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EXTRAORDINARY ECONOMY POLICIES AMID COVID-19 PANDEMIC CRISIS: ECONOMIC GROWTH, LABOR PRODUCTIVITY AND ELASTICITY OF SUBSTITUTION

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ABSTRACT

Purpose- This study investigates current financial, fiscal and monetary policies implemented to enhance growth rate in developed economies. First main theoretical findings of neoclassical growth theory are reconsidered. Second, current economy policies from the perspectives of Central banks and Treasury departments are analyzed. Finally, the relationship between these two is investigated and whether the policies are adequate to theoretical findings is examined.
Methodology- From the perspective of descriptive statistics, first; time evlotion of labor's share of output from 1947Q1 through 2016Q3 is analyzed. Second, time evolution of percentage change in labor productivity with respect to real hourly compensation are considered from 1948Q1 through 2022Q1. In addition, to identify the accelerating gap between labor productivity and compensation over recent decades, annual index levels from 1973 to 2022 for labor productivity with respect to real hourly compensation are taken into account. Third, the phase-space representation of rate of real growth for output per capita is developed. In methodological perspective, both time-space and phase-space analyses on output per capita, labor productivity and labor compensation clear the way to establish a theoretical model, which explains the interaction between these variables based on constant elasticity of substitution production function.
Findings- For case of elasticity of substitution lower-than-unity, the relationship between rate of real growth for marginal productivity and average productivity of labor is obtained and is used to enlighten current U.S. monetary and fiscal policy implementations.
Conclusion- The results demonstrate that amid Covid-19 pandemics, U.S. fiscal policy and monetary policy do not optimally match and hence the fiscal policy should be calibrated. U.S. fiscal policy increased minimum wages and U.S. monetary policy addressed tighter and perfectly competitive labor market. These two policies do not coincide in terms of efficiency. In other words, simultaneous application of these two policies will not give desired compound result.

Keywords: Economic growth, labor productivity, fiscal policy, labor compensation, monetary policy
JEL Codes: E62, O40, O41,

1. INTRODUCTION

Following the declaration of COVID-19 pandemics (World Health Organization, 2020/03/11), in the mid-March 2020, to restrain and control spread of the novel coronavirus governments around the world adopted rigid measures to lock down countries and major trade hubs. These are suspending trade and travel, closing borders, shutting manufacturing units, touristic places, schools and imposing physical distance among people. These necessary measures deeply impacted the global economic activity and led to a "great lockdown" according to the International Monetary Fund (IMF).

In April 2020, from the perspective of monetary policy, the Federal Reserve Open Market Committee (FOMC) was in line with Treasury department's view and had observed that the shocks were amplifying in financial system, weighed on economic activity and disrupted the supply chains (minutes of the FOMC, April,28-29, 2020 https://www.federalreserve.gov/monetarypolicy/fomcminutes20200429.htm). The FOMC employed expansionary monetary policy and doubled the portfolio as the Central bank snapped up the assets to stabilize markets and the economy.

In September 2020, the perspective of fiscal policy in U.S. has been announced by Treasury Secretary Steve Mnuchin. In the face of increasing concerns on slowing economic activity, the secretary explained Congress that lawmakers should not worried about increasing deficit of the national budget or the increasing size of Federal Reserve's balance sheet to delay additional Covid-19 relief.

Inherently, the expansionary fiscal and monetary policies resulted with booming demand. On August, 27, 2021 FOMC announced that "*Booming demand for goods and the strength and speed of the reopening have led to shortages and bottlenecks, leaving the COVID-constrained supply side unable to keep up. The result has been elevated inflation in durable goods—a sector that has experienced an annual inflation rate well below zero over the past quarter century*."

On November 3, 2021, FOMC declared that supply and demand imbalances related to Covid-19 pandemic and reactivation of economy have continued to support elevated levels of inflation.

On February 2022, the US government realized an increase in minimum federal wage rate by 50 %, which signals the increase in marginal product of labor and expectations on increase in growth rate. The executive order of that policy had already been released as "…*Today, President Biden is issuing an executive order requiring federal contractors to pay a $15 minimum wage to hundreds of thousands of workers who are working on federal contracts*." (Statement, April 27, 2021). These facts reveal that beginning from 2021Q4 US Government had predicted a considerable increase in economic activity and hence in real GDP.

