

Policy Solutions to the Productivity Growth Crisis

by Neal Solomon†

Abstract

In the past decade, economic growth, wage growth, business investment and productivity growth have declined dramatically. Economists have discovered that productivity growth alone explains the dramatic development of industrial economies. Yet, the causes of productivity growth are unclear, with capital, labor and technological contributions.

Economists offer a number of theories involving exogenous growth theory, endogenous growth theory and evolutionary growth theory to explain the phenomenon of productivity growth and its centrality to economic development.

The essential ingredient of productivity growth is total factor productivity (TFP), which represents an intangible collection of intellectual human attributes that we designate as technology innovation. Macroeconomic theories, however, fail to adequately represent the source and mechanisms of the decline in productivity growth and in TFP in recent years.

The present article suggests that there are two main sources of the dramatic declines in productivity growth and TFP in the past decade. First, the U.S. patent system has been substantially degraded. Second, the competitive configuration of the technology industry has become highly concentrated. The combination of the reduced competition from the oligopolous configuration of technology incumbents with reduced patent rights for market entrants shows a mechanism for the decline in investment in innovative R&D that has been the engine for economic growth for hundreds of years.

The patent system has been attacked by radicals on the left and the right. On the right, incumbents seek to protect monopoly profits. On the left, progressives attack the property right in a patent in order to seek a public interest benefit to innovation research. As these critiques have influenced patent policy, patent law has been cabined into a narrow scope which only benefits wealthy companies through dramatic increases in enforcement transaction costs.

In a weak patent regime, there is limited enforcement of patent rights. For instance, large technology incumbents may engage in efficient infringement in which they infringe others' technologies until they are caught, typically many years later, and then only pay a nominal fee that they otherwise would pay if they negotiated a license. Without strong patent enforcement, there is no incentive to invest in innovation, either by incumbents that can infringe with impunity or by market entrants that cannot reasonably enforce their patent rights.

The weak patent system, combined with the oligopolous technology market configuration, explains the declining investment in technology R&D even as technology incumbents realize record profits and enjoy historic cash hoards.

These policy factors explain the recent dramatic drop in productivity growth, the slowest economic recovery in about a hundred years, slow wage growth, weak business investment and the general discontent that is shaping politics.

If the causes of weak productivity growth involve government policies – patent policy and competition policy – we can modify the policies to restore growth. In many cases, these policy prescriptions are simple to implement and may provide dramatic catalyst for economic growth.

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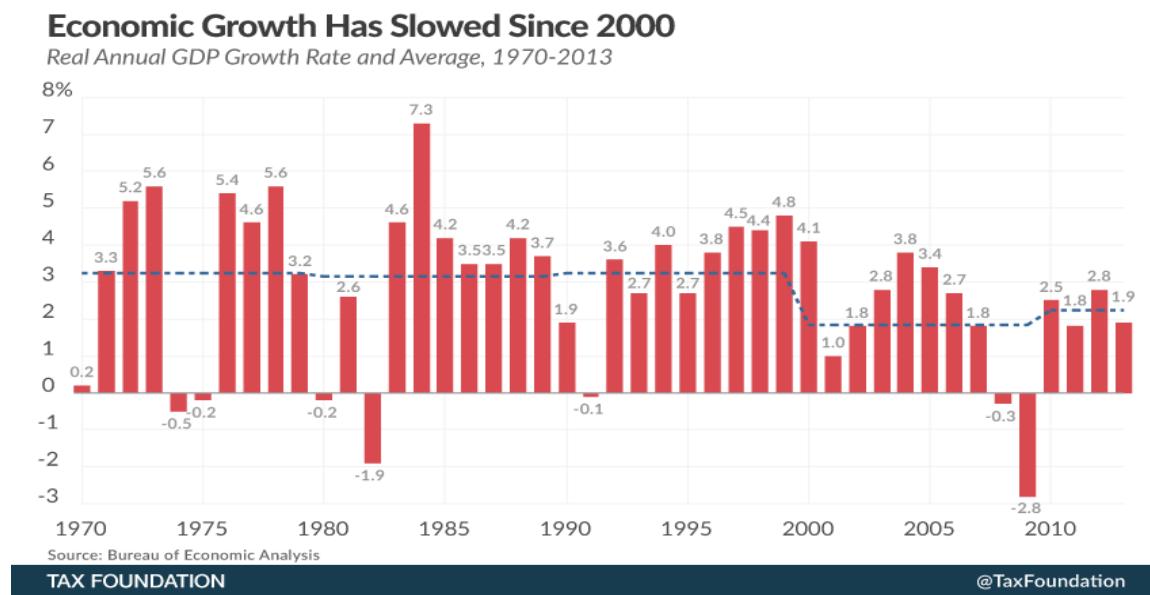
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(I) Economic Data and Theoretical Background

(A) Economic Trends and Productivity Growth Decline Data

Economic growth in the U.S. and in the world economies has been anemic from 2010 to 2016. U.S. economic growth in the six years from the end of the recession (2009) has averaged about 2 percent annually, the lowest long-term economic growth since WWII.

Chart I: Real Annual GDP Growth Rate and Average, 1970-2013



While the Great Recession and the Global Financial Crisis were complex economic disruptions, the data on economic growth immediately before the recession was also not robust. The economies of the U.S., Japan and Europe all appear to be experiencing secular stagnation, with neither significant growth nor significant decline in output.¹

¹ Worse yet, the *projected* growth rate for the U.S. economy is expected to be below long-term averages for many years. The IMF projects a 2% growth rate for 2016-2021, the Economist Intelligence Unit projects 1 – 2.3% growth for 2016-2021 and the OECD Long-Term Forecast projects growth for 2016 to 2050 from 1.5 to 3%, with descending growth projected for each decade.

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Chart II: Quarterly Growth in GDP, 2012-2016



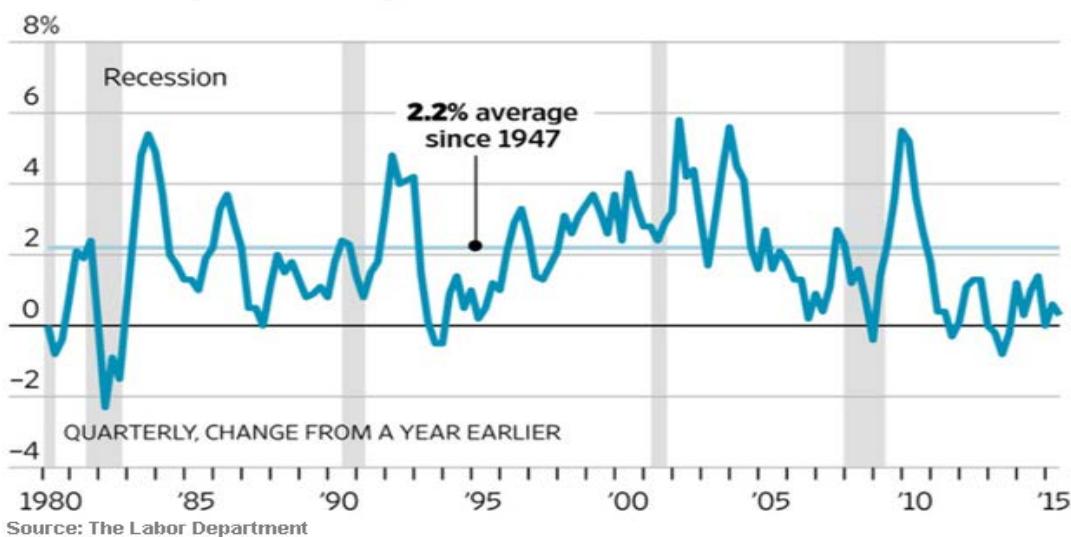
U.S. Bureau of Economic Analysis

A consensus view believes that a key source of the mediocre economic growth data lies in the trend for productivity growth. In the period after the recovery, productivity growth data show a clear pattern of decline. Productivity growth declines are near zero in 2016 after very poor showings of less than 1% growth from 2010 to the present.

Chart III: Productivity Growth Rate Declines, 1980-2015

Below Average

Productivity growth during the recovery has been well below the 2.2% long-term average...



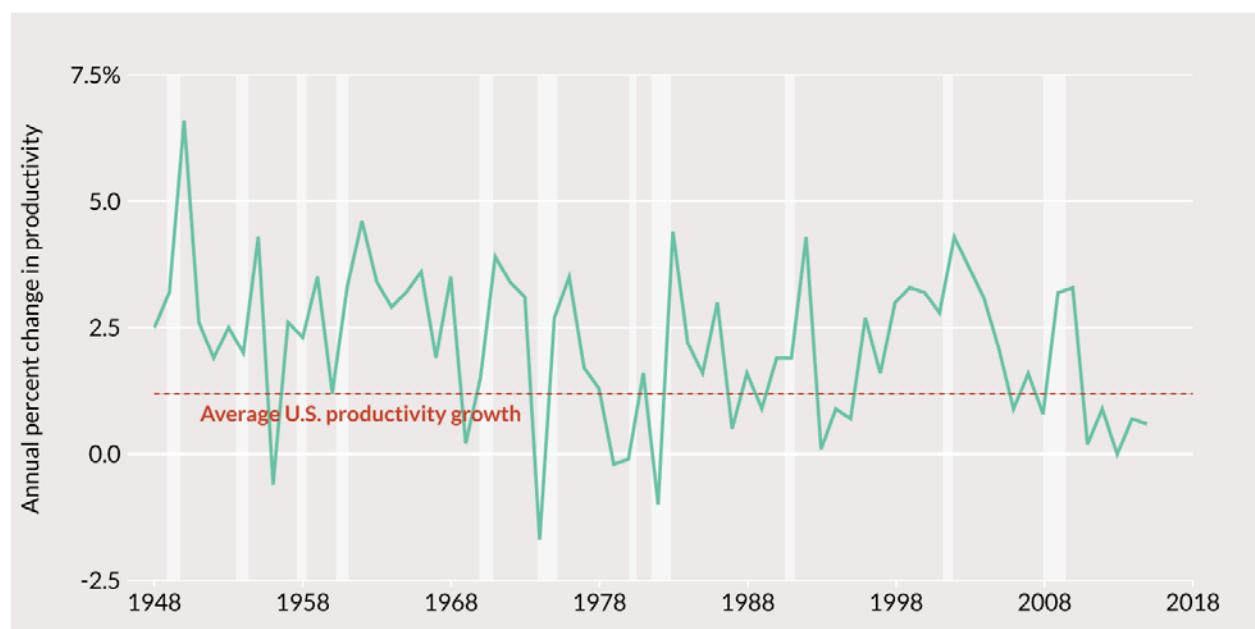
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There has been little precedence for the decline to zero, or negative, for productivity growth data for several generations. Specifically, productivity growth has been under 1% for six years and appears to be falling. Many economists point to productivity growth declines as a main source of anemic economic growth.

Chart IV: U.S. Productivity Growth Trends, 1948-2016

U.S. productivity growth has slowed since 2003

U.S. productivity growth was robust in the late “90s” and early “00s”, but has slowed down since, and has been below historical levels for the past five years.



Source: U.S. Bureau of Labor Statistics, Nonfarm Business Sector: Real Output Per Hour of All Persons [OPHNFB], retrieved from FRED, Federal Reserve Bank of St. Louis, <https://research.stlouisfed.org/fred2/series/OPHNFB>, February 9, 2016.
Note: Recessions are shaded.



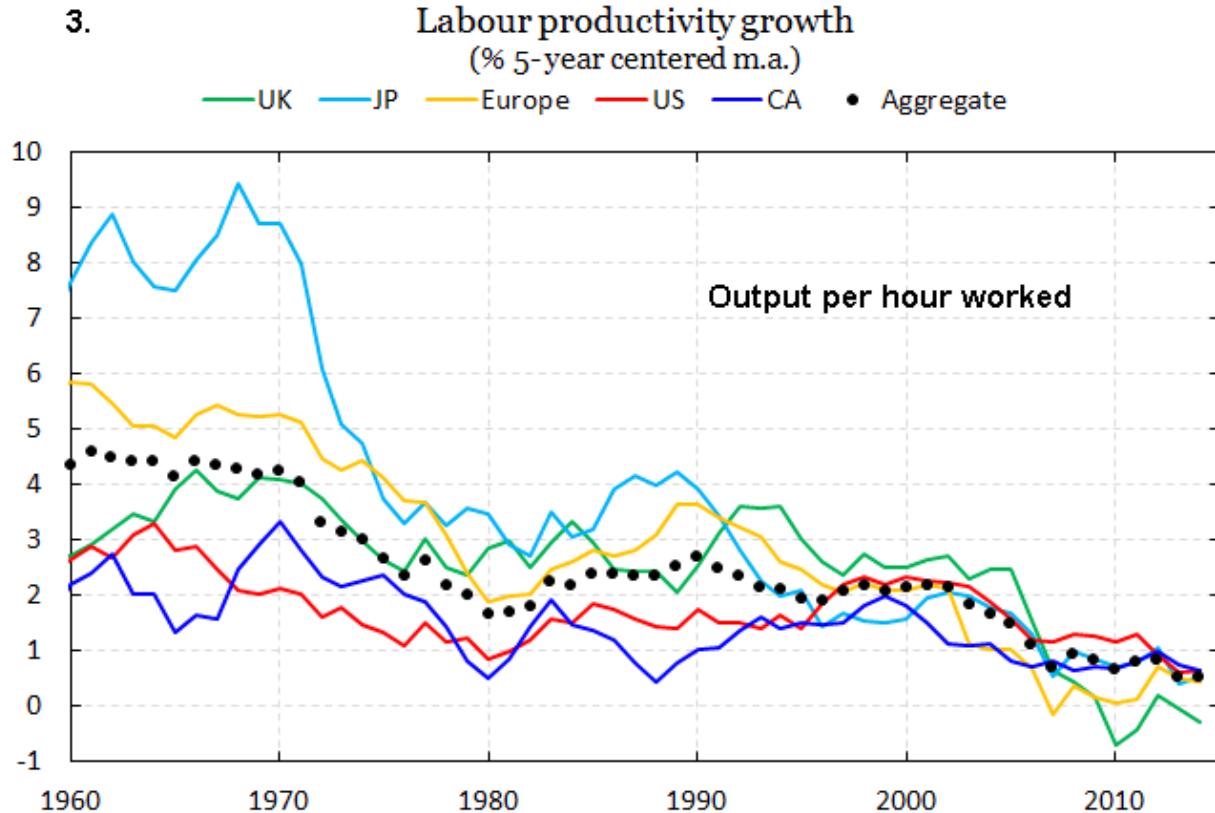
Federal Reserve Chairwoman Yellen indicated alarm at the poor productivity growth data in a June, 2016, speech:

“Over time, productivity growth is the key determinant of improvements in living standards, supporting higher pay for workers without increased costs for employers. Recent weak productivity growth likely helps account for the disappointing pace of wage gains during this economic expansion. Therefore, understanding whether, and by how much, productivity growth will pick up is a crucial part of the economic outlook.”

