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

By its very nature, total factor productivity (TFP) is, despite our best efforts, still a "black box," within which most economists would identify anything that enhances producers' ability to transform inputs into outputs and should, therefore, be regarded as technological advancement. It is, therefore, perfectly reasonable to argue that 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 an extensive literature that attempts to uncover the role that process and product technologies play in economic fluctuations and growth.[1] However, far less research has been devoted to quantifying their impact – even though there is abundant microeconomic evidence to support the view that changes in corporate work rules, team structures, communication channels, morale, and managerial leadership significantly affects firm level productivity.[2]

While managerial/organizational technologies possess many of the same properties as process and product technologies, quantifying their effects on aggregate output and productivity have proven difficult because no adequate measure of managerial innovation exists. In particular, traditional indicators of technical change, based on Research and Development Expenditures (R&D) or Patent Applications, do not generally capture new managerial techniques.[3] Therefore, in this paper, new measures of organizational innovations are presented (based on new titles published in the field as recorded by the Library of Congress) and then used to demonstrate that advances in these intangible technologies have been an important contributor to aggregate output and productivity growth.

Specifically, we use our new indicators to help answer a series of important and interesting 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 relationship exists between managerial innovations and advances in product/process innovations? The answers

[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 Bloom and VanReenen (2007), Cosh, Fu and Hughs (2005), Bertrand and Schoar (2003), and Bartelsman and Dom (2000) provide evidence that skills of managers play a role in explaining productivity differences across firms.

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

implied by our analysis can be summarized as follows. First, we find that managerial technologies do make an important contribution to aggregate fluctuations in output and total factor productivity. Second, 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] 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 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.

Overall, our work contributes to a variety of research areas including those that deal with the links between management and productivity, management fads and fashions, microeconomic studies of the impact of new processes on employment and productivity, business cycles, and finally, measuring innovative activity. In the next section, we tie our work to the relevant literature, in section 3 the new indicators are discussed, in section 4 results, based on a series of vector autoregressions (VARs), are presented to uncover the relationship between the book-based indicators and GDP, productivity and inputs, and section 5 concludes.

2. Review of Relevant literature

To highlight this paper's contributions, it is useful to review some of the findings from related literature in the fields of industrial organization, management and business cycle research. The first line of research focuses on the empirical relationship between management and productivity. In absence of available aggregate measures of managerial innovation, much of this work has taken the form of case studies. These focus on quantifying the productivity enhancing effects of adopting specific management techniques, such as total quality management, quality circles, or business process reengineering, among many others.[5] To take one example, Easton and Jarrell (1998), in a difference-in-difference framework, investigate the response of firm-level financial performance

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

[5] See e.g., Easton and Jarrell (1998), Wayhan and Balderson (2007), Pereira and Osburn (2007), White et al. (1999), and Burns and Wholey (1993).

measures (income-per-worker, inventory levels, stock returns, etc.). They find TQM adoption is associated with significant improvements along these important dimensions, with over $3,000 in additional income-per-worker from basic TQM adoption. However, as the results presented in Wayhan and Balderson's (2007) review show, these findings fail to garner unanimous support. Thus, while in depth studies may help determine which innovations are likely to benefit some firms, it is virtually impossible to infer from such studies the overall impact of managerial innovations on economy wide productivity and growth.

The second line of inquiry – seen in the management literature – uses journal articles on various management techniques to pick up 'fads and fashions' (See Perkmann, 2006; Abrahamson and Fairchild, 1999; Abrahamson, 1997, 1996, and 1991). Unlike the approach emphasized below, these patterns are based on keyword searches, and, hence, focus only on a couple of the most popular tools. Figure 1 depicts article counts for three popular ones covered in this literature: quality circles (QC); total quality management (TQM); and, business process reengineering (BPR). Based on these patterns, the authors argue that companies adopt new management styles when they first appear only to abandon them as soon as the next craze comes along. The traditional interpretation of such time series is as follows: QCs, first popularized in the US in the late 1970s, began its wide-scale adoption around 1980, hit the peak of its popularity in year 1983, and subsequently yielded the floor to TQM. The authors of such studies argue that companies move from fad to fad with no real productivity gain as the managers attempt to ensure their methods are "at the frontier". Since many of these innovations are likely to yield gains only after a period of learning and/or gradual structural integration, this behavior leads myopic decision makers to abandon ship too quickly to reap the benefits.

While the fad and fashion literature makes strong predictions concerning the negative (or at least non-positive) relationship between new management tools and aggregate productivity, none of the papers in the area formally test the theory. As such, it is equally possible to take a more optimistic view of the patterns that would lead to the opposite conclusion. Instead of arguing that firms completely abandon existing procedures for the next fad or fashion, one could theorize that, since one size does not fit all, new ones need to be tailored by managers to their specific organization. Productivity gains could occur over time by utilizing aspects of new techniques that work well and

abandoning those parts that do not. This process of refinement would cause management styles to evolve over time in a beneficial and productivity enhancing way. Moreover, Figure 1 is consistent with this view if the publications essentially spread the news and educate the management about the new innovations in the field. Accordingly, once managers have been informed about the new methods and trained to use them, there is little additional information left to convey and publications on the subject fall off. Of course, this view does not imply that firms have stopped adopting or using the technique – it only implies that the required information is already accessible in past publications.[6] Indeed, the results we present in section 4 provide support for this latter interpretation and suggest that overall these innovations are productivity enhancing.

In a third area, researchers explore whether process and product innovations have differential affects on growth and employment.[7] It is often argued that product innovations have a large positive impact on both labor inputs and output since they often create new goods and/or services which are not simply substitutes for existing ones. Process innovations, on the other hand, are often thought to be labor saving (e.g., machines being utilized to reduce labor input on the factory floor). It follows that, unless price reductions sufficient to stimulate a strong increase in demand flow from the new methods, while output and productivity may rise, employment may be negatively impacted. These hypothesized outcomes appear to be born out in the data. Numerous studies find evidence that product innovations are expansionary.[8] However, Doms, Dunne and Roberts (1995), Blanchflower and Burgess (1999), and Ross and Zimmerman (1993) demonstrate process innovations' employment impacts are less clear.-cut with the first two studies uncovering a positive relationship between innovations and employment, and the latter a negative one. Since, as the OECD's Oslo Manual points out, organizational innovations (which would include the managerial ones we focus on here) are similar in many respects to process innovations, the results of these studies are consistent with the employment responses to managerial innovations identified using our indicators presented below.

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[6] To illustrate this point clearly, consider publications on a widely used product, such as penicillin. While first available in the civilian market in 1945, it is still widely used today. However, recent (non-historical) articles on penicillin primarily deal with new issues pertaining to drug resistance - not how penicillin can be used to treat traditional bacterial infections since this is already well understood.

7 See review articles: Spiezia and Vivarelli (2002) and Chennells and Van Reenen (2002) and cites within.

[8] See, e.g., Harrison et al (2008), Entorf and Pohlmeier (1991), König, Licht and Buscher (1995), VanReenen (1997), Greenan and Guellec (2000), Smolny (1998 and 2002), and Garcia, Jaumandreu and Rodriguez (2004)

The fourth related area of research is in the field of macroeconomics. Specifically, our results contribute to the business cycle literature by investigating the impulse responses to managerial technology shocks, and determining if they are a significant source of short run fluctuations. As the followers of this literature well know, recent results concerning both the importance of technology shocks and the short run response of labor to them are hotly contested because of their implications for model selection.[9] Although much of this work identifies "technology shocks" using long-run restrictions in a VAR, where no distinction is made between product, process or managerial based technology shocks, there is some evidence that not all technology shocks are created equal. The work by Fisher (2006) shows that investment specific changes appear to be a more important source of fluctuations than neutral ones. Alexopoulos (forthcoming) and Alexopoulos and Cohen (2009) further show that product and process technologies – especially electrical technologies, machinery and IT – have played an important role in TFP fluctuations over the past century but both the size of the response, the speed with which these shocks affect the economy and the length of time the effects are felt can vary significantly. Basu et al. (2009) illustrate that there are different responses to investment and consumption specific technology shocks. Given that differences in the responses may be useful in helping evaluate and select among competing business cycle models, the results presented here should aid in this endeavor.[10]

Finally, our work is related to the very broad and important literature that focuses on measuring innovation. Without good measures, it is impossible to answer crucial questions about the quantitative importance of technological advancement for growth and business cycles. This research encompasses both identification and use of direct measures of innovative activity (such as measures of patenting activity, research and development expenditure/personnel, and bibliometric measures of publishing)[11] as well as work on creating and cleansing measures of total factor productivity.[12] Each

[9] See Basu et al. (2006), Christiano et al (2002), Fisher (2006), and Gali (1999).

