

PROCEEDINGS OF THE 6th ASIS SIG/CR CLASSIFICATION RESEARCH WORKSHOP

**DO INDUSTRIAL CLASSIFICATIONS NEED RE-INVENTING?
AN ANALYSIS OF THE RELEVANCE OF THE U.S. SIC SYSTEM
FOR PRODUCTIVITY RESEARCH**

by

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ABSTRACT

Two separate empirical investigations into the conceptual structure underlying the U.S. SIC were undertaken. Government industry specialists and industry classification experts reviewed individual 4-digit U.S. SICs and judgmentally determined if these industries had been constructed by grouping similar production processes, or, alternatively, by grouping similar markets. Independently, an algorithm derived from the diversification index developed by Gollop and Monahan (1991) was used to measure the heterogeneity of establishment production functions, by 4-digit industry, using the Census Longitudinal Research Database file. The two reviews yielded broadly similar results: Only about one fifth of U.S. industries have been designed to be approximately consistent with aggregation conditions derived from production theory.

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I. Introduction and Background

"Industry" data are often used for productivity research. In all countries, the "industry" data that are in fact produced by government statistical agencies depend on some industry classification system, such as the U.S. Standard Industrial Classification (SIC) or the Nomenclature des Activités économiques des Communautés Européennes (NACE) for European countries. Whether an empirical study uses published aggregate data or grouped microdata, the quality of these data and the inferences which can be drawn from them are affected by the classification scheme.¹

An example of how the current U.S. SIC system affects empirical research can be found in Davis, Haltiwanger and Schuh (1994). Using plant-level data, they examine restructuring in the U.S. steel industry.² This restructuring involved downsizing and, in some cases, exit of large integrated mills and the appearance and growth of specialty mini-mills. The two types of mills employ distinct technologies and face radically different cost structures. However, the U.S. SIC does not currently distinguish between them. Analysis performed with aggregate data would not reveal the economically significant churning within the industry.

Does the current U.S. SIC system group economic observations in ways that are appropriate for productivity research? Answering this question is a primary objective of this paper. Werden (1988), Pittman and Werden (1990), Froeb and Werden (1992), and Werden and Froeb (1993) have found, at least for antitrust purposes, that the SIC system is inadequate in delineating markets, but efforts to analyze the system on a production basis do not exist.

The U.S. Economic Classification Policy Committee (ECPC) has undertaken a comprehensive review of the U.S. SIC system, with an emphasis on improving its usefulness for

¹There are, of course, countless studies using government data but a few examples include Dunne, Roberts and Samuelson (1988), Griliches and Lichtenberg (1984), Jorgenson, Gollop and Fraumeni (1987) and Norsworthy and Jang (1992).

²See chapter 5, section 4.4.

economic analysis.³ As part of its review, the ECPC initiated a study to ascertain the conceptual basis of the 4-digit industries in the current system.⁴ Two methods were used to approach the problem: an "expert opinion" approach involving a questionnaire, and a statistical analysis of Census microdata on manufacturing establishments.

The balance of this paper describes the two empirical approaches. The results of the two approaches are similar. The current organization of the U.S. SIC reflects a potpourri of conflicting classification concepts. Slightly more than one-fourth of the industries examined are consistent with market or demand-based criteria. Less than one-fifth of the industries have boundaries consistent with production theory. The majority of industries reflect boundaries that are either too broad or too narrow under either market or production criteria. About one-fifth of industries appear to have boundaries consistent with no recognizable concept. Consequently, qualified interpretations must be applied to results of research based on data organized by the current SIC, especially cross-section studies or time-series research making inter-industry comparisons. This applies to both market and production-based research and certainly includes productivity studies.

II. The Expert Opinion Approach

The expert opinion approach employed existing statistical agency expertise on the development and evolution of the existing SIC system and on the production processes and markets in individual SIC industries. The working group of classification experts and economists reviewed individual U.S. 4-digit industries to determine if a conceptual basis for each industry could be identified. A subset of the 1,004 U.S. 4-digit industries was chosen for study, including

³ See ECPC (1993) and Triplett (1993).

