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Management Matters

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Abstract:

New indications of managerial innovations are created and then used to show that changes in organizational technologies are an important source of economic growth. Specifically, the analysis demonstrates that, first, in response to a positive managerial technology shock, output, productivity and hours significantly increase in the short run, second, these types of innovations are as important as non-managerial ones in explaining movements in these variables at business cycle frequencies, and, third, product and process innovations promote the development of new managerial techniques.

Keywords: Business Cycles; Productivity; Management techniques; Technical Change
JEL: E3, M1, M5, O3, O4

1. Introduction

Total factor productivity (TFP) is, despite our best efforts, still a "black box." Most economists would classify as a component of TFP anything that governs the efficiency with which producers' transform inputs into output. The implication: intangible technologies, such as management techniques and production processes, may be no less significant than tangible technologies associated with new machines and products. While many papers explore the role that process and product technologies play in economic fluctuations and growth,[1] far less research has been devoted to quantifying their aggregate impact despite the abundant microeconomic evidence that corporate work rules changes, team structures, communication channels, morale, and managerial leadership significantly affects firm level productivity.[2] Managerial/organizational techniques in particular resist quantification because no adequate aggregate measure of managerial innovation exists. Traditional direct indicators of technical change, such as those based on research and development expenditures (R&D) or patent applications, fail in most instances to capture them[3] To address this, we present new measures of organizational innovations based on new titles published in the field as recorded by the Library of Congress and use them to demonstrate that advances in these intangible technologies have been an important contributor to aggregate output and productivity growth.

Specifically, we use the new indicators answer the following questions: What role do managerial technology shocks play in cyclical fluctuations; What impact does this type of technological change have on employment and productivity; and What is the relationship between managerial innovations and advances in product/process innovations? First, we find GDP, labor and TFP all significantly increase in the short-run following a positive organizational technology shock. However, the impact on labor is relatively modest - a finding consistent with many microeconomic studies that explore the impact of process related technical change on employment.[4] Second, we find that managerial technologies do make an important contribution to aggregate fluctuations in output and total factor

[1] See e.g., the review articles in Spiezia and Vivarelli (2002) and Chennells and Van Reenen (2002) and cites within.

[2] For example, papers such as those of Bloom and VanReenen (2007), Cosh, Fu and Hughs (2005), Bertrand and Schoar (2003), and Bartelsman and Dom (2000) provide evidence that differences in manager skill help explain productivity differences across firms.

[3] See e.g., the discussions in Dutton, Thomas and Butler (1984) and the OECD's Oslo Manual (2005).

[4] See for example Van Reenan (1997), Blanchflower, Millward, and Oswald (1991); and Harrison et al. (2008).

productivity. Third, managerial innovations may be as important as new product/process technologies for productivity growth although the timing of their impacts differ - unanticipated changes in managerial technologies appear to have a faster impact on the economy than traditional technology shocks. Finally, consistent with the Chandler's (1977) research, it appears that product/process innovations cause some innovations in management. Broadly speaking, these enhance four areas of research investigating: (1) the link between management techniques and aggregate productivity; (2) the growth and employment impact of different types of technological advances;[5] (3) the business cycle literature empirically investigating technical change as a source of short-run fluctuations;[6] and (4) the literature on the measurement of innovation.

In absence of available aggregate measures of managerial innovation, much of the work linking managerial techniques to improved performance has taken the form of case studies or surveys.[7] However, to answer critical questions about the quantitative and qualitative impacts of managerial advances on the economy, good aggregate measures are required since TFP (Solow residual) does not distinguish between the different types of technical change, and indicators based on R&D or patents are unlikely to capture this type of innovation. Therefore, to address these issues, we create new measures based on the Library of Congresses' *MA*chine *R*eadable *C*ataloguing (MARC) record collection. The information contained in this database allows us to determine the annual number of new English language titles that were copyrighted in the U.S. from 1929-2002 covering managerial innovation in the fields of production/operations management, human resource management, and industrial relations.[8] The resulting indicator has a number of attractive features. Most importantly, they are objectively determined and capture the innovations when they are first adopted by firms in the U.S.

In the next section, we discuss the new indicators. In section 4 we present results based on a series of vector autoregressions (VARs), are presented to uncover the relationship between the book-

[5] See review articles: Spiezia and Vivarelli (2002) and Chennells and Van Reenen (2002) and cites within. For the relationship between process innovations and employment see Doms, Dunne and Roberts (1995), Blanchflower and Burgess (1999), and Ross and Zimmerman (1993).

[6] See, for example, Fisher (2006), Alexopoulos (forthcoming), Alexopoulos and Cohen (2009),Gali (1999), Francis and Ramey (2005) and Basu et al. (2009).

[7] Bloom and Van Reenen (2010) surveys a large number cross-country survey results that link management techniques to various outcome measures from firm-productivity to employee morale.

[8] We focus on these fields since: (1) they are likely to affect productivity (at least at the firm level) and (2) the channels by which they can affect efficiency are relatively well understood.

based indicators and GDP, productivity and inputs. We conclude in section 5.

3. The indicators

To examine the responses of output, productivity and labor to managerial technology shocks at the aggregate level, we strive to create an indicator that is able to: (1) capture the large array of managerial innovations that are used by firms in the economy; and (2) accurately capture the times that new innovative techniques are first adopted by mainstream management. We argue below that the new indicators created from information on new titles published in the fields of management and subfields of technology, as recorded by the Library of Congress - the American copyright depository and arguably the largest library in the world - satisfy these criteria.

3.1 Creating the New Measures

In order to create the new indicators, we require information on the type of books available each year, information on the book edition, and data on the country of publication. Specifically, we want to focus on the number of new titles in different fields of business and industrial production management each year, excluding books written on the history of a particular topic, to identify new techniques available in the economy. This information is recorded in the Library of Congress' machine readable MARC21 Cataloguing records (See Appendix A for an example of a MARC21 record). These files are used by the Library of Congress to run their online book search program, and are distributed to other libraries to be used for cataloguing purposes. The Library of Congress was established by an act of Congress in 1800 and its collection contains information on a large number of publications since it is both the copyright depository for the U.S., and arguably the largest library in the world.[9] As a result, the database provides an excellent source of information on new books copyrighted within the United States in many subject fields, as well as information on books imported from other countries.

In addition to its language, edition and country of publication fields, the MARC21 records report the Library of Congress' Classification Code, and a set of standardized keywords that describe the major subjects covered by the book. First developed in 1898, the Library of Congress Classification Code is used by the librarians in all North American Research libraries to catalogue new titles and

[9] The Library of Congress' collections include more than 29 million books and other printed materials.

assign call numbers so that items on similar topics are shelved together. For the purpose of this investigation we focus on books listed in the H and T subgroups (Social Science or Technology) and QA75-76 (Computer Software and Hardware). [10] Our management innovation indicator is based on titles classified under the LC class HD28-70 (Management and Industrial Management), HD6958.5-6976 (Industrial Relations), HF5546-5549.5 (Office Management Industrial Psychology, Personnel and Employment Management), T55.4 – 60.8 (Industrial and Management engineering) and TS 155-194 (Production and operations management). Moreover, our total technology indicator is defined as all computer titles (QA 75 – 76 and HF5548.1-5548.1.6) and all technology books (class T) excluding those books on product management and industrial engineering (T55.4 – 60.8 and TS 155-194) as well as the titles in Handicrafts (Class TT), and Home economics (Class TX) that do not focus on products and processes used in the market. [11] Next, we use the information contained in the subject and title fields in the MARC21 records to remove books from these groups that list history as a major topic since they are unlikely to focus on current state-of-the-art practices or technologies.[12] Figure 2 presents the aggregate indicators for management alongside the traditional technology and computer science indicator based on the information from the Library of Congress' records.

3.2. Properties of the indicators

There are a number of properties an ideal indicator of any type of technological change should have. First, it should be available for a long period of time, at least at an annual frequency, to make a time series analysis possible. Second, it should also be objectively determined and cover a wide range of technical advances. Finally, for our type of analysis, it should capture the dates that the new innovations are adopted by firms so that the innovations can actually affect workplace practices and productivity.[13]

[10] See Appendix B for a listing of the major groupings and sub-groupings in H, T and QA.

[11] Our definition of the technology index differs slightly from the one used in Alexopoulos (forthcoming). Specifically, we combine her T measure of technology with the computer titles (including those focusing on office automation) and remove the management titles found in the T class.

[12]For example, a book on the history of the Ford Corporation and its introduction of the assembly line published now will not tell us much about the company's current state of the art practises.

[13] By creating an indicator that captures the initial adoption dates, we avoid the problems associated with long and variable lags between a time of invention and time of use. For example, the presence of these lags was one of the proposed explanations for Shea's (1998) finding of a weak relationship between patents, R&D and TFP.

Although the ideal measure of organizational innovations may always remain elusive, the new book-based indicator does approximate it. As it is based on the collection of the Library of Congress, it guarantees that (1) the database is fairly inclusive of titles published in the US (primarily for domestic use) and (2) the comprehensive information on titles is available for long periods of time at the annual level. In addition, by defining the indication based on the Library of Congress' classification codes, the resulting index is objectively determined in the sense that professional cataloguers assign standardized keywords and determine the class of the title. Finally, as we discuss below, there is evidence to suggest that the book-based measure captures innovations as they are commercialized, at least partially weights innovations by their importance/potential impact, and does not simply track the use of the techniques in the economy.

3.2.1. Dating

One of the most compelling and attractive features of the new indicators is the strong correspondence between the dates new management techniques are first adopted by U.S. firms and the appearance of new titled in the LOC. The reason for this is straightforward. Since these innovations raise productivity, boost competitiveness and potentially expand market share, there is an enormous demand for information about them as soon as they are found to work. Publishers are in the business of packaging information and selling it for profit. Therefore, they have every incentive to bring out titles on new management techniques as quickly as possible, especially since they recognize that any delay in releasing new titles on the subject can result in lost revenues if competitors are able to release a similar book faster.[14,15] This feature of the indicator is highlighted by the dating information on a wide variety of managerial innovations provided in Table 1A and Appendix C. Many, but not all, of these tools/methods were developed and first implemented in the U.S. Some were considered to be revolutionary at the time they were introduced and are still in use

[14] Alexopoulos (forthcoming) displays similar evidence for major product and process innovations captured by her indicators, and similarly argues the timing is related to the fact that: (1) books are costly to produce, and (2) publishers want to release the books as early as possible to maximize the return on each new title She also reports that conversations with publishers confirm that they can release a book on a major technological development within a few months if there is a demand for the information since they recognize that any delay can result in decreased revenues (and perhaps losses) if their competitors are able to release a similar book faster.

[15] While some may be concerned that companies may try to keep their managerial innovations secret, there is evidence to suggest that these attempts are unsuccessful. For example, Wal-Mart has not released books about its practices, but numerous books and articles have been written about them by others. Moreover, the employee at Motorola who helped implement Six Sigma left the company to form his own consulting firm and wrote a training manual for others who showed an interest in the methodology.

by some firms today (e.g., scientific management/Taylorism, quality control, and TQM), while others are considered to be more minor in their influence (e.g., one-minute management and Theories X/Y).

