

Innovation Measurement

Tracking the State of Innovation in the American Economy

A Report to the Secretary of Commerce by
**The Advisory Committee on
Measuring Innovation in the
21st Century Economy**

January 2008

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Acknowledgements

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We have benefited greatly from the guidance of Cynthia A. Glassman, Under Secretary for Economic Affairs, and appreciate the assistance we have received from her staff at the Department as we have prepared this report.*

We are also grateful for the support of the Department's statistical agencies: the Census Bureau and the Bureau of Economic Analysis.

In addition, we wish to thank all those who submitted comments to us in response to our *Federal Register* request. All of the submissions helped us greatly in thinking through our ideas and formulating our recommendations.

* Particular thanks go to: Jane W. Molloy, David N. Beede, Sabrina L. Montes, Joseph V. Kennedy, Cassandra A. Ingram, Beethika S. Khan, Daniel D. Bachman, David K. Henry, Kemble Stokes, Jacque Mason, and Dar Davis.

Transmittal Letter from the Committee

January 2008

The Honorable Carlos M. Gutierrez
Secretary of Commerce
U.S. Department of Commerce
Washington, DC 20230

Dear Mr. Secretary:

You charged this Committee with developing “new and improved measures of innovation” in three areas: how innovation occurs in different sectors of the economy, how it is diffused across the economy, and how it affects economic growth. As chair of the Advisory Committee on Measuring Innovation in the 21st Century Economy, I am pleased to present a report that is the culmination of nearly a year’s worth of study and consideration by the members, and that we believe represents the most fundamental changes that can be made to advance our understanding of innovation.

While we recognize that the American economy is changing in fundamental ways—and that most of this change relates directly to innovation—our understanding remains incomplete. Indeed, data collection and measurement, while seemingly mundane, loom large in understanding these changes. Policymakers, investors, executives, managers, consumers, and researchers require accurate and complete information in order to make informed decisions. The centrality of the need to advance innovation measurement cannot be understated.

The difficult work of improving our measurement systems is only just beginning. On behalf of the Committee, I want to thank you for this opportunity, and I look forward to the improved information that will become available if the Committee’s recommendations are implemented.

Sincerely yours,

A handwritten signature in black ink, reading "Carl J. Schramm". The signature is fluid and cursive, with a prominent "C" and "S".

Carl J. Schramm
Chair
Advisory Committee on Measuring Innovation in the 21st Century Economy

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Executive Summary

MEASURING INNOVATION AND ITS IMPACT ON THE ECONOMY

The Advisory Committee on Measuring Innovation in the 21st Century Economy was established by the Secretary of Commerce in September 2006 to recommend ways to improve the measurement of innovation in the economy. In its report, the Advisory Committee outlines its recommendations to the Secretary of Commerce for steps to be taken by the government, the business community, and government and private sector researchers to foster and improve the measurement of innovation in the economy.

The first act of the Advisory Committee was to establish a definition of innovation that would identify what should be measured. The definition adopted by the Committee is:

The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.

The definition recognizes that the innovation to be measured is more than simply something new; it has the added component of adding value for both customers and firms. The definition also recognizes that innovation measurement needs to extend beyond simply measuring inputs. While it is important to track inputs to innovation – such as research and development spending – that is not enough. Outcomes of innovative activity need to be tracked and measured to determine fully the impact of innovation on the economy.

As part of its work, the Committee published a *Federal Register* request for public comments and received many helpful responses. These comments were extremely useful in informing both the guiding principles and the recommendations adopted by

the Committee. The *Federal Register* request and copies of all the comments received can be accessed on the Advisory Committee's web site at www.innovationmetrics.gov.

The following set of principles was developed by the Advisory Committee to guide its own work:

- Innovation data collection efforts should build on the way firms assess the effectiveness of their innovative activities.
- When developing better ways to quantify innovation in the marketplace, consideration should be given to measuring the impact of legislation and regulations on innovation.
- Because of the nature of innovation and, in particular, the collaborative nature of the innovative process, there needs to be tolerance of qualitative and subjective measures.
- Innovation measurement should not be static. Measurement is an iterative process that needs to be treated less like a 'project' and more like an ongoing 'dialogue.' Learning and improvement are to be gained from each stage of the process.
- Innovation measures should allow for analysis at the establishment, firm, industry, country, international, and, where possible, regional levels.
- A conservative approach should be taken to any new data collection effort by recognizing tradeoffs between costs and potential benefits and considering resource and regulatory constraints. The implementation of pilot projects to gauge the costs and benefits of new data collection efforts is encouraged. To the

extent possible, new innovation measures should be able to be ‘back-tested’; that is, if applied to historical data, the measures should produce the expected innovation relationship.

The principles guided the work of the Advisory Committee and should also apply to implementation of the Committee’s recommendations.

The bulk of the Advisory Committee’s work was devoted to developing recommendations to the Secretary of Commerce for actions to improve innovation measurement. The recommendations endorsed by the Committee are summarized briefly below and appear in a more comprehensive list at the end of this summary. All of the recommendations are described in more detail in the body of the report.

WHAT THE GOVERNMENT SHOULD DO

To achieve the long-term goal of measuring the impact of innovation on the economy, the Advisory Committee recommends that the government create a coordinated emphasis on innovation measurement. The effort will require structural refinements of existing government data sets, the collection of new and better data, improved linkages among statistical agency data sets, and expanded data sharing/synchronization authority.

In particular, the Advisory Committee recommends that the government:

- Create a stronger framework for identifying and measuring innovation in the national economy.
- Better leverage existing data among the statistical agencies to allow for the consistent estimation of the contributions of innovation in the gross domestic product (GDP) and productivity accounts and to develop greater understanding of innovation.
- Increase access to data in order to facilitate more robust innovation research.

- Convene one or more workshops or forums under the auspices of the Secretary of Commerce to discuss innovation drivers, impediments and enablers.
- Continue participation in the international dialogue related to measuring and analyzing innovation and ensure that U.S. efforts are internationally compatible to the extent possible.
- Consider development of a national innovation index when more work has been done on both data collection and analysis of innovation drivers.
- Support funding necessary to implement the above recommendations.

Most of the recommendations for government action build on existing programs or activities. These include the U.S. National Income and Product Accounts (NIPAs) which constitute the official framework used by the Commerce Department’s Bureau of Economic Analysis (BEA) to estimate output, income and expenditure, trade, capital formation, and wealth in the U.S. economy. The NIPAs were devised to help policymakers deal with the severe economic fluctuations produced by the Great Depression and World War II and have been continually refined since then. The NIPAs now provide policymakers with an unrivaled ability to adjust policy quickly and appropriately in response to short-term economic fluctuations. The NIPAs were not originally designed to measure innovation or delve into the causes of long-term productivity growth. Today, however, when policymakers are increasingly shifting attention from short-term stabilization to long-term economic growth, changes to the NIPAs need to be made to accommodate this new focus.

Refining the framework for measuring the performance of the national economy is an essential element in the government’s program to measure innovation in the national economy and refine overall economic measurement. These improvements will take time as there is considerable preliminary work to be done not only by BEA but also by the other

statistical agencies upon which BEA relies for data. The four major elements of this program are: integrating industry-level estimates of total factor productivity¹ with the NIPAs; creating a supplemental innovation account; improving service sector data; and improving the measurement of intangibles. Work on each of these four elements has already begun, although additional funding will be required to move forward.

The Advisory Committee also recommends that the statistical agencies pursue an agenda in support of the development of linkages between data sets both to improve data consistency and to provide a richer data base for understanding and explaining innovation. Full implementation of such an agenda would require new legislation. The statistical agencies are currently limited in their authority to share data and that, in turn, affects data consistency.

Linkages between establishment-based data and firm-based data would be particularly useful for tracking and measuring innovation. Most U.S. industry statistics are estimated using establishment-level data as the basic ‘building blocks.’ Such statistics have been very useful for many purposes, as they combine data for establishments that do approximately the same things. However, many firms own or control more than one establishment, and those establishments may be located in different geographic areas and may be producing different kinds of goods or performing different kinds of services, some of which, such as technology licensing transactions, may be of particular importance to the innovation process. Reassembling establishment-level data into firm-based statistics may lead to better innovation measurements. Furthermore, firm- or establishment-level data from one data source can be augmented by matching them to corresponding data from other sources to obtain a more complete picture of innovation. All of these linked data are understood best when also matched over time to create longitudinal data sets. In the longitudinal records, the dynamics of business and innovation begin to emerge.

¹ Total factor productivity (TFP) is output per unit of total input (hours worked and use of capital). The growth of TFP in excess of the growth of total inputs is attributable, in part, to innovation.

The Advisory Committee recommends that the Secretary support legislation to enable the statistical agencies to undertake expanded data sharing/synchronization activities. In particular, amending the law to expand access to IRS data to additional statistical agencies for the purposes of reconciling the business lists and designing more effective survey business frames would improve our understanding of the U.S. economy.

To encourage more research by non-government researchers, the Advisory Committee recommends that the government encourage innovation research by making public data more transparent through the use of data-tagging or similar methods of making data more user-friendly and by improving access to data through the creation of more public use data files. Such efforts are being undertaken currently by some agencies and the Committee encourages the expansion of such efforts. In addition, the Advisory Committee also recommends the expansion of non-government researcher access to confidential micro-data, including that on business dynamics, while maintaining high standards for confidentiality.

