Government Purchases, the Labor Earnings Gap, and Consumption Dynamics

Preliminary and incomplete

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August 29, 2021

Abstract

In this paper, we revisit the effects of government purchases on consumption by considering its effects on inequality in the United States. We show three empirical facts in this regard: (i) government spending raises consumption as well as labor income inequality between skilled and unskilled workers; (ii) the size of the responses of labor income inequality and consumption to a government spending shock are negatively related; (iii) government purchases concentrate towards sectors with a larger share of skilled workers than the overall economy. We show that a model with two sectors, two groups of workers, and limited access to financial markets in which the government buys more proportionally from the skilled intensive sector can account for these empirical facts. As a consequence of the inequality government purchases generates, the government spending multiplier is about 30 percent lower than when the government spends exclusively on the unskilled intensive sector. The reason for this is that government spending delivers disproportionately more income to skilled workers, who have a low marginal propensity to consume. Therefore, the way government spends matters both for inequality and for the effectiveness of government spending in stimulating the economy.

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1 Introduction

There is an extensive literature that studies the effects of government spending on aggregate outcomes. While this literature agrees that a rise in government spending increases output, the conclusion about its effects on consumption is still open (see Ramey (2016)). Understanding the effects of government purchases on consumption is essential for at least two reasons. First, the response of consumption is crucial to assess the welfare implications of government spending programs. Second, the relationship between consumption and government spending helps us understand the underlying economic model. Some researchers claim that finding a fall in consumption in response to a rise in government purchases favors the Real Business Cycles model (RBC) over the New Keynesian model (or Keynesian) as a consequence of a crowding-out effect of government spending on consumption.

In this paper, we study the effects of government spending on consumption by considering its effects on labor income inequality. The previous literature shows that when consumers have imperfect access to financial markets (and they cannot smooth out consumption perfectly), all sources of income determine consumption in the cycle.[1] Hence, in economies where consumers are heterogeneous and have different MPCs, the effect of government spending on the different types of income matters. If the government affects the distribution of income, it is changing the average MPC of the economy, and thus, it is affecting aggregate consumption and the aggregate demand.[2]

To study empirically to what extent government purchases affect income inequality and then consumption, by using the *Current Population Survey* we build an index of inequality that we call the *earnings gap* for the U.S., which we define as the ratio of skilled to unskilled labor income.[3] We embed this variable into a Bayesian Structural Vector Autoregression following the specification used by Galí et al. (2007) and show that government spending increases this gap. That means that government spending raises the labor income inequality between skilled and unskilled workers. In addition, we study whether the earnings gap is related to aggregate consumption conditional on government spending shocks. We estimate a Time-Varying Structural Vector Autoregression as in Primiceri (2005) and show a negative relationship

[1] See, for instance, Kaplan et al. (2018).

[2] This concept goes back to Keynes (1936) Ch.19, where he mentions that wages enter the aggregate demand if wage fluctuations affect the average MPC of the economy. In this work, we exploit a similar argument in which as a consequence of government spending, there is a redistribution of resources between agents with different MPC, making the avreage MPC fluctuate. That, in turn, affects aggregate consumption. A more modern approach is studied by Bilbiie (2020), where he shows that is the income cyclicality of the high-MPC consumer that matters for the effects of inequality in the business cycle. We exploit these concepts in this work.

[3] Skilled are the workers with completed bachelor's degree or higher; the rest are classed as unskilled.

over time between the responses of consumption and the earnings gap following a government spending shock. That means that when government spending shocks generate higher inequality, consumption responds less strongly. Third, we use microdata for the U.S. government purchases to show that government spending concentrates on sectors with a higher share of skilled workers than the overall economy. For example, Aerospace and R&D services account for about 25 percent of total government spending, and these are sectors with a large skilled income share (66 and 82 percent, respectively which is higher than the 50 percent the overall economy has). That means that an additional dollar of government spending accrues disproportionately to skilled workers. This pattern of distribution could be behind the increase in labor income inequality in response to a government spending shock. Finally, we show that unskilled workers are more financially constrained than skilled workers. We measure the share of Hand-to-Mouth (HtM) consumers as in Kaplan et al. (2014) in both groups of workers.[4] We show that the share of HtM of unskilled workers is about three times higher than that of the skilled workers. This means that unskilled workers have on average a higher MPC.

In the second part, we rationalize these facts in a New Keynesian model with limited asset market participation. We assume there are two productive sectors that supply goods and two groups of workers –skilled and unskilled. Sectors are in monopolistic competition and are subject to price rigidities. Both groups of workers supply labor to both sectors, but in different proportions. To be consistent with the empirical evidence above, we give the two groups of workers different levels of access to financial markets. This generates heterogenous MPCs between the groups of workers. Finally, consumers and the government buy goods from both sectors, with unequal weights.

We develop two analytical results with the model. First, we show that due to the different access to financial markets that different groups of workers have, there is a negative relationship between the earnings gap and consumption; i.e., consumption falls in response to an increase in the earnings gap. That happens because when the earnings gap goes up, skilled workers earn more relative to unskilled workers. As skilled workers have more access to financial markets, they smooth out consumption more, and hence, the average MPC falls, lowering consumption. An interesting consequence of the latter is that if the response of the earnings gap is strong enough, it may reverse the sign of the consumption response (counteracting the positive effect of government spending on consumption highlighted by Galí et al. (2007)). Therefore, we show that consumption may also fall in New Keynesian models with incomplete markets if we consider

[4]We measure the share of Hand-to-Mouth as the share of households who hold zero liquid assets, where zero is defined as having 30 percent (in absolute value) of their income (or less) in these types of assets in a given period. See Kaplan et al. (2014) for more details.

this dimension of heterogeneity (which is consistent with the evidence provided by Ramey (2011)).

We show the conditions for the earnings gap to rise in response to a government spending shock. We show that two channels drive the response of labor income inequality. A *direct channel*, which operates through direct government purchases of the two goods. If the government purchases the high skilled intensive good in a higher proportion than the economy, government purchases raise the earnings gap. The intuition is straightforward: a large proportion of the extra income generated by the government is accrued to skilled workers, increasing labor income inequality. The second channel is a *general equilibrium channel*, which operates through the responses of aggregate variables. We show that the earnings gap depends on output and prices as well as government spending.

Finally, we study these questions quantitatively in a model by analyzing different calibrations focusing on the way government spends. We compare a baseline calibration (where the government spends more proportionally in the skilled intensive sector) with an alternative in which all the spending is in the unskilled intensive sector. We show that switching from the calibration of the actual economy to spending only on unskilled intensive sectors, the response of consumption to a government spending shock is 45 percent larger. That implies that the fiscal multiplier rises by about a third when government spending switches to unskilled intensive sectors.

The main takeaway is that the size of the government spending multiplier is affected by the impact of government spending on earnings inequality. To the extent that, as we show below, an increase in government spending raises earnings inequality, the size of the multiplier also reduces through a dampening effect on private consumption.

Related Literature. This paper is related to two strands of the literature, the literature on the effects of government spending on macroeconomic aggregates and the theoretical mechanisms through which government spending operates.

The former is comprehensively accounted by Ramey (2016), who summarizes the state of the art on the effects of government spending. We use Blanchard and Perotti (2002) (BP) identification, who find a positive effect of government spending on consumption. Additionally, they report a fiscal multiplier between 0.6-1.2. A paper which is related to ours is Galí et al. (2007) who extend the BP identification scheme to focus on the effects of government spending on consumption. They show that government spending raises output and consumption, with the response of the latter following disposable income. That finding motivates considering models for consumption behavior with limited access to financial markets as the one we emphasize. The other strand of the empirical literature is the one led by Ramey (2011) who extends

Ramey and Shapiro (1998) by considering a the period from 1939 to 2006 and building the expected value of military buildups. She finds negative effects of government spending on consumption, unlike BP. The reason why she find these effects is that according to her view, the BP shocks are anticipated while the military spending shocks are not. In the main exercises we use BP since as Ramey (2016) shows, the military spending shocks do not pass the test of weak instruments for the period after the Korean War.

On the theoretical and microdata side, our paper is related to Cox et al. (2020) who study the sectoral composition of government spending, and show that government purchases are concentrated towards sectors that have more sticky prices, which raises the fiscal multiplier. A similar argument is raised by Bouakez et al. (2021) who study the size of the fiscal multiplier in a production-network economy where sectors differ in their price rigidity, factor intensities and use of intermediate inputs. They find that the multimplier rises by 75% with respect to a one-good economy. The amplification they find is due to input-output linkages and sectoral heterogeneity in price rigidity. Another work which studies the effects of the sectoral composition of government spending is by Boehm (2020) who shows that a reason why the fiscal multiplier is relatively low is because it is concentrated towards investment goods.

