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The Historical Productivity Variations During the Recessions' Periods in the U.S. Economy and in the OECD Countries

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Abstract

This paper provides thorough analysis for the changes in total factor productivity TFP and its main determinants in the private business sector through a diagrammatic overview for the patterns of variation over the period from 1949 to 2013. This study attempts to pinpoint the main causes of the TFP slowdown in the US economy and in the OECD countries. Due to data unavailability – during the time at which the research in this paper has been executed – the analysis for the growth in TFP covers the period between 1995 and 2013 for the selected sample from the Organisation for Economic Co-operation and Development economies (OECD). Throughout this period, the collected data reveal an interesting narrative about the slowdown in TFP. Especially after 2004 partly due to a slowdown in capital intensity and capital deepening, a slowdown in the start-ups and small ventures shares in the business sector, and a slowdown in investment growth in recent years.

التغيرات التاريخية في الانتاجية خلال فترات الركود الإقتصادي في الإقتصاد الأمريكي وبلدان منظمة التعاون الإقتصادي والتنمية

سالم غيث

ملخص

تتناول هذه الورقة بالبحث والاستقصاء والاستعراض البياني المُعمّق التقلبات التي طرأت على الانتاجية ومحدداتها أثناء فترات الركود الاقتصادي التي شهدتها الولايات المتحدة ودول منظمة التعاون الاقتصادي والتنمية في قطاع الاعمال الخاص على مدى الأجل الطويل خلال الفترة ما بين 1949و2013. إذ تكشف البيانات المتوفرة من مكتب إحصاءات العمل الأمريكي (BLS) ومن مكتب التحليل الاقتصادي (BEA) عن قصةً مثيرة حول علاقة الانتاجية الكلية بكلٍ من كثافة رأس المال، وتعمّق رأس المال، والتدهور في نسب مساهمة الشركات الصغيرة والجديدة في قطاع الاعمال، والانحسار في حجم الاستثمار الكلي في السنوات موضوع الدراسة.

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1. General Background

The general path of economic development in the developed economies, has established a pattern of resources movement from agriculture to manufacturing, and in a later stage of development to the service industries, (Krüger, 2008).

In relation to the developing countries, the share of employment in agriculture is relatively larger than in developed countries, not to mention that the issue that poses a great deal of concern is that productivity, in absolute terms and relative to the other industries within the economy, is markedly lower in agriculture in developing countries than in developed economies. However, having mentioned that, the structural change had given rise to greater scope for enhancing and encouraging productivity growth across these countries, (Timmer & Szirmai, 2000), (McMillan & Rodrik, 2011).

Since the 1990s, some Asian developing countries have known a productivity-enhancing structural change, and waves of labour movements from low-productivity agriculture to high-productivity manufacturing, (McMillan & Rodrik, 2011). In stark contrast, the Latin American countries pattern of change is different where the employment direction appeared to be to lower-productivity services industries, (Meehan, 2014).

(McMillan & Rodrik, 2011) point to the relatively strong labour productivity growth in Asia in comparison with the relatively weaker growth in Latin America. This is where they attributed this strong growth not to the differences within-industry productivity growth, but due to variations in the effects of structural change on productivity. However, according to some reports for some OECD countries (Denmark, France, the Netherlands, Sweden and the United States) a considerable share of the contribution to GDP growth, over the period of 1995-2003, principally comes from the growth in total capital input and TFP.

This to some extent is relevant to the growing role of innovation and information and communication technologies (ICTs) in economic growth, (OECD, 2006), (Innovation, 2007). This is where ICTs were responsible for 75% of the U.S. productivity growth from 1995-2002, and 44% from 2000-2006, (Brynjolfsson & Saunders, 2009), (Brynjolfsson, 2011). It has accounted for 20% of the U.S. GDP

growth since 1995, 20% in 2010, and 26% in 2016, notwithstanding it constitutes only 4.7%, 4.9%, and 4.9%, respectively of the U.S. GDP,(BEA, 2016).

Over the last two decades, ICTs have made the U.S. economy over two trillion dollars larger in annual GDP terms, (Atkinson et al., 2010). 21% of the annual growth of GDP in the leading economies (Brazil, Canada, China, France, Germany, India, Italy, Japan, Korea, Russia, Sweden, the UK, and the U.S.) is ascribed to the internet alone during the period between 2006 and 2011, (Manyika & Roxburgh, 2011), and the value of the ICTs services in the OECD economies grew by 115% during the period from 1996 to 2008, (OECD, 2011), and as a result of the dot-com internet domains' effects, the annual GDP of the world economy became larger by one and a half trillion dollars, (Atkinson et al., 2010), not to mention that a growth by 10% in the ICTs capital stock in a nation, contributes by almost 0.45 percentage points to the annual growth of its GDP, (Jorgenson & Vu, 2005), (Atkinson & Stewart, 2013).

2. Productivity and the Business Cycles

The impact of the economic downturn can vary in degree from one country to another, and from one industry to another likewise. One of its repercussions is to increase the level of productivity dispersion between firms, and therefore, the variation of productivity between industries.

Numerous studies have been dedicated to investigating the effects of the financial crashes and economic turbulence on the growth in productivity, but less attention has been paid to their impact on the disparities of productivity within and between industries, simply because the focus was by and large on the patterns of change in productivity growth during the crises, and not on the differences in productivity before and after the crises' periods. This is where, according to (Kim, 2013) the accumulated inefficiencies in production will be cleansed out via the so-called "Cleansing Effect", (Caballero & Hammour, 1991), which will contribute to the growth in productivity in the long run in the light of what is known as "Creative Destruction" by (Schumpeter, 1942) and the concept of "Natural Selection" by (Nishimura et al., 2005).

It has been argued that the low and depressed aggregate demand, being prevailed during economic downturns, will lead firms to shift their interests to the low opportunity cost of productivity-ameliorating activities against production activities. Hence, they will centre their efforts to increase the future productivity, (Aghion & Saint-Paul, 1991). As a result of this decision, firms are likely to hoard their labour in anticipation that the demand will recover in the future, this is where the labour productivity is also expected to recover and thrive owing to the anticipated increasing demand, (Kruppe & Scholz, 2014).

The reason why labour hoarding is an attractive tactic, from the firms' point of view, is that it can help firms to avoid the costs of layoffs and dismissals during the downturns, and then the search as well as employment costs during the upturns. Some point out that human and physical capital per worker have both grown during the recession, and subsequently, labour productivity is likely to rise not to fall, and since the least skilled employees are highly likely to lose their jobs (or be involved in short-time work), therefore, human capital per worker is supposed to increase, (Kruppe & Scholz, 2014).

Moreover, the high cost of redundancy deters firms from firing their workers, because of the skills, expertise, and production knowledge they have had during the years of boom, and they prefer not to lose them, especially if they (the plants) expect to bear hiring costs in a short period of time during the next upswing in the economy.

3. Productivity in the United States: Historical Trends

TFP indices calculate productivity growth by measuring the variations in the connection between the quantity of output, generated by any sector or industry, and the amount of inputs combined to produce that volume of output. The measured inputs are composed of labour input, capital services, and intermediate purchases including raw materials, purchased services, as well as purchased energy, (Gullickson, 1995).

According to the Bureau of Labour Statistics, BLS, TFP measures the change in output per unit of combined inputs. More specifically, in the manufacturing industries, TFP is designed to trace the influence of the technological change,

efficiency improvement (e.g. as a result of better transportation and communications), the reallocation of resources (e.g. the shifts of labour forces among industries), along with other influential components, making it a possibility for the capital, labour, and intermediate inputs to affect the economic growth.

It then can be said that TFP has been derived from the difference between the growth rate of the real value-added output (VA) and the growth rate of a Tornqvist index of labour, capital, and intermediate purchases as inputs, which can be expressed as follows:

$$\boldsymbol{LN\left(\frac{A_t}{A_{t-1}}\right) = LN\left(\frac{Q_t}{Q_{t-1}}\right) - \left[W_k\left(LN\frac{K_t}{K_{t-1}}\right) + W_l\left(LN\frac{L_t}{L_{t-1}}\right) + W_{ip}\left(LN\frac{IP_t}{IP_{t-1}}\right)\right]}$$

……. Equation 1

Where:

LN represents the natural logarithm of the variables. A is TFP. Q is the output. L is labour input. K is capital input. IP denotes for the purchased intermediate inputs. Wk, Wl, Wip represent the cost share weights for each of K, L, IP, respectively.

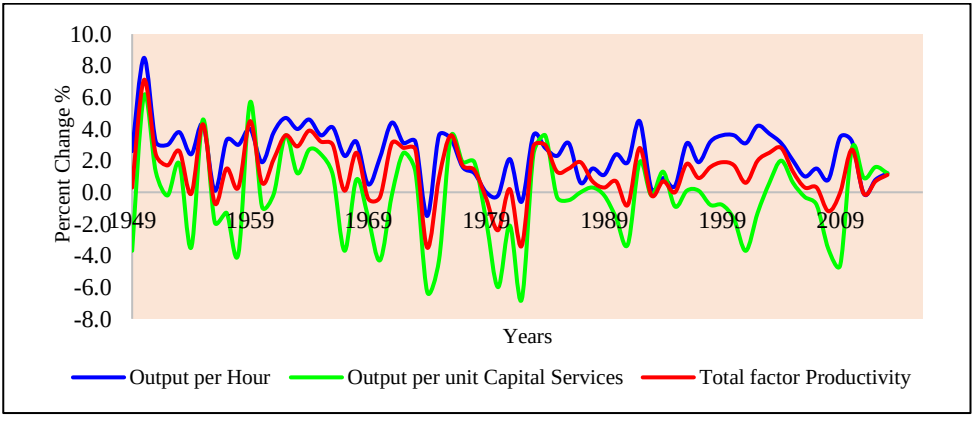
The main distinction between the TFP measures and labour productivity measures is that the former implies information about capital services and intermediate inputs. In addition, the data required to measure TFP are not applicable on a quarterly basis as they are for the labour productivity.

Another relevant strand is that the government enterprises are not included when TFP is calculated due to lack of availability of satisfactory capital measures for government enterprises, while government enterprises are considered in the labour productivity calculations. Specifically, estimates of the appropriate weights for labour and capital in government enterprises cannot be made because subsidies account for a substantial portion of capital income.

3.1 TFP in the Private Business Sector

Total factor productivity in Private Business Sector P.B.S. increased on average at a 1.3% as an annual rate during the period between 1949 and 2013, reflecting a 3.4% increase in output and a 2.0% growth in the combined inputs of capital and labour during the same period 1949-2013

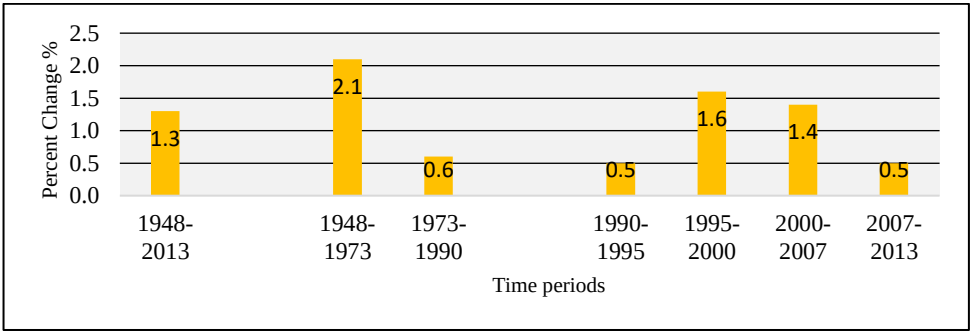
Figure (1): The annual change (%) in output per hour, output per unit of capital services, and TFP in the private business sector in the U.S. economy during the period 1949-2013



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (March - 26 - 2015)

It is important to draw the attention to the point that the highest growth rate in total factor productivity was a 2.1% in the period from 1948 to 1973 due to a 4.0% growth in output coupled with a 1.9% growth in the combined inputs. The growth in the combined inputs reflected a 3.7% increase in capital services, a 0.7% increase in hours of all persons, and a 0.3% rise in labour composition. Where the capital services are derived from the stock of physical assets and intellectual property assets.