A major issue raised by many of the Committee members was the need to examine innovation drivers, impediments, and enablers. Since the issue was outside the scope of the Committee’s mandate, it was not fully explored. However, given the importance of the topic, the Committee calls on the Secretary of Commerce to convene one or more workshops or forums to examine innovation drivers, impediments and enablers.

The Advisory Committee recognizes the importance of the international dialogue on innovation and recommends that it be continued and that efforts be made to ensure that new innovation measures allow for analysis across countries.

Finally, the Advisory Committee recommends support for the additional funding that will be necessary to implement the recommendations.

HOW THE BUSINESS COMMUNITY CAN HELP

Measuring innovation must be a collaborative process, and there is much that the business community can do to assist and drive improvements in innovation measurement. In particular, the Advisory Committee recommends that the business community:

- Create, expand and assess firm and industry-level measures of innovation and develop best practices for innovation management and accounting.
- Participate in research activities and, as appropriate, make innovation information available to researchers.

One of the guiding principles endorsed by the Advisory Committee was that innovation data collection efforts should build on the way firms assess the effectiveness of their innovative activities. Individual firms, trade associations and other organizations are important partners in developing and testing innovation measures.

WHERE RESEARCH IS NEEDED

While our understanding of innovation has increased over recent years, much more needs to be learned about innovation and its measurement. Government, business, and academic researchers should undertake research – alone and in collaborative efforts – to understand innovation better. In particular, the Committee recommends exploration of the following research areas:

- Identification and assessment of innovation outcome measures.
- Identification of gaps in innovation data and how they might be filled.
- Analysis of relationships between innovation activities and collaboration, innovation performance and firm performance.

CONCLUSION

The recommendations, if adopted, will go far in setting this nation on a course toward effectively measuring the impact of innovation on the economy. The work is essential to understanding and developing better policies for innovation. The Committee calls on the government, the business community and researchers to work together to improve the understanding and measurement of innovation.

COMPLETE LIST OF ADVISORY COMMITTEE RECOMMENDATIONS

WHAT THE GOVERNMENT SHOULD DO

Create a stronger framework for identifying and measuring innovation in the national economy.

- Develop annual, industry-level measures of total factor productivity by restructuring the National Income and Product Accounts (NIPAs) to create a more complete and consistent set of accounts integrated with data generated by other statistical agencies to allow for the consistent estimation of the contributions of innovation to economic growth.
- Create a supplemental innovation account for the NIPAs in order to expand the categories of innovation inputs and allow those inputs to be tracked as they flow between industries.
- Improve service sector data and increase survey coverage to provide the data needed to improve estimates from the integrated GDP/productivity accounts and supplemental innovation account.
- Improve measurement of intangibles, particularly intellectual property, building on work currently under way at the National Science Foundation. Consider the best way in which to collect data on transactions involving key intangible assets such as intellectual property licensing expenditures and revenues. The Commerce Department should also explore whether additional identifying information from patent and trademark applicants might provide useful data.

Better leverage existing data among the government statistical agencies to allow for the consistent estimation of the contributions of innovation in the GDP and productivity accounts and to develop greater understanding of innovation.

- Develop linkages within and between existing data; for example, develop linkages between establishment-based data sets and firm-based data sets to provide both greater consistency in estimations and to provide researchers a broader range of innovation data.
- Develop more robust classification methods; for example, classify firms on the basis of both domestic and international activities.
- Seek expanded interagency data sharing/synchronization legislative authority in order to improve the quality of innovation measures while balancing data needs with confidentiality protection.

Increase access to data in order to facilitate more robust innovation research.

- Increase the transparency of and access to public data by fostering the use of data tagging and similar processes.
- Create more public use files in order to encourage more non-governmental research.
- Expand non-government researcher access to confidential micro-data, including that on business dynamics, while maintaining high standards for confidentiality.

Convene one or more workshops or forums under the auspices of the Secretary of Commerce to discuss innovation drivers, impediments and enablers.

Continue participation in the international dialogue related to measuring and analyzing innovation and ensure that U.S. efforts are internationally compatible to the extent possible.

Consider development of a national innovation index when more work has been done on both data collection and analysis of innovation drivers.

Support funding necessary to implement the above recommendations.

HOW THE BUSINESS COMMUNITY CAN HELP

Create, expand and assess firm and industry-level measures of innovation and develop best practices for innovation measurement.

- Institute firm-level measures of innovation to test the correlation of particular measures with known innovation and to measure innovation in the firm and its impact on firm performance. Possible measures might be based on market share or on innovation intensity (e.g., the share of firm revenue attributable to recently introduced products and services).
- Develop and implement best practices in innovation management and accounting.

Participate in research activities and, as appropriate, make innovation information available to researchers.

- Participate in collaborative projects as a means of assembling a broad range of data related to innovation.
- File public reports in XBRL (Extensible Business Reporting Language), a data-tagging format, when it is an option.

WHERE RESEARCH IS NEEDED

Much more needs to be learned about innovation and its measurement. Government, business, and academic researchers should undertake research – alone and in collaborative efforts – to explore the following research areas:

Identification and assessment of innovation outcome measures.

- Assessment of the effectiveness of measures based on market share as innovation measures and the feasibility, cost, and burden of developing such measures.

- Assessment of the feasibility, cost, and burden of developing measures of innovation intensity, including a review of other countries' experience in this area, and consideration of a pilot project.
- Analysis of the qualitative and quantitative impacts of specific innovation drivers, impediments and enablers on innovation outcomes.

Identification of gaps in innovation data and how they might be filled.

- Identification of new data that would be useful in measuring innovation.
- Assessment of the feasibility, cost, and burden of collecting data on intellectual property transactions.
- Identification of ways to overcome gaps and shortcomings in historical empirical measures of intangible investments.

Analysis of relationships between innovation activities and collaboration, innovation performance and firm performance.

- Analysis of the relationship between innovation and occupational employment at firms, using firm-level micro-data.
- Evaluation of whether firms with high innovation intensities perform better than otherwise similar firms with low intensities.
- Assessment of the effect of collaboration on innovation outcomes and identification of the key elements of successful collaborative activities.
- Assessment and analysis of cross-national innovation activities of firms.
- Analysis of publicly filed financial and other data on firms, particularly as the data become more user-friendly, to identify innovative practices and firms.

- Description and explanation of business dynamics and, to the extent possible, analysis of their relationship to innovation using longitudinal business databases.
- Exploration of the use of different sources of available data to determine whether there are correlations between innovative performance of firms in different regulatory environments.

A Message from the Chair

WHY MEASURING INNOVATION MATTERS

In one of his final poems, W.B. Yeats observed, “Measurement began our might.” Considering the role innovation has played in the story of America’s economic expansion, we might say that innovation is our might. As the world’s economies flourish, it will become increasingly easy for our fellow citizens and people across the globe alike to forget that this prosperous economic system we all share—what I have referred to as “entrepreneurial capitalism,”²—is largely an American invention. To make this observation, however, is not to write a final chapter. Rather, reflecting on this great achievement—sustained long-term growth and the political stability it has engendered—prompts at least four key questions that are central to America’s next economic chapter.

The first is, what is the relationship between innovation and economic growth? Even the most casual of observers must notice processes that yield not only improvements in the goods and services we encounter in our daily lives but also radically new inventions, unimaginable but a few years or months earlier. This is the hallmark of daily economic life. From continuous improvements in computers and service delivery to the evolution of methods to make the human gene respond to medical intervention, mankind has come to expect that next year we will enjoy an economy that produces yet deeper meaning to the simple expectation that things will be “better, faster, cheaper.” This is the axiom of innovation, and the vocabulary of growth. If we consider the state of economic knowledge, we can look back on a tremendous accumulated body of insight. Our dedication to understanding economic behavior and the workings of markets has led to what should be appreciated as marvelously practical knowledge. As a result of many years of research, mankind is able to operate within a global milieu where central banking systems, efficient capital markets, and highly

specialized labor markets have produced expanding welfare for more and more people.

But to look at the formal statistical record of the United States economy, the vocabulary of innovation is muted if not silent. To appreciate this lacuna, it is important to understand that our system of measurement was conceived largely in response to the Great Depression. Since then, our statistical agencies have been remarkably competent at maintaining and refining public data series. However, the framework of our data infrastructure does not support or reflect the nature of today’s dynamic economy—an economy that has undergone profound changes over the past seventy years. Whatever innovation is (and the concept, as we shall see throughout this report, presents significant definitional problems), its force in the economy is captured only indirectly.

In an era where capital and labor seem abundant for at least the foreseeable future, we have come to see innovation as the most important avenue to growth.

While obviously important, the nexus between innovation and growth is one of the least understood areas of economic life. One reason is that we have not paid sufficient attention to the question of growth itself and what drives economic growth. Prior to the industrial revolution, growth was an unknown dimension of human experience. It is estimated that for millennia, mankind experienced no growth; centuries came and went with lives changing little. Even more importantly, global wealth remained stagnant—few people became richer and few poorer. If there appeared to be an expansion of wealth in one locale, it usually entailed armed conflict in which static goods or precious metals were wrested away from another family, city, or nation. Since about 1820, America’s particular form of entrepreneurial capitalism has presented the most consistent expansion of wealth experienced in history – a twenty-fold increase in living standards. And, it

² Schramm, C. J. 2006. *The Entrepreneurial Imperative*. Harper Collins.

