# Ramsey Rules, Fiscal Policies, and Labor Shares in the United States: 1948-2018

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**Abstract**

This paper evaluates the effects of optimal Ramsey rules for government investment, educational subsidies and tax rates for labor and capital income, on welfare, debt stabilization and factor shares. Using annual data, we apply the wedge growth accounting approach to match the base model with key features of the US economy between 1948 and 2018. Our optimal policy simulations show that a case can be made to increase infrastructure spend and subsidies to education, financed by tax increases to promote inclusive growth as measured by improving labor shares.

Key words: Ramsey rules, fiscal policy, inclusive growth
JEL: E61, E62, E65

# 1 Introduction

Since the onset of the global financial crisis, and the explosion of public debt across Europe, the United States and Japan, attention has shifted to the use of fiscal instruments when the interest rate is at or near the zero lower bound. For example, Correia et.al (2013) have drawn attention to the way rules for tax rates can serve as effective substitutes for the interest rate for overall stabilization, since both the tax rate and the interest rate enter the Euler equations. These authors have also noted that there is no need to rely on sticky prices or wages for tax-rate rules to be effective stabilization instruments.

At the same time, attention has been drawn to the issue of income inequality within countries again especially since the onset of the global financial crisis. Kumho et.al (2015), for example, have shown how increasing inequality can precipitate crises through incentives for over lending by financial institutions. Bhandari et.al. (2017) have drawn attention to the effect of monetary and fiscal policies on inequality over the course of the business cycle as well as the effects of inflation for redistribution.

Any discussion of fiscal policy, and its effects on welfare and inequality, must also face the issue of large public debt levels across the world, and the inevitable demands for austerity. But this is a complex issue. Leeper (2015) points out that time and time again, when fiscal stimulus packages are proposed or enacted, they are soon followed by promises of austerity programs to reduce the ensuing accumulation of government debt, thus making the expansionary fiscal actions counter-productive.[1]

In a similar vein, Sims (2018) points out that seeing debt as a burden for future generations, which has to be wiped out by higher taxes, is a wrong way to proceed. He notes that if we are really concerned about future generations, we should increase savings and increasing taxes to reduce debt is likely to decrease private saving. He notes that what is costly about large public debt are the distortionary taxes needed to keep debt from expanding. Rapidly increasing taxes to reduce debt creates even more distortions.

In his recent American Economic Association Presidential address, Blanchard (2019) offers another perspective regarding fears of growing public debt in the United States. He notes that with interest rates on public debt being lower than the rate of growth of the economy, the welfare costs of debt are much lower than commonly assumed.

But while lower or even zero interest rates would seem to be good news for fiscal activism, Liu, et.al (2019) offer a challenge. They point out that in periods of prolonged interest rates, when the interest rate falls below a low threshold, the prolonged low interest rates can lead to increased industrial concentration, monopoly power and increased inequality, and lower productivity.

The aim of the paper is to examine how fiscal policies affect inequality through their effects on the labor share of GDP, since movements in this variable are negatively correlated with the Gini coefficient [see Santacreu and .Zhu

[1] He notes that fiscal expansions which are **not** backed by promises of reversal have long and persistent impacts. There is thus a trade off between fiscal sustainability and effective fiscal stabilization. Unfortunately, he notes that most policy makers favor sustainability, thereby removing fiscal policy as a key play in stabilization

(2017)]. We use a model-based approach which allows for government spending on human as well as physical capital. Specifically our model is an extension of Daniel and Gao (2015), which features government subsidies for human capital formation. We augment the Daniel and Gao (hereafter DG) model to include government investment in productive capital, in order to compare the fiscal multipliers associated with government spending in human and physical capital. We also have tax rates on both labor and capital income.

Our analysis is based on a model which is calibrated for the US economy, on an annual basis. We examine the evolution of fiscal policies, both for spending and taxation, as well as the evolution of GDP growth,public debt and the labor share of national income, between 1948 and 2018. In many ways, the decade of the 1950s offers important clues about good conduct of fiscal policy when expenditures were focused on infrastructure and education, with high tax rates on income and dividends. Interest rates were kept low by the Real Bills Doctrine, while the large stock of public debt, due to World War II and the Korean War spending, declined along with a steadily increasing labor share of national income.

While there is a large stock of public debt today, and a low interest rate, as in the 1950s, fiscal policies both in spending and taxation are different. Tax rates are lower, there is much less spending on infrastructure and human capital and the labor share of national income has been steadily declining. A goal of this paper is to find out what Ramsey rules for both expenditures and taxes can teach us about the design of fiscal policy with respect to the stabilization of public debt, sustained growth and stable labor shares.

Our approach has four characteristics. We focus on the labor share, we examine both spending and revenue instruments, we take an historical approach, and we assess the welfare effects of government spending.

First. our focus on labor share is motivated by studies which show a relationship between changes in labour share, the likely effects of technology and its implications on physical and human capital accumulation. These include studies by Acemoglu and. Restrepo (2018, 2019), as well as by Caselli and Manning (2019), who discussed the roles of technological change with specific assumptions about the specification of CES production functions. In particular, Acemoglu and Restrepo note that with an educated work force, the initial replacement effect of new technology is soon followed by a reinstatement effect. Their message is that workers who lose jobs due to automation soon find new employment opportunities due to the productivity gains and new demand generated by the new technology.

Alvarez-Cuadrado, Van Long and Poschke (2018) examined the changes brought out by structural change in capital and labor substitution, while Growiec, McAdam, and Muck (2018) examined the cyclicality of this variable. In contrast, Karabarbounis and. Neiman (2014) compared the behavior of the labor share across countries, finding that it has significantly declined since the 1980's. Rather than focusing on technology, structural changes or cyclical behavior, they explain the global decline as a result of a fall in the price of capital good. To date, little attention has been paid to the role of changing fiscal regimes on the behavior of the labor share. The focus of our paper is with the effects of changes in fiscal expenditures and revenues on labor shares.

Second, examining both fiscal spending and revenue instruments is in accord with Leeper (2015) who notes that there is heterogeneity among fiscal instruments, since each fiscal instrument is likely to generate different dynamic adjustment processes. For example, Garcia-Mila et.al (2010) found that eliminating the tax on capital returns increase the welfare of lower-income workers as well as the efficiency of production. Correia (2010) argued that a switch from a tax on labor and capital income to a flat tax on consumption, coupled with a lump-sum transfer, reduces inequality. Her results stand in stark contrast with the commonly-held view that consumption taxes are regressive.

Third. we adopt an historical perspective since studies have found that fiscal multipliers are contingent on many factors, especially interest rates and the size of the public debt. On this point Christiano et.al. (2011) note the key role of monetary policy in determining the size of spending multipliers. If such spending stimulates inflation and the monetary authority raises interest rates, demand falls, thus cutting the size of the multiplier, likely to values less than one. However when the interest rate is kept at the zero lower bound, these authors point out that the multiplier will be much larger.[2]

Fourth, our model-based approach takes up the issue of the size of government expenditure from a welfare angle. Sims and Wolff (2018) addressed the complexities of fiscal policy with a medium scale DSGE model which include both government consumption and investment.[3] They examined both the multiplier and welfare effects for a combination of spending and fiscal financing mechanisms, as well as the stance of monetary policy and the cyclicality of government spending. One of their main conclusions is that the average size of government consumption may be too high, while the size of government investment may be too low, relative to what would be optimal. They also find no compelling case for countercyclical government spending when monetary policy is active. Furthermore, the presence of distortionary taxes weakens the case for counter-cyclical government spending policies. However, these outcomes change when monetary policy is passive, or when the interest rate is at the zero lower bound.

