000 establishments, while Figure 3 uses annual ASM data with roughly 70,000 establishments. At the aggregate level, the annual diversification index has a downward trend. The trend is mostly explained by the movement of MU establishments.[25]

Is aggregate diversification is pro-cyclical? In the second graph of Figure 3, the diversification index seems to move pro-cyclically until 1990, then starts diverging. The diversification index is linearly detrended and the growth of real shipment in the manufacturing sector is obtained from ASM statistics published by Census.[26] The aggregate cyclical behavior is driven by multi-unit establishments (fourth graph of Figure 3), while single-unit firms show clear counter-cyclical movements. It seems that single-unit firms diversify more in recessions than in booms. On the other hand, multi-unit establishments diversify more in booms than in recessions.

[25] By design, the average diversification index is higher for establishments that produce more products. Roughly 50% of sample establishments produce only one product each year. About 25% produce 2 products, 10% produce three, 5% produce four, and 5% produce five or more products. See Figure 7 for analysis of changes in the number of products.

[26] See Appendix A

Figure 3 Establishment Level Diversification Index(D1)

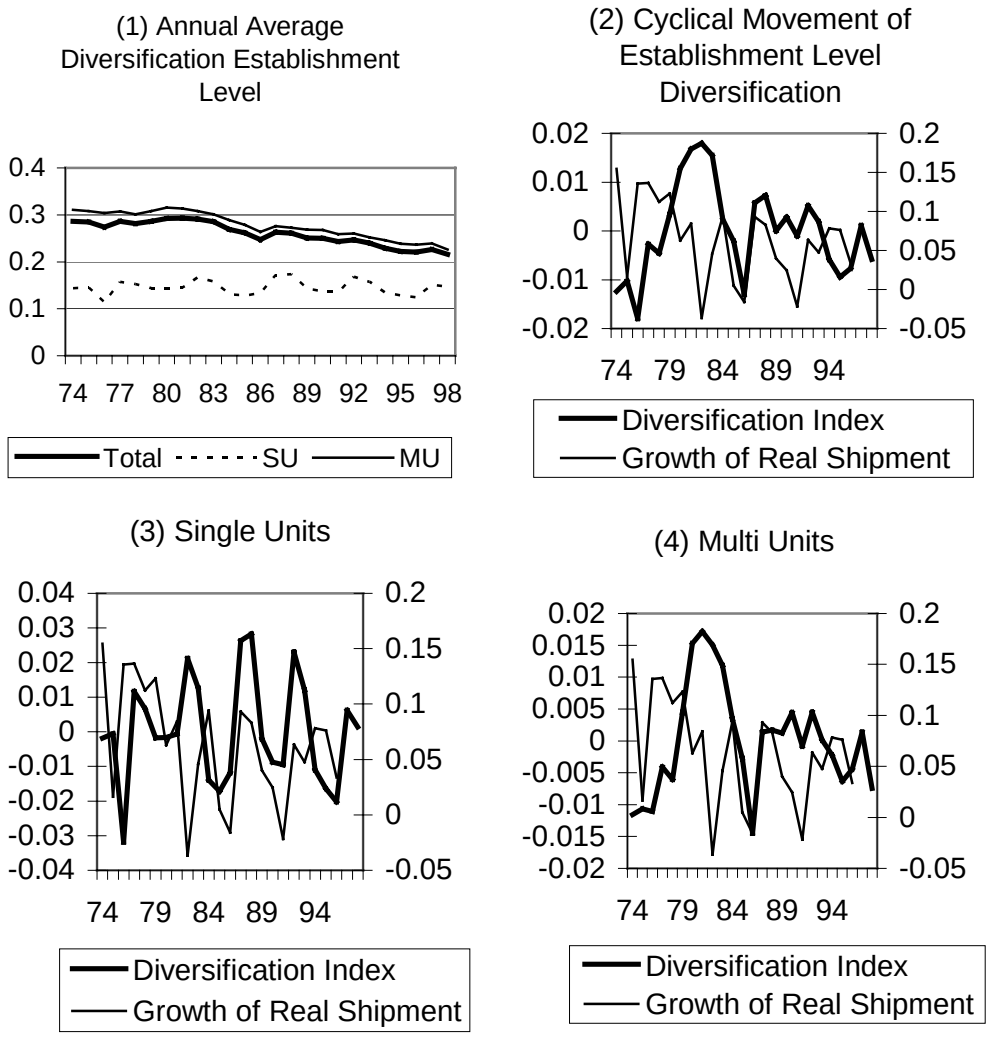
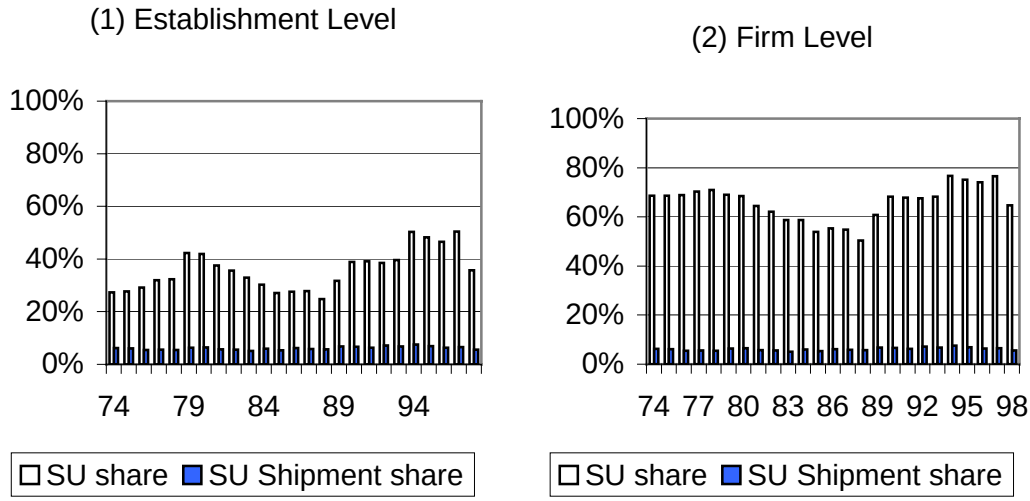


Figure 4 Share of Single Unit Establishments (Firms)



Establishment level Analysis: Industry level

The average diversification index shows large variations across industry, as shown in Table 2.[27] Overall, establishments in Food, Printing, Chemical, Petroleum, and Metal industries have higher diversification on average over the period 1974-1998. For single-unit establishments, Food, Lumber, Printing, Chemical and Petroleum have high diversification. For multi-unit establishments, Printing, Chemical, Petroleum, Metal and Machinery have high diversification. To summarize, Printing, Chemical, and Petroleum industries have high diversification both in single-unit and multi-unit establishments. The high diversification of Food and Lumber is driven by their highly diversified single-unit establishments. Multi-unit establishments in Metal and Machinery crank up the average diversification level in those industries.

Cyclicality is also heterogeneous by industry. The sign of the correlation between the sectoral diversification index and the sectoral growth rate of real shipments is mixed across industries. Out of nineteen industries, eleven have positive correlations. Among the significant six correlations, four industries have positive signs. For single-unit establishments, thirteen industries have positive signs and four of five significant correlations are positive. For multi-unit establishments, eleven industries in total and five out of eight significant correlations have positive signs.

[27] Industry is classified by 1987 basis SIC. See Appendix A for detail.

Table 2 Average Establishment Level Diversification Index and Correlation with Growth of Real Shipment by 2 digit SIC Industry

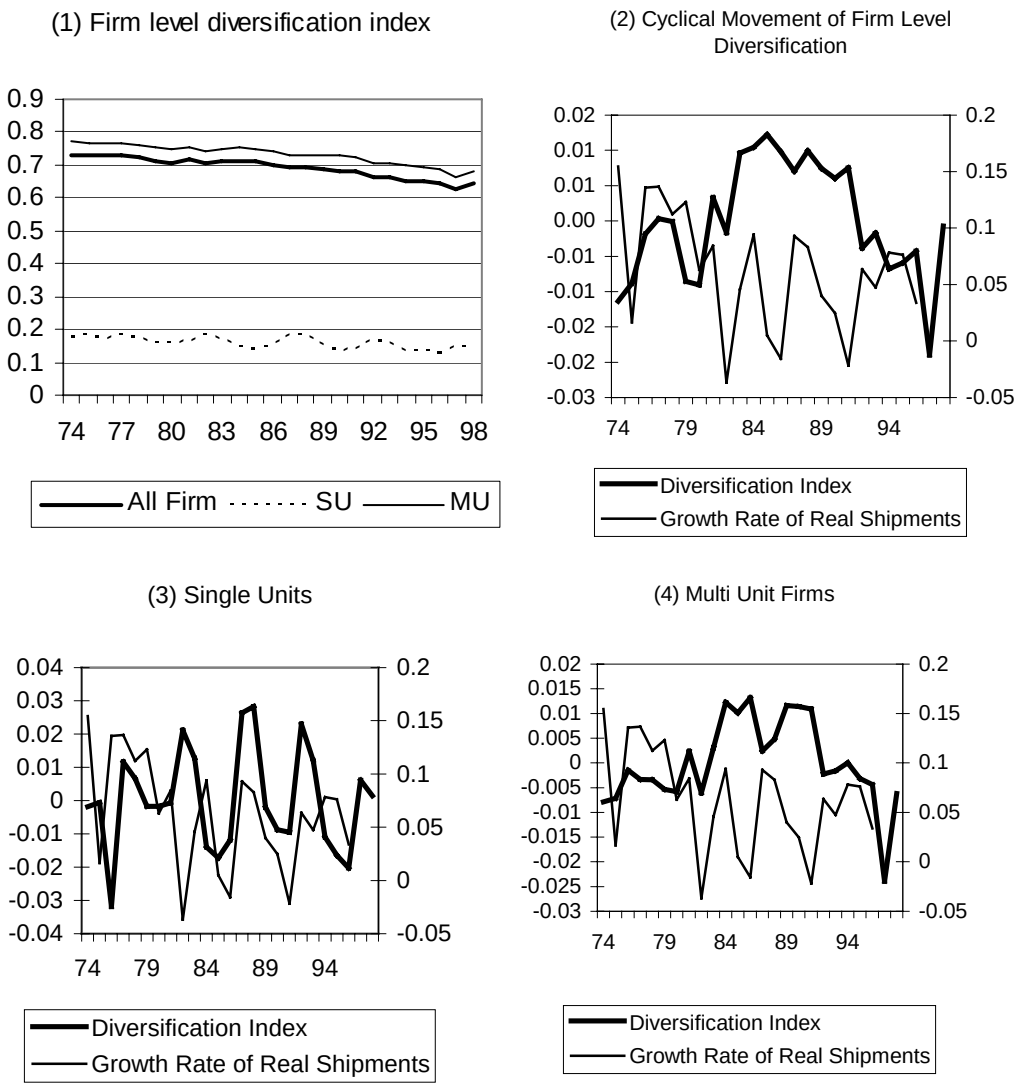
Industry	Total		SU		MU	
	Mean	Corr. coeff.	Mean	Corr. coeff.	Mean	Corr. coeff.
20 Food	0.26	0.09	0.19	-0.28	0.27	0.14
22 Textile	0.19	0.37	0.13	0.26	0.20	0.36
23 Apparel	0.19	0.71*	0.17	0.53*	0.22	0.64*
24 Lumber	0.19	-0.51*	0.18	-0.34	0.20	-0.57*
25 Furniture	0.23	-0.21	0.16	-0.03	0.27	-0.14
26 Paper	0.21	0.10	0.12	0.07	0.22	0.19
27 Printing	0.30	0.08	0.24	0.45*	0.33	0.11
28 Chemical	0.35	-0.09	0.18	-0.42*	0.37	-0.45*
29 Petroleum	0.58	0.75*	0.27	0.36	0.59	0.65*
30 Rubber	0.19	0.61*	0.15	0.25	0.20	0.66*
31 Leather	0.15	0.39	0.13	0.55*	0.16	0.41*
32 Stone	0.11	-0.03	0.10	0.17	0.12	0.00
33 Metal	0.29	0.50*	0.16	-0.11	0.30	0.52*
34 Fabricated Metal	0.16	0.15	0.14	0.03	0.17	0.39
35 Machinery	0.28	-0.31	0.15	0.30	0.31	-0.18
36 Electronic	0.20	-0.24	0.12	-0.25	0.21	-0.17
37 Transportation	0.22	-0.42*	0.13	0.25	0.22	-0.44*
38 Instruments	0.21	-0.16	0.11	0.09	0.23	-0.33
39 Miscellaneous	0.15	0.20	0.09	0.56*	0.18	0.20

*significance at the 95% level
Note: Industry 20 includes industry 21 (Tobacco) due to the private information disclosure issue.
Source: Diversification index from author's calculation, Growth rate of real shipments from Census Bureau

Firm level analysis: Aggregate level

At the aggregate level, the annual diversification index computed at the firm level shows a downward trend from 1974 to 1998 in the first graph of Figure 5. The level of firm diversification is higher than the establishment level index, mainly because of the high diversification of multi-unit firms. Single-unit firms comprise 60% of the sample but account for less than 10% of total shipments in average in Figure 4.