[10] For example the type of medium run business cycle model examined by Comin and Gertler (2006) vs. the standard RBC model.

[11] While a complete summary of TFP measurement literature is beyond the scope of this paper, the pioneering work of Schmookler (1961), as well as the works reviewed and authored by Griliches (1990), provide a good discussion of traditional patent and R&D indicators; Jaffe and Trajtenberg (2002) present a number of works utilizing the more recent citation weighted patent indicators; and Geisler (2000) provides a good for a review of bibliometric measures based on journal publishing activity.

of the existing measures has different strengths and weaknesses associated with them, and the best one to utilize often depends on the questions at hand. However, if one is interested in exploring and quantifying the impact of managerial technologies on the economy, most would agree that the existing measures are far from ideal – the Solow residual measure 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. Thus, to address these issues, we must create new measures.

3. The indicators

To examine the responses of output, productivity and labor to managerial technology shocks at the aggregate level, the first goal is 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

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

[12] Solow's (1957) seminal paper outlines the theory behind the total factor productivity measurement, and papers such as Basu et al (2006) and Ohanian (2001) present cleansed versions of aggregate TFP measures for the U.S.

in the world.[13] 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 assign call numbers so that items on similar topics are shelved together. For the purpose of this investigation we will be primarily looking at books listed in the H and T subgroups (Social Science or Technology) and QA75-76 (Computer Software and Hardware). [14] Specifically our management innovation indicator is based on titles classified under the LC class HD28-70 (Management and Industrial Mangement), 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. [15] 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.[16] 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.

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

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

[15] 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.

[16] Books with history in the title or with history as a major subject are removed to exclude books that have no real link to current practises or technology. 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.

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 would be available for a long period of time, with at least an annual frequency, to make a time series analysis possible. Second, it would also be objectively determined and cover a wide range of technical advances. Finally, it would capture the arrival timing of the new technologies.

Although the perfect measure may always remain unattainable, the new book-based indicator appears to satisfy the general criteria. Its creation based on the collection of the Library of Congress guarantees (1) the database is fairly inclusive of titles published in the US (primarily for domestic use), (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 catalogues 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

Perhaps one of the indicators most compelling and attractive features is its strong relationship to the dates new management techniques are first adopted by U.S. firms. The reasoning is relatively 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 new titles on technical change in management as quickly as possible, especially since they recognize that any delay in releasing new titles on the subject can result in lost revenues if their competitors are able to release a similar book faster.[17] As can been seen from the evidence presented in Table 1A and Appendix C, there is a very close

[17] While some may be concerned that companies may try to keep their managerial innovations secret, there is evidence to suggest that these attempts are somewhat unsuccessful. For example, Walmart 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 as other companies showed interest in the methodology.

correspondence between first known usage and book dates in the U.S. during the 20th century. The purpose of this exercise is to help evaluate the legitimacy of book publications as a proxy for management knowledge. Many, but not all, of these tools/methods were developed in the U.S. Some are considered to be revolutionary at the time they were introduced, such as scientific management, quality control, personnel management, and total quality management, and are still in use by some firms today. Others are considered to be more minor in their influence, such as one-minute management and Theories X and Y.

To help put the timing of the first book published on each technique in perspective, Table 1A displays the copyright date (found in field 008 in the MARC record) for the first book, alongside known dates for creation/discovery, first known commercial use in the U.S., first associated academic article in the Business Premier database, and first known article on the subject in the Harvard Business Review. While dating the creation and first implementation of various techniques is inherently subjective, it is not impossible.[18] The information on the initial creation and adoption dates listed in Table 1A and Appendix C are obtained from sources such as the Encyclopedia of Management, the Harvard Business Review, Wikipedia and a series of journal articles and websites that provide detailed histories of various techniques.

The information in Table 1A reveals a few notable patters. 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 US.[19] 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 beginning of the technique's diffusion among American firms. Third, contrasting the commercialization date with the first Harvard Business Review and

[18] While there is general agreement on the histories of many techniques, 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/).

[19] It should be noted that for techniques that are popularized by consultants through a book. The date of introduction to market and the book date will always go hand in hand.

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. 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."[20] Therefore, articles on techniques used overseas may appear in print even if they are not currently in use in America. Generalizing the results of this table implies our overall index of new US published management book is a close proxy for changes in stock of American management knowledge.

Alexopoulos (forthcoming) presents similar indicators based on new titles published in the field of technology. Her indicators, which are based on the catalogues of the Library of Congress, captures a wide array of product and process innovations when they are first commercialized since new books on technology (e.g., manuals) are written when the idea or product/process is first being utilized (or is in the process of being implemented).[21] While it is certainly true that the nature of management innovations makes it unlikely that the company who first developed the technique will release a manual to the public, book based indicators should still be able to capture changes in management techniques for the simple reason that the publishing houses will want to release titles to disseminate the information due to the fact a market exists for their product.[22]

3.2.2. Weighting

Given that publishers seek to maximize profits, they will generally release more new titles on

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

[21] The timing is related to the fact that: (1) books are costly to produce, and (2) publishers want introduce the books as early as possible to maximize the return on each new title Moreover, while one might initially worry that there is a significant time lag associated with producing new books, discussions with publishers indicate that the publication lags for technology books is relatively short. Specifically, they reported that they can release a book on a major technological development within 3 months (with a 6 month average). This occurs since technology is a rapidly changing field and publishers recognize that any delay in releasing new titles about new technologies can result in the company failing to realize maximum revenues if their competitors are able to release a similar book faster.

[22] An example of this would be Walmart's innovative practices. While it is certainly true that Walmart has not released books about its practices, numerous books and article shave been written on them.

techniques that they view will be widely utilized (or popular) and fewer on those they believe will be picked up by a smaller fraction of the population. This is illustrated 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 standardized subjects in the field of management. The results suggest that more weight will be placed on the advances related to scientific management, personnel management, project management, quality control and total quality management. Less weight will be assigned to innovations such as PERT and zero-base budgeting. Even taking into account the number of years since development, the publication patterns suggest that TQM was more widely used/influential than techniques like quality circles and just in time management. The counts also suggest that the critical path method, which was developed by the private sector for use in the private sector, was more popular that the competing technique PERT which was developed by the Navy.

More evidence on the relationship between the quantity of management book publications and a technique's overall popularity can be found by considering a few case studies of failed techniques and contrast them to a successful widely used one like TQM. While 1209 English language titles are listed under the Total Quality Management subject heading, there are far fewer titles devoted to techniques like "T-groups" or "one minute management". Specifically, the T-group technique of group training within an organization, first developed in 1947, has only 4 books associated with it. It was not adopted by mainstream firms and was never assigned its own subject heading by the Library of Congress. A second more recent example is the early 1980s smash-hit One-Minute Management which advocated that (1) corporate goals be formulated in such a way that one could express them 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). Thirteen of these titles are associated with the creator of the technique, while the remaining ones appear to criticize it and outline ways to beat the one-minute manager (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). Overall, it appears that ineffective techniques, and those likely to be utilized by a small segment of the market, do not receive the same attention by publishers as widely used successful ones, and, therefore one can view the index of new book titles as a *partially-weighted*

index of management techniques.

3.2.3. Patterns over time

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. There are a few reasons for this: first, there is little time series evidence available on the usage of these tools; second, there is evidence to indicate that firms may adopt a technique for a specific purpose only to shelve its usage until the next time it is needed (which complicates any attempt to define "diffusion" in a traditional way); and, third, 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 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. Even though the patterns of publications are similar for both the journal and new title counts, it appears that publications have only a weak relationship with usage. For example, the TQM and BPR cases show the number of new titles decreasing even though many firms are still employing these techniques – a finding at odds with the basic premise in the Fads and Fashion literature.