Thus, our model approach allows us to consider the complexity of fiscal policy as well take into account the interaction of debt and interest rates. In contrast to many studies of multiplier effects we evaluate the effectiveness of fiscal instruments not in terms of one-off changes but as Ramsey-based policy rules. We also consider the combined effects of changes on taxes (imposed on wages or returns to capital) and spending (as infrastructure spend to augment productive capital accumulation or as subsidies to education to augment human capital accumula-

[2]However, Ramey and Zubairy (2018) have called into question the finding of Christiano et.al. (2011). Using quarterly data from the beginning of the last century, these authors found that the results for mutlipliers are more mixed for periods when the economy is at or near the zero lower bound. By contrast, even in the presence of credit-constrained households, the zero lower bound and distortion taxes, Leeper (2010) report a multiple of less than unity, based on Bayesian estimation with U.S. data.

[3]Leeper et.al. (2010) estimated the effects of government investment for a neoclassical growth model of the US economy. Delays in public investment can lead to negative effects in the short run, while distortions in finance can lead to further negative effects in the longer term. Finally, for government spending, using Bayesian estimation for the US economy, Leeper et.al (2017) found that the short-run multipliers across fiscal-monetary regimes have a posterior mean value of 1.3.

tion). As well as assessing the effectiveness of fiscal policy through changes in government spending and tax rates as separate policy regimes, we also consider output and welfare multipliers from joint spending and tax policies, in order to capture fiscal restraint.

The policy simulations examine the effectiveness of alternative government spending and revenue packages on the business cycle, on welfare and on the behavior of debt, as well as on factor shares. We contrast the use of various spending/tax-rate combinations as effective means to effect changes in the labour share.[4] We also consider simple linear approximations to Ramsey to ascertain whether fiscal policies are counter or pro-cyclical, their reactions to changes in the rate of interest and to changes in the deficit/GDP ratio.

The paper is organized as follows. By way of background, the next section summarizes the recent history of the fiscal policy instruments we examine in this paper, in the context of broader macroeconomic adjustments. The third section presents our model as well as the calibration. Then we perform a wedge analysis in the spirit of the growth accounting approach of Chari, Kehoe and McGratten (2007), and extract the estimated productivity, preference and risk wedges. We then simulate the model to compare the effects of specific Ramsey policies on output growth, the debt/GDP ratio and the labor share, relative to a base case without Ramsey rules. We consider different fiscal stances regarding different spending/revenue combinations on growth, welfare and the labor share. The final section concludes.

## 2 US Macroeconomic and Fiscal Indicators

Figure 1 shows the profile of the key macroeconomic variables discussed in the paper: the labor share, the annual growth rate of real per-capita GDP, the real public debt/GDP ratio and the gross real rate of interest on 10-year Treasury bonds. The main indicators of fiscal policy appear in Figure 2. The right hand column contains the data revenues while the left hand column contains data about expenditures.

The labor share of US income remained stable, around 63% until 1970, when there was a steady drop until 1980, followed by a period of stability with even a slight rise, and then another period of steady decline after 2001. Over the same 70 years, we see a clear difference in the growth in real US GDP between the 1950's and the post 1990's decade. The earlier period was one of higher growth while the later period was one of lower growth rates.

Meanwhile, the real gross interest rate was low in the 1950's rose sharply in the period of the Great Inflation in the 1980's, but fell steadily after. The sample contains low rates in both the first and last decade in the sample period.

With respect to the real debt per GDP ratio (and hence the fiscal deficit), we see that the combination of low interest rates and relatively high growth rates in the post-World War II era led to several decades of declining real debt/GDP ratios. Figure 1 shows the US public debt/GDP ratio steadily decreasing until 1980.

[4] Leeper (2010) estimated optimal rules for tax rates based on target public debt/GDP ratios as well as the output gap for the United States.

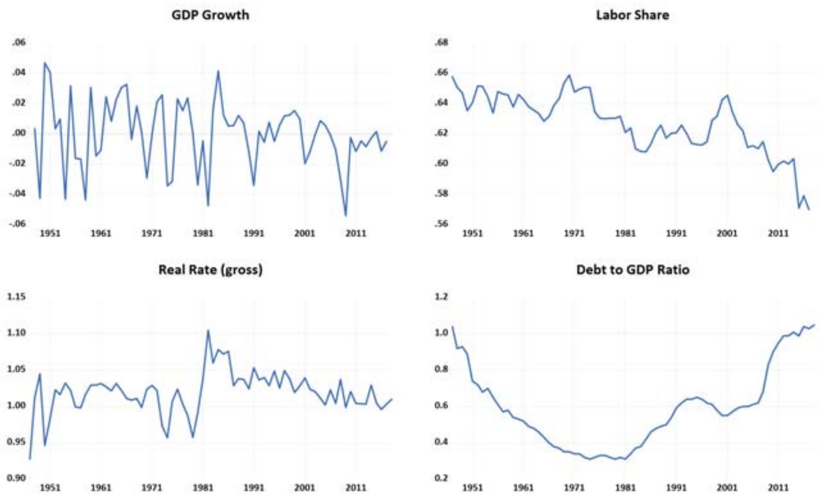


Figure 1: GDP, Labor Share, Real Rate and the Debt to GDP Ratio

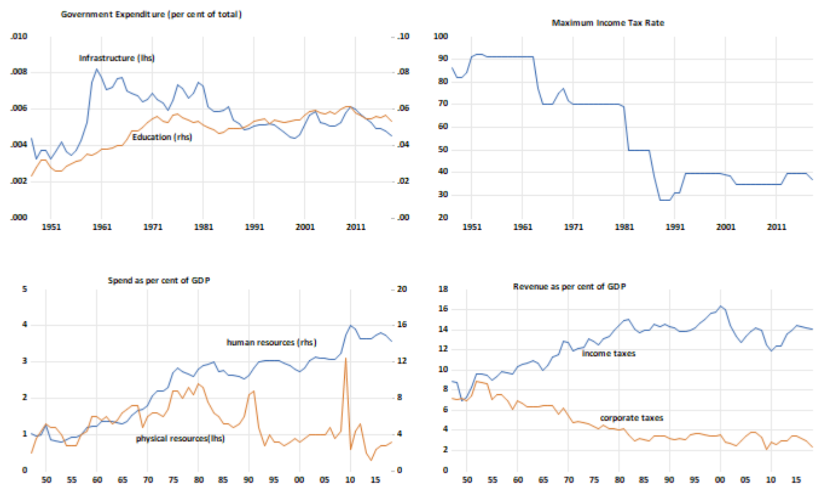


Figure 2: Fiscal Expenditures and Revenues: 1948-2018

After the 1980s, Debt/GDP ratios rose along with increasing deficits (with the exception of a brief period in the late 1990's). The onset of the Global Financial Crisis in 2008 saw deficit/GDP ratios higher than 8%. The reversal of the debt/GDP ratio post 1980 was triggered by the Reagan income-tax cuts. The debt ratio also fell slightly during the 1990's with the Clinton stabilization. More recently, it has leveled off with the return of growth and the low interest rates.

Figure 2 provides more information about revenue from taxes, and expenditures on infrastructures and human resources. With respect to revenues and income taxes, we see that since 1950, the evolution of the highest marginal income tax rate has shown the greatest variation from rates, with rates around 90% in the 1950s to rates around 30% in the 2000s. A brief history of tax reforms follows.

At the start of the 1950s decade, the Truman administration raised the rate to over 90%, due to the costs of the Korean War. Throughout the 1950's the Eisenhower administration maintained the high tax rates to pay for the Cold War military spending as well as to maintain a balanced federal budget. With the advent of the Kennedy New Frontier, the balanced-budget fixation gave way to deficit spending to stimulate the economy. Kennedy's proposed tax cuts were enacted at the start of the Johnson administration in 1964. There was a slight tax increase by the outgoing Johnson administration to pay for the increasing expenses of the Vietnam War, but these tax increases were reversed by the Nixon administration, in the process of reducing U.S. involvement in the Vietnam war.