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The productivity growth problem also appears to have international aspects, with major industrial nations experiencing synchronized productivity growth decline trends in the past decade.

Chart V: Labor Productivity Growth of Industrial Nations, 1960-2015

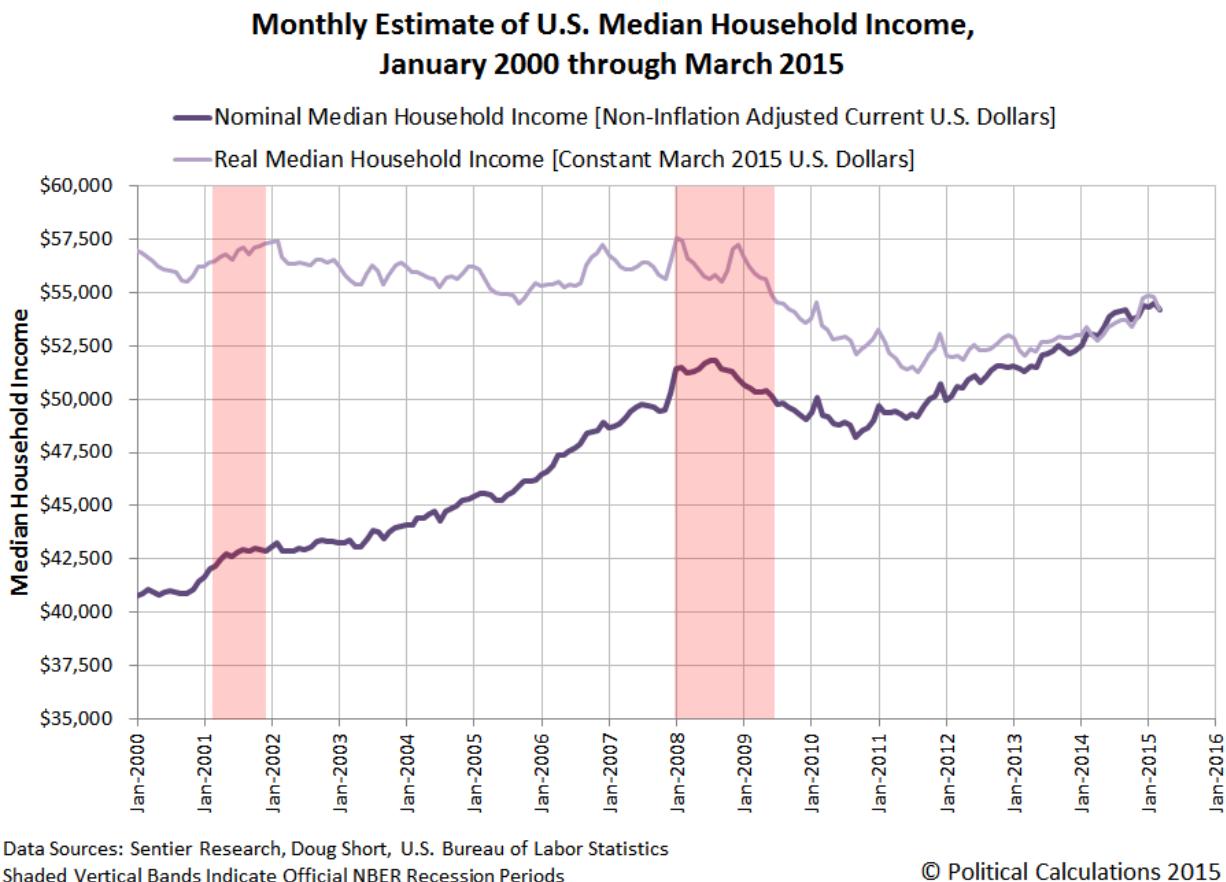


Increased productivity growth yields enhanced wages in the long-run. Like productivity growth, real wage growth has been anemic, little changed since the late 1990s, indicating a structural economic malaise. Because wages have stagnated, overall consumer demand has been slack, which explains the soft demand for commodities as reflected in weak commodity prices. There appears to be a causal link between productivity growth declines and wage growth stagnation.

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Similarly, the effects of positive productivity growth can be disruptive as work is increasingly automated and employment growth is limited; consequently, technology adoption causes increased productivity of existing labor as well as layoffs since more work can be performed by fewer employees. While the official unemployment rate has been restored to historic norms, the unusually low labor force participation rate of 62.6% distorts these labor data.

Chart VI: Monthly Estimate of U.S. Median Household Income, 2000-2015



In addition to wage stagnation, business investment has also stagnated in the last six years. Economists dispute the causes of investment growth after the financial crisis. However, there is a clear pattern of decline in business investment that is related to productivity growth declines.

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Economic theory clearly shows that productivity growth is the central source of aggregate economic growth, profit growth and wage growth.² Moreover, some economists argue that the decline in productivity began *before* the recession from 2007-2009, suggesting a deep structural problem.³

Connected to the observations of economic growth in the last forty years, and complicating causal explanations, is the recognition that productivity growth tends to spike after a recession. These productivity growth spikes are seen in 1980, 1990, 2000 and 2008. It appears that recessions force mass layoffs, which tend to enhance efficiency of surviving labor output per employee. However, in all cases, these post-recession productivity growth increases represent artificial temporary changes rather than long-term growth patterns, followed by periods of productivity weakness.

The effects of declines in productivity growth are substantial. From productivity growth declines flow slower aggregate economic growth, slower employment growth, slower wage growth and less aggregate wealth generation. Interestingly, with declining productivity growth, rising labor costs produce constrained profits for the same output. From poor productivity growth, then, wage increases are difficult without cutting into corporate profits.

If wage stagnation is attributable to productivity growth declines, consequences include enhanced social inequity. Consequences of declining productivity growth, then, include stagnant

² There is an argument that as labor market demand increases, wages increase and that higher wages supply increased demand for goods, which stimulates productivity growth. The argument suggests that labor scarcity provides an incentive for businesses to invest in productivity enhancing machinery. However, the fallacy in the argument is the assumption that businesses invest in machinery as labor costs increase, which is false because investment in both higher wages and equipment cuts into profits. Tighter labor markets typically point to lower productivity growth. Instead, higher labor wages tend to stimulate outsourcing to preserve profits. Finally, when companies do replace workers with automation, wage growth is further reduced, illustrating the complex dynamics of productivity growth, capital investment, wage growth and profits.

³ See Fernald, J., "Productivity and Potential Output Before, During and After the Great Recession," 2014, showing that productivity growth declines started in 2005, not in 2010.

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economic growth, stagnant wages, increased inequality, diminished quality of life, diminished demand for goods and voter angst.⁴

The productivity growth declines of recent years have been the subject of curiosity by a range of economists and journalists across the political spectrum.⁵ Because of its centrality to economic development, economists have sought to explore the causes of productivity growth.

(B) Total Factor Productivity (TFP) Growth Describes Critical Role of Technology

History reveals that until 1720, economies were stagnant. After 1720, the industrial revolution combined enlightenment ideas (from the University of Cambridge) with capital (from London) to generate entrepreneurial organizations that stimulate aggregate economic growth and improved living standards as industrial nations rapidly developed. American economic development from 1870 to 1970, for example, represented a period of dramatic growth in median wages and quality of life. This period benefitted from rapid development of innovations and, from these innovations, productivity growth. But what exactly is productivity and how does it stimulate economic development?

⁴ The dramatic political consequences of slow economic growth and the stagnation of wage growth include the rise of populist movements on the left and the right.

⁵ See Daniel, T. and D. Brown, "Missing the Juice: What's Happening with U.S. Productivity Growth?" Third Way, March 1, 2016; Irwin, N., "Why is Productivity So Weak? Three Theories," NYT, April 28, 2016; Jenkins, H., "Make America Grow Again," WSJ, April 28, 2016; Fleming, S. and C. Giles, "U.S. Productivity Slips For First Time in Three Decades," Financial Times, May 25, 2016; Pethokoukis, J., "U.S. Productivity Growth is Set to Fall for the First Time in Decades: Should We Worry a Little or a Lot," American Enterprise Institute Ideas, May 26, 2016; Bartash, J., "U.S. Worker Productivity Sags Again in the First Quarter," MarketWatch, June 7, 2016; Roubini, N., "Why This Golden Era of Innovation Isn't Improving Productivity," Bloomberg, June 7, 2016; A. Soergel, "The Productivity Paradox," U.S. News and World Report, June 1, 2016; Flowers, A., "The Fed is Worried About Worker Productivity," FiveThirtyEight, June 15, 2016; Krugman, P., "Bull Market Blues," NYT, July 15, 2016; Bunker, N., "Did the Great Recession Reduce U.S. Productivity Growth?," Washington Center for Equitable Growth, July 25, 2016; Morath, E., "Seven Years Later, Recovery Remains the Weakest of the Post-World War II Era," WSJ, July 29, 2016; Review and Outlook, "Make America Grow Again," WSJ, July 29, 2016; Samson, A., U.S. Economic Growth of 1.2% Misses Estimates," Financial Times, July 29, 2016; Gramm, P. and M. Solon, "Why This Recovery is So Lousy," WSJ, August 3, 2016; Irwin, N., "We're in a Low-Growth World: How Did We Get Here?," NYT, August 6, 2016; Gordon, R., "Can Clinton or Trump Recapture Robust American Growth?" NYT, August 8, 2016 and; Leubsdorf, B., "U.S. Productivity Growth Fell for the Third Straight Quarter," WSJ, August 9, 2016.

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Productivity is defined as a measure of the efficiency per unit of labor production and is typically expressed as the quanta of labor output relative to inputs. Macroeconomists distinguish between the capital, labor and “other” components of productivity growth.⁶

Capital investment is a main component of productivity growth. For instance, investment in infrastructure or factory equipment enhances worker output. Labor efficiency also enhances productivity. Skilled education or worker incentives tend to increase output per hour. However, a third, intangible or “residual,” component accounts for the majority of productivity growth. In the 1950s, Solow referred to this new productivity growth component that is not attributable to capital or labor as “multi-factor productivity.” This third element of productivity generally includes aspects of intellectual human capital, creativity or inventiveness. Multi-factor productivity combines elements of investment and labor, but configures these elements into unique combinations of enhancements to improve productive output of hours worked.

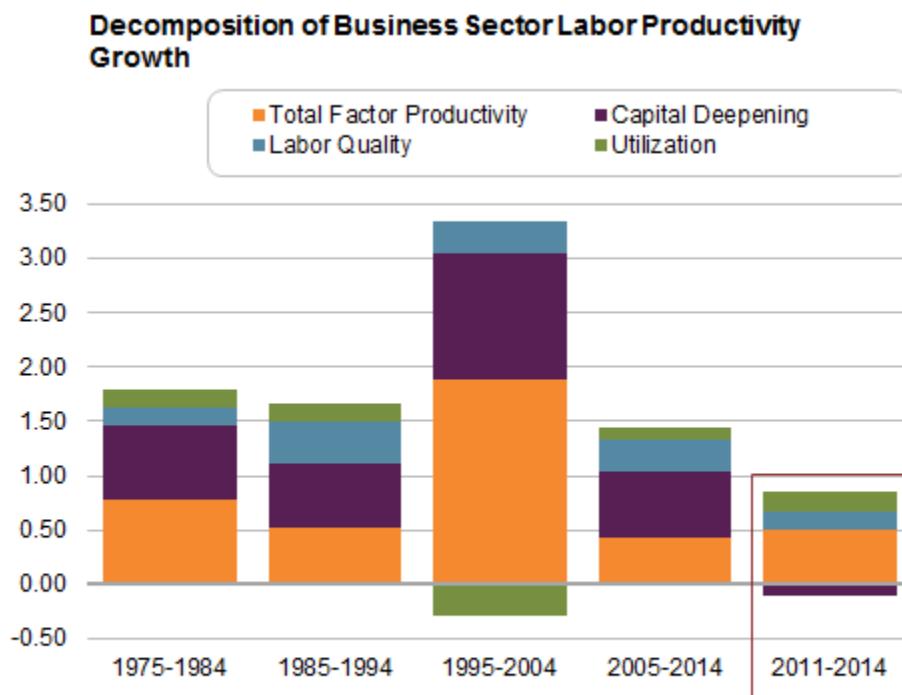
From a process technology viewpoint, this notion of productivity suggests that a reorganization of the shop floor will enhance labor unit output by repositioning machines, improving machines or organizing software in an increasingly efficient way to make products better, more quickly or cheaper. This element increases labor production efficiency. Modern economists refer to this third component as total factor productivity (TFP). We can see TFP as a sort of human ingenuity that applies novel ideas to improve labor efficiency.

Since TFP is focused on technological development, it is suggested that if technology is the core element of increasing productivity and if productivity is the essential ingredient in economic growth, then technology itself is the source of economic progress.

⁶ Solow created the three part scheme to describe productivity consisting of capital, labor and innovation, while others, such as Denison, view additional components (e.g., utilization) of productivity.