3.2.4 Why not use journal article counts?

As Figures 1 and 4 illustrate, the Library of Congress book publication records are correlated with journal counts at a keyword level, given the similar timing in the citation starts and peaks with the LOC data in Table 1. However, the LOC counts provide a superior source of information on management technique adoption along a number of important dimensions. 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.

This contrasts with journal publication indexes that capture publication records only within a limited subset of possible sources. Moreover, 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. Second, 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 carefully 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. Third, 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.

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.[23] 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 Labour, 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 for the period 1945-2002. 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

[23] 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.

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 a simple the time t value of labor's output share, which is calculated using the information in 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 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,[24] ε is an error term and the number of lags to include was selected using the standard Akaike Information Criterion value (Akaike, 1974). Our identification of management shocks is based on 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

[24] Various dates were attempted with no change in the overall results. Moreover, a single cubic trend was also used without change in the results. The date 1973 was selected for consistency with other research.

[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.

measures at a minimum of a 5% significance level.

The variance decompositions, recorded in Table 2, highlight the impact new management techniques have on GDP and productivity. While the percent of variables' variations that are attributable to new managerial techniques (as captured by the indicators) during the first few years depends on the ordering used. However, 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 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, there is evidence that managerial techniques also have a substantial impact on labor productivity with 11.7% of its first year and 55% of its fifth year variation linked to the management variable. Of course, the results presented in the second half of Table 2 do show that the order of the variables matter for the results in the first couple of years. However, these 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% in TFP, GDP and hours worked respectively. As Figure 7 shows, the basic findings are not significantly affected by the ordering used in the VARs.

Although one might initially wonder if the indicators are only capturing trends in the publishing industry or changes in tastes of readers, the evidence presented in Alexopoulos (forthcoming) demonstrate that new titles in fields such as history, music, drama and poetry are not significant predictors of output or productivity. We perform two robustness checks on our results along similar lines, by deflating the management book totals by (1) the number of adult fiction books and (2) the number of children's literature book. Results of both exercises are included in Supplementary Tables and Figures. Our results prove robust to these exercises and, therefore, are strongly suggestive of a nontrivial relationship between management techniques and economic 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.

As Cyert and Mowery (1987) point out new technologies often require changes in the process used to create them, and new processes often affect the types of products. Given that managerial technologies are related in many ways to process innovations, it is interesting and informative to add a measure of non-managerial technical change to the system. To accomplish this, 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.[27]

4.2.1. Output, productivity and hours

The variance decompositions for output, productivity and hours in a specification that includes technology measures are reported in Table 3. Again, they demonstrate the power that new managerial techniques can have on economic output and productivity– especially after a few years. While the percent of the variation attributable to new management techniques does decrease somewhat, the magnitudes are still impressive. While 6% and 4% of the first year variation of TFP and GDP is linked to new management titles, respectively, these magnitudes increase to 21% and 8% after 2 years, and 23% and 12% after 5. For hours worked, a similar pattern emerges with 2% attributable in year one, and nearly 8% linked to management by year 5. 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 5 years. Although, it is clear that the traditional non-managerial technologies captured by the technology indicator has an important role to play at the 5+ year horizons. Indeed, by the 8 year horizon the results suggest that often 40% or more of the variation in GDP and TFP, and almost 35% of the variation in hours, are attributable to the two types of technical 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 5 to 6 years. However, in comparison to the results shown in Figure 6, the peak

[27] 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.

responses for the variables: (1) tend to be hit a couple of years earlier and (2) 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. While managerial technology shocks tend to cause an immediate and significant increase the variables in question for approximately 5 years, non-managerial technology shocks tend to have their greatest impact on output, productivity and hours between 6 years after the date of the shock, and cause significant increases in year 3. Moreover, these findings do not depend on whether or not computer technologies are included in the aggregate measure of technical change used.

4.2. Adding other measures of Technology to the mix

While the result presented above are informative, a number of other interesting issues can be addressed by adding to the VARs a variable that captures the more standard product & process based technical change. The inclusion of such a measure will allow us to: (1) determine if the results presented above survive when 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 accomplish this, 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.[28]

4.2.1. Output, productivity and hours

The variance decompositions for output, productivity and hours in a specification that includes technology measures are reported in Table 3. Again, they demonstrate the power that new managerial techniques can have on economic output and productivity – especially after a few years. While the percent of the variation attributable to new management techniques does decrease somewhat, 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 2 years, and 28% and 16% after 5. For hours worked, a similar pattern emerges with almost 4%

[28] 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.

attributable in year one and 8% linked to management by year 5. 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 5 years. Moreover, it is clear that the traditional non-managerial technologies have an important role to play at the 5+ year horizons. Overall, by the 8 year horizon the results suggest that approximately 40% of the variation in TFP and hours, and almost 45% of the variation in GDP, are attributable to the this type of technical change.

The impulse responses and 95% bootstrapped confidence intervals based on these tri-variate VARs are graphed in Figures 8 and 9, with Figures 8 depicting the responses of the variables to a management technology shock, and Figures 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 5 to 6 years. However, in comparison to the results shown in Figure 6, the peak responses for the variables: (1) tend to be hit a couple of years earlier and (2) 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. While managerial technology shocks tend to cause an immediate and significant increase the variables in question for approximately 5 years, non-managerial technology shocks tend to have their greatest impact on output, productivity and hours between 6 years after the date of the shock, and cause significant increases in year 3.

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.[29] 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 5 years.[30] In contrast, the non-managerial technology shock appears to have no significant short-run decline and significantly expands hours worked between years 3 and 7.[31]

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

[30] 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).

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

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 shocks are, in many ways, related to process based technological change. As the industrial relations literature in this area shows, the response of labor to a process innovation depends on the relative magnitude of two competing effects. 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 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, depends on which of these effects dominate at various points of time. In our case, it appears that the first effect dominates within the first 2 years while the second effect dominates from years 3 to 7.

4.2.2. Which Comes First, Management or Traditional Technology?

Cyert and Mowery (1987), when discussing issues associated with the measurement of product and process innovations, argue that product and process innovation often goes hand in hand with one another. Specifically, 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 hypothesis is consistent with evidence in Alfred Chandler's (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' and depended on advances in railroad, transportation and communications technologies as well as innovations in machinery.[32]

While Chandler's (1977) evidence was based on case studies, we can use the bi-variate and the tri-variate VARs 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. 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

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

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.

The variance decompositions paint a similar picture (see Table 5 for a few examples). While 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

To assess the sensitivity of the results presented above, we estimate a six variable system. The ordering of the variables is as follows: ln(Mgmt), ln(hours), ln(TFP), commercial paper rate, ln(CPI), and ln(non-managerial technology). Since the federal funds rate is unavailable for the entire period 1929-2002 we use the short term commercial paper rate to capture the effects of monetary policy shocks, and include the CPI to determine if the inclusion of prices significantly alters the results.[33] As is standard in the literature on monetary policy shocks, the quantity variables (TFP and Hours) are ordered before the interest rate and prices afterwards.[34] For comparability we maintain our ordering of the management series first and other technology series last. Table 4 reports the variance decompositions and Figure 11 displays the responses to a 1% managerial technology shock. Overall, these results confirm the findings from the tri-variate VARs. In addition, they indicate that prices and interest rates are virtually unaffected by this type of technology shock.

5. Conclusion

Many 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 belief because of the problems associated with measuring technological change in management. To address this issue, in this paper we develop a new indicator of organizational innovations for the U.S and use

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

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

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 compared with 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 appear to be nearly as important as advances in non-managerial technical change. However, the impact of managerial technologies on both productivity and output 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.).

