Economic Analysis

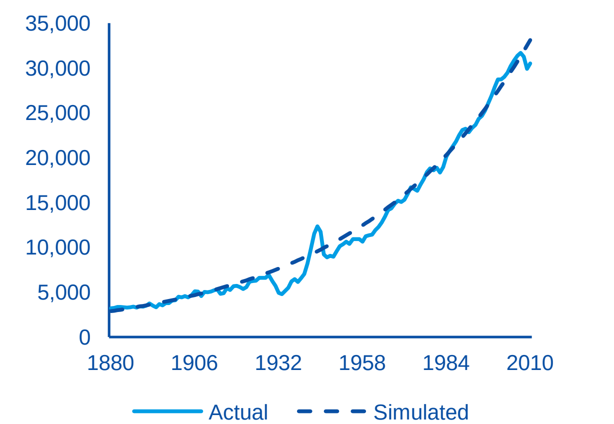
Productivity deceleration: evidence from state-level data of the U.S.

Kan Chen

- **Productivity deceleration happened in most states in the last decade**
- **State-level data suggest significant productivity convergence among states**
- **The task for the government is to eliminate negative externalities through fiscal policies and regulations**

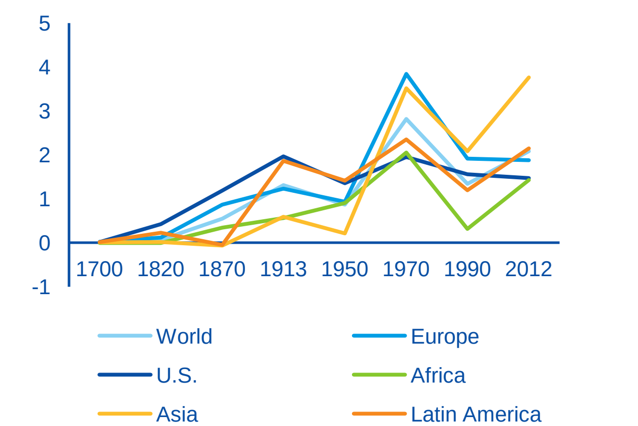
The Great Recession has spurred a strand of research that puts some fundamental assumptions in economic growth theories under scrutiny, particularly equilibrium productivity growth. In the seminal work of Solow (1956), the author proposed the assumption of a constant "neutral technological change," which captures continuous technological innovations. In his canonical exogenous growth model, an economy can expand at a steady pace when productivity growth is constant. This assumption, along with Solow's exogenous growth theory, quickly became the starting point of most economic growth theories due to its elegant mathematical characteristics, and more importantly, its power of explaining many stylized facts of the U.S. economy and other advanced ones. For instance, Chart 1 shows that a simple assumption of 1.9% annual growth rate can generate a GDP per capita series that largely resembles the actual data, with the only notable exceptions being the Great Depression, WWII and the Great Recession.

Chart 1
U.S. GDP per capita, 1990 constant $



Source: BBVA Research & The Maddison-Project

Chart 2
Per capita output growth, %

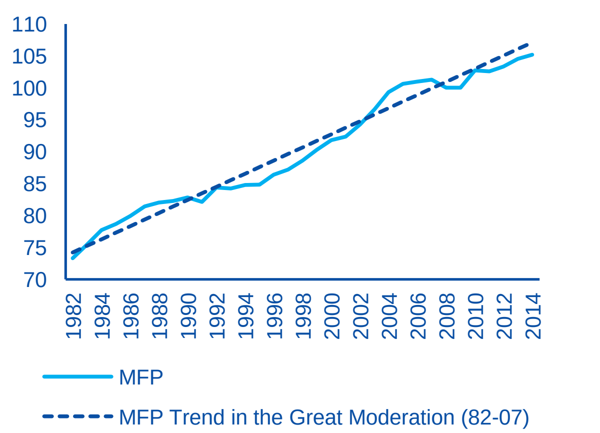


Source: BBVA Research & Piketty (2014)

The constant productivity growth assumption fits well with the data for the U.S. after 1880, yet it is inconsistent with the fact that productivity growth was virtually zero prior to the Industrial Revolution. For example, Thomas Piketty in his best-seller, *Capital in the Twenty-First Century*, shows his estimates of the per capita output growth rates since 1700. As Chart 2 shows, the world economy did not have any noticeable growth until 1820, when the technologies (steam, railways) developed in the previous decades had mostly matured. Moreover, the same chart shows that output growth rates are far from constant across countries and regions. That is, although the constant growth rate assumption is a valid approximation that fits the modern U.S. data, its explanatory power with regard to economic growth in other countries or time periods is questionable.