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Chart VII: Decomposition of Business Sector Labor Productivity Growth, 1975-2014



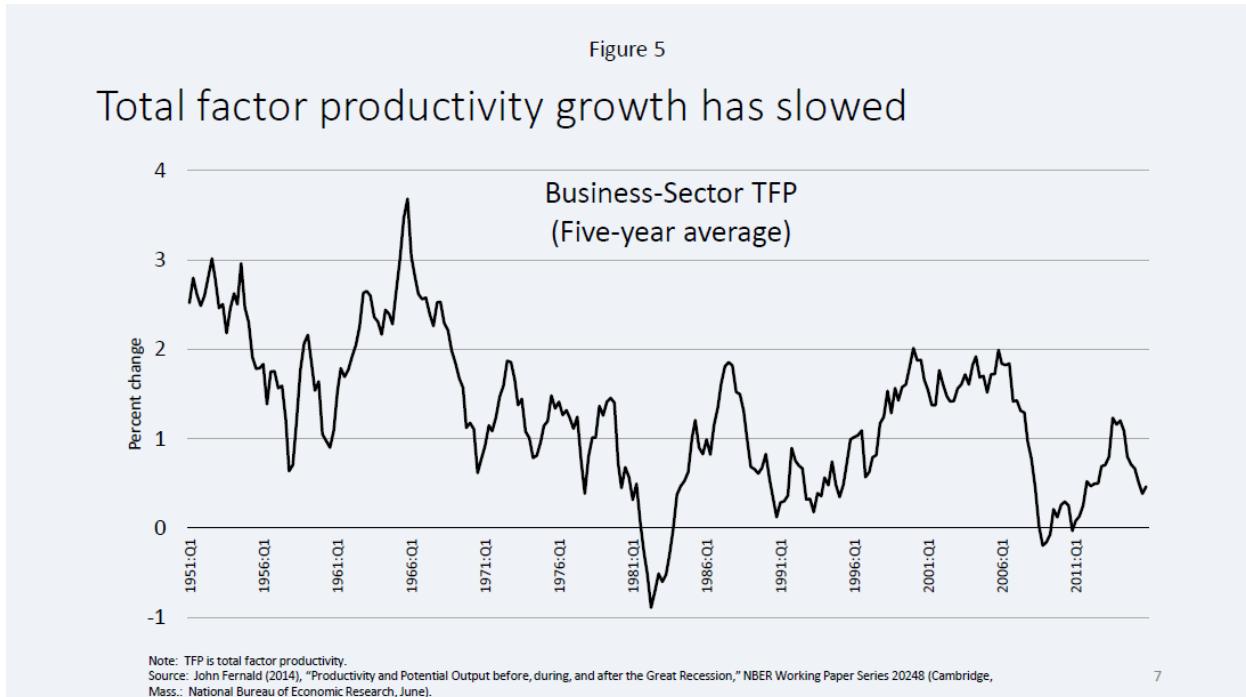
Source: John G. Fernald, "A Quarterly, Utilization-Adjusted Series on Total Factor Productivity." San Francisco Fed Working Paper 2012-19 (updated March 2014).

Most economists recognize differentiated contributions of capital, labor and TFP. While capital contributes about 15% and labor contributes about 25%, TFP contributes about 60% to productivity growth. TFP includes research and development of new innovations, which represent a catalyst to productive work. R&D thus represents a multiplier for productivity growth.⁷

⁷ If 50% of TFP is allocated to R&D investments, finding ways to boost these investments may substantially increase aggregate productivity growth.

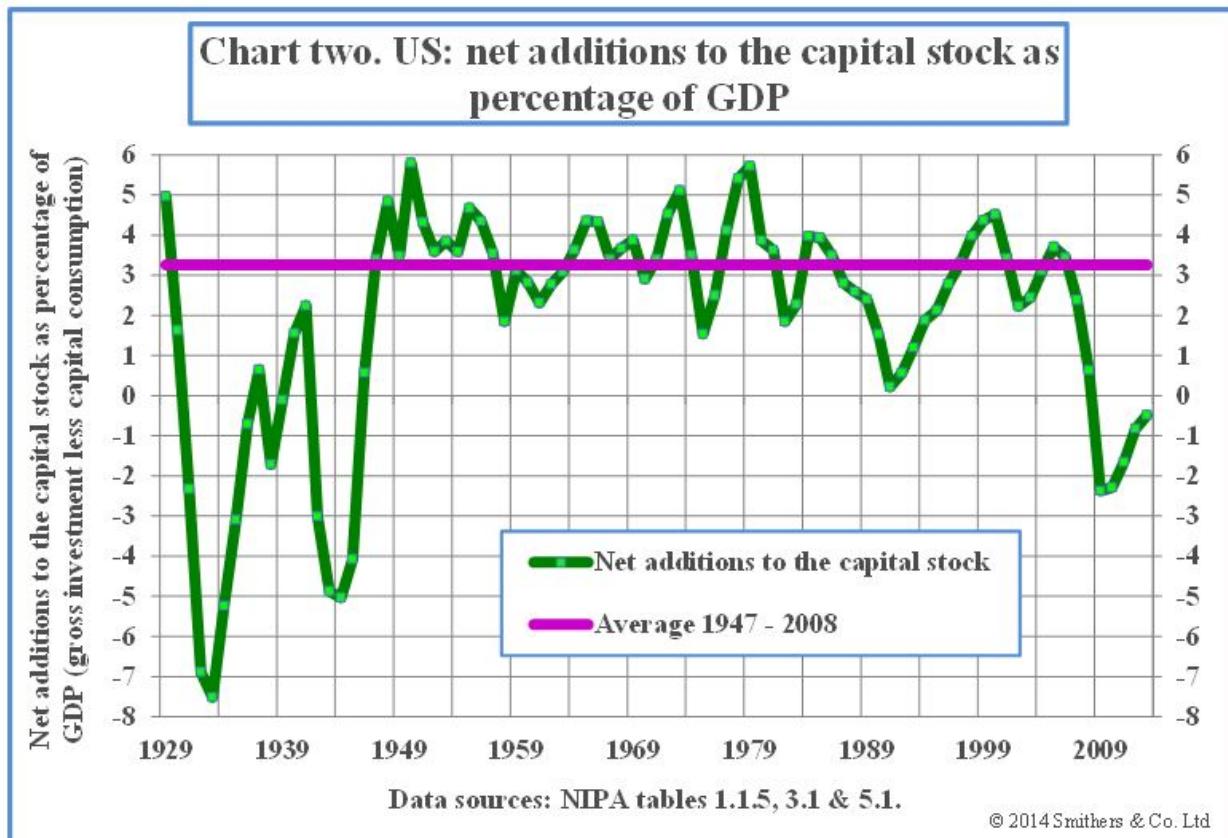
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Chart VIII: Total Factor Productivity Growth Has Slowed, 1951-2014



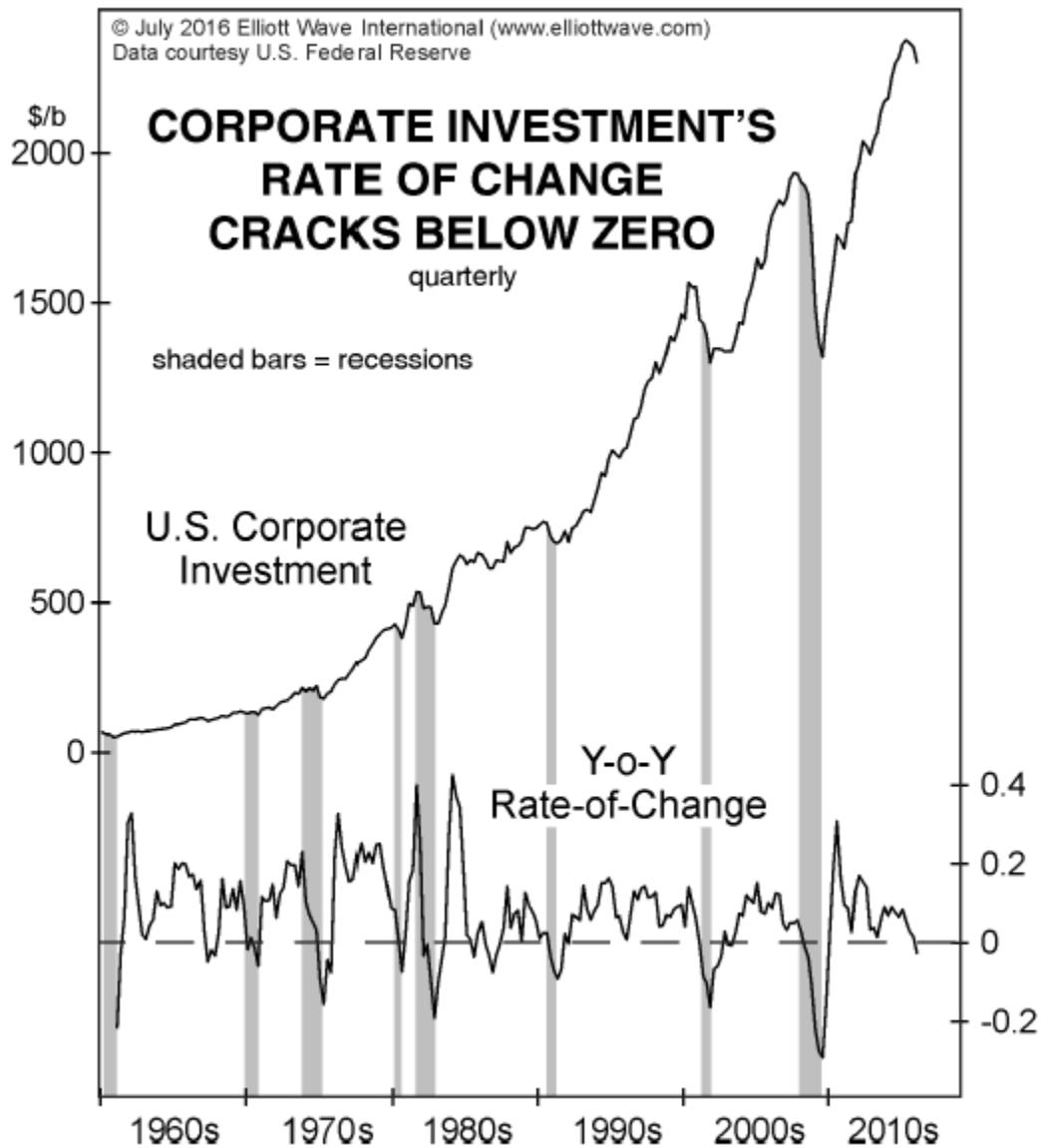
Without new inventions, productivity would be relatively stagnant. TFP can be seen as a form of intellectual human capital that requires a specialized education in order to develop novel inventions. TFP innovations may involve product technologies or process (i.e., manufacturing) technologies that improve earlier approaches. By building on prior systems, technological innovations are shown to contribute to economic output through technological progress. TFP measures the contribution of these innovations and intangible assets to overall productivity growth.

Chart IX: U.S. Net Additions to the Capital Stock, 1929-2014



Investment in technology R&D is a key factor in TFP. While investment in buildings, equipment and education are significant factors for productivity growth, TFP focuses on investment in technology invention. It is notable that there is strong evidence that these investments have declined in the last decade.

Chart X: Corporate Investment's Rate of Change Cracks Below Zero, 1960-2016



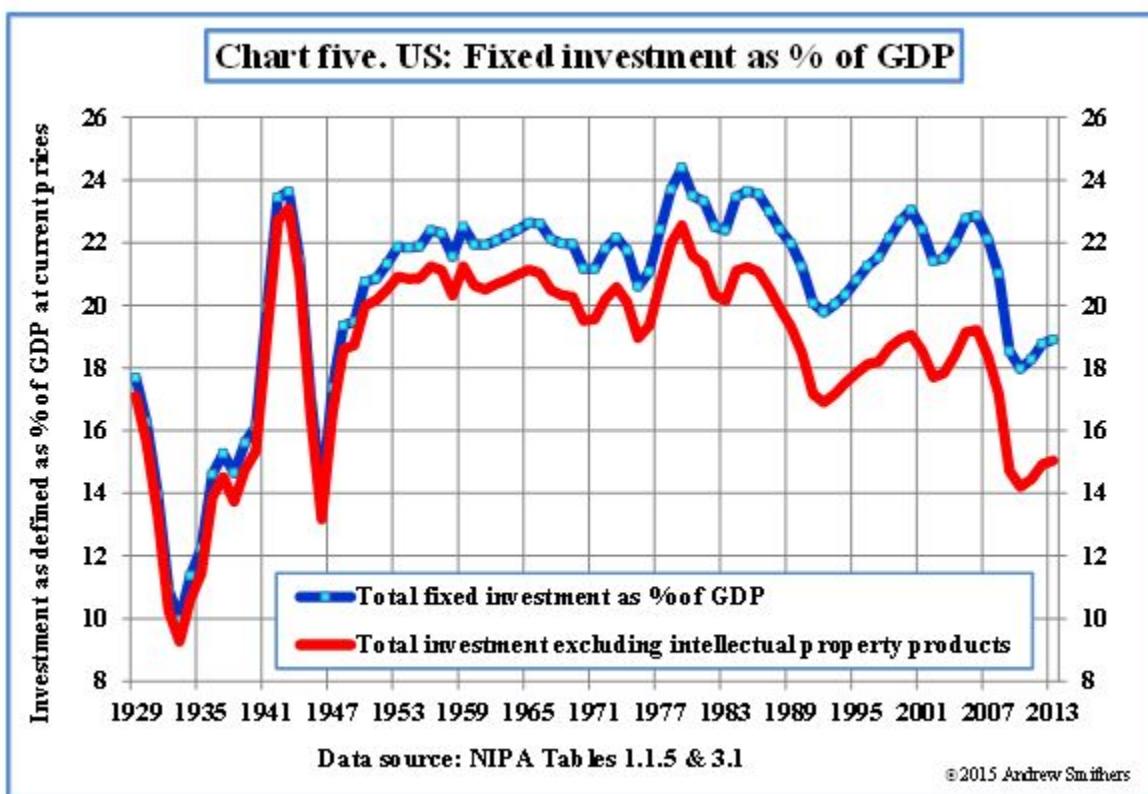
Interestingly, the U.S. is the center of the technological universe.⁸ Until about 2000, the U.S. performed 40-50% of the world's R&D and produced an outside percentage of inventions that are distributed worldwide. Hence, the growth and strength of the world economy are directly attributed to the American technological engine. It should therefore be no surprise that when

⁸ In the 19th century, inventors worldwide came to the U.S. to innovate, from Karl Benz (inventor of the internal combustion engine) and Alexander Graham Bell (inventor of the telephone) to Nikola Tesla (inventor of AC power generators and applications).