Figure 5 Firm Level Average Diversification Index (D1)



There is not a clear cyclicality of diversification at the aggregate level. The second graph of Figure 5 plots the average diversification index and the growth rate of real shipments in the manufacturing sector.[28] SU firms seem to have countercyclical diversification, i.e., firms specialize in booms and diversify in recessions. There is no clear co-movement for MU firms.

[28] I use the linearly detrened diversification index the growth rate of real value of shipment.

Figure 6 Firm Level Average Diversification Index (D1, D2, D3 and D4)

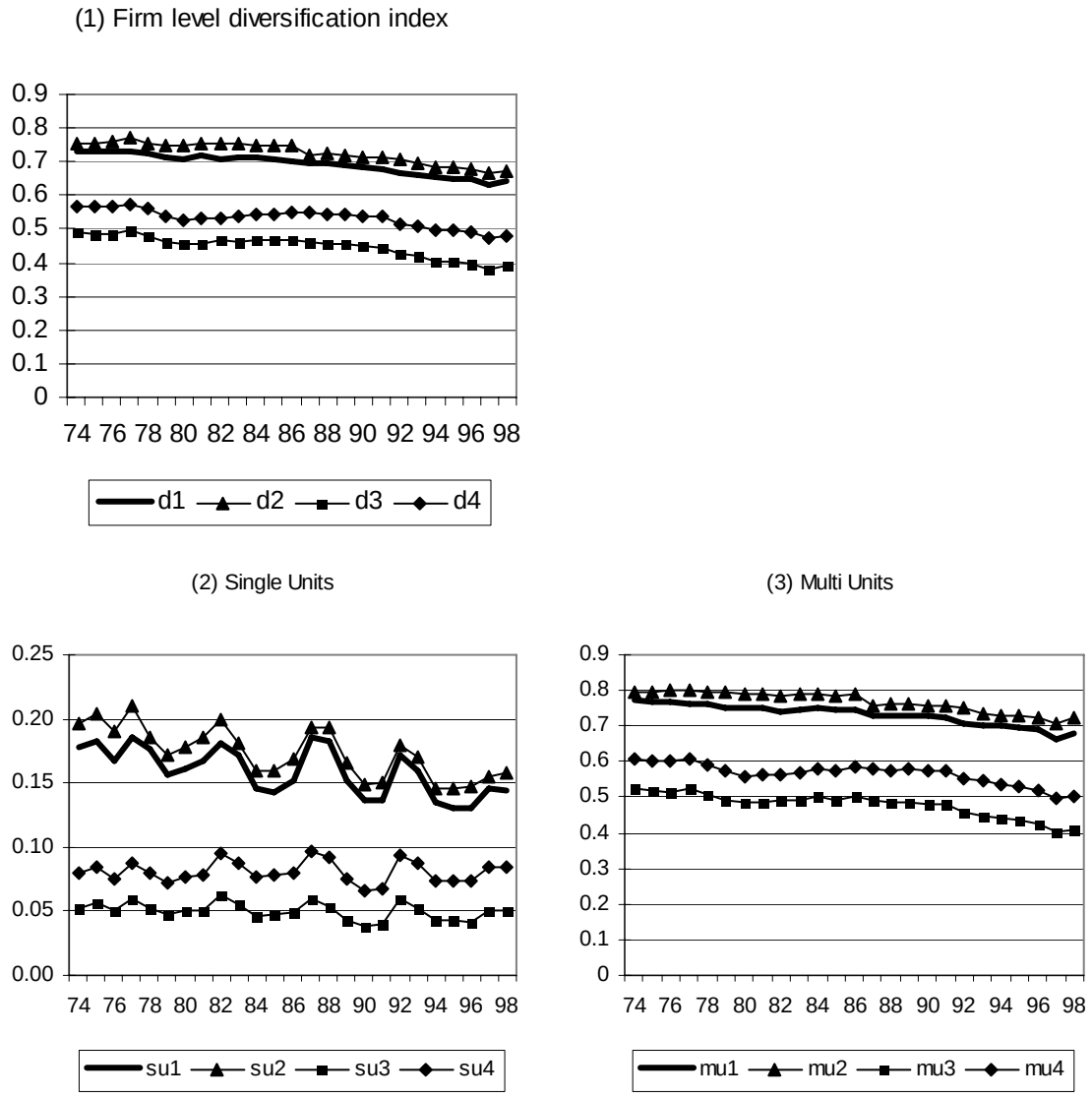


Figure 6 compares different measures of diversification. Since D2 uses distance weights to incorporate the relationship across industries, D2 is higher than D1. However, the gap between D1 and D2 is not so big. Recalling that D1 is close to D2 for a firm if all the industries are positively correlated to the primary industry of the firm, it means that firms do not diversify into really different industries. For single unit firms, the gap between D1 and D2 becomes smaller in

the 1990s. This suggests that specialization in closely related industries is more prevalent in single units.

Since D3 and D4 use less detailed product classification, they are much lower than D1. Using the 4-digit SIC, D4 is about 20% lower than D1 which means the within-industry diversification contributes about 20% of the total 5-digit product level diversification. Using 3-digit SIC, D3 is about 30% lower than D1. However, the proportion of D3 to D1 or D4 to D1 doesn't change much over time. This suggests the composition of across- or within-industry diversification remains stable in my sample period.

Different measures of diversification show different levels of index but the trends and cyclicality look remarkably similar to one another. Since almost all aspects of diversification analyses share similar trends across different measures, I will use D1 to explain trends of diversification for the rest of the paper. However, I'll also show other measures of diversification if discussions about magnitude of different indexes are needed.

Firm level analysis: Industry level

In Table 3, the average diversification index shows great variation by industry.[29] Overall, firms in Paper, Chemical, Petroleum, Transportation, and Instruments have a higher mean diversification index in 1974-1998. Single-unit firms in Food, Lumber, Printing, Chemical and Petroleum industries have high diversification. For multi-unit firms, Paper, Chemical, Machinery, Transportation Equipment and Instruments have high diversification. The Chemical industry has high diversification both in single-unit and multi-unit firms. The high diversification of Paper, Transportation and Instruments is driven by their highly diversified multi-unit firms.

Table 3 also displays the estimates of correlation coefficients between the diversification index and the value of shipments by sector. Out of nineteen industries, twelve have negative correlation coefficients. Among the six significant correlations, four have negative signs. As

[29] SIC is based on 1987 changes. See Appendix A for detail.

Table 3 Firm Level Average Diversification Index(D1) and Correlation with Growth of Real Shipment by 2 digit SIC Industry

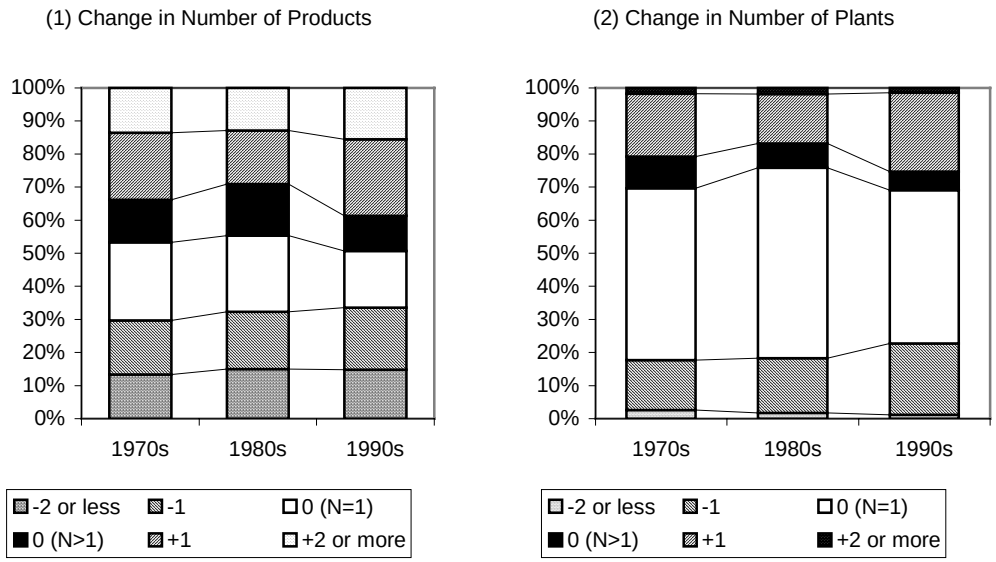
Industry	Total		SU		MU	
	mean	Corr. Coeff.	mean	Corr. Coeff.	mean	Corr. Coeff.
20 Food	0.53	-0.20	0.19	-0.28	0.51	-0.30
22 Textile	0.55	-0.17	0.13	0.26	0.57	-0.02
23 Apparel	0.54	0.44*	0.17	0.53*	0.61	-0.08
24 Lumber	0.47	-0.34	0.18	-0.34	0.63	-0.53*
25 Furniture	0.50	0.07	0.16	-0.03	0.56	-0.44
26 Paper	0.73	0.27	0.12	0.07	0.75	0.10
27 Printing	0.56	-0.57*	0.24	0.45*	0.58	-0.67*
28 Chemical	0.74	-0.64*	0.18	-0.42*	0.77	-0.71*
29 Petroleum	0.70	0.07	0.27	0.36	0.71	0.00
30 Rubber	0.66	0.52*	0.15	0.25	0.71	0.53*
31 Leather	0.49	-0.13	0.13	0.55*	0.55	0.04
32 Stone	0.63	0.35	0.10	0.17	0.68	0.10
33 Metal	0.63	-0.10	0.16	-0.11	0.70	-0.26
34 Fabricated Metal	0.65	-0.02	0.14	0.03	0.72	0.34
35 Machinery	0.69	-0.49*	0.15	0.30	0.73	0.45
36 Electronic	0.69	-0.52*	0.12	-0.25	0.70	-0.28
37 Transportation	0.73	0.08	0.13	0.25	0.75	-0.01
38 Instruments	0.77	-0.18	0.11	0.09	0.80	0.07
39 Miscellaneous	0.78	-0.30	0.09	0.56*	0.81	-0.30

*significance at the 95% level
Note: Industry 20 includes industry 21 (Tobacco) due to the private information disclosure issue.
Source: Diversification index from author's calculation, growth rate of real shipments from Census Bureau

discussed earlier in this paper, thirteen industries have positive signs and four of five significant coefficients are positive for SU firms. For MU firms, twelve industries in total and three of four significant correlations have negative signs.

To summarize, it is very difficult to draw a clear conclusion regarding the cyclicality of aggregate or industry level diversification from the data. It is necessary to see the distribution of firms and to study diversification directly at the firm level to see how firms change their diversification.

Figure 7 Change in the Number of Plants and Products



Firm level analysis: Change of diversification

Since the choice of number of products is discrete, it is interesting to see how firms adjust their number of products over time. The first graph of Figure 7 displays the distribution of firms over year-to-year changes in the number of products. Firms are classified into six groups every year: Firms that discontinue producing two or more products compared to the previous year (-2); Firms that discontinue producing one product (-1); Firms that produce a single product in both years (0 with N=1); Firms that produce the same number of multiple products (0 with N>1); Firms that produce one more product than previous year (+1); Firms that produce 2 or more products than previous year (+2). We get an annual distribution of firms by this classification. Figure 6 shows the distribution of the annual series averaged by decade, showing that the number of single-product producers decreased in the 1990s (white-colored block).[30] Firms with no change in the number of products (black-colored block) also decreased, while there was an increase in the

[30] From the bottom, N(t)-N(t-1)<=-2, -1, 0 given that N(t)-N(t-1)=1, 0 given that N(t-1)>1, +1, and +2 are displayed in Figure 6.

share of firms that increased or decreased one product (slashed blocks). These firms are "product-switchers" that adjust their product portfolio with one marginal product.

Multi-unit firms make a discrete choice regarding the number of plants that operate. The second graph in Figure 7 shows the decade average of the distribution of firms by the annual change in number of plants, with the same categories as the first graph of Figure 7. The shares of single plant firms (white-colored block) and of firms with the same number of plants in any two consecutive years (black-colored block) decreased in the 1990s. There are many multi-unit firms that adjust the number of plants up or down by one.

Even when two multi-unit firms produce identical products, they can be different in terms of how they allocate production. For example, in Table 4, Firm I produces product X in plant A and product Y in plant B. Firm II produces both X and Y in plant A and only X in B. Firm I owns two specialized plants while Firm II has one diversified plant and one specialized plant, although they have the same firm level diversification index. The diversification index can be decomposed to distinguish these two firms. Equation 1 groups the products into two categories: those produced in multiple plants or in a single plant. The share of production diversification factor (r_{pd}) reflects the diversification of production, not the diversification of products. r_{pd} is 0 for Firm 1 and 0.5 for Firm II.

Equation 2 investigates further the link between establishment and firm diversification. Since a firm is defined as the sum of its establishments, a firm's diversification must be a function of diversification within and among its plants. Consider adding and subtracting a shipments-weighted average of diversification indexes for a firm's establishments to the right-hand side of an identity equating the firm's diversification index with itself. The within-plant factor reflects the contribution of within-establishment diversification to overall firm level diversification. The among-plant factor recognizes that differences in product mix across plants are captured in the firm measure but not in the individual plant measure. It quantifies the contribution of

diversification among a firm's plants. In the example of Table 4, the within plant factor is .375 for Firm II.

