Management Matters

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Abstract

To evaluate the effect of managerial innovations on the economy we construct a series of new indicators capturing these advances. We find: first, in response to a positive managerial technology shock, output and productivity significantly increase and hours modestly rise 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 classification: E3, M1, M5, O3, O4

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1. Introduction

TFP is influenced by both tangible technologies associated with new machines and products as well as intangible technologies linked to changes in management techniques and production processes. There is abundant microeconomic evidence suggesting that corporate work rules, team structure, quality control initiatives, and managerial leadership affect productivity at the firm level.[1] However, for the aggregate economy it has been virtually impossible to quantify how important these advances are since traditional indicators of technical change, such as those based on research and development expenditures (R&D) or patent applications, fail to capture innovations in management techniques.[2] We develop new metrics for the U.S. from 1929 to 2002 and use them in a series of vector autoregressions (VARs) to answer three questions. First, what role do managerial technology shocks play in cyclical fluctuations? Second, what impact does this type of technological change have on employment and productivity? Third, what is the relationship between managerial innovations and advances in product/process innovations?

The new measures we develop are similar in many ways to the bibliometric/scientometric indicators commonly used to identify advances in science and technology and to pinpoint dates of major innovations (see, for example, Mensch (1979) and Klienkiencht (1987)). Specifically, we utilize information on publications and subject classifications in the field of management based on new journal articles, new management books, new Library of Congress subject heading, and key dates of major managerial innovations identified by Sibbet's (1997) timeline in the Harvard Business Review.[3] These measures encompass the large array of

[1] For example, papers such as those of Bloom and Van Reenen (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. Bloom (2010) surveys a large number cross-country survey results that link management techniques to various outcome measures from firm-productivity to employee morale.

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

[3] Our use of journal counts in this context complements work on 'fads and fashions' in the management literature. See e.g., Perkmann (2006), Abrahamson and Fairchild (1999) and Abrahamson (1991).

managerial innovations used by firms and provide an accurate timeline of their initial adoption during this period.

Regardless of which metric is utilized in the analysis, the following results emerge. First, GDP, productivity and labor hours increase in the short-run following a positive managerial innovation. Second, the shock's impact on hours is modest – consistent with the view that these advances are often linked to processes that are labor saving.[4] Third, managerial technology shocks can affect GDP and TFP more rapidly than non-managerial ones, and contribute to fluctuations as much as traditional technology shocks linked to product and process innovations. Fourth, advances in management are influenced by technological developments in other areas (such as telecommunications, transportation, IT, etc.).[5] Overall, these results enhance our understanding of the link between management techniques and aggregate productivity, the causes of business cycle fluctuations,[6] and the impact of different types of technological advances on growth and employment.[7]

The remainder of the paper is organized as follows. In section 2 we discuss the new indicators, in section 3 we discuss their properties and in section 4 we utilized the indicators in a series of vector autoregressions (VARs), to uncover the relationship between management innovations and GDP, productivity and inputs. Section 5 concludes and offers suggestions for future research.

[4] Van Reenan (1997), Blanchflower, Millward, and Oswald (1991), and Harrison et al. (2008) discuss the related microeconomic evidence on the effect of process-based technical change on employment.

[5] This finding provides support for Chandler's (1977) hypothesis that technological change in areas such as telecommunications and transportation affected the evolution of business practices in the United States.

[6] See, for example, Fisher (2006), Alexopoulos (2011), Alexopoulos and Cohen (2009), Gali (1999), Francis and Ramey (2005) and Basu et al. (2009).

[7] 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).

2. The Indicators

To perform the analysis, we first need to create reliable measures of advances in managerial techniques. As stated above, patent counts and R&D metrics are commonly used as proxies for technological advances but are not well suited to capture innovations in management. However, we can use information from the sources described below to create a series of suitable measures that are similar to those used to identify advances in the scientific community.

2.1. Journal Article Counts

The number of articles published in different fields of science is currently used in Scientometry/Scientometrics to track advancement of knowledge, while the pattern of citations linked to each article is commonly used to determine the works' importance and the idea's diffusion over time. These types of metrics, based on the pioneering work of Price (1963), are currently employed by the National Science Foundation in their Science and Engineering Indicators database.

In a similar fashion, we use the number of articles that appear annually in Business Source Premiere (BSP) database as one measure of management innovations. Although the BSP does not include all business articles published each year, its coverage is vast - over 3300 journals, magazines and trade publications – and does include a number articles published in the early part of the last century.[8]

2.2. New Book Titles

Aside from journal articles, books can also be used to track advances in management techniques. The intuition behind this metrics is simple. Innovating companies want to promote their innovations (to profit from them) and instruct their customers on how to

[8] Other databases like WilsonWeb and Scopus were not used since they cover a smaller set of journals - especially in the early time period.

use, maintain and potentially repair them – goals that can be achieved by printing and disseminating information in books, manuals, and pamphlets. Independent publishers and writers may publish additional literature if they see the potential to profit from it. *There is, moreover, an economic incentive to bring the new titles to market coincident with the introduction of the innovations, which causes a relationship between the release of new books and the timing of the technological change.*[9]

To create these measures of managerial advances, we begin by using the Library of Congress' MAchine Readable Cataloging record database (See Appendix A for an example of a MARC21 record).[10] This source contains all major American published works in this area since it is both the legal copyright depository for the U.S. and arguably the largest library in the world.[11] Each record provides information on the book's LOC classification code, year of copyright, edition information, language, subject keywords and country of publication which allows us to extract information on the number of new non-historical titles published in the U.S. each year in different fields of management.[12] To create the indicator, we focus on those items classified under the LOC classes 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).[13] To focus sharply on the innovation in current practices and technologies, we exclude from the counts new editions/reprints and books whose titles and/or subject keywords identify their focus as historical in nature.[14]

[9] Alexopoulos (2011, 2008) and Alexopoulos and Cohen (2009, 2011) use this type of measure to document the evolution of technical change over the last century and investigate issues such as the responses of labor, output and productivity to various types of technology shocks and the role of technological change during the 1930s.

[10] 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.

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

[12] First developed in 1898, the Library of Congress Classification Code is used by the librarians in all North American Research libraries to assign call numbers so that items on similar topics are shelved together.

[13] Appendix B displays the major groupings and sub-groupings in H, T and QA.

[14] For example, there are hundreds of titles that have been sold over time on the topic of Scientific Man-

In an attempt to give more weight to titles that are more widely read, we also create an index based on U.S. library holdings drawn from OCLC's WorldCat database.[15] WorldCat is used by many institutions to facilitate inter-library loans, and contains both the MARC21 records and a geographical profile of library holdings. This information offers away to create an index where the importance of a title (and the information in it) is weighted by the number of libraries that hold the book in their collection.

2.3. Management Subject Headings

The standardized subject keywords in the MARC records' 650 fields also provide useful information on the evolution of topics within the management field. Each title can be associated with multiple subject headings since the goal of these keywords is to best describe the content of the publication so library patrons can locate desired information quickly. Unlike the subject keywords assigned to journal articles, the LOC keywords assigned by cataloguers are *standardized* and with each new, distinct topic, new keywords are added.[16] This subject information allows us to produce two additional metrics for publications in the management field. The first, based on the number of new subject keywords that appear each year within the area, allows us to look at the evolution of the stock of subjects over time as a measure of innovation.[17] The second, based on the number of unique subject headings associated with the publications each year, yields information on the range of areas experiencing change and breadth of the knowledge added to management each year.

agement. However, once one excludes reprints, editions, and historical focused titles, there are less than 30 that would be counted in our measure with over 40% of them occuring within the first 6 years of the innovation date 1911.

[15] WorldCat is a worldwide catalogue that collects cataloguing information from over 72,000 libraries across 170 countries. All major American collections are represented in it.

[16] The fact that the journal articles do not have standardized descriptors rules out the possibility of creating meaning subject measures based on sources like BSP.

[17] In the field of science, Price (1961) uses the addition of new elements to the periodic table as a measure of innovation in chemistry.

2.4. Major Innovation Counts

A number of studies have focused on major innovations counts (see e.g., Mensch (1979) and Klienknecht (1987)) to measure the impact of technology on the economy. While there is no common list of major innovations in the management literature, the Harvard Business Review published an article on its 75th anniversary by Sibbet (1997) which included, among other things, dates for "new seminal ideas" and new production techniques in the field such as Theory Y, total quality management and business process reengineering. While this is the least inclusive of the indicators we examine, we include some results based on it to demonstrate that even the more limited HBR count still indicates a strong relationship between productivity and new managerial techniques.

2.5. Resulting Metrics

The various indicators we create are displayed in Figure 1 along with shaded areas representing the dates identified by the NBER as recessions. All of the indicators suggest that there has been an increase in knowledge associated with management techniques over the 73 years in our sample. Moreover, the increase in the number of new subjects headings linked to the materials in this area suggests that our results are driven by advances in the area and not decreases in the costs associated with publishing.[18] Further, the growth in the unique subject counts indicates the advances have occurred over a broad range of activities.