The most related paper to ours is Flynn et al. (2021) who study the sectoral composition of government spending and the effect of the network structure of firms and labor markets taking into account the heterogeneity in MPCs of different households. They show that fiscal multipliers vary substantially depending on where spending and transfers are targeted. They show that to be more effective, government policies must be directed towards higher MPC households.

Our paper is complementary to these in several ways. We exploit the skill composition of the different sectors, extending Cox et al. (2020) and showing that government spends on sectors more skilled intensive than the economy as a whole. Second, we show theoretically, that the previous fact has an aggregate demand channel through heterogenous MPC's; mechanism which is very similar to Flynn et al. (2021) but we only consider two consumers/workers with a different concept of heterogeneity, the one that comes from permanent differences (at least at the business cycle frequency) between households, the skill level. This allows us to abstract from idiosyncratic risk (since the mean income for the different groups would average out the idiosyncratic shocks) and helps us in proposing a more clear target for policies, given by an observable feature. Finally, we contribute in testing the inequality channel on aggregate consumption by showing that this mechanism is present in the data through the negative relationship over time in the size of the responses of consumption and labor income inequality to the government spending shock.

Layout. The remainder of the paper is as follows. Section 2 studies empirically, the effects of government spending on consumption and labor income inequality. Section 3 describes the model. Section 4 develops two analytical results, the solution for the aggregate demand and studies why the earnings gap fluctuates in our model. Section 5 presents quantitative results for different calibrations of our model. Finally, section 6 concludes.

2 Empirical Evidence

In this section, we revisit empirically the effects of government purchases on consumption taking into account its effects on labor income inequality. We first show that an increase in government spending generates income inequality and raises consumption. Then, we show that the size of the responses of consumption and labor income inequality to a government spending shock, are negatively related. Finally, we show that government purchases are concentrated towards sectors with a high share of skilled workers.

2.1 The Earnings Gap

In this subsection, we introduce the variable that we will work with throughout the paper: the earnings gap. We denote the earnings gap by η_t, which formally we define it as the ratio of skilled to unskilled average labor income

$$\eta_t = \frac{\text{Skilled labor income}}{\text{Unskilled labor income}}.$$

For this paper, we divide the population into these two groups, skilled and unskilled. We consider in the former group workers with a completed bachelor degree or higher while an uncompleted bachelor degree or less in the latter.[5] We are interested in the inequality of total labor income (total hours and wages), because it is these together which determine consumption.

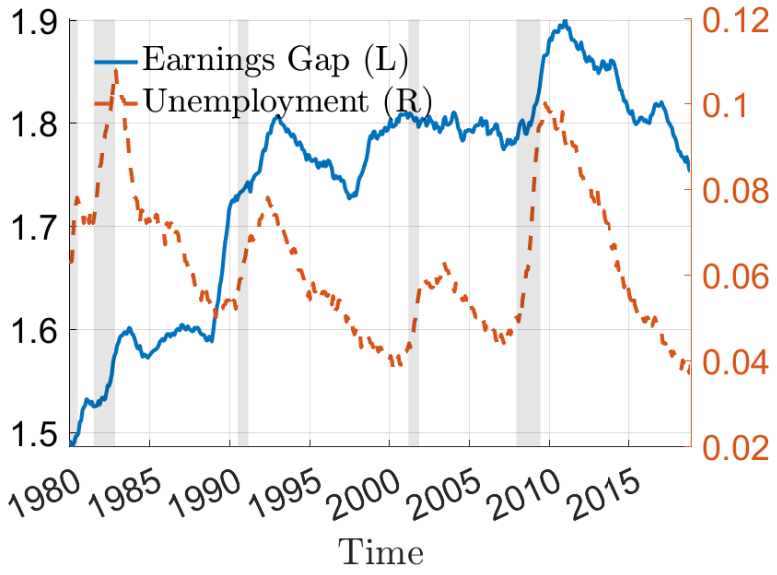
To build η_t, we take the *Current Population Survey* (CPS) that has individual earnings and demographic data. We consider the period from 1979M1 to 2018M12. We use a uniformed version of the CPS built by the *Center of Economic and Policy Research* (CEPR).[6] The CEPR computes uniformed hourly wage and labor earnings for each period, which are comparable between surveys. They also complete the sample by imputing weekly earnings from hourly wages and vice-versa if the respondent lacks one of the variables. We use the CEPR measure of total weekly labor earnings in what follows and we calculate the cross-sectional

[5] According to the Current Population survey, the share of skilled workers is about 40% and the share of unskilled is about 60% by 2018.

[6] See http://ceprdata.org/ for more information.

weighted average of labor income by group. Hence, the earnings gap is a measure of per-capita labor income inequality.

Figure 1: Labor earnings gap and unemployment.



Notes: This figure shows the Earnings Gap in the business cycle. The left-hand panel depicts the level of the earnings gap compared with the unemployment rate. The gray vertical lines correspond to the NBER recessions.

Figure (1) displays the earnings gap. Four observations worth commenting. First, that since the 2000's, the earnings gap is high, and around 1.8. Second, our earnings gap accounts for the increase on labor income inequality between skilled and unskilled workers documented in previous studies (see Acemoglu (2002), for example). At the beginning of the 1980s the earnings gap was about 1.5; i.e, skilled workers earned 50% more than the unskilled on average. During the 1980s the gap increased substantially and rose to about 1.8, to stay around that level until the Great Recession.[7] Third, the earnings gap increases in recessions and falls in expansions. In all the recessions except for 2001 (which seems to be a very particular one), the earnings gap has increased significantly. There are also several periods in which the gap increases even in expansions like the period prior to 1990. However, in long periods of expansion, like 1992-1997 or from 2011 to 2018, the earnings gap fell, but the fall was less pronounced than that of the unemployment rate, suggesting that the earnings gap has even more persistence than the unemployment rate. Fourth, and related to the previous point, the earnings gap seems to behave assymetrically; i.e, the earnings gap

[7]This is consistent with the evidence on the increase of the skill premium. In general, the skill premium literature only looks at the widening of the wage gap. But as we are interested in what determines consumption, we study total labor income since fluctuations in employment also play a role in determining the earnings gap.

increases sharply in recessions but seems to stay at high levels for a long period, often until the next recession takes place and pushes inequality further up.[8]

2.2 Government Spending Raises the Earnings Gap: Evidence from a Bayesian SVAR

The baseline VAR includes the earnings gap, government expenditures in consumption and investment, government receipts, GDP, consumption of non-durables and services, fixed non-residential investment, and unemployment. All the quantity variables are real, are divided by the working-age population, and enter the regressions in logarithms. Data is quarterly and we consider the period 1981Q1-2018Q4 which is the longest sample available for calculating the earnings gap. Finally, we include four lags in the estimation.[9]

We first estimate a Bayesian SVAR with Normal-Inverse Wishart priors, where we study the response of the economy to a government purchases shock. We identify this shock through a Cholesky identification (following Blanchard and Perotti (2002)), by ordering government spending first; i.e., government spending does not respond contemporaneously to the state of the economy. The reason why we use a Bayesian approach is the small sample available (at least for the earnings gap) and the large number of parameters to estimate in the VAR.[10] In the estimation, we follow Miranda-Agrippino and Ricco (2017) and run the Bayesian SVAR, choosing the hyperparameters optimally as in Giannone et al. (2015), who estimate the prior tightness parameters by maximizing a joint maximum likelihood for the Bayesian SVAR model.[11]