Over the period from April 2020 to June 2022, these policies and their mixed effects have strictly influenced the US economy and other developed countries. Beginning from January 2022, inflation level has surged and reached historically high levels. Russian invasion of Ukraine has initiated worldwide oil shocks[1] and energy supply bottlenecks for European Union countries. A measure specifying that an oil shock occurs when oil prices exceed its 3-year peak is accepted in the literature (Lee et al. 1995, Hamilton,2003). U.S. government released White House Inflation Plan on May, 10, 2022.

The plan aims at lowering food prices by helping domestic farmers grow more, and compete more effectively, and at lowering the cost of everyday goods by repairing infrastructure, supply chains, and manufacturing. For reducing oil prices, US government employs international relations, especially with Saudi government. Even though in long-term this plan can be realized, the probability of success in short-term is nearly zero. The fiscal policy continues to be expansionary. On the other hand, the Fed is going to unwind more than 8,7 trillion US Dollar of Mortgage based securities (MBS) and Treasury securities. In May 2022, the Fed began to increase interest rates and clarified the path for interest rates. However, in the eye of inflationary pressures, investors are keen to know what the policy rate level would be at the end of 2022. This fiscal and monetary policy mix indeed aimed at increasing growth rate for US economy. Moreover, this has been also true for other governments across the world. However, now, main concern in financial markets is to understand below which level the mixing of expansionary fiscal policy and contractionary monetary policy will weaken economic growth or is to estimate the probability of a recession.

The purpose of this study is to investigate the consistency of financial, fiscal and monetary policies addressing higher real growth rate for economic output. To do this, first we reconsider main findings of economic growth theory, and then we analyze whether the policies are adequate to theoretical findings.

This research is important because in perspective of policy making, it is crucial to find cutting-edge remedies to boom growth rate of economy, to recover price stability and to accelerate labor compensation of the output. If these remedies are not based on productivity increasing, then compound effect will probably be inflation augmenting.

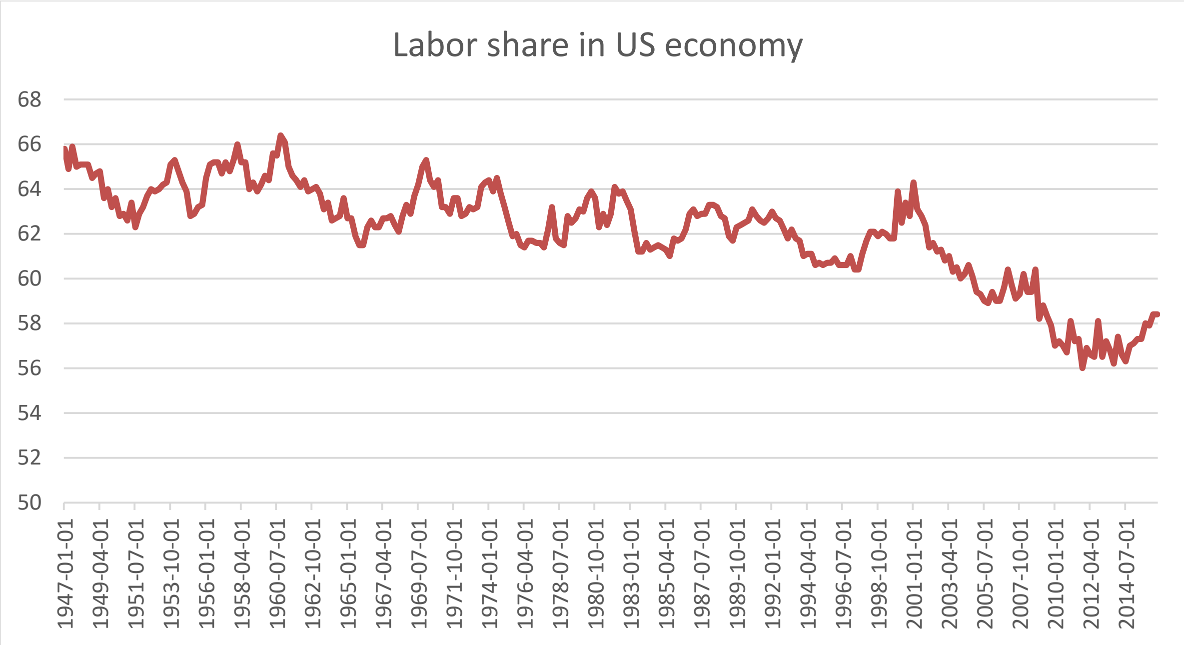
The study is organized as follow. The section 2 explains the stylized facts about labor productivity, labor compensation and real wages in US economy. This section reveals the discrepancy between recent observations and theoretical background. Section 3 introduces theoretical analysis, findings and results of the study. This section aims at aligning the recent observations with growth theory. Last section tabulates conclusion and introduces discussion for the results.