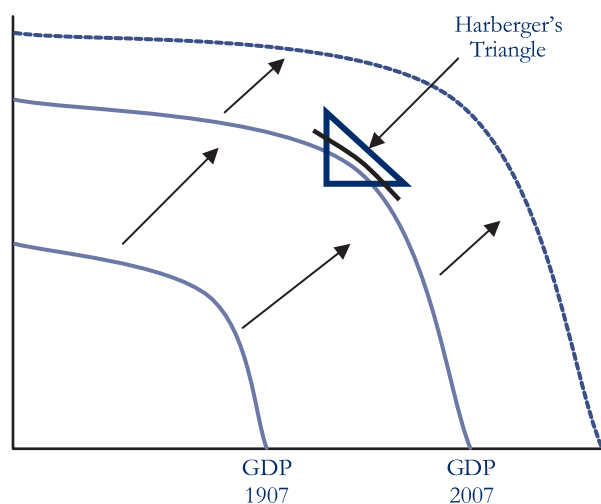
was the wealth and opportunity in the United States that caused nearly all nations to set aside centrally planned socialist economic orders in favor of the dynamic and unpredictable phenomenon of one form or another of capitalism.³

As suggested, however, economic growth remains something of a mystery. The chart that follows presents an illustration of the relationship between economic growth and economic knowledge. The triangle, known for Professor Arnold Harberger, who first observed the limits of economic research, circumscribes most of what has occupied economists over the decades. Studies in monopoly theory, labor, public finance, industrial organization, etc., have a shared goal, namely, advancing the optimized efficiency of the economy so as to capture a marginal gain in growth. But, the story of the growth that counts, the tremendous shift over time of the nation's total production, is largely unaccounted for in such optimization theories. Decades ago, Joseph Schumpeter, the first economist to devote himself to entrepreneurship and innovation, wrote: "This historic and irreversible change in the way of doing things we call 'innovation' and we define: innovations are changes in production functions which cannot be decomposed into infinitesimal steps. Add as many mail-coaches as you please; you will never get a railroad by so doing." Many economists have documented that the most important story of economics is that of how innovation came to be and how it is the hinge that opens the door to economic growth.⁴

The second question that must be addressed in thinking about America's economic future is, what is innovation? In previous ages, invention was thought to be the key to explaining growth in the American

economy. We thought of ourselves as a nation marked by our propensity to invent new things and new processes. Over time, our history suggested to us that this was in our character. Frederick Jackson Turner, one of our most distinguished historians, developed the frontier hypothesis that suggested that while Americans thought that exploring and moving west was our defining frontier, this was really only a metaphor for the creative pioneering that Americans feel is one of our distinctive shared attributes.

Production Possibilities Frontier



Today we increasingly think of innovation, rather than invention, as a word of our times. We believe our propensity to innovate is central to our character and our economy. But just what is innovation, and how is it different from other phenomena that have been with us since our founding? Obviously, as we think of innovation in the context of this Committee, it is not an ephemeral national characteristic or personality attribute—it is a defining part of our economy. It is the edge where the “new” comes into being and is transformed into a concrete reality that produces benefits. So, one of the first acts of the Committee was to develop a definition of innovation that tied “new” to “impact.” The Committee decided that innovation is “the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers in a way that improves the financial returns for the firm.”

³ Baumol, W. R. Litan, and C. Schramm. 2007. *Good Capitalism, Bad Capitalism and the Economics of Growth and Prosperity*. Yale, 2007.

⁴ The seminal work on this subject is found in Robert Solow, “A Contribution to the Theory of Economic Growth,” *Quarterly Journal of Economics* 70:65-94 (1956); and Edward F. Denison, “Sources of Economic Growth in the United States and the Alternatives before Us.” (New York: Committee for Economic Development, 1962). For a more recent treatment, see Baumol, Landes, & Mokyr, *Entrepreneurship and Economic History*. Princeton (forthcoming).

Considering how to define innovation prompts the third question, which is the focus of this report—that is, how do we measure innovation? For those who worry about questions related to expanding human welfare through economic growth, it may be the most important practical inquiry of our times. This report suggests the complexity of this task. It describes the issues surrounding the definition of innovation. And, as might be expected, it points to what amount to proxy measures. As we deliberated, it became clear that sufficient research does not exist to guide us toward a single measure. Perhaps this will always be the case. The very nature of innovation suggests that it will never yield to a tidy and static metric. An enormously complex economy produces millions of ways in which “better, faster, cheaper” comes into play every single day.

In this regard, the report serves as a pointer, describing the first steps of what will necessarily be a very long, maybe never-ending journey. The Committee recommendations start with a suggestion that better measures of the growth in “total factor productivity” – the change in productivity left over after taking account of the growth of capital and labor – are required to begin to zero in on the contribution of innovation. In reaching this conclusion we have benefited from the particular expertise of Professor Dale Jorgenson, one of our fellow members. But, total factor productivity is, as we’ve noted, a surrogate approach. Such a measure only accounts for a portion, albeit a large portion, of the change in the economy’s performance that might be said to be innovation. There are other measures that add more texture to the task but make any approach to an inclusive measure that much more difficult.

In fact, after extensive consideration, the Committee has concluded that as much as an aggregate measure of the entire economy’s innovation might be desirable, recommending an “innovation index,” a sort of all-in-one measure of innovation, would be unwise given the current state of research on innovation and economic growth. A single index would be hard to construct and harder still to defend. Innovation being innovation, it would hardly be established before it would have to be changed. Moreover, the economy does not innovate evenly:

there will always be some firms and sectors that innovate at a greater pace than others. Creating a single index that treats innovation as a single phenomenon might lend itself to policy distortions. It would be used immediately in discussions of what policy steps might be appropriate to stimulate innovation, and an error in the construction of such a unitary index could play through to disastrous consequences.

In the absence of a single indicator, the Committee proposes that the Department of Commerce take steps toward improving, integrating, and expanding on its current data collection efforts in the next few years, while research is undertaken to better inform the task of measuring innovation. Our statistical system captures two of the major inputs that are linked to the innovation process: research and development spending and the number of engineers, scientists, and technicians employed. In addition, data are collected on some other categories of investments, such as expenditures on information technology equipment, which is certainly a factor in expanding innovation. We also measure the number of innovations that are protected by newly-issued patents each year. But, in many firms and industries, significant amounts of investments in innovation are made outside of these categories and go consistently unmeasured or unconnected by the current statistical system. Indeed, even for the variables we measure, such as research and development, the Committee recognizes the need to update the way we quantify these measurements, the frequency of our measurement, and our coverage of younger firms and emerging industries. Further, we must develop more finely calibrated measures of how firms invest in the inputs that become innovation, especially human capital.

In the absence of common public measures of the scope of innovation, many surrogates have sprung up in the private sector. Numerous interest groups, industry associations, and think tanks produce indices of innovation that should be considered as part of the expanding mosaic of data sources. In fact, one of the innovations resulting from this report might be that the government absorbs several of the most statistically valid private sector data series into its own overall measures of innovation.

The final question is the most important one of all. What can we do to drive the American economy to a state of continuous and sustained growth by making our country more innovative? Making innovation an explicit concern of public policy requires that we can measure how innovative the economy is, as well as determine whether the “state” of innovation is improving or decaying. It also requires that we understand the pathways of innovation lest we develop the wrong policy interventions, either to quicken innovation or to shift its course. While it is difficult to say what policy should be, some things are understood and should inform policy considerations.

For example, innovation is meaningless if not considered in the larger context of growth. Indeed, growth should be the touchstone of policy, and in the case of innovation, it is important to understand its role. Innovation propels growth by pushing existing companies to real cost reductions and new firms toward growth. The United States remains unique in its ability to grow companies. Every year roughly thirty-one firms achieve “top line” revenue in excess of \$1 billion.⁵ Each one of the firms that experiences this kind of growth takes as its basis some innovation in the nature of its products or in the nature of its approach to marketing.

Entrepreneurial activity, both in start-ups and in existing large-scale companies, is critical to the firm’s success. Every entrepreneur is a party to innovation; in fact it could be said that entrepreneurs are to our economy as the marines are to our armed forces. Calculated risk taking, with a goal that is often only defined as “let’s win,” is the mindset of entrepreneurs, both those working on their own and those who shoulder the path-breaking and often risky task of changing the culture and identity of mature firms. To make the economy more congenial to innovation is to construct an economic culture that appreciates what entrepreneurs do.

As we consider these observations, it is clear that our economic ecosystem can be helpful to innovation and its ability to flourish. Policy should first focus on putting in place improvements to our measurement

of innovation and then focus on what we know already as key factors for innovation. Without doubt, we must have people who are skilled and trained to see the opportunities where the “better, faster, cheaper” can be realized. This means in real terms that our schools, community colleges, and university-level institutions must prepare more of our young citizens to be better able to advance technical insights such that innovative products and services continue to flow into our economy.

If we are to grow, we need more and more people ready to take entrepreneurial risk. And, we need them flowing from institutions attuned to producing particularly creative people for the new economy. Recent economic and psychological research has confirmed what scientists and entrepreneurs have known for decades: innovative breakthroughs frequently come at the estuary region where different fields, not necessarily related, intersect. This means we need much more cross-disciplinary training where the edge between fields can be developed for the innovations that lie within.