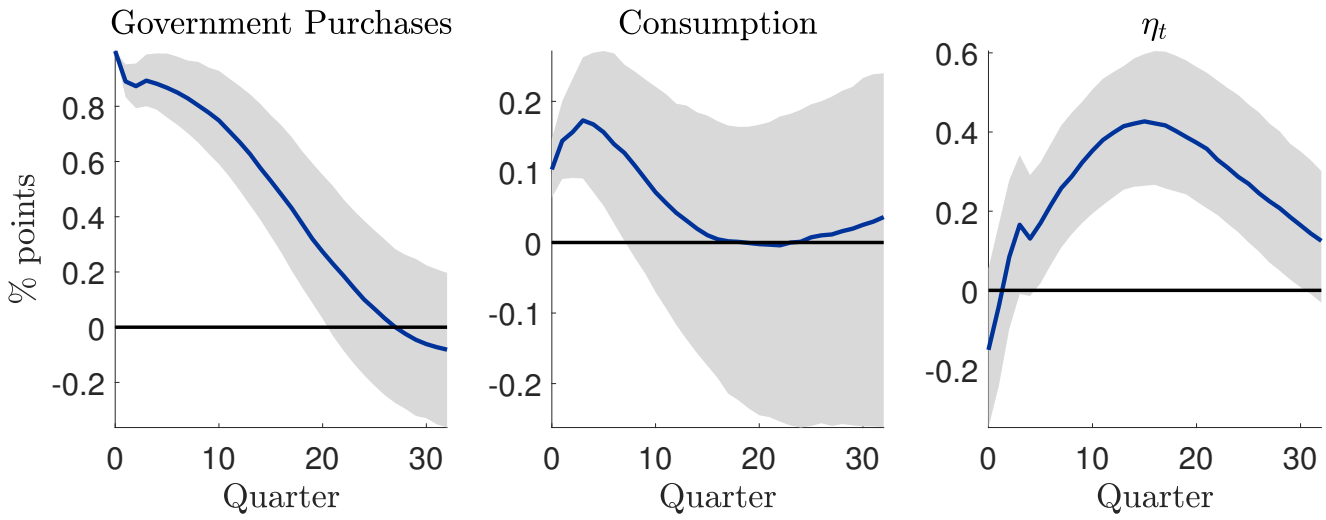
[8] In Chapter 1 we study the reasons why the earnings gap is countercyclical also in response to a monetary policy shock. As we will show below, this countercyclicality is unconditional and does not hold for all aggregate shocks.

[9] We build the Earnings Gap as we exposed before and we average the monthly data in every quarter. We obtain the data from the database presented by McCracken and Ng (2016). All variables drawn from FRED. We consider GCEC1 for government purchases, FGRECPT for government receipts, the sum of the sum of PCESV and PCND for consumption, PNFI for investment, and UNRATE for unemployment. We use this specification in this section to be able to compare the results with Galí et al. (2007).

[10] With four lags, seven endogenous variables and including a constant, the number of parameters is $7 \times (1 + 4 \times 7) = 203$.

[11] For more details, we refer the reader to these articles. And we thank Silvia Miranda-Agrippino for sharing her codes with us.

Figure 2: IRF's to a unitary shock on government spending BSVAR with Cholesky identification. Sample: 1981Q1-2018Q4



Notes: This figure depicts the responses of Government purchases, aggregate consumption, and the Earnings Gap to a unitary government spending shock. These responses are obtained from a Bayesian VAR which includes government revenues, output, investment, and unemployment too. The figure plots the median response from 4000 draws and reports the 68% confidence areas.

Figure 2 depicts the response of the three variables of our interest: government purchases, consumption, and the earnings gap in response to a one-percent increase in government purchases. The solid-blue line shows the median response from the draws in our Bayesian VAR, while the gray areas represent the 68% confidence bands. Two observations worth mentioning. First, that for our sample, consumption increases in response to the government spending shock; although the response is small, it confirms the existence of a Keynesian effect for government spending as pointed out by Galí et al. (2007). And second, that the earnings gap increases significantly and persistently. This implies that when government spending goes up, labor income inequality between skilled and unskilled workers rise.

The reader might argue that the identification scheme used is not the best to study this question since this way of computing government spending shocks does not deliver really exogenous shocks. Unfortunately, for the sample we have the earnings gap available, the shocks as those built with news about military spending are weak instruments, as pointed out by Ramey (2016). Therefore, the best–and simpler– way to conduct this exercise is to consider the identification by Blanchard and Perotti (2002). However, we still provide an estimate (though with these weak instruments) using news about military spending in Appendix A Figure 7. We find that with this alternative identification, the earnings gap still rises and responds in a very similar shape compared to the estimates with Blanchard and Perotti (2002)'s identification.

Moreover, the effects are stronger, which confirm the finding that government spending generates labor income inequality between skilled and unskilled workers. In our specification we find that as in Ramey (2016), consumption falls in response to the government spending shock.

A second issue that may arise is the endogeneity of the government spending shocks with respect to inequality when estimating with a Cholesky identification scheme. One may wonder if government spending reacts contemporaneously to inequality and that is why we observe the positive relationship between government spending and the earnings gap. We can analyze if by switching the ordering between government spending and the earnings gap the result changes. As Appendix B shows, the change in the ordering does not affect the response of the earnings gap and consumption to the government spending shock; the results are almost identical to the ones shown in Figure 2.[12]

2.3 The Size of the Responses of Consumption and the Earnings Gap are Negatively Related: Evidence from a TVC-SVAR

We are also interested in the evolution of the response of consumption and the earnings gap to a government spending shock. One of our hypothesis is that a lower (even negative) response of consumption is related to a higher (positive) response of the earnings gap, as our theory will make clear below. In this subsection we evaluate this hypothesis. To do so, we estimate a Time-Varying Bayesian SVAR (TVC-SVAR) as in Primiceri (2005). The econometric model we assume is the following

$$y_t = c_t + B_{1,t}y_{t-1} + ... + B_{k,t}y_{t-k} + u_t, \quad t = 1, ..., T, \tag{1}$$

where y_t is an $n \times 1$ a vector of endogenous observable variables, c_t is an $n \times 1$ vector of time-varying constants, $B_{i,t}$ are $n \times n$ matrices of time-varying coefficients with k the order of the VAR, and u_t is an $n \times 1$ vector of heteroscedastic unobservable shocks with variance-covariance matrix Ω_t. Consider the triangular reduction of Ω_t, $A_t\Omega_t A_t' = \Sigma_t\Sigma_t'$, where A_t is lower-triangular and Σ_t is diagonal. That allows us to write the model in Equation (1) as

$$y_t = X_t'B_t + A_t^{-1}\Sigma_t\varepsilon_t, \tag{2}$$

with $X_t' = I_n \otimes [\mathbf{1}, y_{t-1}', ...y_{t-k}']$ and B_t is the matrix which contains the matrices $B_{i,t}$ stacked.

As in Primiceri (2005), the time-varying matrices A_t and Σ_t are crucial for the exercise that follows. We want to study both a time-varying relationship between the variables, contained in B_t, while we also want to exploit the time-varying variance-covariance structure of shocks. That implies having both heteroscedastic

[12] We also tried with ordering the earnings gap last, and found no differences.

structural shocks as well as a time-varying contemporaneous relation between them. More importantly, all these elements together bring time-varying impulse responses of the different variables to a government spending shock. To conduct the estimation of model in Equation (2) we must assume a time-varying dynamics for the parameters. Let $\boldsymbol{\alpha}_t$ be the nonzero elements of matrix A_t and $\boldsymbol{\sigma}_t$ the vector of diagonal elements of Σ_t. The dynamics of the parameters are

$$B_t = B_{t-1} + \nu_t,$$
$$\boldsymbol{\alpha}_t = \boldsymbol{\alpha}_{t-1} + \xi_t,$$
$$\log \boldsymbol{\sigma}_t = \log \boldsymbol{\sigma}_{t-1} + \zeta_t.$$

We assume that the parameters B_t and $\boldsymbol{\alpha}_t$ follow a random walk, while the elements of Σ_t follow a geometric random walk.

We assume the innovations in the model follow a joint normal distribution where the variance covariance matrix is given by

$$V = var\left(\begin{bmatrix} \varepsilon_t \\ \nu_t \\ \xi_t \\ \zeta_t \end{bmatrix}\right) = \begin{bmatrix} \boldsymbol{I}_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix}.$$

We use Bayesian methods to evaluate the posterior distributions of the parameters of interest, the sequences of vectors B^T, $\boldsymbol{\alpha}^T$, $\boldsymbol{\sigma}^T$, given the hyperparameters in V. We use Gibbs sampling to evaluate these posterior distributions. In particular, to compute the time-varying parameters, we use the Carter and Kohn (1994) algorithm. As Primiceri (2005), we assume Normal-Inverse Wishart prior which we calibrate by estimating a VAR on the first ten years of data.[13]

We are interested in the effect of government spending on the earnings gap and consumption simultaneously. To do not saturate the model with a large number of parameter estimates, we run a small VAR which only includes government purchases, consumption, and the earnings gap (in that order). We divide aggregate data by the population 16-64 year old, and detrend them with a second order deterministic trend. As in the previous estimation, we identify the government spending shock recursively assuming that government purchases are ordered first. The data is quarterly and the estimation is carried out for the 1981Q1-2018Q4 period as well. We set priors for the starting values (B_0, $\boldsymbol{\alpha}_0$, $\boldsymbol{\sigma}_0$) with an estimate

[13] We set the same hyperparameters Primiceri (2005) use. We also find that the results are robust to the choice of the hyperperameters (see Appendix C). We thank Gary Koop for having available the codes for this procedure.

of a static VAR as in Primiceri (2005). We use the first 40 periods which we drop for the subsequent estimation; hence, we obtain time-varying parameters for the period 1991Q1-2018Q4. We consider four lags in the estimation. The number of replications in the bayesian estimation is set to 15000 where we burn 5000 draws.