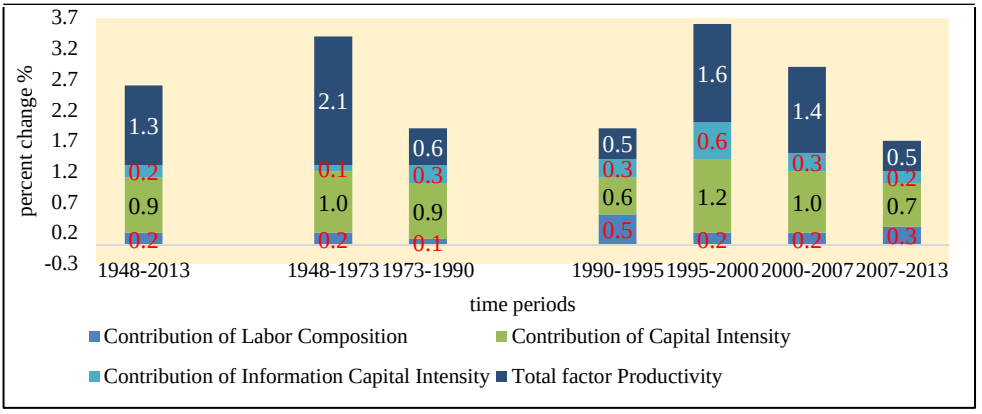
Figure (2): The average growth rates of total factor productivity in the private business sector in the U.S. economy 1948-2013



The trends in the above chart are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

Information processing equipment is composed of three broad classes of assets: computers and related equipment (including mainframe computers, personal computers, printers, terminals, tape drivers, storage devices, and integrated systems), communications equipment (which is not further differentiated), and other information processing equipment (which includes medical equipment and related instruments, photocopying and related equipment, office and accounting machinery). During the period between 1995 and 2000 the contribution of information capital doubled in comparison with the period from 1990 to 1995 mainly as a result of the ICT revolution during that period.

Figure (3): The contribution of labour composition, capital intensity, informational capital, and TFP to GDP throughout the period from 1948 to 2013

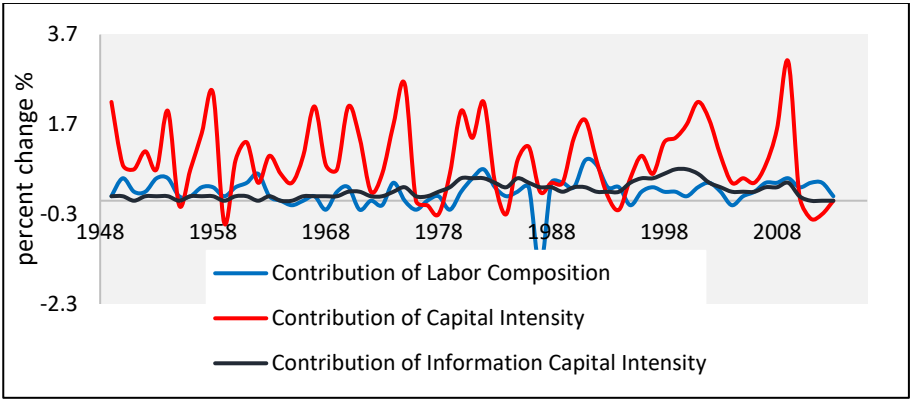


The trends in the above chart are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

Intellectual property products are formed of three main classes of assets: software, research and development, and artistic originals. This is where software implicates pre-packaged, custom, and own-account software. While research and development is a combination of creative work undertaken to increase the stock of knowledge in order to discover or develop new products or to improve already existing ones. Artistic originals comprise theoretical movies, long-lived TV programmes, books…. etc. Structures are composed of non-residential structures and residential capital that are rented out by profit-making firms or persons.

It is worth pointing out that the financial assets are excluded from capital services measures as are owner-occupied residential structures. The contribution of capital intensity plummeted dramatically after 2009 and has recovered since then. Labour composition contribution appeared to be relatively stable.

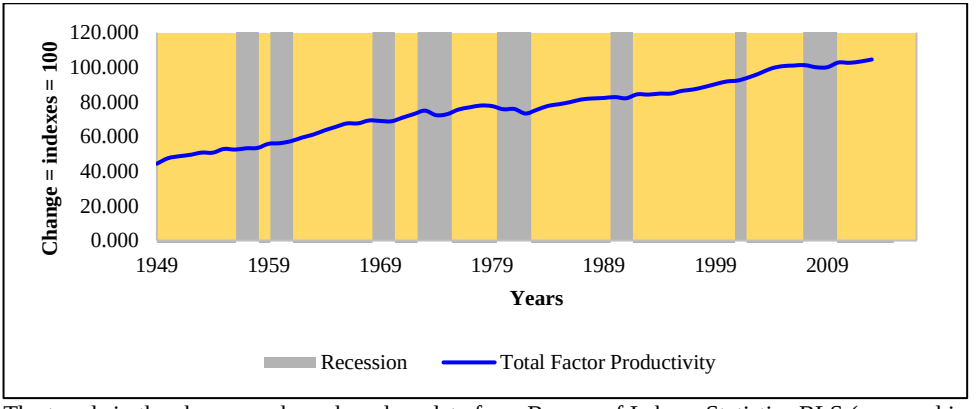
Figure (4): The changes (%) in the contributions of labour composition, information capital intensity and capital intensity in the P.B.S. during 1948-2013



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

When tracking down the progress of total factor productivity over the 64-year period prolonged from 1948 to 2013, it is noticed that during most of the recession waves in the U.S. economy, TFP was negatively affected, mainly during the recessions in 1973-1975, 1981-1982, the early 1990s, and recently the Great Recession 2007-2009.

Figure (5): Total factor productivity in the private business sector in The U.S. economy during the period from 1948 to 2013 Indexes =100 Base Year =2009



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

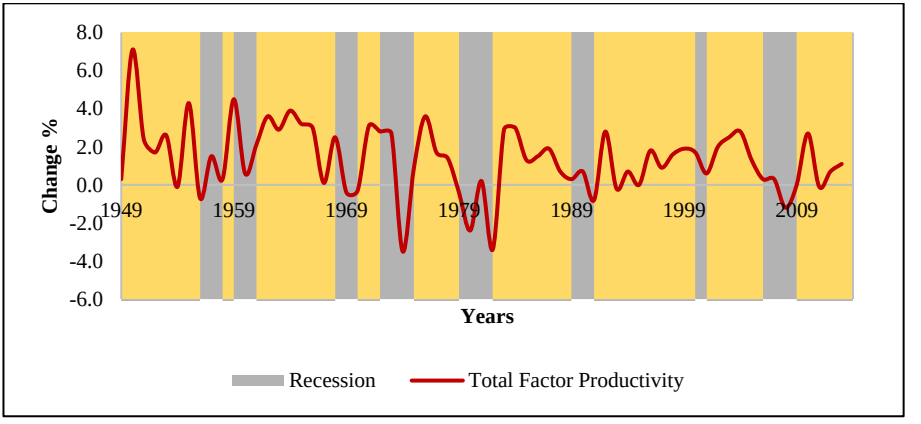
The question that arises in this respect concerns; is it always the case that TFP is expected to be weakened by the business cycles? One of the things that can be noticed here is that TFP growth mostly starts to decline and slowdown during the years prior to any recession surge. thus, the question that arises again is What could cause this decline?

At all events, productivity growth shows signs of obscurity and ambiguity at the same time as it gives the impression of not being an easy phenomenon to understand fully because it is shrouded in multiple levels of enigma and because it is in fact a combination of different things.

Productivity in the U.S. grew by 2.9% per year over the period between 1953 and 1973, and then its growth eroded to 1.5% per year during the period 1973-1995 and grew again to 2.2% per year across the years from 1995 to 2014 but did not recover to the 1953-1973 growth level. The important thing is that productivity grew by just 0.7% at an annual average rate during the aftermath of the recession between 2010 and 2014.

The employment growth in the U.S. during the period 2007-2013 was the worst since the years that followed the end of World War II with (-0.5%) per year which manifests itself in the weak and subdued growth in productivity in recent years.

Figure (6): Changes (%) in total factor productivity in the U.S. private business sector between1949 and 2013



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

During the period 1973-2008, TFP plunged namely in 1974, 1980, 1982, 1991, and in the Great Recession in 2008 by -3.5%, -2.4%, -3.4%, -0.8%, -1.2% respectively. It is also worth noting that after these slumps, TFP quickly bounced back in the years of recovery and boomed significantly.

On the other hand, and from the bigger picture over the long term starting from 1948 up until 2014 we can extrapolate that the average growth in both labour composition and capital intensity aggregated accounted for 50% of growth in productivity and the other 50% is attributed to the average growth in TFP.

During the shorter term over the period 2007-2017 the contribution of capital intensity – the amount of fixed real capital share in relation to other production factors such as labour – to productivity is 0.5 percentage point (42% of the total), whereas the contribution of labour composition – the shift in the age, education, and gender in the work force as a measure that affects labour inputs – is 0.2 percentage point (16% of the total) therefore, (58% is the aggregate contribution of capital intensity and labour composition), and the contribution of TFP is 0.5 percentage point (42% of the total).

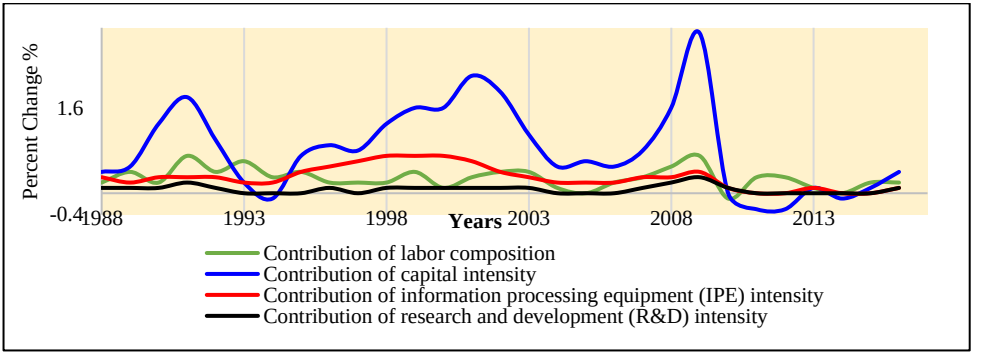
The growth in capital intensity and capital deepening – where the former refers to the amount of capital (the flow of capital services) available per worker/hour worked, while the latter refers to the annual rate of change in capital intensity – declined in recent years in the U.S. economy which means that the sufficient level of aggregate demand that is supposed to motivate more investments to produce goods and services in the economy is neither encouraging nor incentivising for businesses to invest. This resulted in a decrease in output and hence caused the ratio of capital per output (capital/output) to increase and led to constraints on credit in the capital markets.

In fact, TFP and capital deepening seem to change monotonically over time either in the rise or in the fall. Meaning that over the period 1948-1973 (the period of the biggest growth in TFP in the U.S. economy) growth in TFP and capital deepening was 2.1% and 1% respectively, whereas during the period 1973-1995 both dropped to 0.5% and 0.8%, and over the economic boom period in the U.S. from 1995 to 2004 both grew by 1.7% and 1.2% respectively, and their growth eroded again during the period 2004-2015 to 0.5% for both TFP and capital deepening. On the

other hand, growth in labour composition was reasonably steady over the period 1948-2015 at roughly 0.2%.