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U.S. R&D investment and TFP decline, world economic growth and productivity growth decline as well.⁹

Chart XI: U.S. Fixed Investment as Percentage of GDP, 1929-2015



Note from Chart XI the gap between total investment and investment excluding IP shows that about four percent of investment applies to IP. This four percent represents the critical investment in innovation. As this share decreases, TFP is dramatically diminished.

The capital investment component of productivity includes public (roads, transportation systems and education) and private (buildings, equipment and software) investment. However, capital investment is targeted to R&D as well, representing an overlap of capital with TFP.

⁹ One theory suggests that with limited TFP growth, wage growth is constrained, which constrains demand for goods; limited aggregate demand thus drives stagnation of investment. With lower aggregate economic growth, central banks keep interest rates low, which further signals stagnation. This vicious cycle of stagnation has TFP declines at its root. Since the world economy is increasingly integrated, these mechanisms seem intractable.

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The labor investment component of productivity includes both educational and demographic elements. Improvement of labor skills tends to enhance productivity; consequently, investment in specialized (STEM) education makes a significant difference in productivity. With nontrivial declines in education funding in recent decades, there is an argument that educational investments have harmed productivity and have enhanced inequality. In addition, the demographic argument suggests that as older workers retire, they take their experience, leadership skills and training with them, thereby diminishing productivity.¹⁰

The dynamics of capital, labor and TFP show capital investment focused on labor elements as well as innovation elements. Very specialized types of labor, particularly creative and intellectual types of labor that require investment in ingenious learning and technical skills, affect the development of innovation, illustrating the dynamic relation between capital, labor and TFP. These dynamics between productivity components show the complexity of measuring TFP in isolation.

Productivity growth is the holy grail of economics because it holds the secret to economic progress. Since TFP is the critical ingredient in productivity growth and since productivity growth is a central concept explaining aggregate economic growth, in order to explain the dynamics of economic growth we must understand the mechanics of TFP. Rather than merely identify the existence of TFP to economic development, it is imperative to understand how it operates and why it is so central. Economists from Adam Smith to Paul Romer have sought to understand productivity growth as the essential ingredient of economic growth.

¹⁰ See Maestras, N. et al., “The Effect of Population Aging on Economic Growth,” 2014, on the consequences of workforce retirements on productivity. Also, consider a counter-force of labor productivity that suggests the phenomenon of smart phones and the emergence of social media are distractions for workers that negatively impacts productivity.

(C) Theories of Productivity Growth

Classical economists from Adam Smith to Karl Marx have observed that technological change lies at the heart of economic growth. But these economists merely identified the existence of technological change as a factor in economic progress and did not understand the mechanisms of development. For instance, in *The Wealth of Nations*, Adam Smith noticed that some nations were more successful at accumulating wealth than other nations, and identified a relative disparity in efficiency and aggregate production between regions. Similarly, Marx observed that technology – including product and process technology – was a source of economic change. However, neither scholar specified the mechanisms for technological development as a source for general economic development.

Schumpeter¹¹ built on theories of Marx and neoclassical economists to develop a notion of economic growth with a central role for technological change. His concept of “creative destruction” drew upon Marxian ideas of dynamic economic change. However, it was Solow¹² who developed the first modern neoclassical exogenous theory of productivity growth. Solow identified productivity as a key attribute in economic growth that consisted of capital, labor and intellectual human capital contributions.¹³ Nevertheless, Solow did not explain why productivity growth was essential to economic development, leaving descriptions of the mechanisms of productivity growth to future generations.

Romer¹⁴ developed modern endogenous growth theory within the neoclassical economic framework. According to Romer, technology represents efficient and clever combinations of

¹¹ See Schumpeter, J., *The Theory of Economic Development*, 1934.

¹² See Solow, R., “A Contribution to the Theory of Economic Growth,” 1956.

¹³ Solow states, in the Nobel Prize lecture, “Growth Theory and After,” 1987, “Growth theory was invented to provide a systematic way to talk about and to compare equilibrium paths for the economy,” p. 6.

¹⁴ See Romer, P., “Increasing Returns and Long-Run Growth,” 1986 and Romer, P., “Endogenous Technological Change,” 1990. Romer did his graduate studies with Solow at the University of Chicago. The author was a graduate student at Chicago when Romer was completing his dissertation.

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elements, or new “recipes,” that improve productivity. Technology improvements contribute the major component of TFP. Romer’s new growth theory argues that ideas are nonrival, in contrast to capital or land, since they can be disseminated to improve the general wealth of knowledge.

In order to stimulate business investment in risky technology projects, Romer argues that intellectual property rights are required. In order to protect expensive and risky financial investments, Romer argues that the patent system is required to preserve a property right. The emphasis on strong property rights in a patent to induce investment is at the core of endogenous theory of productivity growth. Consistent with Schumpeter’s notion of creative destruction, patents are particularly critical to market entrants, which require market exclusivity. By way of contrast, market incumbents have market power and brand loyalty as competitive advantages and do not necessarily require patent rights on inventions in the short-run.

In addition to Solow and Romer, the evolutionary theorists Nelson and Winter¹⁵ argue that productivity growth results from competitive mechanisms analogous to biological natural selection. Technology, and investment in technology, supplies the tools for market players to compete across an industry life cycle.

The analysis of TFP fits in various economic theories of productivity growth, including exogenous theory of productivity growth in the neoclassical economic framework, endogenous growth theory and the evolutionary theory of economic development. In some ways, a new neoclassical hybrid economic theory of productivity synthesizes these views since endogenous growth theory focuses on the phenomenon of innovation as autonomous, exogenous growth theory focuses on dynamics of the components of productivity while the evolutionary theory focuses on growth in the context of a dynamic system of economic development.

¹⁵ See Nelson and Winter, *An Evolutionary Theory of Economic Change*, 1982.

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Additional contemporary economic theories of productivity growth espouse arguments to explain peak productivity, concentration of wealth, monopoly power, mismeasurement, cyclicity, government investment and secular stagnation.

Gordon's argument¹⁶ for *peak productivity* suggests that in the last generation innovations have been relatively weaker than during the period from 1870 to 1970. He shows a consistent decline of productivity growth since about 1970 because he argues that the quality of recent inventions cannot compare to earlier inventions involving motor vehicles, electricity, air travel, indoor plumbing, vaccines, the telephone, radio and television. According to this view, the dramatic technological developments during the peak period can be neither reproduced nor improved upon. This view, however, ignores revolutionary technological developments of the transistor, semiconductor, internet, wireless telephony, internet of things, robotics, artificial intelligence and the genetic revolution, suggesting that productivity growth may not have hit a peak.

Stiglitz¹⁷ argues that the *concentration of wealth* in the hands of a few restricts economic growth and enhances inequality. However, this theory fails to describe the competitive mechanisms for anticompetitive behavior that leads to retarded technological development. Further, this view cannot refute the counterfactual in which only a few firms are responsible for massive investments in technology that are ultimately distributed to consumers. Finally, this view holds that the government should supply massive R&D investments, while it is unclear that government contributions on non-basic research contribute to productivity growth since a centralized government has a poor record of selecting winners and losers.

¹⁶ See Gordon, R., *The Rise and Fall of American Growth*, 2016.

¹⁷ See Stiglitz, J., "Inequality and Economic Growth," 2016.

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Krugman argues that productivity growth is caused by reduced investment in R&D and that the reduction is due to *monopoly power* of incumbents that do not require investment in R&D to maintain profits. But he does not describe how or why this is the case or the mechanisms of the effects of monopolization. This view is similar to Stiglitz's view that concentration of wealth is *ipso facto* a disincentive to invest in technology development.

One theory to explain productivity growth decline argues that productivity is *mismeasured*. For example, most of productivity growth research focuses on the manufacturing industry, yet U.S. manufacturing peaked in 1970. Consequently, service businesses and software are underrepresented economic categories that are simply unaccounted. In addition, since it is difficult to measure intangibles, technology is mismeasured.

Cycle theorists argue that *lags* of delays exist as the economy adjusts. For example, after a recession, investors apply investment capital to technology projects only when alternative options are exhausted. This theory suggests a temporal mismeasurement problem, yet implies that in the long-run the lags self-organize into a coherent trend of productivity growth.

Another theory argues that *government investment* is a key factor in technological development, particularly for infrastructure and basic research projects in which private investors refuse to participate. When government research funding drops, for example during or after a recession, these theorists argue a correlation exists between reduced government technology funding and productivity growth declines. However, government funding is primarily concentrated on biological and medical technologies, which appear to be stable if not robust.

Summers¹⁸ argues that *secular stagnation* is a core cause of productivity growth declines. Summers argues that limited investment is caused by constrained consumer demand. This view argues that companies reduce investments during recessions due to weak demand. Though

¹⁸ See Summers, L., "The Age of Secular Stagnation," 2016.

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superficially correct, this view fails to supply an explanation of the mechanisms to explain how or why these processes occur.

Finally, political ideologies supply well-worn explanations for and policy prescriptions to remedy productivity growth declines. On the political left, the Democrats argue for investment of public money into education and infrastructure, arguing that these long-term investments supply ultimate productivity benefits. On the political right, the Republicans argue for supply-side economics that includes tax cuts to stimulate investment and business deregulation to encourage competition; however, there is limited evidence of sustained productivity growth in the long-run from these policy prescriptions without adverse effects of inequality and economic concentration.

I argue that these theorists present incomplete arguments to explain productivity growth declines we have witnessed in the last decade. None of them explain the facts. Not a single theory supplies predictive capacity. Only Romer supplies a scintilla of explanation for declining productivity growth that includes a description of the mechanisms of technology development and investment in technology and why these components contribute to productivity growth.

(D) A New Theory of Patent System Degeneration as Explanation of Productivity Growth Decline

The central thesis of this article is that productivity growth is strongly correlated with a strong patent system. Consequently, I will show that the attack on patent rights starting about 2005 is correlated to the decline of productivity growth. The crucial element of TFP preservation is an effective patent system. The patent system is designed to induce business investment in technology R&D. In effect, the macroeconomic analysis of productivity growth

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rests on microeconomic phenomena of decisions made by entrepreneurs to risk capital on technology projects in the expectation of a reward.¹⁹

The U.S. patent system is embedded in Art. I, section 8, clause 8 of the U.S. Constitution: “Congress has the power . . . [t]o promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.” This simple yet elegant sentence describes the core source of America’s power and explains its source of productivity growth.

The high correlation of a strong patent system with positive productivity growth in the 1980s and 1990s is well established as well as the correlation of a weak patent system of the 1970s to weak productivity growth.²⁰ The major factor in 1982 that separates the weak patent period of the 1970s to the strong patent period from 1982 to 2000 was the establishment of the U.S. Court of Appeals for the Federal Circuit to adjudicate patent cases in a specialized court. Similarly, countries with a strong patent system, such as Germany, have a strong economy, while others, such as Japan, with a weak patent system, have economic stagnation.

The weakening of the patent system in the last decade explains the decline in productivity growth that originated *before* the recession. The present theory of productivity growth decline explains the reduction in business investment in R&D, the stagnation in wages, the reduction in

¹⁹ The patent system is paradigmatic of endogenous growth theory since it harnesses animal spirits. As Lincoln observed in the “Second Lecture on Discoveries and Inventions,” 1867: “Next came the Patent laws. These began in England in 1624; and, in this country, with the adoption of our constitution. Before then, any man might instantly use what another had invented; so that the inventor had no special advantage from his own invention. The patent system changed this; secured to the inventor, for a limited time, the exclusive use of his invention; and thereby added the fuel of interest to the fire of genius, in the discovery and production of new and useful things.” Interestingly, Lincoln was the only president that held a patent and thus was speaking from his own experience. Like Edison, he was also a non-practicing entity that sought to license, rather than manufacture, his invention.

²⁰ There was also industrial concentration in the 1980s and 1990s, caused by deregulation, even with high productivity growth from a high level of competition stimulated by a strong patent system. Thus, industry structure alone is not sufficient to explain productivity growth declines from 2006 to the present.

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business starts, the constrained competitive configuration of industries and the concentration of technology incumbents into the highest capitalized and most profitable companies in the world.

The central origins of the weakened patent system lie in political ideology on both the far left and the far right in which narrow anti-patent policies collide with microeconomic reality. Whereas the U.S. patent system represented the democratization of invention from 1790 to 2000, the relentless attacks on the patent system by ideologues on both the left and the right have resulted in an aristocratic patent system that locks out all but the wealthiest players.

One result of a weakened patent system is the concentration of technology industries yielding a competitive configuration of only a few market players with tremendous polarization between incumbents and market entrants. In combination with weak antitrust enforcement, a weak patent system provides the explanation for weak productivity growth, slow aggregate economic growth, limited business investment, and, ultimately, a reduced standard of living.

Without modifying the radical patent policy shifts of the last ten years, there is virtually no reason to expect an improvement in productivity growth in the future. And, since the U.S. is so central to productivity growth worldwide – the U.S. performs about half of R&D and supplies the engine for much of the world’s productivity growth – global economic growth will be atrophied as long as these policies are not substantially modified.

(II) Correlation of the U.S. Patent System and Productivity Growth

An unusual share of American prosperity can be traced to the U.S. patent system that originates in the intellectual property clause of the constitution. Congress established patent laws in 1790, 1793, 1800, 1836, 1952, 1999 and 2011. The 1836 Patent Act did not require modification for over a hundred years, while the 1952 Patent Act incorporated numerous

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Supreme Court decisions. In historical retrospect, the American Inventor's Protection Act of 1999 represented the apex of the U.S. patent system.