Equation 1 Production Diversification

$$d = 1 - (\underbrace{\sum_{i \in A} S_i^2}_{\text{Diversified Production}} + \underbrace{\sum_{i \in B} S_i^2}_{\text{Specialized Production}}) = (r_{pd} + r_{ps})d$$

where,

$$r_{pd} = \sum_{i \in A} S_i^2 / \sum_i S_i^2, \; r_{ps} = 1 - r_{pd}$$

$i \in A$ product i produced in multiple plants

$i \in B$ product i produced only in one plant

Equation 2 Within/Among-plant Diversification

$$d^f = \underbrace{\sum_j a_j d_j^{est}}_{\text{Within-plant}} + \underbrace{(d^f - \sum_j a_j d_j^{est})}_{\text{Among-plant}} = (r_{wp} + r_{ap})d^f$$

where,

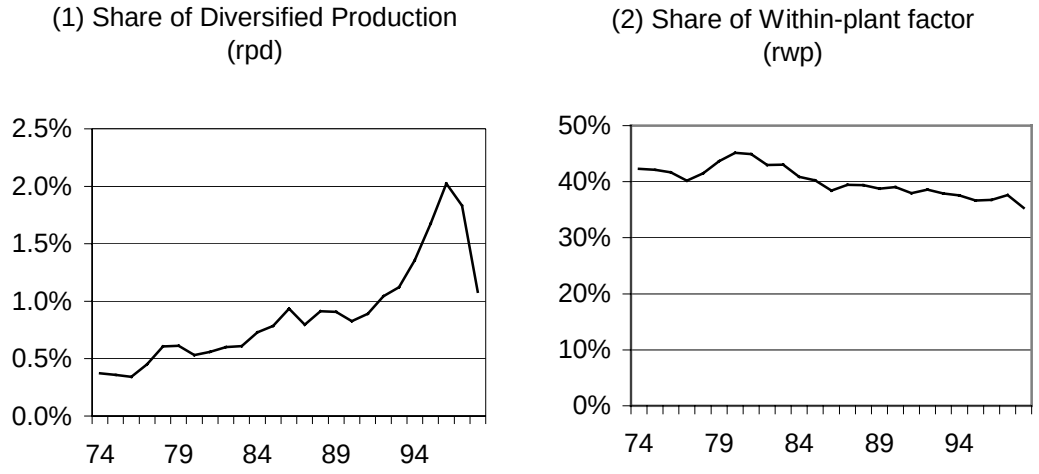
a_j = shipment share of the jth plant

d^f = firm level diversification, d^{est} = plant level diversification

$$\mathrm{r_{wp}} = \sum_j a_j d_j^{est} \Big/ d^f, \; \mathrm{r_{ap}} = 1 - \mathrm{r_{wp}}$$

The first graph in Figure 8 plots the share of diversified production (r_{pd}) from 1974 to 1998. The production diversification factor increased in 1990s but is below 2% for the whole sample period. Therefore, specialized production is much more common. The second graph in Figure 8 plots the share of within plant diversification in overall diversification (r_{wp}). Within-plant

Figure 8 Share of Diversified Production (r_{pd}) and Share of Within-plant diversification (r_{wp})



diversification declined over the last three decades. The two graphs in Figure 8 imply that firms are specializing productions more and more.

The aggregate statistics suggest that the average firm doesn't change its diversification much in short time period. Figure 9 plots the average net change of firms' diversification in two consecutive years, that is, NET=avg(d(t)-(d(t-1)) for firms that are operating in both years. NET is very small throughout the sample period. One might be tempted to conclude that fluctuations in diversification do not matter much because of the small annual changes. However, we see much bigger fluctuation when we break down the net changes into two components, the positive changes (POS=avg(d(t)-(d(t-1)) for the firms with d(t)>(d(t-1)) and negative changes(NEG=avg(d(t)-(d(t-1)) for the firms with d(t)<(d(t-1)). NET is equal to POS minus NEG (NET=POS-NEG). Figure 9 suggests there are many firms that increase or decrease their diversification keeping the overall average change small.

Figure 9 Positive, Negative and Net change of diversification

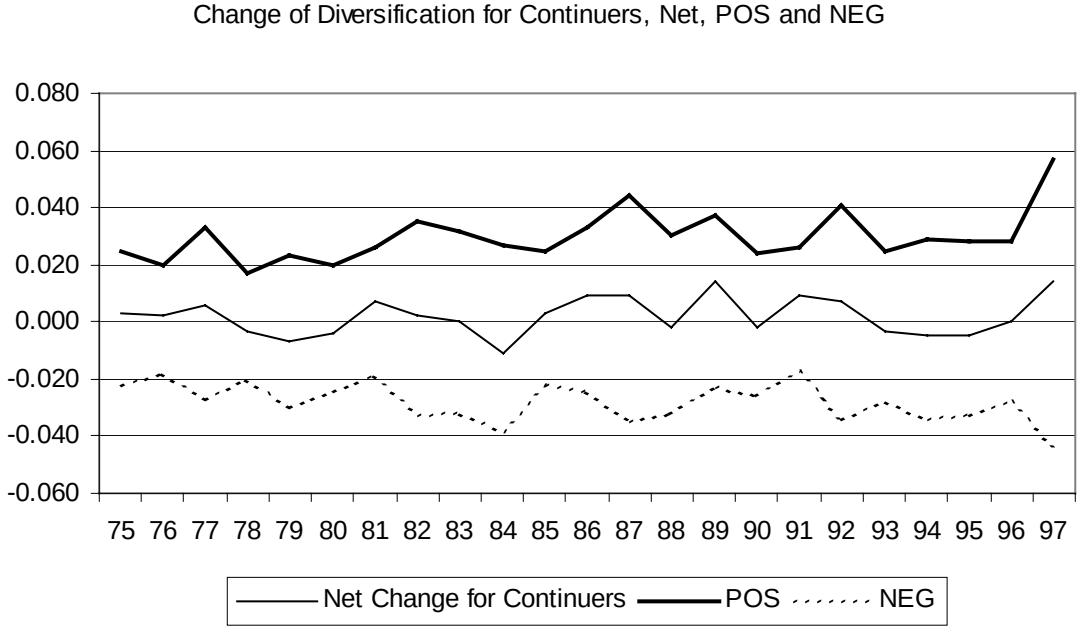


Table 4 Distribution (percentiles) of Firms' correlation coefficients between new/lost industry and the primary industry

	5th	10th	Median	90th	95th
Firms with increasing number of industries	.02	.32	.87	.97	.98
Firms with decreasing number of industries	-.1	.2	.86	.97	.98

It is important to know which industry the firm diversifies. Does the firm diversify into industries which have positive correlation coefficients with current primary industry? We can shed a little bit of light on this issue by looking at the distribution of firms' correlation coefficients between new/lost industry and the primary industry when the firm increases/decreases number of products. Table 4 shows percentiles of correlation coefficients of firms. Among the group of firms with increasing number of industries in two consecutive years, the median firm's correlation coefficient between the new industry and its primary industry is .87. Even the 5th percentile of firms has positive correlation (.02). This suggests that when the firm increases its product portfolio, it usually diversifies into similar industries with positive correlation with its primary

product. Likewise, among the group of firms with decreasing number of industries, the median firm's correlation coefficient is .86. The correlation is .2 for the 10^{th} percentile firm and -.1 for 5^{th} percentile firm. This means many firms shut down products that have positively correlated industries but some firms withdraw from negatively correlated industries. This suggests that the avoiding-risk factor is less important and the trend of specialization is more important in the firm's decision of diversification.

Firm level analysis: average diversification index by firm characteristics

Appendix B includes average diversification indexes by various firm characteristics. Single unit firms have lower diversification than multi unit firms (Table AB-2 and AC-3). Big firms have higher diversification (Table AB-10), as old firms (Table AB-11). There is no clear regional difference in diversification (Table AB-12). If the firm is vertically integrated, the firm will diversify into the products that are consumed within the firm to produce the final product. The share of Interplant Product Transfers to the total value of shipments of the firm (IPT) is used as an indicator for vertical integration. Table AB-13 shows that diversification increases with IPT but starts to decrease if IPT is too high, suggesting that a firm with very high vertical integration diversifies less and specializes more. Table AB-14 shows that diversification is higher for firms with lower labor cost share. Labor intensive firms tend to specialize. A high ratio of organizational workers may be needed facilitate the complicated process of multi-product production. Diversification increases with the share of non-production worker wage to the total wage cost but starts to decrease when the share gets very high (Table AB-15). The relationship between diversification and exporting is not clear in Table AB-16, although non-exporting firms tend to have lower diversification because they are relatively small firms.

With the limited information from ASM product data, we can see how heterogeneous products are by looking at the number of industries (at the 2-digit SIC level) spanned by the number of products of the firm. In Table AB-17, for example, firms which produce 10 products

diversify across 2.7 industries in the 1970s, while they diversify across 2.3 industries in the 1990s (row 10). The number of industries declines for firms that produce many products. The second panel of Table AB-17 shows the number of industries by 3-digit SIC. Table AB-18 shows the geographical dispersion of plants within firms by displaying the number of different counties where plants are located as a function of the number of plants. For example, firms with 10 plants locate them in 8.3 counties in the 1970s and 8.7 counties in 1990s (row 10). In general, firms diversify more geographically in 1990s than in 1970s.

In summary, firm-level diversification is very heterogeneous by firm characteristics, but most of the statistics confirm our conjecture about what types of firms have high diversification: Big firms, old firms, capital-intensive firms, firms with many organizational workers, etc. Furthermore, the trend of diversification is common across regions in US. It is worth a notice that firms seem less diversified horizontally but more diversified geographically: Even the highly diversified firm specializes in a couple of 2-digit industries, but firms have operated their plants in more diversified locations over time.

3. Volatility Change and Diversification

3.1. Overview

Many economic indicators show less volatility in mid-1980s and the change in volatility was not restricted to any one sector, level or indicator. Stock and Watson (2002) show that the moderation in volatility is widespread and appears in both nominal and real series. The decline in volatility is most pronounced for residential investment, output of durable goods and output of structures. The decline in volatility appears both in measures of real economic activity and in broad measures of wage and price inflation. The decline in aggregate volatility is pervasive.

Recent studies show that volatility has decreased not only at the aggregate level but also at sectoral level. They find that the decrease is not confined to any one sector, but is common to many sectors. Kim et al (2004) shows that the volatility reduction in aggregate output is visible in more sectors of output than simply durable goods production. Specifically, there is an evidence of a volatility reduction in the production of structures and non-durable goods.

Comin and Mulani (2003) investigate the evolution of volatility at the firm level. They find that while the growth rate of aggregate sales has become more stable over time at the firm level, the volatility of the growth rate of sales at the firm level has increased. They argue that idiosyncratic firm-level volatility diverges from the aggregate trend. But they use the data only for only public firms.[31] It has not been confirmed whether idiosyncratic volatility has been increasing for all firms, including small non-public firms.

This section verifies these findings on volatility with ASM and CM data. Then I study the effect of volatility on the firm level diversification decision. Among the suggested motives for diversification, risk-avoidance dominates the literature: With liquidity constraints, firm

[31] They use COMPUSTAT data that includes about 20,000 publicly traded U.S. companies.

investment depends on cash flows.[32] If firms diversify over products to smooth their profits, then they should respond to the volatility of profit shocks on every level. In particular, aggregate, sectoral and idiosyncratic profit shocks can affect firm level diversification. My main findings confirm the decrease in aggregate, sectoral and idiosyncratic volatility of the profit rate, and show that a less volatile profit rate leads to less diversification.

3.2. Volatility and Diversification

Changes in volatility can affect diversification at different levels. More formally,

$$(1) \qquad d_{it} = f(\sigma(A_{it})) \quad , \text{ where } i = 1,2,...,N \ , t = 1,2,...T$$

$$(2) \qquad A_{it} = \underbrace{A_t}_{\text{Aggregate factor}} + \underbrace{(A_{st} - A_t)}_{\text{Industrial factor}} + \underbrace{(A_{it} - A_{st})}_{\text{Idiosyncratic factor}}$$

$$\text{where} \qquad A_t = \frac{1}{N}\sum_i A_{it} \quad , \quad A_{st} = \frac{1}{N_s}\sum_{i \in s} A_{it}$$

$$(3) \qquad \sigma(A_{it}) = \sqrt{\frac{\sum_{j=t-4}^{t+5}(A_{ij} - \overline{A}_{it})^2}{10}}, \quad \overline{A}_{it} = \frac{\sum_{j=t-4}^{t+5} A_{ij}}{10}$$

where the diversification for firm i (d_i) is a function of the volatility of the profit rate (A_{it}). In Equation (2), the profit rate consists of three factors, aggregate, industrial, and idiosyncratic factors. There are profit shocks at three levels ($A_t, A_{st} - A_t, A_{it} - A_{st}$) and the equation holds as an identity. So the industrial and idiosyncratic components are defined as deviations from the average industry or firm profit shocks.[33] Equation (3) defines the volatility of the time series for

[32] Jovanovic(1993)
[33] This is similar to a Cholesky decomposition.

firm level profits as $\sigma(A_{it})$ by computing the series of standard deviations of 10-year rolling windows of A_{it}.[34]

Profit shocks at the aggregate, industrial and idiosyncratic level are assumed to be orthogonal to one another by construction. Since the shocks are orthogonal, the standard deviations of the shocks over time (volatility) are orthogonal to one another. Therefore, orthogonality is preserved for the volatility of observed profit rates at the aggregate ($\sigma(A_t)$), industry ($\sigma(A_{st} - A_t)$) and firm level ($\sigma(A_{it} - A_{st})$).