In conclusion, the work of the Committee has brought together experts from across government, industry, and academia to consider changes that can be made today to improve our understanding of the American economy and its innovative capacity in the future. Measuring innovation is central to understanding the economy as it evolves and responds to growing world competition. Indeed, it is better to travel an illuminated path toward future economic progress than to stumble in an unlit direction. Improvements to our measurement of innovation will help to ensure continued economic strength.

⁵ Thomas, David G. 2006. *Blueprint to a Billion: 7 Essentials to Achieve Exponential Growth*. John Wiley & Sons

Chapter One

The Current State of Innovation Measurement and the Establishment of the Advisory Committee

Innovation propels economic growth. Yet the measurement of innovation, in this country and elsewhere, remains rudimentary. To understand better the dynamics of economic growth and, hopefully, avoid harmful policies and enact facilitative policies, we must design improved measures of innovation. With this objective in mind, the Secretary of Commerce, Carlos M. Gutierrez, established the Advisory Committee on Measuring Innovation in the 21st Century Economy.

In the popular mind, innovation is often equated with invention. In some cases, this is correct – Thomas Edison stands out as a prominent example – but invention is simply one type of innovation. Innovation can be an astounding breakthrough (as was often the case with Edison), a mundane shift in process, or a subtle change in culture. Yet each type helps generate a higher yield on resources, boosting economic growth. Examples provided by members of the Advisory Committee at its first meeting illustrate this variety.

- David Bernd, CEO of Sentara Healthcare, an integrated health care provider in Virginia, spoke of getting a cold call from a small start-up company. The caller told him about an innovative method of remotely monitoring intensive care beds from a centralized location. Sentara ultimately became the first hospital to use the system, and now remotely monitors 101 intensive care beds in five institutions. The hope was that the new system would improve the quality of care. At the end of two years, Sentara found that mortality had been reduced by 15 percent, ICU length of stay was reduced by 16 percent, variable costs went down 25 percent and retention of registered nurses in the covered units went up 20 percent.
- James Blanchard, former CEO of Synovus, spoke of the creation of his company's

subsidiary Total System Services, now one of the world's largest processors of credit cards. It started when his small Georgia bank, one of the first to issue a credit card, bought some computers, wrote a program from scratch and automated the entire operation. Ten years later, BankAmericard automated and Synovus became the first bank to use the process. In 1974, almost as a joke, the company offered to process cards for another bank. The other bank accepted the offer and that started a process that continues today. In 1983 Synovus spun off the operation, capitalized it, and did an initial public offering (IPO). Today it is listed on the New York Stock Exchange and processes over 400 million credit card accounts all over the world.

- John Menzer, Vice Chair of Wal-Mart, spoke of his company's process-based gains in the areas of environmental sustainability, prescription drugs and supply chain efficiencies. He considers Wal-Mart's process innovation to be a unique marriage of corporate culture, imagination and technology. He spoke of setting big stretch goals for the company and associates—a 25 percent more efficient trucking fleet in three years and double in ten years, a 20 percent reduction in energy use in new stores in four years, and a 25 percent reduction in solid waste in three years. The company has no specific plans in place to meet the goals but uses the goals to inspire associates to help the company get there, create a business environment that thrives on new ideas and change, and challenge their supplier base to set individual goals. And he noted that all Wal-Mart's innovation is geared toward a better consumer experience and better returns for the company.
- Michael Eskew, Chairman and CEO of UPS, spoke about how UPS transformed itself from a

local delivery company, to a ground company, to an air company, to an international company, to a supply chain company and to what is now largely a technology company. UPS currently uses four innovation processes. For innovation related to its core business it relies both on an internal marketing committee and on external sources, primarily customers. For 'non-core' innovation, UPS uses both an internal strategy group and external groups including universities and pre-IPO venture companies funded by a UPS strategic enterprise fund.

These examples underscore the challenges in attempting to measure innovation in the economy.

The State of Innovation Measurement

Innovation measurement is in its infancy – both here and around the world. Some data related to innovation are collected by the U.S. government statistical agencies; however, the data are incomplete and miss substantial sources of innovation in the economy. Some innovation data are tracked by private sector organizations and firms, but these efforts are also limited. Recently, however, government agencies, businesses and trade associations have been devoting more resources toward the development of such data.

Examples of some of the U.S. statistical agency programs that either currently collect innovation-related data or could be vehicles for enhanced innovation data collection and analysis through linkages, new data or new analysis include the following:

- The Commerce Department's Bureau of Economic Analysis produces the U. S. National Income and Product Accounts (NIPAs). The major agencies providing data for the NIPAs include: (1) the Census Bureau (data from business and population censuses and surveys); (2) the Bureau of Labor Statistics (employment statistics, wage and salary data, productivity statistics, and most underlying price

information); (3) the Internal Revenue Service (tax-based data on individuals and businesses); and (4) the Federal Reserve Board (income statements and balance sheets for major financial and non-financial sectors).

- The Bureau of Economic Analysis, with support from the National Science Foundation (NSF), has developed a Research and Development Satellite Account that estimates the effect of investment in research and development on U.S. economic growth. These experimental estimates of the effect of intangible assets on the U.S. GDP show the size of the impact of research and development (R&D) on U.S. economic growth. BEA also collects data on international technology licensing expenditures.
- The Census Bureau has data on some measures of innovative activities, such as the diffusion of innovation, human and organizational capital, entrepreneurship and other worker and firm characteristics. It is working on improvements in some areas of importance to innovation, particularly related to the service sector. Detailed information has long been collected on manufacturing activities; only recently has emphasis been put on non-manufacturing sectors. The Census Bureau, on behalf of the National Science Foundation (NSF), conducts an annual firm-level survey of industrial R&D that requests data on firms' R&D investments. Census has also created an Integrated Longitudinal Business Database (ILBD) that includes businesses with and without employees, permitting tracking of the growth of start-ups and other aspects of business dynamics.
- The Securities and Exchange Commission (SEC) collects extensive data from public companies. The SEC has embarked on a data-tagging project that will permit analysis of such financial data across public firms.

These examples represent just some of the sources of innovation-related data available. While they currently provide data on only some pieces of the innovation puzzle, they provide a trove of possibilities

for the development of innovation data in the future.

Dedicated innovation surveys such as the European Community's Community Innovation Survey are used by statistical organizations in European Union and some other countries including Australia and Canada. Relatively new, and only tested among manufacturing firms in the U.S., the surveys collect information on different varieties of innovations, including 'new to the firm, new to the industry and new to the world.' They also collect extensive information on innovation expenditures (e.g., capital investment, training and marketing costs) and costs of protecting innovation (e.g., patent and copyright costs). However, such surveys are very costly and have encountered both definitional and response rate problems.

The Establishment of the Advisory Committee

Secretary Gutierrez formed the Advisory Committee to enlist the help of leading business representatives and academics in formulating a plan for improving innovation measurement in this country. One of the first steps taken by the Committee was the adoption of a definition.

For the purposes of its work, the Advisory Committee defined innovation as:

The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.

Early last year, the Advisory Committee published a *Federal Register* request for public comments on innovation measurement. The purpose of the notice was to get broad input into the work of the Committee.

In the notice, the Committee asked for comments on improved or new innovation measures. The

Committee sought comments in four categories: (1) improvement of the underlying architecture of the U.S. system of national accounts to facilitate development of an improved and more detailed measure of innovation and productivity; (2) identification of appropriate economy-wide and sector-specific statistical series or other indicators; (3) identification of firm-specific data items that could enable comparisons and aggregation; and (4) identification of specific 'holes' in the current data collection system that limit our ability to measure innovation.

The Committee received a broad array of thoughtful and substantive responses that covered the full range of categories for which comments were sought. All of the comments were considered during the Committee's deliberations.

In determining the path on which to direct its recommendations, the Advisory Committee determined that its recommendations would build on existing and ongoing work to the extent possible. Where appropriate, new approaches or new data would be recommended but, in the interests of cost and delivery time, the primary focus would be on improving the scope and robustness of existing work.

The Committee recognized that, at least at this time, there is only limited knowledge about innovation drivers, impediments and enablers. And there was awareness of the fact that many businesses do not currently collect all the data that might be desired in an ideal world.

Because it is also clear that innovation measurement is still in its infancy, the Committee chose to recommend differing approaches to innovation measurement. There is no single innovation measure that can be recommended at this time, but the data and analysis to be generated by the improved innovation measures recommended by the Committee should lead to greater understanding of the process of innovation and prove valuable to policymakers in the future.

The next chapters detail the principles and recommendations endorsed by the Advisory Committee.

Chapter Two

GUIDING PRINCIPLES FOR INNOVATION MEASUREMENT

The Advisory Committee's recommendations are intended to improve the measurement of innovation and its impact on the U.S. economy. In particular, the goal is to develop better estimates of the resources devoted to and value generated by innovation by focusing not only on measuring innovation activities and inputs but also on innovation results and outputs.

Measuring innovation has not been a major goal of economic data collection by U.S. statistical agencies. Innovation measurement to date has been largely piecemeal, incomplete, and accidental (i.e., relying on data sets not designed for the purpose of innovation measurement).

Improving our understanding of how much is spent on innovation and how much we benefit from innovation is crucial to answering several key questions: Are we as a society spending too much or too little on innovation? Are the places in which focus is being given to innovation having results? And what, if anything, can we do to improve our innovative activities in the future?