Despite the similarities, there are also some differences. For example, the book title based indicators suggest a larger growth rate in managerial knowledge than the journal article index for the early decades of our sample. This is, in part, driven by the fact that most journals focusing solely on management were launched after 1950.

[18] To further explore if the results for the LOC title counts are driven by trends in the publishing industry, we also estimated some VARs where the management titles were normalized by (1) the number of adult fiction books and (2) the number of children's literature book. Results of these exercises are included in Supplementary Tables and Figures, and demonstrate the conclusions drawn from the title indicators are unaffected by these normalizations. This is consistent with Alexopoulos' (2011) finding that new children's titles, history titles and new titles in music, drama and poetry do not affect TFP, output or hours worked.

Overall, the indicators appear to be procyclical. However, based on the available data on MBA graduates and management book sales from the early 1980s onwards, it does not appear that the indicators are simply driven by demand factors. Indeed, the correlation between MBAs and the publication metrics are approximately 0, as is the correlation between growth in new titles and sales of management books.[19] In Section 4 we also present results for indicators that should not be demand driven, like HBR indicator of a new idea or production technique or the number of new LOC subject headings. The results are similar to our baseline publication series. Together, these suggest that the indicators can be used as reasonable proxies of managerial innovation.

3. Properties of the Indicators

There are a number of properties an ideal indicator of any type of technological change should have. It should be available for a long period of time, at least at an annual frequency, to make a time series analysis possible. It should be objective, cover a wide range of advances, and provide some way of distinguishing major from minor innovations. Finally, for our type of analysis, it is useful for the metric to capture the dates that the new innovations are commercialized and can affect workplace practices and productivity.[20] Although the ideal measure of organizational innovations may always remain elusive, the indicators we create for the period 1929-2002 do share a number of these properties.

[19]Data on the number of business books sold were obtained from the Book Industry Study Group's publications, Book Industry Trends for the years 1982 thru 2002. Early data was unavailable. Furthermore, data on the number of GMAT exams administered appear to be countercyclical which lead to the number of new MBAs to be mildly procyclical in the data.

[20]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.

3.1. Objectivity

The Harvard Business Review major innovation count may be subjective, but the other indicators are more objectively determined. In the case of the journal articles, journal editors determine what meets the criteria of advances in the field by their acceptance/rejection of articles for publication. For the new book measures, publishing houses play a key role in identifying new marketable innovations and professional cataloguers assign standardized classifications and keywords to the works. Finally, new standardized subject headings and keywords are proposed by professional librarians and approved for use by the LOC when it is deemed necessary to accurately describe the content of the item being catalogued.

3.2. Coverage

Although the HBR measure focuses on a small set of innovations, the other metrics are considerably more comprehensive. Since the LOC is the largest library in the world - and the legal copyright depository for the United States - its collection of books on management techniques is vast. Therefore, the title and subject counts based on its MARC records provides virtually complete coverage of managerial innovations discussed in print during this period. The BSP journal article counts also cover a large spectrum of advances. However, because of the relative scarcity of journals focused on management in the early years, its coverage falls short of that provided by the book-based metrics.

3.3. Weighting

One desirable feature of innovation indicators is the ability to weight new advances according to their importance. A number of the metrics we explore do incorporate some degree of weighting. The simple article and title counts have a partial weighing built in. In the case of article counts, the weight is reflected in the number of papers published on the subject. More important or revolutionary innovations are likely to attract more attention than

smaller advances from both researchers and editors, and thus should have a large number of articles associated with them. In the case of new book titles, profit maximizing publishers will tend to release more new titles for more popular/revolutionary techniques since these are the ones with the largest potential market. Title counts thus put a greater emphasis on major advances such as those associated with scientific management, project management, quality control and total quality management and less on innovations such as PERT and zero-base budgeting.[21] As such, it is closer in spirit to a citation weighted patent index than a simple patent count. Finally, the OCLC measure that weights each title by the number of U.S. libraries currently holding it is explicitly designed to differentiate between limited used and widely adopted innovations.

The new subject measure also embeds an implicit weighting – although it differs from the others. Specifically, influential technologies receive more weight since the keywords that are added by the cataloguers to describe new material must meet the criteria of "literary warrant." The HBR measure places more emphasis on major innovation by definition.

3.4. Dating

To address the issue of timing for the bibliometric based metrics, in Table 1 we report initial publication dates alongside creation dates, and U.S. adoption/commercialization dates for a number of managerial innovations.[22] Many, but not all, of these tools/methods were developed and first implemented in the U.S. Some were considered to be revolutionary at

[21] For example, TQM has over 1200 titles; one minute management has 16 and T-groups 4. The critical path method, developed by the private sector for use in the private sector, also has more titles than its competing technique PERT which was created by the Navy for military applications.

[22] Appendix C provides more detailed information on the sources of the information. 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 e.g., Humphrey (2004) and the History of SWOT Analysis available from http://www.zimbio.com/).

the time they were introduced and are still in use 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). The date for the first book is based on the copyright information, the academic and HBR articles dates are based on the publication information recorded in the BSP database.

A few notable patterns emerge. First, for all of these measures, there is a strong relationship between the commercialization date and the first publication date. Second, for most of the U.S. developed techniques, the difference between the creation and first commercial use date is between 1 and 4 years, with a median of about 2 years. Third, the copyright date for the first American book published generally appears within one to two years of the initial U.S. commercial use. Fourth, contrasting the commercialization date with the first Harvard Business Review and academic articles highlights the superior performance of the book indicator for dating the first American usage of imported techniques such as Quality Circles and Just-in-Time. Two thirds of the 15 new book titles occur within one year of our identified commercialization date, while this fraction drops to 2/5 for academic articles, and, for the 13 innovations occurring after the introduction of the Harvard Business Review, less than 31% of their articles on the innovations were printed within this period. Moreover, 4/13 of the Harvard Business Review's articles and 6/15 of the academic articles' publication dates differed from the commercialization date by three or more years while the comparable number of new titles drops to 2/15.

These differences in dating tend to confirm our priors. Book publishers bring out titles on new management techniques as quickly as possible because any delay in releasing new titles can result in lost revenues if competitors beat them to market.[23,24] In contrast, academics

[23] Alexopoulos (2011) displays similar evidence for major product and process innovations captured by her indicators, and argues the timing is related the cost of book production and publishers' incentives maximize the return on each new title Conversations with publishers confirmed they can release a new title within a few months if there is a demand for it.

[24] While some may be concerned that companies may try to keep their managerial innovations secret, evidence suggests these attempts are unsuccessful. For example, Wal-mart has not released books about its

have the luxury to study and evaluate a new procedure either before, during or after their commercialization in any country which weakens the link between the U.S. initial adoption date and the first article published on a technique. Finally, as the HBR states in their guidelines to authors, articles are "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."[25] Consequently there is more of a lag between HBR articles and commercialization dates.

Not all of the techniques listed in Table 1 are associated with Library of Congress standard subject keywords or are seen in the Harvard Business Review's timeline. The HBR chose the major ideas, events and practices on their timeline and their dates based on the input of "many Boston-area experts in business and its history." According to the timeline's introduction, the dates are meant to capture the time that an activity attracted the most attention. Despite the differences in sources, many of their dates are found to be within a year or two of those suggested by the publication measures.

In the case of the subject terms, the decision of when to add a new keyword is based on 'literary warrant.' As such, a new keyword is approved for use by the LOC when it is determined that it is different from the existing keyword list, and that this proposed terminology represents current usage in the literature. Accordingly, there is often a few years lag between the time the first literature is seen on a topic and the time a new keyword may be assigned to new catalogued items. Smaller techniques or techniques viewed to be well described under an existing heading do not have specific keywords associated with them (e.g., one minute management, Theory X & Y, Five forces analysis, and managerial grids), while more major innovations, such as TQM, Quality Circles, Critical Path analysis, PERT, Business Process Reengineering and Just in time, had headings introduced within a few years

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.

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

of the first book's copyright date.

3.5. Innovation vs. Diffusion

Are the indicators more related to the introduction of the idea to market or do they simply track diffusion of it? The answer to this question helps clarify the interpretation of a managerial technology shock. Although little effort has been made in the field of management to directly assess the patterns and speed of new technique adoption, it is useful to briefly review the existing evidence and relate it to our indicators before we use them in our analysis.[26]

The journal article counts, as we mentioned previously, are viewed by the National Science foundation as a measure of innovation. Citation patterns, on the other hand, are an obvious proxy for diffusion and should provide a measure of an article's influence over time (similar to the use of patent citations).[27] Since new book titles, tend to appear shortly after the introduction of the process to market, it is a better measure of innovation than diffusion. The evidence presented in Figure 2 supports these assertions. The different panels depict the measures for two well known management techniques - Total Quality Management and Quality Circles – and one non-managerial technological advance – the Commodore 64 (the most successful computer ever marketed in the U.S.). The metrics for the Commodore 64 are examined to highlight: (1) the similarity between the citations based diffusion measure and a more traditional diffusion measure (e.g., cumulative sales) and (2) the differences between the diffusion measures and the patterns of new book titles and journal articles.