We can test the following hypotheses regarding the partial effect of profit shocks on the firm level diversification:

(1) $H_0 : \frac{\partial f}{\partial \sigma(A_t)} > 0$

(2) $H_0 : \frac{\partial f}{\partial \sigma(A_{st} - A_t)} > 0 \qquad , s = Two - digit\ SIC\ Industry$

(3) $H_0 : \frac{\partial f}{\partial \sigma(A_{it} - A_{st})} > 0 \qquad , i = 1,2,...,N$

It is very intuitive that the sectoral and idiosyncratic volatility affect the diversification decision. Firms can insure themselves against bad profit shocks by diversifying into different industries and products. However, firms cannot avoid the aggregate shock because no matter how many products they produce, the aggregate shock will hit them equally.

[34] The standard deviation of a 10-year window is used as the measure of volatility in Comin and Mulani (2003). Stock and Watson (2002) uses the standard deviation by decade. Kahn et al(2002) uses the standard deviation in three sample periods (1953-1968, 1968-1983, and 1984-2000).

The aggregate shock in this analysis includes not only aggregate profit fluctuations of manufacturing sector but any disturbance that is not captured by sectoral or idiosyncratic volatility in the economy. For example, fluctuations in the service sector or financial sectors will show up as aggregate volatility change.

3.3. Stylized facts: Volatility

Figure 10 shows that the aggregate profit volatility ($\sigma(A_t)$) has constantly decreased over my sample period. Since I use a rolling standard deviation across 10 years as the measure of volatility, the volatility measure for the first 4 years is only forward looking, and volatility for the last 5 years is backward looking. Therefore, only the data between 1978 and 1993 are appropriate. Profit rates are measured as sales minus variable costs, divided by the capital stock.[35]

Table 5 shows the volatility of the average firm level profit rate by industry. Almost all industries had lower profit volatility in 1993 than in 1978. The first graph of Figure 11 displays industries that had low volatility in the 1980s. The second graph of Figure 11 shows industries with high volatility in the 1980s – Rubber, Leather, Machinery and Instruments. The volatility of industries not shown in Figure 11 is constant or slightly decreasing over time. The downward trend of volatility is widespread across industries, but not universal. This is consistent with evidence in the literature.

[35] See Appendix A for detail.

Table 5 Profit Volatility by Industry ($\sigma(A_{st} - A_t)$)

Industry	1978	1983	1988	1993
20 Food	0.19	0.13	0.13	0.11
22 Textile	0.14	0.10	0.12	0.15
23 Apparel	0.52	0.36	0.42	0.38
24 Lumber	1.07	0.06	0.11	0.12
25 Furniture	0.35	0.32	0.29	0.22
26 Paper	0.20	0.22	0.18	0.09
27 Printing	0.30	0.14	0.17	0.09
28 Chemical	0.21	0.28	0.31	0.13
29 Petroleum	0.82	0.72	0.33	0.41
30 Rubber	0.17	0.56	0.65	0.24
31 Leather	1.33	1.31	1.52	1.28
32 Stone	0.10	0.13	0.16	0.20
33 Metal	1.22	0.30	0.39	0.37
34 Fabricated Metal	0.07	0.18	0.20	0.04
35 Machinery	0.58	1.20	1.25	0.52
36 Electronic	0.94	0.73	0.31	0.54
37 Transportation	1.11	0.81	0.55	0.47
38 Instruments	0.44	0.28	0.52	0.47
39 Miscellaneous	1.21	1.08	0.36	0.21

Note: Food (Industry 20) includes Tobacco (Industry 21) due to the private information disclosure policy of the Bureau of Census

At the firm level, some firms have higher idiosyncratic volatility, and other firms have lower volatility in the 1990s than in the 1970s. I calculate the volatility for each firm, then take the mean ($\underset{i}{avg}(\sigma(A_{it} - A_{st}))$) and cross-sectioned standard deviation ($\underset{i}{std}(\sigma(A_{it} - A_{st}))$) in every year. Figure 12 shows the evolution of firm level volatility. The mean of idiosyncratic volatility increased in the early 1980s but fell in the late 1980s as shown in the first graph of Figure 12. Although there is an increase in the late 1990s, the standard deviation of firm level volatility remained the same or slightly increased between 1979 and 1994 as shown in the second graph of Figure 12.

Figure 10 Mean and Average Volatility of Firm Level Profit Rates

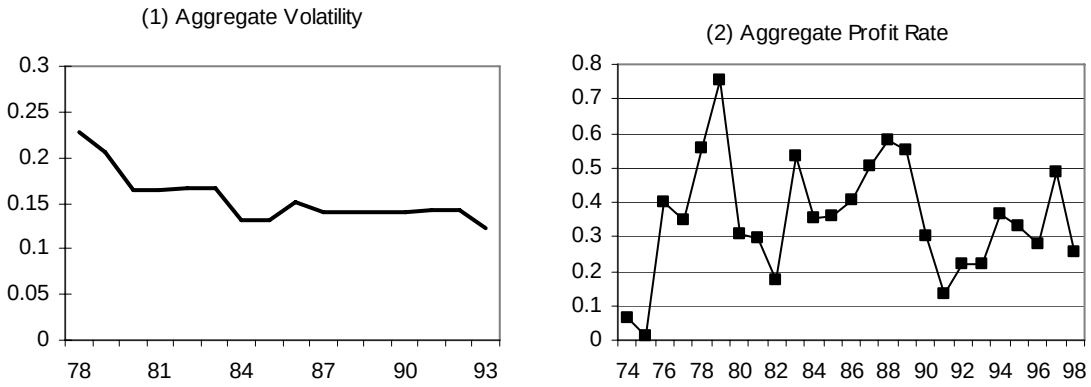


Figure 11 Volatility of average firm level profit rates by industry

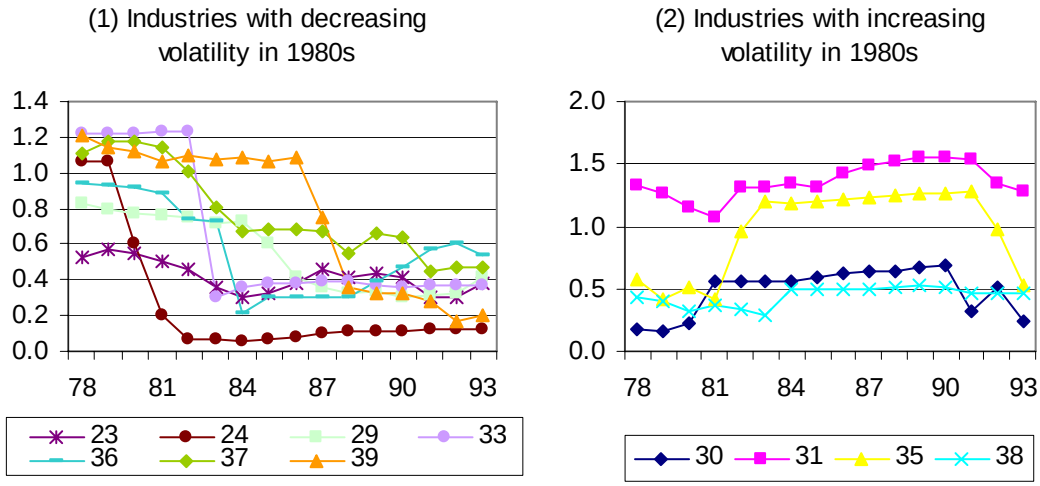


Figure 12 Mean and standard deviation of firm level idiosyncratic volatility

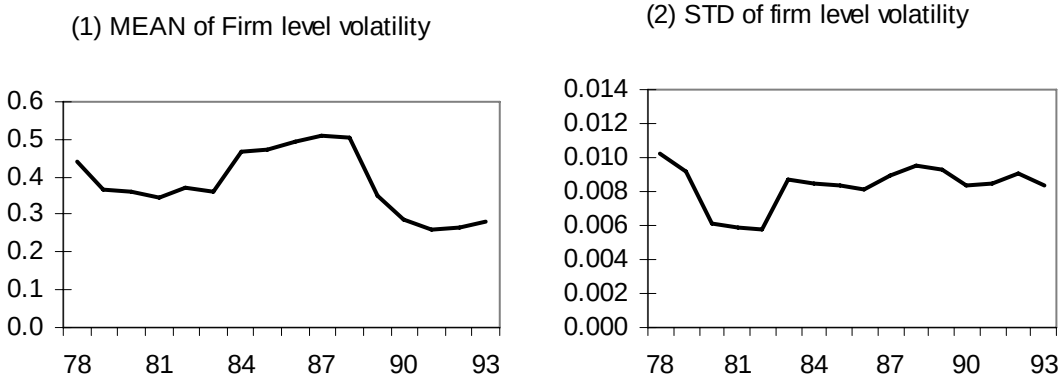
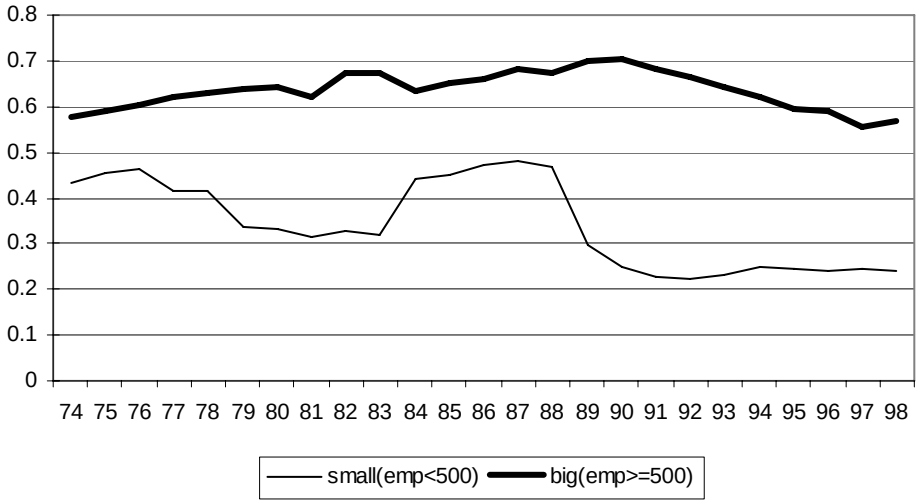


Figure 13 Average Idiosyncratic Volatility by Size of Firm



The downward trend of idiosyncratic volatility is different from evidences in the literature. Comin and Mulani (2003) showed an upward trend of idiosyncratic volatility for relatively big firms in COMPUSTAT data. Although they showed the result is not coming from the sample bias in the paper, I verified the trend of idiosyncratic volatility for big and small firms, separately. Figure 13 shows the idiosyncratic volatility by the two size group of firms.[36] An increasing volatility is not observed even for big firms. Unlike the downward trend of aggregate or sectoral volatility, the trend of idiosyncratic volatility is not unarguable.

3.4. Diversification and Volatility: Estimation

The three key stylized facts of diversification from Section 2 are (1) a strong downward trend of diversification, (2) industrial variation in the cyclicality of diversification and (3) heterogeneous movement of firm level diversification. And the three key empirical results of volatility in Section 3 are (1) decreased aggregate volatility, (2) decreased volatility in many

[36] I used total employment as the size measure.

industries and (3) decrease of firm level volatility. Risk-avoidance is an incentive to diversity which links these sets of findings. The hypopaper is that the change of volatility at the aggregate, industrial and firm level can affect a firm's diversification.

The firm level diversification index is regressed on the volatility of aggregate, industrial and firm level profit rate.

$$d_{it} = \beta_0 + \beta_1 AGGVOL_t + \beta_2 INDVOL_{st} + \beta_3 IDIVOL_{it} + \beta_4 X_{it} + \varepsilon_{it}$$

, where

i = firm i

s = 2 - digit industry of firm i

X = firm level characteristics

d is one of the firm level diversification measures. AGGVOL is the volatility of the average of firm level profit rates($\sigma(A_t)$). INDVOL is the volatility of the industry level average of the deviation from aggregate profit rates ($\sigma(A_{st} - A_t)$). IDIVOL is the volatility of the deviation of firm level profit rates from the industry average($\sigma(A_{it} - A_{st})$). Firm level characteristics(X) include Firm Size(SIZE), Firm Age (AGE), and the Share of Organizational Workers to the total employment(FOE).

