

## NIST Economic Analysis Office Economic & Policy Analysis Brief

### **Key Findings:**

- *The U.S. places excessive reliance on macrostabilization policies*
- *High rates long-term rates of economic growth require sustained investment in a set of productivity-enhancing assets*
- *High rates of return on investment in technology require managing the amount, composition and efficiency of R&D*

## ***Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy<sup>1</sup>***

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### ***Summary***

- The onset of globalization leaves the competing nations of the world with two rather stark choices: (1) accept lower wages in order to compete in global markets, or (2) invest in productivity enhancing assets to enable dominance in enough high value-added markets to lift real incomes. Almost no one would opt for the first policy option. However, the choice of economic growth policies to achieve the second option is extremely varied across the world's economies.
- For four years since the Great Recession began, the discussion in the United States regarding the right policy response has been intense. However, the vast majority of the debate over the right set of strategies to restore acceptable rates of economic growth has been focused on monetary and fiscal policies. The resulting growth rates have been meager at best.
- The multiplier effect, required to turn government spending into much larger levels of output and hence income, seems to

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be weakening. Bill Gross of the Wall Street bond fund group PIMCO, for example, estimates that it now takes five times as much new debt to create a unit of real GDP as it did in the 1980s. Traditional economic thinking nevertheless continues to urge more of the same. The proponents of fiscal policies (Keynesians) led by Nobel Laureate Paul Krugman argue that even the trillions of dollars in deficit spending has not been enough to jump start sustained economic growth. Implicitly admitting that the multiplier effect has been reduced by the debt burden on consumers, their recommended policy response is more deficit spending.<sup>2</sup> But clearly something is wrong with the conventional “growth model.” In castigating the “debt scolds,” Krugman overlooks the fact that the low return on deficit spending is in part due to the larger portion of the domestic demand going to imports. Therefore, even as American households slowly reduce their debt burden and can increase consumption, the sluggish growth is likely to continue in the future. The reason is that real wages are falling due to the fact that American wages are too high for the workforce’s average productivity relative to rising productivities in other economies.

- Over time, the multiplier effect from deficit spending is further reduced by the crowding out of fiscal stimulus by the need to allocate increasing portions of the government’s budget to paying interest on the rising debt. The interest expense on the federal debt fell to \$360B in fiscal year 2012—almost identical to the interest paid in 2001, in spite of a huge increase in national debt during that period. The reason is that the interest expense is currently being incurred with rates at historically low levels. As greater and greater stimulus eventually pushes rates up, the interest expense will mushroom. Further, many individuals have been buying Treasury bonds for security. As rates rise from historic lows, these investors will suffer significant capital losses. One bond fund manager estimates that if the 10-year Treasury returns to the average rate over the past decade of approximately 4 percent, investors will suffer a capital loss of about \$500B.<sup>3</sup>
- Stimulative fiscal policies include tax cuts, but reducing taxes is a weak policy tool as consumers will use a portion of the extra income to pay down debt and another portion will be saved, leaving only a fraction for increased consumption. The effect of historically aggressive monetary policy has been equally restrained by the fact that zero or even negative real interest

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rates cause consumers (adjusted for risk) to be indifferent between investing in debt, thereby financing growth, and simply holding cash. In addition, holders of debt suffer drastically reduced income and thereby cut back on consumption. This “liquidity trap” phenomenon reduces the “velocity” of money and thereby nominal GDP growth.

- The standard explanation for the weak response to such massive stimulus is consumer debt. But this is where the growth policy debate gets interesting. Ever more stimulus will continue to have weaker and weaker responses in the current constrained domestic demand situation—unless productivity is substantially increased to generate more output for the same expenditure. Raising productivity will increase national income even while domestic consumers are paying down debt, as the productivity gains will make the economy’s products and services more competitive in global markets. Ninety-five percent of the world’s consumers live outside the United States, so the opportunity is huge to the point of making an export-based growth strategy imperative. However, the United States has had 37 consecutive years of trade deficits, and each dollar of deficit is a dollar subtracted from GDP.
- The central role of technology in long-term productivity and output growth has been documented by economists over several decades. Yet, the still dominant neoclassical economic perspective, which emphasizes reliance on price-induced resource reallocation and which still dominates high-level policy advisory positions, gives little or no attention to complex public-private processes by which modern technologies are developed, assimilated, and ultimately used to increase productivity. Instead, technology is viewed as a pure private good and thus requires no support from government—at least when the objective is economic growth. Therefore, neoclassical economists, by ignoring the public-private nature of new technology development, its appropriability problems, and long gestation times, can casually dismiss concerns over underinvestment—especially by the public sector. Not surprisingly, therefore, the US federal R&D funding relative to GDP has dropped over the past 50 years by 167 percent—a counter trend to the rest of the global economy.
- An economy cannot attain long-term growth without substantial investment in “productivity-enhancing assets.” Self-sustaining growth can only result from long-term investment in