For the case of the Commodore 64 (panel (a)) the subject heading was assigned shortly

[26] Unfortunately, there is no survey evidence that allows one to accurately track the diffusion of techniques over time, nor is there data that would enable one to track sales of various management books over time as a proxy. However, it is interesting to note that 14/15 of the seminal books listed by Sibbert (1997) and 9/15 of the titles listed as the first book on the topics in Appendix C are currently still in print in some form and available for purchase from Amazon.com. The fact that reprints and new printings of these titles exist suggest that the original copyright dates do not accurately capture the diffusion of the knowledge within these titles.

[27] See Timonen and Palheimo (2008) for a recent example of the use of citation patterns.

after the innovation came to market. This date is followed by an initial spike in new publications that is quickly exhausted – suggesting these metrics do provide a good proxy for the initial introduction of the innovation to the American market. In contrast, the article citation measure indicates this technology was still rapidly diffusing – a finding confirmed by the cumulative sales data. Panels (b) and (c) of Figure 2 shows the counts and citation measures for Total Quality Management and Quality Circles. They again suggest that the count measures are linked to the initial introduction of the techniques, while the citations indicate interest in the techniques continued for a more extended period of time. Indeed, even though there are a limited number new articles and books on TQM currently published, the limited survey data from Bain and Company for 2009 continues to report a substantial fraction (nearly two-thirds) of the firms continue to using TQM techniques with more indicating they intend to adopt the technique in the near future.[28] Given this evidence, the managerial technology shocks identified using the indicators should be linked to innovation in this area.

How fast can firms adopt new techniques and reap the benefits? While large scale surveys have not been conducted, the smaller ones preformed across various countries does give an indication about the possible speed. For example evidence in Ju et al. (2006) and Thawesaengskulthai (2007) show that techniques like ISO 9000 and Knowledge Management can successfully be implemented (and therefore yield gains) in 6 months to 1.5 years, while fully implementing TQM often takes longer. Bain and Co.'s 1993 survey found 67% of the respondent had already adopted Reengineering (first introduced in 1991). Bloom et al.'s (2011) findings also demonstrate that many techniques can be quickly implemented and result in substantial gains. Therefore, in our VARs we order the management indicators first in the system to allow for the possibility that managerial innovation impact can have a

[28] In addition the evidence provided by Gibson et. al (2003), suggests that (1) many firms still consider TQM and Quality Circles to be relevant in today's environment and (2) not all firms have yet been exposed to the techniques indicating that there is still room for further diffusion.

contemporaneous impact on productivity, output and labor.

4. Empirical Results

To explore the aggregate economic impact of managerial innovations, we use annual data for GDP, labor, TFP, prices, interest rates, and the various indicators from 1929 to 2002 in a series of VARs.[29] The GDP statistics are obtained from the Bureau of Economic Analysis' National Income and Product Account (NIPA) Historical Table 1.2 – Real Gross Domestic Product (Billions of chained (1996) dollars). Our measure of labor hours, L_t, is derived from combining the Conference Board's Economic Almanac series for 1929-1945 with Global Insight's Basic Economics database (series LPMHU) on the non-agricultural sectors' employee hours from 1945-2002. The real capital stock, K_t, is the net stock of fixed reproducible tangible wealth in billions of chained (1996) dollars, as reported in Global Insight's database (series KNIQ). Finally, the total factor productivity (TFP) series is constructed using a Tornqvist index: $\Delta\ln(\text{TFP})_t = \Delta\ln(\text{GDP}_t) - (1\text{-}\omega_t)\Delta\ln(\text{K}_t) - (\omega_t)\Delta\ln\text{L}_t$, 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.

4.1. Output, Productivity, Labor and Management – The Bivariate case

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

$$X_t = \alpha + \sum_{i=1}^{4} \beta_{t-i} X_{t-i} + f(t) + \varepsilon_t \text{ where } X_t = \begin{bmatrix} M_t \\ Z_t \end{bmatrix}. \quad (1)$$

[29] Our choice to begin the analysis in 1929 is based on two considerations. First, official data for the U.S. national accounts begin in 1929, and, second, prior to this date, the field of management was still very much in its infancy.

M_t is one of the following management indicators: {ln(management titles), ln(journal articles), ln(unique subject headings), ln (stock of new subject headings), ln (weighted management titles), or HBR key dates}, Z_t is then one of variables {ln(GDP), ln(TFP), or ln(L)}, α is a constant, the t and d terms capture a quadratic time trend with a structural break in 1973,[30] and ε is an error term.[31] The shocks to managerial innovation (which we refer to as 'management shocks') are identified using a Cholesky decomposition.[32] Therefore, given the evidence that new techniques can have a contemporaneous impact on economic variables, we order the management innovation metric first.[33]

The estimated coefficients and the corresponding Granger causality tests indicate that, with the exception of the HBR indicator, the new management indicators are associated with all of the productivity, and output measures at a minimum of a 5% significance level. The variance decompositions, recorded in Table 2, highlight the magnitude of the new management techniques' impact on these variables. For example, the percent of TFP variation attributable to management in the first year is 10.7% with the impact growing to 60% by year 5 when in-novation is identified by new management books. The story is similar for output 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, and for the variation in average hours worked which ranges from 9.2% for the first year to 28.6% by year five. The results based on sub-

[30] Francis and Ramey (2004) present evidence in favor of a quadratic trend over this time period and our inclusion of a break in 1973 is consistent with the results in Fernald's (2007) paper on the identifying the effects of technology shocks in the post war period.Varying the date of the break by a few years did not change the overall results.

[31] We estimate the VARs in levels with trends using a short run indentification procedure based on the findings of Gospodinov, Manard and Pensavento (2011). Specifically they discuss problems associated with choosing a specification based on univariate unit root tests and demonstrate severe biases can be introduced by removing low frequency movements via first differencing. Moreover, we include four lags in our VARs based on the fact that the AIC criterion generally selected lag lengths between 3 and 5 years for the different cases considered.

[32] 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.

[33] This ordering is also consistent with the view that non-management shocks (such as fiscal or monetary policy shocks) only affect the number of titles with a lag since it takes time to write and publish new books. To determine if the baseline results were sensitive to the ordering, we also estimate systems where the management innovation indicator was ordered last. In general the results were robust to variable ordering.

ject count indicators (both the unique count and the stock of new subject headings) display similar magnitudes. Finally, when the weighted titles count, journal article counts and HBR indicators are used the variations attributable to the management innovations are weaker, albeit still sizable.[34]

The bivariate VARs impulse response functions for ln(TFP), ln(GDP) and ln(hours) associated with a one standard deviation management shock are depicted in Figure 3 along with 90% bootstrapped confidence intervals. Overall, the results indicate that a management shock tends to increase productivity, output and hours in the short run, although there are some differences in the estimated responses. While there is an immediate increase in the variables when the LOC book count, subject counts or HBR indicator is used, the initial positive responses are not observed when the journal article count or the weighted title count is used to identify the shock. In the case of the journal counts, the delayed positive response may be due to many articles written in advance of the technique being implemented. The apparent negative response in the period of the shock when the weighted measure is used may be due to this index placing considerable weight on revolutionary techniques like TQM that take time to fully implement and reap the rewards but are costly to first adopt. Finally, we see that, for the majority of cases, the peak responses are observed between years 2 thru 4 and with the management shock producing (at the peak) a 0.01-0.02%, 0.02-0.03%, and 0.01-0.015% increase in TFP, GDP and hours worked respectively.[35]

4.2. Adding other Technological Innovations

As Cyert and Mowery (1987) note, it is often possible to observe a symbiotic relationship between new technologies and production processes. Since one can view managerial

[34]The fact that the journal counts yield weaker results is not surprising given that the counts include a number non-management articles published in the economics journals that are covered by BSP.

[35]These magnitudes imply that, for all cases except the one using the stock of subject keywords, a 1% management shock translates into peak TFP responses of 0.07-0.1%, peak GDP responses of 0.1-0.2%, and peak hours responses of 0.07-0.1%. For the case using the appearance of new subject keywords to capture innovation, a 1% increase in the stock of subjects leads to peak increases of 2%, 3%, and 1.5% in TFP, GDP and hours respectively.

technology as a type of process innovation, it is interesting to include a measure of non-managerial technical change to the system 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 innovations. Since there are well known problem with the patent statistics for the early time period and R&D figures do not exist on an annual basis prior to 1953, we use the log of the Library of Congress based technology book title measure proposed by Alexopoulos (2011), ln(TECH), and order it last in the system as she does.[36,37]

4.2.1. Output, Productivity and Hours

Despite the inclusion of the other technology measure, managerial innovations continue to have a significant effect on output, productivity and hours. The variance decompositions reported in Table 3 confirm a sizable impact of new managerial techniques on the variables– 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. For example, when management titles are used as the management innovation measure, 8% and 6% of the first year variation of TFP and GDP respectively is linked to these innovations, with these magnitudes increasing 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% by year five. Moreover, a comparison of these numbers with the variation attributable to the non-managerial technology series (last three columns of Table 3), demonstrates that the

[36] 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.