⁴A similar study of the Canadian SIC system has been conducted by Statistics Canada.

all those in the 2-digit SIC major groups listed in Table 1. The results of this process were summarized in a matrix detailing the conceptual basis for each of the 4-digit industries studied. A portion of this matrix is reproduced in Appendix B and the entire matrix is reported in ECPC (1994).

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Table 1
Two-Digit Industries Included in Study

| Manufacturing Major Groups | |
|-----------------------------------|---|
| Major Group 20 | Food and Kindred Products |
| Major Group 23 | Apparel and Other Finished Products Made from Fabrics and Similar Materials |
| Major Group 33 | Primary Metal Industries |
| Major Group 35 | Industrial and Commercial Machinery and Computer Equipment |
| Major Group 37 | Transportation Equipment |
| Service Major Groups | |
| Major Group 72 | Personal Services |
| Major Group 73 | Business Services |
| Major Group 87 | Engineering, Accounting, Research, Management, and Related Services |

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Description of the Expert Opinion Approach. The 2-digit major groups from the manufacturing sector were selected to include a cross-section of industries that vary in their capital intensity as well as their mix of consumer and intermediate goods; and both durables and nondurables. The 4-digit industries in these 2-digit major groups account for 37 percent of the 459 industries in manufacturing and 43 percent of U.S. manufacturing value of shipments in the 1987 Economic Census.

The working group also studied the 60 4-digit industries in the service sectors. The services industries selected for review account for the same proportion of services industry receipts (43 percent) as the matrix manufacturing industries share of manufacturing. The selected services industries included many that provided rigorous "test cases" for application of the economic concepts (which was an additional ECPC objective for the project).

In total, the working group reviewed 235 industries, 23 percent of the 1,004 U.S. SIC 4-digit industries. These industries account for 19 percent of U.S. total value of shipments in 1987.

To facilitate the analysis, the working group designed a questionnaire that helped focus the discussion for each industry. A copy of that questionnaire is reproduced as Appendix A. Each 4-digit industry was discussed at length among the members of the working group until a consensus was reached on the presence or absence of an economic concept that described the industry. The discussion was directed, either explicitly or implicitly, by the questionnaire. Answers to the questions on the questionnaire dictate the corresponding entries in the matrix (Appendix B), according to the rules set forth in the instructions on the questionnaire.

Reviewing the questionnaire (Appendix A) is useful for understanding how the matrix was constructed. Each question has a counterpart result in the matrix, with questions in the questionnaire and columns in the matrix organized into production-oriented (supply-based) and market-oriented (demand-based) blocks.

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Consider first the production-oriented questions (part A of the questionnaire).⁵ The first question under part A asks whether there is a common production process that is shared by the establishments in this industry, and if it distinguishes those establishments from establishments in other industries. An affirmative answer implies that, in the expert group's judgment, the production process defines the industry, and the letter "D" (defines a conceptually-based industry) was entered in the matrix under the column labeled "process." The process of churning to make butter, for example, appears unique to the Creamery Butter industry, SIC 2021. Therefore, a "D" is entered in the process column.

Question A.2 asks about the materials used in the industry. A material was considered to define an industry only if the characteristics of the material imply a fundamental part of the technology. For example, the physical properties of cream dictate the technology used to separate butter. As another example, the physical properties of fluid milk dictate the processing methods and the types of machinery and equipment that must be used to handle it.

Note, however, that an industry's mere use of a characteristic material is not sufficient to define a production-oriented industry. For example, baking chocolate cakes implies the use of chocolate, which is not an ingredient in baking white cakes. Nothing in the technology of cake baking differs fundamentally with the presence or absence of chocolate, so the use of this material does not define the technology of an industry.

Though it was central in many services industries, the labor question, A.3, did not define the technology of most manufacturing industries. An exception is SIC 3544, Special Dies and Tools, Die Sets, Jigs and Fixtures, and Industrial Molds, because of the special labor requirements (tool and die making) of the industry.