In addition to providing the first measure of technical change in management, our findings should be useful in evaluating and selecting among competing business cycle models. 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	First HBR Article**	First Academic Article***	First U.S. Book Published	First Known Commercial Adoption In the U.S.
Scientific Management	1910	n/a	1911	1911	1910
Personnel Management	1910	n/a	1923	1910	1914
Quality Control	1922-1924	1925	1925	1922	1924
Management by Objectives	1954	1957	1957	1954	Mid-50s
Critical path Analysis/ Critical Path Method	1956	1963	1959	1961	1958-1959 (Dupont)
Program Evaluation and Review Technique (PERT)	Jan. 1958	1962	1959	1961	1958-Navy 1961-mainstream adoption
Theory X and Theory Y	1957	1963	1963	1960	Early-60s
Managerial Grid	1962	1964	1964	1964	1963
SWOT / SOFT	1963	1971	1971	1971	1966 (prototype)
Experience / Learning Curve	1936 (Related Concept) 1962-1965	1954 (1st) 1964 (2nd)	1962	1965	1966
Just-In-Time	1948 (JPN: Toyota)	1985	1977	1982	Late 1980
Quality Circles	Early-60s (Japan)	1985	1967	1976	1974
Five Forces Analysis	1979	1979	1979	1980	Early-80s
One-Minute Management	1982	1984	1982	1982	1982
Total Quality Management	1951 (Japan)	1956 (TQC) 1981	1981	1982	Early-80s
Business Process Reengineering / Redesign	1990	1990	1990	1992	1991

*Detailed source information for these dates may be found in Appendix B
**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
Personnel Management	Personnel Management (c)	8077
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*)

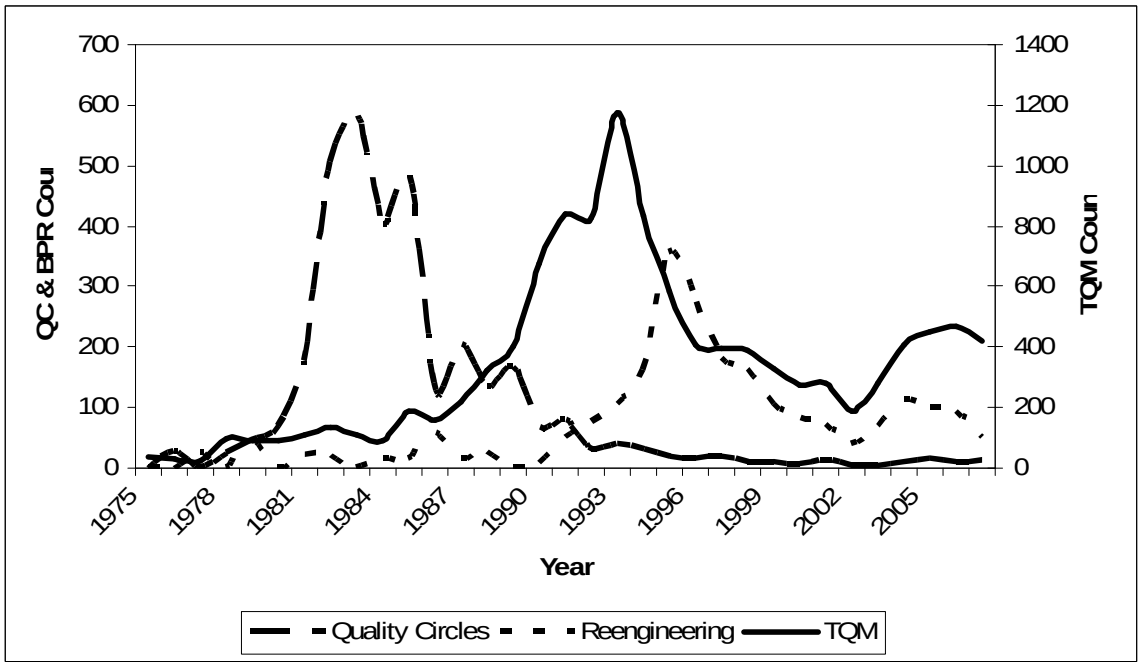
	Response Variable				
Horizon	Log(H_t)	Log(TFP_t)	CP Rate	CPI	Log(Tech.)
1	0.2714	5.3092	0.1192	0.0505	3.5917
2	4.3231	19.0183	1.2491	0.7641	4.1154
3	17.6858	17.285	1.1402	6.1597	4.8341
5	17.5955	13.1351	2.8623	6.7365	4.1726
8	16.9381	7.8213	2.7925	6.1331	4.3065

Table 5: VAR Variance Decomposition

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

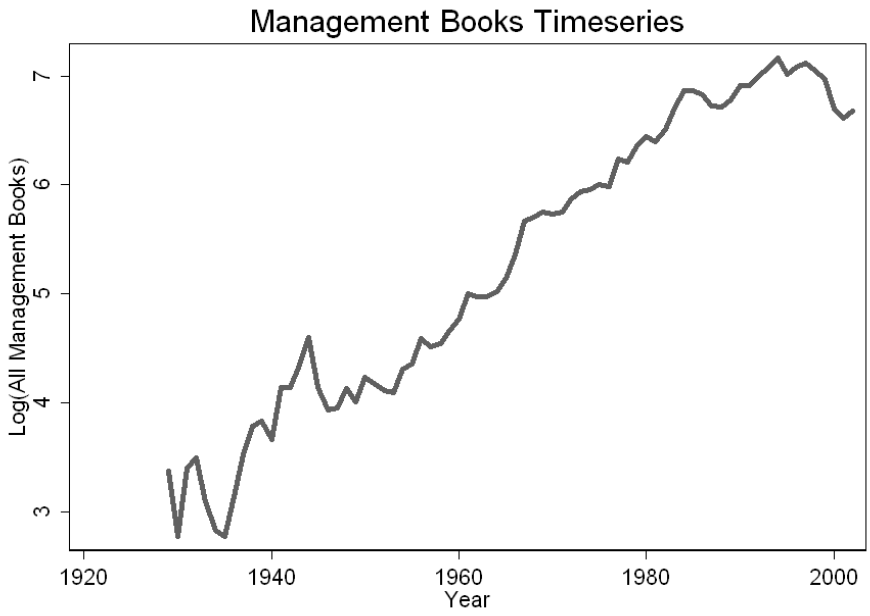
Horizon	Technology Response to Management Shock	Management Response to Technology Shock	Technology Response to Management Shock	Management Response to Technology Shock
	Bivariate Case		***Trivariate Case (Includes GDP)***	
1	9.13	0	8.863	0
2	6.0691	5.38	5.5392	7.5456
3	4.6412	26.3763	4.3173	28.0743
5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