[37] Specifically we define the technology indicator as all computer titles (QA 75 – 76 and HF5548.1-5548.1.6) and all technology books (class T) excluding titles in Handicrafts (Class TT), and Home economics (Class TX) and those books on product management and industrial engineering (T55.4 – 60.8 and TS 155-194).

impact of the new managerial technologies is often greater during the first five years even though the traditional non-managerial technologies are more important for horizons beyond five years.

A series of impulse responses based on these trivariate VARs are graphed in Figure 4. Again, new managerial technologies have a significant impact output and TFP within the first five to six years. However, in comparison to the results shown in Figure 3, for some cases the peak responses occur a couple of years earlier and are smaller.

The last three columns of Figure 4, highlight some differences in both the timing and magnitude between managerial and non-managerial technology shocks. For all but the journal count index, the managerial technology shock tends to cause an immediate and significant increase in the response variables for approximately five years, while a similar sized non-management technology shock results in a longer lasting rise in the variables with the greatest impact occurring 5-6 years after the shock. Moreover, the short-run response of labor depends on the type of technology shock examined.[38] Specifically, in the tri-variate VARs, a non-managerial technology shock tends to increase hours worked while a managerial technology shock may induce an initial *reduction* in labor hours within the first two years, followed by a subsequent increase.[39] Even though the response of hours worked to a management shock may appear non-standard, it is not surprising when one considers that managerial technology shocks are, in many ways, related to process based technological change. As the industrial organizational literature in this area highlights, the response of labor to a process innovation depends on the relative magnitude of two competing effects. On the one hand, many of these processes tend to reduce the quantities of inputs, including labor, needed to produce a unit of output. On the other, they tend to lead to price reductions (and quality

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

[39] 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).

enhancements) which work to stimulate demand for the products/services thereby increasing demand for labor. The overall response of hours, then, depends on which of these effects dominate at various points of time. In our case, it appears that the first effect may dominate within the first few years with the second effect dominating thereafter.

4.2.2. Which Comes First, Management or Traditional Technology?

In his 1977 Pulitzer Prize winning book, "The Visible Hand," Alfred Chandler hypothesized that the evolution of the American business organizations was not random - in-stead, 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.[40] While Chandler's (1977) evidence was based on case studies, the results from our VARs can help determine whether a link exists between the technological advances (captured by the TECH indicator) and the new managerial techniques that are measured by our new indices of management innovations. Figure 5 shows the effect of a one-standard deviation non-managerial technology shock on new managerial titles, and the effect of a managerial technology shock on non-managerial technology titles (again along with 90% bootstrapped confidence intervals) for the tri-variate VAR with real GDP included in the system. The results are striking and consistent with Chandler's theory. Specifically, the responses depicted in the second row suggest that unanticipated changes in non-managerial technologies have a significant impact on managerial titles. If we express the responses in percentage terms we find a 1% increase in the TECH-measured technologies appears to raise the management titles by about 1%, new journal articles by 0.7%, the unique subject counts by 0.6% and the stock of management subjects by 0.2%. The first row of the figure demonstrates there is some evidence that a management shock affects non-managerial technology titles. However, the magnitudes of the responses are generally smaller and often insignificant.

The variance decompositions in Panel B of Table 4 paint a similar picture in terms of

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

TECH's influence on managerial innovation and provide compelling evidence in support of Chandler's (1977) hypothesis. When new management books, subject keywords or the unique subject counts are used as the proxy, the percent of variation attributable to the TECH indicator is greater than 25% by year 5, and, for the book and subject cases, this percentage rises to almost 50% by year 7. In contrast, the percent of the TECH variation linked to the management proxies is 18% over the same time horizon.

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 an expanded system. The ordering of the variables in this VAR is as follows: ln(M), ln(hours), ln(TFP), commercial paper rate, ln(CPI), and ln(TECH). Here, we again place the management series first and other technology series last to maintain comparability with the earlier results, and, 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.[41] 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.[42] Figure 6 displays some of the impulse responses to one-standard deviation shocks to management and non-management technology along with the corresponding 90% confidence bands.[43]

A comparison of these patterns with those depicted in Figure 4 reveals that the shape of the hours response to a management shock is robust to the inclusion of the other variables and TFP still rises above trend in the short run.[44] Again, we find little evidence of a consistent significant relationship between organizational innovations and advances in tradi-

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

[42] 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.

[43] While we do not report the responses of prices to the shocks due to space constraints, the point estimates suggest that, following both management and non-management technology shocks, prices fall in the short run.

[44] The responses using the weighted book metric are similar to those depicted in the figure.

tional technologies captured by the TECH indicator. Moreover, Column 4 shows that the peak responses of TFP to a TECH shock also tend to occur later than the responses to a management shock depicted in Column 1. Hours rise in response to the non-management technology shock by year 3, and Column 6 again illustrates a clear positive and significant response of the managerial innovation measures to the TECH shock.

Panel C of Table 4 reports the variance decompositions for TFP and hours. Overall, there is still evidence that managerial innovations remain an important force behind movements in TFP and employment when the advances are measured using the introduction of new titles or new subject keywords. However, the magnitudes are somewhat different than those obtained using the tri-variate VARs. For example, when the new book titles are used, the numbers for the expanded system suggest that: (1) only 17% of the variation in productivity is attributable to advances in management techniques by year three, instead of the nearly 30% suggested by the tri-variate VAR, and (2) the variation in hours linked to management titles rises to almost 18%.[45] Moreover, these magnitudes are significantly larger than the shares attributable to the commercial paper rates. Finally, the results confirm innovations in the TECH measure are an important contributor to fluctuations in the management indicators, and that sizable variations in TFP and hours can be attributed to the TECH at medium to long run horizons.

4.4. Conclusion

Although many economists believe that innovations in management are a significant source of changes in productivity, it has been difficult to provide quantitative support for this view because of the problems associated with measuring advances in this field. To address this issue, we develop the first indicators of organizational innovations for the U.S. and use them to answer a number of questions. First, what role do managerial technology

[45] While we omit the responses for the weighted book series to save space, the variance decompositions in this case suggest that by year 6 over 20% of the variation in TFP is attributable to the weighted index, and within the first two years over 23% of the variation in hours is linked to it.

shocks play in short run fluctuations? Second, what impact does this type of technological change have on output, employment and productivity? Finally, what is the relationship between managerial innovations and advances in product/process innovations?

Our results can be summarized as follows. First, organizational innovations significantly increase both aggregate output and productivity and the effect on labor, while positive, is much weaker. Second, the response of labor to a management technology shock is consistent with evidence in the industrial organizational literature on the impact of process technologies on employment at the firm level. Third, new managerial technologies may be as important as advances in non-managerial technical change in explaining changes in productivity and output. However, these variables tend to respond quicker to a managerial technology shock than a non-managerial one. Fourth, consistent with the hypothesis forward by Chandler (1977), we find evidence of a link between traditional technological developments (e.g., advances in telecommunications, computers, transportation, etc.) and managerial innovations.

In addition to providing the first aggregate measure of technical change in management, these results enhance our understanding of the link between management techniques and aggregate productivity, and the causes of business cycle fluctuations. They confirm that the type of organizational innovations captured by our new indicators do indeed deserve further study and highlight the importance of developing models that allows for multiple types of technological change to affect the economy.

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Appendix A: Sample MARC Record

00926cama2200229145000010008000000050017000080080041000250350021000669060045000870100017001320350019001490400025001680500020001931000043002132450078002562600050003343000031003845000185004156500027006009850021006279910048006487290167-20040503180407.0-751008s1911 nyu 000 0 eng - 9(DLC) 11010339- a7bcbccoclcrplduencipf19gy-gencatlg- a 11010339 - a(OCoLC)1686367- aDLCcFMUdOCoLCdDLC-00aT58.D4bA3 1911-1 -aTaylor, Frederick Winslow,d1856-1915.-14aThe principles of scientific management,cby Frederick Winslow Taylor ...- aNew York,aLondon,bHarper & Brothers,c1911.- a2 p. l., [7]-77 p.c23 cm.- -a"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."- 0aIndustrial efficiency.- eOCLC REPLACEMENT- bc-GenCollhT58.D4iA3 1911tCopy 1wOCLCREP-

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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.