⁵Production processes may be considered broadly or narrowly. Gas welding and brazing are nearly the same process; however, when one considers arc welding, they are quite different. Manufacture of parts may involve quite different technology from assembly of the parts into the ultimate product, and the two kinds of processes may or may not occur together in the same establishment. Provisional judgments on production processes had to be made in order to carry out the study.

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The same process was used for the market-oriented portion of the questionnaire. Again using the example of SIC 2021, Creamery Butter, the working group determined that the primary products produced in this industry (butter, of different types and in different packages) are better substitutes for each other than are the products of any other industry. Thus, butter itself is a reasonable market category (Appendix A, question B.1). This answer leads to the symbol "D" (again meaning that it defines a conceptually-based classification) under the column "market" in the matrix (Appendix B, fourth column). The working group also noted that a broader market category might include margarine and other fats and oils, which illustrates the subjective nature of the judgments that must be made in constructing the matrix.

In the case of SIC 2021, Creamery Butter, the symbol "D" appears on both the production-oriented, and the market-oriented sides of the matrix. This means that data for the butter industry are appropriate for use in production-related analyses and also in demand and marketing analyses. Accordingly, creamery butter is designated as an "ideal" industry, and is so coded under the "ideal industry" column of the matrix.

The working group considered the possibility that the establishments in an industry might share a common production process among them, yet the same or a closely-similar production process might be used in other industries as well (Appendix A, question A.1.a). In such cases, the symbol "P" (for partial process) was entered in the appropriate column in the production-oriented side of the matrix. For example, similar processing and freezing technologies are used by the establishments in SIC 2037, Frozen Fruits, Fruit Juices, and Vegetables, but it is by no means a unique process for this industry. Indeed, frozen fish are produced in Canada at establishments using the same technology to produce frozen fruits and vegetables. In the matrix, the symbol "P" (for "partial") appears under process for industry 2037, because the industry as now defined appears to include only part of an industry defined by a production-oriented concept.

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Where the symbol "P" appears on the production-oriented side of the matrix, this implies that a better production-oriented industry could be constructed by combining this industry with some other industry or industries, or parts of them. The opposite case occurs where a 4-digit industry encompasses more than one production process (Appendix A, question A.1.b). For these cases, the matrix symbol "M" (for multiple process) is used. For example, SIC 2034, Dried and Dehydrated Fruits, Vegetables, and Soup Mixes, consists of two production processes: One set of establishments uses dehydration technology; another set of establishments mixes dehydrated ingredients into soup mixes. The working group commented that separating soup mixes from the dehydrated fruit and vegetables portion of the industry would create a better production-oriented industry (in this case, they also judged that it would improve the industry as a marketing category).

On the market-oriented side, similar definitions of "P" and "M" symbols were used. For example, all of the products produced in an industry might belong to the same market, but products from some other industry might also belong in this market (Appendix A, question B.1.a). These cases are treated in parallel with the partial process industries: The symbol "P" (for partial market) is entered in the appropriate column or columns of the market-oriented side of the matrix. If multiple markets exist within an industry (Appendix A, question B.1.b), an "M" is entered in the appropriate column of the matrix.

The final column in the matrix records cases where the working group gave a negative answer to every question on the questionnaire. The working group judged, for example, that SIC 2023, Dry, Condensed, and Evaporated Dairy Products, neither combines common production processes nor does it correspond to a marketing category. Therefore, the symbol "N," for "No conceptual basis," was entered in the far right-hand column of the matrix. Most of the SIC system's "99" or "not elsewhere classified" (nec) industries lack any economic concept by definition, and were recorded as an "N" in the matrix.

