KEY POINTS

- The Consumer Budget Office (CBO) estimates that a .1 percent increase in GDP—i.e. a one-tenth of 1 percentage point increase in GDP—will produce a cumulative deficit reduction of $63 billion over five years. We can increase GDP by increasing labor quality, by capital deepening, or by innovation.
- Many economists believe that up to three-quarters of the nation's growth post-World War II is potentially linked to innovation. That is, the average growth rate in the U.S. post World War II has been 3.4 percent a year in GDP; 2.5 percentage points of that 3.4 percent are potentially linked to innovation.
- Economic growth is as at least a partial answer to the major problems our economy faces today, including high unemployment rates, high budget deficits, and stagnant incomes.
- If innovation is key to productivity, and productivity is key to addressing serious social and economic problems, then innovation necessarily is a valid point of concern for the U.S. government. That is, the United States stands to benefit from government policies that encourage innovation and, indeed, a national innovation strategy is called for.

Building an Innovation Economy

REBECCA BLANK U.S. DEPARTMENT OF COMMERCE

An infrastructure that encourages and sustains innovation is almost surely a necessary and important element of any modern economy that wants to remain at the cutting edge of high economic growth and technological leadership of the world. Rebecca Blank, Under Secretary for Economic Affairs at the U.S. Department of Commerce with oversight responsibility for the two premier statistical agencies in the United States, the Census Bureau and the Bureau of Economic Analysis,[1] notes that economic growth is as at least a partial answer to the major problems our economy faces today, including high unemployment rates, high budget deficits, and stagnant incomes. Blank explains the components that lead to GDP growth and notes that one of the best ways to produce higher economic growth is to support innovation. She outlines the infrastructure needed for an innovation-based economy and reviews policies being pursued by the Obama administration to support that infrastructure. Excerpts of Blank's remarks at the Forum's 2010 Aspen Symposium are reprinted here.

A broad group of people within the Obama administration—both inside and outside the Department of Commerce—have been talking about what an innovation-based economy would look like, and what policies, if any, would improve innovation. There's a good deal of research in this area and though I'm familiar with it, I haven't directly contributed to it. So, unlike some other presenters, I'm going to summarize what we know for you rather than presenting work I've done more directly.

"High innovation economy" is a phrase that gets used a lot, both in and outside of government. It's one of those wonderfully vague rhetorical phrases that has great value to politicians because it can mean anything to anyone. Who can be against a high innovation economy, particularly without any clear definition of exactly what that might imply? One of the things that a group of us has been thinking about is how we would actually put meat on these bones. How do we support a high innovation economy? What national innovation strategy should be put together?

In my job at the Department of Commerce I primarily do two things: I think about measurement and I think about economics. In this talk I'm going to do those two things in relation to innovation. First I'll talk about what innovation is, and how we think about measuring it. I oversee the

[1] Blank is currently Acting Secretary of the U.S. Department of Commerce.

Bureau of Economic Analysis (BEA), which produces the U.S. national income and product accounts. It puts out the GDP numbers and all of its components. The BEA aims to be on the cutting edge of economic measurement. One of its major initiatives over the last five years is focused on how to better measure innovation in the national income and product accounts. I'll show you what the measurement of innovation suggests about the importance of innovation in the U.S. economy. Second, I'll talk about a framework for an innovation-based economy. Anyone who thinks about economics has to think about the ways in which innovation and productivity interact. This is a substantial part of economic growth, and the there are ways in which government can support these activities.

Innovation and Economic Growth

Many economists believe that up to three-quarters of the nation's growth post-World War II is potentially linked to innovation. That is, the average growth rate in the U.S. has been 3.4 percent a year in GDP since World War II; 2.5 percentage points of that 3.4 percent are potentially linked to innovation.

What is innovation and why do we care about it? Let's start by thinking about how we might track innovation through the economy. Since I'm an economist I have to put a few equations up, but they're pretty mild as equations go.