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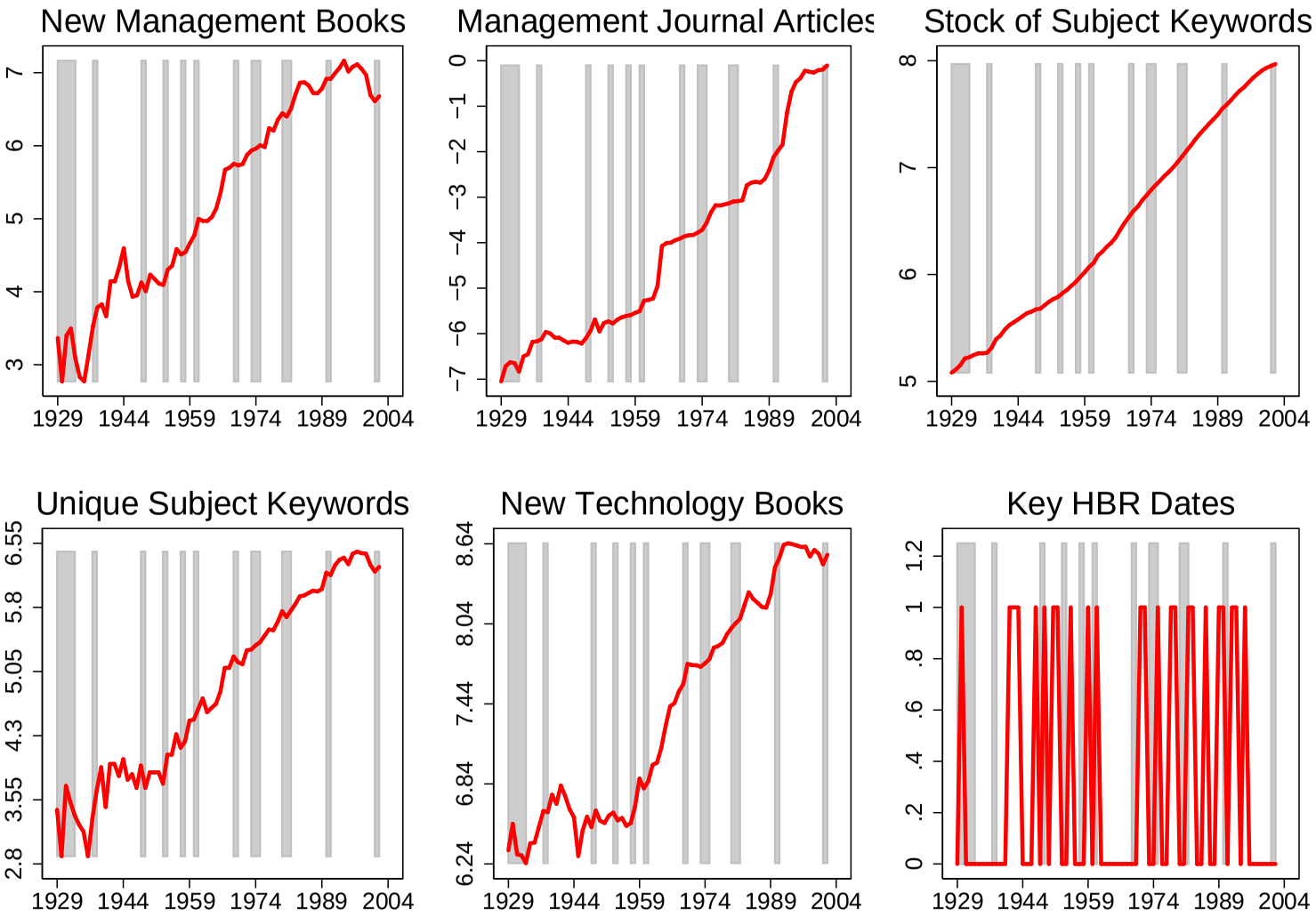
ZIMBO Online: http://www.zimbio.com/Business+Planning+and+Control+Systems/articles/40/History+of+the+SWOT+analysis

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

Figure 1: Time Series Patterns of Key Measures of Management Knowledge

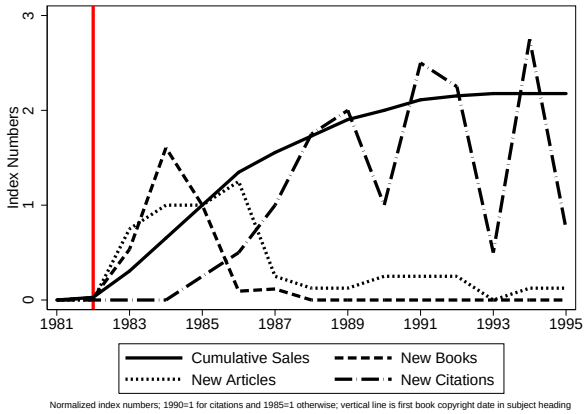


Notes: The journal article index is normalized to 0 for 2002. NBER recession dates are shaded in grey. The management book series contains all of the new management titles in the fields of industrial management, industrial relations, office management, industrial psychology, personnel management, industrial engineering as well as production and operations management. The technology book series includes titles in the 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).

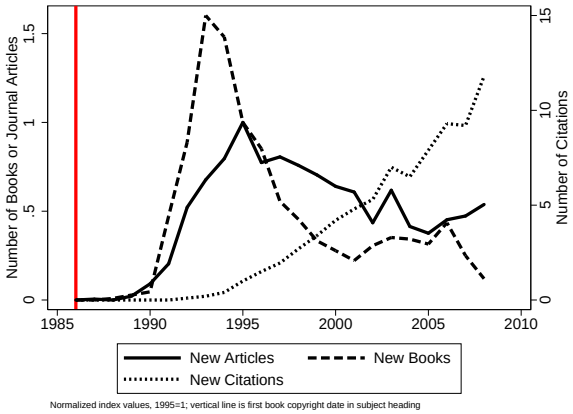
Sources: Journal counts are based on the number of management journal articles as recorded in Business Source Premier. The number of new book titles, the stock of subject keywords in management and the unique number of subject keywords associated with management publications per year are computed using information contained in the Library of Congress' MARC record database. The holdings-weighted new title series is based on the information obtained from OCLC's WorldCat database, and the Key HBR dates are based on the dating of the seminal ideas and production techniques highlighted in Sibbert (1997).

Figure 2: Innovation and Diffusion Patters

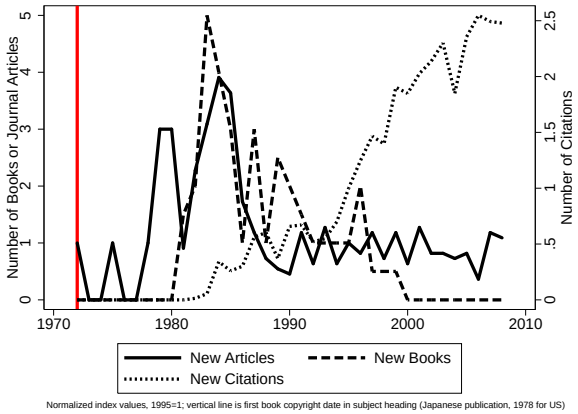
(a) Commodore 64 Sales and Books



(b) TQM Publications, Books, and Citations



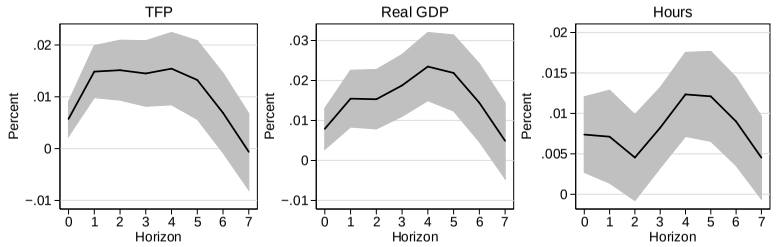
(c) QC Publications, Books, and Citations



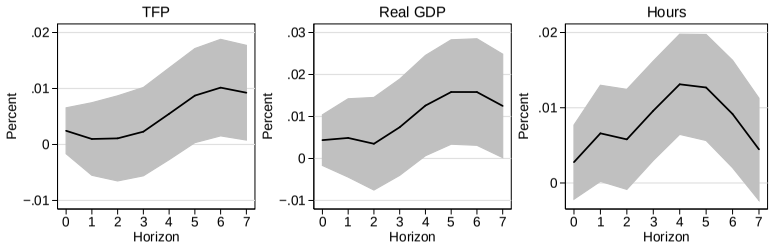
Sources: Journal article counts and the corresponding citation counts are based on information from the ISI Web of Science Database. New book titles for each subject, and the copyright data associated with the first publication utilizing the subject keyword are based on information contained in the Library of Congress' MARC records database. Commodore 64 unit sales statistics are from Reimer (2005).