Results of the Expert Opinion Approach. Information from the 1987 Census of Manufactures permits tabulating the relative importance of industries that have been placed in the different categories of the matrix. Table 2 presents the proportion of U.S. industries that were selected for the analysis, and the proportion of total U.S. value of shipments accounted for by these industries. The manufacturing industries included in the analysis accounted for \$1.06 trillion of 1987 shipments, representing 43 percent of total manufacturing shipments of \$2.48 trillion. The service industries examined had 1987 receipts of \$329 billion, representing 43 percent of total service industries receipts of \$772 billion. Overall, the 235 industries reviewed accounted for 19.3 percent of total 1987 industry value of shipments.

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Table 2.—Matrix Analysis: Proportions of Industries Included in Matrix

| | Number of industries | Percent | Value of shipments or receipts (Millions of dollars) | Percent |
|---|----------------------------|---------|--|---------|
| All SIC industries | 1,004 | 100 | 7,234,108 | 100 |
| Manufacturing industries, total | 459 | 46 | 2,475,901 ^a | 34 |
| Service industries, total | 150 | 15 | 772,194 ^b | 11 |
| All other industries | 396 | 39 | 3,986,013 | 55 |
| All matrix industries | 235 | 23 | 1,394,051 | 19 |
| <i>Manufacturing matrix industries:</i> | | | | |
| In relation to total | 175 | 17 | 1,064,806 | 15 |
| In relation to manufacturing | 175 | 37 | 1,064,806 | 43 |
| <i>Services matrix industries:</i> | | | | |
| In relation to total | 60 | 6 | 329,245 | 5 |
| In relation to services | 60 | 40 | 329,245 | 43 |

^a/ Bureau of the Census, *1987 Census of Manufactures, General Summary: Industry Product Class, and Geographic Area Statistics*, MC87-S-1, U.S. Department of Commerce, March 1991, Table 3.

^b/ Bureau of the Census, *1987 Census of Service Industries, Geographic Area Series: United States*," SC87-A-52, U.S. Department of Commerce, November 1989, Table 1a.

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Table 3 presents the results for the manufacturing industries. The results suggest that the current U.S. SIC has no dominating economic concept. Only 16.6 percent of the industries (accounting for 18.8 percent of manufacturing value of shipments) are fully defined on a production-oriented concept. Roughly half of these are ideal industries, that is, cases where the same industry definition would emerge from application of either a production-oriented or market-oriented economic concept.

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Table 3.--Matrix Analysis of Manufacturing Industries: Proportions of Production-Oriented and Market-Oriented Industries

| | Number of industries | Percent | Value of shipments | Percent |
|---|----------------------|---------|--------------------|---------|
| Matrix industries in manufacturing | 175 | 100 | 1,064,806 | 100 |
| <i>Production-oriented</i> | 102 | 58.3 | 678,102 | 63.7 |
| Fully-defined industry (D) | 29 | 16.6 | 200,474 | 18.8 |
| (Of which: Ideal industry) | (15) | (8.6) | (108,523) | (10.2) |
| Partial process industry (P) | 35 | 20.0 | 119,392 | 11.2 |
| Multiple process industry (M) | 37 | 21.1 | 357,780 | 33.6 |
| Both partial and multiple processes (PM) | 1 | .6 | 456 | 0.0 |
| <i>No production-oriented basis</i> | 73 | 41.7 | 386,704 | 36.3 |
| <i>Market-oriented</i> | 121 | 69.1 | 779,008 | 73.2 |
| Fully-defined market (D) | 48 | 27.4 | 246,552 | 23.2 |
| (Of which: Ideal industry) | (15) | (8.6) | (108,523) | (10.2) |
| Partial market (P) | 47 | 26.9 | 215,751 | 20.3 |
| Multiple markets (M) | 22 | 12.6 | 163,428 | 15.3 |
| Both partial and multiple market (PM) | 4 | 2.3 | 153,277 | 14.4 |
| <i>No market-oriented basis</i> | 54 | 30.9 | 285,798 | 26.8 |
| <i>Ideal industries</i> | 15 | 8.6 | 108,523 | 10.2 |
| <i>No conceptual basis, neither production nor market</i> | 31 | 17.7 | 182,352 | 17.1 |

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One fifth of manufacturing industries are partial production-oriented industries. These are cases where combination with some other industry, or parts of another industry, would create a better production-oriented industry.