First, what is GDP growth? GDP growth is basically two things, as shown in Figure 1. First, it's growth in labor input, which is how many hours of work there are out there in the economy. You can increase hours of work by increasing the number of people who are working or by increasing the hours that each person works. This is just a total aggregate measure of labor input. Second, GDP growth is growth in productivity. That is, how much does each person produce per hour?

If you care about GDP, you care about labor and you care about productivity. Productivity is one of those magic things in economics—more productivity gets you almost everything that's good and less productivity gets you almost everything that's bad.

Next, the bottom equation—growth in productivity. It has three components: First is growth in labor quality. All of you from the realm of higher education know better than I do just what labor quality is all about. It tends to be measured in terms of years of education and years of experience in the work force. Second, growth in productivity is also a result of capital deepening, which is investment in plant and equipment resources. The third factor is what economists call total factor productivity—TFP. The best description of TFP is that it's everything we can't measure in the first two components. It's one of those aggregate categories.

Capital deepening and TFP account for approximately three-quarters of overall GDP growth, and each of these is all about innovation. Thus, innovation accounts for a high share of productivity growth. Let me talk briefly about each of these aspects of productivity growth.

Figure 1. **How is Innovation Related to Economic Growth?**

GDP Growth =

Growth in Labor Input (Hours) +
Growth in Productivity

Growth in Productivity =

Growth in labor quality +
Capital Deepening +
TFP (Total Factor Productivity)

Capital Deepening

Capital deepening is investment in new plant and equipment. It's changes in equipment design and capacity, the ability to build things faster, and the ability to build them cheaper using the same amount of resources. When firms are investing in new plant or equipment, much of the time they're not buying exactly the same thing they bought in the past. Indeed, if they always bought the same thing—if investment in plant and equipment was purely replacement and nothing else—there would be no innovation involved in capital deepening. But the fact is, there's very little investment that's purely replacement. Almost all investment involves changes to equipment and design.

More recently—obviously this wasn't on our list in the past—changes in the software used to run machinery are also all about innovation. In fact, this is one of the measurements that has changed: Software in the national income and product accounts used to be accounted for in the catch-all category, total factor productivity; only more recently has it been moved into the investment in plant and equipment area and, therefore, counted as part of the capital deepening process.

The contribution of capital deepening to GDP growth has been quite high for a variety of reasons, one of the most important of which is that capital has, compared to other inputs, become progressively cheaper over multiple decades. For example, from 1991 to 2008 all prices rose 45 percent in the economy, but the price for capital equipment fell by 20 percent.

Earlier I was talking to someone here about his new iPad. I said, "It's selling at $500, I'm going to wait until it's $350 to buy one." That's because I know that the price of equipment is falling over time—particularly the price of new technologies.

We've been innovating in ways that make products faster and cheaper at the same time. That has made investments in capital look very attractive relative to investments in labor, and it's one of the reasons why capital deepening has gone on at a relatively high rate in the U.S. economy over the last several decades.

Total Factor Productivity (TFP)

The third element of productivity—in addition to labor quality and capital deepening—is total factor productivity. Again, this is sort of the catch-all everything-else category. It contains a number of elements. In most people's mind, TFP is all about innovation; that is, virtually all of the things dropped into TFP are innovations in some form or another. That includes, most notably, research and development efforts coming out of both universities and the private sector. These are intangibles, things that we can't measure in the same way we can measure plant equipment or labor input. And so of course that means that measuring their value and their impact is often very hard.

The classic way to measure total factor productivity is to do everything you can to measure labor input (which we do pretty well) and do everything you can to measure capital (which we do pretty well), and assume that everything that's left over is total factor productivity. Then you try to tease out what is included in total factor productivity, using much less direct evidence. Recent research points toward improvements in measuring TFP. Interesting efforts are going on in a number of other economies. "Innovation surveys," for example, are designed to measure some TFP elements through survey techniques. This work is very much in its infancy, but it's a fascinating area of study and one that I think we will improve on over time.