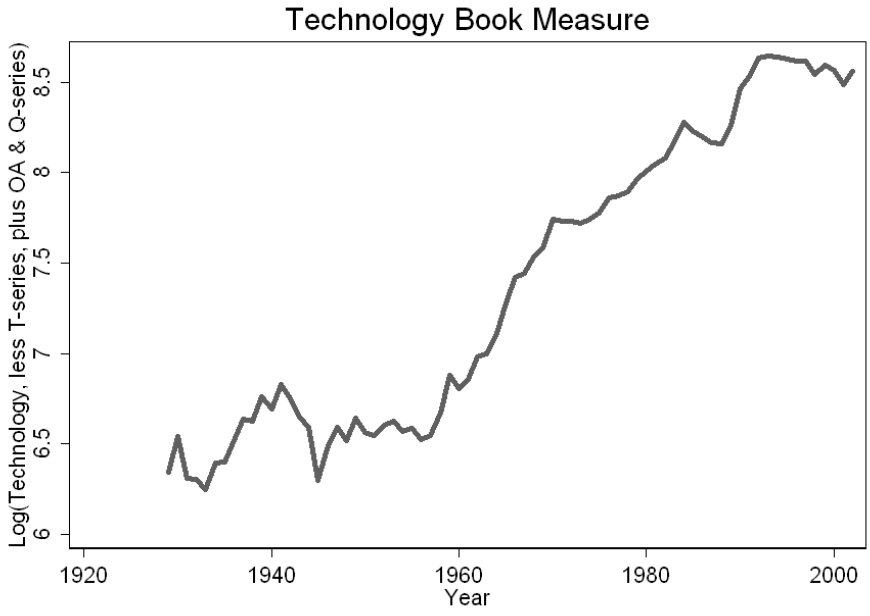
Figure 1: Adjusted Article Counts



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

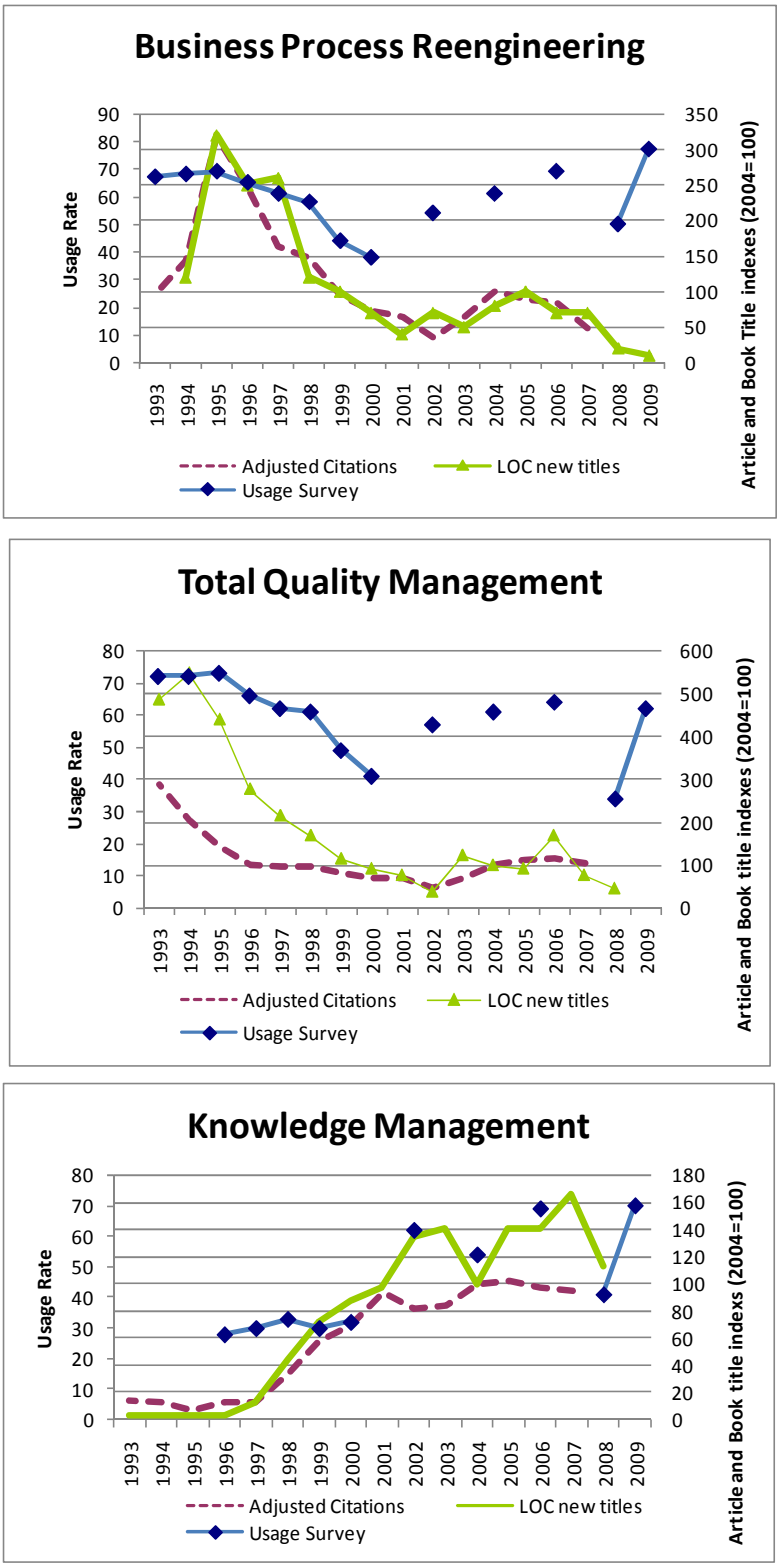


Figure 4: Selected Library of Congress Book Counts

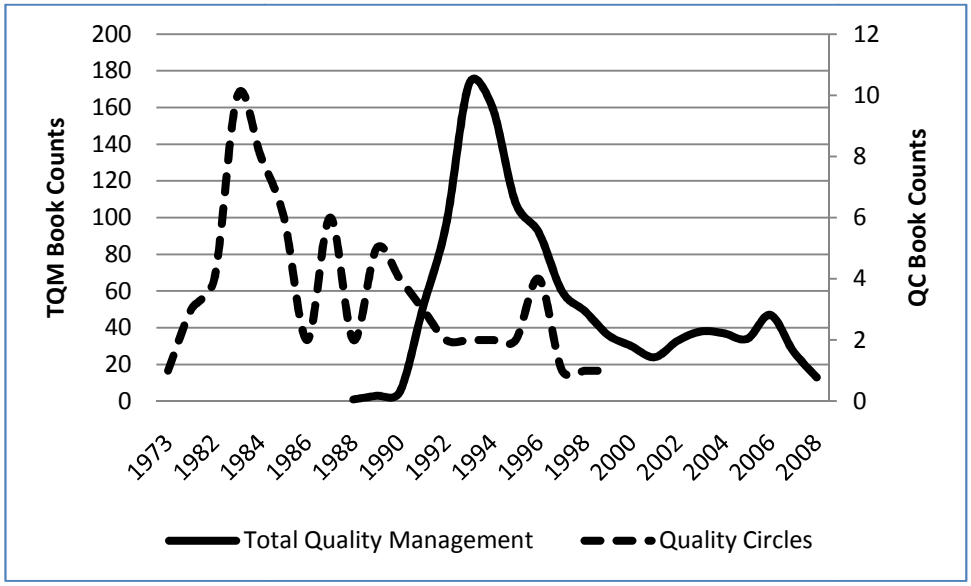
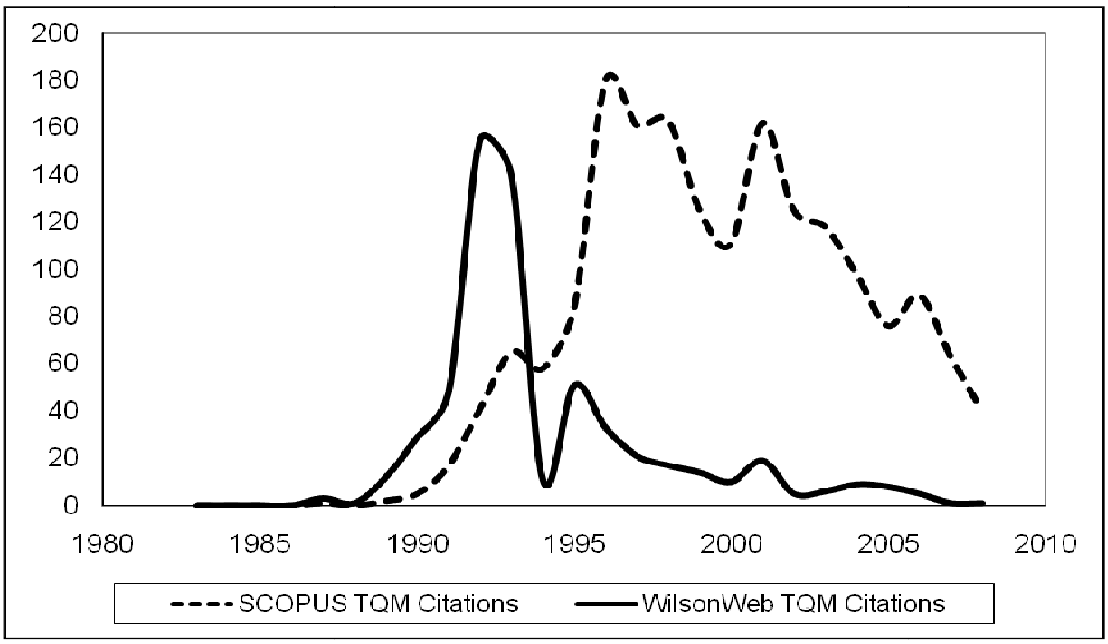


Figure 5: Journal Entry Counts



Source: Author's calculations from respective online database.