Another fifth (21.1 percent) of manufacturing industries employ multiple production processes within the same SIC industry definition. Multiple-process industries, however, account for a third of manufacturing shipments, so they are among the relatively larger industries in economic importance. Multiple-process industries could be made into fully-defined production-oriented industries with relatively simple divisions of the presently-defined industries.

Overall, roughly three-fifths (58.3 percent) of manufacturing industries incorporate the production-oriented concept in some way (whether fully-defined, partial, or multiple processes). Two-fifths (41.7 percent) of manufacturing 4-digit industries, accounting for more than a third of manufacturing shipments, have no production-oriented basis in the current SIC classification system. 26.4 percent of these are "nec" industries, which are appropriate subjects for review and redefinition.

A similar situation exists with respect to the market-oriented concept. A somewhat larger number of current 4-digit manufacturing SIC's are fully defined according to the market-oriented concept (27.4 percent). A nearly equal number of manufacturing industries (26.9 percent) are partial markets, accounting for about the same share of manufacturing shipments as the fully-defined market industries (20.2 and 23.2 percent of shipments, respectively). Slightly more than two-thirds of manufacturing industries incorporate the market-oriented concept in their definitions in some way (fully-defined, partial, or multiple markets).

By shipments shares, 10 percent of manufacturing shipments arise from ideal industries in the present SIC system, which is more than equalled by the 17.1 percent of shipments that come from industries with no conceptual basis.

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The percentages discussed in this section and displayed in Table 3 pertain only to the manufacturing industries chosen for review. Manufacturing industries that have not yet been reviewed account for more than half of manufacturing, so the picture might change when a full review of all 459 manufacturing industries is carried out.

Table 4 presents results for the services industries. As with manufacturing, the analysis suggests that the current U.S. SIC has no single dominating economic concept. Services have a higher percentage of fully-defined industries than does manufacturing, 21.7 percent for production-oriented and 30.0 percent for market-oriented industries. For production-oriented industries, 26.7 percent were categorized as having multiple processes, which may indicate that these processes could be the basis for partitioning the services activities into a larger number of fully-defined production-oriented industries.

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Table 4.--Matrix Analysis of Services: Proportions of Production-Oriented and Market-Oriented Industries

| | Number of industries | Percent | Value of shipments (Millions of dollars) | Percent |
|---|----------------------|---------|---|---------|
| Matrix industries in services | 60 | 100 | 329,245 | 100 |
| <i>Production-oriented</i> | 44 | 73.3 | 219,181 | 66.6 |
| Fully-defined industry (D) | 13 | 21.7 | 45,906 | 13.9 |
| (Of which: Ideal industry) | (7) | (11.7) | 23,743 | 7.2 |
| Partial process industry (P) | 8 | 13.3 | 29,510 | 9.0 |
| Multiple process industry (M) | 16 | 26.7 | 110,995 | 33.7 |
| Both partial and multiple processes (PM) | 7 | 11.7 | 32,770 | 10.0 |
| <i>No production-oriented basis</i> | 15 | 25.0 | 94,012 | 28.6 |
| <i>Market-oriented</i> | 45 | 75.0 | 224,208 | 68.1 |
| Fully-defined market (D) | 18 | 30.0 | 4,789 | 1.5 |
| (Of which: Ideal industry) | (7) | (11.7) | 23,743 | 7.2 |
| Partial market (P) | 19 | 31.7 | 81,953 | 24.9 |
| Multiple markets (M) | 6 | 10.0 | 85,150 | 25.9 |
| Both partial and multiple market (PM) | 2 | 3.3 | 9,216 | 2.8 |
| <i>No market-oriented basis</i> | 14 | 23.3 | 88,985 | 27.0 |
| <i>Ideal industries</i> | 7 | 11.7 | 23,743 | 7.2 |
| <i>No conceptual basis, neither production nor market</i> | 13 | 21.7 | 86,284 | 26.2 |
| No decision made--SIC 7363 | 1 | 1.7 | 16,051 | 4.9 |