2. DESCRIPTIVE ANALYSIS AND PRELIMINARY ISSUES

Economic theory suggests that firms pay workers according to their productivity. That is, workers' compensation reflects the value of the goods and services they produce. Figure 1 depicts the time evolution of labor share of output in nonfarm business sector. In last two decades, the decreasing process is accelerated. One might then wonder whether the slow growth in labor compensation is simply due to slow growth in labor productivity.

[1] As an example, the price of Saudi crude has gone from $3.01/barrel on 10.15 to $11.65 in 01.10.1974. In August 2022, it is expected that the price hike would drive prices close to record high levels, $9.35/barrel. Recent movements in oil prices can be accepted as an oil shock.

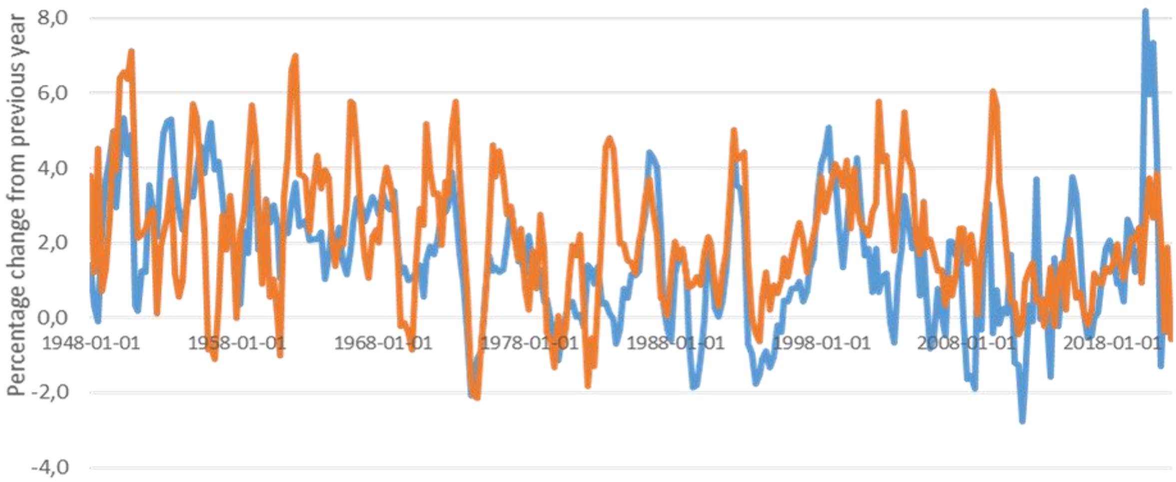
Figure 1: Labor's Share in U.S. Economy, first quarter 1947 through third quarter 2016



Source: U.S. Bureau of Labor Statistics, Nonfarm Business Sector: Labor Share for All Employed Persons [PRS85006173], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/PRS85006173.

When we compare labor compensation and labor productivity[2] during the same period, we observe that real growth rate for labor productivity and average wages are partially related.