Figure 6: Impulse Response Functions, First Ordering

Figure 6 (a): Management on Real GDP

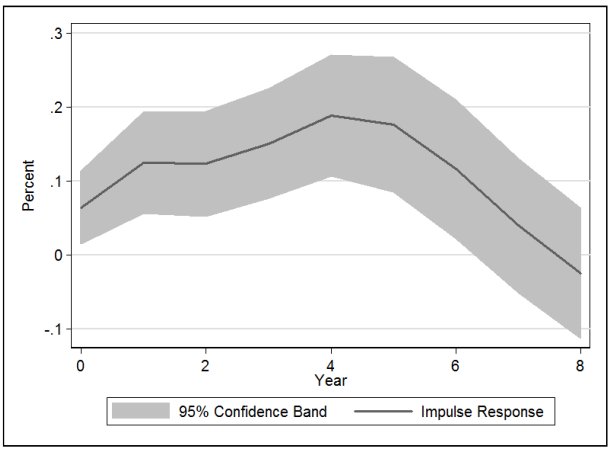


Figure 6 (b): Management on TFP

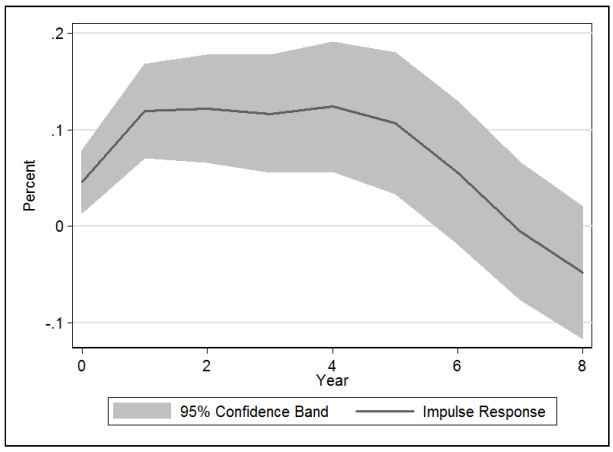


Figure 6 (c): Management on Labour Supply (Hours)

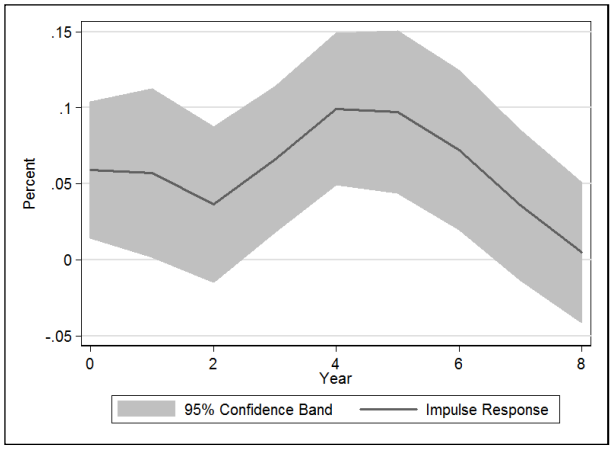


Figure 7: Impulse Response Functions, Second Ordering

Figure 7 (a): Management on Real GDP

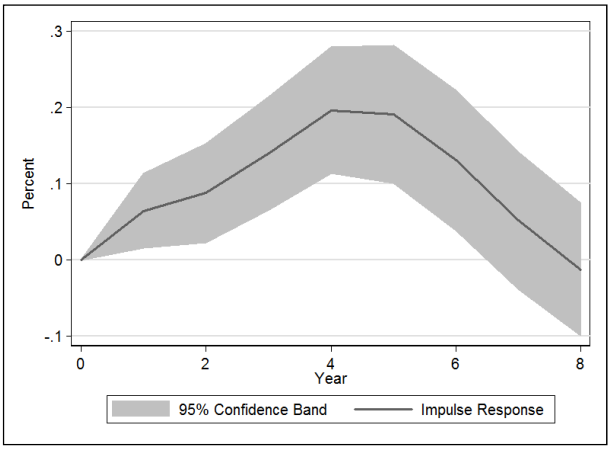


Figure 7 (b): Management on TFP

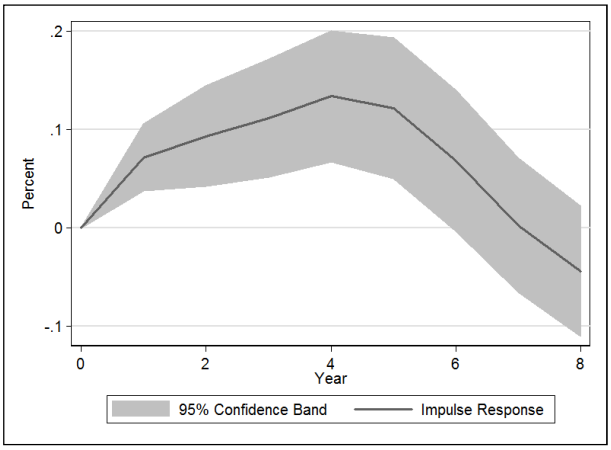


Figure 7 (c): Management on Labour Supply (Hours)

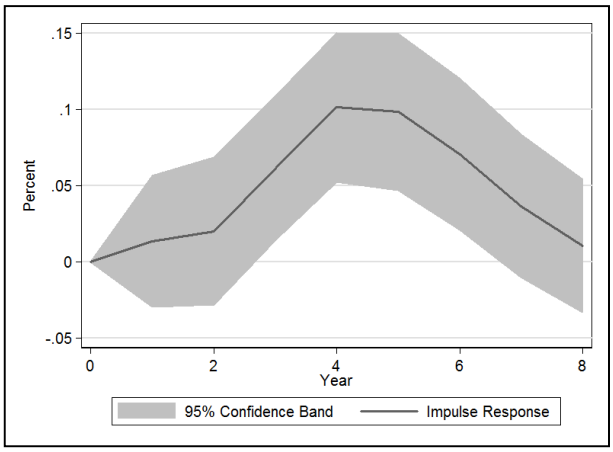


Figure 8: Impulse Response Functions (Tech: All, plus OA, less T-series man.)

Figure 8 (a): Management on Real GDP

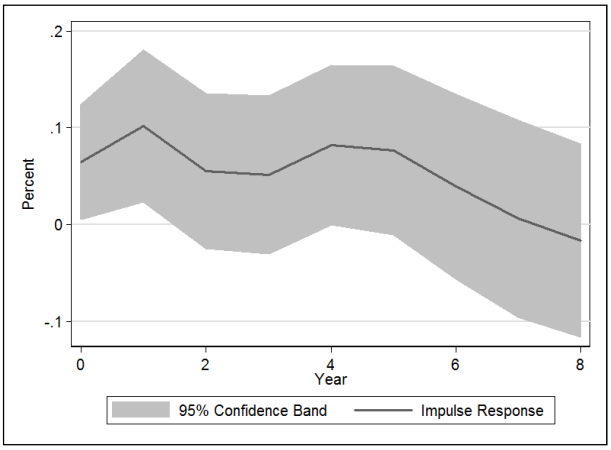


Figure 8 (b): Management on TFP

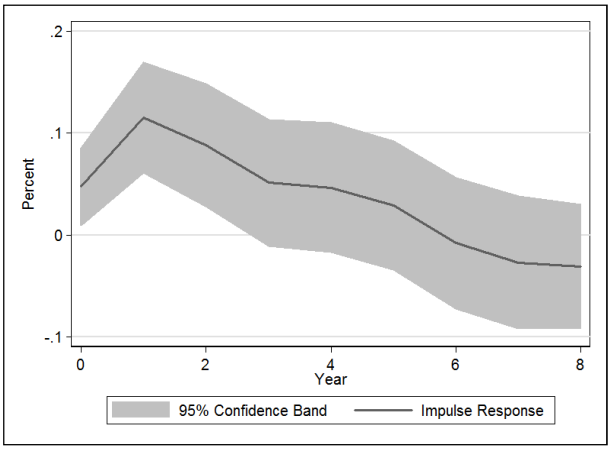


Figure 8 (c): Management on Labour Supply (Hours)

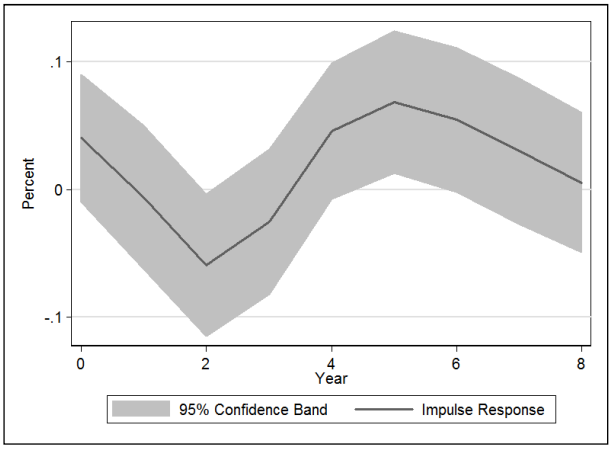


Figure 9: Impulse Response Functions (Tech: All, plus OA, less T-series man.)