Figure 3: Bivariate Impulse Response Functions, Response to Management Shock

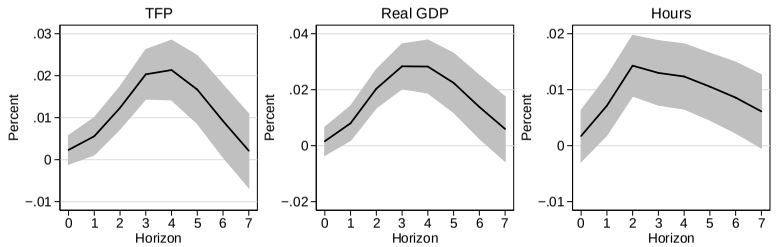
(a) Indicator: New Management Books



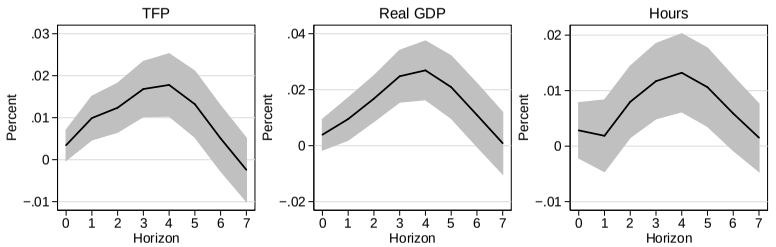
(b) Indicator: Management Journal Articles



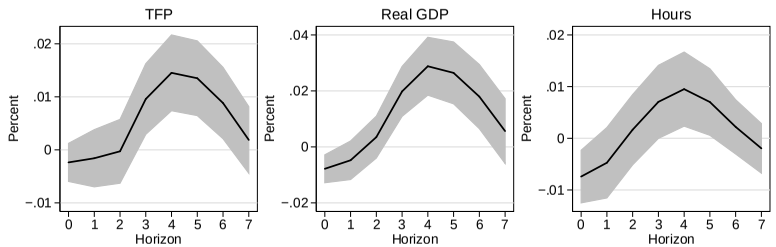
(c) Indicator: Stock of Subject Keywords



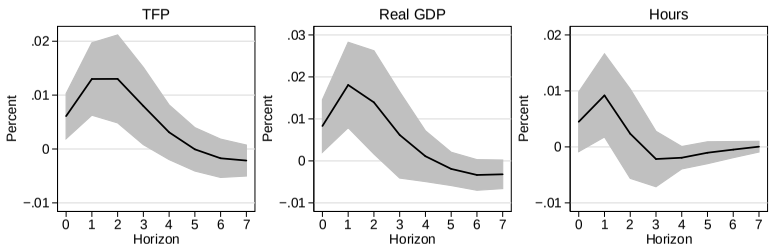
(d) Indicator: Unique Subject Keywords



(e) Indicator: Holdings-Weighted New Books



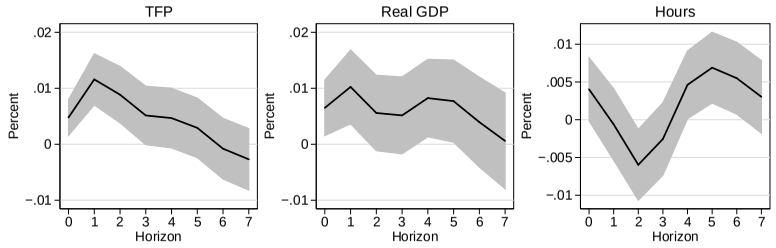
(f) Indicator: Key HBR Dates



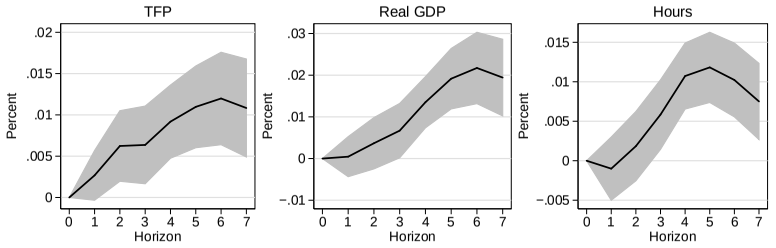
Notes: These VAR Cholesky orthogonalized impulse response functions are estimated using annual data from 1929-2002. Each panel displays the response to a one standard deviation management shock and the 90% confidence interval. The management indicator is ordered first in each bivariate VAR.

Figure 4: Trivariate Impulse Response Functions, Response to Management and Technology Shocks

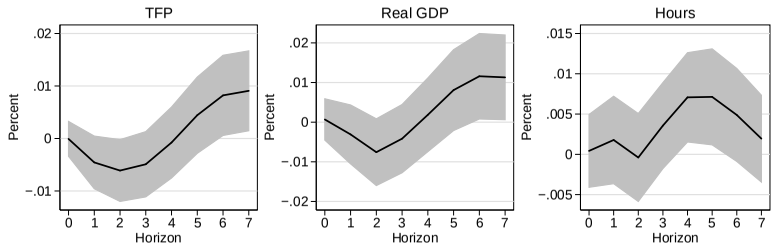
(a) Response to Management Shock (Indicator: New Management Books)



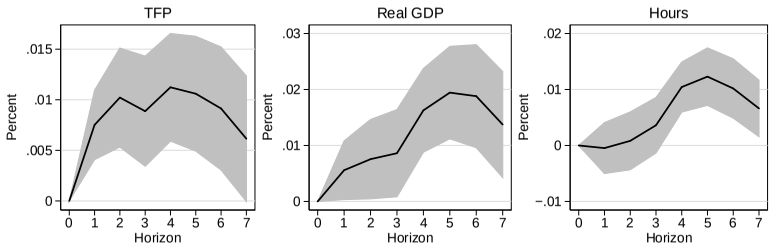
(b) Response to Technology Shock (Indicator: New Management Books)



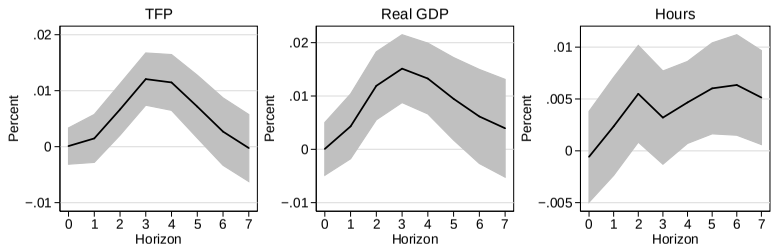
(c) Response to Management Shock (Indicator: Management Journal Articles)



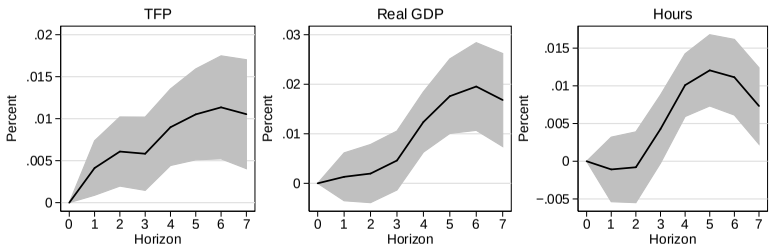
(d) Response to Technology Shock (Indicator: Management Journal Articles)



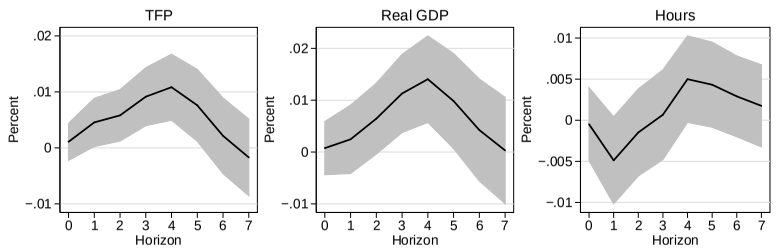
(e) Response to Management Shock (Indicator: Stock of Subject Keywords)



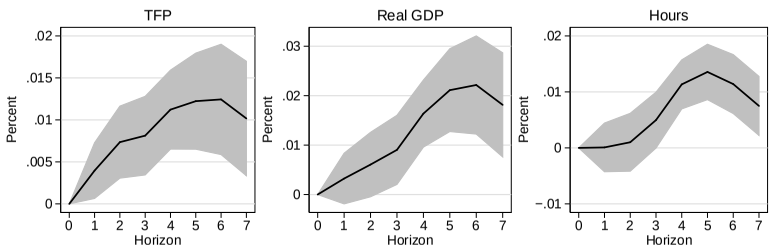
(f) Response to Technology Shock (Indicator: Stock of Subject Keywords)



(g) Response to Management Shock (Indicator: Unique Subject Keywords)



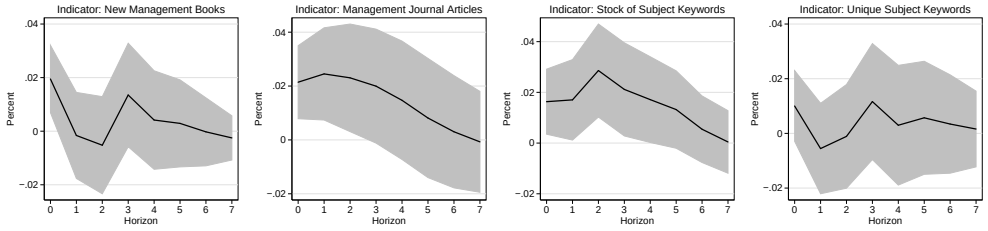
(h) Response to Technology Shock (Indicator: Unique Subject Keywords)



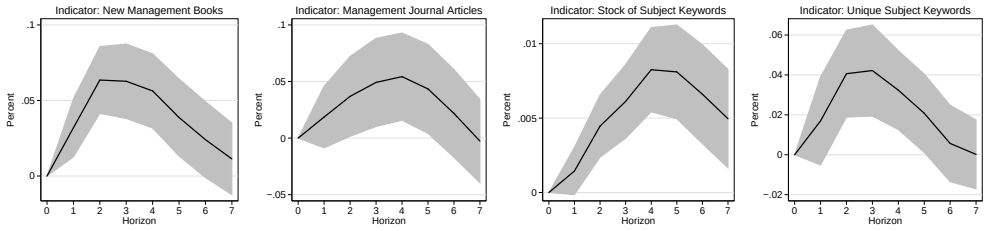
Notes: These VAR Cholesky orthogonalized impulse response functions are estimated using annual data from 1929-2002. Panels in the first three columns display the response to a one standard deviation management shock and the 90% confidence interval. Panels in the last three columns display the response to a one standard deviation non-management technology shock and the 90% confidence interval The management indicator is ordered first in each trivariate VAR and the technology indicator is ordered last.