Figure 2: Labor Productivity and Real Hourly Compensation, first quarter 1948 through first quarter 2022



Source: U.S. Bureau of Labor Statistics, Nonfarm Business Sector: Labor Productivity (Output per Hour) for All Employed Persons [OPHNFB], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/OPHNFB. Labor productivity, or output per hour, is calculated by dividing an index of real output by an index of hours worked of all persons, including employees, proprietors, and unpaid family workers. U.S. Bureau of Labor Statistics, Nonfarm Business Sector: Real Hourly Compensation for All Employed Persons [COMPRNFB], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/COMPRNFB.

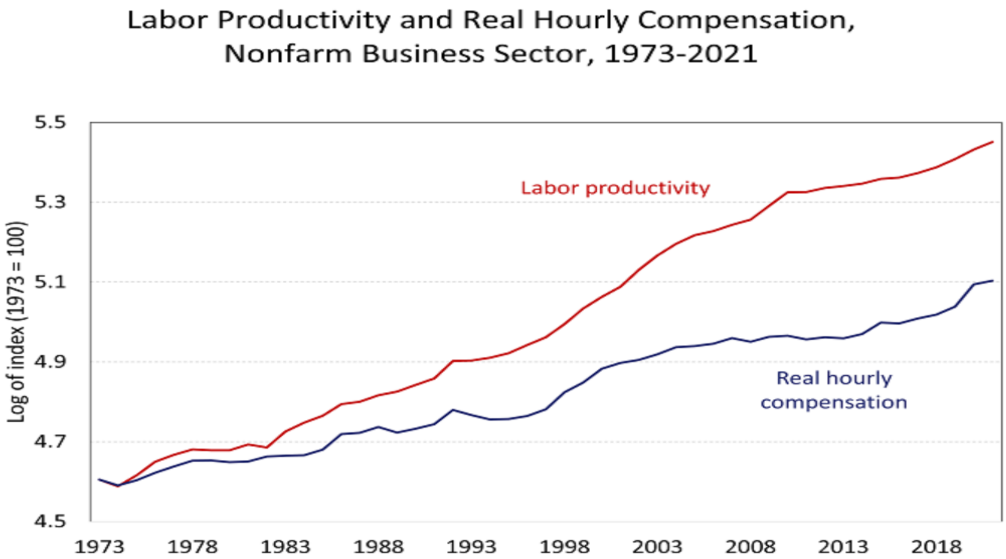
[2] Labor productivity is measured as real total output divided by total hours worked and labor compensation as real total labor compensation divided by total hours worked.

Figure 2 depicts the time-evolution of percentage changes in average productivity and average wages, respectively. The labor productivity is measured in terms of average product of labor. The data is seasonally adjusted. Particularly, the orange-line depicts the time evolution of percentage change in average product of labor from quarter one year ago. On the other hand, blue-line shows the time evolution of percentage change in average wages from year ago. The relationship between productivity and earnings can be seen in Figure 2, which depicts real rate of growth for labor productivity and real rate of growth for (consumer price index-adjusted) hourly compensation. During some periods wage growth rate correlates closely with productivity growth rate, but during some other periods, it does not likely correlate with productivity growth rate. Specifically, over the 1948-1971 period the growth rate for wage has been equal to growth rate for labor productivity and each has reached 2.7 percent. After then, a continual gap has persisted between two series and, in last two decades the two series significantly diverged.

According to the literature of Economic theory, it is known that in a perfectly competitive labor market, labor should be paid according to its marginal product. The last workers to be hired by a firm should earn pay that is equal to their contribution to the output of that firm.

Unfortunately, there is no data on the marginal product. But, we can measure average product. Although it's not a certainty given in the literature, these two products *should* be correlated. The labor market could be less than perfectly competitive or the theory could be revised or reinterpreted. Proposing a perspective different from percentage changes shown in Figure 2, Figure 3 depicts the level for labor productivity and real hourly compensation. Figure 3 clarifies that the gap between labor productivity and compensation has been widening for the past four decades (Domenech, 2015, Fleck, Glaser, & Sprague, 2011). The slower growth in labor compensation relative to labor productivity during last two decades is part of this long-term trend (Ravikumar & Shao, 2016).