With the election of Bush in 2000, the balance of power in patent law shifted dramatically to the large institutions that were targets of patent infringement lawsuits.²¹ In 2003, technology incumbents influenced an FTC report to recommend changes to patent law and, in 2006, the Supreme Court changed the standards of eligibility for an injunction, which essentially transformed patent law from a set of property rules to liability rules.²² Numerous additional judicial decisions from 2006 to 2016 degraded the power of patent holders to maintain a limited exclusive right to their innovations. In 2011, the America Invents Act completed a transformation in American patent law that shifted power away from patent holders and towards the large technology companies. In a fifteen year period, patent law fundamentally disintegrated.

What exactly happened in the fifteen years from 2001 to 2016? Why did Congress and the courts so fundamentally change a patent system that provided the basis for a prosperous economy? How did these changes manifest in patent law in order to alter the patent system to shift rights away from patent holders? What are the consequences of these changes?

(A) The Connection of a Strong U.S. Patent System and Economic Progress

The U.S. constitution embeds exclusive rights in a patent. Though patent laws originated in 1624 in Britain, this view was radical in the 18th century since the dominant way of encouraging scientific discovery was by awarding prizes. However, by providing a property right in exchange for the disclosure of a novel and useful invention, patent law supplied an incentive to perform risky and expensive scientific research. By embedding a property right in a

²¹ See Chart XII.

²² See Solomon, N., "Adverse Effects of Moving from Property Rules to Liability Rules in Intellectual Property," 2010.

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patent, the market, not a biased government, could pick winners and determine value. A patent embeds a micro-economic property right in an invention from which market-based incentives are derived. From the property right, market competition is developed as multiple competing parties enjoy similar benefits of owning the fruits of discoveries in which they have vested financial interests. The patent system thus levels the playing field for different competitors as it encourages investment in scientific research. From the fair competition that arises in the system of patent rights that protects investment evolves economic and technological progress.

Without a limited exclusive right in a patent, there is simply no incentive to perform risky and expensive research because anyone can steal the invention with impunity. When the patent system is corrupted, anyone can infringe an invention and become a free rider. If the patent system does not protect the investment in research with a strong property right, there is not an opportunity to obtain a return on investment and thus the incentives to invent are absent. The ability to enforce patents with strong property rights is thus critical to a healthy patent system.

The U.S. patent system was, nevertheless, distinguished from European patent systems. In Europe, the costs of patenting on invention were extremely high, thereby limiting technological development only to the rich. By way of contrast, the U.S. patent laws allowed anyone to invent by reducing the cost of a patent examination and offering reasonable access to courts for enforcement. This democratization of invention enabled the worker on the shop floor to identify improvements in technologies that expanded technological progress.²³ Similarly, while large corporations rely on market power and brand awareness as competitive advantages, small companies require strong patents in order to compete against incumbents with high entry barriers.

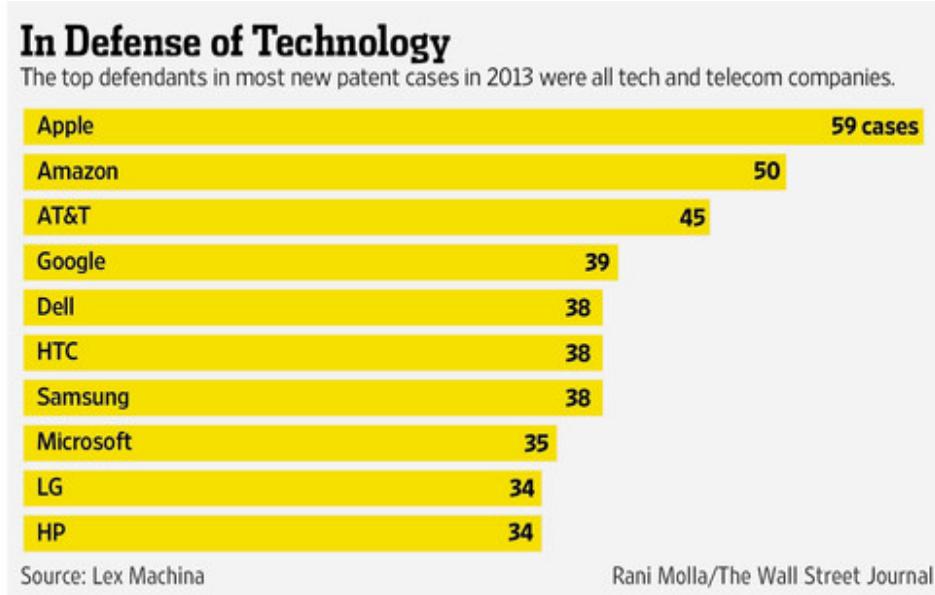
²³ See Khan, B., *The Democratization of Invention*, 2005.

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Patent law represents a delicate balance. A patent is a *disclosure* of a useful discovery. Patents are required to be novel, non-obvious, useful and well described. In addition, there is a limited period of exclusive right of a patent, after which rights to the discovery flow to the public sphere and can be used by anyone. The disclosure of a novel scientific or technological discovery enables researchers to learn about a new innovation and to discover new ways to add to it. In this way, technology progresses and enriches the public in the long-run. In order to justify the investment and time costs of invention, a private property right is critical to enable a return on investment. No other system has reliably provided a justification to invest in solving complex problems.

In the 1960s and 1970s, U.S. patent law was split among the various regional U.S. Courts of Appeals. This period experienced a weak patent system with large corporations dominating market share; during this period entry barriers for small companies were very high because patent enforcement was uncertain. In 1982, the creation of the U.S. Court of Appeals for the Federal Circuit with the Federal Courts Improvement Act consolidated patent appeals into a single unified court, which resulted in upholding strong patent rights until about 2000. It was during this period, from 1982 to 2000 that the venture capital industry evolved into a major economic force to create technology startups, including Apple, Microsoft, Google and Amazon, which are now the largest corporations by market capitalization in the world.

Chart XII: List of Top Patent Infringers, 2013



Whereas before 2000, the patent system was considered neutral, after 2000, the patent system was politicized with attacks from the far right and the far left. These critiques of the patent system led to a transformation that weakened patent rights and created uncertainty. A perverse and lasting consequence of these dramatic changes were increased examination and enforcement costs, which increased the costs and risks of investment.

After 2000, large technology corporations sought to make radical changes in patent law. In particular, since they were serial defendants in patent infringement suits, their main aim was to weaken the property right in a patent. The large technology corporations argued that patent holders were holding them up by excluding them from using small inventions in larger devices. This “hold up” by patent holders was enforced by injunctive relief barring further use as well as monetary damages. Consequently, the disintegration of patent law originated with the U.S. Supreme Court decision in *eBay vs. MercExchange*,²⁴ which invoked a high bar to justify an

²⁴ *eBay Inc. v. MercExchange, L.L.C.*, 547 U.S. 388 (2006).

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injunction.²⁵ Without an injunction, infringers could simply use a patented invention and, when caught, merely pay a fee for its use.²⁶ Numerous additional judicial opinions and the America Invents Act of 2011 further limited patent rights for patent holders, thereby undermining the incentive to invest in technology research. The fundamental *property right* in a patent was reduced to set of *liability* rules.²⁷ These dramatic changes enabled the “efficient infringement” model employed by large corporations that allow companies to get a free ride on others’ research investments. It is precisely these changes to patent law that are the source of the productivity growth declines we witnessed not only in the years since the recession, but in the years before the recession as well.

(B) Radical Left and Radical Right Ideological Critiques of U.S. Patent System and Recent Disruptive Policy Changes

Recent radical changes in patent law represent a detour from over two hundred years of consistent policy. The U.S. patent system is now unrecognizable from even fifteen years ago. What forces brought about these dramatic changes? I suggest that there was cooperation among radical ideologues on both the far left and the far right²⁸ that persuaded Congress and the courts to make unprecedented changes to patent law. For many decades, these groups were considered peripheral, but in a perfect storm they consolidated forces to make changes to the fundamental

²⁵ The imposition of a high bar to obtain an injunction for patent infringement has several adverse consequences. First, without an injunction to protect a property right, liability rules are applied to infringement remedies, reducing patent infringement to a matter of assessing monetary damages. Second, with no injunction eligibility, anyone can use the patented property. In effect, this lack of an injunction brought an era of compulsory licensing. The patent holder can no longer control use of his property and, in particular, the exclusive use of patents is corrupted without protection of property rights via injunctive relief. Third, without an injunction, there is little incentive for companies to license technology, enabling “efficient infringement.” See Solomon, “Analysis of the ‘Four-Factor Test,’ in Patent Cases Post-*eBay*,” 2010 and Diessel, B., “Trolling for Trolls: The Pitfalls of the Emerging Market Competition Requirement for Permanent Injunctions in Patent Cases Post-*eBay*,” 2007.

²⁶ The absence of an injunction enables a compulsory license.

²⁷ See Solomon, N., “Adverse Effects,” op. cit.

²⁸ See Atkinson, R., “Why Life-Sciences Innovation is Politically ‘Purple’ – and How Partisans Get It Wrong,” 2016. See also Solomon, N., “Three Dogmas of Intellectual Property Jurisprudence,” 2010.

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engine of technological change, with profoundly adverse consequences for economic development.

Traditionally, conservatives supported strong property rights in a patent and a strong patent system in order to supply an even playing field to all competitors. In recent years, however, large technology incumbents – charged with serial infringement – have gone off the reservation to relentlessly attack the patent system.

The primary impetus for attacking patents from the viewpoint of technology incumbents is to preserve monopoly profits and to attack competitors. By killing the baby in the cradle, incumbents get a free ride to use others' technologies. This self-interest drives the narrative that patents are bad, weak, cover unpatentable matter, should have diminished valuation and that patent holders should be judged on whether they manufacture products covering the patents.²⁹

²⁹ The “patent troll” narrative was originally developed by Intel Corporation to defend against companies seeking to license technology. The “patent troll” myth is targeted to companies that do not manufacture goods, but rather *license* technology to incumbents. The *manufacturing* nexus thus becomes a central part of the patent debates. It is particularly interesting that from 2001 to 2016, American manufacturing has dramatically declined. As Americans’ desire increases for inexpensive goods, American companies offshore their manufacturing to East Asian, particularly Chinese, companies. The U.S. manufacturing sector represents about 10% of the economy, with half of this from five companies (Ford, GM, Intel, Caterpillar and Boeing). The utopian dream that the U.S. is a manufacturing country is simply false. Rather, U.S. competitive advantage lies in innovation. By partnering with (i.e., licensing technology to) manufacturing companies in Asia, American innovators are part of an integrated global economy.

Nevertheless, the “patent troll” debate relies on the assumption that the U.S. manufactures goods. It is ironic, then, that the degradation of the licensing model in the patent debate benefits Asian manufacturers and harms American innovators. One can argue that the dominant business model going forward is the invent-and-license business model, not a manufacturing or vertically integrated business model, which requires intensive capital resources and limited profits. From Lincoln to Edison and from universities to Alphabet’s self-driving car technology, the non-practicing entity (NPE) invent-and-license business model is more efficient than the manufacturing model. Interestingly, the differentiating feature of eligibility for an injunction in patent infringement cases is the manufacturing nexus. In instituting the “patent troll” narrative, policy makers ignore the importance of patents to market entrants.

The “patent troll” arguments are primarily directed at companies that perform research, do not manufacture products and use business models that license technologies in a fair, reasonable and non-discriminatory (FRAND) way. IBM and Qualcomm, for example, are leaders of the invent-and-license business model. Therefore, the attack on the patent system that results from a narrow “patent troll” argument seems self-serving at best and self-destructive at worst. Attacking the licensing model in an era of decline of manufacturing is disingenuous.

Nevertheless, entities that acquire patents and abuse the judicial system present problems for which the courts are well suited to resolve.

Unfortunately, the popular revolt against patents stimulated by the “patent troll” narrative is largely without foundation since advocates only supply anecdotal evidence of a problem. Unlike incumbents, the CBO, ITC and CAFC do not see these issues as problems. See Khan, B., “Trolls and Other Patent Inventions,” 2013.

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The big technology cartel consists of about a dozen corporations that cooperate on the issue of attacking the patent system. These companies include several of the highest capitalized companies in the world.³⁰ Not coincidentally, the big tech cartel includes companies frequently sued for patent infringement. Note Chart XII illustrates suits initiated only in 2013. This chart provides clear evidence of “efficient infringement” by large technology companies.

The oligopoly of large technology companies operate in industry segments with relatively limited competition from entrants as a consequence of attacks on the patent system. With limited patent rights, it is difficult for start-ups to raise capital, which further benefits incumbents. Consequently, the attack on the patent system by incumbents is win-win for them since they preserve their monopoly profits while also constraining competition.

Furthermore, in a weak patent enforcement regime, high transaction costs provide a high barrier to enforce patents while large corporations get a free ride to use competitors’ technologies. As a key motive for raising transaction costs, the high bar for enforcement diminishes the incumbent costs of IP by devaluing patented inventions. However, since they can use others’ technologies with impunity, there is also a disincentive to invest in their own research programs.³¹

While the one-dimensional “patent troll” narrative is persuasive to policy makers, it does not justify the wholesale transformation of patent rights. The “patent troll” myth³² is actually a straw man offered to preserve incumbents’ monopolies and monopoly profits. Nevertheless,

³⁰ Apple (\$597B), Alphabet (\$515B), Microsoft (\$434B) and Amazon (\$356B) are *the* four highest capitalized public companies in the world at the end of Q2, 2016.

³¹ See discussion below on diminished investments by big tech companies despite record amounts of cash on hand.

³² Some “patent trolls” or patent assertion entities (PAEs) aggressively exploit high litigation transaction costs to obtain settlements from alleged infringers. However, these market participants are in the minority. The majority of universities and small business entities that perform research in-house do not apply aggressive tactics to achieve unethical results. To attack the entire patent system for the problems of a few players is inefficient, with adverse consequences for incentives to invest in technology R&D.

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invoking the “patent troll” myth has enabled large technology companies to engineer a transformation of the U.S. patent system to provide them with competitive advantages.³³

One irony of the large technology incumbent attacks on the patent system is that they actually need strong patents to preserve their own investments in research. Their position is therefore the epitome of hypocrisy since their main objective is to increase costs for patent examination and patent enforcement so dramatically as to supply substantially high barriers to entry for all but the best funded competitors. In essence, then, the patent critics from the right are motivated by pure greed and a clear anti-competitive position.