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these assets:

- (1) Intellectual capital (technology)
  - (2) Physical capital (hardware and software)
  - (3) Human capital (skilled workers)
  - (4) Organizational/structural capital (regionally concentrated industries in the form of high-tech supply chains that capture the synergies needed for competitive development and manufacture of new technologies)
  - (5) Technical infrastructure capital (methods and techniques, communications networks, standards, etc., that are the modern day version of the traditional infrastructure that drove the Industrial Revolution).
- Implementing the needed substantial and long-term investment requires a public-private partnership strategy because even the largest R&D-intensive companies no longer have the total complement of internal research and production assets nor the market scope to capture the full benefits of investment in new technology platforms. Further, new technology platforms are typically developed years in advance of initial commercialization. Thus, the higher discount rates now applied by companies to R&D investments are leading to declining investment in the radically new technologies that will drive the industries of the future. Small high-tech start-up firms, while still able to get product development research funding, frequently find the availability of needed process technologies and funding for scale up (capital formation) to be unavailable from disorganized and misdirected technical and financial infrastructures.
  - A few states have looked around the world and observed the rapidly increasing public-private investment in the early phases of a technology's development. Their response has been to initiate local technology investment based on the "innovation clusters" model, which includes ensuring a supportive local university and educational infrastructure. Such clusters are the policy tool of the future for achieving R&D efficiency. The Obama Administration has proposed several economy-wide policy initiatives that have the potential to respond to global trends, but a fiscal-debt focused Congress and an out-of-date national technology-based growth strategy present huge obstacles.

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- The ultimate objectives of economic growth policy are to create jobs and to increase per capita income. With respect to employment, recent analysis shows that with one exception, over successive ten-year periods, employment and productivity growth have an almost perfect correlation.<sup>4</sup> Moreover, decades of research have demonstrated beyond a doubt that technology drives long-term productivity growth and hence incomes. Bureau of Labor Statistics (BLS) data show that technology-oriented occupations have much higher median incomes than the overall industry median. The bottom line is that the high-income economy must be the high-tech economy.
- The correct growth model characterizes technology as a multi-element asset that evolves over the entire technology life cycle, is developed by a public-private investment strategy, and is commercialized by a complex industry structure that includes complementary roles by large and small firms. The overall target is sustained rates of productivity growth.
- The US growth mode has emphasized government support of technologies that focus on specific social objectives: national defense, clean energy, space exploration, environment, health, etc. While the R&D budgets of the agencies that focus on these areas may be optimized for their specific missions, they are not optimized for economic growth.
- Further, these “R&D policies” are not connected to the subsequent “scale-up (commercialization)” policies, as is the case in northern European economies (Sweden, Finland, Germany) and in many Asian economies. Ironically, the vast majority of domestic economic gain from new technologies occurs later in the technology’s life cycle as global markets expand and create many high-paying jobs and large corporate profits. The above economies have implemented such “total technology life-cycle strategies” and are reaping the benefits in terms of regular trade surpluses. Such success is taking place in spite of the fact that manufacturing workers in northern European economies are much more highly paid than are American workers. The bottom line is that in a global economy private resources will flow to those countries where labor productivity is higher relative to levels of pay. Worker productivity is, in turn, determined by the degrees of investment in the full range of productivity enhancing assets.
- The policy implications of this technology life cycle model of

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economic growth reflect the increasingly complex and technology-intensive nature of global competition. As stated above, the development and utilization of technologies on a scale large enough to attain significant global market shares for domestic industries require investment in a number of other categories of assets. They include human capital, better channels for technical and business knowledge diffusion to firms of all sizes, capital formation, intellectual property protection, and modern industry structure (i.e., co-located and functionally integrated supply chains). These assets form the foundation of a broad ecosystem that functionally integrates R&D, capital-formation, business management, and skilled labor.