Figure 3: Labor Productivity and Real Hourly Compensation, in index levels

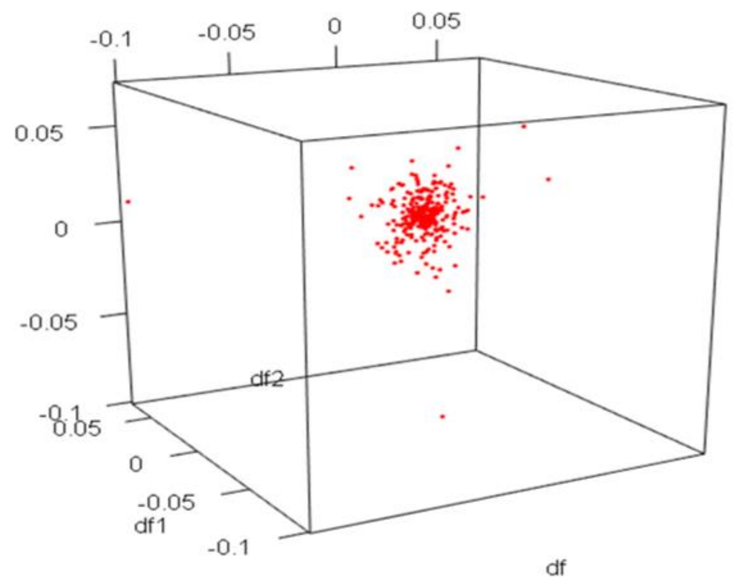


Source: U.S Bureau of Labour Statistics, https://www.bls.gov/productivity/graphics/2022/graphic-4.htm

In addition, we propose Figure 4. Figure 4 depicts the phase-space representation[3] of $\frac{\dot{f}}{f}$, real growth rate of output per capita. X-axis plots time series, y-axis plots one-iterated time series, and z-axis plots two-iterated time series. As it can be seen, most of the duration the process is steadily around 0.2%. $f(k)$ is real gross domestic product per capita, chained 2012 Dollars, quarterly, seasonally adjusted annual rate. The data covers the period from 1947/1/1 to 2022/1/1.

[3] For the theoretical framework of Phase-space representation see Eckmann et al (1987), Marwan et al (2007).

Figure 4: Phase-Space Representation of Real Growth Rate of Output per Capita



Source: Author. Data: Federal Reserve, St.Louis database ,https://fred.stlouisfed.org/series/A939RX0Q048SBEA

4. FINDINGS AND DISCUSSIONS

Arrow et al. (1961) defined constant elasticity of substitution function as given below.

$Y = F(K,L) = \gamma[\delta.K^{-\rho} + (1-\delta).L^{-\rho}]^{\frac{-1}{\rho}}$, where $\rho = \frac{1}{\sigma} - 1$ and σ signifies elasticity of substitution.

In this setting the distribution parameter (δ) and the efficiency parameter (γ) are arbitrarily free parameters. Indeed, these parameters are integration constants which are derived from second-order differential equation defining the elasticity of substitution. However, In the related literature these parameters are introduced as arbitrarily free constants. Based on the studies Barelli & Abreu Pessôa (2003) and Litina & Palivos (2008), Ozkaya (2021) proposed a general solution to so-called differential equation and exactly determined what those integration constants are and what their economic implications are. The analysis in this section is based on the result in Ozkaya (2021). We determined that the distribution parameter (δ) and the efficiency parameter (γ) are components of the initial-terminal conditions of the marginal products. In the economy, capital services are K_t and labor hours are L_t at a given time *t.* For the notational easiness, we drop time notation.

Whenever $\sigma > 1$, the production function is:

$$F(K,L) = \left((F_K(K,0).K)^{\frac{\sigma-1}{\sigma}} + (F_L(0,L).L)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \quad (1)$$

The production function in case of $\sigma > 1$ depends on initial condition (state) for marginal products, $F_K(K,0)$ and $F_L(0,L)$.