The positions of anti-patent critics on the political left, on the other hand, have two main motivations. First, the socialist faction prefers “openness” as a justification to contravene private property rights, which reflects a naïve view of business operation. Second, one faction of the left prefers low drug prices and specifically attacks the pharmaceutical industry, largely ignoring the *ex-ante* costs of research and production.³⁴ Both positions were considered on the margins of debate until recent years.

In the case of the open society adherents, reflected in the open source movement, the left wishes to have free stuff: free software, images, video, audio, books and information. This ethos of openness seeks no barriers to the self-interest in using others’ property for personal use. The anti-patent progressives argue that it ought to be a public right to use others’ property. In the case of government funded research, they argue that they are entitled to use property from research that should be directed to the public interest.³⁵ Progressives seek consumer entitlements

³³ See Solomon, N., “The Problem of Oligopsonistic Collusion in a Weak Patent Regime,” 2010.

³⁴ Some progressives intend to narrow patent rights further by demanding march-in rights to NIH funded university biological invention. This extreme approach seeks to undo the benefits of Bayh-Dole’s commercialization success by requiring open licenses, the effect of which is to sabotage investment in innovation. Fortunately, the NIH itself is resisting this approach to removing exclusivity in university technology transfer.

³⁵ The argument that government funded research should yield technology that is freely open to the public has been tested in the past. However, before 1980, investors refused to commercialize government-funded university

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and freedom to operate. Quite simply, property rights embedded in intellectual property, designed to benefit the author or inventor of original works, interferes with their preference for open entitlement. Consequently, they seek a radical abandonment of the patent system. This naïve view, of course, ignores the source of extremely poor countries that simply lack an effective patent system that is required to preserve investment incentives.

In the case of the critics of patented drugs, there is a complete disregard for the extraordinarily high costs – typically over one billion dollars – on research of new drugs. Nevertheless, the left wants cheap drugs and are willing to compromise the entire patent system to seek their objectives.

The critique of the patent system from the far left begins at the top. President Barack Obama synthesizes the critiques of the patent system from the two leftist ideological factions. First, Obama openly attacked patent holders with rhetoric exactly tracking the big technology company lobbyist talking points.³⁶ In addition, in July, 2016, Obama published an article in JAMA discussing a presumed weakness in the Affordable Care Act, namely, the high cost of drugs. This attack on drug prices is a familiar critique, but Obama sees this critique on high drug prices as a justification for an attack on the entire U.S. patent system. It should be clear, then, that Obama's radical ideological agenda is to undermine the patent system to seek his objective

research. The Bayh-Dole Act provided universities with patent rights to government funded research. From this inspiration of embedding patent rights into government-funded research, the commercialization of inventions multiplied many times and stimulated an entire generation of technology transfer that partnered venture capital funded start-ups with university research. While the general research itself may have been publicly provided, the private rights in patents incentivize business commercialization of technology. Thus, there are *ex ante* incentives in patent rights as well as *ex post* incentives. The evidence therefore shows that the revolution in biotechnology was enabled by the provision of strong patent rights to government funded research.

³⁶ As Stoll, T., “Intellectual Property Laws,” 2016, states on p. 3, “In 2013, the President’s Council of Economic Advisers, the National Economic Council, and the Office of Science & Technology Policy drafted a report detailing five executive actions and seven legislative recommendations to fight patent trolls. The next year, during a town hall in Los Angeles, President Obama stated: ‘One of the biggest problems that we’ve been working on is how do we deal with these folks who basically are filing phony patents and are costing some of our best innovators tons of money in court.’ That’s right, the president of the United States said he thinks that patents are causing one of the biggest problems his administration is facing. He even mentioned patent reform in his 2014 State of the Union Address.”

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of obtaining cheaper drug prices. Since he blames high drug prices on the patent system, it is the patent system that is a target. This extreme position indicates the real motivation for attacking patents, not the “patent troll” narrative – a straw man – proposed by the big tech cartel.

There are a set of contradictions in the positions of the left regarding the patent system. First, it is sheer folly to believe that R&D can be performed for pure interest, say, by an academic with no profit motive. No profit-seeking business can operate without a functioning patent system to preserve a property right and enable a return on investment. Second, by ignoring *ex ante* costs, the left misses the fact that the public interest is harmed in the long-run since there is no incentive to perform risky research without preserving patent property rights. Third, by undermining patents, the left inadvertently helps market incumbents, which they despise. Fourth, the left inadvertently promotes inequality by harming the democratization of patents in so weakening patent rights that then require far greater capital. Fifth, by limiting patent rights to the middle class and poor in a weak patent system in which costs of entry are substantially increased, the left destroys middle class opportunities and institutionalizes poverty. The U.S. patent system for two hundred years provided anyone with an opportunity to supply their ingenuity and hard work to create something new, which was preserved by the patent property right for a limited time. The left would disregard these opportunities. Not only is the left naïve about the patent system, competition and economics, their ideology is inflexible. Most of the left’s arguments rest on ignorance, utopian myths or mistakes. For these reasons, their ideas have been marginalized until recent years during which many radical positions have been given a voice.

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Interestingly, the radical left combined with tremendous big technology incumbent wealth and lobbying to generate a narrative that seemed persuasive about the need to attack the U.S. patent system. And so the patent system was dramatically modified and destabilized.

(C) Legislating Away Patent Rights

The radical left and the tech incumbents combined to attack the patent system in different ways. First, the anti-patent advocates attacked patents in the courts. Starting with *eBay* in 2006, the U.S. Supreme Court addressed dozens of patent cases, in almost all cases narrowing patent rights. The Court addressed issues involving standards for injunctions,³⁷ validity challenges,³⁸ patentability,³⁹ obviousness,⁴⁰ written description,⁴¹ fee shifting⁴² and willful infringement damages⁴³ over a ten year period. The big tech cartel complained about weak and improvidently granted patents, particularly involving software, for which the large technology companies were required to pay royalties. Consequently, the big tech cartel sought to reform the entire patent system through legislation.

Patent critics held the view that patents issued by the U.S. Patent and Trademark Office (PTO) were generally weak and that only a “golden patent” or gold-plated patent that endured a higher level of examination was valid.⁴⁴ Contrary to this view of the “golden patent,” the Court reviewed the issue of patent validity (35 U.S.C. § 282) in *i4i vs. Microsoft*⁴⁵ and upheld the two

³⁷ See *eBay*, op cit.

³⁸ *MedImmune, Inc. v. Genentech, Inc.*, 549 U.S. 118 (2007).

³⁹ *Bilski v. Kappos*, 561 U.S. 593 (2010); *Mayo Collaborative Services v. Prometheus Laboratories*, 132 S. Ct. 1289 (2013) and; *Alice Corporation v. CLS Bank*, 134 S. Ct. 2347 (2014).

⁴⁰ *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007).

⁴¹ *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. ____ (2014).

⁴² *Octane Fitness LLC v. ICON Health & Fitness, Inc.*, 134 S. Ct. 1749 (2014) and *Highmark Inc. v. Allcare Health Management Systems, Inc.*, 487 U.S. 552 (2014).

⁴³ *Halo Electronics, Inc. v. Pulse Electronics, Inc.*, 579 U.S. ____ (2016).

⁴⁴ See Lemley, M., “What to do About Bad Patents,” 2005.

⁴⁵ *i4i Limited Partnership v. Microsoft Corporation*, 564 U.S. ____ (2011).

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hundred year tradition of supporting a high bar to challenging patent validity. However, with very little substantive debate, and by relying on self-serving patent studies, the big-tech-cartel-authored America Invents Act, passed by Congress in 2011, enabled the PTO to establish after-grant patent reviews of previously issued patents. Though focused only on “novelty” and “obviousness,” the new after-grant patent review procedures dramatically altered the practice of patent law. The post-grant review (PGR), covered business method (CBM) and inter-partes review (IPR) mechanisms established a de facto two-tier examination system in the PTO, appealable only to the U.S. Court of Appeals for the Federal Circuit. While the pharmaceutical industry fought against the changes in “patent reform,” the big tech cartel was successful in instituting the new layer of examination procedures. The IPR process in particular effectively removed the majority of patent validity decisions from the judiciary back to the administrative agency that originally examined and issued the patents. Institution of the after-grant patent review system effectively did an end-run around the long-established traditions of establishing patent validity in the courts. Finally, in *Cuozzo Speed Technologies v. Lee*,⁴⁶ the Supreme Court affirmed the PTO’s IPR rulemaking authority.⁴⁷

The net effect of the IPR procedures was to substantially raise the costs of patent enforcement by creating an expensive – typically at least several hundred thousand dollars – and time-consuming layer of reexamination in the PTO.⁴⁸ In most cases, the patents that are reviewed are ruled invalid because of discovery of additional prior art that is interpreted to challenge their novelty and non-obviousness. Nevertheless, if the big tech cartel complaints

⁴⁶ *Cuozzo Speed Technologies, LLC v. Lee*, 579 U.S. ____ (2016).

⁴⁷ See Lee, P., “The Supreme Assimilation of Patent Law,” 2016, in which he argues that the Supreme Court’s attempts to equalize patent law with general legal principles may be misguided because of specialized features unique to patent law.

⁴⁸ IPRs are well-known as a harassment of patent holders. This is particularly the case when a third-party attacks a patent in an IPR. Also, when multiple infringers collaborate to bring serial IPRs, the system’s bias and illegitimacy is clearly illustrated. The European Patent Office eliminated similar trials of patent validity as a consequence of these harassing behaviors.

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against “patent trolls” were the only concern, the after-grant patent review process would not be applied systematically to all patents. However, the application of after-grant patent reviews to almost all patents that are enforced in the courts suggests the ulterior motive of the patent critics to attack the patent system itself.⁴⁹

In almost all cases, the after-grant patent review process was targeted against small entities and start-ups that sought to enforce their technologies against large tech incumbents. These start-ups need patent rights to compete against large incumbents. In about a decade, inventors went from being heroes of technology development to villains even as the U.S. economy shifted away from manufacturing in the 2000s and towards the innovation and licensing model. In an unprecedented move, the presumption of validity in a patent was shifted to a presumption of invalidity by the patent critic influence on Congress and the courts.

Nevertheless, the Patent Trial and Appeal Board (PTAB) established in the PTO to review granted patents is not without controversy. Under an aggressive PTO director with an anti-patent bias, the PTAB can be ordered to aggressively attack patent validity. For instance, the broadest reasonable interpretation (BRI) standard may be applied to patents rather than the narrower Phillips standard applied in the courts. Further, the statutory ability to amend claims has been systematically disallowed. These rules are asymmetric, benefitting the patent attacker and harming the patent holder. The combination of the PTAB rules tends to knock out a majority of issued patent claims, which delegitimizes the after-grant patent review process. In the very least, in order to maintain some legitimacy, the PTAB process of after-grant patent reviews must be neutral and fair, reflecting a need for courts to review these procedures or

⁴⁹ Not surprisingly, the tech cartel seeks further patent reform. They have lobbied Congress to pass the Innovation Act, HR 9 and S 1137, which mandates *one-way* fee shifting if a patent holder loses in court, thereby forcing the patent holder to pay the infringer’s legal fees. The lobbyists push for this statute even after the Supreme Court reviewed two-way fee shifting (35 U.S.C. § 285) in *Octane Fitness* and *Highmark*. If enacted, this statute would further stymie legitimate patent enforcement.

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eliminate the process entirely and return patent validity decisions to the courts. Without neutrality, the anti-patent bias of the PTO can be seen as an abuse of discretion that tends to taint the PTO’s legitimacy. These anti-patent biases are also evident in the extremely low pass rates (e.g., under 10%) in some PTO art units. Congress did not intend to perpetuate an anti-patent bias of ideologues, empower ideological inflexibility or to enable a PTO power grab when it passed the AIA.⁵⁰

From a periphery issue of “patent trolls” engaging in abusive and aggressive enforcement of occasional “bad” patents to the wholesale transformation of the patent system that raises transaction costs by twenty-fold to retest validity of previously examined and issued patents in a two-tier examination system, it should be clear that the anti-patent movement has succeeded in undermining the U.S. patent examination system. This fundamental transformation of the patent system to solve a minor “patent troll” problem is equivalent to burning down a house to stop a few termites. The cumulative effect of these dramatic changes in reexaminations is the disruption and destabilization of the patent system. Another effect is to shift power away from start-ups that need patents to promote competition and towards market incumbents that seek to protect their monopoly profits.

Yet, the attack of patents in the U.S. PTO is only one venue for criticism of the patent system. The patent critics also attack patent rights in the courts, limiting enforceability and damages as well.

The effect of the AIA’s systematic re-exam protocols and judicial changes in patent law were to effectively destroy the voluntary patent licensing model in the U.S. After all, without an injunction, with a high bar for enhanced damages and with a new mechanism for attacking

⁵⁰ The ideological bias of the administration is contrasted with the neutrality of Art. III federal courts. Patent holders need a fair and neutral forum for adjudication of patent rights, not ideological bias and inflexibility.

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granted patents in the PTO’s PTAB, why would anyone want to license new technology? This weakening of patent law enabled a new era of “efficient infringement” in which large technology incumbents and manufacturers ignore and simply infringe patents without concern for enforcement. If a patent holder could raise the capital resources to enforce the patent in court and could withstand an IPR, then the infringer could negotiate a license that they would initially have negotiated in a voluntary licensing regime. With the entry barriers for patent infringement enforcement at mid-seven and eight figures, the big tech cartel was immunized from the vast majority of patent infringement cases. However, small entities and market entrants were badly harmed by the new procedures. This suggests a fundamentally anti-competitive aspect of changes to the patent system.

Ironically, the primary motivation for initiating patent reform was absent since the main argument of the big tech cartel was that the exclusive property right in a patent supplied the patent holder with the opportunity to “hold up” the infringer by obtaining an injunction to force the infringer to stop using the patented invention. However, after *eBay*’s decision set a high bar for injunctions, this argument no longer applied to most cases. Rather, the big tech incumbents would refuse to deal with patent holders in a reverse hold up. The technology incumbents effectively transformed the U.S. patent system from one with strong rights to one with very weak rights that enabled the incumbents to refuse to deal with patent holders and to effectively ignore patents and voluntary patent licensing.