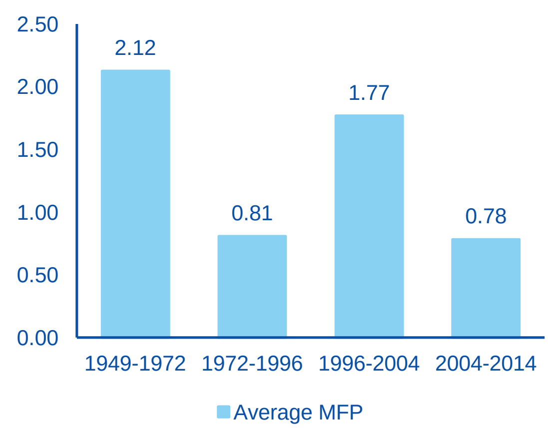
A notable effort to debunk the myth of the constant productivity growth assumption is from Robert Gordon of Northwestern University. Gordon recently released a series of papers (Gordon 2012, 2014) examining the impact of three industrial revolutions (IR's), including IR #1 (steam, railways), IR #2 (electricity, internal combustion engine, running water, indoor toilets, communications, entertainment, chemicals, petroleum), and IR #3 (computers, internet, mobile phones). He argues that the nearly constant growth rate of the U.S. economy is due to persistent effects of these three successive IR's. Moreover, productivity growth is significantly lower between 1972 and 1996, when the impact of the IR #2 nearly wore out before the IR #3 picked up. For instance, by eyeballing Chart 3 we can find that U.S. multifactor productivity (MFP) slows down after 2004. Also, Chart 4 shows that the average MFP varies significantly in different sub-periods in U.S. history. Therefore, there is no guarantee that stable productivity growth will last indefinitely. Furthermore, Gordon argues that the boost from IR #3 has diminished since 2004, and therefore the U.S. will probably experience a long period of mediocre economic growth until the next IR takes place. This concern is also shared by IMF Managing Director Christine Lagarde, whose recent speeches candidly advocate possible prevention measures against the "New Mediocre."

Chart 3
U.S. multifactor productivity (MFP)
Index, 2009=100



Source: BBVA Research, BLS & Haver

Chart 4
U.S. average MFP growth in sub-periods
%



Source: BBVA Research, BLS & Haver

Productivity growth at the state level

Total-factor productivity (TFP) is the most common productivity measure, and its growth reflects the portion of economic growth that is not caused by changes in the quantity of the inputs, such as labor or capital. Since it is input-independent, the level of TFP essentially represents how efficiently various inputs are utilized in the production process. In Solow's exogenous growth model, the constant "neutral technological change" is equivalent to a fixed TFP growth rate.[1] Moreover, because the effect of technological innovations is not measurable, in economic growth accounting, the TFP growth rate is estimated by calculating the residual growth

[1] For more details of total-factor productivity, please refer to Hulten, C. (2001). *Total Factor Productivity: A Short Biography.* (http://www.nber.org/chapters/c10122.pdf)

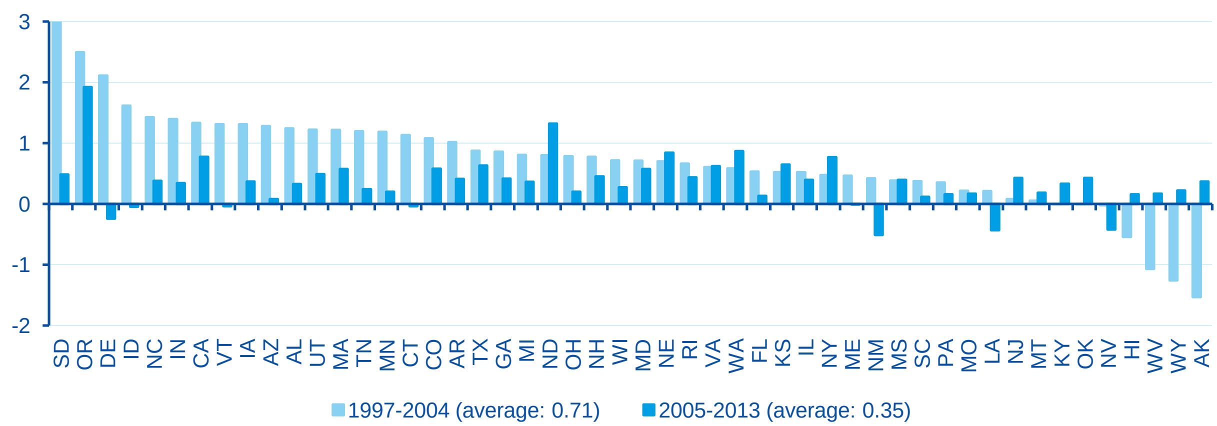
rate of output that is not explained by the growth rate of any input. Therefore, the estimated TFP growth rate is also called "the Solow residual," due to its theoretical root in Solow's exogenous growth model.