Figure 9 (a): Technology on Real GDP

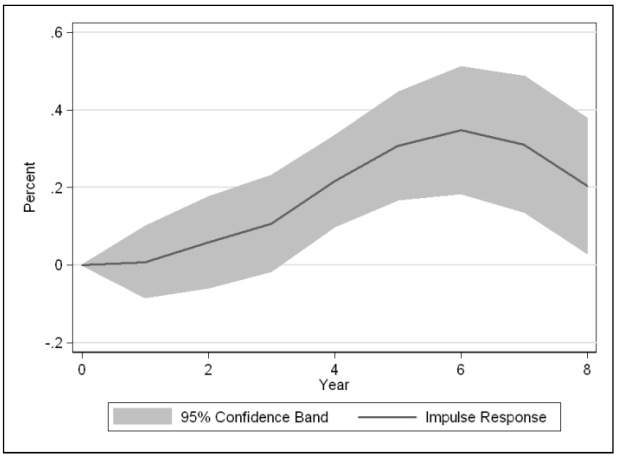


Figure 9 (b): Technology on TFP

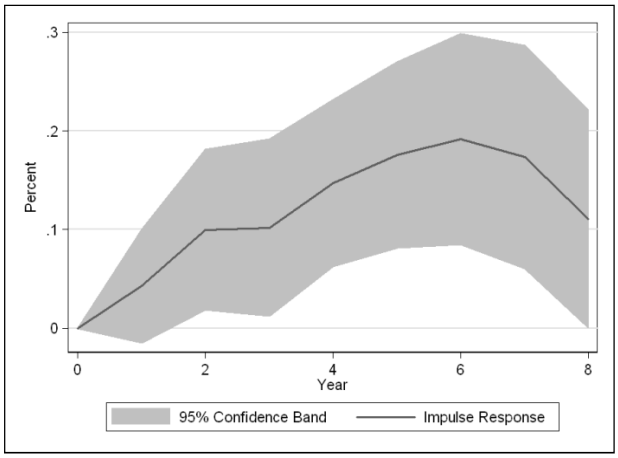


Figure 9 (c): Technology on Labour Supply (Hours)