Top taxes rates remained about 70% throughout the Ford and Carter administrations. After the Reagan administration took office in 1980, there were two dramatic tax-rate cuts which effectively reduced the highest marginal tax rate to below 30%. As the US public debt increased, George H.W. Bush signed into law a small tax increase to a level over 30%. This was followed by Clinton's administration's tax increase to above 40% which was subsequently reduced to about 35% by George W. Bush. Eight years later, the Obama administration raised the same rate to slightly below 40%. In 2016, the Trump administration lowered this same rate to a level close to that of the George W. Bush taxes.

Thus there were dramatic changes in the income tax rates, from 1950-80 and less dramatic changes post 1980. Since the major tax reductions in the 1980s, the average highest income tax bracket has fallen by almost 50% and the highest income tax rates have fluctuated between 30 and 40 percent. For the most part, dividends were taxed at the highest income tax rate. However, exceptions were made under the George W. Bush administration for qualified dividends, with tax rates of 15%.

The bottom right quadrant in Figure 2 pictures the fiscal revenue, as a percentage of GDP, due to taxes on labor income and returns to capital. Since 1960, there has been a steady decline in the tax revenue coming from taxation of capital returns. Since 1980, there has also been greater volatility in the revenue coming from taxation of labor income due in part to the increased volatility of the tax rates since then.

With respect to expenditures on physical and human resources, we see that the big acceleration in both forms of spending took place early in the sample, during the decade of the 1950s and the early 1960s. While government spending on human resources leveled out after that, spending on physical resources diminished as a percentage of GDP. The spending on human resources includes the increases after the enactment of the Medicare-Medicaid programs in the mid-1960s as well as further increases from higher health care costs due to the aging population in the later part of the sample. Again, a brief history follows.

Government infrastructure spending had been very small, prior to World War II. However, spending on the St. Lawrence Seaway (1954) and the US Interstate Highway system through the 1956 Federal Highway Act were major infrastructure initiatives of the Eisenhower administration. The official reason for the Federal Highway Act was for defense. This was at the time of increasing Cold War tensions. Such an expanded highway system was needed to move military equipment and forces across the country more rapidly, and also for evacuation of key population centers, in case of an all-out nuclear war [see Hitchcock (2018)]. Since then, government spending has fallen over time, with occasional spurts at the time of the oil crises in the 1970's, for energy exploration, in the late 1990's, during the Clinton boom years as well as in 2005, for recovery efforts following Hurricane Katrina.

The increase in education subsidies were due to the GI Bill of Rights, officially the Servicemen's Readjustment Act, signed into law by President Roosevelt in 1944, and continued by the Eisenhower administration. This bill provided massive subsidies for veterans of both World War II and Korea to obtain university education. Later in his administration, Eisenhower signed into law the National Defense Educational Act, in wake of the launch of Sputnik by the Soviet Union in 1957. This act gave massive subsidies for science education at all levels. Federal involvement in education came to the fore with the creation of the U.S. Department of Education at the end of the Carter administration in 1980. Many of the expenditures of this department took the form of transfers to state and local governments, but also in the form of Pell grants for higher education loans. The appropriations to Federal education has climbed steadily since its inception. The major decrease came at the time of the Global Financial Crisis. There were also smaller decreases in 2012 but there was a increase at the end of the Obama administration. The Trump administration cut federal appropriations to this Department in 2017.

Overall, we see a major shift in fiscal regimes in the United States. The Eisenhower administration made use of either low-deficit or balanced-budget fiscal policy with spending on infrastructure and education as well as defense, coupled with relatively high and stable tax rates [see Hitchcock (2018)]. By contrast, after 1980, changes in tax rates became the primary fiscal instrument, with much less concern for balanced-budget targets, and of course rising debt/GDP ratios. Casual analysis of the data suggest that as both forms of government spending programs began to taper off or decrease, by the 1970s, precisely at the same time when the labor share of US income reversed direction and started its decline.

# 3 Model and Calibration

This paper studies the interaction between infrastructure investment and subsidies to human capital, financed by taxes on labor income or dividends, to see how sustained fiscal activities may affect both overall welfare, debt and the labor share of income. The model is based on Daniel and Gao (2015) which allows a role for both physical and human capital in production. We adapt the DG model to allow for government investment expenditure on physical capital in an analogous manner to how DG specify investment in human capital.

Thus our model has three types of government expenditure. There is government subsidies to increase investment in education (human capital in general), government infrastructure investment to increase capital accumulation in physical capital and other government spending which increases directly the utility of households.

On the revenue side, there are taxes on wage income and taxes on profits/dividends. Since the fiscal module is central to the analysis, the model is calibrated to match shares (receipts and revenue as percentage of GDP) reported by the Office of Management and Budget (OMB) in the Historical Tables.

In the following sub-sections, we describe briefly, the behavioral equations in the economy, for the production, household and government sectors.

## 3.1 Production

The CES production function for aggregate output ($y_t$), is a function of physical capital ($k$), human capital ($h$) and hours worked ($n_w$)

$$y_t = (\theta_k k_t^{-\rho} + \theta_h h_t^{-\rho} + (1 - \theta_k - \theta_h) n_{w,t}^{-\rho})^{\frac{-1}{\rho}} \tag{1}$$

Maximizing profit $\pi$ with respect to $k, h, n_w$:

$$\pi_t = y_t - d_t k_t - w_t n_{w,t} - w_{h,t} h_t \tag{2}$$

where the variables $d_t, w_t, w_{h,t}$ represent respectively dividends, wage per hour, and wage paid to human capital, yields the usual first-order conditions:

$$d_t = \theta_k \left(\frac{y_t}{k_t}\right)^{1+\rho} \tag{3}$$

$$w_{h,t} = \theta_h \left(\frac{y_t}{h_t}\right)^{1+\rho} \tag{4}$$

$$w_t = (1 - \theta_k - \theta_h) \left(\frac{y_t}{n_{wt}}\right)^{1+\rho} \tag{5}$$

The national accounting equation for this close economy has the following representation:

$$y_t = c_t + m_t + e_t + g_{ct} \tag{6}$$

where $c_t$ is consumption, $m_t$ is investment expenditure to build up physical capital, $e_t$ is educational expenses to build up human capital and $g_{c,t}$ is government (transfer) expenditures.

The shares of national income to work, human and physical capital are:

$$wage\_share = \frac{w_t n_{wt}}{y_t} \tag{7}$$

$$human\_capital\_share = \frac{w_{ht} h_t}{y_t} \tag{8}$$

$$physical\_capital\_share = \frac{d_t k_t}{y_t} \tag{9}$$

## 3.2 Households

The representative household has the following logarithmic utility function:

$$U_t = \log c_t + \alpha_n \log(1 - n_{wt} - n_{ht}) + \alpha_g \log g_{ct} \tag{10}$$

where the variables $c_t, n_{w,t}, n_{h,t}, g_{c,t}$ represent consumption, hours worked, hours spent on acquiring capital and government spending (like welfare payments, defense) which enhances household utility. The household has 1 (normalized) unit of labour hours, so $(1 - n_{w,t} - n_{h,t})$ represents leisure. The parameters $\alpha_n, \alpha_g$ capture the effects of leisure and government spending on utility. The budget constraint of the household is:

$$c_t + (1-s_t)e_t + (1-g_t)m_t + b_t = (1-\tau_{nt})(w_t n_{wt} + w_{ht} h_t) + (1-\tau_{kt}) d_t k_t + R_{t-1} b_{t-1} \tag{11}$$

We assume, for simplicity, that the household pays no taxes on consumption, but pays taxes on labor income and on capital returns with time-varying rates $\tau_{n,t}, \tau_{k,t}$. The household purchases consumption, $c_t$, spends on education $e_t$ (receiving $s_t e_t$ as a government subsidy for human capital accumulation) and on investment goods $m_t$ (receiving $g_t m_t$ as government payments for infrastructure capital accumulation). The household lends to the government via purchases of bonds $b_t$ and receives returns on risk-free governments bonds, $R_{t-1} b_{t-1}$.