For $\sigma < 1$, the production function should be defined as in (2).

$$F(K,L) = \left((F_K(K,\infty).K)^{\frac{\sigma-1}{\sigma}} + (F_L(\infty,L).L)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \quad (2)$$

The production function in case of $\sigma > 1$ depends on terminal condition (state) for marginal products, $F_K(K,\infty)$ and $F_L(\infty,L)$.

For case $\sigma < 1$, the relationship between marginal product of labor and average product of labor should be as given in (3). In (3), the constant term $F_L(\infty,L)$ is maximum marginal product of labor.

$$F_L(K,L) = \left(\frac{F(K,L)}{L}\right)^{\frac{1}{\sigma}}.F_L(\infty,L)^{\frac{\sigma-1}{\sigma}} \quad (3)$$

For case $\sigma < 1$, Proposition 1 determines the relationship between change in marginal product of labor with respect to time (w.r.t time) and change in average product of labor w.r.t time.

Proposition 1. The relationship between time evolution of marginal productivity of labor and time evolution of average productivity of labor.

$\frac{dF_L(K,L)}{dt} = \frac{(1-\pi)}{\sigma} . \frac{d\left(F(K,L)/_L\right)}{dt}$ where $1 - \pi = \frac{L.F_L(K,L)}{F(K,L)}$ is the labor share of output. (4)

(4) shows that as long as $\frac{(1-\pi)}{\sigma} > 1$, then change in marginal product of labor w.r.t time will be greater than change in average product w.r.t time. On the other hand, if $\frac{(1-\pi)}{\sigma} < 1$, then change in marginal product will be lower than change in average product. Note that $\frac{dF_L(K,L)}{dt} > 0$ denotes growth, whereas $\frac{dF_L(K,L)}{dt} < 0$ stands for decay.

Proof 1: Derivation of both sides of (3) w.r.t time gives the desired result.

Proposition 1 implies that if marginal product of labor and average product of labor are initially assumed to be equal to each other, then through time evolution average product should overwhelm. The reason is that: even though theoretically it is possible $\frac{(1-\pi)}{\sigma} > 1$, the empirical evidence from the literature certainly suggests that $\frac{(1-\pi)}{\sigma} < 1$ is observed over last two decades. The main findings in the literature are summarized below.

The recent estimates of the elasticity of substitution in US economy at aggregate level is shown to fluctuate between 0.4-0.6 interval (Herrendorf et al., 2015, Chirinko & Mallick, 2017, Knoblach et al., 2020). The US economy historically has elasticity of substitution level lower-than-unity. A recent survey in Chirinko (2008) suggests that most evidence favors elasticities ranges of 0.4–0.6 for the United States. More recently, Knoblach et al (2020) estimate a long-run meta-elasticity for the aggregate economy in the range of 0.45–0.87 and conclude that "*Estimates of σ at the aggregate or manufacturing level of the U.S. economy are characterized by large heterogeneity. Although the range of estimates is wide, the majority of the empirical evidence suggests that σ is below the Cobb–Douglas value of unity*". Given this fact, the analysis focuses on the case $\sigma < 1$.

On the other hand, the recent studies report that estimates of labor share in US economy is shown to lie between 0.55 and 0.6 (Lawrance 2015, Giandrea & Sprague 2016). The labor share $(1 - \pi)$ is the percentage of economic output that accrues to workers in the form of compensation. It is calculated by dividing the compensation earned during a certain period by the economic output produced over the same period. Labor compensation is a measure that includes wages and benefits. The official data released from the U.S. Bureau of Labor Statistics (BLS) suggest that, while the labor share had already fluctuated over the period from 1960 to 2000, the fastest decline occurred in last two decades—from 63.3 percent in 2000 to 56.7 percent in 2016 (Giandrea & Sprague,2016, Lawrance, 2015; Elsby, Hobijn, & Şahin, 2013; Karabarbounis & Neiman, 2012). The time evolution is plotted in Figure 1.