We estimate the impulse responses of our variables of interest in a time-varying fashion. We compute the cumulative response of consumption, the earnings gap, and government spending, and then, we calculate the *dynamic multiplier* of the variables with respect to government spending. We define the dynamic multiplier as the ratio of the sum of the impulse response of the variable of interest to the sum of the response of government spending, which we denote by $\mathcal{D}_{Xs}$ and is given by

$$\mathcal{D}_{Xs} = \frac{\sum_{k=0}^{K} IRF^{s}_{Xg,k}}{\sum_{k=0}^{K} IRF^{s}_{gg,k}}.$$

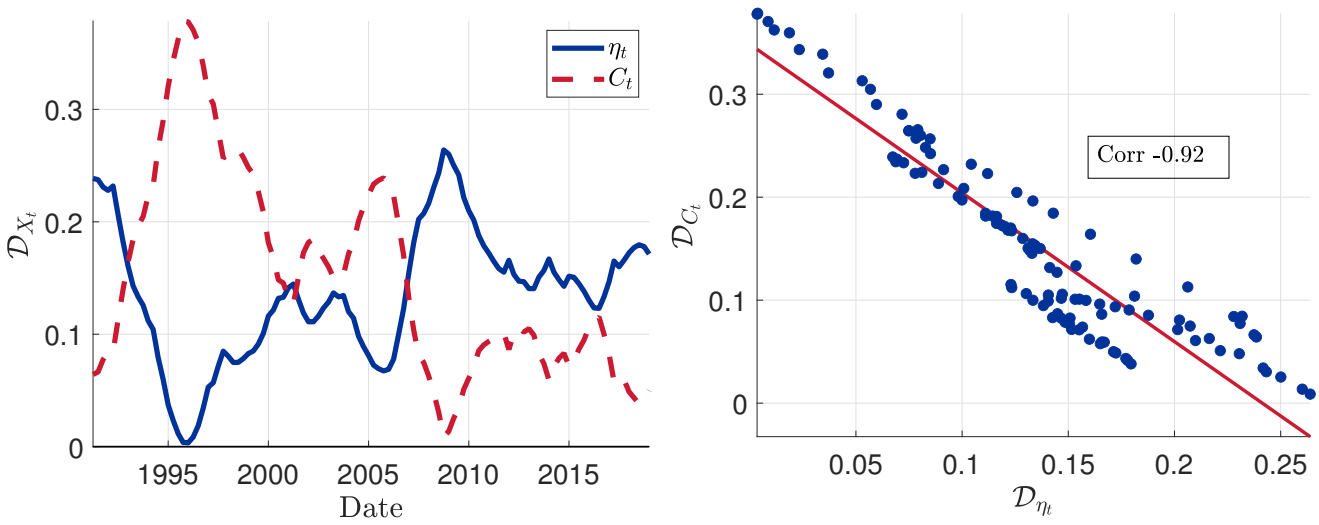
which represents the dynamic multiplier of variable X in period s. We calculate these indicators for a horizon of 20 quarters ($K = 20$) at every period in our time-varying estimates. The dynamic multiplier is an appropriate statistic since it allows us to take into account the response of government spending as well, by *discounting* for the evolution of government spending, as if may vary in the different periods.[14]

Figure 3 shows the dynamic multipliers of consumption and the earnings gap in the left-hand panel, and a scatterplot for these two estimates in the right-hand panel. The left-hand panel shows that for all our sample, the dynamic multiplier of the earnings gap and consumption are positive. This means that throughout the full sample, from 1991 to 2018, increases in government spending raised labor income inequality between skilled and unskilled workers. On the other hand, we find that the dynamic multiplier of consumption is also positive throughout the full sample. Both dynamic multipliers fluctuate strongly with peaks and throughs in periods that coincide. More interestingly, the responses of the earnings gap and consumption have a negative relationship, which is confirmed in the right-hand panel that shows the scatterplot of the two dynamic multipliers. Therefore, when the earnings gap increases by more, consumption rises by less in response to a government spending shock.[15]

[14] As Mountford and Uhlig (2009) propose.

[15] Appendix C shows the responses of consumption and the earnings gap to the government spending shock. We find that the IRF's are very similar to the ones obtained in the time-invariant Bayesian SVAR.

Figure 3: Time-Varying Dynamic Multipliers of C_t and η_t



Notes: Cumulative responses of consumption and the earnings gap estimated with a time varying coefficients VAR. The cumulative response is obtained by summing up to 20 quarters. The left-hand panel shows the cumulative responses over time and the right-hand side shows the relationship between the two responses.

We consider these results as evidence of the relationship between labor income inequality and consumption conditional on government spending shocks. In the next subsection we explore a reason why this relationship exists.

2.4 Government Spending is Concentrated Towards Skilled Intensive Sectors

A possible reason for the positive effect of government purchases on the earnings gap is that government purchases are concentrated on skilled intensive sectors. This implies that when government increases spending, a higher proportion of this demand is directed towards skilled workers, increasing their labor income with respect to the labor income of the unskilled workers.

To study this question, we use the most comprehensible government spending database, available at usaspending.gov. This database contains all the procurement transactions between private firms and the Federal Government in the US. It has the awarded amounts given to firms at the transaction level. The database is publicly available on their website, and it runs from 2001 to present. Government purchases released by USA Spending are composed by an average of about 3 million yearly transactions, with a scope on about 160 thousand companies each year and covering nearly all the sectors in the economy. An extensive analysis of the features of this database is made by Cox et al. (2020) where they report that government spending is concentrated in few sectors and firms, in sectors that have more sticky prices, that government contracts are short, and fluctuations in aggregate government spending are driven mainly

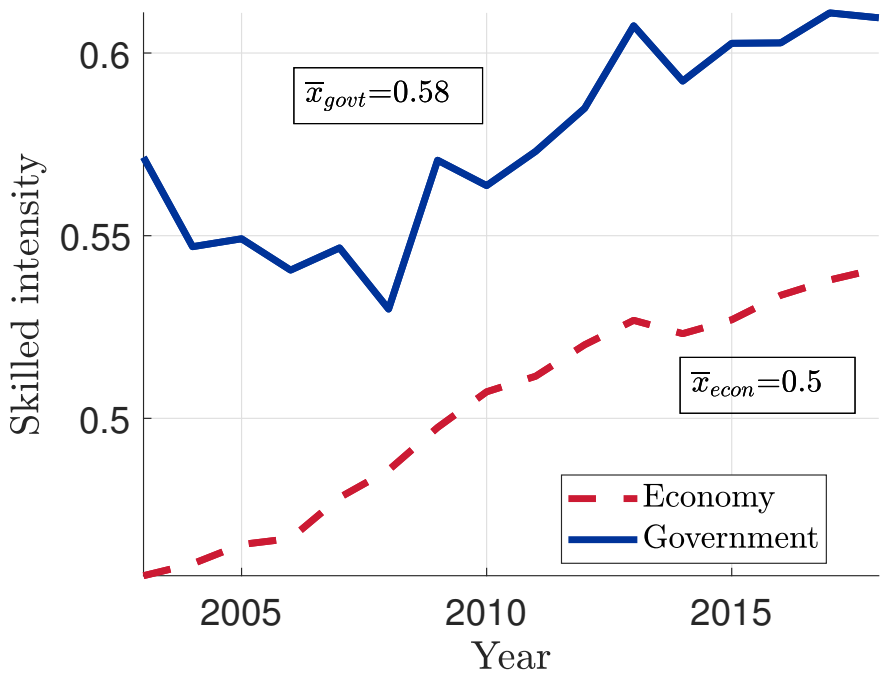
by granular fluctuations in the sense of Gabaix (2011). More importantly, they show that the data on procurement is a good representation of total government spending.

Here we study at what extent government spending is concentrated towards more or less skilled intensive sectors. To do so, we calculate in each year, the share of government spending on each sector. Then, with the CPS data, we calculate the share of labor income paid to skilled and unskilled within each sector. With the latter, we obtain the skill intensity by sector, and also we can obtain a measure of the average skill intensity of the economy. Having the skill intensities of every sector in the economy, we can calculate the average share of skilled and unskilled income of government spending. That is a measure of the level of skills the government is buying from the private sector in average.