The law of motion for physical and human capital has the following forms:

$$k_t = (1 - \delta_k) k_{t-1} + i_{k,t} \tag{12}$$

$$h_t = (1 - \delta_h) h_{t-1} + i_{h,t} \tag{13}$$

$$i_{k,t} = p_t^{\omega_p} k_{t-1}^{\omega_k} (n_{h,t})^{1-\omega_k-\omega_m} \tag{14}$$

$$i_{h,t} = e_t^{\omega_e} h_{t-1}^{\omega_h} (n_{h,t})^{1-\omega_h-\omega_e} \tag{15}$$

where, $\delta_k, \delta_h$ are the depreciation rates. Following Daniel-Gao, we model investment as a function of the respective expenditures spent on physical and human capital accumulation $(m_t, e_t)$, existing stock $(k_{t-1}, h_{t-1})$ and extra hours $n_h$. When $\omega_m = 1$ and $\omega_k = 0$, we have the usual $i_{k,t} = m_t$.

Deriving the first order conditions with respect to $c_t, m_t, e_t, b_t, k_t, h_t, n_{wt}, n_{ht}$ (and after various manipulations) yields the following behavioral equations:

$$\alpha_n c_t = (1 - \tau_{nt})(w_t)(1 - n_{wt} - n_{ht}) \tag{16}$$

$$\frac{n_{ht}(1 - \tau_{nt})(w_t)}{} = \begin{bmatrix} \frac{(1-s_t)(1-\omega_e-\omega_h)e_t}{\omega_e} \\ + \frac{(1-g_t)(1-\omega_p-\omega_k)p_t}{\omega_p} \end{bmatrix} \tag{17}$$

$$\frac{1}{c_t} = \beta R_t \frac{1}{c_{t+1}} \tag{18}$$

$$\alpha_n = \frac{1}{c_t}(1-\tau_{nt})(w_t)(1-n_{wt}-n_{ht}) \tag{19}$$

$$\frac{\alpha_n c_t n_{ht}}{(1-n_{wt}-n_{ht})} = \left[ \begin{array}{c} \frac{(1-s_t)(1-\omega_e-\omega_h)e_t}{\omega_e} \\ +\frac{(1-g_t)(1-\omega_p-\omega_k)p_t}{\omega_p} \end{array} \right] \tag{20}$$

$$\frac{c_{t+1}}{c_t} \left[ \begin{array}{c} (1-\tau_{k,t})d_t\omega_p \\ -\frac{(1-g_t)m_t}{i_{kt}} \end{array} \right] = -\left[\beta(1-g_{t+1})p_{t+1}\right] \left( \frac{(1-\delta_k)}{i_{k,t+1}} + \frac{\omega_k}{k_t} \right) \tag{21}$$

$$\frac{c_{t+1}}{c_t} \left[ \begin{array}{c} (1-\tau_{n,t})w_{ht}\omega_e \\ -\frac{(1-s_t)e_t}{i_{ht}} \end{array} \right] = -\left[\beta(1-s_{t+1})e_{t+1}\right] \left( \frac{(1-\delta_h)}{i_{h,t+1}} + \frac{\omega_h}{h_t} \right) \tag{22}$$

## 3.3 Government

The government's budget equation is:

$$g_{ct} + e_t s_t + g_t m_t + R_{t-1} b_{t-1} = \tau_{n,t}(w_t n_{w,t} + w_{h,t} h_t) + \tau_{k,t} d_t k_t + b_t \tag{23}$$

which shows the three forms of government spending (welfare/defense payments to enhance utility ($g_{c,t}$) spending as subsidies to education ($e_t s_t$) and spending on productive capital as a proportion of total investment ($\gamma_t m_t$)) and the two types of taxes (on labor income (derived from work and increment to human capital, e.g. skills, $\tau_{n,t}(w_t n_{w,t} + w_{h,t} h_t)$) and on capital returns, $\tau_{k,t} d_t k_t$).

We assume that government policies are in place to ensure a sustainable public sector, such that for a given $R$, in steady state, $b/y$ satisfies:

$$\left(\overline{\frac{b}{y}}\right)(\overline{R}-1) = \overline{\tau_n}\left(\frac{wn_w + w_h h}{y}\right) + \overline{\tau_k}\left(\frac{dk}{y}\right) - \left(\frac{g_c + es + gm}{y}\right) \tag{24}$$

The post-tax factor shares are:

$$labor\_share = \frac{(1-\tau_n)(w_t n_{wt} + w_{ht} h_t)}{y_t} \tag{25}$$

$$capital\_share = \frac{(1-\tau_k)d_t k_t + (R_t - 1)b_t}{y_t} \tag{26}$$

## 3.4 Wedges and shocks

We consider three stochastic processes - one each for the production, household and government sectors. We introduce a wedge process $z_t$ to production as follows:

$$y_t = z_t(\theta_k k_t^{-\rho} + \theta_h h_t^{-\rho} + (1-\theta_k-\theta_h) n_{w,t}^{-\rho})^{\frac{-1}{\rho}} \tag{27}$$

$$z_t = \rho_z z_{t-1} + (1-\rho_z)\overline{z} + e_{zt}; e_{zt} \sim N(0, \sigma_z^2) \tag{28}$$

where the productivity factor ($z$) follows a stationary auto-regressive process and $\overline{z}$ is the steady-state value (normalized at unity). The $z_t$ process represents the evolution of technical changes and $e_{zt}$ is the technological shock.

For the household sector, we introduce a wedge into the marginal rate of substitution function:

$$\frac{c_{t+1}}{c_t} = x_t \beta R_t \tag{29}$$

$$x_t = \rho_x x_{t-1} + (1-\rho_z)\overline{x} + e_{xt}; e_{xt} \sim N(0, \sigma_x^2) \tag{30}$$

where the preference factor ($x$) follows a stationary auto-regressive process and $\overline{x}$ is the steady-state value (normalized at 1). The $x_t$ process captures behavioral changes in labor/leisure choices and $e_{xt}$ is the consumption/labor market shock.

Finally, we introduce a wedge into the government budget equation as:

$$\left(\frac{b}{y}\right)(R-1) = q_t \left(\overline{\frac{b}{y}}\right)(\overline{R}-1) \tag{31}$$

$$q_t = \rho_r q_{t-1} + (1-\rho_z)\overline{q} + e_{qt}; e_{qt} \sim N(0, \sigma_q^2) \tag{32}$$

where the risk factor ($q$) follows a stationary auto-regressive process and $\overline{q}$ is the steady-state value (normalized at 1). The $q_t$ wedge picks up changes in fiscal instruments and $e_{rt}$ are other institutional/policy shocks.

Finally, we model the evolution of each of the fiscal policy instruments as:

$$s_t = \rho_s s_{t-1} + (1-\rho_s)\overline{s} + e_{st}; \quad e_{st} \sim N(0, \sigma_s^2) \tag{33}$$

$$g_t = \rho_g g_{t-1} + (1-\rho_g)\overline{g} + e_{gt}; \quad e_{gt} \sim N(0, \sigma_g^2) \tag{34}$$

$$\tau_{kt} = \rho_k \tau_{kt-1} + (1-\rho_s)\overline{\tau_k} + e_{kt}; \quad e_{kt} \sim N(0, \sigma_k^2) \tag{35}$$

$$\tau_{nt} = \rho_n \tau_{nt-1} + (1-\rho_n)\overline{\tau_n} + e_{nt}; \quad e_{nt} \sim N(0, \sigma_n^2) \tag{36}$$

### 3.5 Calibration

Our study spans the years 1948-2018, with particular focus on the relation between fiscal policy and the wage share. Consequently, the model is calibrated to yield steady-state shares that correspond to the sample average for the US labor share, as well as to match the sample averages for various revenue and outlay shares (expressed as a percentage of GDP).