Although the equivalence of TFP growth rate and the Solow residual strictly holds in theory, in practice, Solow residuals will inevitably contain unwanted components, such as measurement error and aggregation bias. While measurement errors can be random and cancel each other out, inappropriate aggregation methodology may introduce systematic bias into the estimated TFP growth rate. For example, Feenstra et al. (2013) argue that the official aggregation methodology omits U.S. tariff changes from 1995, and therefore causes overestimation of productivity growth in 1995-2006. The measurement error could account for 0.2 percentage point of the 1995-2006 productivity growth.

On the other hand, state-level studies are often a cogent instrument to recover the information missed or distorted from the country-level data in the aggregating process. Despite the common headache of limited data availability at the state level, we overcome this obstacle and estimate the total factor productivity (TFP) growth rates for each state by using the methodology developed by Garofalo and Yamarik (2002). Since the economic structure within the U.S. is highly diversified, we can reveal more detailed information on productivity deceleration. Furthermore, we examine the average TFP growth rates in two sub-periods: 1997-2004 and 2005-13. We break down the whole sample because 2004 is the year when country-level productivity began to show slowdown.

Our estimation shows strong convergence of productivity among states: the dispersion of TFP growth rates has declined significantly during the last 10 years. As Chart 5 shows, state TFP growth rates have a range between -1.5% and 3.0% in 1997-2004 and between -0.5% and 1.8% in 2005-13. That is, the range reduces by half from 4.5% to 2.3%. Also, we see that almost none of the states have persistently high or low growth rates in both sub-periods, with Oregon being the only exception.[2]

Chart 5
TFP growth rates, %

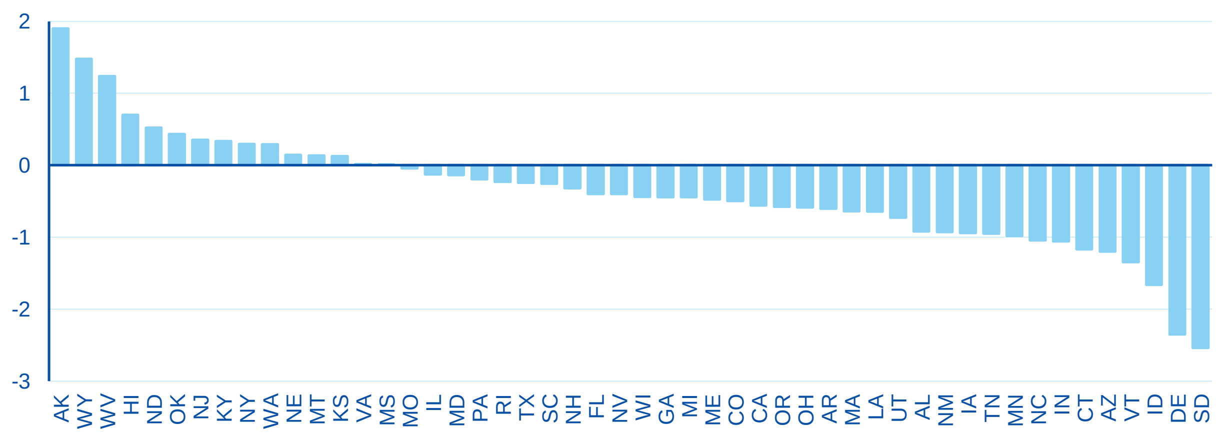


Source: BBVA Research

[2] Since Intel is Oregon's largest private employer and puts its production unit in this state, Oregon's persistently high productivity growth might be attributable to Moore's Law.