The Committee's recommendations call on the government, the business community and researchers (in both government and the private sector) to work together to further both the understanding and the measurement of innovation in the economy.

The Advisory Committee recommends that the work be guided by the following principles.

- *Innovation data collection efforts should build on the way firms assess the effectiveness of their innovative activities.*

Data collection should be informed by what firms are actually doing rather than being based solely on theory. Also, to the extent possible, the burden on firms should be minimized.

- *When developing better ways to quantify innovation in the marketplace, consideration should be given to measuring the impact of legislation and regulations on innovation.*

Some regulatory policies (e.g., certain tax and education policies) may explicitly support innovation. Other policies may have the unintended consequence of inhibiting innovation (e.g., overly restrictive caps on immigration and some Sarbanes-Oxley rules). Improved data on innovation are essential for assessing the impact that regulatory policies have on innovation. Better firm-specific and economy-wide data will help reveal the impact – both positive and negative – of regulatory policies on innovation and the environment that produces innovation.

- *Because of the nature of innovation and, in particular, the collaborative nature of the innovative process, there needs to be tolerance of qualitative and subjective measures.*

Not all measures of innovation may be quantifiable; and progress in developing better quantification of some dimensions of innovation may depend on improved qualitative measures. For example, measuring the resources invested in and the outcomes of collaboration may be very important but also very difficult, especially if such partnerships are informal or if the benefits are subject to spillovers (i.e., are difficult to capture fully in a contractual arrangement).

- *Innovation measurement should not be static. Measurement is an iterative process that needs to be treated less like a 'project' and more like an ongoing 'dialogue.' Learning and improvement are to be gained from each stage of the process.*

As new innovation data are collected, they should be refined and continually re-evaluated for their cost-effectiveness and ability to push out the frontiers of knowledge about innovation and its impact on the economy. The government needs the aid of the researcher community in order to do so in a timely manner. And while timeliness is important in understanding innovation, different measures of innovation may capture relatively quick-return innovation while other measures may capture innovations which require longer periods of time to cause measurable economic change.

- *Innovation measures should allow for analysis at the establishment, firm, industry, country, international and, where possible, regional levels.*

Improved data on innovation should permit industry- and sector-specific analysis, recognizing that innovation manifests itself differently in different parts of the economy. In particular, international comparisons would help explain why different countries are experiencing different

economic growth rates. When compared with different national policy mixes, it may be possible to achieve a better understanding of the impact public policies have on growth and innovation.

- *A conservative approach should be taken to any new data collection efforts by recognizing tradeoffs between costs and potential benefits and considering resource and regulatory constraints. The implementation of pilot projects to gauge the costs and benefits of new data collection efforts is encouraged. To the extent possible, new innovation measures should be able to be 'back-tested'; that is, if applied to historical data, the measures should produce the expected innovation relationship.*

The costs of new data collection include both direct program costs and the cost burden imposed on potential survey respondents. Many conceptual ideas for new data collection need to be tested on diverse industry samples of large and small or young and old firms before new surveys (or substantial changes to existing surveys) are implemented.

Chapter Three

WHAT GOVERNMENT SHOULD DO

To measure innovation and its economic impact better, the government must make structural refinements to existing government data sets, improve linkages among them, collect new and better data, and expand data sharing/synchronization.

The Advisory Committee's recommendations for government action and the elements within each recommendation are discussed in this chapter.

1. THE GOVERNMENT SHOULD CREATE A STRONGER FRAMEWORK FOR IDENTIFYING AND MEASURING INNOVATION IN THE NATIONAL ECONOMY.

Refining the framework for measuring the performance of the national economy is an essential element in the government's program to measure innovation. These improvements will take time, as there is considerable preliminary work to be done. The four major elements of this program include: refining the National Income and Product Accounts (NIPAs) to permit estimation of industry-level measures of total factor productivity; creating an innovation supplementary account; improving service sector data; and improving the measurement of intangibles (particularly intellectual property and improved measures of technology licensing activity). Each of these elements is discussed in more detail below.

- *Develop annual, industry-level measures of total factor productivity by restructuring the NIPAs to create a more complete and consistent set of accounts integrated with data generated by other statistical agencies to allow for the consistent estimation of the contribution of innovation to economic growth.*

The NIPAs constitute the official framework used by the Commerce Department's Bureau of Economic

Analysis (BEA) to estimate output, income and expenditure, trade, capital formation, and wealth in the U.S. economy. The NIPAs were devised to help policymakers deal with the severe economic fluctuations produced by the Great Depression and World War II. The NIPAs were not originally designed to measure innovation or delve into the causes of long-term productivity growth. Today, however, when policymakers are increasingly shifting attention from short-term stabilization to long-term economic growth, changes need to be made to measure innovation in this context.

Economic growth depends – in large measure – on productivity growth. Innovation is a major determinant of productivity growth. Without innovation, output generally can only grow by increasing inputs – through a combination of expanding the labor force and increasing the utilization of capital (such as machines, buildings, and skills, using existing technologies). The implementation by entrepreneurs, managers, and employees of innovations – in the form of new products or services, processes, organizational structures, or business models – enables output growth to exceed the growth of inputs. Measuring that excess growth – known as Total Factor Productivity (TFP) growth – for the entire private sector economy as well as by industry is the primary goal of this proposal. A longer-term goal, discussed later in this report, is to parse TFP growth estimates into amounts attributable to expenditures by firms on scientific R&D and information technologies (using available data), and other measurable investments by firms in innovation (using data the Committee proposes to be collected), and amounts due to other factors.

The Committee recommends an ambitious program to eliminate gaps and inconsistencies within the NIPAs and between data produced by other statistical agencies and those produced by BEA. The proposed

new ‘architecture’ for the NIPAs would consist of a set of income statements, balance sheets, flow of funds statements, and productivity estimates for the entire economy and by sector that are more accurate and internally consistent. The new architecture will make the NIPAs much more relevant to today’s technology-driven and globalizing economy and will facilitate the publication of much more detailed and reliable estimates of innovation’s contribution to productivity growth.

The most salient (for purposes of this Committee) goal of the proposal is to integrate BLS’s current TFP (also known as ‘multifactor productivity’) growth estimation program with the NIPAs and extend their coverage to all industries. Doing so would require completion of BEA’s plan to improve its industry-level statistics, including fully integrating its input-output tables with the NIPAs and incorporating new data collected by the Census Bureau on the output and intermediate inputs of services industries, as described later in this report. Greater coordination between BEA and BLS will be required in other areas as well, including increased data sharing between the two agencies; acceleration of the development of the capital services accounts; and expansion of efforts to incorporate quality adjustments and identify new products and services for prompt inclusion in BLS’s Consumer, Wholesale, and International Price Index programs. In addition, BEA will have to work with the Federal Reserve Board (FRB) to develop an integrated wealth account.

The new NIPA architecture will be flexible enough to accommodate the inclusion of information from new supplemental accounts and to permit the easy incorporation of these accounts into the proposed NIPA system. Data developed for capital stocks and service flows for intangible assets (such as technology that passes among firms through licensing agreements and other forms of intellectual property) can be used to parse TFP growth estimates.

The TFP growth estimates proposed by the Committee would be consistent with estimates currently published by the European Union, Canada, Japan, and South Korea and with estimates planned by other countries, including Brazil, China, India, and Russia. The availability of consistently estimated

measures of TFP will allow for rigorous comparisons of the sources of growth across countries and over time. Such information would be valuable to policymakers trying to gauge the effectiveness of national innovation policies.

- *Create a supplemental innovation account for the National Income and Product Accounts (NIPAs) in order to expand the categories of innovation inputs and allow those inputs to be tracked as they flow between industries.*

Supplemental accounts (sometimes referred to as satellite accounts) provide additional detail about a part of the economy using the same structure as the National Income and Product Accounts without being integrated with the NIPAs. Establishing a new supplemental account that is conceptually consistent with the NIPAs but based on data that are not as time-tested as those used in the core NIPAs helps facilitate the development of the NIPAs. For example, in 2006, BEA inaugurated a supplemental account for investments in research and development activities conducted by scientists and engineers; ultimately, BEA proposes to incorporate the R&D supplemental account into the NIPAs.

Developing a broad supplemental innovation account for intangible assets – including estimates of intangible asset capital stocks and service flows – would introduce a broader range of capital inputs into the NIPA product and capital accounts. Such inputs have hitherto been classified as expenses rather than as accumulated capital. Data on intangible asset capital stocks and service flows could be used to further refine estimates of the impacts of innovation on economic growth.

The Committee calls for the development of a new NIPA supplemental innovation account that would include intangible assets, such as investments by firms in research and development (conducted by scientists and engineers as well as workers in other occupations); human capital; patents and trade secrets; copyrights, trademarks and brands; and other forms of intellectual property. The development of a supplemental innovation account depends on the collection of additional data on intangible innovation assets.

- *Improve service sector data and increase survey coverage to provide the data needed to improve estimates from the integrated GDP/productivity accounts and supplemental innovation account.*

It is widely believed that much innovation in recent decades has taken place in the service sector, and this belief is bolstered by evidence (albeit based on incomplete and highly aggregated data) that service sector productivity has increased after a long period of stagnation. However, collection of annual data on the service sector has lagged that of other sectors (in particular, manufacturing), and improved service sector data collection is a necessary step toward better measurement of innovation and its impacts in the service sector.