Table **??** shows the five main sectors that supply goods to the government. We display the share of spending on that sector out of total government spending G_j/G, the cumulative share, and the share of skilled income of each sector. What can be seen from that table is that government spending is concentrated towards few sectors. In fact, 44% of the purchases is concentrated on these five sectors. Aerospace manufactures distinguishes as it exceeds by several percentage points the second largest sector. Aerospace manufactures accounts for 13.6% of the government spending in the period 2001-2020. This, followed by R&D services. As we may suppose, these sectors have a large share of skilled workers.

The purpose of this analysis is to study the share of skilled income embedded in goverment purchases as a whole. Figure 4 displays the average share of skilled income of the economy (red-dashed line) and the average share of skilled income of government purchases (blue-solid line). Two main conclusions arise from this picture. First, that the skilled income share embedded in government purchases is at all times larger than that of the overall economy. The skilled income share on government purchases (on average) is about 58% for the 2003-2018 sample, while that share on the economy as a whole is about 50%. Second, the skilled income share in both measures is increasing, at least from 2008. The trend is a consequence of the rise in the share of skilled workers in the population, which increased from 30% to 40% between 2003 and 2018, according to CPS. Third, the share of skilled in government purchases fluctuates more than that of the economy. In fact this share fell from 2003 to 2008, while it begun an upward trend in the periods after.

Figure 4: Average Share of Skilled Income



Notes: This figure depicts the average share of skilled workers. The red-dashed line shows the average share of skilled labor income in the overall economy calculated from the Current Population Survey. The blue-solid line shows the average share of skilled income weighted by sectoral government spending according to data from usaspending.gov.

Summary of the Empirical Findings. First, we find that the earnings gap increases in response to a government spending shock. We show this by estimating a Bayesian VAR augmented with the gap and find that government purchases generate inequality. Second, we show that over time, there is a negative relationship between the responses of consumption and the earnings gap to a government spending shock. And finally, we show that the government purchases goods from sectors that hire a higher share of skilled workers than the overall economy. We think these findings are important for several reasons. First, because government spending, while generating inequality it is distributing income between different worker types. And second, because these redistribution of resources might impact the response of consumption as the estimations show.

3 Model

Our model is a Two-Agent New Keynesian (TANK) model with two sectors, two groups of workers (skilled and unskilled), and a share of financially constrained households within the groups. The model is an

extension of Debortoli and Galí (2017) and Bilbiie (2008). We assume that for each group of workers, wages are determined by a union on behalf of households. A continuum of measure one households populates each skill group, where there is a fixed share of financially constrained agents. These constrained households can not save, borrow, or hold equity; while the rest have full access to financial markets. We assume there are two sectors which require different shares of skilled and unskilled workers in technology. Production of both sectors is demanded by the government and households. There are two types of firms in each sector. There is a continuum of monopolistically competitive intermediate goods producers and a final goods producer that aggregates these intermediate goods through a CES production function. The intermediate producers demands workers of both types and are subject to price adjustment costs. We close the model with a Taylor rule.

3.1 Government

The key feature of our model is how government spending is distributed among the different sectors. If government spending is distributed differently among the sectors, an increase in *total* government purchases has distributional effects. That has consequences on the distribution of income between skilled and unskilled households as long as the sectors hire the two types of workers in different proportions.

The government in this model has preferences over the sectors of the economy. The government solves a static problem in which it delivers utility from a Cobb-Douglas composite of the sectors

$$G_t = G_{1t}^{\aleph} G_{2t}^{1-\aleph},$$

where $\aleph$ is the share of spending on sector one out of total spending. From now on, we consider the sector one as the skilled intensive sector. Hence, $\aleph$ is the share of government spending in the skilled intensive sector. The government solves the following static cost minimization problem

$$\min_{G_{1t}, G_{2t}} \quad P_{1t} G_{1t} + P_{2t} G_{2t} - P_t^G \left(G_{1t}^{\aleph} G_{2t}^{1-\aleph} - G_t \right)$$

where P_t^G is a Lagrange multiplier that coincides with the government price index. Cost minimization implies the following government demands for each good

$$G_{1t} = \aleph \left(\frac{P_{1t}}{P_t^g} \right)^{-1} G_t, \quad G_{2t} = (1-\aleph) \left(\frac{P_{2t}}{P_t^g} \right)^{-1} G_t, \tag{3}$$

where P_t^g is the government's price index which is given by

$$P_t^G = \frac{1}{\aleph^{\aleph}(1-\aleph)^{1-\aleph}} P_{1t}^{\aleph} P_{2t}^{1-\aleph}.$$

This price index is different to the consumer price index as long as household's preferences are different to government's preferences. To finance purchases, the government sets a flat rate on labor income τ_t. We assume the government finances spending with a budget balance, which requires

$$G_t = \tau_t W_t N_t,$$

where $W_t N_t$ denotes aggregate labor income. We assume that aggregate government spending G_t is exogenous and follows an AR(1) process with persistence ρ_g. In the exercises below we study the effects of an increase in total government spending G_t which is distributed according to the demands in Equation (3), instead of analyzing the impact of raising G_{1t} or G_{2t} separately.

3.2 Households

There are two groups of workers, skilled and unskilled, denoted by s and u, respectively. Each household belongs to a group $h \in \{s, u\}$ with μ the share of unskilled workers while $(1-\mu)$ the share of skilled workers. We assume that a share λ_h of households in skill group h have no access to financial markets (cannot borrow, lend, and own firms' shares), while the remaining $(1-\lambda_h)$ are unconstrained (they can borrow, lend, and own firms). We index with i the dimension of access to financial markets; i.e., $i \in \{k, r\}$, with r denoting unconstrained (with r for Ricardian) and k denoting constrained (with k for Keynesian). Hence, household features are given by a pair (i, h) of indices.

A household (i, h) derives utility from consumption and disutility from labor, maximizing its lifetime utility, time-discounted at a factor $0 < \beta < 1$, given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathcal{U}\left(c_{ht}^i, n_{ht}\right), \tag{4}$$

where c_{ht}^i is total real consumption and n_{ht} is hours supplied by the household. In particular, we assume a separable utility function of the form

$$\mathcal{U}(c_{ht}^i, n_{ht}^i) = \frac{(c_{ht}^i)^{1-\gamma}}{1-\gamma} - \chi_h \frac{(n_{ht})^{1+\varphi}}{1+\varphi},$$

where γ is the inverse of the intertemporal elasticity of substitution, φ is the inverse of the Frisch elasticity of the labor supply, and χ_h is the parameter of disutility of labor of each worker's group.

As the economy is two-sector, total household's consumption is given by a bundle of the two goods. We assume total household's consumption is derived from a Cobb-Douglas composite of the goods produced by these two sectors,

$$c_{ht}^i = (c_{1ht}^i)^{\xi} (c_{2ht}^i)^{1-\xi}. \tag{5}$$

c^i_{jht} is consumption of good j by household i who belongs to group h at time t. ξ is the share of spending on good one, the skilled intensive. The Cobb-Douglas aggregator implies the following demands for each good:

$$c^i_{1ht} = \xi \left(\frac{P_{1t}}{P^C_t} \right)^{-1} c^i_{ht}, \quad c^i_{2ht} = (1-\xi) \left(\frac{P_{2t}}{P^C_t} \right)^{-1} c^i_{ht}. \tag{6}$$

With these demands, we can derive the consumer price index which is given by

$$P^C_t = \frac{1}{\xi(1-\xi)} P^{\xi}_{1t} P^{1-\xi}_{2t}. \tag{7}$$

In what follows, we assume all consumers have the same preferences for the different goods; i.e. ξ is equal for all consumers. This assumption simplifies aggregation, and allows us to determine final consumption as the numeraire good. Then, when we mention sectoral prices, we are referring to the price *relative* to the final consumption good. Although there are no differences in preferences between the different workers, they do have differences in their access to financial markets and income, so their total consumption fluctuates differently.

Unconstrained Households' Problem. Unconstrained households can accumulate risk-free bonds and their budget constraint is given by

$$b^r_{ht+1} = (1+r_t) b^r_{ht} + (1-\tau^n_t) \widetilde{w}_{ht} n_{ht} + D^r_{ht} - c^r_{ht}, \tag{8}$$

where $\widetilde{w}_{ht} = \widetilde{W}_{ht}/P^C_t$ is the real per capita wage per unit of labor n_{ht}. We assume $\widetilde{w}_{st} = w_{st}/(1-\mu)$ and $\widetilde{w}_{st} = w_{ut}/\mu$, where w_{ht} are the wages at which firms demand the different workers. Due to labor market frictions n_{ht} is taken as given by the household; r_t is the real return on risk-free bonds; and D^r_{ht} are firm's dividends accrued by unconstrained households of group h, who receive a fixed fraction of total shares that are distributed among unconstrained households of both types of workers as we explain below. Hence, these workers maximize function (4) subject to constraint (8). The maximization problem of these households gives as a result the Euler equation

$$1 = \beta(1+r_t) \mathbb{E}_t \left(\frac{c^r_{ht}}{c^r_{ht+1}} \right)^{-\gamma}. \tag{9}$$

Constrained Households' Problem. Constrained households consume their flow of disposable income every period. Hence, consumption is given by

$$c^k_{ht} = (1-\tau^n_t) \widetilde{w}_{ht} n_{ht}, \tag{10}$$

where as they are out of the financial market, consume their disposable income, which is their labor income after taxes . They are also subject to frictions in labor markets so they take n_{ht} as given, which is determined by the union as we explain below.