The value of new design gets added into total factor productivity, as do art and architecture, which add value and are accounted for as intangibles. Organizational innovation, a topic that business schools talk a lot about, and figuring out new and more effective ways to manage brand equity, marketing and advertising, are also a part of total factor productivity. Similarly, new management techniques and better ways to work with people are included. If a firm is able to use capital and labor more efficiently and therefore produces more, that is a result of organizational innovation. On-the-job training is often included in organizational structured management processes as well—that is, how labor is used and how it's trained are added to TFP and not to the labor quality side.

Finally, there is another part to TFP which isn't quite an intangible but is the result of much that is intangible. If you believe that firms that adopt innovations and become more efficient capture a higher share of the market, the result is that over time more efficient firms capture a larger market share and less efficient firms capture less. There is a sort of aggregation effect due to firm dynamics. If innovation is occurring, early and more effective adopters will become a larger share of the economy, and that itself will create efficiency because more efficient firms are growing while less efficient firms are shrinking. So, this over-time dynamic effect gets added into the TFP measures as well.

Few economists would argue that greater productivity is not absolutely key for economic growth. I would add that economic growth is at least a partial answer to the major problems that we talk about in this economy: high unemployment rates, high budget deficits, and stagnant incomes. All of these things would look much better—at both the state and the federal level—if we had a period of high economic growth. And one of the best ways to produce higher economic growth is to have more innovation going on.

Few economists would argue that greater productivity is not absolutely key for economic growth. I would add that economic growth is at least a partial answer to the major problems that we talk about in this economy: high unemployment rates, high budget deficits, and stagnant incomes.

Thus if innovation is key to productivity, and productivity is key to addressing serious social and economic problems, that means that innovation necessarily is a valid point of concern for the U.S. government. That is, the United States stands to benefit from government policies that encourage innovation and, indeed, a national innovation strategy is called for.

The Consumer Budget Office (CBO) estimates that a .1 percent increase in GDP—i.e. a one-tenth of 1 percentage point increase in GDP—will produce a cumulative deficit reduction of $63 billion over five years. How do we get a one-tenth of 1 percent increase in GDP growth? We can do it by increasing labor quality, by capital deepening, or by innovation.

If we could increase, say, total factor productivity by .1 percent over what it is now and keep it there, that would have substantial impacts on the deficit. That's one way to measure the effect. Clearly, even relatively small increases in innovation can translate into very real social economic benefits.

Contributions to GDP Growth

Figure 2 shows the four contributors—labor hours, labor quality, capital deepening and TFP—to GDP growth from 1975 through 2008. While there may be a lot of problems

with putting such data together over time, within an order of magnitude this figure is fairly accurate.

Labor hours, shown at the bottom of the graph, are a fairly strong share of economic growth—a little under a third in most of the years shown. This comes from increases in female labor force participation and from increases in immigration. To a certain extent it's also coming from the baby boomers, who are all flowing into their working years over much of this period.

One of the arguments for why we are going to have slower economic growth in the next several decades is that female labor force participation seems to have reached an asymptote. It has not increased much in the last decade. As for immigration, we don't know whether it's going to slow down or not, nor what the United States will do with regard to immigration policy. And now that the baby boomers have begun to retire, we're potentially going to have less growth in labor input.

Thus, labor hours, which since 1975 have comprised almost one-third of GDP growth, is potentially going to be smaller. That makes it all the more important to think about how we can grow the other three factors even more if we want higher GDP growth in the economy. We're basically fighting against lower labor hours—if they're going down the other components have to grow or we're going to have a lower GDP growth. Labor input is actually quite an important component of GDP growth. But you can see that in 2008, in fact, its contribution was almost zero. There was no growth in labor input from 2007 to 2008, largely due to the recession and the increase in unemployment that occurred that year.

The black line in the middle of the graph is the labor quality input. This is largely measured by some mix of education and experience. It has slowed a small amount in recent years, and it's not actually very big at any point. It's not that it's unimportant, it's just a smaller share of overall GDP growth than some of the other components.