Figure 5: Trivariate Impulse Response Functions, Technology vs. Management Shocks

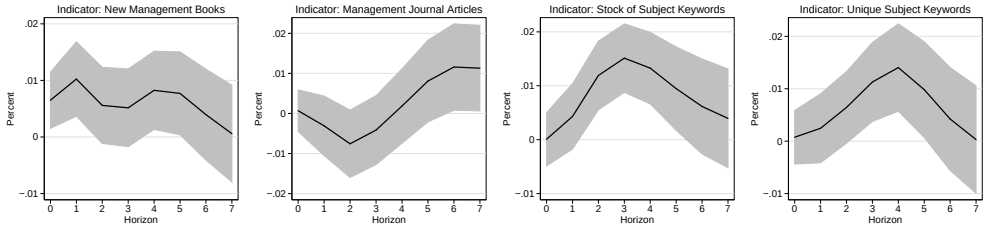
(a) Technology's Response to Management Shock



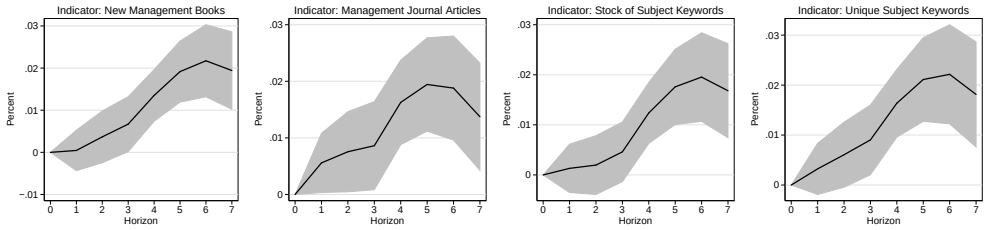
(b) Management Response to Technology Shock



(c) Real GDP Response to Management Shock



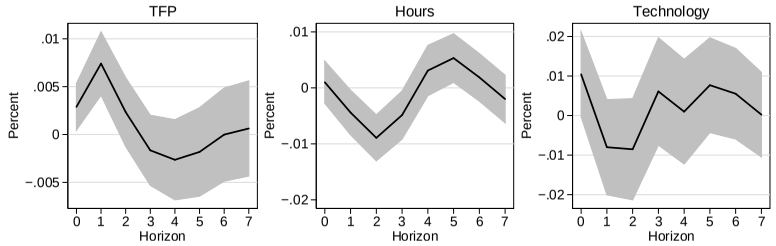
(d) Real GDP Response to Technology Shock



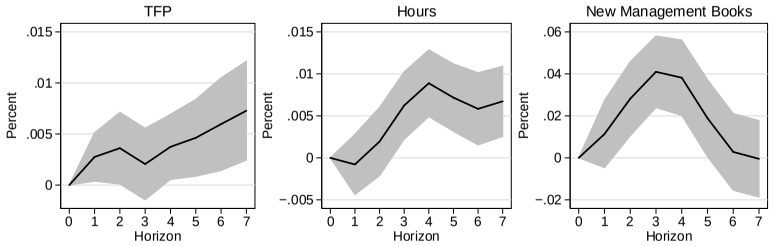
Notes: These VAR Cholesky orthogonalized impulse response functions are estimated using annual data from 1929-2002. Each panel displays the response to a one standard deviation shock and the 90% confidence interval. The management indicator is ordered first in each trivariate VAR and the technology indicator is ordered last.

Figure 6: Multivariate Impulse Response Functions, Response to Management and Technology Shocks

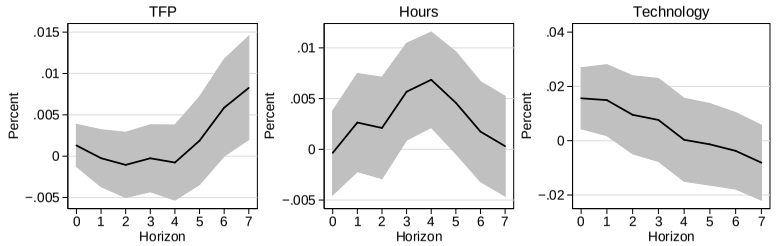
(a) Response to Management Shock (Indicator: New Management Books)



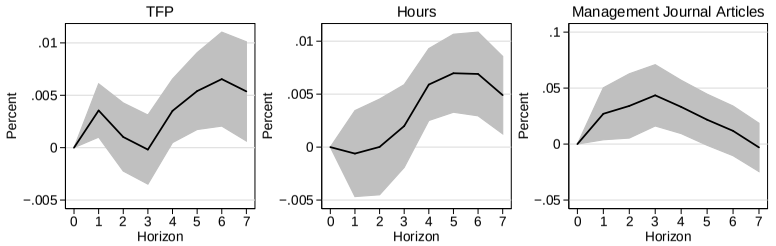
(b) Response to Technology Shock (Indicator: New Management Books)



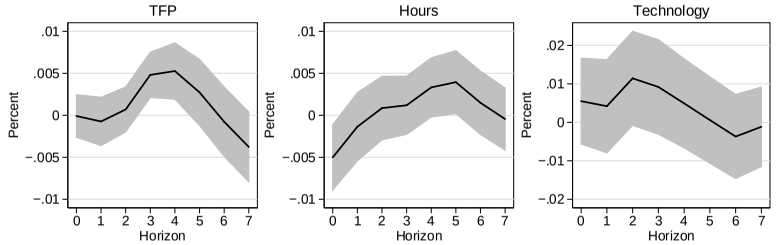
(c) Response to Management Shock (Indicator: Management Journal Articles)



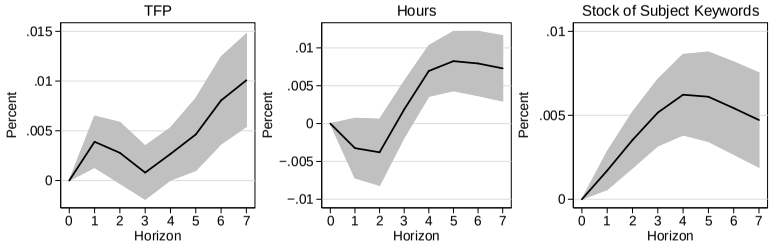
(d) Response to Technology Shock (Indicator: Management Journal Articles)



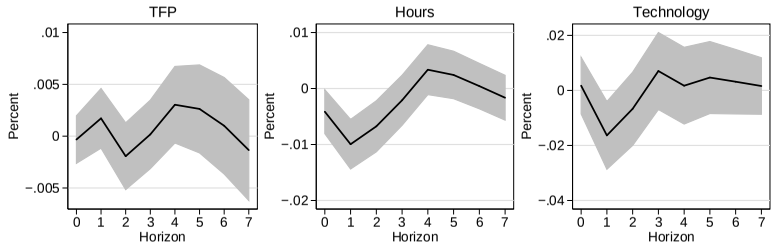
(e) Response to Management Shock (Indicator: Stock of Subject Keywords)



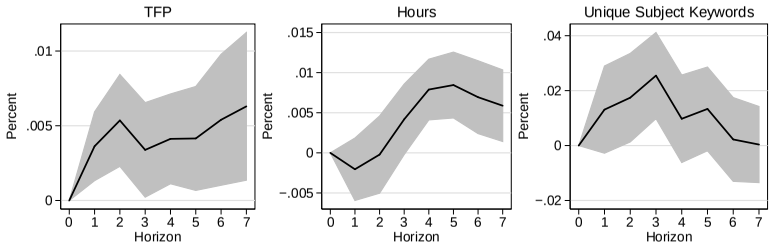
(f) Response to Technology Shock (Indicator: Stock of Subject Keywords)



(g) Response to Management Shock (Indicator: Unique Subject Keywords)



(h) Response to Technology Shock (Indicator: Unique Subject Keywords)



Notes: These VAR Cholesky orthogonalized impulse response functions are estimated using annual data from 1929-2002. Each panel displays the response to a one standard deviation shock and the 90% confidence interval. In each multivariate VAR the ordering of the variables is as follows: ln(management indicator), ln(hours), ln(TFP), commercial paper rate, ln(CPI), and ln(technology indicator).

Table 1: 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
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)
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	Early-80s
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.
*** Includes the HBR.