That might be explained by the fact that when TFP is growing, more opportunities for businesses arise and more capital accumulation becomes available for investments resulting in more capital per hour worked and therefore greater share of capital's contribution to productivity growth. But at the same time this can cause the growth in capital supply sourced from the capital markets to shrink which in turn can be justified by the pre-existing overabundance of capital in the economy.

Figure (7): Changes (%) in labour composition, capital intensity, R&D, and information processing equipment contributions in the U.S. private business sector between 1988 and 2016

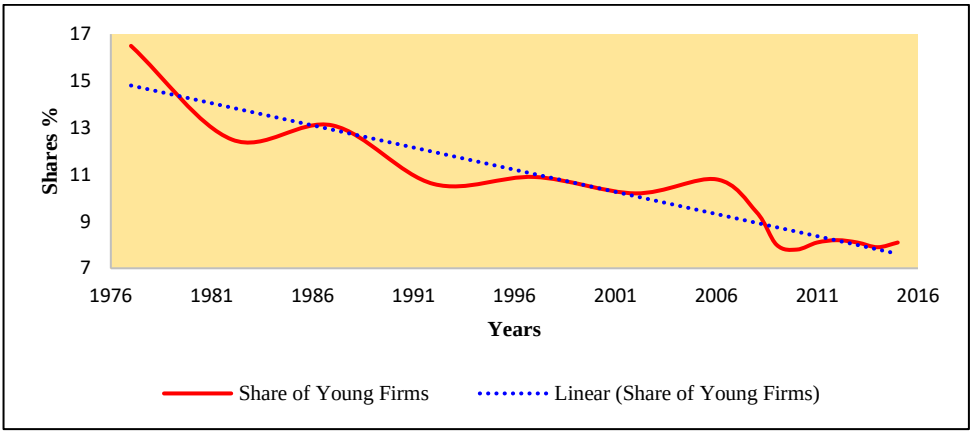


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2018).

At industry level, and during the growth surge in the U.S. economy 1995-2004 the largest contribution to TFP growth came from the service sector by 0.44%, and then came the manufacturing sector with 0.39% and the wholesale trade by 0.15%.

The manufacturing sector contribution was mainly driven by the semiconductors and information technology manufacturing boosted up by the decline in ICT prices in product markets which increased the growth in aggregate demand for this kind of products which in turn led to higher investments and increased productivity.

Figure (8): The share of young firms and start-ups in the U.S. economy during the period 1977-2015 (% of the total)



Source: Figures in this graph extracted from the U.S. Census Bureau (accessed in April 2017).

However, on the other hand, the main contributors to slowdown in TFP growth during the period 2004 -2015 are the manufacturing sector by (-0.73%) and retail trade by (-0.30%) wholesale trade by (-0.29%) and services by (-0.16%). It is worth noting here, that the slowdown in growth in the semiconductors industry, caused many small retailers to exit the retail trade market, leading to a decline in productivity growth as well, which accounted for part of the aggregate drop in TFP during that period, not to mention the Amazon effect on the retail trade sector as a whole.

The decline and slowdown in TFP growth, potential output and labour productivity can be also partly explained by the deterioration in business dynamism in the U.S. One way to measure business dynamism is by the number of the start-ups (the share of new firms entering the marketplace as a percentage of the total number of firms in the marketplace) during certain period. Start-ups can play important role in promoting output by bringing new ideas into the mixture of firms that are already operating in the market.

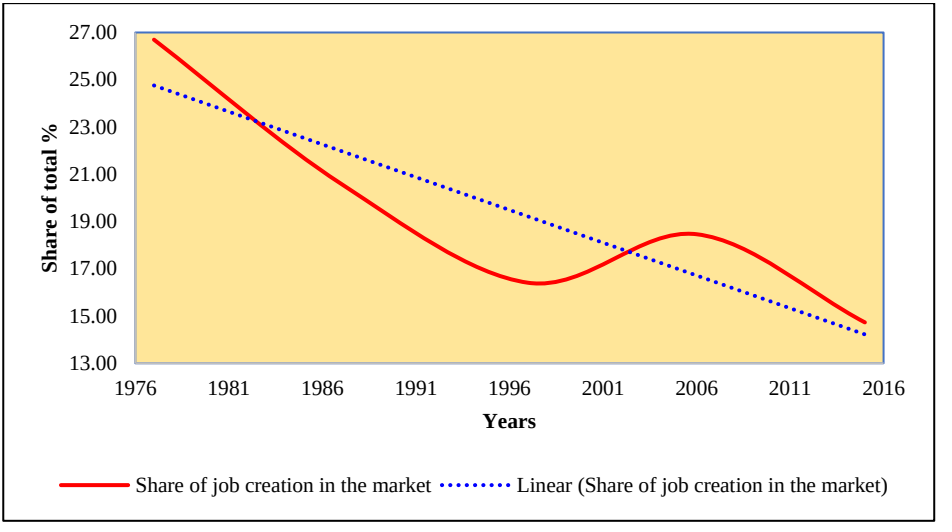
During the period from 1977 to 2015 there was a continuous decline in the share of newly born firms (less than a year-old firms) as shown in the line graph above. The share of start-ups number of the total number of firms in the U.S. economy has

declined markedly since 1977. It decreased continuously from 16.5% in 1977 to 13.1% in 1987 and to 10.9% in 1997 to 8% in 2009 as shown in figure 9.

However, the data sourced from the U.S. Census Bureau show some improvement in 2015 to 8.1% of the total number of firms with different age yet it still below its level before the financial crisis in 2006 at 10.8%. The decline in start-ups age points to the relatively weaker firm dynamics in the U.S. economy. Market power makes it difficult for small new ventures to compete with the existing corporations.

The small enterprises are key players in the market in terms of their tendency to introduce new production techniques and new ideas. In addition, small firms are historically proven to be the job creation hitters which drives job opportunities to grow especially for the low-skilled and less-educated labour force. The answer for what causes this continuous slump is not yet clear. This could be accredited to the strong competition as the incumbent big businesses appear to be the ascendant power in the market.

Figure (9): The start-ups share in jobs creation in the U.S. labour market during the period 1977-2015



Source: Figures in this graph extracted from the U.S. Census Bureau (accessed in April 2017).

Moreover, the decline in the number of start-ups caused the percentage of employees who work in this subset of firms to decline as well. In 1977 in the job creation by firms with less than a year old represented more than 26% of the total job creation that year. In 1978 the share declined to 20.60% of the total yet the new firms are still in the top as a ladder for job creation more than the sets of older age firms. In 1997 the slump continued to reach 16.40% with the start-ups remain the main job creation hitters in the market. In 2006 however, the percentage improved to 18.5% and then it dropped again during the Great Recession period it did not recover since then where in 2015 the job creation in new venture represented about 14.7% of the total job opportunities available in the labour market.

The slowdown in R&D intensity is another determinant of TFP growth because it is partly responsible for creating new ideas, innovation and new technology which is partly captured by TFP. The contribution of R&D intensity did not grow by more than 0.1 percentage point over the period from 1987 to 2017 according to the BLS 2018.

More precisely and going back in the history of the TFP growth, there was a dramatic decline in the TFP growth in the business sector beginning from the first quarter in 1974 by -7.76% compared with 0.36% in the last quarter in 1973. This mainstream of decrease continued until the first quarter in 1975 where it increased by 0.68 %. In the first two quarters of 1980, the growth of TFP has been experiencing a steep fall from -0.35% to -8.47%. From the 1981's third quarter up to the 1982's fourth quarter, TFP dropped dramatically from 4.12% to -7.78% in the fourth quarter in 1981 and continued to grow with a negative rate till the fourth quarter in 1982 when it grew by 0.67%.

Figure (11): Changes in Total Factor Productivity during 1974: Q1 and 1975: Q1

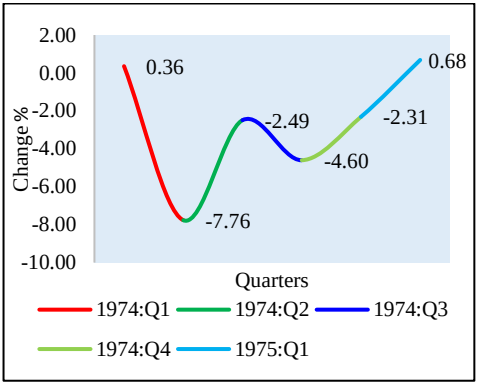
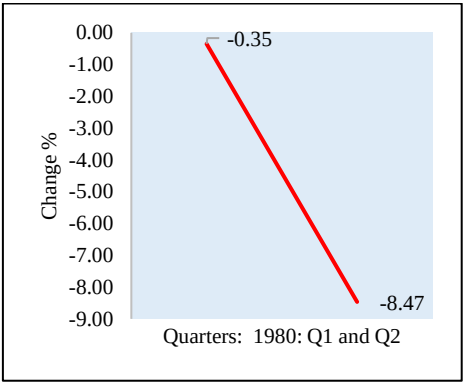


Figure (10): Changes in Total Factor Productivity during1980: Q1 and 1980: Q2



Since the third quarter in 1990, total factor productivity went down from -1.25% to - 4.05% and then it grew by 1.80% towards the end of this period.

During the years prior to the Great Recession, the growth in TFP slowed markedly after the growth it achieved during the period 1995-2004. One possible justification to this might lie in the fact that the technological and information advances during the 1995-2000 period were vital in encouraging TFP, but the retardation in the rate of growth in TFP in the mid-2000s cannot be attributed to the financial crisis only as it started few years before the crisis.

Figure (13): Changes in Total Factor Productivity during 1981: Q4 and 1982: Q4

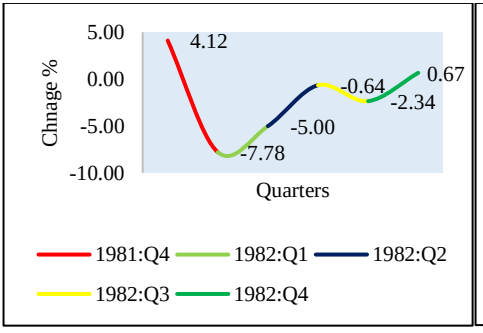
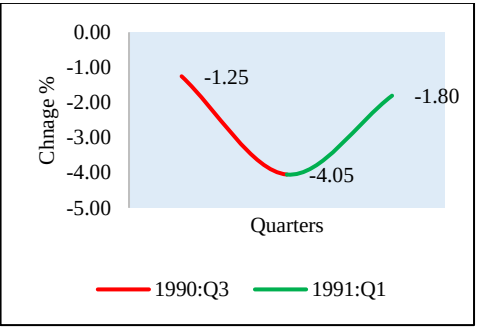


Figure (12): Changes in TFP in the business sector between 1990: Q3 and 1991: Q1



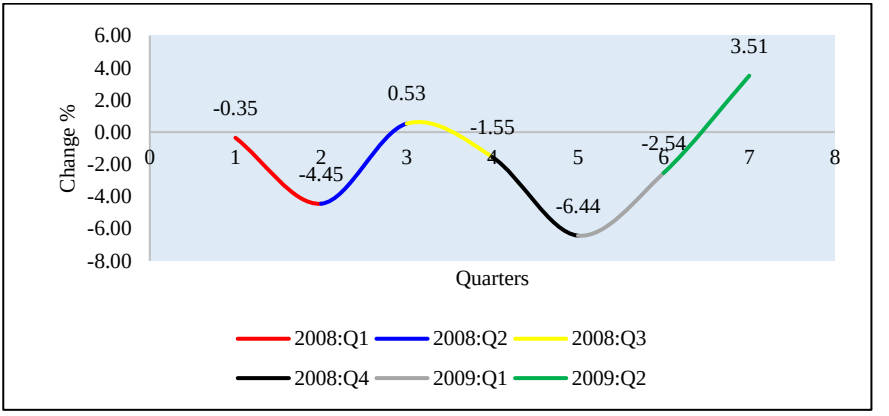
The suppressed growth in TFP can be normal after the exceptional increase over the nine years past 1996-2004 or it could be ascribed to the decline in the economy's capacity to gain more benefits from the technological revolution that accelerated the growth pace in the mid-1990s until 2004.