The strong convergence during the last decade also indicates that the sector that enjoys substantial progress in productivity has been shifting, and therefore states with lower industrial diversification may be more affected than those with higher industrial diversification. For example, Chart 6 lists the change of average TFP growth rates between the two sub-periods. The states with large changes in productivity growth generally have small economies. For instance, the Shale Revolution, beginning around 2005, has significantly benefited the productivity growth of North Dakota and Oklahoma—two states that have rich shale gas reserves. Yet the same revolution does not further boost the productivity of Texas, another major shale oil producing state, because Texas has a much larger size of economy.

Chart 6
Change of TFP growth between two sub-periods (1997-2004 & 2005-13), %



Source: BBVA Research

Furthermore, our estimation shows that most states have experienced productivity deceleration during the last decade. As Chart 6 demonstrates, 35 states have slower TFP growth in 2005-13 than in 1997-2004. Also, the unweighted average TFP growth drops from 0.71% to 0.35%. This result is in line with the decreasing MFP at the country level. As Chart 4 shows, the MFP growth rates are 1.77% and 0.78% in the two sub-periods, respectively. Unless there are major measurement errors in the data, or the official aggregation methodology is severely flawed, the cut in both measures illustrates productivity deceleration across the country.

Theory and policy implications

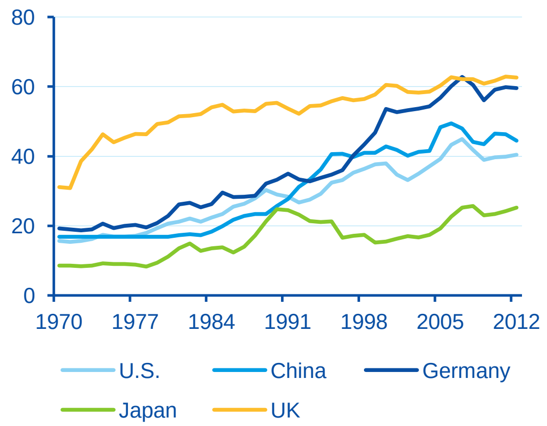
In *Capitalism, Socialism, and Democracy,* originally published in 1942, the Austrian economist Joseph Schumpeter popularized the term “creative destruction” by stating:

> The opening up of new markets, foreign or domestic, and the organizational development from the craft shop to such concerns as U.S. Steel illustrate the same process of industrial mutation - if I may use that biological term - that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. (p. 83)

In other words, unlike other economic growth theories that mainly focus on the positive side of productivity growth, Schumpeterian theories also pay attention to the negative side: as new technologies move forward, destruction of outdated capital, as well as job positions, is an unavoidable price of economic progress, especially in a capitalist economy.

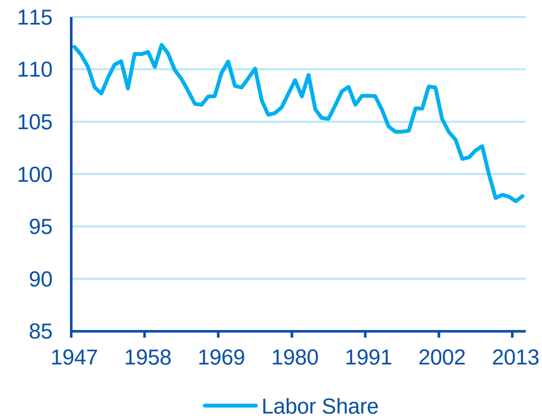
As we have seen in the last decades, innovations in IR #3 have made jobs more globally transferable and more transitional ("the gig economy"). Also, new capital is more labor-saving than old capital. Moreover, new technologies require more high-skilled, and less low-skilled, labor. Combining all the effects from IR #3 together, it should cause higher global integration (Chart 7), lower labor share of output (Chart 8), lower labor participation rates (Chart 9) and higher income inequality among people (Chart 10). We have witnessed the materialization of all of these.