Capital deepening has become more important in growth in the last decade or so, which reflects all the new sorts of high technology equipment that have become available and in which companies have invested.

Total factor productivity—research and development, innovation, new management and organizational styles, etc.—is on top of the graph. Increases in the last decade reflect the burst of a variety of new technologies; broadly, computer, Internet, iPhone, iPad and so on. Many of the new things happening at the TFP level feed through into capital deepening as well. That is, there's a cycle of new ideas and innovation that, over time, if they're effective and they're commercialized, become part of the capital deepening side as well.

The fact that total factor productivity has had such a strong impact on overall economic growth in recent years leads to the observation that if labor hours are shrinking, and if labor quality isn't growing very fast, then we really have to keep the capital deepening and TFP components of GDP growth high. Likewise, research and development becomes very important to overall GDP growth, as does its translation into real applications that can be used to change what's happening on the plant and equipment side as well. The importance of TFP on overall growth is starkly illustrated on the graph by the deep recession of the early 1980s. Many firms simply could not keep doing R&D during that period.

Figure 3 illustrates the research and development component that lies within TFP.

This figure graphs research and development expenditures as a share of GDP from the early 1950s through 2008. The share rises very steeply in the post-Sputnik period, falls off for a while, and then is quite flat.

Breaking the expenditures down into the federal and the non-federal share, the orange line that falls fairly steadily is the federal share of dollars that go into research and development. The grey line is the non-federal share—the private and foundation dollars going to R&D. Many people point to this graph to show that the federal government has not done its job in supporting R&D. If you believe that innovation is important to economic growth, then basic R&D is critically important—if we don't kick that up, we can't possibly expect over time to see higher innovation returns in the economy. The question is how the government should be involved in establishing an innovation strategy to support an innovation economy.

Framework for an Innovation Economy

To get at the question of what sort of infrastructure is needed for an innovation economy, let's start with what we know. Let's look at the infrastructure needed to produce goods. There is an enormous amount of research on this topic, and economists believe they know something about how to develop a well-functioning and effective market in goods. Let's start with what that infrastructure looks like, and then think about how it would differ to support an innovation-based economy rather than a goods-based economy.

The infrastructure needed to produce goods is straightforward. Its key elements include:

- *Know-how and skill.* We need educated people who know how to make things. They can be artisans or craftsmen; they can be engineers—the key is that know-how is embedded in the labor force.
- *A well-functioning market.* The market should have limited corruption, free-flowing information, access to capital, and accepted standards of behavior that everyone follows and that grease the wheels of commerce.

• *An effective legal structure.* This includes property laws and their enforcement (goods cannot be dispossessed or expropriated too readily), effective and balanced regulation, and tax laws that result in a level playing field.

• *A developed transportation system.* People need to be able to move goods from one place to another. In developing countries, for example, good roads are critical for trade; before those countries have a reliable transportation system and can trade, they are stuck in a subsistence economy.

These are the primary elements that economists identify as needed for a well-functioning goods-producing economy. How might these elements differ for an innovation-based economy?

Similar to the infrastructure needed for a goods-producing economy, know-how and skill are very much at the top of the list for an innovation-based economy too. (See Figure 4.) We need to have people who understand something about research, who are engaging in it, and who are interested in being entrepreneurs—we need the Steve Jobs and Bill Gates out there in some form or another.

We also need a well-functioning market to support innovation. That means we need to have basic research that is supported over the long-term in a variety of ways. We need access to capital to support research and its commercialization, and to support the new startups that take that commercialization and translate it into activity in the economy.