By using four measures of diversification as dependent variable, we can capture different effects of volatility and firm characteristics on diversification. D1 uses 5-digit SIC which is the most detailed information available on products in ASM firms and it is the benchmark case of estimations. D2 adds distance measure to D1 using correlation of industries in which the firm diversifies. D2 is bigger than D1 when the firm diversifies in uncorrelated or negatively correlated industries. Therefore, effects of right hand side variables will be magnified for firms with D2 higher than D1. When we use 3-digit or 4-digit SIC (D3 and D4), we only consider

across-industry diversification. The same amount of change in right hand side variable has different effects on these different measures of diversification and a comparison of coefficients shows whether the firm reacts most sensitively with its diversification across 3-digit, 4-digit or 5-digit industry.

Table 6 shows the results of firm level regressions using the left-censored Tobit estimation method. By definition, single-product producers have a diversification index equal to 0. Therefore, the left-censored Tobit model is appropriate because we have a mass point at 0 for the dependent variable. I use 10 year rolling window to get volatility, but volatility in 1974-1977 and 1994-1998 can use less than ten years of observation. Therefore, I showed the estimation results for the total sample period (1974-1998) and the period of 1978-1993 to check the robustness of estimation. I repeated the regression using Diversification Index(D1), Index with distance weight(D2), Index using 3-digit SIC(D3) and Index using 4-digit SIC(D4) as the left-hand side variable. Time trend(YEAR) and location(REGION) are controlled as fixed effects.

In the sample period of 1974-1998, the coefficient estimates for volatility (AGGVOL, INDVOL, IDIOVOL) are in all cases and they are statistically significant for most cases. Coefficients for AGGVOL are different by the specification, but coefficients for INDVOL and IDIOVOL are relatively stable and robust. Coefficients for AGGVOL, INDVOL and IDIOVOL are different depending which measure of diversification is used as the left-hand side variable. However, the sign of the estimates remains positive and the order of magnitude (AGGVOL>IDIOVOL>INDVOL) are the same with D1 and D3 as the dependent variable. Estimation result for time period 1978-1993 is very similar to the result for 1974-1998. The sign and order of magnitude are not affected by the choice of left-hand side variable or specification. The result shows that diversification responds to aggregate volatility, industry volatility, and the idiosyncratic volatility of firm performance relative to those of other firms in the sector. When

other idiosyncratic firm level characteristics (SIZE, AGE, FOE) are included in the estimation, they reduce the level of IDIOVOL and INDVOL coefficients.

Decreased aggregate volatility can reduce diversification by a great amount. In the specification IV for sample period 1978-1994, on average, 1% change in aggregate volatility (AGGVOL) will reduce diversification by .9% in 3-digit (D3), .93% in 4-digit (D4), and 1.4% in 5-digit (D1). When the aggregate volatility falls, firms reduce diversification at all levels, 3, 4 or 5-digit industries, but the biggest decrease occurs at the 5-digit SIC level diversification (D1). It suggests that firms specialize within (3 or 4 digit) industries but relatively diversify across multiple industries when volatility declines, which is consistent with other results in the previous section. The decrease of diversification is even bigger when we consider the distance between diversified industries (D2). If the aggregate volatility decreases by 1%, diversification decreases by 1.73% for D2.

Estimates for coefficients of INDVOL or IDIOVOL do not show much difference among one another. On average, 1% change in the industry volatility will reduce diversification measures by 0.01-0.05%. Likewise, 1% change in the idiosyncratic volatility will reduce an average firm's diversification measures by 0.01-0.02%.

The results in Table 6 show that the effect of aggregate volatility change on diversification is sensitive to the measurement of diversification. D3 uses 3-digit SIC and it is most closely linked to the "segment" which is widely used in diversification literature as the definition of industry. From the fact the aggregate volatility have decreased in last three decades in U.S., I find that the decrease in aggregate volatility can have contributed to the decrease in diversification. There is little difference in magnitude of this effect on D3 and D4, which suggests that the average firm has changed its diversification by changing the product portfolio across 3-digit industries, not 4-digit when aggregate volatility falls. However, the fact that the magnitude of this effect is much bigger for D1 suggests that the average firm has reduced its diversification

across 5-digit industries by a lot. The coefficient is biggest for D2 where the firm diversifies across non-correlated or negatively correlated industries. A firm that has diversified across many 5-digit industries and across non-correlated or negatively correlated industries will have biggest decreased in its diversification with the same amount of changes in volatility if we measure diversification as D2. It predicts that we will observe much bigger decrease in diversification by industry (5-digit) than diversification by segments (3-digit) when the aggregate volatility declines. If we study diversification only using segments of firms, we may not be able to capture this high underlying degree of specialization at 5-digit industry level.

Regression results suggest that firm diversification responds positively to the volatility of aggregate, industrial, and idiosyncratic profit shocks. As the aggregate volatility has decreased in the U.S. manufacturing sector, firms have had less incentive to diversify against bad aggregate shocks. Industrial volatility has the same effect on firm level diversification. Idiosyncratic volatility decreased in the late 1980s, suggesting that firms have less incentive to diversify to hedge against idiosyncratic shocks.

Aggregate volatility plays a big role in explaining the change of diversification. Although firms cannot hedge themselves against aggregate volatility by diversification, they still adjust diversification in response to the aggregate shocks, which might include business trend, changes in the financial environment, or business regulation changes.

Table 6 Left-censored Tobit Estimation (Firm Level) for 1974-1998

Dependent Variable=D1, D2, D3, and D4 (Firm level diversification index)
Fixed Effects= YEAR, REGION Name of Distribution=Normal
Sample Period: 1974-1998
Number of Observations=561,565 Non-censored Values=234,490

		I			II			III			IV		
		coeff		std	coeff		std	coeff		std	coeff		std
d1	Intercept	-0.37	**	0.006	-0.71	**	0.006	-0.80	**	0.006	-0.84	**	0.006
	Aggvol	0.61	**	0.150	0.40	**	0.013	0.85	**	0.014	0.87	**	0.014
	Indvol	0.04	**	0.020	0.02	**	0.002	0.02	**	0.002	0.02	**	0.002
	Idiovol	0.05	**	0.010	0.01	**	0.001	0.01	**	0.001	0.01	**	0.001
	Aggprof	0.18	**	0.040	0.02	**	0.003	0.02	**	0.003	0.02	**	0.003
	Indrpof	0.04	**	0.010	-0.03	**	0.001	-0.02	**	0.001	-0.02	**	0.001
	Idioprof	0.05	**	0.010	-0.01	**	0.001	0.01	**	0.001	-0.01	**	0.001
	Size				0.13	**	0.001	0.11	**	0.000	0.11	**	0.000
	Age							0.01		0.000	0.01	**	0.000
	Foe										0.17	**	0.005
d2	Intercept	-0.32	**	0.006	-0.66	**	0.006	-0.75	**	0.006	-0.79	**	0.006
	Aggvol	0.85	**	0.150	0.67	**	0.013	1.10	**	0.014	1.12	**	0.014
	Indvol	0.03	**	0.020	0.02	**	0.002	0.01	**	0.002	0.01	**	0.002
	Idiovol	0.05	**	0.010	0.02	**	0.001	0.02	**	0.001	0.02	**	0.001
	Aggprof	0.14	**	0.040	-0.01	*	0.003	-0.01	**	0.004	-0.01	**	0.004
	Indrpof	0.04	**	0.010	-0.02	**	0.001	-0.02	**	0.001	-0.02	**	0.001
	Idioprof	0.05	**	0.010	-0.01	**	0.001	-0.01	**	0.001	-0.01	**	0.001
	Size				0.13	**	0.001	0.11	**	0.000	0.11	**	0.000
	Age							0.01		0.000	0.01	**	0.000
	Foe										0.16	**	0.006
d3	Intercept	-0.68	**	0.009	-1.08	**	0.008	-1.18	**	0.008	-1.22	**	0.008
	Aggvol	0.43	**	0.021	0.13	*	0.010	0.55	**	0.019	0.57	**	0.019
	Indvol	0.04	**	0.003	0.04	**	0.003	0.05	**	0.003	0.05	**	0.003
	Idiovol	0.06	**	0.002	0.03	**	0.002	0.02	**	0.002	0.02	**	0.002
	Aggprof	0.12	**	0.006	-0.04	**	0.005	-0.04	**	0.005	-0.05	**	0.005
	Indrpof	0.02	**	0.002	-0.07	**	0.001	-0.06	**	0.001	-0.06	**	0.001
	Idioprof	0.04	**	0.001	-0.04	**	0.001	-0.04	**	0.001	-0.04	**	0.001
	Size				0.16	**	0.001	0.14	**	0.001	0.14	**	0.001
	Age							0.01		0.000	0.01	**	0.000
	Foe										0.17	**	0.008
d4	Intercept	-0.60	**	0.008	-1.00	**	0.007	-1.11	**	0.007	-1.15	**	0.008
	Aggvol	0.44	**	0.010	0.16	**	0.010	0.67	**	0.010	0.69	**	0.010
	Indvol	0.00		0.003	0.01	**	0.003	0.01	**	0.003	0.01	**	0.003
	Idiovol	0.06	**	0.002	0.02	**	0.001	0.02	**	0.001	0.02	**	0.001
	Aggprof	0.16	**	0.005	0.00		0.004	0.00		0.004	0.00		0.004
	Indrpof	0.04	**	0.002	-0.03	**	0.001	-0.03	**	0.001	-0.03	**	0.001
	Idioprof	0.05	**	0.001	-0.01	**	0.001	-0.01	**	0.001	-0.01	**	0.001
	Size				0.15	**	0.001	0.13	**	0.001	0.13	**	0.001
	Age							0.01		0.000	0.01	**	0.000
	Foe										0.15	**	0.007

Note: * significance at the 95% level, ** significance at the 99% level
REGION: represents 9 different geographical locations in the data. See Appendix C.

Table 6 Left-censored Tobit Estimation (continued) for 1978-1993

Dependent Variable=D1, D2, D3 and D4 (Firm level diversification index)
Fixed Effects= YEAR, REGION Name of Distribution=Normal
Sample Period: 1978-1993
Number of Observations=359,177 Non-censored Values=156,234

		I		II		III		IV	
		coeff	std	coeff	std	coeff	std	coeff	std
d1	Intercept	-0.26 **	0.007	-0.63 **	0.006	-0.74 **	0.006	-0.78 **	0.007
	Aggvol	-0.07	0.040	0.04 **	0.030	1.36 **	0.030	1.40 **	0.030
	Indvol	0.04 **	0.003	0.02 **	0.002	0.02 **	0.002	0.02 **	0.002
	Idiovol	0.07 **	0.002	0.01 **	0.002	0.01 **	0.002	0.01 **	0.002
	Aggprof	0.18 **	0.006	-0.03 **	0.005	-0.06 **	0.005	-0.07 **	0.005
	Indrpof	0.02 **	0.002	-0.02 **	0.001	-0.01 **	0.001	-0.01 **	0.001
	Idioprof	0.05 **	0.001	-0.01 **	0.001	0.00 **	0.001	0.00 *	0.001
	Size			0.13 **	0.001	0.11 **	0.001	0.11 **	0.001
	Age					0.01	0.000	0.01 **	0.000
	Foe							0.16 **	0.007
d2	Intercept	-0.21 **	0.007	-0.59 **	0.006	-0.69 **	0.006	-0.73 **	0.007
	Aggvol	0.27 **	0.040	1.00 **	0.030	1.69 **	0.030	1.73 **	0.030
	Indvol	0.02 **	0.003	0.01	0.002	0.00	0.002	0.00	0.002
	Idiovol	0.07 **	0.002	0.01 **	0.002	0.01 **	0.002	0.01 **	0.002
	Aggprof	0.12 **	0.006	-0.10 **	0.005	-0.13 **	0.005	-0.13 **	0.005
	Indrpof	0.03 **	0.002	-0.02 **	0.001	-0.01 **	0.001	-0.01 **	0.001
	Idioprof	0.05 **	0.001	-0.01 **	0.001	0.00 **	0.001	-0.01 **	0.001
	Size			0.13 **	0.001	0.11 **	0.001	0.11 **	0.001
	Age					0.01	0.000	0.01 **	0.000
	Foe							0.15 **	0.007
d3	Intercept	-0.56 **	0.010	-0.98 **	0.009	-1.11 **	0.008	-1.15 **	0.010
	Aggvol	0.57 **	0.050	0.20 *	0.047	0.87 **	0.019	0.90 **	0.049
	Indvol	0.04 **	0.004	0.05 **	0.003	0.05 **	0.003	0.05 **	0.003
	Idiovol	0.10 **	0.003	0.03 **	0.002	0.02 **	0.002	0.02 **	0.002
	Aggprof	0.14 **	0.008	-0.12 **	0.007	-0.14 **	0.005	-0.14 **	0.007
	Indrpof	0.00 *	0.002	-0.07 **	0.002	-0.06 **	0.001	-0.06 **	0.002
	Idioprof	0.03 **	0.001	-0.04 **	0.001	-0.04 **	0.001	-0.04 **	0.001
	Size			0.16 **	0.001	0.14 **	0.001	0.14 **	0.001
	Age					0.01 **	0.000	0.01 **	0.000
	Foe							0.16 **	0.010
d4	Intercept	-0.47 **	0.009	-0.89 **	0.008	-1.03 **	0.009	-1.07 **	0.009
	Aggvol	0.67 **	0.050	0.11 *	0.040	0.90 **	0.040	0.93 **	0.040
	Indvol	0.00	0.004	0.01 **	0.003	0.01 **	0.003	0.01 **	0.003
	Idiovol	0.09 **	0.002	0.02 **	0.002	0.02 **	0.002	0.02 **	0.002
	Aggprof	0.20 **	0.008	-0.05 **	0.006	-0.08 **	0.006	-0.08 **	0.006
	Indrpof	0.02 **	0.002	-0.03 **	0.002	-0.02 **	0.002	-0.02 **	0.002
	Idioprof	0.04 **	0.001	-0.01 **	0.001	-0.01 **	0.001	-0.01 **	0.001
	Size			0.15 **	0.001	0.13 **	0.001	0.13 **	0.001
	Age					0.01	0.000	0.01 **	0.000
	Foe							0.14 **	0.009

Note: * significance at the 95% level, ** significance at the 99% level
REGION: represents 9 different geographical locations in the data. See Appendix C.