The Census Bureau has long covered retail and wholesale trade in its annual surveys. Of the rest of the service sector, which currently accounts for 55 percent of GDP, the Census Bureau's annual survey covers only 30 percent of GDP. Put another way, the Census Bureau does not collect annual data on one-quarter of the nation's economy.

The Committee recognizes that the funds needed to implement the Census Bureau's proposal to extend annual survey coverage to all remaining service sectors by FY2010 and to improve the data on service industry inputs have not been appropriated. The current lack of funding will impede some activities necessary for improved innovation measurement. For example, BEA's efforts to develop more detailed data on the input/output matrices to track innovation across industries hinges on the Census Bureau collecting more comprehensive service sector data.

The Committee also calls for the development of a more nuanced classification system with finer granularity of data on different types of economic activity in the service sector. In particular, the Committee calls for improved accounting for transfers of intangible assets (such as intellectual property licensing and assignments) and the development of more detailed and quality-adjusted price indices for services.

Since a number of service sector industries (e.g., software, consulting, and intellectual property

licensing and transfers) are considered particularly innovative, better data on the service sector will improve our understanding of innovation processes. Improved services price indices will improve estimates of inflation-adjusted inputs purchased from the service sector inputs, including those purchased from highly innovative industries, and will enhance the quality of estimates of productivity growth attributable to innovation.

- *Improve measurement of intangibles, particularly intellectual property, building on work currently under way at the National Science Foundation. Consider the best way in which to collect data on transactions involving key intangible assets such as intellectual property licensing expenditures and revenues. The Commerce Department should also explore whether additional identifying information from patent and trademark applicants might provide useful data.*

Statistical agencies largely focus on collecting data on firms' investments in physical capital. Little is known about firms' investments in intangible assets beyond data on expenditures on scientific and engineering research and development collected by the Census Bureau for the National Science Foundation (NSF) and data on own-account software development collected by the Census Bureau. Data on investments by firms in 'research and development' activities *other* than scientific and engineering R&D are scarce, as are data on investments in organizational and human capital and marketing and brand equity.

Data on patent and trademark applications and assignments are publicly available, but it is difficult for researchers to match these data to data on applicants and assignees. Better matching would help researchers develop ways to put a value on intellectual property.

Data are similarly scarce on the income earned on intellectual property. The Bureau of Economic Analysis collects data on cross-border royalty payments for intangible assets, but no data are currently collected on purely domestic royalty revenues and payments.

The lack of information on intangible assets' depreciation rates and how to adjust the value of investments in intangibles for price inflation makes it difficult to estimate the wealth that is created by firms' investments in innovation. Sound estimates of intangible capital stocks are needed to refine estimates of innovation's contribution to productivity growth. However, intangible asset valuation is difficult because of the relative scarcity of directly observable prices, and the data collection and methodological challenges are daunting.

The Committee recommends improvements in intangibles measurement by expanding data collection on intangible investments beyond scientific and engineering R&D and own-account software development to include *all* resources devoted to innovation. Such improvements might be achieved by expanding NSF's R&D survey to encompass a broader range of innovation investment activities. Past experience with collecting such data at BLS and in other countries (notably Canada) could be used to inform the development of a survey in the United States.

The U.S. Patent and Trademark Office should collect additional identifying information from patent and trademark applicants to facilitate matching application and assignment data to census and other data sets. Such information could include Employer Identification Numbers (with appropriate confidentiality safeguards), CUSIP numbers, DUNS numbers, or other widely used firm identifiers. Collecting such additional information should impose little additional burden on patent and trademark applicants and would aid the development of patent quality indices using stock market valuations and other data.

The Committee further recommends that BEA and the Census Bureau collaborate to collect domestic (as well as cross-border) data on revenues from and expenses associated with licensing and transferring technology (patents and trade secrets), copyrights, franchise fees, and trademarks.

Finally, the Committee calls for the development of improved estimates of depreciation rates of intangible assets and specific price indices for intangible assets.

2. THE GOVERNMENT SHOULD BETTER LEVERAGE EXISTING DATA AMONG THE GOVERNMENT STATISTICAL AGENCIES TO ALLOW FOR THE CONSISTENT ESTIMATION OF THE CONTRIBUTIONS OF INNOVATION IN THE GDP AND PRODUCTIVITY ACCOUNTS AND TO DEVELOP GREATER UNDERSTANDING OF INNOVATION.

Much could be learned about innovation from data that have already been collected if the statistical agencies were to develop new linkages. Much of this work would require new legislative authority.

- *Develop linkages within and between existing data; for example, develop linkages between establishment-based data sets and firm-based data sets to provide both greater consistency in estimations and to provide researchers a broader range of innovation data.*

Most U.S. industry statistics are estimated using establishment-level data as the basic 'building blocks.' An establishment is a commercial or non-profit entity at a single physical location that produces goods or performs services, for example, a store or a manufacturing plant. Statistical agencies gather data from establishments located within the United States operating within the same industry and publish descriptive statistics for each industry based on such data. Such statistics have been very useful for many purposes, as they combine data for establishments that do approximately the same things.

However, many firms own or control more than one establishment, and those establishments may be located in different geographic areas and may be producing different kinds of goods or performing different kinds of services, some of which may be important to innovation. Statistics based on firm rather than establishment data can be useful in other contexts, especially in innovation measurement. By disassembling the establishment building blocks used to construct industry statistics and reassembling them into firm-based statistics, better innovation measurements may be obtained. Furthermore, firm or establishment data from one data source can be augmented by matching to corresponding data from other sources to obtain a more complete picture of innovation.

- *Develop more robust classification methods; for example, classify firms on the basis of both domestic and international activities.*

Even in those cases where data are collected and classified at the firm level, classification is based only on the activities of domestic establishments. Consider a firm that designs and markets shoes under its own brand name in the United States but manufactures them abroad. Based exclusively on the data collected from establishments located in the United States, the firm would be classified as a wholesaler, but such a firm would likely be very different in terms of innovation activities from a firm that acted solely as a merchant wholesaler (i.e., buying shoes from manufacturers and reselling them to retailers without any design or manufacturing activities). Classification on the basis of both domestic and international activities would improve innovation measurement.

- *Seek expanded interagency data sharing/synchronization legislative authority in order to improve the quality of innovation measures while balancing data needs with confidentiality protection.*

While the Committee has given much consideration to new or expanded surveys of firms, much remains to be learned from data that have already been collected. However, because of a host of laws and other restrictions affecting firm micro-data (that is, establishment- or firm-specific data records), agencies are often limited in their abilities to share data with other agencies.

Within the federal government, limitations placed upon the use of IRS data affect the accuracy of business registers used by federal agencies to carry out business surveys. Partially because of these inaccuracies, differences arise in how different agencies measure economic activity. Additionally, existing topical surveys have been hampered by lack of access to a good business frame from which to draw a sample.

The Committee recommends that Congress enact legislation to enable and encourage statistical agencies to expand data sharing activities subject to strict

confidentiality requirements. Specifically, the Committee recommends that access to IRS data be expanded to additional statistical agencies for the purposes of reconciling the business lists and designing effective special surveys. The grant of such authority would greatly enhance data quality and consistency and improve innovation measurement.

3. THE GOVERNMENT SHOULD INCREASE ACCESS TO DATA IN ORDER TO FACILITATE MORE ROBUST INNOVATION RESEARCH.

- *Increase the transparency of and access to public data by fostering the use of data tagging and similar processes.*

The government collects a vast store of non-confidential data from firms. Analysis of such data by researchers might provide considerable new information on innovation and innovation-related activities. For example, analysis of financial data and reports filed with the Securities and Exchange Commission (SEC) by public companies might provide insights into what differentiates innovative firms. But, until recently, such data have been locked into a format consisting of fixed blocks of text, making it difficult for researchers to process and analyze the data.

Government agencies have begun a process of making public data more user-friendly; for example, the SEC, the Federal Deposit Insurance Corporation and other banking regulators, and several European governments are using or testing XBRL (Extensible Business Reporting Language), a process that ‘tags’ data (i.e., attaches a standardized, searchable label to each data item filed by firms). Tagging enables ‘intelligent’ computerized recognition of each piece of information in a document, thereby facilitating accurate, automated, and flexible selection, analysis, storage, exchange, and presentation of data at high speed and reduced cost. The SEC data-tagging project is still in its pilot stage but some firms are reporting tagged data.

Expanded use of data tagging of public information could increase transparency of public information and provide a wealth of information for researchers and other members of the public.

■ *Create more public use files in order to encourage more non-governmental research.*

Statistical agencies should consider creating more public use files that would be accessible to non-government researchers. While confidentiality requirements may impose some limits to the depth of public use files, greater public access through web-based public use files could increase innovation research since the data would be far more widely available. This is not considered a substitute but rather a complement to greater accessibility of confidential micro-data to the research community.