To highlight the dating properties in Table 1A we display the copyright date (found in field 008 in the MARC record) for the first book, the date of the first associated academic article in the Business Premier database, and the date of the first known article on the subject in the Harvard Business Review. Alongside this information are the known dates for creation/discovery and first known commercial use in the U.S. where the information on the initial creation and adoption dates listed in are obtained from the sources listed in Appendix C.[16] This information reveals a few notable patterns. First, for most of the techniques listed that are developed in the USA, the time between the creation date and the first commercial use date is between 1 and 4 years, with a median of 2 years. Second, the copyright date for the first American book published generally appears within one to two years of the initial commercial use in the U.S. This finding helps to confirm our contention that the dating of a technique inferred from our book-based measure is a reasonable proxy for the initial wave of technique adoption by American firms. Third, contrasting the commercialization date with the first Harvard Business Review and academic articles highlights the excellent performance of the book indicator for dating the first American usage of imported techniques such as Quality Circles and Just-in-Time. This may not be surprising since: (1) there is nothing to prevent or discourage academics from publishing on the interesting experiences of firms in foreign countries, and (2) articles in the HBR are supposed to be "written for senior managers by experts whose authority comes from careful analysis, study, and experience. The ideas presented in these articles can be translated into action and have been tested in the real world of business."[17] Therefore, articles on techniques used overseas may appear in print even if they are not currently in use in America.

Overall these findings can be summed up by two statements. First, it appears that there is a very close link between first known usage of managerial innovations and first book dates in the U.S. during the 20th century regardless of the country of invention or the eventual success of the technique.

[16] While dating the creation and first implementation of various techniques is inherently subjective, it is not impossible. There is general agreement on the histories of many of the techniques we examined. However, the dates associated with some others are harder to pin down. The SOFT/SWOT technique is one such example. One set of sources attribute its creation to Kenneth Andrews and other Harvard academics in the late 1960s with the major adoption following the release of Andrew's 1971 book, while others link SWOT to the research performed by Robert Stewart and his team at the Stanford Research Institute between 1960-69 which resulted in a 1966 prototype with final modifications completed in 1973. (See cites and links in Appendix C).

[17] See http://harvardbusiness.org/guidelines-for-authors-hbr.

Second, the U.S. adoption timing implied by the first title in the LOC database tends to be more reliable than the dates implied by articles in the HBR or academic journals –especially for techniques first developed or adopted abroad.

3.2.2. Weighting

As profit maximizers, publishers tend to release more new titles for potentially popular techniques and fewer titles for less attractive ones. This view is supported by the evidence present in Table 1B. Here we report the number of titles in English held by the Library of Congress in a number of the Library of Congress' standardized subjects in the field of management. The results show that our indicators put more weight on the advances related to scientific management, project management, quality control and total quality management (because of the number of titles associated with these techniques) and less weight on innovations such as PERT and zero-base budgeting.[18] Moreover the number of new releases to date indicates the publishers believe that interest in TQM is larger than BPR, and the counts suggest that the critical path method, which was produced by a private company, has received more attention than its competitor PERT which was developed by the Navy for military purposes.

More evidence on the relationship between the quantity of management titles and a technique's popularity can be discerned from a couple of comparisons between failed and highly popular techniques. Consider, for example, Total Quality Management, with 1209 English language titles, and T-groups, with only four titles. Very few mainstream firms adopted the latter technique and the LOC never created for it a unique subject heading. A second more recent example is the early 1980s smash-hit One-Minute Management that advocated that (1) one should be able to express corporate goals in under a minute, and (2) managerial praise/criticism of employees must occur immediately and be limited to a minute. The number of titles associated with this technique is 16 (including new editions and electronic versions of the texts), 13 of which are associated with the

[18] Even taking into account the number of years since development, the publication patterns suggest that TQM was (and likely still is) more widely used/influential than techniques like quality circles and just-in-time management. The counts also confirm that the critical path method, which was developed by the private sector for use in the private sector, was more popular than the competing technique PERT (which was developed by the Navy for military use).

creator of the technique, while rest are critical.[19] Overall, it appears that ineffective techniques or those utilized by a small segment of the market do not receive the same attention by publishers as widely used successful ones. In short, one can view the index of new book titles as a *partially weighted* index of management techniques. As such, it should be viewed as closer in spirit to a citation weighted patent index than a simple patent count measure.

3.2.3. Patterns over time

Of course, it is natural to ask whether the new indicators simply track diffusion of innovations or if it is more related to innovation? While it is possible to examine the relationship between the initial adoption of the techniques and the book dates, it is much more difficult to uncover the relationship between the "diffusion" of the technique and the patterns of publications on it for a few reasons. First, there is virtually no time series evidence available on the usage of these tools, and second, the techniques themselves tend to evolve over time, which makes it difficult to distinguish between technique diffusion and additional innovations in the original tool/method. These caveats aside, it is useful to know if publications follow the usage.

To explore this issue, we obtained information about the utilization of major management tools from 1993 to now from Bain and Company, a consulting company that has performed numerous surveys over time for the purpose of examining the extent to which the most popular techniques are used by firms, and which of the practices yielded successful results. Figure 3 depicts the patterns of usage from their surveys graphed along with the journal and new title counts for three cases – Business Process Reengineering, TQM, and Knowledge Management. A few notable results stand out from their survey data. First, there is evidence to indicate that firms may adopt a technique for a specific purpose only to put it in cold storage until the next time it is needed (which suggests that managerial innovations may not follow the traditional S-shape diffusion curves). Second, the TQM and BPR cases show the number of new titles decreasing even though many firms are still employing these techniques.[20] Third, even though the patterns of publications are similar for both the journal and new title counts in these cases, it appears that publications have only a weak relationship with

[19] See e.g., titles such as The 59-Second Employee: How to Stay One Second Ahead of Your One-Minute Manager; The one-minute maniac; and Managing to survive: how to outsmart the one minute manager

[20] This finding is at odds with the basic premise put forth on Fads and Fashions in the management literature where they interpret the decline in journal articles as abandonment of the technique. See e.g. Abrahamson and Fairchild (1999).

usage. Overall, the numbers suggest that one should view the new indicator as reflecting more of the initial innovation and less of the subsequent diffusion.

3.2.4 Why not use journal article counts?

Books, obviously, are only one method of spreading the word about innovations. Journals and trade publications are another likely source of information which leads to the natural question: Why don't we use journal article counts to track managerial innovations the way the National Science Foundation uses the Science Citation Index as a metric capturing scientific advances? As a comparison of the journal counts in Figures 1 and LOC book publication records in Figure 4 for TQM and Quality Circles reveals, there can be a high degree of correlation between journal-based and book-based indicators at the technique level. However, the LOC counts provide a superior source of information for the creation of an indicator of management innovations *at the aggregate level* for a number of reasons. First, given that the LOC is the largest library in the world and the legal copyright depository for the United States, its collection represents a fairly accurate picture of the information available on management techniques. The searchable coverage of journal publication indexes, in contrast, capture articles only within a limited set of journals (which also varies over time). Second, as the patterns displayed in Figure 5 demonstrate, the journal count data are sensitive to the source database, resulting in problems such as misidentified initial adoption dates or misleading inference about the interest in the topic. Third, the Library of Congress' classification system allows a clear delimitation of texts by broad topic (e.g., publications on human resource management). That is, librarians apply a standardized, time-invariant subject based classification to each item (See Appendix B) along with approved subject keywords. Journal databases, on the other hand, only assign keywords (which themselves change over time) to articles, which complicates the process of accurately identifying all items that belong to a broader subject group. Fourth, since new book titles are more costly to produce than journal articles, publishers have every incentive to release titles on new techniques as close to the market's adoption date as possible in order to capture the market and maximize profits. In contrast, journal articles are often written by academics for other academics and do not have the same incentive for timeliness.[21] The patterns that emerge when

[21] See Geisler (2000) for more discussion on this point and other problems associated with journal article metrics.

looking at the dates in Table 1 provide support for this view. They reveal that over two thirds of the 15 new book titles occur within one year of our identified commercialization date, while this fraction drops to 47% for academic articles, and, for the 14 innovations occurring after the introduction of the Harvard Business Review, only 36% of their articles on the innovations were printed within this period. Moreover, all of the new book titles emerged during or within two years of the initial implementation for these techniques while 5/14 of the Harvard Business Review's articles and 3/15 of the academic articles' publication dates differed from the commercialization date by three or more years.

4. Empirical Results

To explore the impact of managerial innovations on the aggregate economy, we use annual data for the variables (GDP, Labor, TFP, prices, interest rates, and the indicators) from 1929 to 2002 in the Vector Autoregressions specified in detail below. While it is certainly possible to create the management title series for earlier time periods, we begin our analysis in 1929 since official data for the U.S. national accounts are not available before this date.[22] We obtain GDP figures from the Bureau of Economic Analysis' GDP and the National Income and Product Account (NIPA) Historical Table 1.2 – Real Gross Domestic Product (Billions of chained (1996) dollars). The measure of labor hours, L_t, is derived from splicing two series. Specifically, for the period 1929-1944, we use the statistics from the Conference Board's Economic Almanac, and for the period 1945-2002, data is from Global Insight's Basic Economics database (series LPMHU) on the non-agricultural sectors' employee hours. The real capital stock, K_t, is the net stock of fixed reproducible tangible wealth in billions of chained (1996) dollars, also from Global Insight's database (series KNIQ). Finally, the total factor productivity (TFP) series was constructed using a Tornqvist index. That is,

$$\Delta \ln(TFP)_t = \Delta \ln(GDP_t) - (1-\omega_t)\Delta \ln(K_t) - (\omega_t)\Delta \ln L_t ,$$

where ω_t, is the time t value of labor's output share calculated using NIPA Table 1.10 and the assumption that 70% of proprietors' income and taxes on production less subsidies are assigned to labor.

[22] While the inclusion of the earlier years may be desirable, starting the analysis in 1929 is still likely to yield important insights into the effect of management on productivity and output given that prior to this date, the field of management was still very much in its infancy.

4.1. Output, Productivity, Labor and Management – The Bi-Variate case

We begin the analysis by presenting the results from a series of bi-variate VARs. Specifically, we estimate:

$$\ln(X_t) = \alpha + \sum_{i=1}^{4}(\beta_i \ln(X_{t-i})) + \delta_0 t + \delta_1 t^2 + \delta_3 d + \delta_4 d * t + \delta_5 d * t^2 + \varepsilon_t$$

$$\text{where } X_t = \begin{bmatrix} Mgmt_t \\ Z_t \end{bmatrix},$$

$Mgmt_t$ is our management technology series, Z_t is one of the variables {GDP, TFP, labor hours, or output per hour}, α is a constant, the t and d terms capture a quadratic time trend with a structural break in 1973,[23,24] ε is an error term and the number of lags to include was selected using the standard Akaike Information Criterion value (Akaike, 1974). Management shocks are identified using a Cholesky decomposition.[25] For our baseline system we order management titles first based on the assumption that new management techniques may have an influence on output and productivity within the year they are introduce, but non-management shocks only affect the number of titles with a lag since it takes time to write and publish new books. However, we also estimate a series of systems with the reverse ordering to determine the sensitivity of the results to this assumption.

The estimated coefficients and the corresponding Granger causality tests indicate that new management books are positively associated with all of the productivity, labor and output measures at a minimum of a 5% significance level. The variance decompositions, recorded in Table 2, highlight new management techniques' impact on GDP and productivity. While the variation in TFP, GDP, and the other responses, attributable to new managerial techniques (as captured by the indicators) during the first few years depends on the ordering used, the results from either ordering suggests an important role for this type of technical change. For example, in our baseline case, the percent of variation in the productivity measures (TFP, and output per hour) attributable to

[23] Various dates were attempted with no change in the overall results. Moreover, a single cubic trend was also used without change in the results.