At state-level, the slowdown of TFP growth was different, and the evidence on whether states that are regarded as technology-intensive producers and technology users does not appear to be decisive.

During the 4th quarter of 2007 when the Great Recession commenced, TFP declined to -0.35 % and carried on in the same direction of decrease to reach -4.45% in 2008: Q1. Its lowest point was in the fourth quarter in 2008 at - 6.44%. However, in a stark contrast, it recovered very quickly in the first quarter in 2009 to reach 3.51 % in the second quarter in the same year and continued to improve in the third and fourth quarter at 4.76% and 5.54% respectively.

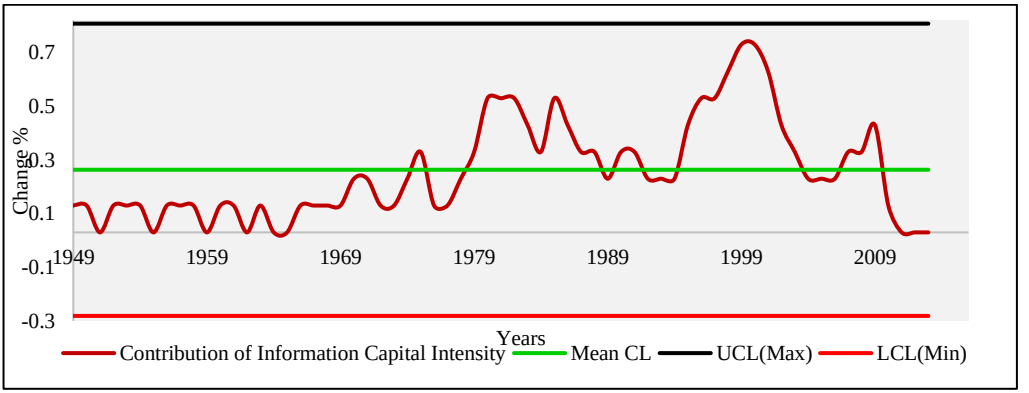
The contribution of information capital intensity developments suggests that it grew significantly from the mid-1990s up to the mid-2000s which is the same period when total factor productivity had experienced a continued period of growth. However, at the same time, the growth of productivity ended before the period of recession. For instance, in the early 1990s recession, the growth of productivity slowed down in 1988 to 0.7% and to 0.3% in 1989.

Figure (14): Changes in TFP in the business sector between 2008: Q1 and 2009: Q2



In the early 2000s recession, productivity declined from 1.9% in 1999 to 1.7% in 2000, and in the period predated the Great Recession years the same happened when productivity fell sharply from 2.8% in 2004 to 1.3%, and 0.3% in 2005, 2006, and 2007 respectively.

Figure (15): Changes (%) in the contribution of information capital intensity in the U.S. private business sector during 1949-2013

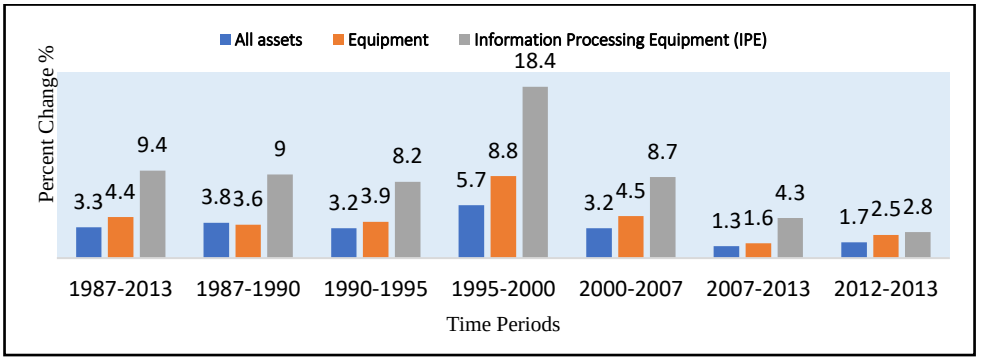


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

It is also noted that productivity recovered rapidly when the recession ended. In the early 2000s it tends to have dramatically increased from 0.6% 2001 to 2.0%, 2.5%, and 2.8% in 2002, 2003, and 2004 consecutively. Following the same pattern, in a subsequent time when the Great Recession ended, it rose from 0% in 2009 to 2.7% in 2010. Another issue worthy of noting is that the growth rates of the contribution of information processing equipment (IPE) intensity remained at the level of zero percentage point in the years 2011, 2012, and 2014, 2015 and it grew by no more than 0.1 percentage point in 2013 and 2016.

During the period between1995-2000, the information processing equipment (IPE) jumped dramatically from 8.2% during 1990-1995 to 18.4% during 1995-2000, but it slipped back to 8.7% during 2000-2007 and decreased consistently since then until it reached to only 2.8% during 2012-2013. Meanwhile, the computers and related equipment were growing and flourishing very fast in the same period of 1995-2000, this is where it rocketed to 40.6% after it was only 16% in the previous period.

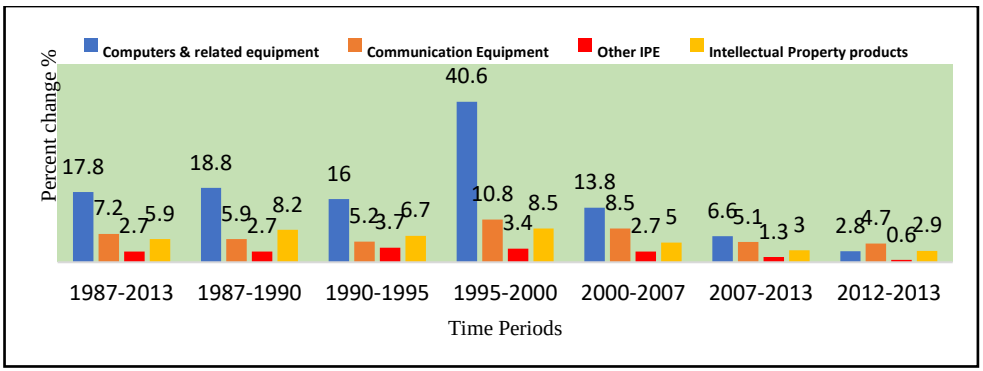
Figure (16): The growth in equipment and information processing equipment in the U.S. economy from 1987 to 2013



The figures in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

Similarly, real value-added output and hours of all persons both have been experiencing the same pattern of changes before, during, and after the recession periods. Where the VA suffered steep falls from 3.4% in 1979, for instance, to -1.2% in 1980, and from 3.9% in 1989 to 1.6% in 1990. In the period prior to the Great Recession it started to drop from 4.5% annual growth in 2004 to 3.8%, 3.2%, and 2.2% in 2005, 2006, and 2007.

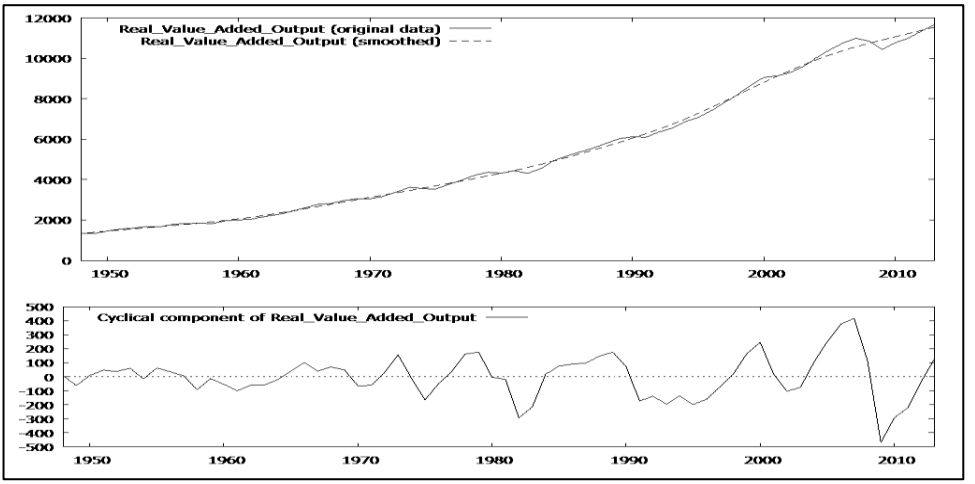
Figure (17): The growth in communication and computer equipment, and intellectual property products in the U.S. economy from 1987 to 2013



The figures in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

The U.S. share of global value added decreased in the 1970s and 1980s where in the same time Japan resumed its fast growth in copying and foreign technological knowledge reverse modification and engineering after the end of the second world war and therefore improved its proportion in the global value added. However, the U.S. has recovered quickly from the early 1990s recession and grown faster and Japan who dominated the second half of the 20th century through its innovation-based production system.

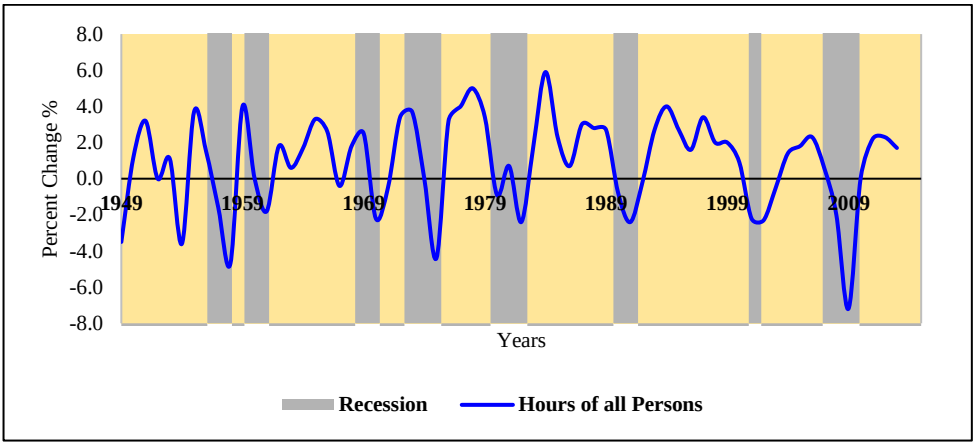
Figure (18): The growth (%) of real value-added output in the U.S. private business sector in the U.S. during 1949-2013



The trends in the above graph are created using (gretl software) based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

The slowdown in investment partly accounted for the deterioration in potential growth, labour productivity and TFP. In other words, investment in intangible assets and knowledge-based capital, R&D, managerial know-how are key ingredients of growth. The tacit knowledge is important in terms of marrying up tangible capital and labour inputs to produce more output. The same analysis can be applied to the progress in hours of all persons. As can be seen from the graphs.