■ *Expand non-government researcher access to confidential micro-data, including that on business dynamics, while maintaining high standards for confidentiality.*

The Committee recommends that the statistical agencies expand research access to confidential micro-data while maintaining high standards for preserving confidentiality. Outside researcher access to business data, particularly business micro-data, collected by the Federal agencies remains extremely limited. Many scholars are interested in – and with proper confidentiality training and safeguards could be engaged in – research that would further the understanding of different aspects of innovation. While concerns about confidentiality are important and should be at the fore of any discussion on researcher access, current limitations on access are impeding understanding of the dynamic aspects of the economy. Federal agencies do not have adequate funding for in-house staff to exploit fully the research potential of the data. In addition, advances in remote access technologies and the success to date of specific federal agencies in offering outside researcher access make this an opportune time to expand outside researcher access to business micro-data. Academic researchers, subject to confidentiality provisions, could facilitate linkages between confidential micro-data and other existing data such as data collected by the Securities and Exchange Commission, thus providing a richer

picture of innovation in the economy. Some agencies have made significant progress in demonstrating the feasibility of expanded access while maintaining strict confidentiality.

4. THE GOVERNMENT SHOULD CONVENE ONE OR MORE WORKSHOPS OR FORUMS UNDER THE AUSPICES OF THE SECRETARY OF COMMERCE TO DISCUSS INNOVATION DRIVERS, IMPEDIMENTS AND ENABLERS.

Many of the members suggested that the development of more effective innovation policies requires undertaking more work to get better identification and examination of innovation drivers, impediments and enablers. Insofar as the Advisory Committee's charge was limited to innovation measurement, these issues have not been directly addressed by the Committee. Nonetheless, given the importance of the issue in the view of most of the Committee members, the Committee is recommending that the Secretary of Commerce convene one or more workshops or forums devoted to examining innovation drivers, impediments and enablers.

Members of the Committee and public commenters identified a broad variety of drivers and enablers of innovation. These included tax policy (R&D tax credits); education policy (promoting science and math); the availability of venture capital; the business climate; ease of entry into and exit from markets; education and skills; research and development expenditures; and specific firm culture and environment. However, in many instances, the correlation between the identified driver or enabler and innovation outcomes is not well understood or convincingly demonstrated empirically.

Impediments to innovation that have been suggested include some immigration policies, trade restrictions, Sarbanes-Oxley rules (particularly Section 404), and other government regulations. As with drivers and enablers, there are many assertions made but the actual impact of such policies on innovation activity is much less clear.

5. THE GOVERNMENT SHOULD CONTINUE PARTICIPATION IN THE INTERNATIONAL DIALOGUE RELATED TO MEASURING AND ANALYZING INNOVATION AND ENSURE THAT U.S. EFFORTS ARE INTERNATIONALLY COMPATIBLE TO THE EXTENT POSSIBLE.

The Advisory Committee is aware of the work that has been and is being done on innovation measurement in the international community. The Advisory Committee supports the international dialogue on innovation and, indeed, one of the principles adopted by the Committee calls for innovation measures to allow for analysis at international levels.

The United States is actively engaged in international dialogue on innovation and innovation measurement. The National Science Foundation works closely with the Organisation for Economic Co-operation and Development's Working Party of National Experts on Science and Technology Indicators (NESTI). NESTI's mission – to “ensure the continued improvement of the methodologies for the collection of internationally comparable data for measuring the input, output, diffusion and impact of science, technology and innovation (including linkages to economic growth)” – is similar to the mission of this Advisory Committee. The Financial Accounting Standards Board (FASB) and the International Accounting Standards Board (IASB) are working together to converge two sets of standards, which currently differ on the circumstances under which research and development costs can be expensed versus capitalized as intangible assets. The Committee supports such efforts.

6. THE GOVERNMENT SHOULD CONSIDER DEVELOPMENT OF A NATIONAL INNOVATION INDEX WHEN MORE WORK HAS BEEN DONE ON BOTH DATA COLLECTION AND ANALYSIS OF INNOVATION DRIVERS.

An index of innovation or innovation scorecard or dashboard could give some sense of how the U.S. fares on a combination of different measures of innovation. However, even among the members who supported the idea of constructing an index, there was uncertainty as to what measures should be

aggregated and how the components should be weighted, if done as a scorecard, and the purpose to which the index would be put. Additionally, while some innovations have immediate and significant economic impact, many innovations appear to have a longer lag before affecting output. As such, a careful consideration of how to weight the long-term and short-term impacts of innovations is necessary prior to implementing an index.

Consideration would need to be given as to the types of measures that would be reported and whether or not data currently are collected on these measures; whether this should be all public data or a mix of public and private information; and whether or not it should be done immediately or be an end product following the development of new innovation measures. Such an index could be a useful tool for international comparisons if there were comparability with measures used in other countries. The development of an innovation index could be useful in the future when more data are available and more is known about specific innovation drivers.

7. THE GOVERNMENT SHOULD SUPPORT FUNDING NECESSARY TO IMPLEMENT THE ABOVE RECOMMENDATIONS.

Many of the above recommendations will require new funding. The Advisory Committee recommends that the government support the additional funding necessary.

Chapter Four

HOW THE BUSINESS COMMUNITY CAN HELP

Innovation is a collaborative process and there is much that the business community – individual firms and business organizations – can do to both assist and drive improvements in innovation measurement. One of the guiding principles endorsed by the Advisory Committee was that innovation data collection efforts should build on the way firms assess the effectiveness of their innovative activities. Insights from individual firms and other organizations can be integrated with those from government efforts to assess innovation activities and performance more comprehensively.

1. THE ADVISORY COMMITTEE RECOMMENDS THAT THE BUSINESS COMMUNITY CREATE, EXPAND AND ASSESS FIRM AND INDUSTRY-LEVEL MEASURES OF INNOVATION AND DEVELOP BEST PRACTICES FOR INNOVATION MEASUREMENT.

To provide information on firm and industry-level innovation measures and assess their effectiveness, the Advisory Committee calls on the business community to:

- *Institute firm-level measures of innovation to test the correlation of particular measures with known innovation and to measure innovation in the firm and its impact on firm performance. Possible measures might be based on market share or on innovation intensity.*

Two possible market share measures of innovation were discussed by the Committee. The rationale for looking at a measures based on market share is the assumption that products and services gain market share because they provide better value by being lower priced and/or better satisfying customers' needs. One variation focuses specifically on the share of a firm's new product sales in markets in which the firm is gaining market share. The second variation would measure the extent to which a firm's overall

share is growing in a growing market. Individual firms might wish to develop their own market share measures to measure their own innovation performance. In addition, trade associations or other organizations might develop such measures for particular industries and aggregate the results into industry-level measures.

A major issue in designing survey questions based on market share is how to define 'market' in a way that is sufficiently clear to survey respondents to yield a meaningful innovation measure, since a growing market share even in a growing market is not necessarily the result of innovative activity.

Measures of innovation intensity (i.e., the share of firm revenue attributable to recently introduced products and services) may be another useful way to track the impact of innovation. Again, individual firms could track such a measure for their own use or trade associations or other organizations could develop surveys to collect data on total sales revenues and those attributable to products and services introduced to the market in the preceding three years. The data would be used to calculate innovation intensities for each firm in the sample and perhaps could be aggregated to arrive at publishable, industry- and economy-level measures. Researchers could also analyze the resulting firm-level data to better understand the characteristics and performance of firms with different innovation intensities.

Firms with high innovation intensities would presumably be among the most successful in designing, inventing, developing, and implementing new or altered products and services. However, there are formidable interpretive challenges. A 'new' product or service may be 'new' only to the firm and it could be difficult to differentiate truly innovative activity. 'New to market' in manufacturing may only capture product innovations; while 'new to firm' in

service industries may be an indirect indicator of innovations in processes, systems, organizational structures, or business models. At least initially, such measures may be most useful for individual firms to develop and test the usefulness of their own innovation intensities.

The Organization for Economic Cooperation and Development (OECD) has designed survey questions to collect data for the development of measures of innovation intensity. Several countries have implemented such surveys (e.g., the EU Community Innovation Survey), and the U.S. business community could build on that experience.

The Committee calls on the business community, particularly individual firms and trade associations, in cooperation with the research community, to experiment with collecting data on market share-based and innovation intensity measures, analyze the relationship between such measures and firm performance and report on the findings. Insights from such analyses could be integrated with those from government and academia to provide a comprehensive view of innovation in the economy.

■ *Develop and implement best practices in innovation management and accounting.*

The development of best practices in innovation management and accounting appears to be in its infancy. The Committee calls on the business community, particularly trade associations, to collect information about current innovation management and accounting practices, and calls on universities to develop curricula and research programs in innovation management and accounting. The government can help academic research programs in

this area by supporting such efforts through agencies such as the National Science Foundation.

2. THE ADVISORY COMMITTEE RECOMMENDS THAT THE BUSINESS COMMUNITY PARTICIPATE IN RESEARCH ACTIVITIES AND, AS APPROPRIATE, MAKE INNOVATION INFORMATION AVAILABLE TO RESEARCHERS.

Sharing knowledge about innovation and participating in the development of it is a way the business community can help drive the way toward better innovation measurement. In particular, the Advisory Committee recommends that firms and associations:

■ *Participate in collaborative projects as a means of assembling a broad range of data related to innovation.*

Private sector initiatives to collect and analyze data on innovation activities and outcomes can complement and help inform government data collection and publication efforts as well as help identify and disseminate best practices in innovation management.

■ *File public reports in XBRL format when it is an option.*

As noted elsewhere in the report, firms could facilitate measurement and analysis of innovation activities and outcomes by reporting financial and other information in XBRL format. The Committee calls on firms to report information in XBRL format whenever possible.