4. Conclusion

One of the achievements of this paper is to discover the trend and cyclicality of diversification in the entire U.S. manufacturing sector in the last 30 years. Findings are summarized as follows: (1) Aggregate diversification declined both at the establishment and firm level since the early 1980s. The downward trend is common in many industries. The declining diversification is quite contrary to the conjecture that the diversification has been increasing in the last three decades. (2) Whether the diversification is pro-cyclical or counter-cyclical is not clear at the aggregate or industry level. The conjecture that the diversification is pro-cyclical cannot be confirmed by the data. (3) A large fraction of firms change the number of products and plants annually. The declining diversification measure suggest that firms becomes more specialyzed, but it is certain that the number of product is not fixed for firms even in the short run. It is shown that product diversification is a decision variable for firms, which is contrary to assumptions of fixed diversification in many theoretical models in literature. I show that firms actively change their product diversification at a short-term frequency. More Firms specialize in one product and the number of products and plants behaves like an adjustment margin.

Trend of volatility is verified by the micro level data and new empirical relationship between diversification and volatility is found. Using the firm level profit rates, I find: (1) the aggregate volatility declined. (2) The volatility decreased since the 1980s for most industries. (3) The mean of firm level idiosyncratic volatilities decreased in late 1980s and the standard deviation doesn't change much. The left-censored Tobit regression shows that the firm level diversification is positively affected by the aggregate, industrial and idiosyncratic profit volatility. Therefore, the decrease of volatility, in other words, the reduced risks in US manufacturing sector contributes to the decrease of diversification.

In summary, firms specialize more in the past 30 years in U.S. manufacturing sector. It is because the profit volatility decreased at the aggregate, industrial and firm level. Therefore, firms have less incentive to diversify over different products to insure themselves against profit shocks. However, a large fraction of firms adopt flexible production lines which allow them to adjust the number of products at the short term frequency responding to the economic fluctuation.

A lot of questions about diversification have been raised and partially answered. But it was not easy to see the whole picture of evolution of diversification because there hadn't been enough data. With rich description and analysis in this paper, we now better understand diversification of firms and the role of volatility on diversification. Now we are able to ask subsequent questions on diversification and specialization: whether specialization enhanced productivity, whether diversification increased the profits by reducing idiosyncratic risks, whether the high volatility played a role in high diversification in developing countries.

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Appendix A: Data and Variable Construction

Primary Data source: LRD and LBD

LRD: LRD provides a company-level database containing detailed statistics on research and development activities; and supports research on the issues of productivity, profitability, and the use of research and development. The database contains detailed company-level research and development information compiled from the annual Industrial Research and Development survey for survey years 1972 through 2001. Over the 30 year period, the total sample for the survey size has varied considerably. Since 1992, the total sample size has been fairly stable at approximately 25,000 companies. The sample design strategy has evolved over the years. The company has been defined as both the sample unit and the data collection unit since inception. Prior to 1992, a given sample would be used for a number of years before being replaced. The probability of selection was a direct function of total company employment; companies with more than 500 employees were included with certainty.

LBD: LBD is a research dataset constructed at the Census Bureau's Center for Economic Studies. LBD is an establishment based file created by linking the annual snapshot files from Census Bureau's Business Register over time. It contains high quality longitudinal establishment linkages. Firm level linkages are currently under development at CES. Currently, LBD contains the universe of all U.S. business establishments with paid employees from 1976 to present. LBD covers almost 24 million unique establishments from 1975 to present.

Supplementary Data source: NBER R&D and Productivity file from NBER, and statistics from *ASM: Annual Survey of Manufactures* published by Census Bureau.

Diversification Index: I measure 5-digit product diversification using LRD as described in the text. 5-digit product shares are calculated by TVPS/TVS where TVS (Total Value of shipments) is the sum of TVPS (Total Value of Product Shipment) at the establishment level. For a firm level index, the product shares are calculated by FTVPS/FTVS, where FTVPS is the sum of TVPS of a product produced in every plant of the firm and FTVS is the sum of TVS across plants. Some product data are imputed and they are eliminated from the sample.

ASM sample base is the establishment rather than the firm, some establishments of a multi-unit firm may not be selected in ASM sample. This can distort the firm-level diversification measure of multi-unit firms. In most cases, however, all the establishments of a multi-unit firm are included in ASM sample. All the plants of a company, so-called Certainty Companies, are included in ASM for certain, but many of the non-certainty multi-unit firms also have all of their plants in ASM.[37] Matching ASM and LBD enables us to find the establishments of a multi-unit firm which are not selected for the ASM sample. See LRD documentation for detail.

Industry Classification: LRD classifies establishments by industry using the Standard Industrial Classification System (SIC). The structure of SIC makes it possible to tabulate, analyze, and publish establishment data on a 2-digit, a 3-digit, or a 4-digit industry code basis, according the level of industrial detail considered most appropriate. In addition to industry, the Census Bureau also collects and publishes information on product classes and individual products produced by manufacturing establishments. Product classes (5-digit codes) and products (7-digit codes) of manufacturing industries are assigned codes based on the industry from which they originate. Beginning in 1997 the US, Canada, and Mexico began publishing and collecting statistics under the new North American Industrial Classification Systems (NAICS). NAICS is based on a

[37] Those companies are usually big firms with no less than 250 employees. The establishments that had been dropped out of sample were added with zero statistical weight and called 'McGuckin Adds'.

consistent, economic concept: Establishments that use the same or similar processes to produce goods or services are grouped together. The SIC, developed in the 1930s and revised periodically over the past 50 years, was not based on a consistent economic concept. A major change in SIC occurred in 1987. Some industries are demand based while others are production based. From 1998 ASM, the product class is coded by NAICS.

Establishment and Firm Identifier: Permanent Plant Number (PPN) assigned to each establishment by Census is used as the establishment identifier. For the single-unit firms/establishments, PPN begins with 0. For multi-units, the first six digits of the ten-digit PPN identify the firm.

Profit rate: Profit rate is measured by the nominal sales (TVS) minus the variable costs, divided by the capital stock. The variable costs are composed of total wage cost (SW) and the total material costs (CM). Profit is deflated by GDP deflator. Book value of capital stock(MA and BA) is collected in ASM and CM and it is deflated by the 2-digit industry level deflator. The Bureau of Economic Analysis publishes 2-digit industry capital stock both in nominal and real values. I use the ratio of the nominal capital stock to real capital stock as the 2-digit industry level capital deflator. The base year for the deflator is 1996. The growth rate of real shipment (RTVS) is the symmetric growth measure: Growth of RTVS at time t = $(RTVS_t-RTVS_{t-1})/ [(RTVS_t+RTVS_{t-1})/2]$.

Appendix B: Additional Statistics of Annual Firm-level Product Diversification

Table AB-1 Average Firm level Diversification Index

year	frequency	Not weighted	Shipment weighted
74	21018	0.17204	0.72984
75	20605	0.17327	0.72827
76	20913	0.16792	0.73121
77	24889	0.17545	0.72929
78	23973	0.17235	0.72479
79	25306	0.15597	0.71227
80	25024	0.15612	0.70771
81	23277	0.15839	0.71600
82	22770	0.19000	0.70695
83	20079	0.18967	0.71414
84	20055	0.16184	0.71090
85	18089	0.16478	0.70861
86	17914	0.16314	0.70209
87	19085	0.20029	0.69528
88	16835	0.20881	0.69410
89	21211	0.16033	0.68754
90	29814	0.10996	0.68208
91	29975	0.12077	0.67950
92	30728	0.16033	0.66403
93	30744	0.13381	0.66211
94	40298	0.09048	0.65296
95	38547	0.09355	0.64973
96	36961	0.09561	0.64735
97	42766	0.11777	0.62857
98	25359	0.13921	0.64273

Table AB-2 Average Firm level Diversification Index of Single Unit firms			
year	frequency	Not weighted	Shipment weighted
74	17495	0.10282	0.17855
75	17228	0.10550	0.18238
76	17655	0.10258	0.16741
77	20925	0.11449	0.18504
78	20061	0.11005	0.17599
79	21503	0.10384	0.15623
80	21465	0.10621	0.16029
81	19897	0.10692	0.16702
82	18864	0.13812	0.18113
83	16364	0.13223	0.17185
84	16533	0.10144	0.14605
85	14717	0.10125	0.14244
86	14760	0.10396	0.15206
87	15141	0.13981	0.18516
88	12818	0.14349	0.18218
89	17434	0.10485	0.15249
90	26218	0.06756	0.13617
91	26592	0.08218	0.13718
92	26532	0.12504	0.17138
93	26704	0.09106	0.16005
94	36439	0.05728	0.13421
95	34846	0.06069	0.13091
96	33426	0.06310	0.13068
97	38635	0.08861	0.14643
98	22226	0.09980	0.14477

Table AB-3 Average Firm level Diversification Index of Multi Unit firms

year	frequency	Not weighted	Shipment weighted
74	3523	0.51578	0.77045
75	3377	0.51901	0.76725
76	3258	0.52204	0.76902
77	3964	0.49729	0.76322
78	3912	0.49183	0.75931
79	3803	0.45077	0.75342
80	3559	0.45714	0.74905
81	3380	0.46143	0.75328
82	3906	0.44055	0.74102
83	3715	0.44266	0.74617
84	3522	0.44536	0.75148
85	3372	0.44204	0.74545
86	3154	0.44010	0.74465
87	3944	0.43247	0.72989
88	4017	0.41725	0.7284
89	3777	0.41640	0.7313
90	3596	0.41907	0.72715
91	3383	0.42409	0.72277
92	4196	0.42149	0.70572
93	4040	0.41641	0.70243
94	3859	0.40397	0.70013
95	3701	0.40291	0.69309
96	3535	0.40299	0.68796
97	4131	0.39044	0.6645
98	3133	0.41877	0.67831

Table AB-4 Share of Diversified Production (r_{pd})	
year	Share of Diversified Production (r_{pd})
74	0.003744
75	0.003589
76	0.003430
77	0.004498
78	0.006080
79	0.006118
80	0.005320
81	0.005597
82	0.006016
83	0.006107
84	0.007289
85	0.007863
86	0.009350
87	0.007971
88	0.009129
89	0.009075
90	0.008278
91	0.008905
92	0.010446
93	0.011226
94	0.013564
95	0.016755
96	0.020226
97	0.018314
98	0.010821

Note:

$$d = 1 - \Big(\underbrace{\sum_{i \in A} S_i^2}_{\text{Diversified Production}} + \underbrace{\sum_{i \in B} S_i^2}_{\text{Specialized Production}} \Big) = (r_{pd} + r_{ps})d$$

where,

$$r_{pd} = \sum_{i \in A} S_i^2 \Big/ \sum_i S_i^2, \; r_{ps} = 1 - r_{pd}$$

$i \in A$ product i produced in multiple plants

$i \in B$ product i produced only in one plant

Table AB-5 Share of Within-plant Factor in Firm Level Diversification(r_{wp})	
year	Share of Within-plant factor(r_{wp})
74	0.422879
75	0.421189
76	0.416774
77	0.402075
78	0.414824
79	0.436601
80	0.451316
81	0.448953
82	0.429708
83	0.430263
84	0.408616
85	0.402632
86	0.384211
87	0.394595
88	0.393574
89	0.387701
90	0.39031
91	0.37973
92	0.385892
93	0.378976
94	0.375346
95	0.366295
96	0.367318
97	0.375907
98	0.353448

Note:

$$d^f = \underbrace{\sum_j a_j d_j^{est}}_{\text{Within-plant}} + \underbrace{(d^f - \sum_j a_j d_j^{est})}_{\text{Among-plant}} = (r_{wp} + r_{ap}) d^f$$

where,

a_j = shipment share of the jth plant

d^f = firm level diversification, d^{est} = plant level diversification

$\mathrm{r_{wp}} = \sum_j a_j d_j^{est} \Big/ d^f$, $\mathrm{r_{ap}} = 1 - \mathrm{r_{wp}}$