Figure (19): Changes (%) in hours worked by all persons in the U.S. private business sector during the period 1949 - 2013

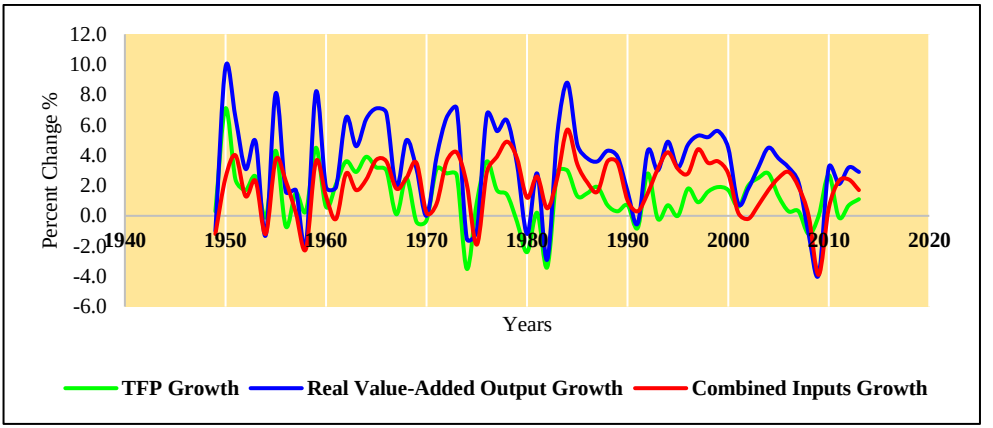


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

3.1.1 The Changes in Real Value-Added GDP 1949 -2013

Growth in Real Value-Added Output can be attributed to two major sources. The growth in the combined inputs and the rest of it to the growth in total factor productivity. This is where the output grew at a 3.4% from 1949 to 2013, a 2.1% of it was due to the growth in the combined inputs (capital services + hours of all persons + labour composition). While a 1.3% is coming from the growth in TFP.

Figure (20): The growth rates of TFP, real value-added output, and combined inputs over the period of 1949-2013 in the U.S. private business sector

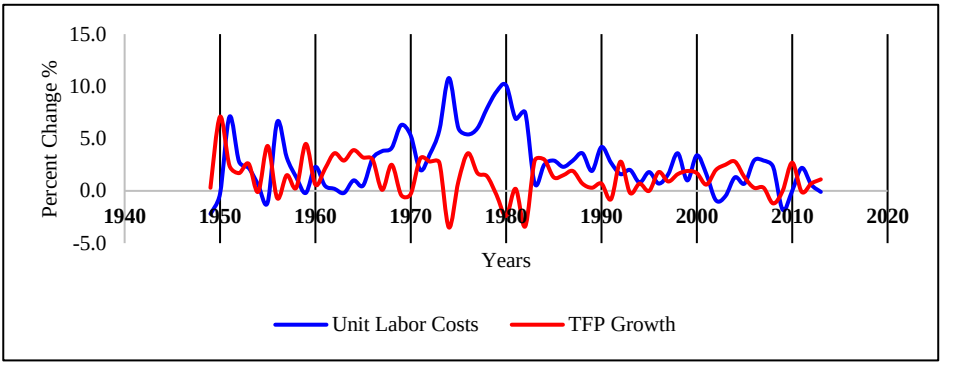


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

3.1.2 The Changes in Labour Costs

Since the unit labour cost is the required cost of labour so as to produce one unit of output, and it describes the relationship between compensation per hour and real output per hour which in other words the labour productivity. Then it can be concluded that the higher labour productivity is, the lower unit labour cost would be. Whereas the higher compensation per hour is, the higher unit labour cost would tend to be.

Figure (21): The changes in unit labour costs and TFP over the period 1949-2013 in the U.S. private business sector.

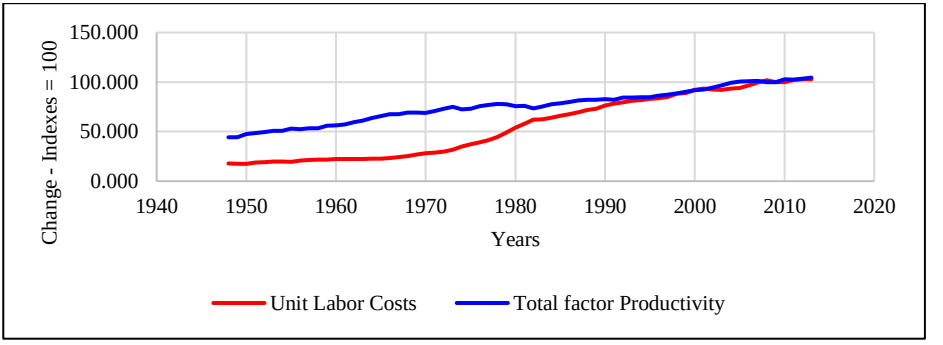


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

From the data available on unit labour costs in the private business sector, it seems that in the periods when TFP has been experiencing deep slumps, namely in 1974, 1980 and 1982, with -3.5%, -2.4% and -3.4% respectively, the growth in unit labour costs had experienced high rates at 10.8%, 10.1% and 7.5% in the same period.

From the figure above, it is noticeable that the unit labour cost improved markedly during the period 1948-2013, and it was notably greater the growth in total factor productivity.

Figure (22): Changes (Indexes) in unit labour costs and total factor productivity in the U.S. private business sector during 1948-2013

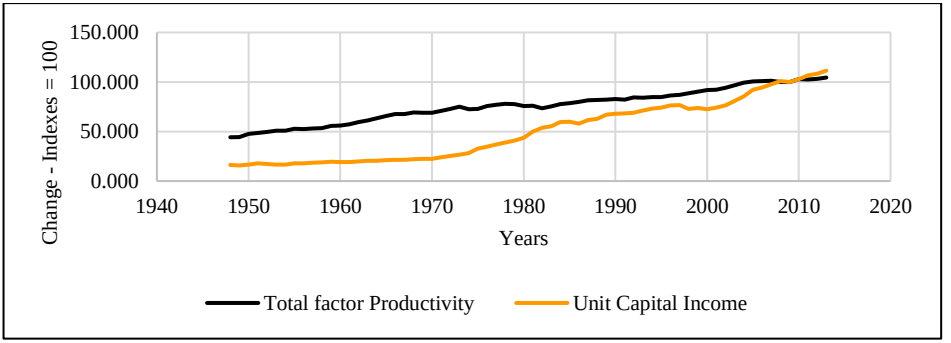


The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

When looking at the unit capital income growth, it is apparent that it has steadily climbed during the period from 1970 to 1985 as the annual indexes demonstrate. On the other hand, it appears that total factor productivity was at a higher level than the unit capital income over the period 1948 until 2008, when they were relatively at the same level.

Figure (23): The progress in the TFP and unit capital income during 1948-2013

Indexes = 100 Base Year =2009



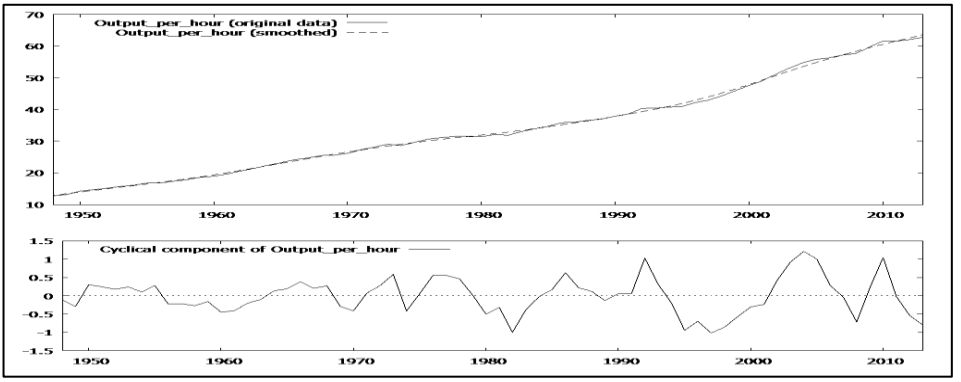
The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

3.1.3 The Changes in Labour Productivity (Output per hour)

Over the course of the recession times, labour productivity had experienced substantial falls. For instance, in 1974 the growth rate of output per hour in the private business sector has fallen from 3.2% in 1973 to -1.5% down in 1974. In 1981 labour productivity grew by 2.1%, while in 1982 it decreased to -0.6%. In 2007, it was at the level of 1.5% but in 2008 it has declined to 0.8%.

It is widely agreed upon, that in the long run, more innovation, more technology, and more capital available to labour or better skills would give rise to better labour productivity. However, on the other hand, in the short term, the cyclical variation of inputs utilization could have an effect as well.

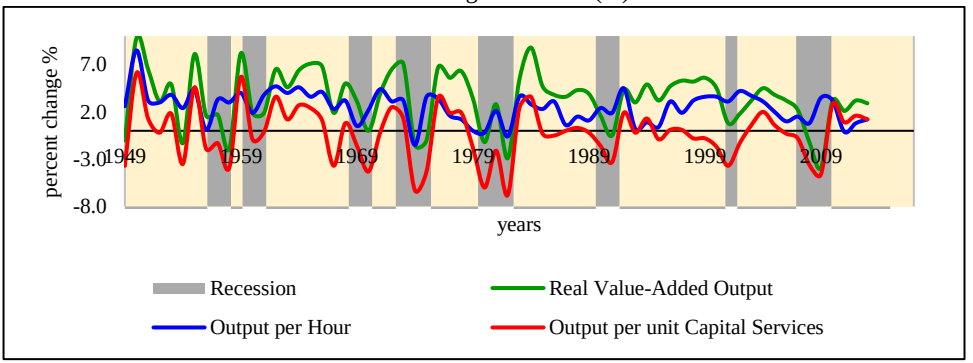
Figure (24): Output per hour (labour productivity) during the period between1948 and 2013 in the private business sector (Indexes = 100 = 2009)



The trends in the above graph are created using (gretl software) based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

Over the period from 1948 to 2013, output per hour has risen steadily apart from some dips throughout the course of the recession. In stark contrast, the output per unit of capital services had experienced notable fluctuations through the same period and its general trend started to go downhill since 1966 leading up to 2009 were it rose again with output per hour. As an average growth rate during the period between 1949 -2013 output per unit of capital services has grown by -0.2%, whilst output per hour increased at 2.5% as an average growth.

Figure (25): Changes in real value-added, labour productivity, and capital productivity in the U.S. P.B.S. during 1949-2013 (%)



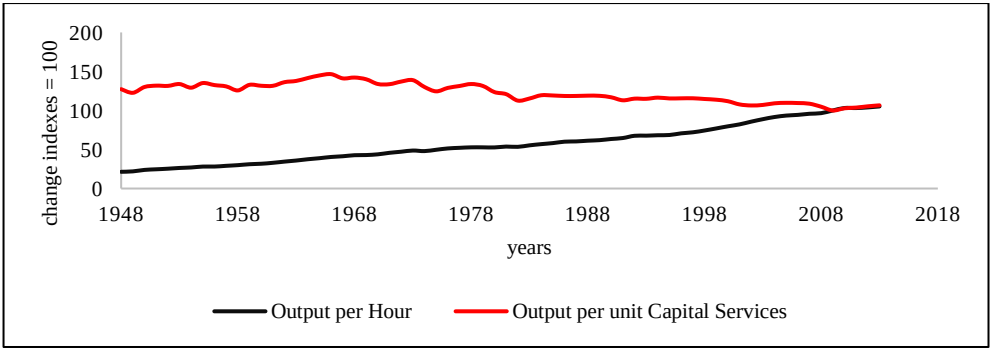
The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

Mathematically, labour productivity can be obtained through the following formula:

$$Log\ Y - Log\ H = \alpha\ Log\ (K - H - LQ) + Log\ LQ + Log\ Util + Log\ A =$$
$$\alpha\ Log(K - H - LQ) + Log\ LQ + Log\ TFP \quad \ldots\ldots\ldots \quad \textit{Equation 2}$$

Where:
Y is the output produced by combining the inputs (K, L) in the production process.
H is the hours worked by a particular type of worker, differentiated by education, age, and other characteristics.
K is the observed capital input.
LQ is the contribution of changing worker characteristics to labour services growth beyond raw hours. Which represents (Labour composition/ quality from BLS).
Util captures variations in the capital workweek and the labour effort (unobserved variation in the utilisation of capital and labour).
A is technology or growth in TFP.