The difference between constrained and unconstrained consumers is crucial in our model because it implies different MPCs out of total income among households. From the permanent income hypothesis, we know that the MPC of unconstrained consumers is approximately $r/(1+r)$, while that of the constrained worker is equal to one, as Equation (10) shows. Those differences generate departing consumption dynamics between groups as long as the shares of hand-to-mouth λ_h's are distinct and labor income fluctuates differently. The group with higher λ_h has a higher average MPC; hence, their consumption responds much more to labor income fluctuations than the other group. These are the features that we will exploit in the analysis below.

Distribution of Monopoly Profits. In New Keynesian models, monopoly profits are an essential source of fluctuations. As we assume monopolistic competition in intermediate markets, firms charge a markup over marginal costs. With sticky prices, this markup fluctuates. As there are differences in access to financial markets and the sources of income of the different consumers are different, fluctuations in markups have distributional effects we must take into account. A widely known result is that markups are countercyclical in response to demand shocks in this class of models. The implication of this is that in a boom, markups fall, so labor income gets a higher proportion of total income. This effect typically generates amplification effects from limited asset participation. That is why the distribution of monopoly profits matters.

Therefore, to avoid "spurious" redistribution from aggregate variables to not wealthy agents, we assume the distribution of profits is according to the data. In particular, we set the distribution of profits to unconstrained consumers in each group of workers to be equal to a share of total profits in the economy. This share is denoted by ϑ_h, which we calibrate according to the *Survey of Consumer Finances 2016*. Therefore, per-capita dividends are given by

$$D_t^u = \frac{\vartheta_u}{\mu(1-\lambda_u)} D_t \quad \text{and} \quad D_t^s = \frac{\vartheta_s}{(1-\mu)(1-\lambda_s)} D_t. \tag{11}$$

3.3 Labor Supply

We assume that due to labor market frictions both the constrained and unconstrained workers of a group h supply the same quantity of labor. In our setting, the labor supplied is determined by a union that represents each worker type h and sets a common labor supply for all households in the same worker

group. Essentially, we split the consumption-labor problem described above in two: the consumption and the labor problem. The union solves the latter by maximizing the average utility of workers in group h:

$$\max_{c^r_{ht},c^k_{ht},n_{ht}} \quad \lambda_h \frac{(c^k_{ht})^{1-\gamma}}{1-\gamma} + (1-\lambda_h)\frac{(c^r_{ht})^{1-\gamma}}{1-\gamma} - \frac{n^{1+\varphi}_{ht}}{1+\varphi}$$

$$s.t$$

$$b^r_{ht+1} = (1+r_t)b_{ht} + (1-\tau^n_t)\widetilde{w}_{ht}n_{ht} + D^r_{ht} - c^r_{ht},$$

$$c^k_{ht} = (1-\tau^n_t)\widetilde{w}_{ht}n_{ht}$$

The solution of this problem delivers the following labor supply for each workers' group h:

$$\widetilde{w}_{ht} = \chi_h \frac{\overline{mg}_{ht} n^{\varphi}_{ht}}{(1-\tau_t)}$$

where $\overline{mg}_{ht} = (\lambda_h (c^k_{ht})^{-\gamma} + (1-\lambda_h)(c^r_{ht})^{-\gamma})^{-1}$, which implies that the labor supply in our model depends on the average marginal rate of substitution of constrained and unconstrained in the group h. We assume this to avoid insurance with labor. In this case, we obtain well behaved labor supplies whereas if individual consumers are let to determine their own supply, the constrained consumer could have an inelastic labor supply (if preferences for consumption are logarithmic) as shown by Bilbiie (2008).[16]

Finally, we assume each workers' group work in both sectors, and hence the supply of labor must meet the sum of the demands from all sectors:

$$n_{ht} = n_{1ht} + n_{2ht}.$$

where n_{jht} is the total hours worked by workers' group h in sector j at a given period t.

3.4 Firms

The two sectors in this economy are populated by a continuum measure one of intermediate goods producers that are in monopolistic competition. These sectors demand both types of workers in a different proportion, which we consider as a technological feature. Next, we describe the setup and optimality conditions for a sector $j \in \{1, 2\}$.

Final Goods Producers. In sector j, a competitive representative firm produces a final good by aggregating a continuum of intermediate inputs with a CES production function,

$$Y_{jt} = \left(\int_0^1 y_{jt}(m)^{\frac{\varepsilon-1}{\varepsilon}} dm \right)^{\frac{\varepsilon}{\varepsilon-1}}.$$

[16] This approach is also used by Auclert et al. (2018) when studying the effects of fiscal transfers in HANK.

This composite aggregates a continuum of intermediate goods with measure one, with $m \in [0,1]$. In this setting, the final firm decides how to allocate its demand among the different intermediate goods. After cost minimization, the demand for each intermediate good m, and sector's j price index write

$$y_{jt}(m) = \left(\frac{p_{jt}(m)}{P_{jt}}\right)^{-\epsilon} Y_t, \quad \text{and} \quad P_{jt} = \left(\int_0^1 p_{jt}(m)^{1-\varepsilon} dm\right)^{\frac{1}{1-\varepsilon}}.$$

Intermediate Goods Producers: Labor Demand. Each intermediate good m in sector j is produced by a monopolistically competitive producer using labor of both skill groups according to the production function

$$y_{jt}(m) = A_{jt} n_{jst}(m)^{\omega_j} n_{jut}(m)^{1-\omega_j},$$

where ω_j is the share of (total) skilled income in sector j and A_{jt} is the productivity of the sector that allows us to calibrate the size of the sector.

Each intermediate producer hires workers from each skill group h at a real wage w_{ht}. Therefore, the demand of the sector for the workers of group h implies per-capita wages given by[17]

$$w_{ht} = mc_{jt} \ \omega_j \ \frac{Y_{jt}}{n_{jst}} \ \text{and} \ w_{ut} = mc_{jt} \ (1-\omega_j) \ \frac{Y_{jt}}{n_{jut}}.$$

Intermediate Goods Producers: Price Setting. In each sector, the intermediate producer chooses its price to maximize profits subject to Rotemberg (1982) price adjustment costs, denoted by $\Theta_{jt}(m)$. These adjustment costs are quadratic in the rate of price change $\frac{p_{jt}(m)}{p_{jt-1}(m)} - 1$ and are expressed as a fraction of output $p_{jt}(m) y_{jt}(m)$:

$$\Theta_{jt}(m) = \frac{\theta_j}{2}\left(\frac{p_{jt}(m)}{p_{jt-1}(m)} - 1\right)^2 p_{jt}(m) y_{jt}(m).$$

Therefore, each intermediate producer chooses $\{p_{jt}(m)\}_{t\geq 0}$ to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{c^r_{t+1}}{c^r_t}\right)^{\gamma} \left\{\Pi_t(p_{jt}(m)) - \Theta_{jt}(m)\right\},$$

with

$$\Pi^m_{jt}(p_{jt}(m)) = \left(\frac{p_{jt}(m)}{P_{jt}} - mc_{jt}(m)\right)\left(\frac{p_{jt}(m)}{P_{jt}}\right)^{-\varepsilon_j} y_{jt},$$

[17] These optimality conditions arise from minimizing costs subject to technology (after symmetry):

$$\min_{n_{jst}, n_{jut}} w_{st} n_{jst} + w_{ut} n_{jut} - mc_{jt}\left(A_{jt} n_{jst}^{\omega_j} n_{jut}^{1-\omega_j} - Y_{jt}\right)$$

where mc_{jt} is the Lagrange multiplier of the cost minimization problem of firms, which in equilibrium corresponds to the real marginal cost (nominal marginal cost of sector j divided by the price level). Firms minimize a per-capita labor cost, taking into account the shares of population of the different workers. This is an assumption which allows us to close the model.

where $\beta\left(\frac{c_{t+1}^r}{c_t^r}\right)^\gamma$ is the stochastic discount factor of the pool of unconstrained agents, and $mc_{jt}(m)$ is the marginal cost. Given the assumptions above, the inflation rate (after the intermediate firms optimization) is determined by the following New Keynesian Phillips curve for sector j:

$$(\pi_{jt} - \overline{\pi}_j)\pi_{jt} = \frac{\varepsilon_j}{\theta_j}\left(\frac{mc_{jt}}{p_{jt}} - \frac{\varepsilon_j - 1}{\varepsilon_j}\right) + \beta\mathbb{E}_t\left[\beta^t\left(\frac{c_{t+1}^r}{c_t^r}\right)^\gamma(\pi_{jt+1} - \overline{\pi}_j)\pi_{jt+1}\frac{p_{jt+1}y_{jt+1}}{p_{jt}y_{jt}}\right], \tag{12}$$

with

$$\pi_{jt} = \frac{p_{jt}}{p_{jt-1}}\pi_t, \tag{13}$$

where π_t denotes CPI inflation.[18]

Intermediate firms generate each period an aggregate amount of profits given by

$$D_{jt} = (1 - mc_{jt})\, Y_{jt} - \frac{\theta_j}{2}\pi_{jt}^2 Y_{jt},$$

that are distributed among households according to the rules described above.