[24] Fernald's (2007) paper on the identifying the effects of technology shocks also finds evidence of a trend break in 1973.

[25] Shea (1998) uses a similar framework to examine the responses of TFP and inputs to a technology shock identified using patents and R&D expenditures.

management in the first year ranges from 4 - 10.7% with the impact growing to between 40% and 60% by year 5. For output, the story is similar with the estimates of the impact in year one of 8.9% with the magnitude increasing to more than 50% over the next four years. Finally, the variation in labor productivity attributable to managerial innovations is range from 11.7% for the first year to 55% for year five. Although, as noted, and as can be seen in the second part of Table 2, ordering matters - especially in early years. However, the differences diminish significantly from the 5 year horizon onwards.

The bi-variate VARs impulse response functions for TFP, GDP and hours associated with a 1% management shock are depicted in Figure 6 along with 95% bootstrapped confidence intervals.[26] These responses indicate that after 4-5 years (the peak effect) there is approximately a 0.1%, 0.2%, and 0.1% increase in TFP, GDP and hours worked respectively. As Figure 7 shows, the basic findings are insensitive to variable ordering.

Of course, one might be concerned that our book-based measure merely reflects general trends in publishing (as opposed to actually capturing innovations) and that these trends are responsible for our results. In an attempt to address this issue in a similar context, Alexopoulos (forthcoming) examined the relationship between output (and productivity) and new titles in history, music, drama and poetry since the later types of publications should be affected by trend in publishing but have almost no relationship with technological change or production. She found these other types of publications had zero influence on the variables of interest. We adopt a similar strategy in this paper to examine the robustness of our results. In particular, we repeated our analysis using as the measure of managerial innovation the new management book totals deflated first by the number of adult fiction books and second by the number of children's literature book.[27] Results of both exercises are included in Supplementary Tables and Figures, and demonstrate our conclusions are unaffected by these normalizations.[28] Indeed it appears that a nontrivial relationship exists between management techniques and productivity.

4.2. Adding other measures of Technology to the mix

[26] We do not report results for labor productivity responses since they are similar to those reported for TFP.

[27] This method is also used in Alexopoulos and Cohen (2010) to demonstrate the results are not primarily driven by trends in the publishing industry.

[28] The supplementary material is available at http://www.economics.utoronto.ca/malex/

As Cyert and Mowery (1987) note, it is often possible to observe a symbiotic relationship between new technologies and productions processes. Since one can view managerial technology as a type of process innovation, it is interesting and informative to add a measure of non-managerial technical change to the system. The inclusion of such a measure will allow us to: (1) determine if the results presented above survive when more traditional types of innovations in product and process technologies are taken into account, (2) explore whether the economy responds differently to managerial and non-managerial technology shocks, and (3) investigate if there is a relationship between the various types of technical change. To test for the interaction of process and product changes, we add the type of Library of Congress based publication measure developed in Alexopoulos (forthcoming) and order it last in the system as she does.[29]

4.2.1. Output, productivity and hours

In all of the cases considered, we find that the management indicator Granger-causes the variables at better than a 1% level of significance. The variance decompositions for output, productivity and hours in a specification that includes technology measures are reported in Table 3. Again, they demonstrate the powerful impact of new managerial techniques on economic output and productivity– especially after a few years. While the variation attributable to new management techniques does drop compared to the bivariate case, the magnitudes are still impressive. While 8% and 6% of the first year variation of TFP and GDP is linked to new management titles, respectively, these magnitudes increase to 25% and 12% after two years, and 28% and 16% after five. For hours worked, a similar pattern emerges with almost 4% attributable in year one and nearly 8% linked to management by year five. Indeed a comparison of these numbers with the variation attributable to the non-managerial technology series (reported in the bottom half of Table 3), demonstrates that the impact of the new managerial technologies is significantly greater during the first five years. It is clear that the traditional non-managerial technologies are important for horizons beyond five years. Indeed, by the eight-year horizon the results suggest that often 40% or more of the variation in GDP and TFP, and almost 45% of the variation in hours, are attributable to the two types of technical

[29] This ordering suggests that changes in traditional technologies, like machinery, only affect the variables of interest with a lag. However, to determine if our results are solely driven by this choice of ordering, we estimated a series of VAR with the technology variable ordered first. While there were some slight differences, none of the major findings reported here were affected. Therefore, we chose to omit these results here, but will make them available upon request.

change.

The impulse responses and 95% bootstrapped confidence intervals based on these tri-variate VARs are graphed in Figures 8 and 9, with Figure 8 depicting the responses of the variables to a management technology shock, and Figure 9 showing the responses to a non-managerial technology shock. The figures confirm that new managerial technologies have a significant impact on output and TFP within the first five to six years. However, in comparison to the results shown in Figure 6, the peak responses for the variables tend to be hit a couple of years earlier and have a peak response only half as large. Furthermore, a comparison of the responses to managerial shocks and non-managerial technology shocks highlights the differences in both the timing and magnitude of the variables responses. The managerial technology shocks tend to cause an immediate and significant increase in the variables in question for approximately five years, while the non-managerial technology ones tend to have their greatest impact on output, productivity and hours six years after the date of the shock, and cause significant increases in year three.

Another interesting result illustrated by these Figures is that the short-run response of labor to a technology shock depends on the type of technical innovation examined. [30] Specifically we find that, once the other technology indicator is included in the system, a managerial technology shock induces an initial *reduction* in labor hours within the first two years, followed by a subsequent increase that peaks in approximately five years.[31] In contrast, the non-managerial technology shock does not cause a short-run decline in hours and significantly expands hours between years three and seven.[32]

While the response of hours worked to a management shock in this case may appear somewhat non-standard, it is not surprising when one considers that managerial technology innovations are, in many ways, related to process based technological change. As the industrial organizational literature in this area shows, the response of labor to a process innovation depends on the relative magnitude of two competing effects.[33] On the one hand, many of these innovations tend to reduce the quantities of the factors required to produce a unit of output - including labor. On the other hand, these advances

[30] These findings do not depend on whether or not computer technologies are included in the aggregate measure of technical change used.

[31] While no distinction is made between different technology shocks in most of the related business cycle literature, an initial decline in hours following a positive neutral-technology shock is seen in papers such as Gali (1998), Francis and Ramey (2005) and Basu et al (2006).

[32] This pattern is similar to the ones uncovered by Christiano, Eichenbaum and Vigfusson (2002) and Fisher (2006).

[33] See e.g., Harrison et al (2008) for a discussion of this point.

tend to lead to price reductions (and quality enhancements) which work to stimulate demand for the products/services thereby increasing demand for worker hours. The response of hours, then, would depend on which of these effects dominate at various points of time. In our case, it appears that the first effect dominates within the first two years while the second effect dominates from year three to year seven.

4.2.2. Which Comes First, Management or Traditional Technology?

As papers such as Cyert and Mowery (1987) point out product innovation often induces changes in the production processes used to create the new good, and that changes in processes often results in new products. Given the similarities between process and managerial innovations, it is certainly plausible that there could be relationships between product and organizational innovations as well. Indeed, this view is consistent with evidence and hypothesis advanced by Alfred Chandler in his 1977 Pulitzer Prize winning book, "The Visible Hand". According to him the evolution of business organizations did not appear randomly - instead, the pattern was 'technologically determined' (at least in part) and depended on advances in railroad, transportation and communications technologies as well as innovations in machinery.[34]

While Chandler's (1977) evidence was based on case studies, we can use the VARs to help determine the extent to which a link exists between the product and managerial type innovations that are captured by our indicators. Figure 10 shows the effect of a non-managerial technology shock on new managerial titles, and the effect of a managerial technology shock on non-managerial technology titles (again along with 95% bootstrapped confidence intervals). The results are striking and consistent with Chandler's theory. Specifically, they imply that unanticipated changes in non-managerial technologies have a significant impact on managerial titles. Indeed a shock that induces a 1% increase in the technologies captured by the Tech measure also appears to raise the management titles by 1%. However, there appears to be little to no impact on non-managerial technology titles after an unanticipated change in new management technologies. Moreover, these results appear unaffected by the inclusion of variables such as GDP or TFP in the system which should help control for the aggregate state of the economy.

The variance decompositions paint a similar picture (see Table 4 for a few examples). While

[34] See Temin (1978) for an excellent review of Chandler's (1977) work.

approximately half of the variation of management titles may be attributable to the other technologies variable by year 5, less than 5% of the variation in the non-managerial technology variables is linked to the innovations captured by changes in the management titles.

4.3. The six variable system

Given that the inclusion of non-technology shocks (such as monetary policy shocks and price shocks) may affect our findings we assess the sensitivity of our results by estimating a six variable system. The ordering of the variables in this system is as follows: ln(Mgmt), ln(hours), ln(TFP), commercial paper rate, ln(CPI), and ln(non-managerial technology). As is standard in the literature on monetary policy shocks, we order the quantity variables (TFP and Hours) before the interest rate variable and prices afterwards.[35] Moreover, for comparability we maintain our ordering of the management series first and other technology series last. Finally, we use the short term commercial paper rate to capture the effects of monetary policy shocks since the federal funds rate is unavailable for the entire period 1929-2002.[36] Table 5 reports the variance decompositions. Overall, these results confirm the findings from the tri-variate VARs - managerial innovations remain an important force behind movements in TFP and employment. However, the magnitudes differ somewhat. The numbers for the expanded system suggest that now only 20% of the variation in productivity is attributable to advances in management techniques in the first few years, while for hours worked the fraction attributable to the new management technologies by year 3 increases from 8 to approximately 17 percent. In addition, we find evidence that prices and interest rates are virtually unaffected by this type of technology shock.

Figure 11 displays the response to a positive 1% management shock along with the corresponding 95% confidence bands. A comparison of these patterns with those depicted in figure 8 reveals that the shape of the hours response is robust to the inclusion of the other variables and TFP still rises above trend in the short run. Again, we find no evidence that advances in traditional technologies are affected by an organizational innovation. However, the shock does appear to weakly decrease prices in the short run.

[35] See e.g., Christiano, Eichenbaum and Evans (1997).

[36] Harrison and Weder (2006) and Nason and Smith (2008) also use the short term commercial paper rate due to the lack of Federal funds rate data.

5. Conclusion

Many economists believe that innovations in management are as important as technological advancement in products and processes. However, it has been difficult to provide quantitative support for this view because of the problems associated with measuring technological change in management. To address this issue, in this paper we develop the first indicator of organizational innovations for the U.S and use them to answer four questions. First, what is the relationship between management techniques (as measured by the newly created indicators) and aggregate output and productivity? Second, what impact do organizational innovations have on labor inputs? Third, how important are innovations in managerial technologies in comparison to other types of technical change (e.g., product and process innovation)? Forth, is there a relationship between changes in managerial techniques and other types of technical change (e.g. product innovation)?

Our results indicate organizational innovations significantly increase both aggregate output and productivity and the effect on labor, while positive, is much weaker. Moreover new managerial technologies are almost as important as advances in non-managerial technical change in explaining changes in productivity and output. However, the impact of managerial technologies on both these variables is more immediate. Finally, we find evidence suggesting that management techniques significantly respond to other technical advances (such as changes in computer technology, machinery, etc.).