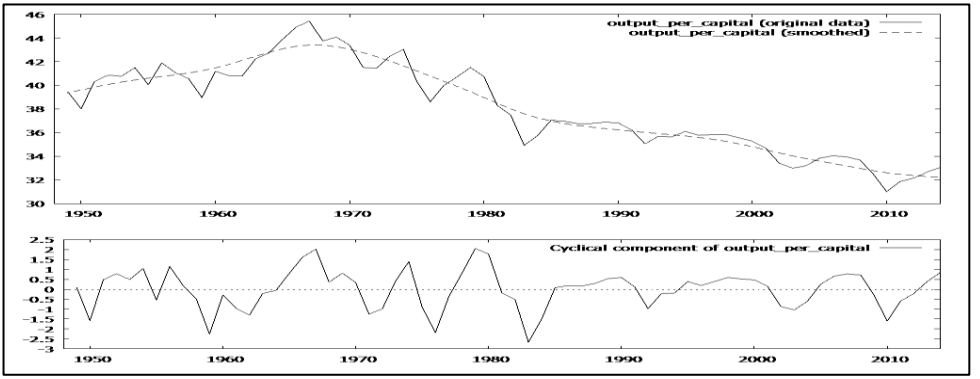
Figure (26): Changes in output per hour and output per unit of capital services 1948-2013 (Indexes=100=2009)



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

The above line graph depicts two different trajectories of labour productivity – measured by output per hour – and capital productivity – measured by output per capital services units – where the former seemed to be steadily and slowly progressing until it flatlined recently. Whereas, on the other hand, the latter – capital productivity – deteriorated continuously since 1966.

Figure (27): Changes (%) in output per unit of capital services 1948-2013
(Changes in percentage point)

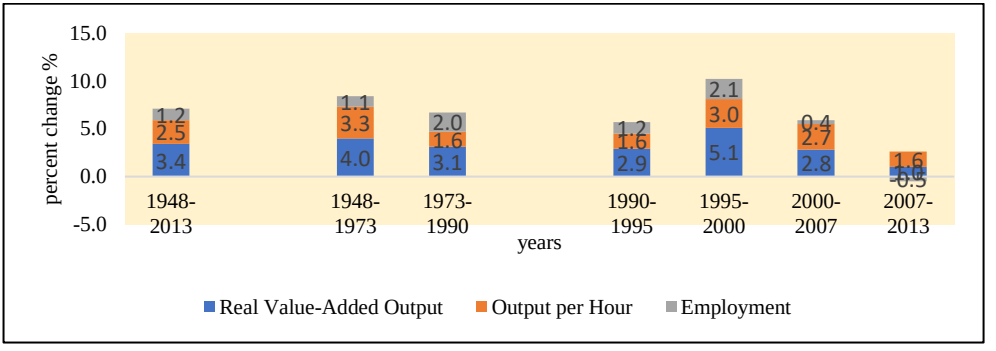


The trends in the above graph are created using (gretl software) based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

3.1.4 Real Output, Employment, and Output per Hour

During the period between 2007 and 2013, the three variables; real output, employment, and output per hour, have experienced notable falls to 1.0%, -0.5%, and 1.6%, respectively, compared with the previous period between 2000 and 2007, were they were at the levels of 2.8%, 0.4%, and 2.7 %, and the period between 1995 and 2000 at 5.1%, 2.1%, and 3.0 %, consecutively.

Figure (28): real value-added output, employment, and output per hour in the P.B.S.
from 1948 to 213

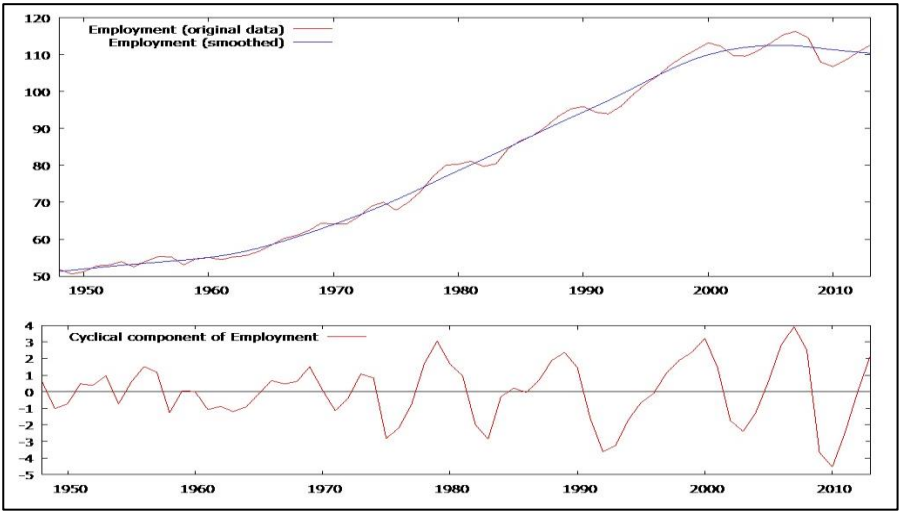


The trends in the above chart are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

The decline in the overall investment is partly responsible for potential output decline, and it also led to a decrease in employment growth in recent years in the U.S. which in turn added to the deterioration in output growth.

There are several reasons and explanations for why TFP is declining and slowing down in the U.S. economy for more than a decade. One of which is that innovations that have been taking place in recent years might not be as important as the innovations that had been accomplished and used during the eighties and nineties, in terms of the scale of their effects on productivity and growth, and based on the diminishing returns to scale, in spite of the fact that many of the innovations which have been achieved in the last decade or so, have played significant roles as productivity enhancers.

Figure (29): Growth (%) in employment in the private business sector during the period 1949-2013



The trends in the above graph are created using (gretl software) based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

3.1.5 The Changes in Labour Composition

Another explanation is that licensing over-restriction on innovations, could have played a negative role by preventing them from being diffused and spread out in the mainstream, which does not allow the stragglers and the less productive firms in the middle and the bottom of the distribution to pick and adopt new technologies, in order to raise their productivity, and converge, and close the gap, with the more productive firms. However, even with the available innovations and new technologies that are already in the public use, it tends to be the case, at times, that some of the less efficient firms, find it difficult to deploy these information technologies and innovations, because they lack the managerial expertise, and the adequate skills embodied in their labour force, in order to adopt and adapt to the best practices by the frontier firms, bearing in mind the necessity for the frontier firms to protect themselves, and stay one step ahead of the competition, where they need to patent and license their new and cutting-edge innovation and technology, so as to receive the economic reward for their investments, which will keep them incentivised, and encouraged to generate more new ideas and new innovations.

In addition to the lack of access to innovations, and the lack of ability to use these innovations, the slowdown can be also attributed to policies and regulations that are restricting and limiting the competition in the market economy, which to some extent, affects the process of dynamism and resources reallocation to the best level possible.

Over the period between 1949 and 2013, labour composition in the private business sector has risen by 0.3% as an annual average growth rate. It reached its highest peak over the period 1990-1995 with an average growth rate of 0.7%. At the same time labour input grew by average annual rate at 1.2%, but the highest level of growth was in the 1995-2000 period at 2.3% per annum while it was at the level of 2.1% in the 1990-1995 period. (While labour composition is known as the ratio of labour inputs to hours of all persons).

As can be observed, hours of all persons grew by an average rate 2.0% between 1995 and 2000 and by a 0.9% annually through the 64-year period from 1949 to 2013. It can also be seen that labour input substantially affected by the notable

decrease in hours worked by -0.6% during 2007-2013. Where it had experienced – as will appear in the private nonfarm business sector – a 0.0% growth rate in this period compared with the previous interval.

Table (1): The annual % change in hours of all persons, inputs productivity, and labour composition in the private business sector in the U.S. economy during the period 1949-2013

Private Business Sector						
Time Periods	**Real Value-Added Output**	**Output per Hour**	**Output per unit Capital Services**	**Employment**	**Hours of all Persons**	**Labour Composition**
1948-2013	3.4	2.5	-0.3	1.2	0.9	0.3
1948-1973	4.0	3.3	0.3	1.1	0.7	0.3
1973-1990	3.1	1.6	-1.0	2.0	1.5	0.2
1990-1995	2.9	1.6	-0.3	1.2	1.4	0.7
1995-2000	5.1	3.0	-0.6	2.1	2.0	0.3
2000-2007	2.8	2.7	-0.4	0.4	0.1	0.3
2007-2013	1.0	1.6	-0.3	-0.5	-0.6	0.5

Source: Bureau of Labour Statistics BLS, (March 26, 2015).

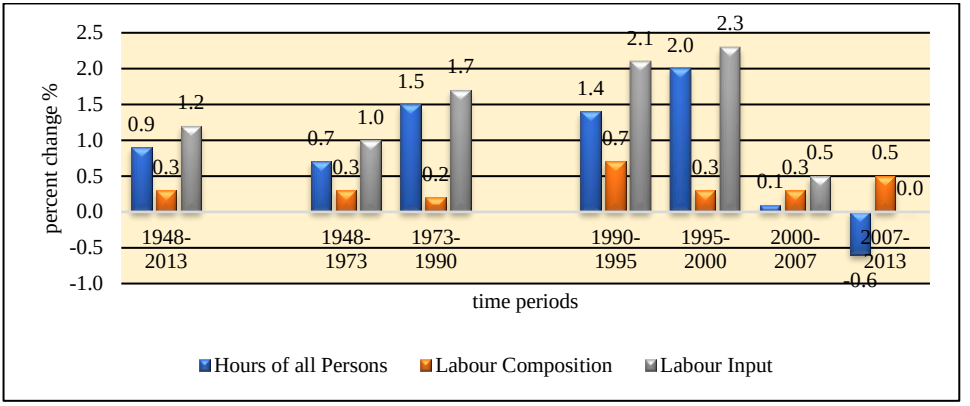
Notes:

1) (Gross Value-Added growth = Contribution of Labour input growth + Contribution of capital input growth + Contribution of TFP growth).
2) (Contribution of Labour input growth = Contribution of Total hours worked + Contribution of Labour composition).
3) (Contribution of capital input growth = Contribution of ICT capital + Contribution of Non-ICT capital).

It is noticeable that labour composition grows faster in the middle of the recession times and carries on in the early stages of recovery. This can be put down to the fact that younger and less-educated workers are the ones who are likely to lose their places in the labour market faster than those who are older or highly educated.

In general, labour input is the product of (hours of all persons + labour composition). The contribution of labour composition in labour input is small but steady.

Figure (30): Changes (%) in hours of all persons, labour composition, and labour input during 1948-2013



The trends in the above chart are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

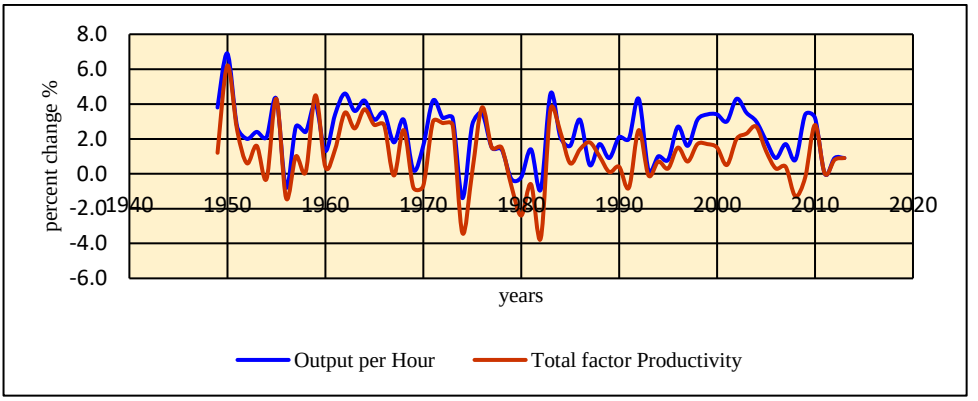
3.1.6 Labour Productivity and Total Factor Productivity

Total factor productivity is one of labour productivity components, along with the labour composition and capital intensity. Labour productivity and TFP are quite similar in terms of their growth over the course of the last six decades 1949-2013.