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The mixture of market and production-oriented concepts underlying the current SIC is troubling enough. What is perhaps more troubling is the significant proportion of industries that, according to the expert panel, have neither a production nor a market basis. In manufacturing, industries having no recognizable conceptual basis represent 17.7 percent of industries and roughly the same percentage (17.1 percent) of shipments. The corresponding values for services are 21.7 percent of service industries and 26.2 percent of service revenues. In fact, the percentage of service industry receipts accounted for by industries lacking any recognizable conceptual basis (26.2%) far exceeds the combined percentage of receipts (8.2%) accounted for by service industries fully defined by market and/or production bases. Not only is there no single concept underlying the SIC or even the majority of its industries, but in a significant proportion of cases there appears to be no recognizable basis for defining an industry's boundaries.

III. The Heterogeneity Index

A complementary study, using a variant of the heterogeneity component of the diversification index introduced by Gollop and Monahan (1991), was carried out to provide a quantitative assessment of the expert opinion approach. A more complete discussion of the heterogeneity index can be found in ECPC (1994b). Essentially, this index measures the "dissimilarity" of the shares of establishments' total cost caused by each of a number of inputs as described below.

The objective is to quantify the extent of similarity among the production functions of the establishments assigned to an SIC industry category. Given the aggregation principles discussed above, the index can be a useful diagnostic tool to evaluate the degree to which the current SIC system incorporates production-oriented concepts.

The index is based on the Cobb-Douglas production function, $\ln(y_i) = \sum_j \beta_{ij} \ln(X_j)$,

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where y_i is a vector of outputs produced by the i th establishment using a set of inputs X_i and a technology described by the parameters β_{ij} . Since the parameters of the production function can be shown to equal the input cost shares w_{ij} , differences in cost shares can be used to quantify differences among production functions (assuming input markets are competitive). An index of production heterogeneity in an industry follows:

$$H = \sum_i \sum_k s_i s_k \frac{\sum_j |w_{ij} - w_{kj}|}{2} \quad (1)$$

where s_i and s_k are the respective shares of establishments i and k in total industry sales.

The heterogeneity index in Equation (1) was computed for the 175 manufacturing industries examined in the matrix described in Section II. The ten inputs used in the calculation are production workers, other labor, fuel, electricity, purchased services, agricultural materials, mineral inputs, nondurable materials, durable materials and capital. The share of capital is estimated by computing the difference between total receipts and total expenditures on the other nine input categories. The data are drawn from the 1987 Census of Manufacturers, and the indexes are calculated using the full population of establishments (excluding administrative records) in each industry. The index values are converted to percentiles, since only their ordinal values have meaning.

The latter fact is suggestive of the reason there is no critical value of the raw index which can be used as a "test statistic" for the acceptance or rejection of a well-defined production-based industry. Comparing H-index values is, however, potentially useful as a means of identifying those industries that have the most diverse production characteristics, and therefore become prime candidates for SIC revision.

For the purposes of this paper, the H-index can be used to examine the results of the expert opinion exercise described above. One would expect that those industries with a "D" in

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any production-oriented column to have H index values that are low relative to other industries. That turns out, in the large, to be the case. Of the 40 industries judged to be defined "D" on a production basis, 34 have H values below the median. Moreover, 23 of these 34 industries with below-median H values have index values less than the 20th percentile, and fourteen of these have index values less than the 10th percentile. Overall, the correlation between the H-index percentile and an indicator for production-defined industries is -0.22; not exceedingly large in absolute value, but statistically significant at the 1% level. The H-index appears to more or less capture quantitatively the expert opinion analysis.

Another hypothesis, symmetric with the first, can also be examined. Industries with high H values should not also be industries identified as production-defined industries by the expert group. This also turns out to be true. Twelve industries have H values greater than or equal to the 90th percentile. Of these twelve, only one has been judged by the expert panel to be production defined.