One of the most interesting findings is related to the response of hours worked to a management shock. The results from simply bi-variate VARs suggest that organizational innovations tend to increase hours worked. However, once an indicator capturing changes in more traditional products and processes are added to the system, hours fall upon impact but increase after a few years. If we view managerial change as a type of process innovation, these responses are consistent with the industrial organization literature investigating the impact of process technologies on employment at the micro level.

Finally, in addition to providing the first measure of technical change in management, our findings: (1) should be useful in evaluating and selecting among competing business cycle models, and (2) highlight the need for new business cycle models that embed within them different types of technological change. Moreover, they complement related work in industrial organization,

management, and business cycle research, and confirm that the type of organizational innovations captured by our new indicators do indeed deserve further study.

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Table 1A: Timeline of Selected Management Innovations*

Management Technique	Creation Date	Country of Creation	First HBR Article**	First Academic Article***	First U.S. Book Published	First Known Commercial Adoption In the U.S.
Scientific Management	1910	US	n/a	1911	1911	1910
Quality Control	1922-24	US	1925	1925	1922	1924
Management by Objectives	1951-54	US	1957	1957	1954	1954
Critical Path Analysis/Method	1956	US	1963	1960	1961	1958-59
Program Evaluation and Review Technique (PERT)	1958	US	1962	1959	1961	1958-Navy 1961-Private Co.
Theories X and Y	1957	US	1963	1963	1960	1960-61
Managerial Grid	1962	US	1964	1964	1964	1963
SWOT / SOFT	1963	US	1971	1971	1971	1966-prototype 1973-final prototype
Experience / Learning Curve	1936 (LC) 1962-5(EC)	US	1954 (1st) 1964 (2nd)	1956 (1st) 1962 (2nd)	1965	1966
Just-In-Time	1948	Japan	1985	1977	1982	1980-1982
Quality Circles	1962	Japan	1985	1976	1976	1974
Five Forces Analysis	1979	US	1979	1979	1980	1980
One-Minute Management	1982	US	1984	1982	1982	1982
Total Quality Management	1951	Japan	1981	1981	1982	1983
Business Process Reengineering / Redesign	1990	US	1990	1990	1992	1991

*Detailed source information for these dates may be found in Appendix C, D
**Publication began in 1922, so HBR dating meaningless for early techniques
***Includes the HBR

Table 1B. Examples of the number of books per technique

Management Technique	Library of Congress' Standardized Subject Keyword	Number of English Titles published on Subject carried by the Library of Congress
Scientific Management	Industrial Management (a) Factory Management (b)	6658 (a) 753 (b)
Quality Control	Quality Control (d)	4233
Project management	Project Management	1524
Total Quality Management	Total Quality Management	1209
Business Process Reengineering/Redesign	Reengineering (Management)	304
Six Sigma	Six sigma (Quality control standard)	214
Just in time manufacturing	Just in time systems	161
Critical Path Analysis/ Critical Path Method	Critical Path Analysis	159
Management by Objectives	Management by objectives Goal setting in personnel management (e)	112 43 (e)
Quality Circles	Quality Circles	74
Zero-base budgeting	Zero-base budgeting	53
PERT	PERT (Network analysis)	22
Learning/Experience curves	Learning curve (Industrial engineering)	12

(a) Here are entered works on the application of the principles of management to industrial enterprises, including production, office management, marketing, finance, etc.

(b) Here are entered works on the technical control of manufacturing processes.

(c) Here are entered works on that field of management which has the fundamental responsibility for recruiting, hiring, training, compensating, developing and caring for the general welfare of employees. Works on the managing of employees by their supervisors so that duties are performed according to instructions are entered under Supervision of employees. Works dealing with employer-employee relations in general are entered under Industrial relations.

(d) Here are entered works on the procedures used in establishing and maintaining acceptable limits of variation for products and services.

(e) The Library of Congress' subject 'Management by objectives' also points to titles classified in this official narrower subject classification.

Table 2: Bivariate VAR Variance Decomposition of Management Shock

	Order: Management First					Order: Management Last				
Horizon	Log(TFP_t)	Log(GDP_t)	Log(H_t)	Log(Y_t/H_t)	Log(Y_t/L_t)	Log(TFP_t)	Log(GDP_t)	Log(H_t)	Log(Y_t/H_t)	Log(Y_t/L_t)
1	10.732	8.857	9.217	4.008	11.694	0.000	0.000	0.000	0.000	0.000
2	32.867	20.696	11.398	21.257	24.249	10.290	4.428	0.312	9.708	4.154
3	45.191	29.016	12.856	32.434	32.061	20.055	9.935	0.945	19.402	8.654
5	59.830	51.416	28.647	40.048	54.654	43.927	38.758	18.933	33.922	34.861
8	61.155	57.965	40.607	39.902	63.162	52.174	52.746	32.636	37.745	50.591

Table 3: Multivariate VAR Variance Decompositions (Order: Management, Other, Tech)

	Response Variable				
Horizon	Log(TFP_t)	Log(GDP_t)	Log(H_t)	Log(Y_t/H_t)	Log(Y_t/L_t)
Percent of Variation due to Management Shocks:					
All Management Books					
1	8.272	6.405	3.528	6.781	5.637
2	25.176	12.178	2.751	24.911	10.087
3	29.693	13.046	8.075	30.738	10.118
5	27.653	15.505	9.678	28.614	12.577
8	19.519	10.787	13.575	24.388	9.690
Percent of Variation due to Technology Shocks:					
All Management Books					
1	0.000	0.000	0.000	0.000	0.000
2	1.147	0.017	0.167	1.077	0.114
3	5.801	1.000	0.681	4.363	2.569
5	16.634	13.691	18.527	7.675	21.476
8	35.876	45.149	36.888	16.013	52.646

Table 4: Expanded VAR Variance Decomposition of Management Shock

Ordering: All Management, Hours, TFP, CP Rate, CPI, Technology (*All, less T-series plus OA & Q-series*)

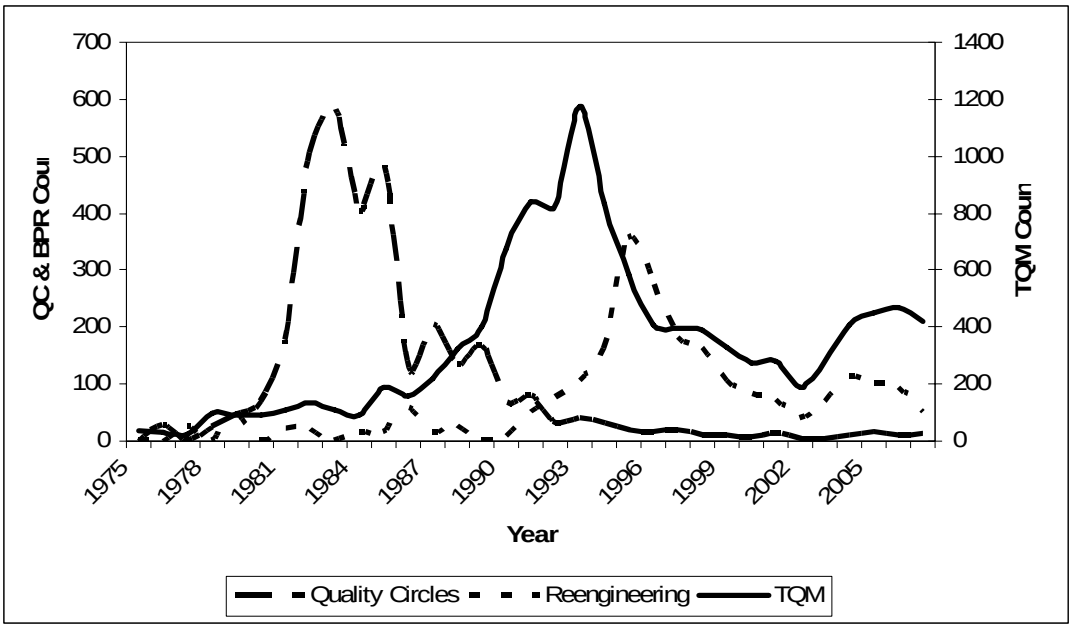
	Response Variable				
Horizon	Log(H_t)	Log(TFP_t)	CP Rate	CPI	Log(Tech.)
1	0.2714	5.3092	0.1192	0.0505	3.5917
2	4.3231	19.0183	1.2491	0.7641	4.1154
3	17.6858	17.285	1.1402	6.1597	4.8341
5	17.5955	13.1351	2.8623	6.7365	4.1726
8	16.9381	7.8213	2.7925	6.1331	4.3065

Table 5: VAR Variance Decomposition

Ordering: All Management, GDP (in trivariate case), Technology (*All, less T-series plus OA & Q-series*)

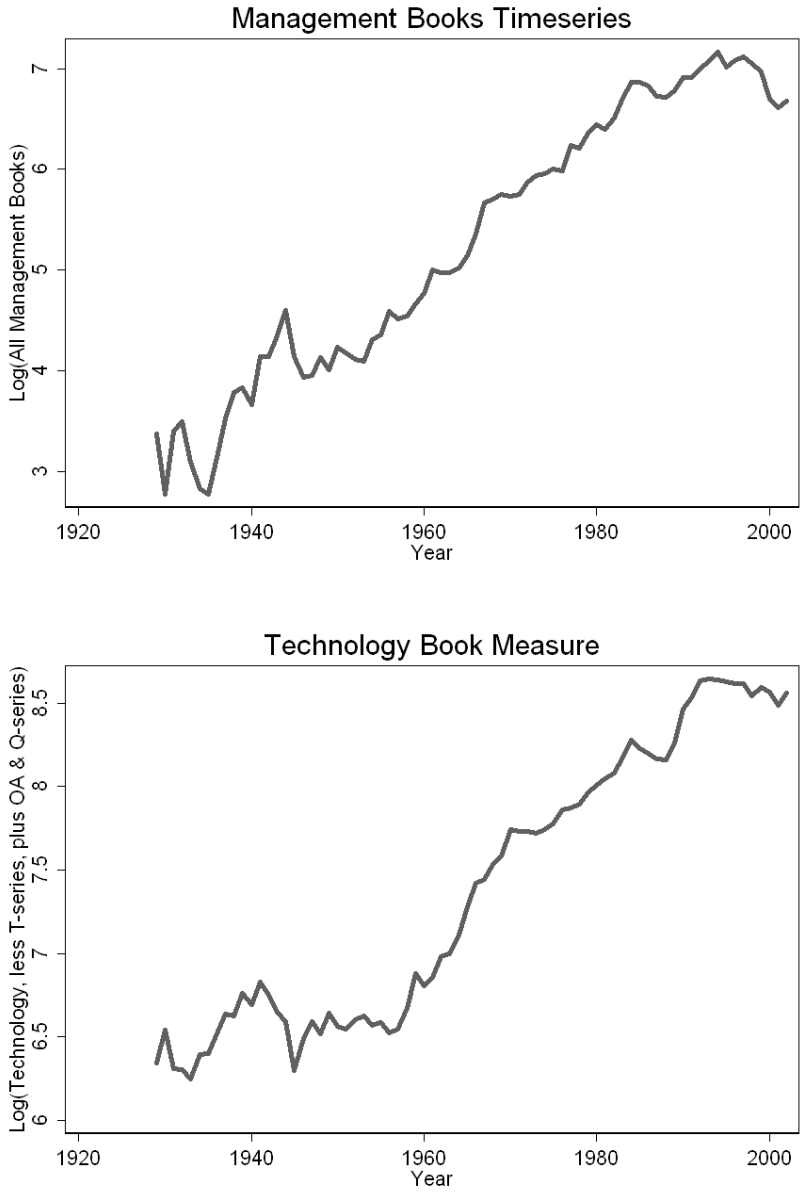
Horizon	Technology Response to Management Shock	Management Response to Technology Shock	Technology Response to Management Shock	Management Response to Technology Shock
	Bivariate Case		***Trivariate Case (Includes GDP)***	
1	9.13	0	8.863	0
2	6.0691	5.38	5.5392	7.5456
3	4.6412	26.3763	4.3173	28.0743
5	5.7661	49.9768	5.2005	48.0724
8	5.9212	53.9453	5.2231	51.0912