Table 1: Fiscal & Other Steady-State Shares

| Variable | value | source |
|---|---|---|
| consumption to GDP ratio: $\frac{c}{y}$ | 0.722 | St.Louis FRED |
| wages share: $\frac{wn_w}{y}$ | 0.619 | St.Louis FRED |
| Federal outlay on human capital to GDP ratio: $\frac{se}{y}$ | 0.097 | OMB, Table 3.1 |
| Federal outlay on physical capital to GDP ratio: $\frac{gm}{y}$ | 0.013 | OMB, Table 3.1 |
| Other outlay as ratio of GDP: $\frac{g_c}{y}$ | 0.058 | OMB, Table 3.1 |
| corporation taxes as ratio of GDP: $\frac{\tau_k(dk)}{y}$ | 0.045 | OMB, Table 2.3 |
| individual taxes as a ratio of GDP: $\frac{\tau_n(wn_w+w_h h)}{y}$ | 0.126 | OMB, Table 2.3 |

OMB: https://www.whitehouse.gov/omb/historical-tables/

The classification of outlays into expenditure on physical resources, human resources and others (mainly military) and the classification of revenue into individual and corporations, follow the definitions in the OMB tables. The definitions correspond to the broad categories in the model. Outlays on human resources cover spending on Education, Training, Employment, and Social Services and Health while outlays on physical resources covers spending on transportation, energy, natural resources.

The calibrated parameters are internally consistent with the steady state values of the model. We depart from DG in using the CES production to allow for a variable labor share of GDP. Consequently, we have adopted some of the DG calibrated parameters, but have re-calibrated parameters that were directly affected by our CES production function, our revised capital accumulation and infrastructure spend. Like, in DG, the deep parameters were solved to match various expenditure shares expressed as ratios of GDP.

Table 2: Calibrated parameters

| Parameter | | Value | |
|---|---|---|---|
| leisure coefficient in utility | $\alpha_n$ | 1.96 | calibrated to match shares |
| govt services coefficient in utility | $\alpha_g$ | 0.06 | DG (2015) |
| CES parameter | $\rho$ | 0.25 | AR (2019), LL (2010) |
| share of physical capital in production | $\theta_k$ | 0.33 | Ravel (2010) |
| share of human capital in production | $\theta_h$ | 0.23 | calibrated to match shares |
| coefficient of education in investment | $\omega_e$ | 0.51 | calibrated to match shares |
| coefficient of human capital in investment | $\omega_h$ | 0.24 | calibrated to match shares |
| coefficient of infrastructure in investment | $\omega_m$ | 0.18 | calibrated to match shares |
| coefficient of physical capital in investment | $\omega_k$ | 0.54 | calibrated to match shares |
| depreciation rate, physical capital | $\delta_k$ | 0.10 | consistent with SW (2018) |
| depreciation rate, human capital | $\delta_h$ | 0.10 | consistent with SW (2018) |

Notes: DG (2015): Daniel and Gao; AR (2019): Acemoglu & Restrepo; LL (2010): Leon-Ledesma; SW (2018): Sims and Wolf

For the CES production function, we calibrated $\rho$ at 0.25 which is equivalent to a coefficient of substitution of 0.8 This is consistent with Leon-Ledesma (2010) where they estimated a CES function to evaluate the effect of technical change on the labor share for the US economy.

Also, given the CES specification, we find that the depreciation rates are higher, but we have set $\delta_k = \delta_h$. The coefficients in human and physical capital accumulation are re-calibrated differently from DG and we find that, for human resources, more weight is put on the flow than the stock of capital; the converse is true for physical capital, with the greater weight on existing physical resources.

The coefficients in human and physical capital accumulation are re-calibrated differently from DG and we find that, for human resources, more weight is put on the flow than the stock of capital; the converse is true for physical capital, with the greater weight on existing physical resources.

The fiscal policy instruments are: $s, g, \tau_n, \tau_k$. We follow DG in setting the steady-state values for $s, g, \tau_n, \tau_k$ to match the shares reported in OMB tables. Note that $s > g$, as per their respective shares of outlays; and that the tax rates are average rates, not marginal rates.

Table 3: Steady-State Values of the Fiscal Instruments

| | | |
|---|---|---|
| subsidy share of educational expenses | $s$ | 0.54 |
| infrastructure share of capital expenditure | $g$ | 0.24 |
| average (corporate) tax rate | $\tau_k$ | 0.23 |
| average (individual) tax rate | $\tau_n$ | 0.16 |

# 4 Estimation of the Shock Processes

This section estimates the autoregressive parameters governing the wedge/shock processes for productivity, preferences and policy frictions, as well as the processes governing the fiscal instruments $(\rho_z, \rho_x, \rho_r, \rho_s, \rho_g, \rho_k, \rho_n)$. We take as observable the demeaned log first differences of real per-capital real GDP (ie growth rates), the demeaned labor share and the demeaned real gross long term interest rate and the demeaned data (expressed as percentage of GDP) for the two outlays (on physical and human capital) and the two revenues. The frequency of the data is annual from 1948 to 2018.

Table 4 presents the parameter estimates for the autoregressive stochastic processes in the three sectors - production, households and government and the fiscal instruments. We also include the corresponding standard deviations. This table shows the degree of persistence in the posterior means for six of the seven variables and the faster adjustment in the fiscal instrument for expenditure on physical capital (like transport). The standard deviation for this expenditure shock is also higher, showing the greater discretionary component in this type of spending.

Table 4: Estimated Parameters and Standard Deviations

| | mean | Inf | Sup |
|---|---|---|---|
| Parameters | | | |
| $\rho_z$ | 0.902 | 0.863 | 0.942 |
| $\rho_x$ | 0.932 | 0.897 | 0.970 |
| $\rho_r$ | 0.835 | 0.777 | 0.892 |
| $\rho_s$ | 0.918 | 0.888 | 0.947 |
| $\rho_g$ | 0.528 | 0.410 | 0.644 |
| $\rho_k$ | 0.881 | 0.836 | 0.922 |
| $\rho_n$ | 0.904 | 0.867 | 0.939 |
| Standard.deviation | | | |
| $\sigma_z$ | 0.035 | 0.029 | 0.039 |
| $\sigma_x$ | 0.025 | 0.019 | 0.029 |
| $\sigma_r$ | 0.022 | 0.019 | 0.025 |
| $\sigma_s$ | 0.032 | 0.028 | 0.037 |
| $\sigma_g$ | 0.052 | 0.044 | 0.059 |
| $\sigma_k$ | 0.024 | 0.020 | 0.027 |
| $\sigma_n$ | 0.008 | 0.006 | 0.009 |

Figure 3 pictures the implied wedge process, given the estimated smooth shocks for productivity, labor share and the real rate $(\widehat{e}_{zt}, \widehat{e}_{xt}, \widehat{e}_{rt})$ and the estimated autoregressive coefficients $(\widehat{\rho}_z, \widehat{\rho}_x, \widehat{\rho}_r)$. The shocks to productivity show the marked downturns at the time of the oil shocks in the mid and late 70's, at the time of the Gulf War in the early 90's. But the large and protracted decline in the productivity wedge began after the September 2011 terrorist attack on the Twin Towers, with a further drop at the time of the Global Financial Crisis in 2008. Overall, the results show the decline in the productivity/efficiency wedge ($z$).

For the household sector, we see that the rise in positive shocks to the marginal utility of consumption (thus lowering consumption demand) after the onset of the global financial crisis in 2008. But overall, the wedge show a rise in the preference factor ($x$). Shocks to the real rate are relatively smaller for most of the sample and positive, with the evolution of the risk wedge rising.