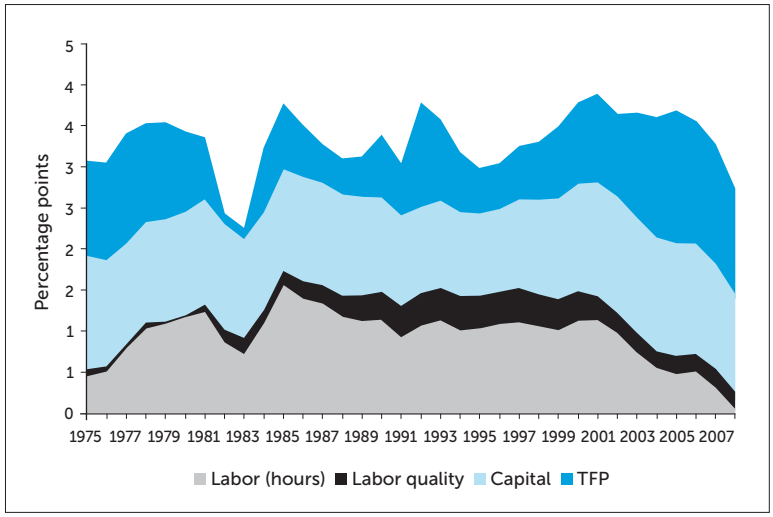
Clearly, we need to be concerned about the linkages between R&D and commercialization. This is one of the big issues that universities are often charged with being very bad at; that is, for not providing the incentive structure that links basic R&D to the commercial end-product.

We need a functioning legal structure. This is not about property rights as for the goods-producing economy. Rather, it's about a well-functioning patent/copyright/trademark system and its enforcement—it's not enough to just have the laws on the books. Today, many claim that the problem isn't the system; the problem is non-enforcement, particularly across national lines. We need strong protection of intellectual property.

There are also regulatory issues to be addressed, depending upon what sort of innovation we're looking at. These regulatory issues may well differ from those of a goods-producing economy. There might be issues around privacy, or around what information gets shared and how. There are certainly issues of national security around intellectual property, and how we put protections around it and what those mean in practice.

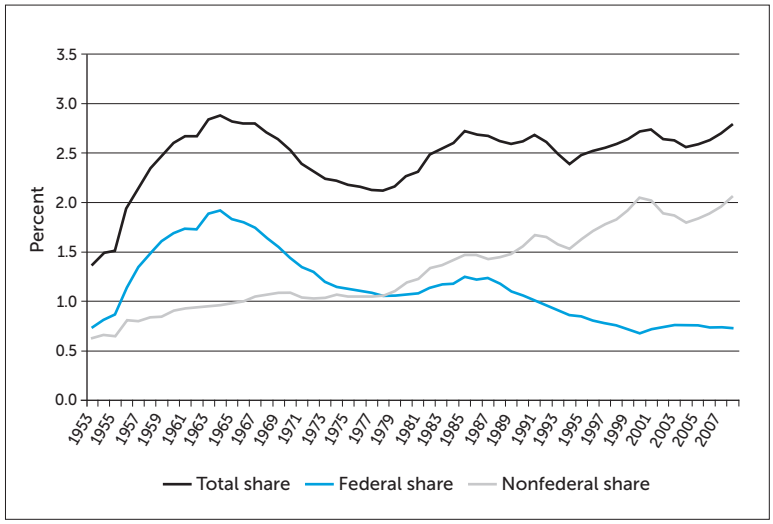
We have tax issues to contend with too. That is, how are all of these activities taxed, and are they taxed in a way that isn't

Figure 2. **Contributions to Output Growth, 1975-2008**
10-Year Moving Averages, Nonfarm Business Sector



Source: John Fernald, Federal Reserve Bank of San Francisco

Figure 3. **Research and Development Expenditures as a Share of GDP 1953-2008**



Source: National Science Foundation, Division of Science Resources Statistics

Figure 4. **Infrastructure Needed for an Innovation Economy**

Know-how and skill

Well-functioning market
- ✓ Support for basic R&D
- ✓ Access to capital
- ✓ Linkages between R&D and commercialization

Legal structure
- ✓ Patent/copyright system (& its enforcement)
- ✓ Regulation
- ✓ Tax laws

Transportation infrastructure for ideas
- ✓ Web access
- ✓ Forums for idea exchange

expropriatory and doesn't unduly benefit or hurt certain segments of the innovation economy?