Extending this analysis to the 38 industries having H values above the 70th percentile leads to the same inference. Among these 38, only three were judged defined by production-based criteria. Thirteen of the 38 are judged to have neither production nor market-based criteria, and another 10 are determined to be pure market-based industries.

The expert opinion approach suggests that multiple concepts underlie the current SIC. Independent application of the heterogeneity index reinforces this conclusion. Most importantly for productivity research, it appears that a pure production-oriented concept does not dominate the SIC.

IV. Conclusions and Implications for the North American Industrial Classification System

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The analysis clearly suggests that, at least for the subset of industries examined, there is no single consistent economic concept underlying the existing structure of the SIC. Moreover, it appears that SIC industries have not been defined appropriately for productivity analysis. Less than one-fifth of the industries have boundaries wholly consistent with production theory. The vast majority of industries are defined either too broadly or too narrowly according to standards judged consistent with production concepts. Though slightly more than one fourth of the industries examined are consistent with market or demand-based criteria, nearly a fifth of industries appear to have boundaries consistent with no recognizable economic concept.

The lack of a well-identified and carefully applied conceptual framework for the SIC undoubtedly affects empirical economic research relying on data grouped by the SIC categories. Productivity researchers cannot assume that establishments within an SIC industry share identical or even related technologies. By extension, conclusions and policy implications drawn from that research may well suffer significant bias. Put simply, the data may not be drawn from an environment assumed by the applied model. This may be particularly significant for cross section work or studies that, like most productivity research, attempt to draw intersectoral comparisons.

The good news for those engaged in productivity research is that the U.S., Canada, and Mexico have agreed to construct a common industry classification system. Moreover, that common system will be based on a production concept consistent with economic principles. Following Triplett (1990), the North American countries have agreed that "industries" should group establishments having common production functions. Consistently defined industry data gathered under the new North American Industry Classification System (NAICS) will provide a consistent basis for productivity research.

The definition of industry boundaries and the assignment of establishments (plants) to particular industries, even under NAICS, no doubt will continue to be the result of informed judgment. The difference will be that formal economic concepts derived from output aggregation

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principles (e.g., Fisher (1993)) and metrics like the heterogeneity index introduced in this paper will have more of a voice in guiding the evolution of NAICS.

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PROCEEDINGS OF THE 6th ASIS SIG/CR CLASSIFICATION RESEARCH WORKSHOP

APPENDIX A

QUESTIONNAIRE

A. Production-oriented or Supply-based questions

- (1) Does the production process uniquely define this industry?

IF YES, ENTER D IN COLUMN 2.

IF NO:

- (a) Is the process used in other industries?

IF THE INCLUSION OF THESE OTHER INDUSTRIES, OR PARTS OF THEM, WOULD CHANGE YOUR ANSWER TO (1), ENTER P IN COLUMN 2 AND ENTER THE OTHER INDUSTRIES IN THE NOTES.

- (b) Are there two distinct processes in this industry?

IF SPLITTING THIS INDUSTRY INTO 2 OR MORE PARTS WOULD CHANGE YOUR ANSWER TO QUESTION (1), ENTER M IN COLUMN 2, AND INDICATE IN THE NOTES WHAT THE DIVIDED INDUSTRIES MIGHT BE CALLED.

- (2) Do the materials used in this industry uniquely define the industry?

IF YES, ENTER D IN COLUMN 3.

IF NO:

- (a) Are these materials used in other industries?

IF THE INCLUSION OF THESE OTHER INDUSTRIES, OR PARTS OF THEM, WOULD CHANGE YOUR ANSWER TO (2), ENTER P IN COLUMN 3 AND ENTER THE OTHER INDUSTRIES IN THE NOTES.

- (b) Are there two distinct materials in this industry?

IF SPLITTING THIS INDUSTRY INTO 2 OR MORE PARTS WOULD CHANGE YOUR ANSWER TO QUESTION (2), ENTER M IN COLUMN 3, AND INDICATE IN THE NOTES WHAT THE DIVIDED INDUSTRIES MIGHT BE CALLED.