Chart 7
KOF Index of globalization, economic flows index



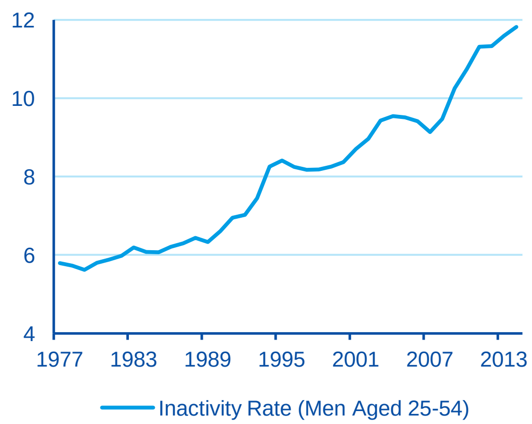
Source: BBVA Research & ETH, Zurich

Chart 8
U.S. labor share in non-farm business sector index 2009=100



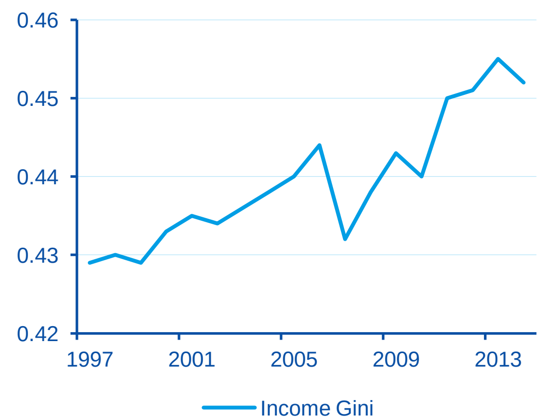
Source: : BBVA Research & Haver

Chart 9
U.S. inactivity rate, men aged 25-54 %



Source: BBVA Research & OECD

Chart 10
U.S. family income Gini ratios



Source: : BBVA Research, Census Bureau & OECD

Although the creative destruction caused by technological progress is evident and unavoidable in a market economy, the government can play an important role in reducing its negative effects. As increasing income inequality and labor inactivity impose substantial costs on the whole of society, they can be viewed as negative externalities produced by newly-invented technology and capital. Therefore, proper government regulation and intervention are essential to eliminate such externalities. For example, expanding infrastructure investment, among other benefits discussed by many economists, such as indirectly boosting productivity in the private sector,[3] can also effectively raise the demand for low-skilled labor. Since infrastructure investment is generally labor-intensive, the inactive workers previously depressed by the labor market will be encouraged to look for jobs that suit their skill-sets. Hence, it will improve the labor participation rate, narrow the income gap between high-skilled and low-skilled labor and eventually reduce income inequality.

There are other policies that can reduce income inequality. For example, Steve Jobs reportedly advised President Obama that "any foreign students who earned an engineering degree in the U.S. should be given a visa to stay in the country" (WSJ, 31 October 2011). Although his advice seems unfeasible under the current immigration system, the principle is clear: policymakers should raise the supply of high-skilled labor.[4] Increasing the supply of high-skilled labor will not only make better use of the newly technology-intensive capital, but also lower the market income of high-skilled labor, which will also reduce income inequality. Moreover, reducing income inequality can also be achieved by tax reform. Tax cuts for job creators, tax exemptions for low-income families and an increase in the capital gains tax can all be used to mitigate the income gap.[5]

Bottom line

The "new mediocre" economic growth after the Great Recession has inspired economists to examine the role of productivity, besides other transitory factors, in economic growth. We conduct analysis with state-level data, and confirm with recent findings that the U.S. is experiencing a productivity deceleration. Moreover, we find strong convergence of productivity across states. The convergence implies that productivity boosts from technological innovations can shift quickly across sectors and that they have a higher impact on states with simpler economic structures.

Finally, while progress in technology has dramatically changed our lives, it can create negative externalities through "creative destruction." Thus, it is important for the government to confront and cope with the new situation, and to mitigate the externalities with proper fiscal policies and regulations.

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[3] For example, Leduc and Wilson (2012) of the San Francisco Fed found that recent federal highway projects have a multiplier of at least two, meaning that for each dollar of federal highway grants received by a state, that state's gross output rises by at least two dollars.
[4] For in-depth analysis on immigration reform, please refer to BBVA Research, *Immigration Reform: Enhancing Growth through Immigration Policy*
[5] For more policy discussion, please refer to BBVA Research, *U.S. Transitioning to an Environment That Rewards Productivity over Growth*,.

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