Finally, we need a transportation infrastructure for ideas. Clearly, that's the World Wide Web and broad access to it. The more web access, the more ideas flow freely, particularly in the scientific community. We don't go to libraries anymore. And we need forums, places where people can come together to exchange ideas. Universities are often at the center of providing forums for ideas exchange, and supporting conferences and publications too.

I'm sure that there are other things one could put on this list comparing the infrastructure for an innovation-based economy with that for a goods-based economy. Many of these things are similar conceptually, but look a little different from the innovation perspective.

...universities do basic R&D very well, but have not been nearly as good at providing the infrastructure and the incentives that lead toward commercialization of research as opposed to publishing in, for example, the basic physics journal.

Policies for an Innovation Economy

The Obama administration is working on an array of policies that in some way support this framework of an innovation economy. I'll briefly describe a few.

To support development of know-how and skill, for example, there is quite a lot going on in the education area. Changes to student financial aid—in the application process, additional money going into Pell grants, and student loan provisions—are an important way to support access to higher education and increase know-how and skill.

Secretary of Education Arnie Duncan is pursuing a broad agenda around improvements in elementary and secondary education, including assistance in setting standards and implementing school reforms. In some ways, in this realm the federal government is the secondary actor, but it's clear that Secretary Duncan has been playing a very active role as a convener and advocate for reform. All the efforts related to our education system are designed explicitly to increase the skills of the American workforce.

With regard to supporting a well-functioning market, item number one has been support for basic R&D. The 2010 budget doubled the research budget for basic science over the next 10 years. Those funds are targeted to three different organizations: the National Science Foundation, the National Institute for Standards and Technology (NIST), which is part of the Department of Commerce, and the Department of Energy's science office.

The Department of Energy is of great interest because of a strong belief on the part of the administration that innovation in new energy technologies is incredibly important for the future of the U.S. economy, particularly given the environmental challenges and the related political challenges that we will be facing in the years ahead.

The second key aspect of a well-functioning market is access to capital to encourage entrepreneurship. Financial reform is the number one approach here. If we don't have a stable financial sector and push the next financial crisis off 75 years or more, then the whole economy is at risk of going bust and all else fails. Clearly, the financial reforms are extremely important.

Credit constraints are still a source of concern in the current financial climate. Those credit constraints are not on big businesses, they're on new business startups and on small businesses. The Small Business Lending Act of 2010 (known as TARP junior) is an effort to support innovation and new business startups until the financial sector is fully functional again.

Concerning linkages between the R&D sector and commercialization, Secretary of Commerce Gary Locke recently convened a variety of people from higher education to talk about the role of higher education in basic research and the translation from research into innovation. The Secretary is planning to hold similar forums at several different universities in the near future. The question is whether the federal government can be helpful to universities in thinking about ways to move from basic R&D to commercialization. Obviously a few universities have done this already, and I think many universities are trying to do so. My experience—you can tell me if I'm wrong—is that universities do basic R&D very well, but have not been nearly as good at providing the infrastructure and the incentives that lead toward commercialization of research as opposed to publishing in, for example, the basic physics journal. One role we've been talking about in the Department of Commerce is how we can act as a convener to start some conversations about best practices to translate basic R&D into usable products.

The legal structure and the patent/trademark/copyright system is a key issue that the administration is currently working on. Our current patent system is almost entirely broken. It takes three years on average for a patent to be approved. There's a set of issues that focuses on timeliness of the payment system, how patents get challenged or not, and a whole series of changes that I think would greatly improve this particular aspect of the innovation economy.

Finally, there's the idea infrastructure. What can the government do here? I think the government can play much more of a convener role in terms of the exchange of ideas. Universities are at the center of this. The administration is also working very hard on all sorts of expanded availability of web and Internet resources. The American Recovery and Reinvestment

Act (ARRA) funds provide dollars that greatly expand internet access for rural or inner-city communities, trying to make sure that broadband access is available to anyone, including public institutions, that want it. There's also a big focus right now throughout the administration on cyberspace security, which is particularly important to those who want to use the Internet to exchange confidential information.