Figure 4 pictures the estimated evolution of the fiscal instruments which reflect the policies discussed above. We see the upward trend in subsidies for human resources (which includes education and medical expenditures). Government expenditure on physical resources is more variable, with increases in the mid 1970s, 1990s and post GFC. There has also been a decline in the implicit tax rate on capital, but an increase in income taxes.

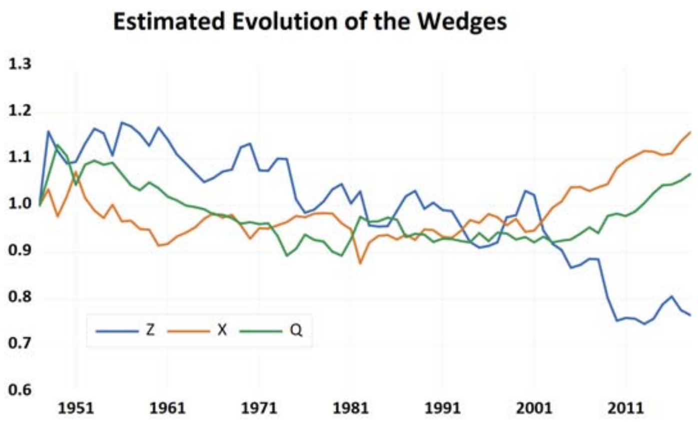


Figure 3: Estimated Wedges

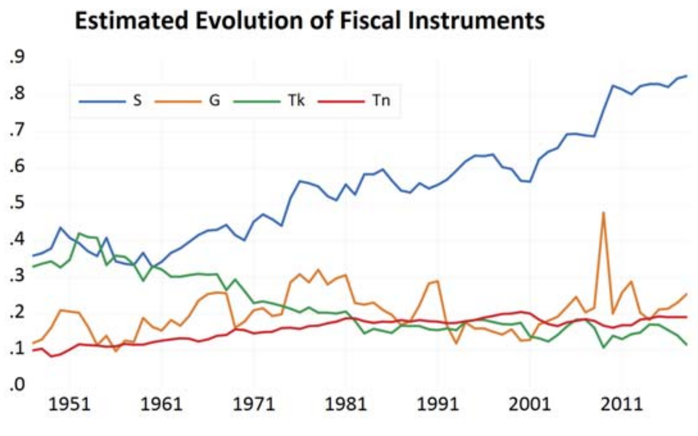


Figure 4: Estimated Fiscal Instruments

## 4.1 Contributions to changes in the wage share

Figure 5 shows the historical decomposition of shocks to productivity $z$, preference $x$ and risk $q$ and the aggregate fiscal shock (ie due to changes in $s, g, \tau_k, \tau_n$) to deviations of the wage share. As is clear, productivity shocks have the greatest effect, followed by changes in consumption preferences. But note that the changes in the fiscal instruments (collectively) have generated opposing effects, acting negatively on labour change in the first half of the sample, but acting positively in the latter part of the sample.

A clearer representation of the role of fiscal policies can be seen from a decomposition based on contributions from physical and human capital. In equilibrium, after some manipulations, we obtain a relation which relates the wage share to the ratio of expenditure on human capital $\frac{e}{y}$ and on physical capital $\frac{m}{y}$ ,where $\Phi_{gkt}$ and $\Phi_{sh}$ are functions of the deep production and investment parameters:

$$\left(\frac{wn_w}{y}\right) = 1 - \left(\frac{p}{y}\right)\left(\frac{(1-g)}{(1-\tau_k)}\Phi_k\right) - \left(\frac{e}{y}\right)\left(\frac{(1-s)}{(1-\tau_n)}\Phi_h\right)$$

$$\Phi_k = \left[\left(\frac{1-\beta\left[(1-\delta_k)+\delta_k\omega_k\right]}{\delta_k\omega_p}\right)\right]$$

$$\Phi_h = \left[\left(\frac{1-\beta\left[(1-\delta_h)+\delta_h\omega_h\right]}{\delta_h\omega_e}\right)\right]$$

The equation shows how the direct effect of changes in the fiscal instruments $g, s, \tau_k, \tau_n$ affect the weights put on changes in human and physical capital expenditure and their relationship with the wage share. The equation is a steady-state long run relationship, but we can use it to decompose the profit share at each point in time as follows:

$$profit\_share_t = (1 - \frac{w_t n_{wt}}{y_t}) = physical_t + human_t + residual_t$$

$$physical_t = \left(\frac{p_t}{y_t}\right)\left(\frac{(1-g_t)}{(1-\tau_{kt})}\Phi_k\right)$$

$$human_t = \left(\frac{e_t}{y_t}\right)\left(\frac{(1-s_t)}{(1-\tau_{nt})}\Phi_h\right)$$

The residual represents all factors/frictions such as lagged effects, changes in deep parameters not accounted for by the fiscal shocks. Figure 6 pictures these effects. The startling result is the persistence of the residual item since the beginning of the 21st century. The structural effects of spending on the wage share has been quite modest since 2000.

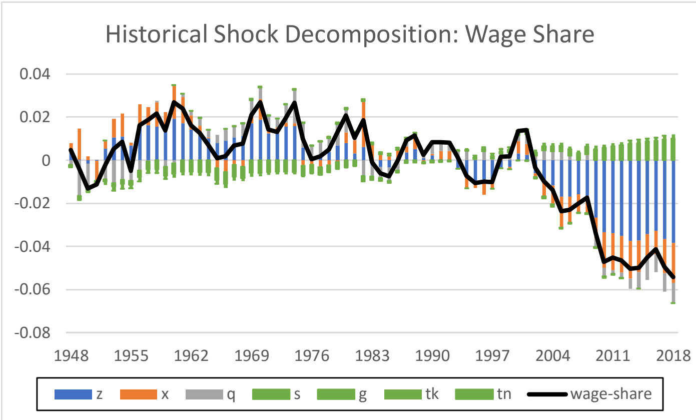


Figure 5: Wage Share

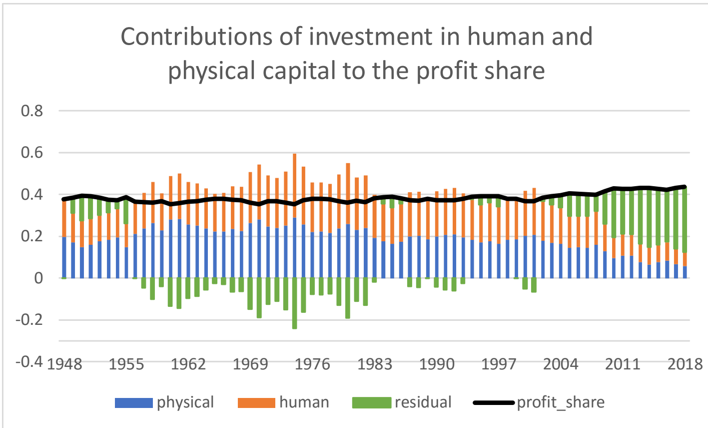


Figure 6: Profit Share

## 5 Policy simulations

Fiscal rules have been categorized as less flexible than monetary rules, due to legislative decision-making, but as we see in the above charts, tax rates and spending have fluctuated over the past decades.