Chapter Five

WHERE RESEARCH IS NEEDED

Much more needs to be learned about measuring innovation and its impact. Knowledge about innovation would be greatly enhanced if government, academic and private sector researchers—alone and in collaborative efforts—were to undertake research in the following areas:

1. IDENTIFICATION AND ASSESSMENT OF INNOVATION OUTCOME MEASURES.

The definition for innovation adopted by the Advisory Committee focuses on innovation outcomes. Much of the innovation measurement currently focuses solely on inputs to innovation. More work needs to be done to define appropriate outcome measures and analyze their utility and effectiveness. Particular research areas include:

- *Assessment of the effectiveness of measures based on market share as innovation measures and the feasibility, cost, and burden of developing such measures.*

The Advisory Committee has called on the business community to develop and test measures based on market share. Researchers, too, need to examine these measures. The Committee calls on researchers to assess the feasibility, cost, and effectiveness of collecting data to develop measures based on market share, and, where appropriate, to sponsor or participate in pilot projects to test such measures.

- *Assessment of the feasibility, cost, and burden of developing measures of innovation intensity, including a review of other countries' experience in this area and consideration of a pilot project.*

High innovation intensity (the share of revenues earned by recently introduced products and services) is also considered to be a possible indicator of successful innovation. The Committee calls for research to assess the feasibility, cost, and effectiveness

of collecting data to estimate innovation intensity measures, and, where appropriate, to sponsor or participate in pilot projects to test such measures.

- *Analysis of the qualitative and quantitative impacts of specific drivers, impediments and enablers on innovation outcomes.*

Work needs to be done to determine the actual impacts of particular drivers, enablers and impediments – both internal to firms (such as firm culture) and externally imposed (such as accounting rules and immigration policies). In many instances, the connection between an identified driver, enabler or impediment and innovation outcomes is neither well understood nor convincingly demonstrated empirically.

2. IDENTIFICATION OF GAPS IN INNOVATION DATA AND HOW THEY MIGHT BE FILLED.

There are many gaps in the collection of data that might explain innovation better. The Advisory Committee urges work in the following areas:

- *Identification of new data that would be useful in measuring innovation.*

Simply implementing the Committee's proposals for data collection is unlikely to answer all questions about innovation. The process of implementing the proposals will raise new questions and stimulate new ideas for measuring various facets of innovation. The Committee urges that researchers continually probe the data generated by this project to discover ways to improve the data or propose new kinds of data that would help fulfill the Committee's mission, and identify data the Committee has proposed collecting that should be abandoned as not cost-effective with respect to the Committee's mission.

■ *Assessment of the feasibility, cost and burden of collecting data on intellectual property transactions.*

The Committee has proposed the collection of more complete data on firms' total expenditures on and revenues from intellectual property transactions (including both domestic as well as cross-border transactions). In addition, the Committee urges researchers to assess the feasibility, cost and burden of collecting such data not just at the firm level but also at the transaction level by contracting with a representative sample of buyers and sellers in the academic, non-profit, and private sectors to compile periodic data on transactions involving technology licensing. It may be appropriate to carry out a pilot study to assess the nature and extent of the data available.

Measuring this "innovations market" is vital for measuring innovation in a knowledge economy. Insofar as innovation results in the creation of intangible knowledge assets, which yield a flow of benefits over time, measuring transactions in intangible knowledge assets is a good way to measure the value of these assets. Further, transactions data would complement the proposed new NIPA architecture by providing more accurate measures of purchases of the services of intangible inputs. Given that such purchases have grown very substantially in the last two decades, ignoring them risks the very objective that the new NIPA architecture is to accomplish. Finally, transactions data would complement the proposal to improve measures of services industries; many services firms play a crucial role in generating and diffusing innovations through the economy.

■ *Identification of ways to overcome gaps and shortcomings in historical measures of intangible investments.*

The proposals on measuring intangible assets discussed elsewhere in this report focus mainly on collecting data on new investments in intangibles or estimates of the market value of intangible capital stocks. Absent good data on the market value of intangible capital stocks, however, it may be necessary to develop historical cost estimates in order

to account for the contribution of intangible capital stocks to productivity growth. The Committee encourages researchers to develop methods for estimating past investments in intangibles.

3. ANALYSIS OF RELATIONSHIPS BETWEEN INNOVATION ACTIVITIES AND COLLABORATION, INNOVATION PERFORMANCE, AND FIRM PERFORMANCE.

A major goal of innovation measurement is to develop estimates of the rate of return to investments in innovation activities.

A methodological challenge is to untangle the direction of causality between activities and innovation performance. Suppose researchers find that increasing innovation activity X (e.g., spending on a broad set of innovation activities, including but not limited to R&D) is associated with an increase in firm innovation performance Y (e.g., number of new trademarks). And suppose researchers also found that increasing firm innovation performance Y is associated with an increase in firm financial performance measure Z (e.g., sales revenue). Does this mean that X causes Z? Or do growing firms simply tend to spend more on innovation activities?

Another methodological and data challenge is dealing with the fact that much innovation is not done strictly within a firm's boundaries – firms collaborate with other firms and with universities; firms purchase and sell intellectual property rights; firms outsource some innovation activities – so getting the whole picture of innovation is key to estimating the rate of return to innovation activities. And, indeed, innovative activity happens in an international setting where many of these interactions cross national borders.

■ *Analysis of the relationship between innovation and occupational employment using firm-level micro-data.*

Some observers have suggested that the United States faces shortages of workers in scientific, engineering, and technical (SET) occupations that will harm our ability to compete with other countries in the global marketplace. Others have suggested that firms in the

United States can leverage their SET employees by outsourcing some scientific R&D and other innovation-related work or by increasing immigration of SET workers. Still others have suggested that competitiveness depends on a broader range of occupations that includes other kinds of creative workers (e.g., artists and designers) making it harder to say definitively that the United States is ‘falling behind’ other economies when it comes to the supply of innovation workers.

A possible research area using the data generated by implementing the Committee’s proposals is to explore the relationship between occupational employment – of SET workers and more broadly defined ‘innovation workers’ – and various measures of innovation outputs such as intellectual property (patents, copyrights, trademarks), intellectual property licensing revenue and expenditure flows, innovation intensity, and measures of firm performance.

- *Evaluation of whether firms with high innovation intensities perform better than otherwise similar firms with low intensities.*

This is perhaps the most direct measure of how the introduction of new products and services is associated with firm performance. It provides a key link that helps explain how investments in innovation may yield better firm performance. It does so by bridging the gap between investment and financial results to get at how the introduction of new products has an impact on firm profitability.

- *Assessment of the effect of collaboration on innovation outcomes and identification of the key elements of successful collaborative activities.*

Collaboration is believed to be a key element in fostering innovation yet little research has been done to confirm this belief. Work needs to be done both to develop methods to analyze collaboration and assess its actual impact.

- *Assessment and analysis of cross-national innovation activities of firms.*

In today’s globally connected world, many U.S. multinationals conduct a significant part of their

innovation activities outside the United States. Conversely, many non-U.S. firms conduct a significant part of their innovation activities in the United States. These cross-national innovation activities undoubtedly affect the U.S. economy. The statistical agencies are currently working to link data on domestic and international research and development expenses by U.S. and foreign multinational firms. Such efforts should be encouraged and expanded to permit examination of the output of cross-national innovation activities.

- *Analysis of publicly filed financial and other data on firms, particularly as the data become more user-friendly, to identify innovative practices and firms.*

Publicly filed financial data could be used to examine characteristics of firms considered innovative and to consider whether these innovative firms have unique practices or characteristics.

- *Description and explanation of business dynamics and, to the extent possible, analysis of their relationship to innovation using longitudinal business databases.*

Studying the entry, growth, and exit of establishments and firms could provide important information on the characteristics of successful and unsuccessful firms. Much innovation occurs in the smallest firms, where high exit and entry rates are common. Evidence for several industries suggests that entering firms are, on average, more productive than exiting firms but the role played by innovation is not known.

The Census Bureau is developing a longitudinal business database from which it is planning to publish data on establishment and firm births and deaths, job creation and destruction by firm size, age, and industrial sector, and other measures of business dynamics over the past three decades. The resulting data will help researchers distinguish between the effects of short-term economic fluctuations and long-term effects (such as innovation) on business dynamics.

Analysis of longitudinal business dynamics data is believed to be able to provide insight into the patterns of innovative activity in the economy and the innovative and entrepreneurial environment in various time periods. New data sets such as the Kauffman Firm Survey show potential for understanding how high-impact firms evolve, but longer business panel surveys and additional government support are needed to exploit their full potential.

The Committee encourages the Census Bureau to continue its efforts to publish reports on business dynamics and explore the possibility of developing public use micro-data on business dynamics. The Committee also encourages researchers to use longitudinal business databases to help describe and explain business dynamics and, to the extent possible, analyze its relationship to innovation.

- *Exploration of the use of different sources of available data to determine whether there are correlations between innovative performance of firms and the existence of a new regulatory environment.*

Regulatory policies are believed to impact innovation – both positively and negatively – but there is little or no empirical evidence of their impact.

CONCLUSION

The Advisory Committee's recommendations, if adopted, will go far in setting this nation on a course toward effectively measuring the impact of innovation on the economy. The work is essential and the Committee calls on the government, the business community and researchers to adopt the recommendations.



**The Advisory Committee on Measuring Innovation
in the 21st Century Economy**

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