Figure 1: Adjusted Article Counts



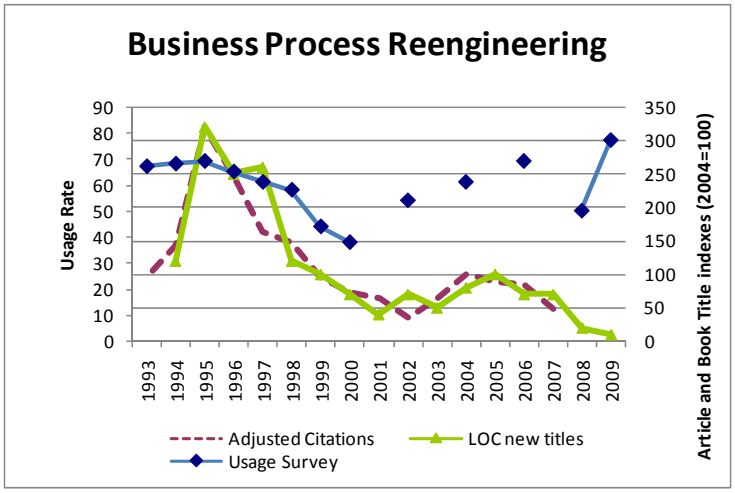
Source: Author's calculations from Business Source Premier online database.

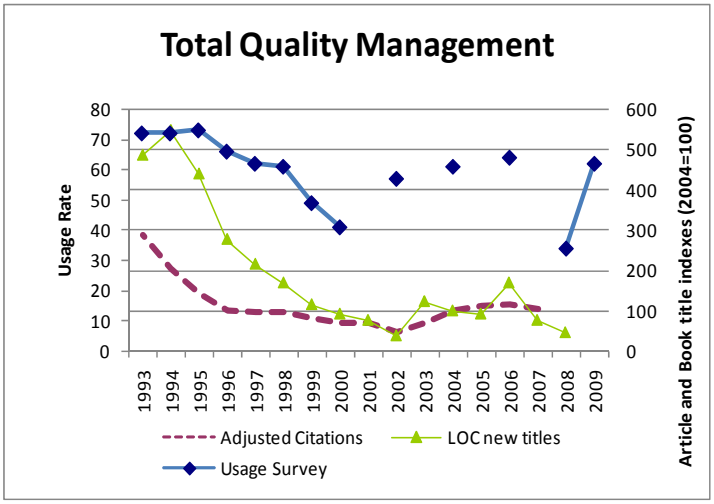
Figure 2: Timeseries of Management and Technology Book Measures



Notes: The management series contains all of the new management titles in the fields of industrial management, industrial relations, office management, industrial psychology, personnel management, industrial engineering as well as production and operations management. The Technology series includes titles in the Library of Congress' T classification (excluding non-market technologies classified under TT and TX) along with computer titles found in the QA classification and office automation tiles found in class H)

Figure 3: Bain and Company Survey Patterns





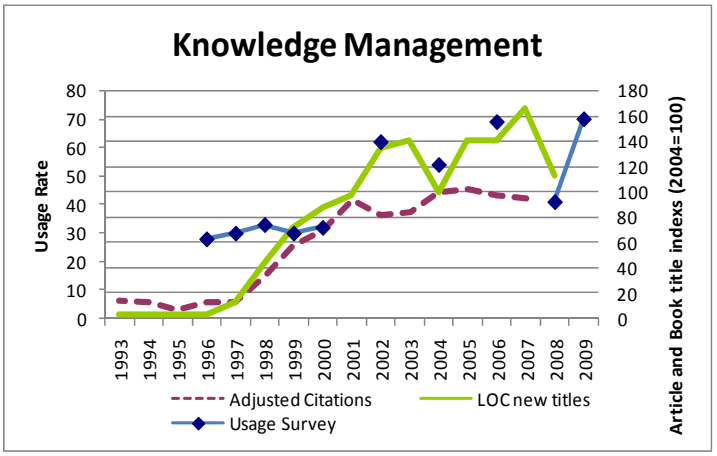


Figure 4: Selected Library of Congress Book Counts

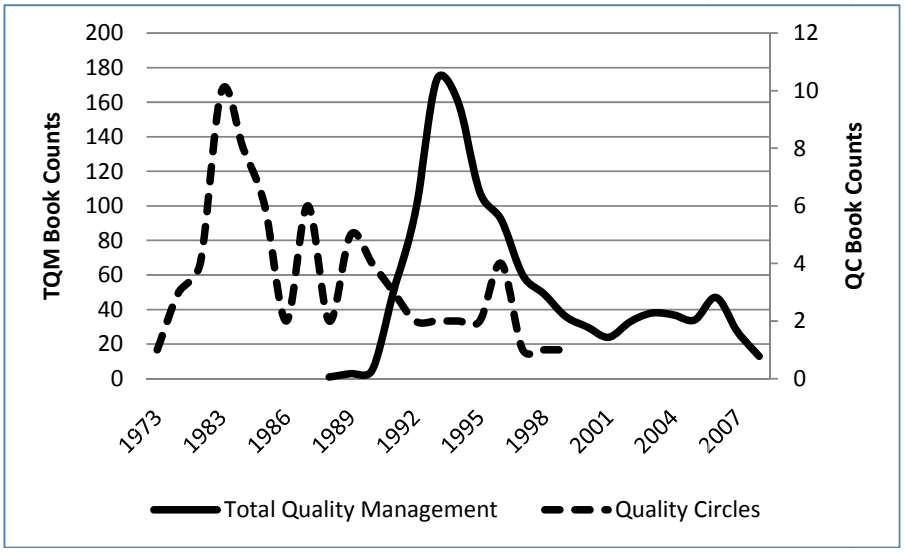
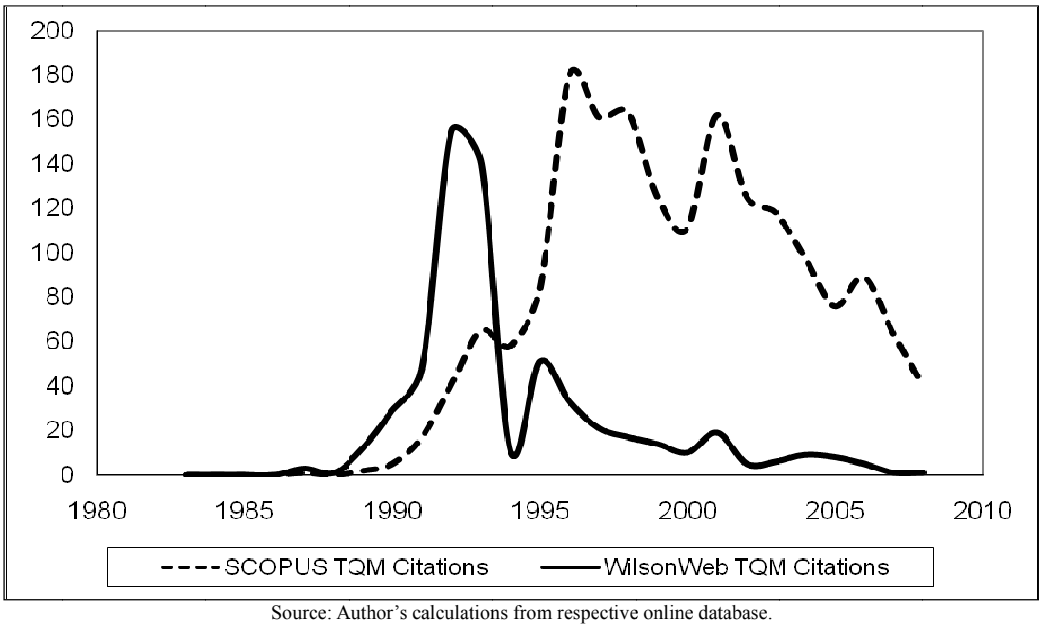


Figure 5: Journal Entry Counts



Source: Author's calculations from respective online database.