One may consider that both labor share and elasticity of substitution may change over time. This is true. Empirical evidence suggests that whereas labor share is decreasing over time, elasticity of substitution is increasing in the same period. Oberfield & Raval (2014) and Cantore et al (2017) report evidence that the elasticity of substitution for the U.S. economy is rising over time. Consequently, decreasing labor share and increasing elasticity of substitution yield $\frac{(1-\pi)}{\sigma} < 1$ over the period under examination.

Relating theoretical framework to the empirical measurements, ILO states that "*Labour productivity is an important economic indicator that is closely linked to economic growth, competitiveness, and living standards. Labour productivity represents the total volume of output (measured in terms of Gross Domestic Product, GDP) produced per unit of labour (measured in terms of the number of employed persons or hours worked) during a given time reference period*."

The data observed in Figure 2 relates percentage change in average product of labor and percentage change in average wages. Examining average annual change, Sprague (2021) finds that "*The rate of output growth during the 2005–18 slowdown period (2.1 percent) is a historically weak growth rate. Not only does this rate pale in comparison to the 3.7-percent growth of the speedup period, but it also represents a historically slow rate for the entire post-WWII period, well below the historical average growth rate of 3.4 percent.*" The quarterly data in Figure 2 is consistent with this finding.

Eq.(4) enables to establish the relationship between percentage change in average product of labor and percentage change in marginal product of labor. Dividing both sides with $F_L(K,L).\left(F(K,L)/_L\right)$ and rearranging expression (4) yields (5).

$\frac{dF_L(K,L)/_{dt}}{F_L(K,L)} = \frac{1}{\sigma} . \frac{d\left(F(K,L)/_L\right)/_{dt}}{\left(F(K,L)/_L\right)}$, for notational easiness let us introduce (5).

$$\mu = \frac{\theta}{\sigma} \tag{5}$$

where μ is real growth rate for marginal product, and θ is real growth rate for average product. The parameter, θ also corresponds to the rate of real growth for labor productivity of the economy.

Since $\sigma < 1$, rate of real growth for marginal product should be greater than rate of real growth for average product. Therefore, for case $\sigma < 1$, it is also true that percentage change in marginal product of labor is greater than percentage change in average product of labor.

(5) enables to distinguish between labor's marginal productivity growth rate and labor's average productivity growth rate. In the literature the labor productivity growth is defined to be sum of multifactor productivity growth, contribution of capital intensity and contribution of labor composition. Marginal productivity growth can be assimilated to multifactor productivity growth. Sprague (2021) already defined that multifactor productivity growth (MFP) corresponds to the share of output growth which is not explained by capital growth and labor growth, but stems from other factors. Innovative capacity of firms' R&D departments advances in cutting-edge knowledge and technology in the production process, organizational development and efficiency, reallocation of factors toward higher productive industries. Therefore, MFP growth can be measured by substracting labor growth and capital growth from overall growth, which can be considered as a residual.

In order to explain (5), one should rely on this decomposition. As elasticity of substitution increases, real growth rate for marginal productivity decreases.

The last two decades cover the period where real growth rate of average product is relatively reducing, and elasticity of substitution is increasing. Therefore, (5) implies that real growth rate of marginal labor productivity should gradually weaken in this period.

As a result, as labor market becomes perfectly competitive, -since marginal product and marginal price should converge- then the marginal price for labor should be eroded.

This finding is consistent with empirical result given in Sprague (2021). The author concludes that the deceleration in MFP growth, which is the largest contributor to the slowdown explains 65 percent of the slowdown in labor productivity growth.

This result implies that Central bank policy to make labor market perfectly competitive is not best policy choice, unless evolution of elasticity of substitution is significantly estimated and controlled.

On the other hand, fiscal policy designed to augment hourly wages from $10 to $15- a 50 percent increase in minimum marginal price of labor- will influence earnings of a partition of nonfarm business sector and other sectors. Therefore, this policy causes an increase in average hourly wages in labor market. According to expression (1), in a perfectly competitive economy an increase in minimum marginal product of labor coincides with an increase in minimum marginal price of labor. Therefore, the expectation of policy makers that the rate of growth for economy would increase, makes them to employ an increase in minimum wages. However, we have already explained that the U.S. economy historically has elasticity of substitution level lower-than-unity, which theoretically makes U.S. economy sensitive to maximum marginal product of labor. Expression (2) deals with the case of $\sigma < 1$ and thus we focus on (2) to solve this inconsistency.