In this section, we discuss results from a number of experiments that approximate fiscal policies. The eight fiscal options considered are as follow:

1. change to the subsidy rate for education, $\Delta s_t$, resulting in a fiscal stimulus of $\Delta s_t(e_t)$
2. change to the government contribution to infrastructure spending, $\Delta g_t$, resulting in a fiscal stimulus of $\Delta g_t(m_t)$
3. change to the income tax rate: $\Delta \tau_{n,t}$, resulting in a fiscal change of $\Delta \tau_{n,t}(w_t n_{wt} + w_{ht} h_t)$
4. change to the tax rate on earnings from non labour income (dividends), $\Delta \tau_{k,t}$ resulting in a fiscal change of $\Delta \tau_{k,t}(d_t k_t)$
5. combination of a change in the subsidy rate and in the tax rate on labor income such that the increment to the expenditure on education is balanced against an increase in income tax revenue: $e_t \Delta s_t = \Delta \tau_{n,t}(w_t n_{wt} + w_{ht} h_t)$
6. combination of a change to the subsidy rate and to the tax on non-labor income (dividends) such that the increment to educational expenditure is matched by an increase in tax revenue from dividends: $e_t \Delta s_t = \Delta \tau_{k,t}(d_t k_t)$
7. combination of a change in government capital infrastructure spend and the tax rate on labor income such that the increment to expenditure is balanced against an increase in tax revenue: $m_t \Delta g_t = \Delta \tau_{n,t}(w_t n_{wt} + w_{ht} h_t)$
8. combination of a change in government capital expenditure and the tax rate on dividends such that the increment to expenditure is balanced against an increase in tax revenue: $m_t \Delta g_t = \Delta \tau_{k,t}(d_t k_t)$.

The first four simulations consider individual changes in spending and revenue and the following four consider policies where expenditure and revenue policies are linked. This is because fiscal policies often adopt sequestering or pay-as-you-go spending rules. We consider combinations of revenue changes tied to infrastructure spending and/or subsidies to education. All four of these combination policies are by definition balanced-budget policies in the sense that they are, on impact, debt neutral.

We examine next how these fiscal rules affect welfare as well as the labor's share of national income.

## 5.1 Ramsey Policies and Fiscal Multipliers

This section examines the effects of Ramsey fiscal policies. Specifically we conduct eight Ramsey policy simulations to derive the optimal time-varying values for the fiscal policy instruments by optimizing welfare defined as the discounted value of household utility:

$$V_t = \sum_{t=0}^{\infty} \beta^i U_{t+1}$$

Table 5 compares the steady-state values of the policy instrument under Ramsey rules relative to the base case. The base case are based on the steady-state values: subsidy rate (0.56), government share of capital expenditure (0.21), average income tax (0.16) and average tax on profits (0.22).

In the first experiment, we consider a change in subsidies $s_t$, holding unchanged all other calibrated parameters. As shown, the Ramsey suggested subsidy rate is 0.51. In contrast, in the experiment to determine the Ramsey value for the government investment share $g_t$ the results show that it should be increased. For the tax rates, we find that both the tax rate on labor income $\tau_{n,t}$ and on capital income $\tau_{k,t}$ should be lower: $\tau_k$ from 0.22 to 0.18 while $\tau_n$ is about optimal at 0.16.

When policies take into account both spending and revenue aspects, the results suggest a reduction in subsidies with accompanying lower tax rates. Spending on physical capital is also likewise reduced. Thus our result support both Sims and Wolf (2018) and Bilbie, Monacelli, and Perotti (2019). The former argue that: on average the size of government consumption (as revealed in direct subsidies to households for education) may be too high, and the size of government investment (as revealed in infrastructure spend) is too low, relative to what would be optimal, while the latter argue that the further increases in government consumption, relative to what was done at the start of the Global Financial Crisis, would have been sub-optimal. Our results are also consistent with Bouakez, Guillard, and Roulleau-Pasdeloup (2017), who find much stronger multipliers associated with public investment, due to "time to build" dynamics.

However, this result is modified once we assume a degree of fiscal restraint, that is the changes in the instruments are paired so that both the revenue and expenditure sides of the budgetary equation adjust. In the cases when financing is also taken into account, the Ramsey values are all lower.

Table 5: Ramsey Values*

| policy instrument | base values | Ramsey values |
|---|---|---|
| $s_t$ | 0.54 | 0.51 |
| $g_t$ | 0.24 | 0.28 |
| $\tau_{k,t}$ | 0.23 | 0.18 |
| $\tau_{n,t}$ | 0.16 | 0.16 |
| $s_t, \tau_{k,t}$ | (0.54, 0.23) | (0.37, 0.10) |
| $s_t, \tau_{n,t}$ | (0.54, 0.16) | (0.37, 0.13) |
| $g_t, \tau_{k,t}$ | (0.24, 0.23) | (0.19, 0.21) |
| $g_t, \tau_{n,t}$ | (0.24, 0.16) | (0.16, 0.15) |

* all other calibrated values unchanged

## 5.2 Fiscal Effects on the Wage/Labor Share

The Ramsey rules, by construction maximize welfare. Our interest here is how changing the fiscal instrument affects the wage share (the payment for work) and the post-tax labour share (which includes the skill premium) To this end, we simulate the model, using the information about the size of shocks for $z, x$ and $q$. We consider eight experiments - four cases with changes in each of the fiscal instruments, and four more cases, when changes in the expenditure options are matched with changes in the tax financing options.

For the paired instrument experiments, we let the shocks be close to being perfectly correlated. The standard deviations for the shock to the instrument correspond to the estimated standard errors in all the experiments to yield min-max range for the instruments as: $s$ (0.34-0.79), $g$ (0.05-0.40), $\tau_k$ (0.08-0.37); $\tau_n$ (0.11-0.23). These are realistic ranges for fiscal policies. In these experiments the real rate varies between 0.94 to 1.10 while the growth rate varies between -0.33 to 0.49.

Table 6 presents the (average) correlations of the fiscal stimulus with the wage share and labor share. They show that the fiscal instruments that affect spending on human and physical capital ($s$ and $g$) have the strongest direct effect on the wage and labour shares. But, these direct effects are offset to a large extent once tax rates are changed to finance the spending.

Table 6 also presents associated fiscal-wage multipliers computed as the max-min change in the wage/labour shares per unit max-min change in the fiscal stimulus. The min-max range of outcomes in all the experiments are: wage share (0.58-0.67), labor share (0.51-0.58). The change in fiscal stimulus is now different. As we can see, the consequences for the effects of the subsidies and government public infrastructure spending is high; once taxation is coupled with these spending programs.

Table 6: Simulated Results

| | correlations | | multipliers | |
|---|---|---|---|---|
| policies | wage-share | labor-share | wage-share | labor-share |
| $\Delta s$ | 0.53 | 0.23 | 0.37 | 0.29 |
| $\Delta g$ | 0.37 | 0.18 | 2.48 | 1.97 |
| $\Delta\tau_k$ | -0.01 | 0.09 | 1.57 | 1.25 |
| $\Delta\tau_n$ | 0.22 | -0.60 | 1.22 | 1.22 |
| $\Delta s, \Delta\tau_k$ | 0.42 | 0.13 | 0.40 | 0.35 |
| $\Delta s, \Delta\tau_n$ | 0.36 | 0.27 | 0.41 | 0.45 |
| $\Delta g, \Delta\tau_k$ | 0.17 | 0.05 | 1.56 | 1.35 |
| $\Delta g, \Delta\tau_n$ | -0.05 | 0.59 | 1.38 | 1.48 |

Our results on multipliers show that spending on infrastructure has strong long-term effects on the wage share while subsiding educational expenses will have very modest multiplier effects on the wage share. However, the tax strategy matters. Obviously, increasing capital tax to support the infrastructure spend will lower the post tax capital share, and increasing labor tax rates will lower the post-tax labor share. But, what matters for inequality is the relative effect on the factor shares. In the case where taxes are increased to support infrastructure spend, the overall effect is to improve the post-tax labor share.

## 5.3 Approximations to Ramsey Policy Rules

So far, we have discussed the effects of Ramsey policy rules for the fiscal instruments, either taken independently, one by one, or as linked instruments between tax and spending. The Ramsey rule for each of these instruments is based on all the state variables in the model, as well as the lagged Lagrangean multipliers associated with the constraints of the Ramsey problem. It is unlikely that fiscal authorities would observe all of these variables at the time of policy formulation and implementation.