Figure 6: Impulse Response Functions: Management Shock, First Ordering

Figure 6 (a): Response of Real GDP to a Positive Management Shock

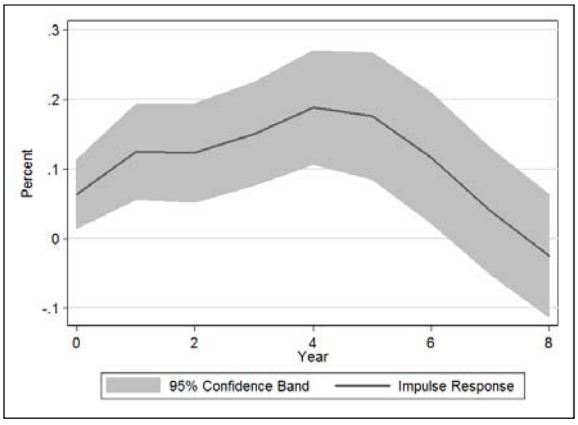


Figure 6 (b): Response of TFP to a Positive Management Shock

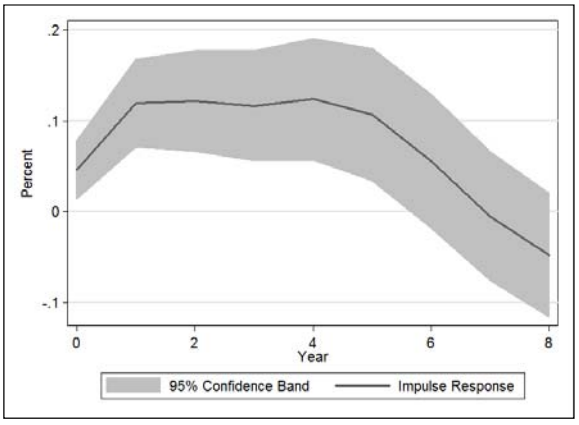


Figure 6 (c): Response of Labour Supply (Hours) to a Positive Management Shock

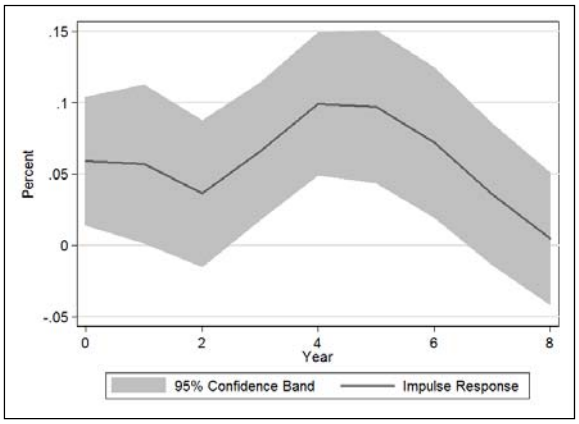


Figure 7: Impulse Response Functions: Management Shock, Second Ordering

Figure 7 (a): Response of Real GDP to a Positive Management Shock

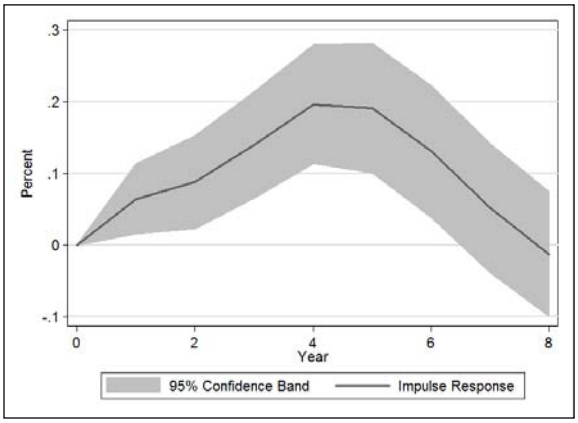


Figure 7 (b): Response of TFP to a Positive Management Shock

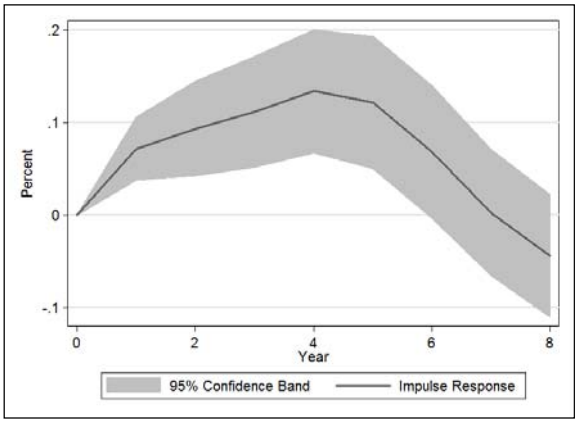


Figure 7 (c): Response of Labour Supply (Hours) to a Positive Management Shock

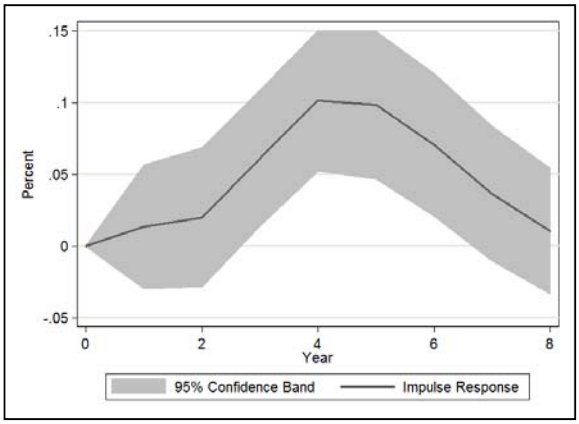


Figure 8: Impulse Response Functions (Tech: All, plus OA, less T-series man.)

Figure 8 (a): Response of Real GDP to a Positive Management Shock

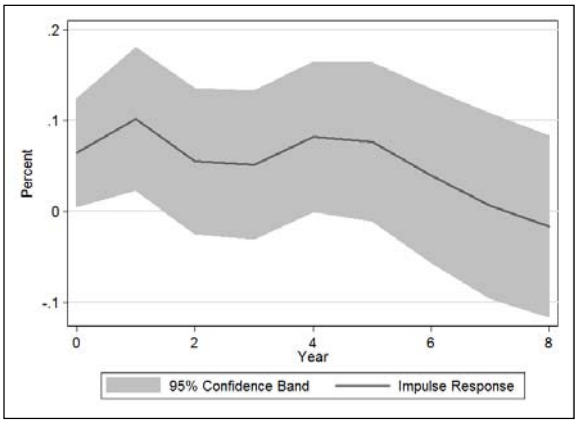


Figure 8 (b): Response of TFP to a Positive Management Shock

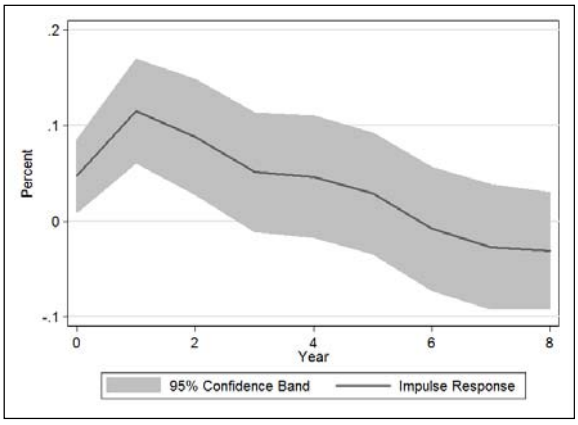


Figure 8 (c): Response of Labour Supply (Hours) to a Positive Management Shock

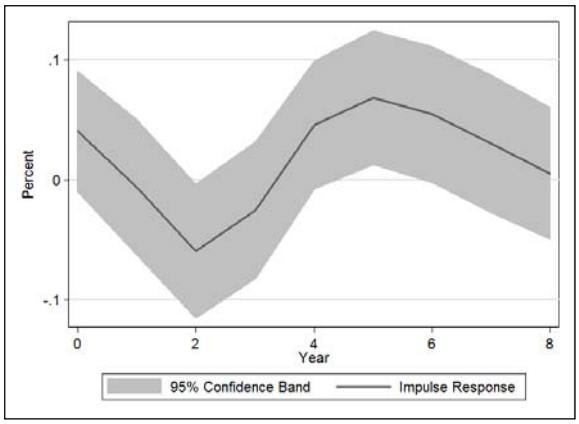


Figure 9: Impulse Response Functions (Tech: All, plus OA, less T-series man.)