3.5 Monetary Authority

In the presence of nominal rigidities, the return on assets r_t is affected by monetary policy, which sets the nominal interest rate i_t according to a Taylor rule

$$i_t = \rho + \phi_\pi \mathbb{E}_t \pi_{t+1},$$

where ϕ_π is the preference parameter of the monetary authority with respect to expected inflation and ρ is the steady state interest rate which is equal to the discount rate. Given the inflation level and the nominal interest rate, the real return on the risk-free asset is determined by the Fisher equation $r_t = i_t - \mathbb{E}_t\pi_{t+1}$.

3.6 Equilibrium

An equilibrium of this economy is given by paths of individual variables for households' decisions $\{c_{ht}^i\}_{t\geq 0}$ $\forall\ (i,h)$; labor market prices and quantities $\{\{n_{1st}, n_{2st}, w_{st}\},\ \ h \in \{u,s\}\}_{t\geq 0}$;
prices and returns $\{p_{1t}, p_{2t}, \pi_{1t}, \pi_{2t}, r_t, i_t\}_{t\geq 0}$, and aggregate quantities such that: (i) households maximize their objective functions taking as given both prices and aggregate quantities; (ii) the government budget

[18] This expression arises from the definition of sectoral inflation $\pi_{jt} = \frac{P_{jt}}{P_{jt-1}} = \frac{p_{jt}P_t^C}{p_{jt-1}P_{t-1}^C} = \frac{p_{jt}}{p_{jt-1}}\pi_t$.

constraint holds; and (iii) all markets clear. In our economy, we have five markets: two goods markets, the market for bonds, and two labor markets.

As we assume that each class of workers are split between constrained and unconstrained, the aggregation of group h consumption is

$$c_{ht} = \lambda_h c_{ht}^k + (1 - \lambda_h) c_{ht}^r,$$

then, aggregate consumption writes

$$C_t = \mu_u c_{ut} + \mu_s c_{st}.$$

Goods market clearing in each sector is given by

$$y_{jt} = C_{jt} + G_{jt} + \Theta_{jt},$$

where C_{jt} and G_{jt} are given by the demand for each good. And finally, aggregate goods market clearing implies

$$GDP_t = p_{1t} y_{1t} + p_{2t} y_{2t} = C_t + p_t^g G_t + \Theta_{1t} + \Theta_{2t}$$

4 Analytical Results

In this section, we obtain two analytical results that guide us in understanding the role of labor income inequality in the transmission of government spending shocks to consumption and output. First, we show how the earnings gap affects aggregate consumption. In particular, we study how, due to market incompleteness, the earnings gap influences consumption behavior by entering in the aggregate Euler equation. There we show that if the earnings gap increases in response to a government spending shock, the response of consumption is dampened. Second, we show the conditions under which the earnings gap increases in response to a government spending shock in our model.

To study these questions in a simple and tractable way, throughout this section, we assume that the share of hand-to-mouth workers in the unskilled group of workers is equal to one and the share of hand-to-mouth in the skilled group is zero. Additionally, we study a symmetric equilibrium in steady state, in which wages of both workers are equal which implies that sectoral prices are the same.

4.1 Aggregate Demand and the Earnings Gap

In what follows, we show that in the presence of financial markets incompleteness, the earnings gap enters the aggregate demand equation.

Following Debortoli and Galí (2017), we exploit that when there is limited access to financial markets, the IS equation (or the aggregate demand) depends on inequality wedges. Recall aggregate consumption $C_t = \mu c_{ut} + (1-\mu)c_{st}$, where each group's consumption is given by $c_{ht} = \lambda_h c^k_{ht} + (1-\lambda_h)c^r_{ht}$. Under the assumptions we mentioned above ($\lambda_u = 1$ and $\lambda_s = 0$), consumption of the unskilled workers is $c_{ut} = c^k_{ut}$ and consumption of the skilled workers is $c_{st} = c^r_{st}$. Notice that the aggregate share of hand-to-mouth is now given by μ. Then in this case, c^s_t is determined by a Euler equation, and c^u_t is equal to labor income.

Next, we introduce the *consumption gap*, which is defined as the percent difference between workers' consumption with respect to skilled consumption, given by $\nu_t = 1 - \frac{c_{ut}}{c_{st}}$. In equilibrium, consumption of unskilled workers is $c_{ut} = (1-\tau_t)w_{ut}n_{ut}$ while that of skilled workers is $c_{st} = (1-\tau_t)w_{st}n_{st} + \frac{1}{1-\mu}D_t$. Therefore, the consumption gap writes

$$\nu_t = 1 - \frac{w_{ut}n_{ut}}{w_{st}n_{st} + \frac{1}{1-\mu}D_t} = 1 - \frac{1}{\eta_t + \frac{1}{1-\mu}\delta_t}. \tag{14}$$

Equation (14) shows that in this setup, the consumption gap depends on two variables, the earnings gap $\eta_t = \frac{w_{st}n_{st}}{w_{ut}n_{ut}}$, and the ratio of dividends to labor income of the unskilled, $\delta_t = \frac{D_t}{(1-\tau_t)w_{ut}n_{ut}}$. The log-linear approximation of the consumption gap (Equation (14)) is given by

$$\hat{\nu}_t = \nu_\eta \hat{\eta}_t + \nu_\delta \hat{\delta}_t, \tag{15}$$

with $\nu_\eta = \frac{\eta}{\nu}\frac{1}{(1-\nu)^2}$ and $\nu_\delta = \frac{\delta}{\nu}\frac{1}{1-\mu}\frac{1}{(1-\nu)^2}$. Recall that the agents who can save or borrow are the skilled workers; hence, there is only one Euler equation which writes

$$\hat{c}_{st} = \mathbb{E}_t\{\hat{c}_{st+1}\} - \frac{1}{\gamma}(r_t - \rho), \tag{16}$$

where γ is the inverse of the intertemporal elasticity of substitution, and ρ is the time discount rate. Rewrite aggregate consumption as $C_t = c_{st}(1-\mu\nu_t)$, which in log deviations with respect to the steady state is

$$\hat{c}_t = \hat{c}_{st} - \frac{\mu}{1-\nu\mu}\hat{\nu}_t.$$

Using this equation and replacing it in Equation (16), we obtain the aggregate Euler equation:

$$\hat{c}_t + \frac{\mu}{1-\nu\mu}\hat{\nu}_t = \mathbb{E}_t\left\{\hat{c}_{t+1} + \frac{\mu}{1-\nu\mu}\hat{\nu}_{t+1}\right\} - \frac{1}{\gamma}(r_t - \rho). \tag{17}$$

Substituting Equation (15) in Equation (17) and solving forward, we obtain the expression for contemporaneous consumption

$$\hat{c}_t = -\frac{1}{\gamma}\mathbb{E}_t\sum_{s=0}\hat{r}_{t+s} - \frac{\mu\nu_\eta}{1-\nu\mu}\hat{\eta}_t - \frac{\mu\nu_\delta}{1-\nu\mu}\hat{\delta}_t. \tag{18}$$

Equation (18) shows how aggregate consumption is related to the earnings gap. When the earnings gap increases in response to a government spending shock, consumption goes down, all else being equal. The relationship between the earnings gap and consumption is negative because when the earnings gap rises, there is a redistribution of resources (on average) from high- to low-MPC consumers; i.e., the labor income of the skilled with low-MPCs rises by more than the labor income of the unskilled with high-MPCs. This effect is similar to the one emphasized by Bilbiie (2020) which is that the cyclicality income of the high-MPC consumer is what matters for the amplification or dampening effects of inequality. We extend his argument by exploring the impact of different cyclicalities among workers in segmented labor markets.