- (3) Do the human capital components of the labor force uniquely define this industry?

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IF YES, ENTER D IN COLUMN 4.

IF NO:

- (a) Are these skills used in other industries?

IF THE INCLUSION OF THESE OTHER INDUSTRIES, OR PARTS OF THEM, WOULD CHANGE YOUR ANSWER TO (3), ENTER P IN COLUMN 4 AND ENTER THE OTHER INDUSTRIES IN THE NOTES.

- (b) Are there two distinct labor types in this industry?

IF SPLITTING THIS INDUSTRY INTO 2 OR MORE PARTS WOULD CHANGE YOUR ANSWER TO QUESTION (3), ENTER M IN COLUMN 4, AND INDICATE IN THE NOTES WHAT THE DIVIDED INDUSTRIES MIGHT BE CALLED.

- (4) Does a **COMBINATION** of material, labor, and/or process uniquely define this industry?

IF YES, THIS IS A SUPPLY-BASED INDUSTRY. ENTER D IN APPROPRIATE COLUMNS (COULD BE ANY COMBINATION OF 2, 3, AND 4).

B. Market-oriented or Demand-based questions

- (1) Are the products of this industry closer substitutes among themselves than anything produced outside the industry?

IF YES, ENTER D IN COLUMN 5.

IF NO:

- (a) Would the inclusion of another industry (or several, or part of another) change your answer?

IF YES, ENTER P IN COLUMN 5 AND ENTER THE OTHER INDUSTRIES IN THE NOTES.

- (b) Would splitting this industry into two change your answer?

IF YES, ENTER M IN COLUMN 5 AND INDICATE IN THE NOTES WHAT THE DIVIDED INDUSTRIES MIGHT BE CALLED.

- (2) Are the products of this industry typically distributed or used together?

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IF YES, ENTER D IN COLUMN 6.

IF NO:

(a) Would the inclusion of another industry, or part of an industry, or of several industries or parts of several industries, change your answer?

IF YES, ENTER P IN COLUMN 6 AND ENTER THE OTHER INDUSTRIES IN THE NOTES.

(b) Would splitting this industry into two or more industries change your answer?

IF YES, ENTER M IN COLUMN 6 AND INDICATE IN THE NOTES WHAT THE DIVIDED INDUSTRIES MIGHT BE CALLED.

APPENDIX B
SAMPLE PAGE: EXPERT OPINION MATRIX

| Codes | INDUSTRY | SUP BAS | PLY ED | DEM BAS | AND- ED | NEITHER BASIS |
|----------------|---|---|--------------------------------|-------------------------------------|--|--------------------------------|
| ===== Codes | ===== D - Defines a conceptually based industry M - Multiple processes/markets N - Neither conceptual basis P - Partial, e.g. markets V - Vertical integration is part of definition * - Changes/notes based on 10/4 mtg with Can | ===== P R O C E S S I N G | ===== L A B O R | ===== M A R K E T | ===== U S E D / D I S T | ===== O T H E R |
| ===== SIC | ===== (United States, 1987) | ===== D V | ===== D V | ===== D V | ===== P | ===== P |
| 2011 | Meat packing plants | DV | DV | DV | P | P |
| 2013 | Sausages and other prepared meats | DV | DV | DV | P | P |
| 2015 | Poultry slaughtering and processing | M | D | D | M | M |
| 2021 | Creamery butter | D | D | D | D | D |
| 2022 | Cheese, natural and processed | D | D | D | D | D |
| 2023 | Dry, condensed, evaporated dairy products | | | | | |
| 2024 | Ice cream and frozen desserts | D | D | D | D | D |
| 2026 | Fluid milk | D | D | D | D | D |
| 2032 | Canned specialties | D | D | D | D | D |
| | | | .399 | .201 | .078 | .444 |
| | | | .274 | .564 | .111 | .519 |
| | | | .457 | | | |