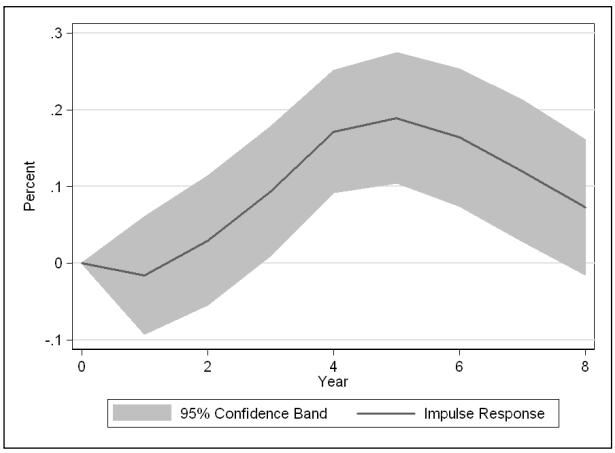


Figure 10: Impulse Response Functions, Technology vs. Management

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

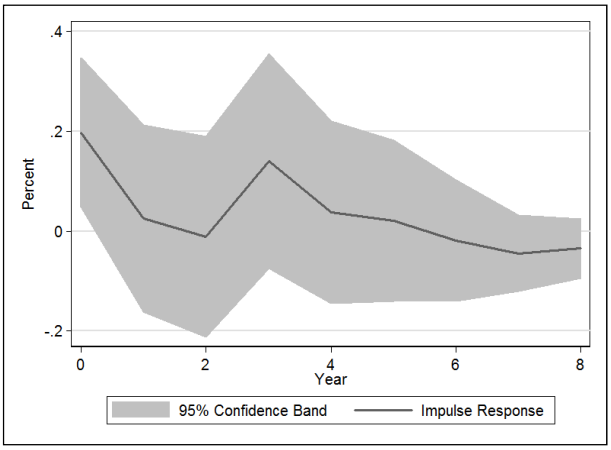


Figure 10 (b): Bivariate Case, Management Response to Technology Shock

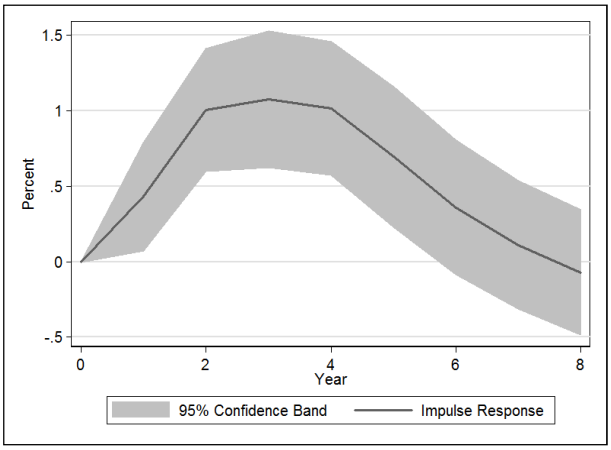


Figure 10 (c): Trivariate Case, Technology Response to Management Shock

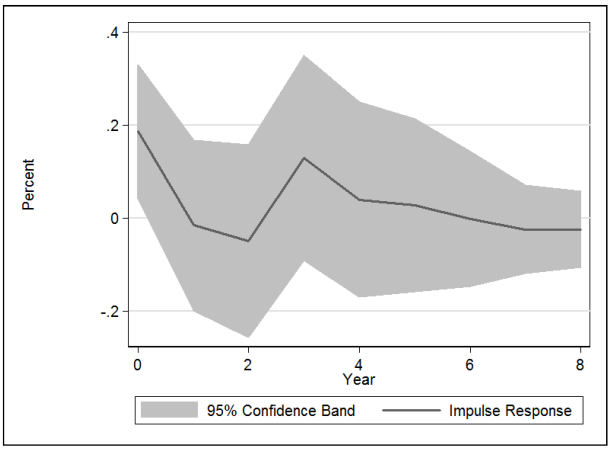


Figure 10 (d): Trivariate Case, Management Response to Technology Shock

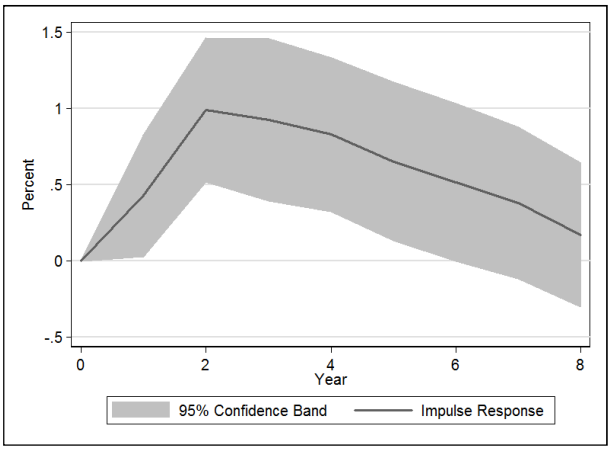


Figure 11: Impulse Response Functions, Large Multivariate Specification

Figure 11 (a): Management on Hours

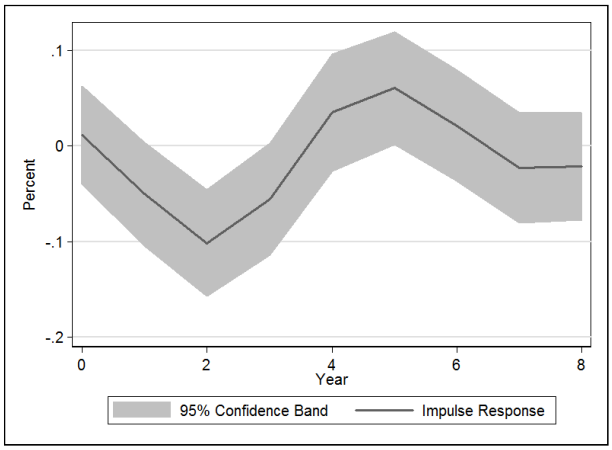


Figure 11 (b): Management on TFP

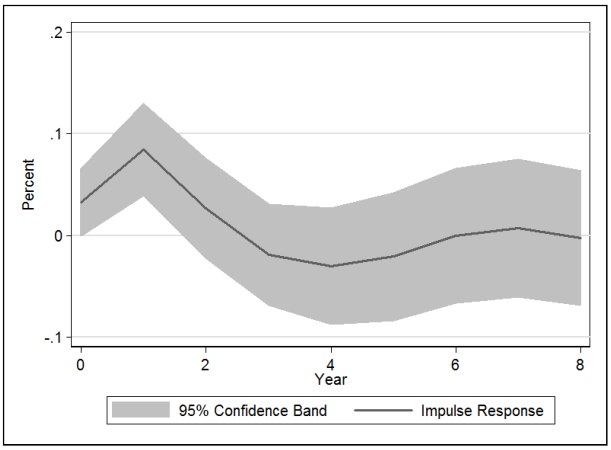


Figure 11 (c): Management on CP-Rate %

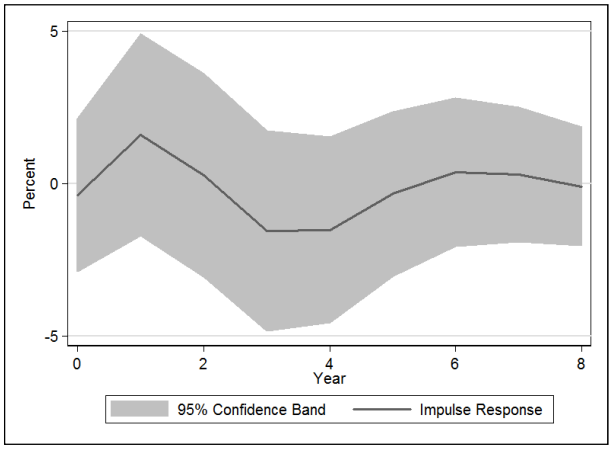


Figure 11 (d): Management on CPI

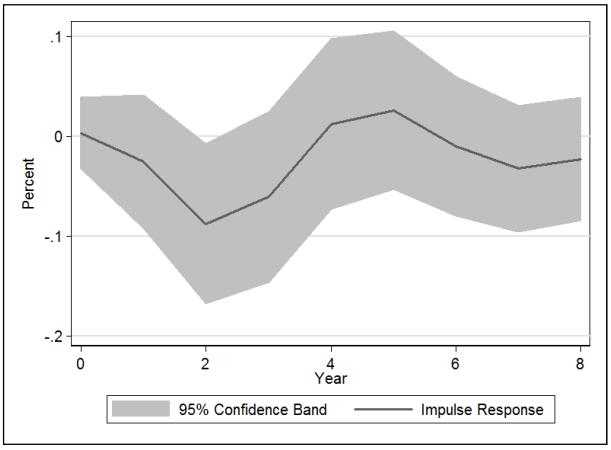
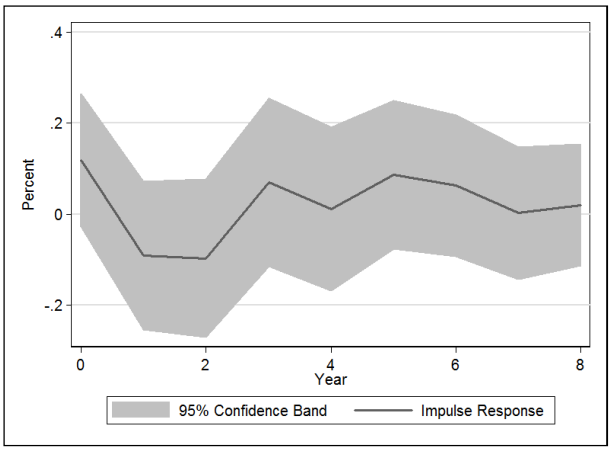


Figure 11 (e): Management on Technology



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	1911	Frederick Taylor, "Principles of Scientific Management" and Frank Galbraith, "Motion Study"	1910-1912	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		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
Human Relations	1913-1924	Industrial psychology in 1913, followed by work by mary Follet in "Creative Experience"	1923-1924	The first HBR article: Willard E. Hotchkiss, 1923. "Industrial Relations Management," Harvard Business Review 1 (4): 438-450. In 1924 Mark Follet published "Creative Experience"	1913	Huge Munsterberg, "Psycology and Industrial Efficiency," was the first book on industrial psychology (George, 1972)
SWOT	1963	Kenneth Andrews at Harvard Business Policy Symposium	1971	Kenneth Andrews, "The Concept of Corporate Strategy"	1971	Kenneth Andrews, "The Concept of Corporate Strategy"
Project Management	1956-58	DuPont develops CPM and US Navy develops PERT	1963	First HBR article: 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	1964	Joseph J. Moder and Cecil R. Phillips, "Project management with CPM and PERT," New York, Reinhold Pub. Corp., 1964
Five Forces Analysis	1979		1979	Michael Porter, 1979. "How competitive forces shape strategy," Harvard Business Review 57 (2): 137-145	1980	Michael Porter, "Competitive Strategy"
Managerial Grid	1962	Robert Blake and Jane Mouton, 1962. "The Managerial Grid." Advanced Management Office Executive, 36. (source: Bennis, 1963)	1964	Thousands attended seminars before the book came out. 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"

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"
Management by Objectives	1954		1954-1957	Peter Drucker, "The Practice of Management" (1954) and Douglas McGregor, "An Uneasy Look at Performance Appraisal," Harvard Business Review (May-June, 1957)	1954	Peter Drucker, "The Practice of Management"
Experience Curve	1965	Boston Consulting Group (Ghemawat, 2002)	1968	Publication by Boston Consulting Group, "Perspectives on Experience," Boston: Boston Consulting Group.(source: Bass, 1980)	1968	E. B. Cochran, "Planning production costs: using the improvement curve," San Francisco, Chandler Pub. Co., 1968
Just-in-Time	1972	Taiichi Ohno and the "Toyota Production System" (Schonberger, 1982)	1980-1982	Kawasaki plant in Lincoln, Nebraska adopted in 1980, with published results of their experience in 1982 (Schonberger, 1982)	1985	Robert W. Hall, "The implementation of zero inventory/just-in-time," Falls Church, Va.: APICS, 1985
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)
Business Process Reengineering	1990	Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," Harvard Business Review; Jul/Aug90, Vol. 68 Issue 4, p104-112	1993-1995	O'Mahoney (2007) states it was the 1993 book that made it catch on and "within two years... 75 percent of companies in some sectors reported its implementation."	1993	Michael Hammer and James Champy, "Reengineering the Corporation: A Manifesto for Business Revolution," New York, NY : HarperBusiness, c1993.

General Table Sources:

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Pankaj Ghemawat, 2002. "Competition and business strategy in historical perspective." The Business History Review 76 (1): 37-74
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
Frank H. Freeman, 1985. "Books That Mean Business: The Management Best Sellers", The Academy of Management Review 10 (2): 345-350
Joseph O'Mahoney, 2007. "The Diffusion of Management Innovations: The Possibilities and Limitations of Memetics," Journal of Management Studies 44 (8): 1324-1348