Table 2: Variance Decomposition of Management Shock, Bivariate Case

	% of Variation due to Management:					
Horizon	Log(TFP_t)	Log(GDP_t)	Log(H_t)	Log(TFP_t)	Log(GDP_t)	Log(H_t)
	Indicator: New Management Books			*Indicator: Management Journal Articles*		
1	10.73	8.86	9.22	1.36	2.01	1.21
2	32.87	20.70	11.40	0.63	1.90	4.76
3	45.19	29.02	12.86	0.53	1.77	7.22
5	59.83	51.42	28.65	2.58	7.46	23.94
7	61.39	58.25	39.78	11.76	18.52	34.37
	Indicator: Stock of Subject Keywords			*Indicator: Unique Subject Keywords*		
1	1.79	0.39	0.56	3.47	1.96	1.25
2	6.51	5.86	6.58	13.89	6.61	1.04
3	24.49	29.35	25.05	24.21	17.84	5.95
5	63.38	61.99	41.15	50.79	48.47	24.42
7	67.07	64.39	47.14	54.79	54.00	30.66
	Indicator: Holdings-Weighted New Management Books			*Indicator: Key HBR Dates*		
1	1.66	9.07	7.85	7.68	6.44	2.63
2	1.02	6.44	6.02	15.54	13.17	6.71
3	0.72	5.58	5.36	19.45	13.72	6.16
5	18.43	38.31	12.77	20.70	13.23	6.52
7	29.23	52.23	15.27	20.66	13.30	6.46

Note: The decompositions are based on the bi-variate VARs: $X_t = \alpha + \sum_{i=1}^{4} \beta_i X_{t-i} + f(t) + \varepsilon_t$ *where* $X_t = [\ln(M_t), \ln(Z_t)]'$, M_t *is one of the managerial innovation indicators {new books, journal articles, stock of subject keywords in management, unique subject keywords or weighted new book titles}, f(t) is a quadratic time trend with a structural break in 1973, and* Z_t *is one of {TFP, GDP or hours} at time* t. *The decomposition using the HBR indicator includes only two lags in the VAR.*

Table 3: Variance Decomposition of Management Shock, Trivariate Case

	% of Variation due to Management:			*% of Variation due to Technology:*		
Horizon	Log(TFP_t)	Log(GDP_t)	Log($Hours_t$)	Log(TFP_t)	Log(GDP_t)	Log($Hours_t$)
Indicator: New Management Books						
1	8.27	6.40	3.53	0.00	0.00	0.00
2	25.18	12.18	2.75	1.15	0.02	0.17
3	29.69	13.05	8.08	5.80	1.00	0.68
5	27.65	15.51	9.68	16.63	13.69	18.53
7	20.74	12.24	13.61	30.76	38.01	34.27
Indicator: Management Journal Articles						
1	0.00	0.07	0.03	0.00	0.00	0.00
2	3.11	0.70	0.44	8.46	2.17	0.03
3	6.30	3.68	0.45	17.46	4.82	0.11
5	6.95	3.96	6.68	30.70	19.20	12.38
7	10.76	8.71	10.65	35.55	35.08	28.50
Indicator: Stock of Subject Keywords						
1	0.00	0.00	0.07	0.00	0.00	0.00
2	0.44	1.75	0.86	3.45	0.16	0.17
3	7.39	12.49	5.05	8.62	0.44	0.25
5	30.22	28.08	7.37	15.75	8.93	13.18
7	24.76	21.31	11.29	26.44	26.78	30.51
Indicator: Unique Subject Keywords						
1	0.41	0.08	0.05	0.00	0.00	0.00
2	4.06	0.55	3.15	2.90	0.87	0.00
3	8.24	3.43	3.40	10.33	3.37	0.13
5	22.53	17.29	5.36	22.97	18.39	15.98
7	19.17	14.03	6.03	33.99	38.35	35.80
Indicator: Holdings-Weighted New Management Books						
1	4.68	14.25	11.27	0.00	0.00	0.00
2	5.69	15.33	12.42	5.21	2.17	0.06
3	5.90	12.93	12.24	13.81	7.73	0.41
5	17.78	35.31	16.19	31.71	20.43	12.08
7	18.86	34.51	15.17	45.83	37.02	27.74
Indicator: Key HBR Dates						
1	8.67	6.15	3.50	0.00	0.00	0.00
2	15.69	12.37	4.87	2.54	0.11	1.06
3	17.84	12.31	6.61	5.83	0.54	1.05
5	16.65	12.35	15.53	16.99	14.18	17.43
7	16.65	11.30	13.33	28.54	33.23	29.20

Note: The decompositions are based on the trivariate VARs: $X_t = \alpha + \sum_{i=1}^{4} \beta_i X_{t-i} + f(t) + \varepsilon_t$ *where* $X_t = [\ln(M_t), \ln(Z_t), \ln(T_t)]'$, *$M_t$ is one of the managerial innovation indicators {new books, journal articles, stock of subject keywords in management, unique subject keywords or weighted new book titles}, f(t) is a quadratic time trend with a structural break in 1973, Z_t is one of {TFP, GDP or hours} at time t and T_t is the measure of non-managerial technological innovation at time* t. *The decomposition using the HBR indicator includes only two lags in the VAR.*

Table 4: Other Variable Interrelationships, Variance Decompositions

(a) Bivariate Case

Horizon \ Indicator:	% of Technology Variation due to Management				% of Management Variation due to Technology			
	New Management Books	Management Journal Articles	Stock of Subject Keywords	Unique Subject Keywords	New Management Books	Management Journal Articles	Stock of Subject Keywords	Unique Subject Keywords
1	9.13	9.73	8.28	3.99	0.00	0.00	0.00	0.00
2	6.07	14.07	7.55	2.59	5.38	1.41	2.00	2.98
3	4.64	15.84	10.39	1.97	26.38	5.35	9.68	10.38
5	5.77	17.94	11.31	2.40	49.98	14.47	39.56	24.68
7	5.76	18.14	11.65	2.41	53.92	17.22	58.70	27.53

(b) Trivariate Case

Horizon \ Indicator	% of Technology Variation due to Management				% of Management Variation due to Technology			
	New Management Books	Management Journal Articles	Stock of Subject Keywords	Unique Subject Keywords	New Management Books	Management Journal Articles	Stock of Subject Keywords	Unique Subject Keywords
1	8.86	9.21	6.07	2.29	0.00	0.00	0.00	0.00
2	5.54	13.43	7.62	1.74	7.55	0.96	1.72	2.12
3	4.32	15.29	13.42	1.27	28.07	3.71	11.66	12.00
5	5.20	17.46	16.45	2.14	48.07	12.29	35.71	24.99
7	5.21	17.76	17.40	2.44	50.96	15.56	44.26	26.57

(c) Multivariate Case

	% of Variation due to Management			% of Variation due to Technology			% of Variation due to Management			% of Variation due to Technology		
Variable:	ln(Tech)	ln(Hours)	ln(TFP)	ln(Mgmt)	ln(Hours)	ln(TFP)	ln(Tech)	ln(Hours)	ln(TFP)	ln(Mgmt)	ln(Hours)	ln(TFP)
Horizon	Indicator: New Management Books						Indicator: Management Journal Articles					
1	3.59	0.27	5.31	0.00	0.00	0.00	7.21	0.03	1.01	0.00	0.00	0.00
2	4.12	4.32	19.02	1.49	0.13	2.28	10.16	1.15	0.57	3.08	0.06	4.06
3	4.83	17.69	17.29	9.28	0.78	5.19	10.01	1.72	0.70	6.54	0.06	3.31
5	4.17	17.60	13.14	26.61	16.17	6.51	7.91	10.66	0.54	13.45	4.60	3.99
7	4.48	17.99	8.78	24.12	22.66	10.28	7.24	10.74	3.62	13.43	12.67	8.55
Horizon	Indicator: Stock of Subject Keywords						Indicator: Unique Subject Keywords					
1	0.94	6.28	0.00	0.00	0.00	0.00	0.11	4.21	0.08	0.00	0.00	0.00
2	1.02	4.99	0.21	4.19	1.94	5.80	6.03	18.73	1.29	2.22	0.68	5.56
3	3.10	4.75	0.36	14.11	4.26	8.01	5.76	23.73	2.16	5.07	0.62	13.27
5	3.61	5.09	9.66	34.71	9.72	5.71	4.86	21.37	3.28	9.74	10.12	14.38
7	3.19	5.85	6.94	44.16	20.97	13.52	4.60	18.08	2.75	10.03	20.07	13.41

Note: The decompositions are based on the VARs: $X_t = \alpha + \sum_{i=1}^{4} \beta_i X_{t-i} + f(t) + \varepsilon_t$. $X_t = [\ln(Mgmt_t), \ln(Tech_t)]'$ *for the bivariate cases,* $X_t = [\ln(Mgmt_t), \ln(GDP_t), \ln(Tech_t)]'$*, for the trivariate cases and* $X_t = [\ln(Mgmt_t), \ln(Hours_t), \ln(TFP_t), CP\text{-}rate_t, \ln(CPI_t)\ \ln(Tech_t)]'$ *for the multivariate case where* $Mgmt_t$ *is one of the managerial innovation indicators {new management books, journal articles, stock of subject keywords in management, or unique number of subject keywords }, f(t) is a quadratic time trend with a structural break in 1973, and* $Tech_t$ *is the measure of non-managerial technological innovation at time* t.