For $\sigma < 1$, an increase[4] in maximum marginal product of labor, $F_L(\infty, L)$ causes an increase or a decrease in the growth rate of income per capita, which depends on certain conditions. Derivation of real growth rate for output per capita with respect to maximum marginal product gives the following result. In order to obtain output per capita function, one may divide (2) with labor, L.

$\frac{\partial}{\partial b}\left(\frac{\dot{f}}{f}\right) = \frac{(\sigma-1)}{\sigma.b}(1-\pi)\pi\left(\frac{sf}{k}\left(1+\frac{\sigma\pi}{(\sigma-1)(1-\pi)}\right)-n\right)$ where $b = F_L(\infty, L)$. It is straightforward that

$\frac{\partial\left(\dot{f}/f\right)}{\partial b} > 0$ if $\frac{1-\pi}{\sigma} < 1$. From Proof 1, we have already shown that $\frac{1-\pi}{\sigma} < 1$ is valid through US economy.

This result implies that as long as labor productivity slows down, the growth rate of output per capita decreases. Therefore, a fiscal policy addressing an increase in maximum marginal product of labor will be growth enhancing. Taken inversely, if maximum marginal product is observed to be increasing, then an adequate policy would be to augment average wages. The minimum wage has been increased in Federal contracts and it triggered approximately 5 % annual increase in private sector average wages. To what extent an increase in minimum wage will cause an increase in maximum wage, and hence average wage? Under the circumstances where labor productivity is decreasing, a fiscal policy aims at pushing up average wages will eventually result with inflationary pressures. Thus, the U.S. fiscal policy is addressing the "wrong layers" in determinants for labor productivity.

[4] The increase in maximum marginal product is considered as a result of policy making (*Peretto & Seater, 2013).*

5. CONCLUSION AND IMPLICATIONS

Following Covid-19 vaccine production success across the developed countries, "normalization" process of the economic activity has scheduled. US fiscal policy increased minimum wages and US monetary policy addressed tighter and perfectly competitive labor market. These two policies do not coincide in terms of efficiency. In other words, simultaneous application of these two policies will not give desired compound result. Contractionary monetary policy will increase competitiveness whereas increasing minimum wage does influence average wages, which causes an additional inflation. The reason is that marginal labor productivity has been slowing down, resulting with a decrease in real growth rate for output per capita. Moreover, real growth rate for wages (marginal price) will get slower.

Since the elasticity of substitution between input factors is shown to be augmenting, but is staying lower-than-unity, real growth rate of marginal productivity is decelerating w.r.t real growth rate of average labor productivity. As long as U.S. labor market becomes perfectly competitive, the labor compensation should decrease. Taken inversely, the reason that labor share's deceleration may be decrease in real growth rate for marginal productivity of labor through last two decades. Moreover, in last two decades growth rate of labor productivity decreased faster than observed in previous decades. Therefore, it is plausible to suggest that deceleration in growth rate for marginal productivity is speeded up.

This policy measure would be better one given the substitution elasticity level higher-than-unity. Therefore, given the results of present study, increasing maximum marginal product of capital would be a better policy choice in terms of fiscal approach. Our results demonstrate that amid Covid-19 pandemics, US fiscal policy and monetary policy do not optimally match and hence the fiscal policy should be calibrated. Secondly, monetary tightening will influence unit labor costs in certain sectors. In this vein, future studies may focus on the evolution of linkage between labor productivity and unit labor costs in subsectors.

More generally, the effect of elasticity of substitution on economic growth depends strictly on the level of elasticity with respect to the unity. Therefore, the fiscal and monetary policies should be diversified in countries with elasticity of substitution level lower-than-unity w.r.t the countries where elasticity of substitution stays higher-than-unity. Whereas elasticity of substitution is lower-than-unity then automation (Aghion et al., 2019) and factor-eliminating process should be imposed (*Peretto & Seater, 2013).*

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