The combination of these patent law changes dramatically increased patent enforcement costs, particularly for small start-ups that require patent rights to compete with larger rivals. In fact, the new rules actually *encouraged* larger rivals to steal patented technology since there was no effective enforcement mechanism in most cases.

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It should, then, be no surprise that the patent system was weakened in the period after 2000. The effects of these dramatic changes to patent law have been witnessed in the competitive configuration of technology rivalry, in the productivity growth decline trend and in the weak economic development data of recent years.

(III) Connecting the Dots of a Weak U.S. Patent System and Productivity Growth Decline

When a company invests in a new technology, it commits capital and human resources in the long-run and expects a return on this investment. Historically, the U.S. patent system was a fundamental mechanism to enable a return on investment by embedding a limited exclusive right in patents for innovations. The genius of the U.S. patent system was to embed rights in microeconomic entities and to provide access to the patent system for anyone.

However, after a decade of attacks by anti-patent critics, the patent system has been destabilized by the disintegration of private property rights as the examination system in the PTO and the enforcement mechanism in the courts has been redesigned to require substantial capital resources. While a few mid-sized companies can marshal the capital resources to enforce their patent rights, the small entities that require patent rights the most in order to compete do not have these resources. Consequently, business starts have declined dramatically in the last decade to the lowest numbers recorded.

Strong productivity growth requires incentives to innovate offered by a strong patent system. The patent system has traditionally provided strong enforcement mechanisms to protect investments in innovation. Consequently, in a strong patent system, we witness the virtuous cycle of innovation investment protection and productivity growth. It is not a radical view to suggest that strong property rights in the patent system enables a level playing field and

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promotes competition among rivals big and small. Strong institutions – such as the judicial system – protect intellectual property rights as an incentive to invest in risky inventions and to solve complex technical problems that often don't pay off for several years.

On the other hand, in a weak patent regime, capital investments are not protected since anyone can use the patented inventions as free riders. In fact, it is difficult to obtain any investments in a weak patent regime if one's competitors can use the innovations with little or no compensation

These observations of a weakened patent system in the last decade explain the background for a dramatic decline in productivity growth during the same period. Worse yet, the structure of technology industries in the past decade have revealed a profound concentration of resources among the largest companies, with very little competition in the middle market and slow growth patterns of start-ups. These data suggest that the weakened patent system has a critical role in the general economy that affects market competition and enables the large technology companies to perpetuate competitive advantages.

(A) Mechanisms of a Weak Patent System on Declining Business Investment

Recent data show declines in small business starts, technology business investment and big tech investment.

Despite the decline in business investment, the largest technology companies enjoy extraordinary profits, often over \$10B annually. Apple alone enjoyed an annual profit in the year ended October 1, 2015, of \$53.4B, the largest in the history of capitalism. Because of these extraordinary profits, these companies hold extraordinary amounts of cash on hand, with Apple holding over \$230B alone and the top five tech companies collectively holding \$504B, or 30% of

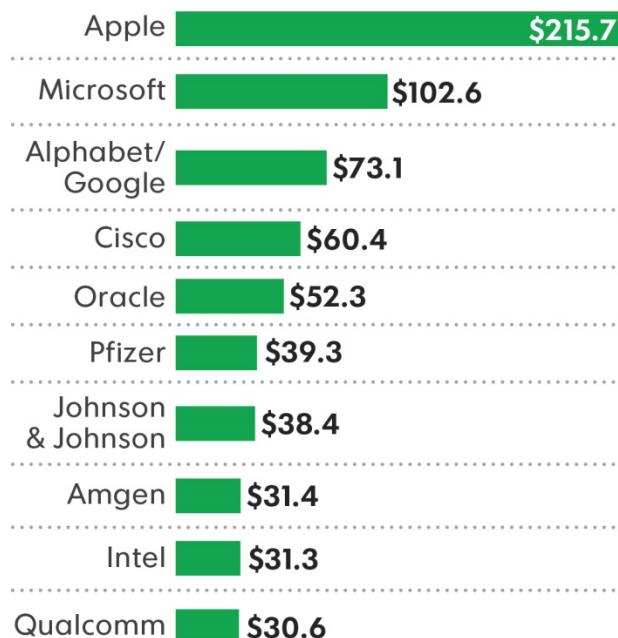
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cash of all non-financial companies, in the first quarter of 2016. Much of these capital resources are stored offshore to avoid taxes. Nevertheless, these companies are not spending more capital resources on investments into innovation. Rather, they are hoarding their capital resources.⁵¹

Chart XIII: Companies with the Most Cash, 2015

COMPANIES WITH THE MOST CASH

The top 10 companies by cash and cash equivalents held¹ (in billions):



1— as of end of 2015

SOURCE Moody's Investor Service
George Petras, USA TODAY



The consistent pattern of investment declines are a key factor behind the productivity growth declines and the weak aggregate economic growth. What mechanism lies behind these across-the-board declines in business investment?

Technology transfer is blocked in a weak patent system since companies employ the “efficient infringement” model. In a weak patent system, enforcement is expensive and

⁵¹ The argument for constrained demand to justify lack of investment is a vicious circle since wages are suppressed by lack of investment and economic growth, with higher wages generating greater demand for goods.

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burdensome, supplying the infringer with incentives to infringe. Rather than voluntarily license technology, incumbents engage in reverse hold out in which they ignore patents and refuse to deal with patent holders. When an entire industry engages in reverse hold out, that is, collective refusal to deal, which is enabled by a weak patent system with high barriers to enforcement, they exhibit anti-competitive behaviors. In fact, enforcement in the courts, as expensive as it is, is generally caused by the belligerence and refusal to deal by technology incumbents which force matters to the courts. Particularly in the absence of an injunction as a remedy for the patent holder, the patent holder can no longer possibly be considered a hold out because their patents cannot enforce an exclusive property patent right. In the pervasive business and political environment that enables the collective refusal to deal with patent-holding market entrants, with high transaction costs to patent enforcement and with reduced compensation from enforcement because of a reduction in patent remedies, there is no incentive to invest in innovation.

When a patent holder seeks to enforce a patent, the infringer challenges the patent in an IPR in the PTO, with asymmetric risks and costs to the patent holder. If the patent survives the IPR, the patent holder must still expend considerable capital and time in search of a fair royalty. Without an available injunction in most cases, the only remedy for the patent holder is monetary damages. In many cases, the infringer has little downside risk and only seeks to pay the license they would pay if they negotiated in good faith. With increased risks to the patent holder, the costs increase, which require a greater return in order to justify the investment; however, the infringer blocks a reasonable return on investment by forcing the patent holder to expend substantial resources on litigation. The higher burdens in the enforcement regime of a weak patent system supply a dramatically high tax on the most productive and innovation companies that perform original research. The system clearly becomes biased to large companies,

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representing a major power shift from small companies to incumbents. Consequently, technology progress lags in a weak patent regime and, with it, productivity growth and aggregate economic growth.

(B) The Connection of Declining Investment and Market Distortions

A critical benefit of strong patent rights is that patents enable fair competition between rivals. If all companies in an industry compete on an even playing field, each company can invent and protect products from infringement. Without a patent system, the strongest companies can perpetuate their advantages, not by investing in innovation but in stealing others' technologies and fighting them in court with more substantial resources. Patents are thus an essential tool to enable competition only in a healthy patent system. In fact, without patents, there is no systematic mechanism to enable start-ups to compete with incumbents.

The Schumpeterian theory of creative destruction advocates that the dynamism of profit-seeking companies is driven by entrepreneurial activity of multiple competitors. As companies innovate to solve problems and meet customer needs, the companies grow. A key to economic growth is the dynamism of multiple rivals as they compete by constantly innovating. For this reason, technology companies provide the engine of economic growth. In fact, companies with fewer than 500 employees supply two-thirds of U.S. job growth. In addition, technology companies tend to provide higher-quality and higher wage jobs.

Oligopolous industry structures tend to dominate the innovation-centric technology, telecommunications and pharmaceutical industries. In general, only a few companies in each industry hold the majority of the revenues and profits.⁵² Many of these market incumbents enjoy

⁵² There is not an incentive for an industry monopolist to invest in innovation at a rate that they may invest if there was industry competition. For example, in the case of microprocessor monopolist Intel, the rate of change of the

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high profits because of market position and brand recognition rather than intellectual property rights. By contrast, smaller market entrants require patents on novel inventions in order to compete with the larger rivals. Hence, the patent system has historically provided the mechanism to enable competition for market entrants.

When market incumbents, individually or collectively, ignore patents and misappropriate technology, patent enforcement is the only tool available for competitors. However, with the dramatic changes in the patent system in the last decade, the competition from small companies has been highly constrained. The entry barriers for start-ups are now so high to pursue patent enforcement as to require substantial capital resources and long delays for return on investment. In addition, there has been a dramatic decline in small entities and independent inventors procuring patents in the U.S. PTO, with the rate of American inventors procuring patents declining from 15% in 2000 to less than 5% today. These facts explain the record low small company formation rates in recent years.

Patents have been at the core of a company's ability to procure capital. With a weak patent regime, capital is extremely difficult to procure and very expensive when it is procured.

Economist Douglas North⁵³ advocated that oligopolies tend to influence rules that benefit and perpetuate their own power. The technology industry incumbents, a group that consists of about a dozen mega-cap corporations, appears to follow this pathway by advocating for a weak patent regime that benefits their monopoly profits at the expense of start-ups. However, the technology industry has a unique catalytic effect on the overall economy because adoption of its products enhances other industries' productivity. The technology industry, although

speed of microprocessors has declined without competition. Since Intel has slowed down Moore's law due to this lack of competition, they are not providing customers a reason to replace computers. Intel complains about a slowing market for its goods but creates the slowdown itself by not having an incentive to develop better technologies.

⁵³ See North, D., *Institutional Change and American Economic Growth*, 1971.

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oligopolously configured, has an outsized effect on productivity growth and total factor productivity (TFP) growth in particular. Consequently, since the tech cartel has extraordinary market power, the degradation of the patent system in recent years becomes an anticompetitive phenomenon that ultimately retards investment in new technology by incumbents and start-ups alike. The effective hostile takeover of the U.S. patent system by the big tech cartel has a simple effect of retarding productivity growth. This suggests that the U.S. economy has a fundamental structural problem and that productivity growth will not be improved until the government changes policies to modify the structural problem itself. Whereas the federal government ought to recognize the antitrust and anticompetitive nature of the tech cartel problem, and seek to resolve it, in point of fact, the government itself was party to the problem by enabling the cartel to obtain benefits of a weak patent system at the expense of smaller competitors. Ultimately, not only did the government engage in weak antitrust monitoring and action, but the government substantially destabilized the only mechanism for competition for market entrants by weakening the patent system.

While the U.S. sabotaged its only sustainable competitive advantage of promoting a strong and democratized patent system, China has committed to investing in its technology industry.

(C) Consequences of a Weak Patent System Explain a Persistent Productivity Growth Decline

A weak patent system has a number of adverse consequences for businesses. First, in a weak patent regime, larger firms engage in “efficient infringement” in which they infringe with impunity and only when caught pay the original licensing fee and transaction costs in a calculation that they profit by infringing many more times than the number of times of getting

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caught. The incumbents then become free riders. Second, incumbents engage in reverse hold out by refusing to deal with patent holders, thereby forcing much higher transaction costs for patent holders to enforce their patents. Third, in the absence of a willingness to negotiate licenses by incumbents, there is no voluntary licensing market. This market has been referred to as an honor system in which ethical companies would honor others' IP; this honor market has effectively dissolved in a weak patent regime. Fourth, all patent infringement suits are driven to the courts, which dramatically increase transaction costs for all parties, but which costs fall as a burden particularly on the smaller entities enforcing patents. Fifth, with the high barriers to enforce IP, the valuation of patents drops dramatically. In point of fact, patents are completely valueless in the absence of enforcement, which is prohibitively expensive if the market size does not justify the expected rewards. If patents are without any value in the majority of cases, there is zero incentive to develop innovation. Sixth, in an environment with high costs to process research and enforce patents, investment in research, particularly at the margins for risky innovation, is scarce. Seventh, with a high bar to enforce IP, incumbents themselves have a disincentive to invent or invest in innovation since they can steal others' IP with impunity in most cases without risk of expensive enforcement. Eighth, other than the big tech cartel, by far the biggest beneficiary of a weak U.S. patent system is the East Asian manufacturers, particularly in China, that benefit at the expense of American innovators. Hence, a weak U.S. patent system provides a free ride to Asian rivals.

The ubiquitous "efficient infringement" model forces all matters to the courts for adjudication, with corresponding high transaction costs. This is a perverse outcome of attacking patent holders, but only the courts supply a remedy for innovators in the face of persistent refusal to engage in voluntary licensing by incumbents. In the aftermath of the AIA, it is now easier to

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burden the patent holder with validity challenges at the PTAB than to communicate about a fair license. The existence of the new layer of the PTAB in the patent system supplies a further argument for incumbents to engage in “efficient infringement” and ignore patent holders. The net effect of high barriers to patent enforcement is to promote monopoly profits of market incumbents. These analytical mechanisms describing changes to the patent system explain the facts of oligopolist market power, historically high incumbent profits, historically low business start-ups, law business investment and the difficulty for start-ups to obtain capital. In a weak patent regime, these trends are intractable.

High transaction costs, in the PTO and in the courts, provide a capital liquidity squeeze to innovators. On the one hand, in addition to R&D costs, transaction costs are increased substantially by instituting reexams and requiring enforcement in the courts. On the other hand, there is reduced compensation for licenses when infringers limit remedies of injunctions or enhanced damages. The increased transaction costs require substantial capital resources – typically seven figures – in order to enforce patents against infringers as well as elongating the period from invention to compensation to five to ten years or more. The effect of this shift from labor (human capital) to capital removes incentives to invent. In particular, small and mid-sized company licensing deals evaporate in an environment with high transaction costs, increasing risks for innovations at the margins.