Table AB-6 Annual Diversification Index Change Decomposed by POSC, NEGC, POSB and NEGD

year	Net D change	POSC	NEGC	POSB	NEGD
75	0.003	0.025	-0.022	0.421	0.448
76	0.002	0.020	-0.018	0.391	0.447
77	0.006	0.033	-0.027	0.540	0.564
78	-0.003	0.017	-0.020	0.342	0.393
79	-0.007	0.023	-0.030	0.294	0.511
80	-0.004	0.020	-0.024	0.405	0.463
81	0.007	0.026	-0.019	0.361	0.509
82	0.002	0.035	-0.033	0.518	0.580
83	0.000	0.032	-0.032	0.297	0.514
84	-0.011	0.027	-0.038	0.342	0.395
85	0.003	0.025	-0.022	0.479	0.607
86	0.009	0.033	-0.024	0.372	0.673
87	0.009	0.044	-0.035	0.558	0.569
88	-0.002	0.030	-0.032	0.389	0.498
89	0.014	0.037	-0.023	0.303	0.564
90	-0.002	0.024	-0.026	0.398	0.568
91	0.009	0.026	-0.017	0.334	0.500
92	0.007	0.041	-0.034	0.533	0.509
93	-0.003	0.025	-0.028	0.336	0.459
94	-0.005	0.029	-0.034	0.324	0.379
95	-0.005	0.028	-0.033	0.450	0.567
96	0.000	0.028	-0.028	0.413	0.532
97	0.014	0.057	-0.043	0.514	0.570

Note:
POSC=average diversification change of continuing firms with positive change
NEGC=average diversification change of continuing firms with negative change
POSB=average diversification change of starting firms
NEGD=average diversification change of shutting-down firms

Table AB-7 Firm level Diversification Index Change Decomposed by Diversified/Specialized Plants (MU Firms)

year	D(t-1)	D(t)	D(t)-D(t-1)	Diversified Production	Specialized Production	Net Entry Plant
75	0.77045	0.76725	-0.0032	0.001	0	0.002
76	0.76725	0.76902	0.001771	0	0.006	-0.001
77	0.76902	0.76322	-0.00581	0.002	-0.008	0
78	0.76322	0.75931	-0.00391	0.001	0.017	-0.009
79	0.75931	0.75342	-0.00589	0.006	0.072	-0.039
80	0.75342	0.74905	-0.00437	0	0.004	0
81	0.74905	0.75328	0.004227	0	-0.007	0.007
82	0.75328	0.74102	-0.01226	-0.002	-0.017	0.007
83	0.74102	0.74617	0.00515	0	0.004	0.001
84	0.74617	0.75148	0.005311	0.006	0.001	-0.001
85	0.75148	0.74545	-0.00602	0.001	0.009	-0.002
86	0.74545	0.74465	-0.0008	0.004	0.006	-0.003
87	0.74465	0.72989	-0.01476	-0.011	-0.019	0.012
88	0.72989	0.7284	-0.00149	0.008	0.004	-0.001
89	0.7284	0.7313	0.002899	0.004	0.005	-0.003
90	0.7313	0.72715	-0.00415	0	-0.004	0.005
91	0.72715	0.72277	-0.00438	0	0.001	0
92	0.72277	0.70572	-0.01705	-0.002	-0.03	0.018
93	0.70572	0.70243	-0.00329	0	0.015	-0.007
94	0.70243	0.70013	-0.00231	0.006	0.035	-0.025
95	0.70013	0.69309	-0.00704	0.001	0	0.003
96	0.69309	0.68796	-0.00513	0.003	-0.002	0.003
97	0.68796	0.6645	-0.02346	-0.003	-0.01	0.007
98	0.6645	0.67831	0.013819	0.003	-0.006	0.005

Note:

$$\Delta d_t = \underbrace{-\left(\sum_{i\in PN,PC} S_{i,t}^2 - \sum_{i\in PC,PX} S_{i,t-1}^2\right)}_{\text{Diversified Production Factor}} \underbrace{-\left(\sum_{i\in PC} S_{i,t}^2 - \sum_{i\in PC} S_{i,t-1}^2\right)}_{\text{Specialized Production Factor}} \underbrace{-\left(\sum_{i\in PN} S_{i,t}^2 - \sum_{i\in PX} S_{i,t-1}^2\right)}_{\text{Plant Net Enry Factor}}$$

Where,

$i \in PC,PN$ product i which is produced both in plant *PC* and *PN*

$i \in PC$ product i which is produced only in plant *PC*

PC = Continuously operating plant at time t-1 and t

PN = new plant in time t

PX = exiting plant in time t

Table AB-8 Firm Level Diversification Change Decomposed by Intensive/Extensive Components (Continuing MU Firms)

year	D(t-1)	D(t)	D(t)-D(t-1)	intensive	extensive
75	0.72984	0.72827	-0.00157	0.014	-0.065
76	0.72827	0.73121	0.002944	0.013	-0.063
77	0.73121	0.72929	-0.00192	-0.008	-0.326
78	0.72929	0.72479	-0.0045	0.022	-0.054
79	0.72479	0.71227	-0.01253	0.087	-0.078
80	0.71227	0.70771	-0.00456	0.008	-0.084
81	0.70771	0.716	0.008293	0	-0.072
82	0.716	0.70695	-0.00905	-0.032	-0.425
83	0.70695	0.71414	0.007188	0.008	-0.35
84	0.71414	0.7109	-0.00324	0.008	-0.218
85	0.7109	0.70861	-0.00229	0.02	-0.083
86	0.70861	0.70209	-0.00652	0.021	-0.167
87	0.70209	0.69528	-0.00681	-0.016	-0.659
88	0.69528	0.6941	-0.00118	0.033	-0.119
89	0.6941	0.68754	-0.00656	0.009	-0.114
90	0.68754	0.68208	-0.00546	0	-0.077
91	0.68208	0.6795	-0.00258	0.006	-0.104
92	0.6795	0.66403	-0.01547	-0.034	-0.464
93	0.66403	0.66211	-0.00192	0.026	-0.103
94	0.66211	0.65296	-0.00915	0.037	-0.089
95	0.65296	0.64973	-0.00323	0.011	-0.067
96	0.64973	0.64735	-0.00237	0.012	-0.078
97	0.64735	0.62857	-0.01878	-0.017	-0.412

Note:

$$\Delta d_t = \underbrace{-\sum_{i \in NC}\left(S_{it}^2 - S_{it-1}^2\right)}_{\text{Intensive Component}} \underbrace{-\left(\sum_{i \in NN} S_{it}^2 - \sum_{i \in NX} S_{it-1}^2\right)}_{\text{Extensive Component}}$$

where,
NC = Products which are continuously produced at time t and t-1
NN = New products at time t
NX = Exiting products at time t

Table AB-9 Firm Level Diversification Change Decomposition (Continuing MU Firms)

year	D(t-1)	D(t)	D(t)-D(t-1)	I	II	III	IV	V	VI
75	0.729	0.728	-0.002	-0.001	0.000	-0.003	0.002	-0.001	0.000
76	0.728	0.731	0.003	0.000	0.000	-0.009	0.001	0.002	0.000
77	0.731	0.729	-0.002	-0.001	-0.001	0.008	0.003	-0.003	-0.001
78	0.729	0.725	-0.005	-0.001	0.000	-0.017	0.001	0.007	0.000
79	0.724	0.712	-0.013	-0.005	0.000	-0.071	0.001	0.033	0.004
80	0.712	0.708	-0.005	0.000	0.000	-0.004	0.000	0.000	0.000
81	0.707	0.716	0.008	0.000	0.000	0.006	0.001	-0.006	-0.001
82	0.716	0.707	-0.009	0.002	0.000	0.018	-0.002	-0.005	0.000
83	0.706	0.714	0.007	0.000	0.000	-0.003	0.000	0.000	-0.002
84	0.714	0.711	-0.003	-0.006	0.000	-0.001	0.001	0.003	-0.002
85	0.710	0.709	-0.002	-0.001	0.000	-0.010	0.002	0.002	0.000
86	0.708	0.702	-0.007	-0.003	0.000	-0.008	0.004	0.001	0.000
87	0.702	0.695	-0.007	0.005	0.005	0.007	0.009	-0.006	-0.003
88	0.695	0.694	-0.001	-0.008	0.000	-0.005	0.006	-0.003	-0.001
89	0.694	0.688	-0.007	-0.004	0.000	-0.002	0.000	0.000	0.000
90	0.687	0.682	-0.005	0.001	0.000	0.001	0.002	-0.002	-0.001
91	0.682	0.680	-0.003	0.000	0.000	-0.003	0.001	0.000	0.000
92	0.679	0.664	-0.015	0.002	0.000	0.031	0.001	-0.017	-0.002
93	0.664	0.662	-0.002	0.000	0.000	-0.020	0.004	0.007	0.000
94	0.662	0.653	-0.009	-0.006	0.000	-0.033	0.000	0.021	0.001
95	0.652	0.650	-0.003	-0.001	0.000	-0.001	0.001	-0.003	0.000
96	0.649	0.647	-0.002	-0.003	0.000	0.002	0.002	-0.005	0.000
97	0.647	0.629	-0.019	0.003	0.000	0.009	-0.001	-0.004	-0.001

Note:

$$\Delta d_t = \begin{cases} \underbrace{-\left(\sum_{\substack{i\in PN,PC\\ i\in NC}} S_{it}^2 - \sum_{\substack{i\in PC,PX\\ i\in NC}} S_{it-1}^2\right)}_{I} \underbrace{-\left(\sum_{\substack{i\in PN,PC\\ i\in NN}} S_{it}^2 - \sum_{\substack{i\in PC,PX\\ i\in NX}} S_{it-1}^2\right)}_{II} \underbrace{-\left(\sum_{\substack{i\in PC\\ i\in NC}} S_{it}^2 - \sum_{\substack{i\in PC\\ i\in NC}} S_{it-1}^2\right)}_{III} \\ \underbrace{-\left(\sum_{\substack{i\in PC\\ i\in NN}} S_{it}^2 - \sum_{\substack{i\in PC\\ i\in NX}} S_{it-1}^2\right)}_{IV} \underbrace{-\left(\sum_{\substack{i\in PN\\ i\in NC}} S_{it}^2 - \sum_{\substack{i\in PX\\ i\in NC}} S_{it-1}^2\right)}_{V} \underbrace{-\left(\sum_{\substack{i\in PN\\ i\in NN}} S_{it}^2 - \sum_{\substack{i\in PX\\ i\in NX}} S_{it-1}^2\right)}_{VI} \end{cases}$$

where,

$i \in PC,PN$ product i which is produced both in plant *PC* and *PN*

$i \in PC$ product i which is produced only in plant *PC*

PC = Continuously operating plant at time t-1 and t

PN = new plant in time t

PX = exiting plant in time t

NC = Products which are continuously produced at time t and t-1

NN = New products at time t

NX = Exiting products at time t

Table AB-10 Average Diversification index by Firm Size Quartile (using Total Employment)				
year	Q1	Q2	Q3	Q4
74	0.07024	0.11382	0.14729	0.75515
75	0.08011	0.10555	0.15428	0.75116
76	0.06637	0.08019	0.1505	0.75283
77	0.07045	0.1081	0.16285	0.74781
78	0.07293	0.10058	0.15412	0.74418
79	0.07987	0.09921	0.13989	0.73631
80	0.07995	0.1018	0.14419	0.73015
81	0.08231	0.10548	0.14073	0.73629
82	0.11481	0.13247	0.16729	0.72735
83	0.10931	0.12754	0.17919	0.73425
84	0.07759	0.10823	0.15079	0.73811
85	0.07221	0.10397	0.15143	0.73414
86	0.07345	0.10293	0.15335	0.72898
87	0.10895	0.1343	0.1843	0.72023
88	0.12096	0.1465	0.19893	0.72184
89	0.06612	0.10534	0.14494	0.71398
90	0.0256	0.05889	0.10398	0.7002
91	0.06967	0.07131	0.09999	0.69605
92	0.09566	0.11621	0.14918	0.67995
93	0.04253	0.08192	0.13201	0.67592
94	0.02035	0.04344	0.07967	0.66692
95	0.03054	0.05187	0.08986	0.66235
96	0.02431	0.05761	0.08899	0.65909
97	0.04765	0.08467	0.11322	0.6391
98	0.06216	0.08942	0.12658	0.65602

Table AB-11 Average Diversification index by Firm Age Quartile				
year	Q1	Q2	Q3	Q4
74	0.10838	0.73304		
75	0.09881	0.73066		
76	0.10149	0.7334		
77	0.11194	0.74246	0.20676	
78	0.10493	0.7389	0.21242	
79	0.11248	0.73188	0.18803	
80	0.1119	0.7268	0.18362	
81	0.13044	0.73308	0.19815	
82	0.18572	0.72829	0.23278	
83	0.21439	0.73565	0.22702	
84	0.16314	0.74176	0.21376	
85	0.16239	0.73685	0.22128	
86	0.15152	0.73123	0.21645	
87	0.20567	0.72757	0.24972	
88	0.2022	0.72996	0.25988	
89	0.1482	0.71243	0.21835	
90	0.01702	0.72989	0.13726	0.25671
91	0.06007	0.71629	0.10023	0.27856
92	0.17508	0.71894	0.17977	0.2963
93	0.14875	0.70952	0.16359	0.26939
94	0.00988	0.6992	0.15489	0.24911
95	0.00819	0.70008	0.14159	0.22522
96	0.03105	0.69624	0.13328	0.23635
97	0.033	0.67854	0.09753	0.25665
98	0.0651	0.69799	0.18122	0.28749

Note: The firm age variable is very limited in the data and it is not easy to determine the exact age if the firm is already old in early years of the panel. For example, most of firms are one year old or eleven years old in 1974. Therefore, we get only Q1 and Q2 in 1974.