That's a very quick rundown on some of the things that the administration is in the midst of, to at least offer a sense of the range of topics that one might fold into a national innovation strategy.

Conclusion

An infrastructure that encourages and sustains innovation is almost surely a necessary and important element of any modern economy that wants to remain at the cutting edge of high economic growth and technological leadership of the world—which means that some degree of government attention to the innovation sector is necessary. That said, this is an argument that is not always easy to make to all groups, as Americans have a sort of love-hate relationship with government intervention anywhere in the economy.

I believe that the world of research and development, new business startups, and innovation is different in kind than the standard world of goods that most economists think in terms of. Further, there are a variety of standard market failures that occur in the movement of basic R&D to commercialization that call for some form of government involvement and intervention.

Whether it's public education, government support for certain types of basic R&D, assuring that everyone has Internet access, or protecting intellectual property, there is an important role for some federal involvement and for a national innovation strategy. Producing the research, the know-how, and the entrepreneurs, which is essentially what universities are about, is a deeply important part of this strategy.

Discussion

Speaker: I want to go back to one of your opening comments, and that was if we can goose up GDP growth by one-tenth of a percent over five years, we can reduce the deficit by $63 billion. What kind of conversations are going on within the administration, knowing that because of the size of the federal government debt, the CBO recently reduced its growth estimate by 1 full percentage point?

Ms. Blank: It is an art to determine how much to do deficit reduction and how much to do what I've been describing here as investments in things that lead to economic growth. Which is going to give you a bigger return over the long run? There's an asymmetry, because it is always easier to run spending programs (even if we all think they're long-term investment programs), than it is to deal with deficit discipline. And I worry a lot about deficit discipline, particularly in the current environment where you've got a whole movement on the right that not only doesn't want to see taxes raised, but they actually want to see taxes reduced. It's going to be really hard to invest in our innovation infrastructure in the years ahead, even if this is something we very much need to do.

Speaker: The president has had a rough time getting bipartisan support for public policy. We really need innovation policy. What are the odds and what would the strategies be to make it sustainable and bipartisan?

Ms. Blank: I'm not the right person to answer that—you want to ask that of one of the Hill political strategists, right? This innovation strategy is not one big piece of legislation. There is a patent reform bill, and that is one piece of legislation. There is the bill that completely redefined how we award student aid. That was a separate piece of legislation. So there's not one big bill called "innovation strategy" that has everything in it. And I think that's probably the right way to go. It would be a mistake to try to put this all together.

One effect of this approach is that it doesn't look like the administration has a clearly defined innovation strategy because we don't have one big piece of legislation saying here's what we're going to do. But big pieces of legislation bring big problems. I think we'll do better picking off a series of discrete activities and pushing them and giving different agencies ownership over them. Commerce, for example, has a lot of interest in seeing that patent reform goes through. Another agency has a lot of interest in seeing that changes in education go through.

The challenge lies in building bipartisan support around each of those pieces. It will be a test, I think, to see whether patent reform can get bipartisan support. To me, that's a bellwether issue to watch, because given its broad appeal it really should go through with a strong bipartisan vote. We'll see.

↘ **REBECCA BLANK** is the Acting Secretary of the U.S. Department of Commerce. Prior to that, she served as Under Secretary for Economic Affairs at Commerce, where she had oversight responsibility for the two premier statistical agencies in the United States, the Census Bureau and the Bureau of Economic Analysis. Before joining the Commerce department, Blank was the Robert S. Kerr Senior Fellow at the Brookings Institution, and prior to that she was dean of the Gerald R. Ford School of Public Policy at the University of Michigan. Blank served on the President's Council of Economic Advisers under President Clinton. She is a member of the American Academy of Arts and Sciences and a Lifetime Associate at the National Academies of Science.