Many studies have compared the Ramsey outcomes with optimal simple rules, based on a few variables which have readily observable counterparts in macroeconomic time series. The goal of much of this research is to find the best simple rules which minimize the distance between its outcome and the Ramsey outcome. Our intention in this section is more modest. We ask, what are the suggested Ramsey responses to deviations of GDP, wage share, real rate and the deficit to GDP ratio from their respective means? Should the fiscal instruments be counter or pro-cyclical with respect to GDP growth, should they respond to engender greater or lower labor shares (and thus to promote equality), should they respond positively or negatively to changes in the real interest rate and to changes in the real deficit to GDP ratio?

We simulate the model for the respective Ramsey rules for T = 1000 and estimate the response of each fiscal instrument either individually or in paired relations of tax and spending changes, in a regression context to deviations of GDP, wage share, real interest rate and the deficit to GDP ratio (all relative to their steady states). These variables correspond to our three observables; the deficit variable corresponds to the difference between the fiscal expenditure and revenue variables. The results are presented in Table 7.

For convenience of discussion, the results are presented in 4 blocks corresponding to the fiscal instruments: subsidy rate to support investment in human resources ($s$), share of government investment in physical resources ($g$), tax rate on income from capital ($t_k$) and tax on labour income ($t_n$). The column headed "base" is the non-Ramsey policy case where the instruments are assumed to evolve as an AR process. The next columns show the regression estimates when Ramsey rules are implemented.

The three columns show respectively, the single instrument Ramsey policy case, then the paired expenditure-revenue Ramsey policies. For example, results under policy heading $(s, t_k)$ and $(s, t_n)$ show respectively how the fiscal instruments respond under Ramsey conditions for the subsidy rate, under two different financing cases - one when the tax revenue is generated from taxing capital and the other when the tax revenue comes from wages.

First, a couple of general observations. The Ramsey policy rules suggest more persistence in revenue instruments $(t_k, t_n)$ than expenditure instruments $(s, g)$. The second general observation is with respect to the deficit to GDP ratio. The results are consistent across options, namely curtail expenditures and increase taxes when the deficit to GDP ratio rises. The magnitude of response varies, but not the direction.

Table 7: Fiscal Instrument Responses to Selected Observables*

| policies | base | $s$ | $s, t_k$ | $s, t_n$ |
|---|---|---|---|---|
| AR(1) | 0.81* | 0.23* | 0.52* | 0.50* |
| y-growth | 0.02* | 0.38* | 0.35* | 0.91* |
| wage-share | -0.52* | 1.28* | -0.69 | 1.06* |
| R | -0.02 | -0.22* | 0.89* | 0.66* |
| Deficit/y | -0.34* | -2.16* | -3.74* | -3.52* |
| constant | 0.10* | 0.42* | 0.24* | 0.26* |

| policies | base | $g$ | $g, t_k$ | $g, t_n$ |
|---|---|---|---|---|
| AR(1) | 0.54* | 0.40* | 0.75* | 0.65* |
| y-growth | -0.00 | 3.84* | -0.35 | 6.98* |
| wage-share | -0.28* | -1.23 | -8.66* | -6.12* |
| R | 0.00 | -0.46 | 3.59* | 3.07* |
| Deficit/y | -0.16* | -7.17* | -1.63* | -1.67* |
| constant | 0.11* | 0.14* | 0.08* | 0.18* |

| policies | base | $t_k$ | $t_k, s$ | $t_k, g$ |
|---|---|---|---|---|
| AR(1) | 0.86* | 0.01* | 0.99* | 0.90* |
| y-growth | -0.01 | 0.69* | 0.53* | 1.28* |
| wage-share | 0.05 | 0.16 | -0.13 | -0.04 |
| R | -0.01 | 0.72* | 0.05 | 0.42* |
| Deficit/y | 0.06* | 5.01* | 0.07* | 0.68* |
| constant | 0.03* | 0.23* | -0.00 | 0.03* |

| policies | base | $t_n$ | $t_n, s$ | $t_n, g$ |
|---|---|---|---|---|
| AR(1) | 0.86* | 0.18* | 1.02* | 0.91* |
| y-growth | 0.00 | -0.14* | 0.18* | 0.05* |
| wage-share | 0.06* | 0.35* | -0.02 | 0.50* |
| R | -0.01 | 0.26* | 0.03* | 0.16* |
| Deficit/y | 0.03* | 0.95* | 0.07* | 0.91* |
| constant | 0.02* | 0.13* | -0.01* | 0.02* |

* Demeaned values of observables

The fiscal responses to changes in the wage share are mixed and probably reflect a re-balancing of factor incomes. When the wage share is high (above its steady-state value), fiscal support for physical capital accumulation could be reduced while taxation could be increased. The reduced–form regression support a fall in infrastructure spend and a hike in the income tax rate (but not on taxes on dividends).

The Ramsey response for the subsidy rate is positive meaning that when the wage share increase above its steady state value, spending on human capital could increase (thereby increasing returns to human capital and by extension the profit share of total GDP will also increase). This also implies the reverse - the public sector can reduce its subsidy spending on long-term investments in human capital but increase its spending on physical capital during periods of falling wage shares (computed as worker compensation).

When the real rate is high and/or growth is above the steady-state, Ramsey policy rules suggest expanding subsidies in education, increasing spend on infrastructure, and raising taxes. These responses reflect the higher capacity of the household sector to bear higher taxes, and the potential of the public sector to boost investment in human and physical capital.

The exception occurs when revenue and spending fiscal policies are not paired. During periods of high real rates spending to support human capital could fall when viewed in isolation. Likewise, during periods of high growth, tax rate on income from wages could also fall (because the taxation base has increased). These counter-cyclical relationship between the fiscal instruments and GDP growth (the result holds for contemporaneous and lagged growth) are consistent with the widely accepted idea of optimal counter-cyclical fiscal policy, namely that government expenditures and taxes can fall when output growth is high.

In general though, these simple regression results show that, so long as growth is positive, a case can be made to increase spending on human and physical capital, supported by higher taxes. To be sure, these regression results represent approximations to the broader Ramsey rules for the fiscal instruments. Nevertheless, they show the contemporaneous relationships between the fiscal instrument and the main macroeconomic indicators and the results suggest that higher subsidies to support human capital accumulation along with higher income taxes are compatible with promoting economic growth and higher wage share. However, while higher government expenditure on capital is compatible with higher growth, it will also lead to lower wage shares.

# 6 Concluding Remarks

We have adopted a model-based approach to consider the role of fiscal policy, both on the expenditure and taxation sides, on the wage/labor share, as well as on GDP growth and public debt. The model has a CES production function where investment in human and physical capital require time away from working for a wage. Fiscal policy contributes directly to these decisions.

Our optimal policy simulations show that on average the size of government investment (as revealed in infrastructure spend) is lower than optimal. The case for spending on infrastructure is further supported by strong output and welfare multiplier effects. Our long-run multiplier analysis shows that spending on infrastructure financed from capital taxes is the preferred stimulus, as it has both strong impact effects as well as strong long-term effects. Boosting educational subsidies will have very modest impact effect, but steady long run multiplier effects. Furthermore, financing the educational subsidies with taxation on labour returns will not have detrimental effects on the labor share of GDP.

Our results suggest that a "back-to-the future" policy reform is in order both for public expenditures and for tax policies. The 1950s saw sustained growth, declining debt, and rising labor shares supported by increased spending both on human resources as well as infrastructure financed by high tax rates on income and corporate earnings.

The case for massive infrastructure spending of the 1950s may be a hard case to make in terms of political economy of today [see, for example, Taylor (2000, 2018)]. However, setting fiscal policies aimed at long-run targets of a stable labor share and stable debt/GDP ratios through educational subsidies and tax rates stands out as an important lesson to learn from the experience of the 1950s.

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