Figure 9 (a): Response of Real GDP to a Positive Technology Shock

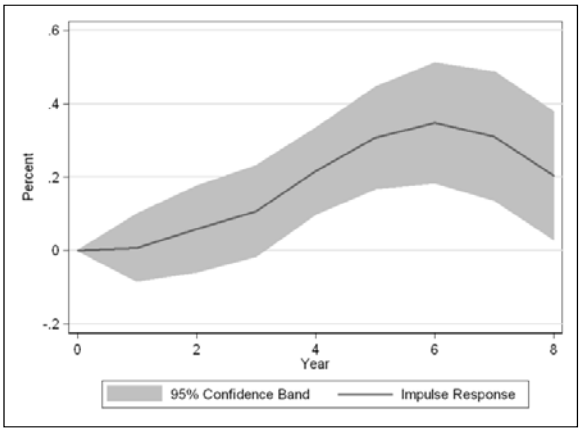


Figure 9 (b): Response of TFP to a Positive Technology Shock

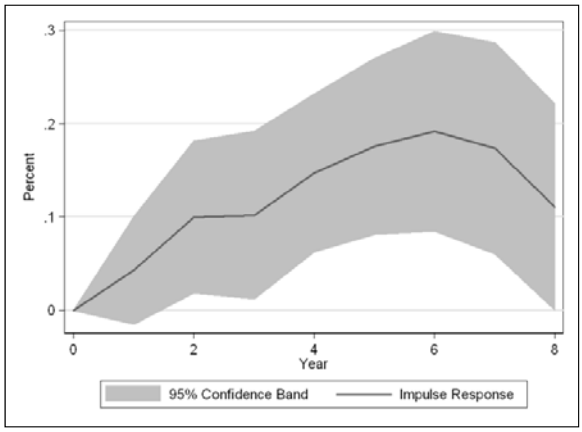


Figure 9 (c): Response of Labour Supply (Hours) to a Positive Technology Shock

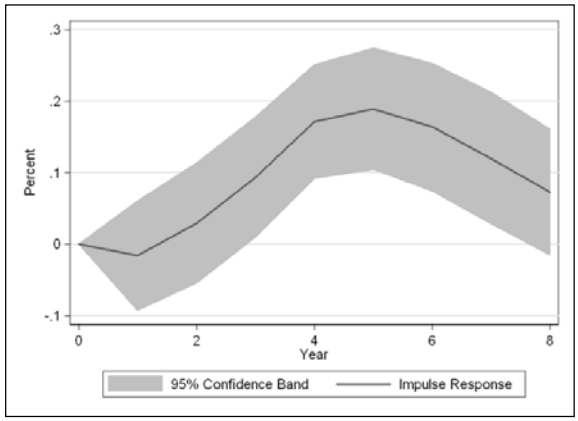


Figure 10: Impulse Response Functions, Technology vs. Management

Figure 10 (a): Bivariate Case, Technology Response to Management Shock

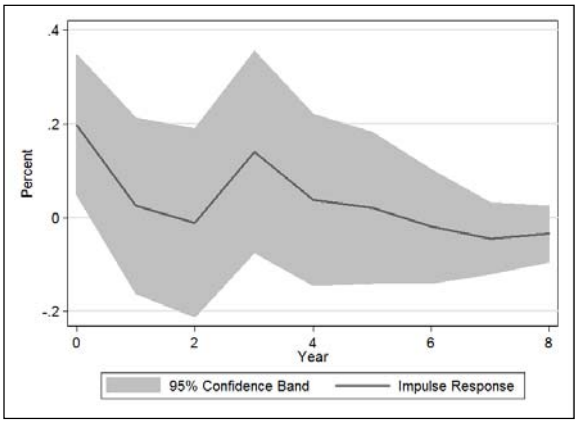


Figure 10 (b): Bivariate Case, Management Response to Technology Shock

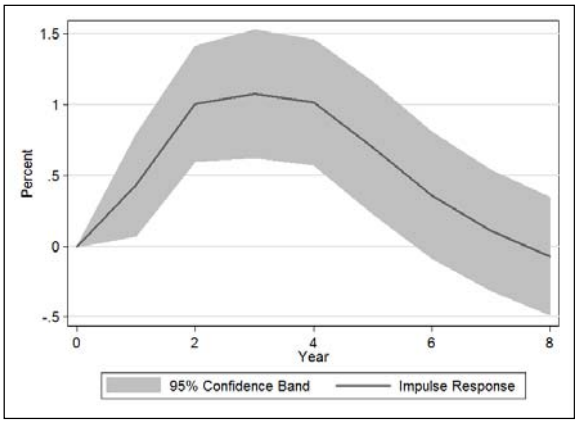


Figure 10 (c): Trivariate Case, Technology Response to Management Shock

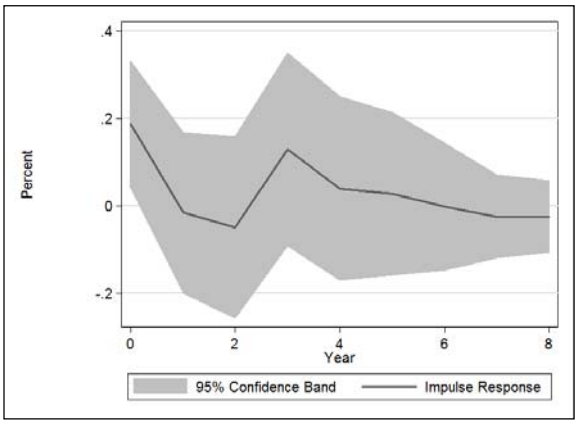


Figure 10 (d): Trivariate Case, Management Response to Technology Shock

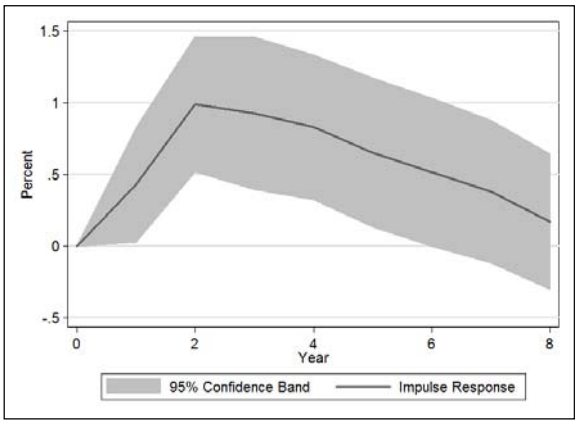


Figure 11: Impulse Response Functions, Multivariate Specification

Figure 11 (a): Response of Hours to a Positive Management Shock

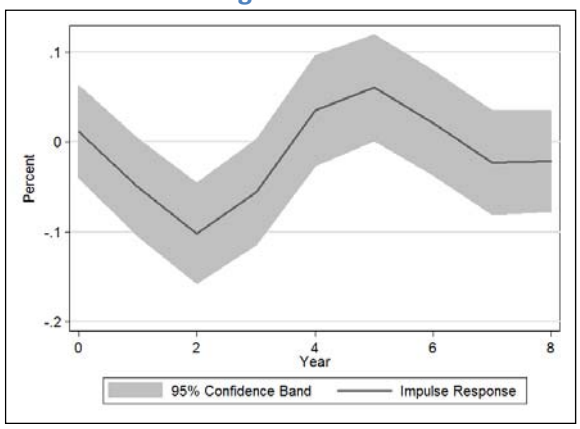


Figure 11 (b): Response of TFP to a Positive Management Shock

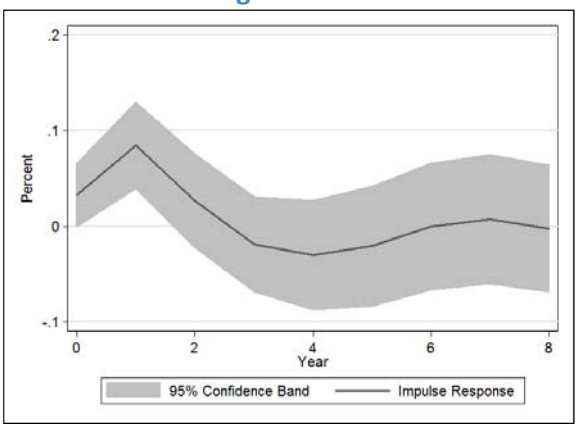


Figure 11 (c): Response of CP-Rate to a Positive Management Shock

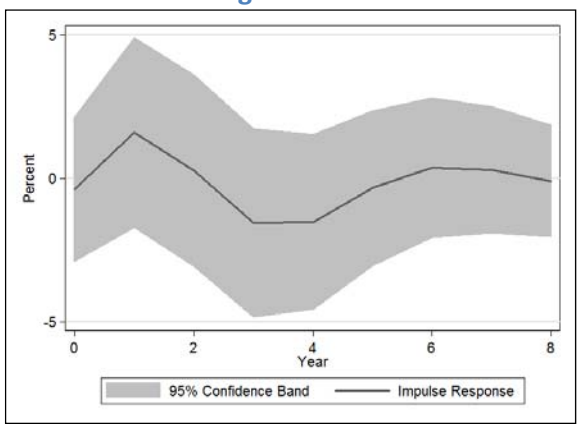


Figure 11 (d): Response of CPI to a Positive Management Shock

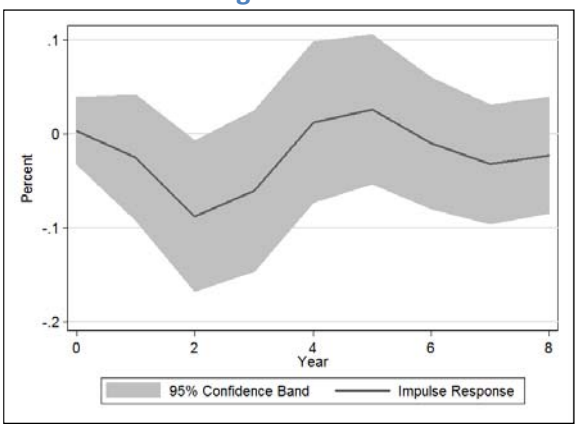
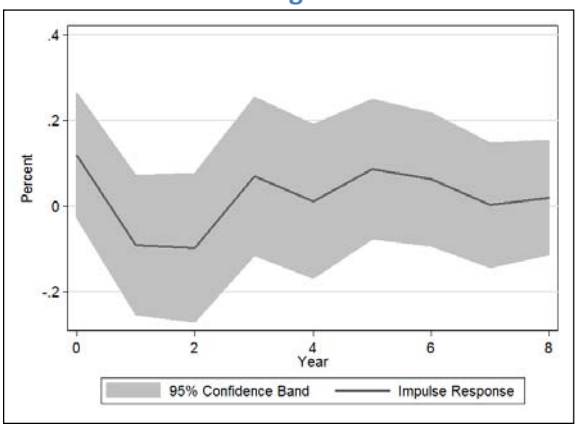


Figure 11 (e): Response of Technology to a Positive Management Shock



Appendix A: Sample MARC Record

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Online Display of full record

The principles of scientific management, by Frederick Winslow Taylor ...

LC Control No.: 11010339
LCCN Permalink: http://lccn.loc.gov/11010339
Type of Material: Book (Print, Microform, Electronic, etc.)
Personal Name: Taylor, Frederick Winslow, 1856-1915.
Main Title: The principles of scientific management, by Frederick Winslow Taylor ...
Published/Created: New York, London, Harper & Brothers, 1911.
Description: 2 p. l., [7]-77 p. 23 cm.
Notes: "This special edition printed in February 1911, for confidential circulation among the members of the American Society of Mechanical Engineers, with the compliments of the author."
Subjects: Industrial efficiency.
LC Classification: T58.D4 A3 1911
Other System No.: (OCoLC)1686367

CALL NUMBER: T58.D4 A3 1911

Appendix B: Library of Congress Classification Groups by indicator

Categories Covered by Management Indicator

Subclass HD (Industries, Land Use & Labour)
HD28-70 Management. Industrial management
HD39-40.7 Capital. Capital investments
HD41 Competition
HD45-45.2 Technological innovations. Automation
HD47-47.4 Costs
HD49-49.5 Crisis management. Emergency management. Inflation
HD50-50.5 Delegation of authority. Decentralization. Span of control
HD56-57.5 Industrial productivity
HD58 Location of industry
HD58.7-58.95 Organizational behavior, change and effectiveness. Corporate culture
HD59-59.6 Public relations. Industrial publicity
HD60-60.5 Social responsibility of business
HD61 Risk in industry. Risk management
HD62 Standardization. Simplification. Waste
HD62.2-62.8 Management of special enterprises
HD66-66.2 Work groups. Team work in industry. Quality circles
HD69 Other Including business consultants, capacity, size of industries, etc.
HD6958.5-6976 Industrial relations

Subclass HF (Commerce)
HF5546-5548.6 Office management
HF5548.7-5548.85 Industrial psychology
HF5549-5549.5 Personnel management. Employment management

Subclass T (General Technology)
T55.4-60.8 Industrial & Management engineering.

Subclass TS (Manufactures)
TS155-194 Production & Operations management.

Categories covered by Traditional Technologies book indicator

Subclass T Technology (General)
Subclass TA Engineering (General). Civil engineering
Subclass TC Hydraulic engineering. Ocean engineering
Subclass TD Environmental technology. Sanitary engineering
Subclass TE Highway engineering. Roads and pavements
Subclass TF Railroad engineering and operation
Subclass TG Bridge engineering
Subclass TH Building construction
Subclass TJ Mechanical engineering and machinery
Subclass TK Electrical engineering. Electronics. Nuclear engineering
Subclass TL Motor vehicles. Aeronautics. Astronautics
Subclass TN Mining engineering. Metallurgy
Subclass TP Chemical technology
Subclass TR Photography
Subclass TS Manufactures

Subclass QA Mathematics
- QA71-90 Instruments and machines
- QA75-76.95 Calculating machines
- QA75.5-76.95 Electronic computers. Computer science
- QA76.75-76.765 Computer software

Appendix C: Timeline of Significant Management Innovations

	Creation Date	Creation Notes	Mainstream Adoption	Adoption Notes	Book Date	Book Information
Scientific Management	1910	Frederick Taylor, "Principles of Scientific Management" and Frank Galbraith, "Motion Study"	1910	Encyclopedia of Management claims by this date the results were known and adopted by 1910. In 1912, Taylor testified before congress on Scientific Management.	1911	Frederick Taylor, "Principles of Scientific Management" and Frank Galbraith, "Motion Study"
Quality Control	1922-1924	G.S. Radford, "The Control of Quality in Manufacturing," New York: The Ronald Press Co., 1922	1924	H.F. Dodge, H.G. Romig, and W. Shewhart at Bell Telephone Laboratories (George, 1972)	1922	G.S. Radford, "The Control of Quality in Manufacturing," New York: The Ronald Press Co., 1922
Management by Objectives	1951-1954	Lecture given by Peter Drucker beginning 1951, and culminating in a 1954 book "The Practice of Management" (1954) and Douglas McGregor, "An Uneasy Look at Performance Appraisal," Harvard Business Review (May-June, 1957)	1954	General Electric in 1954	1954	Peter Drucker, "The Practice of Management"
Critical Path Analysis/Method	1956	DuPont	1958-59	DuPont, under Dr. Mauchly, establish separate organization/consultancy to solve industrial problems with CPM (http://www.referenceforbusiness.com/encyclopedia/Cos-Des/Critical-Path-Method.html)	1961	Roderick W. Clarke, "An Introduction to Critical Path Analysis," Stanford, Calf. Graduate School of Business, Stanford University, 1961
Program Evaluation and Review Technique (PERT)	1958	US Navy	1958 - Navy 1961 - Mainstream	For mainstream: See NASA handbook in 1961 (right column) and Levy, Ferdinand L.; Thompson, Gerald L.; and Weist, Jerome D., 1963. "The ABCs of the Critical Path Method," Harvard Business Review 41 (5): 98-108	1961	"NASA PERT (program evaluation and review technique) Handbook," Washington, NASA, 1961
Theory X and Theory Y	1957	Douglas McGregor, "The Human Side of Enterprise" Adventures in Thoughts and Action, 5th Anniversary Convocation of School of Industry and Management, MIT	1960	Douglas McGregor, "The Human Side of Enterprise"	1960	Douglas McGregor, "The Human Side of Enterprise"
Managerial Grid	1962	Robert Blake and Jane Mouton, 1962. "The Managerial Grid." Advanced Management Office Executive, 36. (source: Bennis, 1963)	1963	Thousands attended seminars before the book came out in 1964. The book was also designed for a wider audience. (Robertson, 1964)	1964	Robert Blake and Jane Mouton, "The Managerial Grid: The Key to Leadership Excellence"
SWOT	1963	Kenneth Andrews at Harvard Business Policy Symposium	1966 (prototype)	See research performed by Robert Stewart and his team at the Stanford Research Institute between 1960-69 which resulted in a 1966 prototype with final modifications completed in 1973. History of SWOT Analysis (see Zimbo Online link below)	1971	Kenneth Andrews, "The Concept of Corporate Strategy"