- The bottom line is that the emerging innovation ecosystem is a far more complex and integrated set of industries, universities, and government institutions than what characterized the Industrial Revolution. This new model is emerging on a global scale and thus a domestic economy-wide response is imperative. The Industrial Revolution was based entirely on achieving *scale* economies (larger and larger factories producing undifferentiated products at low prices). Today, the exact opposite is occurring. Companies must develop/acquire highly sophisticated process technologies that can produce a large variety of the same generic product type, but do so quickly and at a low cost and high quality—i.e., economies of *scope* is the driving competitive force.
- The technical infrastructure to support such technology platforms is complex and includes common technology platforms and technical infrastructure (infratechnologies) in which individual companies will underinvest. The semiconductor industry, for example, relies on roughly 1600 standards—without which that industry could not function. Yet, the underlying infratechnologies must be shared by competitors and this public-good character leads to underinvestment.
- Further, the technological intensity of today's products and services requires a wider distribution of R&D within industry supply chains. This creates information sharing and coordination problems that require public-private partnerships, especially in the early critical phases of a technology's development.
- Underlying all of these trends is the fundamental—and still



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largely rejected—fact that R&D is not a homogeneous investment, as assumed by neoclassical economic growth models. Therefore, in addition to the *amount* of R&D, the *composition* of R&D is a critical strategy metric, and the *efficiency* by which each of these investment characteristics is managed is increasingly important in a global economy with shrinking R&D cycle times. The world now spends \$1.4 trillion per year on R&D. While this is a large number by itself and projects intense competition, each dollar of R&D leverages many dollars of subsequent investment in hardware and software and creates many high-paying jobs. Thus, R&D investment should be regarded as the critical growth policy variable.

**SUMMARY:** Several developments in the global economy are requiring a new characterization of the “advanced economy”:

- (1) The dynamics of global competition is reducing the effectiveness of traditional macrostabilization (monetary and fiscal) policies. The complexity of emerging technologies requires a wider range of assets supplied by both industry and government
- (2) Rapidly growing technology-based competition in the global economy in all asset categories is having a compressing effect on technology life cycles and a positive impact on the productivity of R&D—for the nations making the requisite investments.

The impacts of these trends on the advanced economy are

- (1) Technological complexity is extending beyond the capabilities of even the largest R&D-intensive firms resulting in underinvestment by industry, especially with respect to (a) early-phase, proof-of-concept technology research and (2) infratechnology research and related standards.
- (2) The need for longer development times and greater foreign competition is making industry use higher discount rates when considering alternative R&D projects; the result is less investment in longer-term, higher-risk but higher-payoff innovation.
- (3) Government R&D funding programs are moving away from traditional “point-source” funding to “portfolio” funding to respond to complexity and recognition of the need to (a) focus on the “technology system” rather than

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individual components and (b) elevate the return on R&D at both the component and systems levels

- (4) Technological complexity is leading to greater barriers to the diffusion of technical knowledge and to capital formation; the latter is a particularly severe problem for small and medium firms for whom traditional financial markets fail to adequately serve.
- (5) Supplying the rapidly changing required mix of skilled workers is exceeding the current capabilities of the educational system.

The “advanced economy” is adjusting to these trends by creating a new “ecosystem” that addresses the larger and more varied public-good content in emerging technologies and subsequent capital formation. This in turn requires new institutional mechanisms such as technology-based regional clusters and more joint strategic planning among industry, universities, community colleges, and government.

The paper from which this summary is extracted can be accessed at

[http://www.nist.gov/manuscript-publication-search.cfm?pub\\_id=910384](http://www.nist.gov/manuscript-publication-search.cfm?pub_id=910384)

## Endnotes

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<sup>1</sup> Published online in the *Journal of Science and Public Policy*, December, 2012. The paper can be downloaded at

[http://www.nist.gov/customcf/get\\_pdf.cfm?pub\\_id=910384](http://www.nist.gov/customcf/get_pdf.cfm?pub_id=910384).

<sup>2</sup> [http://www.nytimes.com/2012/11/26/opinion/krugman-fighting-fiscal-phantoms.html?nl=todaysheadlines&emc=edit\\_th\\_20121126&r=0](http://www.nytimes.com/2012/11/26/opinion/krugman-fighting-fiscal-phantoms.html?nl=todaysheadlines&emc=edit_th_20121126&r=0).



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<sup>3</sup>[http://www.nypost.com/p/news/business/bond\\_bubble\\_bust\\_z56Re3oMqGljsYzwjb4khO?source=email\\_rt\\_mc\\_body&ifp=0](http://www.nypost.com/p/news/business/bond_bubble_bust_z56Re3oMqGljsYzwjb4khO?source=email_rt_mc_body&ifp=0).

<sup>4</sup> McKinsey Global Institute.