The line graph below shows that both labour productivity, and total factor productivity, have experienced the same pattern of progress, over the stated period. As can be observed, the growth rate of labour productivity was higher at all times than that of total factor productivity.

In truth, labour productivity is shifted up by the reasonably constant contribution of labour quality and capital intensity.

Figure (31): The growth rates (%) of labour productivity and total factor productivity during 1949-2013



The trends in the above graph are based on data from Bureau of Labour Statistics BLS (accessed in April 2015).

This is to be expected, given that the growth rate of total factor productivity is one of the elements of growth in labour productivity, in addition to the growth of both the contribution of capital intensity, and the contribution of labour composition. Whilst the growth in total factor productivity is equal to the difference between the growth in labour productivity on the one side, and the growth in the labour composition and capital intensity contributions on the other side.

Both TFP and labour productivity growth rates, declined over the period between 2007 and 2017 by 0.5 and 1.2 %age points, respectively. This can be reconciled by the unprecedented decline in capital intensity by 1.3 percentage point, over the same period, whilst the growth in labour composition remained relatively constant at 0.4 percentage point during the last ten years. Moreover, the growth in the research and development intensity contribution, was just at the level of 0.1 percentage point during the stated period.

3.2 TFP in the Private Nonfarm Business Sector (P.N.B.S.)

Private Nonfarm Business Sector's TFP increased on average at a 1.2% annual rate during the period between 1949 and 2013. This has reflected a 3.5% average growth in output, and a 2.3% growth in the combined inputs of capital and labour

over the same period. The highest growth rate in total factor productivity is achieved in the period between 1948 and 2013 where it was 1.9% per annum.

This was a result of a 4.2% growth in output along with a 2.3% increase in combined inputs. This is to say that the growth in the combined inputs can be attributed to the 4.0% increase in capital services, a 1.2% rise in hours of all persons, and to the 0.2% increase in the labour composition.

It might be an interesting observation to say that the combined inputs growth was not at its highest level in this period (1948-1973). A closer look would show that the highest growth rate achieved in the combined inputs – labour and capital – was in the period between 1995 and 2000 at a 3.6%, this is where total factor productivity growth rate in the same period was at the level of 1.4%, and the growth rates of the three components – capital services, hours of all persons, and labour composition – which reflect the growth in combined inputs were at 5.9%, 2.1%, and 0.3%, respectively. Which is the same period when the contribution of information capital intensity was at its pinnacle during the period 1995-2000.

During the period 1949-2013 the labour composition grew by an average rate of 0.3%, while the labour input increased at 1.5% and the rate hours worked has risen by 1.2% for the same period.

4. Productivity in the OECD Countries

The Organisation for Economic and Co-operation and Development OECD was formed as the Organisation for European Economic Co-operation OEEC on the 16th of April 1948, and later was reformed as the OECD in September 1961 consisting of 36 nations, (Kutlar et al., 2017). It is an intergovernmental organisation with a net budget of 427 million US dollars in 2019. Most OECD members are high-income economies with very high Human Development Index HDI. In 2017 the GDP of this organisation comprised 62.2% of the world nominal GDP.

This group of countries describe themselves as committed to market economy, high productivity and growth, high level of GINI Index, high spending on research and development R&D activities and democracy. In the market economy including the

OECD, the EU KLEMS manual (European Union research project for Capital, Labour, Energy, Materials, and Service inputs productivity and growth accounts on industry level) suggests that an economy comprises one information and communication technology-producing sector, two goods-producing, and three services-producing sectors.

Therefore, the growth in TFP can be defined as

$$\Delta \ln TFP_{it} = \Delta \ln V_{it} - \sum_{X=L,K} \bar{v}_{X,t} \Delta \ln X_{it} \quad \text{.....Equation (3)}$$

Where.

TFP, represents total factor productivity.
V, L, K represent real value added, labour, and capital inputs.

$$\bar{v}_{X,t} = 0.5\left(v_{X,t} + v_{X,t-1}\right) \quad \text{.....Equation (4)}$$

$$\sum_{X=L,K} \bar{v}_{X,t} = 1$$

Labour services are further decomposed into hours and compositional change. As regards the inputs shares, the compensation of employees is used as the shares of labour inputs, and the value-added remained is used as the shares of capital inputs.

In consistency with the availability of the data on the EU KLEMS, the comparison would be reasonable and beneficial if it is done between two periods (1980-1995) and (1995-2005), and that is due to the fact that some countries like the U.S economy have been experiencing a faster productivity growth after 1995 whereas many other economies in Europe have not (Timmer et al., 2007). The results obtained in this comparison have shown that there was a hitch in output growth in the Korean economy merely in 1998 after the financial crisis in December 1997 which had not occurred even in the times of the first oil crisis 1974-1975 and the second oil crisis between 1980 and1981, where Korea continued to grow without serious deficiencies.

During the period between (1980-1995) the growth rate in GDP (the value-added growth) has reached the point of 9.5% in the Korean economy, which is two to four

times higher than the growth rates in the EU, U.S, and Japan. The contribution of capital inputs to the GDP growth rate was about 58%, whereas the labour inputs and the total factor productivity were about 23% and 19% consecutively. Therefore, it can be claimed that the capital inputs are a fundamental contributor to ensure a faster GDP growth in Korea over the period of (1980-1995), comparing to the other three economies of (The EU, Japan, and the U.S) where the contribution of TFP to the growth in GDP which varies between 23% to 48% and higher than it was in Korea.

Table (2): The average annual growth of total factor productivity in the OECD countries (%) selected time periods

Country/ Time	2001-2007	2007-2009	2007-2011	2009-2013	1995-2013
Australia	0.2	0	-0.1	0.5	0.8
Austria	1.2	-0.9	0.1	0.6	0.8
Belgium	0.8	-1.7	-0.6	0	0.2
Canada	0.4	-0.6	0.2	0.8	0.6
Denmark	0.6	-2.8	-0.8	0.6	0.1
Finland	1.9	-3.8	-0.9	0.7	1.2
France	0.9	-1.4	-0.3	0.6	0.7
Germany	0.9	-1.9	0	1.3	0.8
Ireland	1	-1.8	0.5	0.4	1.6
Italy	-0.5	-2.4	-0.6	0.2	-0.3
Japan	1	-1.6	0.2	1.6	0.6
Korea	3.4	1.8	3.6	2.6	3
Netherlands	0.9	-1.4	-0.7	0	0.4
New Zealand	0.7	-1.6	0.2	0	0.2
Portugal	0.1	-1.3	0	..	..
Spain	-0.2	-0.5	0.1	0.4	-0.1
Sweden	2	-3.1	-0.4	0.9	1
Switzerland	0.8	-1.4	0.3	0.6	0.5
United Kingdom	1.7	-1.9	-1.1	0.1	0.8
United States	1.3	0.4	1	0.8	1.1

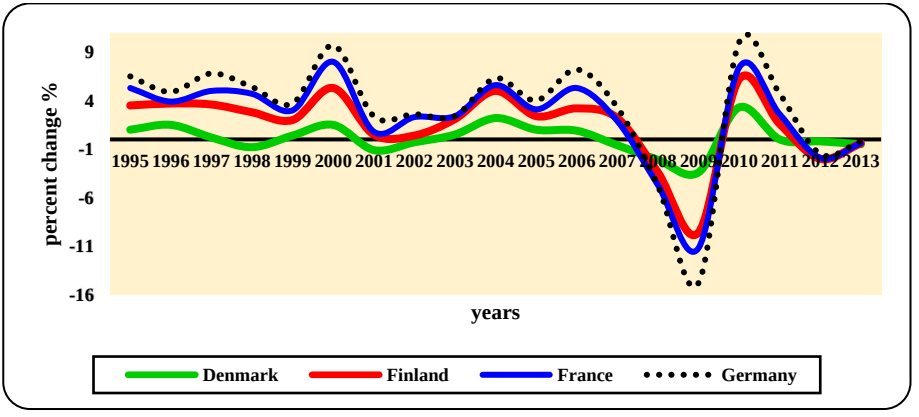
Source: OECD.Stat (extracted on 15 Aug 2015).

When comparing the growth in TFP during the two periods mentioned above, it has been found that The EU and Japan have known a deceleration in TFP growth, but the United States have experienced an acceleration in TFP growth rates from 0.7% to 1.7% for the same period of time. Korea – in particular – witnessed a lag in TFP growth rates from 1.8% to 1.2%. In this respect, it is worth noting that the rhythm of deceleration in TFP in Korea is quite distinct form that of the EU. In the period

between 1995-2005 the GDP growth rate in Korea is significantly lower than it was over the period before, which is not mainly a result of the lag of productivity growth, especially when the figures depict that there was a slight rise in the contribution of TFP to the value-added (GDP growth) from 19% in (1980-1995) to 25% in (1995-2005) excluding the crisis times.

The main reason that stands behind the slowdown of growth in Korea is the slowdown of the labour hours and capital inputs growth, not due to the TFP growth. To put it another way, the restructuring policies in Korea with other factors after the financial crisis in 1997 particularly, have their impact on the contributions of inputs and TFP. Of the all of the OECD economies in the sample, only Korea, Ireland, Finland, and the United States achieved growth rates above 1% in total factor productivity during the period from 1995 to 2013 as shown in the above table.

Figure (32): TFP Change in Germany, France, Finland, and Denmark 1995-2013

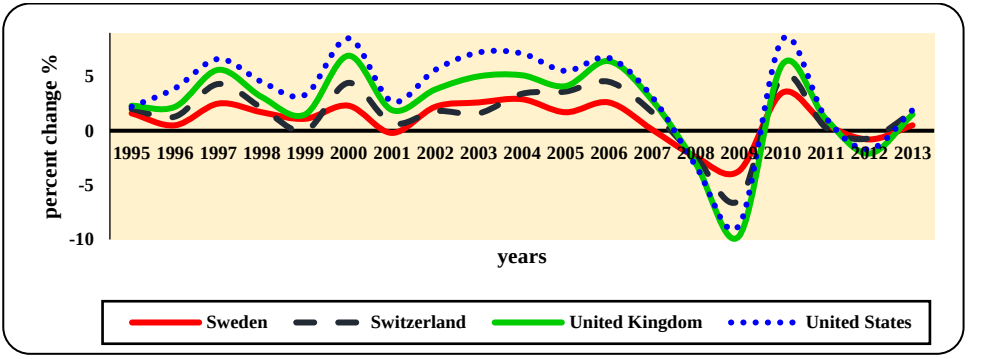


Source: OECD.Stat (extracted on 15 Aug 2015).

Mathematically speaking, productivity growth can be decomposed into output growth subtracting the labour input growth from it. Where the two elements are likely to change differently inside and among counries. As can be noticed, TFP in the UK has fallen substantially commencing from 2001- 2007 with growth rate at 1.7% to -1.9% in 2007 - 2009 and has not recovered again.

As for the growth in total factor productivity and as shown above, the deepest drop was as it turns out in 1986 when TFP plummeted to (-8) % from 1 % in 1985. Whilst the highest growth rate noted so far was in 2003 at 5.5%. During the Great Recession period TFP slumped again in 2009 to (-6.5) %, and gradually started to soar up to reach 2.4 % in 2011.