Experience/Learning Curve	1936 (LC) 1962-65 (EC)	(LC) Wright, "Factors Affecting the Costs of Airplanes," Journal of the Aeronautical Sciences, 1963. (EC) Arrow (1962),"The Economic Implications of Learning by Doing," The Review of Economic Studies, Vol. 29, No. 3 (Jun., 1962), pp. 155-173; More: Ghemawat, 2002	1966	Readings of the history of BCG History (http://www.referenceforbusiness.com/history2/21/The-Boston-Consulting-Group.html) Publication by Boston Consulting Group, "Perspectives on Experience," Boston: Boston Consulting Group.(source: Bass, 1980)	1965	Jordan Raymond (1965), "How to use the learning curve." Boston, Materials Management Group.
Just-in-Time	1948 (Japan)	Precise dating not possible, we selected this date based on the information from: Taiichi Ohno (1988), "Toyota Production System: Beyond Large-Scale Production." Productivity Press, 1st Edition.	1980-1982	Kawasaki plant in Lincoln, Nebraska adopted in 1980, with published results of their experience in 1982 (Schonberger, 1982)	1982	Richard Schonberger, "Japanese Manufacturing Techniques: nine hidden lessons in simplicity." New York: Free Press, c1982.
Quality Circles	1962 (Japan)	See: John D. Blair, Stanley L. Cohen and Jerome V. Hurwitz, "Quality Circles: Practical Considerations for Public Managers," Public Productivity Review, Vol. 6, No. 1/2 (Mar. - Jun., 1982), pp. 9-18	1974	"Lockheed Martin adopted it in 1974 and disbanded their program in 1979. Source: David Strang and Michael W. Macy, ""In Search of Excellence: Fads, Success Stories, and Adaptive Emulation,"" The American Journal of Sociology, Vol. 107, No. 1 (Jul., 2001), pp. 147-182 *and* Abrahamson and Fairchild (1999)"	1976	"QC Circles: Application, Tools, and Theory." Edited by Davida and Robert Amsden. Milwaukee, Wis.: American Society for Quality Circles, 1976.
Five Forces Analysis	1979	Michael Porter, 1979. "How competitive forces shape strategy," Harvard Business Review 57 (2): 137-145	1980	Thomas Haynes, "Industry Competition Analyzed," New York Times; New York, NY: January 2nd, 1981. D1.	1980	Michael Porter, "Competitive Strategy"
One-Minute Managing	1982	Strategic Management Journal, Vol. 6, No. 2 (Apr. - Jun., 1985), pp. 181-189	1982	Kenneth Blanchard and Spencer Johnson, "The One Minute Manager" (source: Conkling, 1983; Freeman, 1985)	1982	Kenneth Blanchard and Spencer Johnson, "The One Minute Manager" (source: Conkling, 1983; Freeman, 1985)
Total Quality Management	1951	First put to use in Japan and largely ignored everywhere else. Source: Armand Feigenbaum, "Quality Control: Principles, Practices, and Administration".	1983	Corning. Source: Liebowitz, Jay and Kevin Holden (1995). "Are Self-managing teams worthwhile? A tale of two companies." *SAM Advanced Management Journal*, Spring 1995.	1982	William Deming, "Quality, Productivity, and Competitive Position"
Business Process Reengineering	1990	Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," Harvard Business Review; Jul/Aug90, Vol. 68 Issue 4, p104-112	1992	"By 1993, as many as 65% of Fortune 500 companies claimed to have either initiated reengineering efforts or had plans to do so" Source: Toor, Tajinder (2009). "Building effective service management." *Business Strategy Series* 10 (1): 61-67.	1992	Edwin Shore, "Business Reengineering: fast track to operational excellence," Carrollton, Tex.: Chantico Pub. Co., 1992.

General Table Sources:

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Frank M. Bass, 1980. "The Relationship Between Diffusion Rates, Experience Curves, and Demand Elasticities," The Journal of Business 53 (3.2): S51-S67
Richard J. Schonberger, 1982. "The Transfer of Japanese Manufacturing Management Approaches to U. S. Industry," The Academy of Management Review 7 (3):479-487
Lori Conkling, 1983. Public Productivity Review 7 (1): 90-91
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Appendix D: First Academic and Harvard Business Review Articles

Management Technique	First HBR Article	First Academic Article
Scientific Management	n/a	SCIENTIFIC MANAGEMENT IN THE OPERATION OF RAILROADS. Quarterly Journal of Economics, May11, Vol. 25 Issue 3, p539-562, 24p; (AN 9405838)
Quality Control	POSITION OF THE INSPECTION DEPARTMENT IN AN ORGANIZATION MANUFACTURING ELECTRICAL GOODS. Harvard Business Review, Jan25, Vol. 3 Issue 2, p238-240, 3p, 1 Diagram; (AN 6766009)	POSITION OF THE INSPECTION DEPARTMENT IN AN ORGANIZATION MANUFACTURING ELECTRICAL GOODS. Harvard Business Review, Jan25, Vol. 3 Issue 2, p238-240, 3p, 1 Diagram; (AN 6766009)
Management by Objectives	Douglas McGregor, "An Uneasy Look at Performance Appraisal," Harvard Business Review (May-June, 1957)	Douglas McGregor, "An Uneasy Look at Performance Appraisal," Harvard Business Review (May-June, 1957)
Critical path Analysis/Critical Path Method	The ABCs of the CRITICAL PATH Method. By: Levy, Ferdinand L.; Thompson, Gerald L.; Weist, Jerome D.. Harvard Business Review, Sep/Oct63, Vol. 41 Issue 5, p98-108, 11p, 4 Diagrams, 1 Chart; (AN 6770388)	ON THE SHORTEST ROUTE THROUGH A NETWORK. By: Dantzig, George B.. Management Science, Jan60, Vol. 6 Issue 2, p187-190, 4p; (AN 7451599)
Program Evaluation and Review Technique (PERT)	How to Plan and Control with PERT. By: Miller, Robert W.. Harvard Business Review, Mar/Apr62, Vol. 40 Issue 2, p93-104, 12p; (AN 7335804)	APPLICATION OF A TECHNIQUE FOR RESEARCH AND DEVELOPMENT PROGRAM EVALUATION. By: Malcolm, D. G.; Roseboom, J. H.; Clark, C. E.; Fazar, W.. Operations Research, Sep/Oct59, Vol. 7 Issue 5, p646, 24p; (AN 7685729)
Theories X and Y	Positive Program for Performance Appraisal. By: Kindall, Alva F.; Gatza, James. Harvard Business Review, Nov/Dec63, Vol. 41 Issue 6, p153-166, 8p; (AN 6780604)	Positive Program for Performance Appraisal. By: Kindall, Alva F.; Gatza, James. Harvard Business Review, Nov/Dec63, Vol. 41 Issue 6, p153-166, 8p; (AN 6780604)
Managerial Grid	Breakthrough in Organization Development. By: Blake, Robert R.; Mouton, Jane S.; Barnes, Louis B.; Greiner, Larry E.. Harvard Business Review, Nov/Dec64, Vol. 42 Issue 6, p133-155, 23p, 14 Charts, 8 Graphs; (AN 6812731)	Breakthrough in Organization Development. By: Blake, Robert R.; Mouton, Jane S.; Barnes, Louis B.; Greiner, Larry E.. Harvard Business Review, Nov/Dec64, Vol. 42 Issue 6, p133-155, 23p, 14 Charts, 8 Graphs; (AN 6812731)
SWOT / SOFT	Personal values & corporate strategy. By: Andrews, Kenneth R.. Harvard Business Review, Nov/Dec71, Vol. 49 Issue 6, p103-103, 1/4p; (AN 17401365)	Personal values & corporate strategy. By: Andrews, Kenneth R.. Harvard Business Review, Nov/Dec71, Vol. 49 Issue 6, p103-103, 1/4p; (AN 17401365)

Experience / Learning Curve	The Learning Curve As a Production Tool. By: Andress, Frank J.. Harvard Business Review, Jan/Feb54, Vol. 32 Issue 1, p87-97, 11p, 1 Chart, 7 Graphs; (AN 6770714) Profit From the Learning Curve. By: Hirschmann, Winfred B.. Harvard Business Review, Jan/Feb64, Vol. 42 Issue 1, p125-139, 15p, 11 Graphs; (AN 6813000)	MEASURING SALES TRAINEE PERFORMANCE. By: Bauer, Frederick W.. Journal of Marketing, Apr56, Vol. 20 Issue 4, p406-410, 5p; (AN 6733250) A MODEL FOR INDUSTRIAL LEARNING COSTS . By: Kilbridge, Maurice. Management Science, Jul62, Vol. 8 Issue 4, p516-527, 12p; (AN 7437735)
Just-In-Time	Target information for competitive performance. By: Cole, Robert E.. Harvard Business Review, May/Jun85, Vol. 63 Issue 3, p100-109, 10p, 2 Black and White Photographs; (AN 8500002481) MRP, JIT, OPT, FMS? By: Aggarwal, Sumer C.. Harvard Business Review, Sep/Oct85, Vol. 63 Issue 5, p8-16, 5p; (AN 4136142)	Toyota production system and Kanban system Materialization of just-in-time and respect-for-human system. By: Sugimori, Y.; Kusunoki, K.; Cho, F.; Uchikawa, S.. International Journal of Production Research, Nov77, Vol. 15 Issue 6, p553, 12p, 2 Diagrams, 4 Charts; (AN 5550906)
Quality Circles	Quality circles. By: Knicely, Howard V.. Harvard Business Review, May/Jun85, Vol. 63 Issue 3, p200-202, 2p; (AN 10157045)	PEER NOMINATIONS: A MODEL, LITERATURE CRITIQUE AND A PARADIGM FOR RESEARCH. By: Lewin, Arie Y.; Zwany, Abram. Personnel Psychology, Autumn76, Vol. 29 Issue 3, p423-447, 25p; (AN 17577254)
Five Forces Analysis	How competitive forces shape strategy. By: Porter, Michael E.. Harvard Business Review, Mar/Apr79, Vol. 57 Issue 2, p137-145, 9p, 1 Diagram; (AN 3867673)	How competitive forces shape strategy. By: Porter, Michael E.. Harvard Business Review, Mar/Apr79, Vol. 57 Issue 2, p137-145, 9p, 1 Diagram; (AN 3867673)
One-Minute Management	The One Minute Manager. Harvard Business Review, May/Jun84, Vol. 62 Issue 3, p62-64, 2p; (AN 12732076)	THE ONE MINUTE MANAGER: HOW TO GIVE YOURSELF AND OTHERS THE "GIFT" OF GETTING GREATER RESULTS IN LESS TIME. By: Sashkin, Marshall. Group & Organization Studies, Jun82, Vol. 7 Issue 2, p254-255, 2p; (AN 6535482)
Total Quality Management	Why Japanese factories work. By: Hayes, Robert H.. Harvard Business Review, Jul/Aug81, Vol. 59 Issue 4, p56-66, 11p; (AN 3867932)	Why Japanese factories work. By: Hayes, Robert H.. Harvard Business Review, Jul/Aug81, Vol. 59 Issue 4, p56-66, 11p; (AN 3867932)
Business Process Reengineering / Redesign	Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," Harvard Business Review; Jul/Aug90, Vol. 68 Issue 4, p104-112	Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," Harvard Business Review; Jul/Aug90, Vol. 68 Issue 4, p104-112