Small companies are particularly affected by the capital liquidity squeeze. Ultimately, small companies are blocked from reinvesting capital into R&D since they cannot easily receive returns on the first generation of their technology or the returns are sharply reduced. Not only are the transaction costs dramatically higher now than they were a decade ago before the transformation of patent law, but the time to receive a return on investment is substantially

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elongated by delays. Consequently, investments, especially at the margins with the greatest need for new discovery, are withdrawn as risks, costs and time to returns are increased.

The left's ideological preferences for a weak patent system to enable their goals of diminishing the property right in patents represents an intentional engineering to help devalue patents. The net effect of these policy changes has been to benefit infringers. In an environment in which free riders dominate by exploiting the "efficient infringement" model, there is no compelling reason for investors to risk capital resources in innovation.

When taken to its extremes, the "efficient infringement" model is employed by a group of companies simultaneously, illustrating its anti-competitive aspects. Many tech incumbents practice collective refusal to deal which represents a type of restraint of trade. When these anticompetitive practices are employed by the American tech cartel, they are given a free pass by regulators, but when they are employed by foreign manufacturers, these anticompetitive practices become highly problematic.

In the exact period of decline of the U.S. patent system, from approximately 2001 to the present, the U.S. manufacturing sector declined. East Asian manufacturing, particularly Chinese manufacturing, became relatively more competitive during the period, as reflected by millions of lost U.S. manufacturing jobs. The U.S. economy is now about ten percent manufacturing, with half of this represented by only five companies. It is a utopian dream to consider the U.S., or any European industrial nation, a major manufacturer. At best, the U.S. economy is based on innovation, with massive R&D performed at U.S. universities and start-ups and diffused to Asian manufacturers through licensing relationships.

However, in a weak patent system, a major class of beneficiary is the Asian manufacturer. The many barriers enacted in recent years against patent holders in order to stop

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the dreaded “patent troll” have effectively helped American foreign competitors. In every industry, from chips to electronics, American innovators invented the technology but eventually shipped the production offshore. This phenomenon reflects the American strength in innovation, not in manufacturing. Nevertheless, the weak patent regime hurts these innovators and helps foreign rivals.

As American investment in R&D declines, the investment in technology research is increasing dramatically in China. If the trends continue, China will become the largest investor in technology within a decade, particularly in strategic technologies such as semiconductors.⁵⁴

Thus, not only is a weak patent system anticompetitive by enabling the big tech cartel to flourish at the expense of smaller rivals, but the weak patent system benefits our foreign rivals at the expense of American innovators. In other words, the U.S. patent system was sabotaged at precisely the worst possible time that corresponded to the rise of American rivals.⁵⁵

The existence of a weak patent system illustrates key economic challenges. First, incentives to invest in research are diminished when incumbents can infringe with impunity. Incentives to invest in innovation by incumbents themselves are diminished since they calculate it is cheaper to infringe than innovate. Second, the weak patent regime is anticompetitive since patents supply critical tools to innovators in order to protect their investments. The main beneficiaries of a weak patent regime are the incumbents that protect their monopoly profits.

⁵⁴ There is good news about the U.S. patent system only if you are a Chinese company. While the transformed U.S. patent system makes it much easier for Chinese companies to misappropriate U.S. company technologies by increasing transaction costs for examination and enforcement, the Chinese government is instituting an aggressive twenty year plan to increase scientific funding by 12-20% annually. In 2010, China surpassed Japan in spending on R&D. Over 40% of Chinese university degrees are awarded in STEM fields. In specific technology sectors, China has committed tens of billions of dollars a year for investment, including strategic technologies of semiconductors and communications.

⁵⁵ When China misappropriates technology, Congress considers the problem a national security issue. See the Defend Trade Secrets Act, which passed nearly unanimously. When big tech incumbents misappropriate technology, Congress is paid to look the other way. Congress should be reminded that China is a competitive threat while American innovators are the heroes of the economy.

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Third, with diminished investment in innovation and reduced competition from entrants, there is diminished productivity growth. The productivity growth declines show a clear trend that corresponds to the weakening of the patent system. With reduced productivity, there is slower aggregate economic growth. Therefore, the mechanisms of a weak patent system described in this article clearly explain the economic phenomena of recent years.

Productivity growth declines explain slow aggregate economic growth in recent years. Poor economic growth affects Fed policy on interest rates, supplying little justification to increase interest rates, which perpetuates persistent economic stagnation. If productivity growth declines are caused by diminished technology investments and these declining investments are caused by a weakened patent system, it is clear that we need to address ways to improve the patent system in order to improve technology investment and overall economic performance.

Given these observations, it is recommended that the U.S. ends its ten-year experiment with a weak patent system and restore strong patent rights.

(IV) Policy Prescriptions

(A) Policy Solutions to Repair the U.S. Patent System and Restore Productivity Growth

The declines in productivity growth in recent years are undisputed. There is some controversy over the causes of these declines, particularly, the sources of the declines in technology investment. However, the arguments of the present article elucidating a decline in the patent system suggest a clear and potent explanation for the declines in technology investment and in productivity growth. If this line of reasoning is accurate, there is some good news. Since the source of the productivity growth declines are traced to patent system

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weakening, the solutions include modifying policies to fortify the patent system. From these policy solutions lie management opportunities for improved economic growth.

Historically, the right has encouraged tax cuts aimed at the wealthy as a policy to improve economic growth. In the main, these work only if they are targeted to induce technology investment. However, the clear consequence of tax cuts for the wealthy is inequality, which has unforeseen adverse consequences that tend to destabilize socio-economic systems in the long-run.

With poor aggregate economic growth, the Fed is compelled to provide low interest rates for an extended time. However, a low interest rate regime reinforces economic stagnation, which presents a set of economic challenges.

The key problem is to find ways to incentivize investment in technology R&D. For centuries, Article I constitutional rights were sufficient to provide these incentives. These incentives need to be strengthened.

Historically, the U.S. has maintained strong economic growth with a strong patent system. The patent system embeds limited exclusive rights in a patent in order to induce investors to risk capital in expectation of a robust return on investment. The disintegration of the property right in patents in the last decade has destabilized the patent system, with consequences of discouraging technology investment. Alternatively, restoration of a strong patent system would create predictability in patent law, which would preserve technology investment in the long-run and enable investors to achieve a return without requiring expensive enforcement. In the present paradigm of a weak patent regime, the “efficient infringement” model encourages free riders and discourages investments in technology. The simple solution, then, is to strengthen patent law and to encourage enforcement of the law.

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The tech cartel has been relentless in denying opportunities for patent holders to enforce patents. The three main ways for attacking patents include instituting IPRs in the PTO, constraining enforcement in federal court and limiting damages. Each of these must be retuned.

First, the PTO should modify its PTAB procedures to align with federal court rules for adjudicating patent validity. Adopting neutral procedures and raising the bar for patent challenges would provide fairness in IPR proceedings. Furthermore, the PTO should allow claim amendments, which is consistent with the language and intent of the AIA. A clear definition of standards to challenge patents, including standards for obviousness challenges, should be considered. If the PTO institutes a high bar for IPRs, consistent with rules of patent validity challenges in federal district courts, they will show a respect for the presumption of validity and Supreme Court jurisprudence. IPRs should be reviewable by Article III federal district courts, which historically have determined patent validity.

In addition, the PTO should reduce patent fees for small entities, which doubled in the last five years. These dramatically higher fees represent a burdensome tax on small entities. Such high fees are particularly harmful to minorities and the middle class. One way to modulate patent application fees is to reconsider the interpretation of a micro-entity as an entity with fewer than 50 employees rather than an individual with less than five patents. Currently, small entities are interpreted as less than 500 employees; however, the distinction between 50 and 500 is substantial. Cutting fees in half only for small entities with fewer than 50 employees affects less than 10% of total PTO fees, but supplies an increase in potential applicants of two- to four-fold because this is a key price point that enables individual inventors to participate in the U.S. patent system.

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The courts can make a major difference in providing a neutral setting to adjudicate patent infringement matters based on the merits of each case rather than blind ideology. In one example, cases can be fast tracked for access to trials in order to enable plaintiffs to have their Seventh Amendment right to a jury trial.

The courts can develop common sense FRAND principles for licensing rates in each industry, consistent with standards setting organization licensing principles. This approach tends to enable a framework of discussion of valuation for patent licensing.

The problem of limited injunctions for patent remedies has been created by the Federal Circuit's unusually broad interpretation of *eBay*. In general, it is very difficult to obtain an injunction in a patent case. Yet, without an injunction, there is no credible enforcement of an exclusive patent right. Much of the problem centers on the issue of hold up of a larger device for a single patented component, which is a legitimate problem. The solution is for courts to restore a narrowly targeted injunction for specific components in order to protect the exclusive right. With a narrowly tailored injunction, there is no overreaching, while still enabling the patent holder to maintain control of the patent rights. This solution limits hold out and encourages the infringer to a design work-around that enables increased competition. The notion of a targeted and carefully crafted injunction is a common sense solution to a cumbersome problem.

In *Halo*, The Supreme Court recently overturned *Seagate*, which governed the law of enhanced damages in patent infringement cases.⁵⁶ This is a good start to restore enhanced damages to plaintiffs for particularly egregious infringing behaviors. For serial infringers, patent damages should be enhanced until their behavior is normalized.

The federal judiciary should establish regional specialist courts to enable rapid access to trials, including a compressed period of discovery of no more than a year. Further, the judiciary

⁵⁶ See Solomon, N., The Problem of Willfulness in Patent Infringement Litigation," 2010.

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should establish a layer of court system for adjudication of matters with claims of under \$5M for particularly rapid administration. In order to facilitate these rapid court tracks, mediators may be involved to resolve disputes quickly. These changes would cut transaction costs appreciably for all parties.

ITC rules should be modified to enable American inventors and invent-and-license companies to qualify as a domestic industry.

The courts should recognize and encourage the university technology transfer model. The ecosystem of very large corporations, for pharmaceuticals or high technology, ought to learn to partner with small companies. FRAND licensing principles should dominate the negotiations between the parties employing the licensing model. Hence, incentives should be provided to large companies to partner with innovative small companies.

Some economists argue that innovation has peaked and that we can therefore expect declining productivity growth and slow economic growth in the future. However, the view that productivity growth is endogenous to the economy implies that innovation is itself a human component that, if properly motivated, can supply inexhaustible ingenuity and opportunity. This suggests that human or intellectual capital is itself a commodity that can be managed.

The U.S. government can increase funding for basic research, technology education and technology research infrastructure. But the government has a poor record of selecting winners and should maintain its neutrality. Still, the government can broaden access to STEM education and opportunities for women and minorities, which are famously underrepresented in the technology industry. For example, the government can encourage modifications of science education away from an emphasis on measurement and towards qualitative approaches.

(B) Directions for Future Research

There is general consensus among economists that productivity growth is the central feature of a growing economy. The economists disagree on what causes productivity growth and how to encourage investment in technology research that stimulates productivity growth. The present article contributes to the literature by identifying sources of the challenges to productivity growth that explain the trends and by suggesting solutions to repair the problems. Clearly, this article's thesis of the cause of productivity growth decline derived from a weakened patent system as well as a description of the mechanisms of changes that adversely affect investment in technology research provide a contribution that requires further investigation.

Further research may be directed at identifying the components of TFP and the dynamics of capital, labor and intellectual capital. The complex combinations of the constituent components in TFP are important to trace.

Future scholars should identify the dynamics of the role of the patent system in TFP changes and in aggregate productivity growth declines. These complex and cross-disciplinary mechanisms require exploration.

Scholars can identify the connections of TFP and technology investment. The connections of technology investment and the patent system should be a major research area that beckons. Without incentives to invest in technology, why would anyone risk capital? Without a patent system, there is no clear way to obtain a return on capital. These connections need to be detailed, perhaps with intensive empirical research.

In addition to analytic investigations, historical investigations may supply insight into the causes of TFP decline. Scholars can apply multiple methodologies to trace the relationships of TFP growth decline, wage growth decline and aggregate economic decline.

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One way to explore these complex connections between patent policy and technology investment is to apply data analytics. Analytics sort data to identify sources of the productivity growth declines. Analytics could also be applied to identify the correlations between the declines in productivity growth, technology investment and the patent system. Specific patent law elements may be identified as particularly important to encouragement of technology investment.

Considerable analysis can be applied to understanding the impact of transaction costs on innovators. For example, the reduction of transaction costs may facilitate the return of a voluntary licensing market. Investigation into these processes would be worthwhile.

The connections between industry competition and productivity growth declines should be identified. Concentrated competitive configurations in the technology industry provide a strong disincentive to invest in technology. With a weak patent system that fails to protect market entrants, the competitive configuration of technology industry segments provides a particular drag on productivity growth. For example, a weak antitrust law regime may affect the concentration of technology companies, a critical link that may require strong patent policy changes in order to encourage competition. These connections need to be described in order to identify policy solutions.

While economics research is valuable, policy research is important as well. Researching the connection between technology industry competition and patent policy dynamics could yield important revelations that will affect future policy reforms. Remarkably, very little empirical evidence was involved in recent patent law changes, suggesting that this area of research is critical.

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Research into the influences of policy changes, including ideological influences and the socio-economics of lobbying organizations, can supply valuable insight into the operation of policy making institutions.

Finally, economists need a meta-analysis of their own profession. After all, economists neither anticipated nor predicted the recession, the financial crisis, the depth and duration of the recession, economic growth rates after the recession, productivity growth rates after the recession or labor market trends after the recession. The fact is that in recent years the economics profession has proven to be poor at prediction. If the thesis of this article is correct, and the evidence is compelling, then economists missed the logic of productivity growth decline as well. Like many academic professions, economists may be too isolated or too focused on measurement and the language of mathematics to realize critical relationships that explain complex economic phenomena. One suggestion is for increased collaboration between economists, the legal profession and policy makers.

One key problem is that recent radical patent law changes are attributed to ideological influences of the far left and the far right. These influences may require analysis in order to develop effective solutions. Only an interdisciplinary approach will yield solutions to these difficult problems.

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