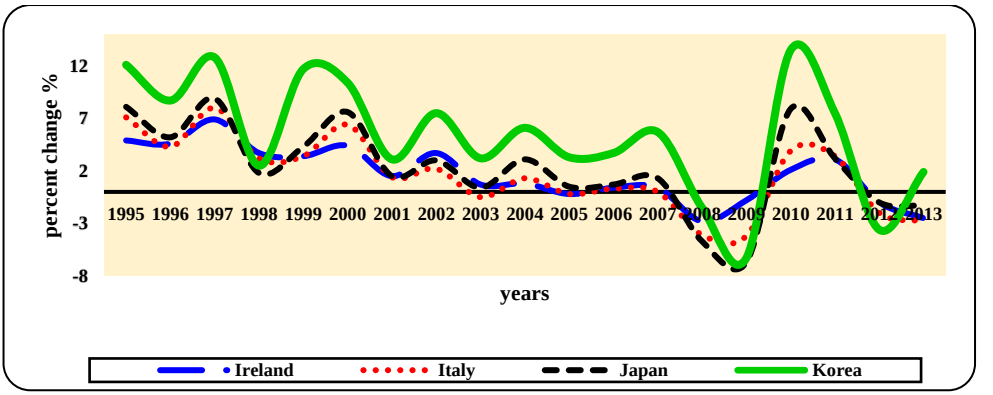
Figure (33): TFP Change in USA, UK, Sweden, and Switzerland 1995-2013



Source: OECD.Stat (extracted on 15 Aug 2015).

Early in the 1950s and 1960s, Japan has started the hyper-growth trend in Asia. The success that occurred in the Asian economies group namely The Asian Newly Industrialised Economies NIEs (South Korea, Hong Kong, Singapore, and Taiwan), then the ASEAN (Thailand, Indonesia, Malaysia, and Philippines) has been regarded as a benchmark worldwide, (Chen, 1997). Many studies have been carried out in order to understand the real source where this fast growth rates in Asia stem from. The general conclusion reached in this regard was that these countries have adopted a strategy in which usually has been referred to as the Export-oriented industrialisation. The question that arises at this point is that, how did they succeed in implementing this strategy?

Figure (34): TFP Change in Japan, Korea, Italy, and Ireland 1995-2013

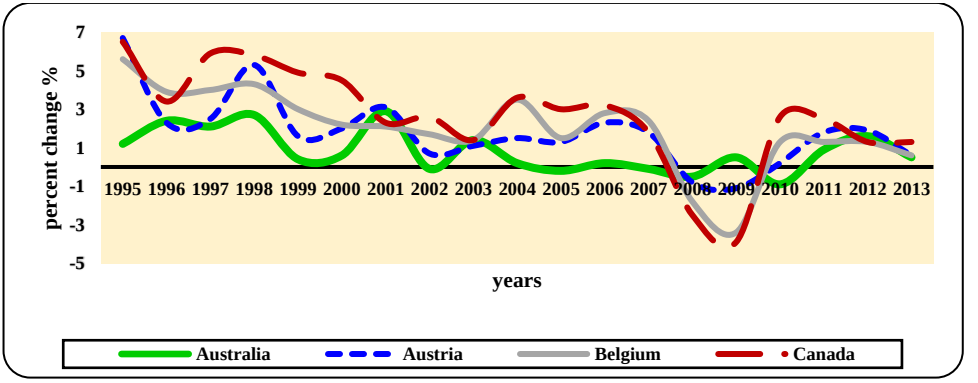


Source: OECD.Stat (extracted on 15 Aug 2015).

It is widely acknowledged that the success in the Asian economies was due to the active and market-friendly intervention policies especially in Korea and Taiwan, while opponents argue that policies are not the necessary condition for success, and the sufficient condition has to be the institutional framework where these policies are gently and smoothly implemented, (Chen, 1997). It is also worth mentioning that some say that the cultural and political structure in these countries played vital role in achieving these high rates of growth.

Empirical results demonstrate that the growth in TFP in the developed economies plays a more significant role as a source of economic growth than it is in the developing countries, and Japan is not an exception. Some estimates (Kanamori, 1972), indicate that 60 % of Japan's high growth of output during the period from 1955 to 1968 was mainly due the growth of TFP. While the outcomes of (Oshima, 1987) demonstrate that 4.9 % of Japan's 8.8 % average annual growth throughout the period of 1953-1971 was a result of TFP growth. The estimates of the World Bank attribute approximately 3.5 % of the 5.9 % growth rate in Japan to the increase in TFP during the years 1960 -1989, (Page, 1994).

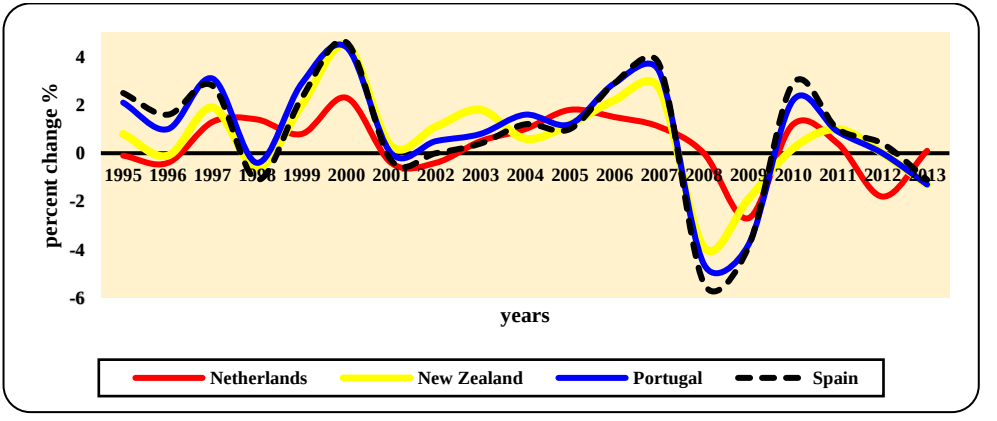
Figure (35): TFP Change in Australia, Austria, Belgium, and Canada 1995-2013



Source: OECD.Stat (extracted on 15 Aug 2015).

The line graphs of the growth rates in total factor productivity in the OECD sample including the United States over the stated period (1995-2013) reveal an interesting story. This is where the pattern of change appeared to be quite similar in most countries, with some discrepancies in the change percentages in each country. This may suggest one way of interaction between these economies, where they seemed to be highly interconnected and mutually joined, and what happens in one economy transcends its geographical borders to its adjacent and peer economies.

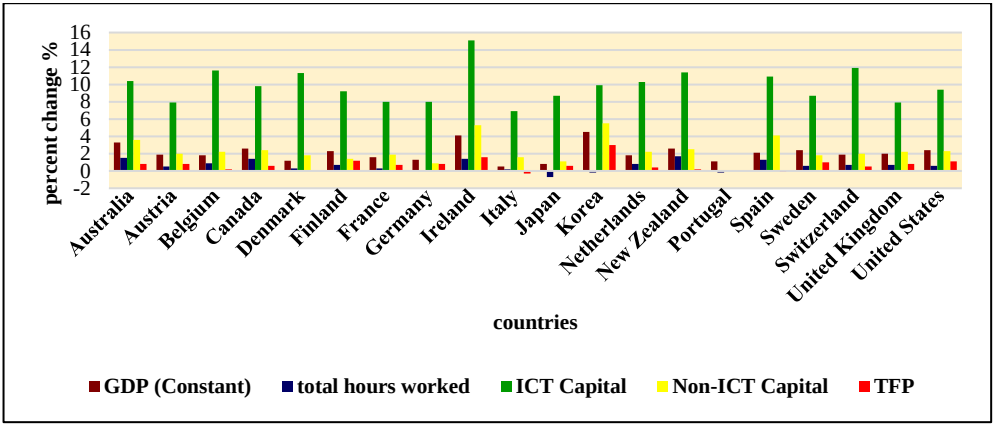
Figure (36): TFP Change in New Zealand, Netherlands, Spain, and Portugal 1995-2013



Source: OECD.Stat (extracted on 15 Aug 2015).

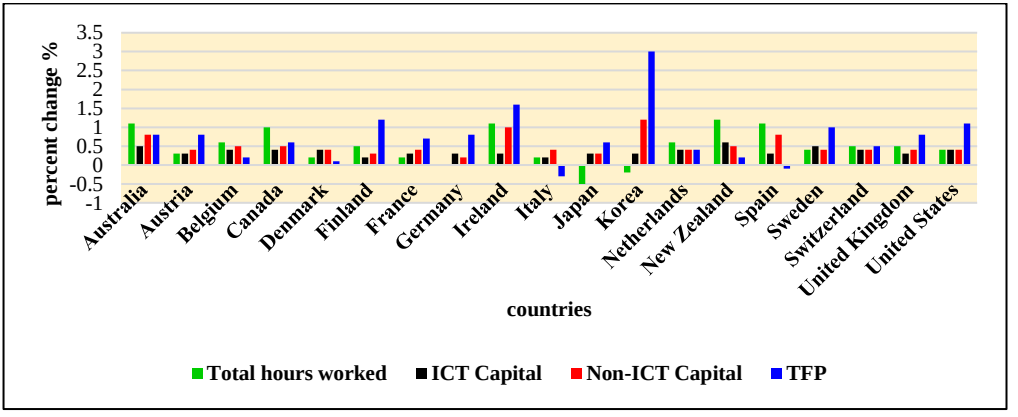
It is also interesting to notice that the growth in the ICTs in most these countries over the same period was comparatively analogous. It is also the same story when it comes to the ICT contribution in the growth of GDP in the sample. This is where it grew with relatively similar rates in most economies subject to study.

Figure (37): Average annual growth in OECD countries over the period between 1995 and 2013



Source: OECD.Stat (extracted on August 15 -2015)

Figure (38): Average percentage point contribution to GDP growth during the period from 1995 to 2013



Source: OECD.Stat (extracted on August 15 -2015)

During the Great Recession years 2007, 2008, and 2009 Korea continues to top all other economies in the OECD in terms of TFP growth with 1.8%, whilst other countries trailed behind in this regard. Surprisingly enough, three Nordic states including Finland, Sweden, Denmark along with a Southern European state; Italy were among the worst in terms of the slowdown in TFP growth during these three years of this deep recession.

5. Conclusions

By way of summary, it turned out that the slowdown in productivity growth tends to be a result of several determinants, and not just the result of the financial turbulence.

After all, the slowdown in productivity does not seem to be incurable, especially if the long-term aggregate demand and investment enhancing economic policies were to be applied, such as tax reforms to encourage businesses, and directing as well as allocating more of the federal governments' spending in the U.S. on R&D activities, towards more diverse set of sciences, with a relatively more balanced spending strategy, between different fields, instead of just concentrating on a limited set of options, because it is hard to project what science is going to be more important, and more decisive, for growth in the future. It is also important to consider more stable policies for R&D tax credit, and subsidies, because the R&D investment is a long-run process. This is where the U.S. falls behind Japan, Korea, and Germany, in terms of the R&D intensity.

It is also proved that the information and telecommunication capital has played a key role in promoting industry efficiency in the U.S. over the period from 1998 to 2013 thanks to the information revolution and the stream of innovations and new technologies in the mid-1990s and its continuous spillovers over the two decades that followed.

This might involve an intra-industry technological exchange of goods with specific technical features where research and development can play a pivotal role in promoting intra-industry trade especially in the manufactured commodities that necessitate intensive R&D activities with high degrees of complexity particularly if

the large industries are the dominants in the economy where the variations in the R&D intensity tend to be quite high between industries.

In addition, intra-industry trade in vertically differentiated goods which are recognised by their variety in quality and prices can reflect some endowments in production factors between industries such as high skilled labour or higher intensity of research and development spending. Hence, trading in these types of markets can offer some industries the opportunity to specialise and direct their resources and trading in the goods that they have comparative advantages in their production cost, such as using expensive educated workers for research and development and knowledge creation activities while allocating less skilled labour in less complex activities.

The nature of these trade relationships between industries with different levels of technology and different factor endowments as well as the pace and scale of diffusion of innovations among industries might be also partly responsible for the difficulty when specifying the effects of R&D capitalised assets on the levels of industry efficiency.

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