Table AB-12 Average Diversification Index by Region									
year	1	2	3	4	5	6	7	8	9
74	0.77	0.73	0.75	0.68	0.75	0.70	0.68	0.63	0.70
75	0.76	0.72	0.75	0.68	0.75	0.69	0.67	0.69	0.72
76	0.73	0.72	0.73	0.71	0.72	0.75	0.67	0.81	0.75
77	0.71	0.75	0.75	0.68	0.70	0.71	0.70	0.73	0.74
78	0.72	0.76	0.74	0.71	0.71	0.71	0.67	0.72	0.71
79	0.74	0.73	0.70	0.68	0.74	0.69	0.69	0.67	0.70
80	0.68	0.69	0.71	0.75	0.74	0.68	0.72	0.67	0.69
81	0.69	0.72	0.70	0.73	0.72	0.73	0.73	0.72	0.72
82	0.66	0.69	0.70	0.70	0.69	0.75	0.70	0.69	0.74
83	0.64	0.71	0.73	0.72	0.72	0.71	0.70	0.72	0.72
84	0.67	0.70	0.72	0.71	0.71	0.77	0.70	0.70	0.69
85	0.65	0.66	0.72	0.72	0.75	0.74	0.70	0.77	0.66
86	0.64	0.68	0.74	0.68	0.70	0.68	0.70	0.76	0.68
87	0.61	0.70	0.73	0.69	0.66	0.72	0.70	0.71	0.68
88	0.66	0.70	0.71	0.70	0.68	0.77	0.70	0.76	0.61
89	0.55	0.70	0.68	0.67	0.73	0.69	0.68	0.75	0.62
90	0.69	0.63	0.69	0.64	0.71	0.66	0.72	0.69	0.66
91	0.69	0.64	0.70	0.68	0.68	0.73	0.69	0.69	0.65
92	0.58	0.70	0.65	0.63	0.69	0.68	0.68	0.62	0.64
93	0.56	0.67	0.69	0.55	0.68	0.70	0.67	0.62	0.63
94	0.53	0.61	0.66	0.62	0.67	0.68	0.69	0.65	0.66
95	0.54	0.66	0.68	0.62	0.68	0.66	0.65	0.67	0.56
96	0.60	0.64	0.63	0.61	0.68	0.68	0.67	0.69	0.62
97	0.67	0.59	0.59	0.56	0.67	0.67	0.72	0.56	0.53
98	0.53	0.63	0.63	0.60	0.66	0.69	0.64	0.71	0.64
growth	-0.30	-0.14	-0.16	-0.11	-0.12	-0.01	-0.07	0.12	-0.08
avg	0.65	0.68	0.70	0.67	0.70	0.71	0.69	0.70	0.67

Region: Census divides the survey coverage area into nine regions

1- New England
2- Middle Atlantic
3- East North Central
4- West North Central
5- South Atlantic
6- East South Central
7- West South Central
8- Mountain
9- Pacific

Table AB-13 Average Diversification Index by Quintile of Share of Interplant Transfer (IPT/TVS)					
year	Q1	Q2	Q3	Q4	Q5
76	0.42182	0.7558	0.79679	0.82443	0.79593
80	0.3851	0.73711	0.7877	0.80484	0.79789
81	0.37644	0.71383	0.80569	0.81557	0.78551
83	0.37729	0.72743	0.79797	0.81067	0.79484
84	0.35734	0.74381	0.78309	0.82224	0.80036
85	0.69318	0.88635	0.84501	0.84354	0.82585
86	0.64833	0.87164	0.85129	0.8146	0.76701
87	0.35649	0.69586	0.77471	0.80134	0.79128
88	0.3628	0.71831	0.79106	0.80681	0.77924
89	0.34989	0.7215	0.77604	0.81465	0.78827
90	0.33929	0.7307	0.76133	0.79746	0.78621
91	0.3516	0.7363	0.77439	0.80103	0.76788
92	0.36359	0.69286	0.75283	0.80838	0.76168
93	0.3722	0.72572	0.801	0.8011	0.75524
94	0.3642	0.75497	0.78134	0.80233	0.76531
95	0.37081	0.74259	0.77943	0.79182	0.768
96	0.38238	0.72306	0.78326	0.79478	0.74925
97	0.35028	0.70035	0.75996	0.77148	0.73377
98	0.3979	0.71243	0.75979	0.77466	0.72153
avg	0.401102	0.741612	0.787509	0.805354	0.775529
growth	-0.05671	-0.05738	-0.04644	-0.06037	-0.09348

Note: If the firm is vertically integrated, the firm will diversify into the products that are consumed within the firm to produce the final product. The share of Interplant Product Transfer (IPT) to the total value of shipment of the firm (TVS) can be used as an indicator for vertical integration. IPT is not available in 1974, 1975, 1977-1979 and 1982. IPT is imputed by Census in 1985 and 1986.

Table AB-14 Average Diversification Index by Quartile of Share of Labor Cost (Wage/Total variable cost)

year	Q1	Q2	Q3	Q4
74	0.73195	0.77103	0.70465	0.47082
75	0.73183	0.77237	0.68039	0.42186
76	0.74156	0.75945	0.68572	0.39776
77	0.74148	0.75151	0.68137	0.4805
78	0.73501	0.75453	0.66543	0.46308
79	0.72745	0.72381	0.70646	0.42038
80	0.7181	0.739	0.67844	0.408
81	0.72583	0.74206	0.68887	0.42501
82	0.71783	0.73063	0.68983	0.39111
83	0.72828	0.72869	0.69865	0.40078
84	0.72607	0.73752	0.68569	0.4363
85	0.72517	0.72687	0.68406	0.48524
86	0.71799	0.72963	0.66074	0.46496
87	0.70771	0.72373	0.66228	0.50532
88	0.71597	0.70859	0.64846	0.42453
89	0.71136	0.69815	0.61738	0.45333
90	0.70265	0.70381	0.60421	0.42153
91	0.69841	0.69354	0.60926	0.32964
92	0.67997	0.68176	0.63447	0.36963
93	0.69016	0.65971	0.57821	0.36207
94	0.68736	0.64837	0.54104	0.41022
95	0.68482	0.61582	0.55917	0.38524
96	0.68435	0.59943	0.55329	0.33004
97	0.66233	0.56502	0.52385	0.32556
98	0.6649	0.63352	0.56906	0.31085
average	0.710342	0.703942	0.640439	0.41175
growth	-0.0916	-0.17835	-0.19242	-0.33977

Table AB-15 Average Diversification Index by Quartile of Share of Non-production Worker Labor Cost (Non-production worker wage/Total labor cost)

year	Q1	Q2	Q3	Q4
74	0.55187	0.75475	0.76206	0.70286
75	0.56427	0.7471	0.76438	0.70123
76	0.57483	0.75197	0.75958	0.70622
77	0.59947	0.7513	0.76723	0.69581
78	0.69377	0.74991	0.74476	0.70855
79	0.69686	0.72402	0.74055	0.68786
80	0.66241	0.72518	0.73253	0.69428
81	0.6767	0.72763	0.73707	0.7065
82	0.54637	0.72389	0.73332	0.70329
83	0.69501	0.71472	0.74301	0.69907
84	0.69692	0.7192	0.74217	0.68599
85	0.68971	0.7229	0.73595	0.68724
86	0.63953	0.73491	0.73584	0.67633
87	0.45808	0.6935	0.73113	0.71745
88	0.69406	0.70099	0.73571	0.64684
89	0.68519	0.70169	0.71826	0.64999
90	0.66614	0.70691	0.70374	0.66552
91	0.60434	0.71988	0.72284	0.63657
92	0.37518	0.65645	0.68251	0.68811
93	0.65794	0.68016	0.69868	0.61852
94	0.64731	0.67238	0.68941	0.60972
95	0.65646	0.68186	0.65506	0.60829
96	0.61303	0.71463	0.63529	0.60625
97	0.6275	0.66142	0.68409	0.56785
98	0.58693	0.68624	0.66646	0.58956
average	0.622395	0.712944	0.720865	0.666396
growth	0.063529	-0.09077	-0.12545	-0.1612

Table AB-16 Average Diversification Index by Quartile of Share of Exported Good (Vale of exported good/Total value of shipment)

year	zero	Q1	Q2	Q3	Q4
76	0.39333	0.73924	0.782	0.79292	0.79241
80	0.37168	0.715	0.77888	0.79276	0.74343
81	0.35137	0.72602	0.78731	0.77326	0.77691
83	0.35646	0.71234	0.76977	0.7855	0.76804
84	0.35952	0.71027	0.78391	0.78461	0.74787
85	0.69156	0.84352	0.53336	0.16977	0.1389
86	0.63121	0.83046	0.73142	0.62301	0.15634
87	0.33951	0.67881	0.75178	0.77366	0.75517
88	0.34016	0.65229	0.7524	0.77518	0.74045
89	0.31167	0.68086	0.73958	0.77748	0.73457
90	0.30347	0.65271	0.75553	0.76801	0.71493
91	0.29289	0.66419	0.7519	0.7608	0.69294
92	0.29181	0.60629	0.73559	0.7554	0.66064
93	0.32628	0.68021	0.73716	0.75447	0.63553
94	0.31695	0.65814	0.7278	0.76065	0.65382
95	0.30225	0.67236	0.72279	0.74663	0.65976
96	0.29083	0.65728	0.73251	0.73671	0.64809
97	0.29153	0.57485	0.71318	0.72691	0.61513
98	0.33604	0.71924	0.61496	0.72717	0.67017
Average	0.36308	0.693373	0.731675	0.725521	0.647637
growth	-0.14565	-0.02705	-0.21361	-0.08292	-0.15426

Table AB-17 Decade Average of Number of Industries of Firms by Number of Products (5-digit SIC) of Firms

Number of 2-digit SIC industry

Number of Products	1970s	1980s	1990s
1	1	1	1
2	1.14	1.17	1.16
3	1.29	1.34	1.31
4	1.45	1.47	1.43
5	1.61	1.61	1.52
6	1.78	1.75	1.69
7	2.04	1.99	1.84
8	2.23	2.12	1.99
9	2.54	2.41	2.12
10+	2.73	2.53	2.37

Number of 3-digit SIC industry

Number of Products	1970s	1980s	1990s
1	1	1	1
2	1.25	1.28	1.27
3	1.58	1.63	1.59
4	1.93	1.95	1.86
5	2.24	2.30	2.15
6	2.66	2.64	2.47
7	3.11	3.11	2.89
8	3.58	3.44	3.16
9	4.12	3.96	3.49
10+	4.46	4.23	3.93

Table AB-18 Decade Average of Number of Counties Where Plants Are Located by Number of Plants			
Number of Plants	1970s	1980s	1990s
1	1	1	1
2	1.7767	1.8325	1.82546
3	2.5164	2.64582	2.68428
4	3.3936	3.52944	3.51556
5	4.19915	4.33805	4.43135
6	5.02278	5.25762	5.0979
7	5.96204	6.0732	6.11653
8	6.47792	6.91824	6.88664
9	7.30809	7.66521	7.63317
10+	8.398	8.1173	8.7455

Table AB-19 Evolution of Aggregate and Idiosyncratic Volatility

Year	Aggregate Volatility	Idiosyncratic Volatility	
		Mean	Standard deviation
74	0.2829	0.45160	0.53751
75	0.25907	0.47257	0.55326
76	0.24071	0.47965	0.56108
77	0.23216	0.44162	0.54740
78	0.22878	0.44330	0.54637
79	0.20681	0.36748	0.45144
80	0.165	0.36301	0.44863
81	0.16504	0.34636	0.42912
82	0.16587	0.36942	0.46405
83	0.16741	0.36309	0.47956
84	0.13238	0.46554	0.54460
85	0.13134	0.47380	0.55781
86	0.15054	0.49389	0.56556
87	0.14018	0.50964	0.59999
88	0.14104	0.50290	0.61146
89	0.14093	0.35073	0.51840
90	0.1411	0.28708	0.44155
91	0.14162	0.26169	0.42493
92	0.14266	0.26486	0.47525
93	0.12227	0.27937	0.56882
94	0.10086	0.28571	0.54273
95	0.10776	0.27957	0.52498
96	0.09622	0.26822	0.49589
97	0.09772	0.27511	0.51267
98	0.09138	0.27344	0.50223