Our model also features the effect of inequality typical of TANK models. This effect operates through profits $\hat{\delta}_t$. Recall that $\hat{\delta}_t = \hat{d}_t - (\hat{w}_{ut} + \hat{n}_{ut} - \hat{\tau}_t)$ and notice that dividends $\hat{d}_t$ are countercyclical in response to demand shocks. In New Keynesian models markups are countercyclical, while unskilled labor income is procyclical. That means that δ_t falls whenever output goes up. This fall has a positive effect on consumption because the income of the unskilled worker is increasing by more than the profits delivered to skilled workers. Therefore, fluctuations in markups generate a redistribution of resources from low- to high-MPC consumers. This is the channel emphasized by Galí et al. (2007) who generate a positive response of output to a government spending expansion. We can use countercyclical markups to obtain a rise in consumption in two ways: (i) with a highly responsive markup (with very rigid prices); and (ii) with a high share of HtM agents (here μ). The latter is the one explored by Galí et al. (2007) who use the estimates for the share of HtM obtained Campbell and Mankiw (1989). Therefore, two forces depending on inequality affect consumption in our model: the cyclicality of the earnings gap and countercyclical markups.

These results are consistent with two of the empirical findings described above. First, consumption may rise in response to a government spending shock; countercyclical markups mainly drive this effect. Second, there is a negative relationship between the earnings gap and consumption. Interestingly, even if the mechanism implied by δ_t is strong, there might be a negative response of consumption. Hence, how the earnings gap responds can reverse the sign of the response of consumption to a rise in government spending. That result depends on the relative strength of the earnings gap response to that of markups.

Finally, to show how this translates to the response of output, we impose goods market clearing ($\hat{y}_t = (1-\gamma_g)\hat{c}_t + \gamma_g \hat{g}_t$) to obtain the IS equation

$$\hat{y}_t = -\frac{1-\gamma_g}{\gamma}\mathbb{E}_t \sum_{s=0}^{\infty} \hat{r}_{t+s} - \frac{\mu\nu_\eta(1-\gamma_g)}{1-\nu\mu}\hat{\eta}_t - \frac{\mu\nu_\delta(1-\gamma_g)}{1-\nu\mu}\hat{\delta}_t + \gamma_g \hat{g}_t. \tag{19}$$

Equation (19) is the expression for output. Government spending enters directly as in the baseline New

Keynesian model; however, the response of output (the fiscal multiplier), now depends on the response of the earnings gap and markups. If the earnings gap increases, the multiplier falls; otherwise, the fiscal multiplier increases due to countercyclical markups $\hat{\delta}_t$.

4.2 Government Purchases and the Earnings Gap

Next, we derive an expression for the earnings gap that depends on government spending. Recall that government spending is exogenous in our model, and it distributes among the sectors. As the labor demand depends on firms' output, labor income is a function of government spending through the demand for production. Moreover, the earnings gap depends on government purchases since the government demands the two sectors (which have different shares of skilled workers) in different proportions.

Take the labor demand for group h from sector j

$$\hat{w}_{ht} = \hat{mc}_{jt} + \hat{y}_{jt} - \hat{n}_{jht}, \quad \text{for } \; j \in [1,2] \; \text{ and } \; h \in [s,u], \tag{20}$$

where $\hat{w}_{ht}$ and $\hat{mc}_{jt}$ are the real wages and marginal costs with respect to the price index, respectively. Take the loglinear approximation of the labor supply and the aggregate labor by worker groups

$$\hat{w}_{ht} = \varphi \hat{n}_{ht} + \hat{mg}_{ht} + \hat{\tau}_t,$$

and

$$\hat{n}_{ht} = \kappa_{1h}\hat{n}_{1ht} + \kappa_{2h}\hat{n}_{2ht},$$

with $\kappa_{jh} = \frac{n_{jh}}{n_h}$ the share of labor supplied to sector j by a given workers' group h in steady state. By definition, $\kappa_{1h} + \kappa_{2h} = 1$.[19]

We can obtain a total demand for the workers of group h, by taking the weighted sum of the demands from each sector, from Equation (20). These demands write:

$$\hat{w}_{ht} = \kappa_{1h}(\hat{mc}_{1t} + \hat{y}_{1t}) + \kappa_{2h}(\hat{mc}_{2t} + \hat{y}_{2t}) - \hat{n}_{ht} \; \text{ for } \; h \in [s,u].$$

Then, equilibrium labor income is given by

$$\hat{w}_{ht} + \hat{n}_{ht} = \kappa_{1h}(\hat{mc}_{1t} + \hat{y}_{1t}) + \kappa_{2h}(\hat{mc}_{2t} + \hat{y}_{2t}),$$

and the earnings gap ($\hat{\eta}_t = [\hat{w}_{st} + \hat{n}_{st} - (\hat{w}_{ut} + \hat{n}_{ut})]$) is

$$\hat{\eta}_t = (\kappa_{1s} - \kappa_{1u})(\hat{y}_{1t} - \hat{y}_{2t}) + (\kappa_{1s} - \kappa_{1u})(\hat{mc}_{1t} - \hat{mc}_{2t}).$$

[19] We derive the expression for κ_{jh} in Appendix D, where we show that the shares of labor in the different sectors depend on the skilled and unskilled intensities and the relative sizes of the sectors.

To obtain an expression for the earnings gap depending on government spending, we need expressions for production in sectors one and two. Taking $\hat{y}_{jt} = \frac{C_j}{Y_j}\hat{c}_{jt} + \frac{G_j}{Y_j}\hat{g}_{jt}$ for $j = \{1, 2\}$, it can be shown that around a symmetric steady state (where $P_1 = P_2 = P^C$):

$$\hat{y}_{1t} = \frac{\xi(1-\gamma_g)}{n}\hat{c}_t + \frac{\aleph\gamma_g}{n}(\hat{g}_t + \hat{p}_t^G) - \hat{p}_{1t},$$
$$\hat{y}_{2t} = \frac{(1-\xi)(1-\gamma_g)}{1-n}\hat{c}_t + \frac{(1-\aleph)\gamma_g}{1-n}(\hat{g}_t + \hat{p}_t^G) - \hat{p}_{2t},$$

with $n = \xi(1-\gamma_g) + \aleph\gamma_g$ the size of sector one. Plugging $\hat{y}_{1t} - \hat{y}_{2t}$ into the Earnings Gap, and using the expression for aggregate output $\hat{p}_t^Y + \hat{y}_t = (1-\gamma_g)\hat{c}_t + \gamma_g(\hat{p}_t^G + \hat{g}_t)$, we obtain the Earnings Gap depending on aggregate variables,

$$\hat{\eta}_t = \Upsilon_\eta \hat{g}_t - \Upsilon_\eta \hat{y}_t + \Upsilon_p(\hat{p}_{1t} - \hat{p}_{2t}) \tag{21}$$

Equation (21) is the earnings gap in our economy. The earnings gap depends on government purchases, output, and prices. The parameters Υ_x are the relationships between labor income inequality and the different variables. First, we have the relationship with aggregate variables, given by $\Upsilon_\eta = \frac{(\kappa_{1s}-\kappa_{1u})}{n(1-n)}(\aleph - \xi)\gamma_g$. Notice that this parameter governs both the cyclicality of the Earnings Gap and its direct relationship with government spending. This is an important result of our model. The earnings gap rises (in response to an increase in government spending) if two conditions hold. First, sector one is the more skilled intensive, i.e. $\kappa_{1s} > \kappa_{1u}$ Second, the share of government spending on sector one is larger than the share of private consumption in that sector, $\aleph > \xi$. Therefore, if government spending is concentrated on skilled sectors in a higher proportion than the overall economy, the earnings gap rises in response to an increase in government spending, which is consistent with the empirical evidence presented in Section 2.

Additionally, under the conditions above, the earnings gap is countercyclical. This is a consequence of the crowding out effect of government spending on consumption. When there is an increase in $\hat{g}_t$, the economy distributes resources to workers, who spend their resources in the two sectors. However, in this setup, the increase in production may not be enough to satisfy the greater demand, and hence, the crowding out takes place. Therefore, the positive relationship between the earnings gap and government spending relies also on $\hat{g}_t > \hat{y}_t$, which holds for any reasonable calibration of our model.

Finally, the earnings gap depends on price dispersion. This relationship is given by $\Upsilon_p = \frac{(\kappa_{1s}-\kappa_{1u})}{n(1-n)}(\aleph - \xi)^2\gamma_g(1-\gamma_g)$. This dependence arises from the differences between spending by government and private consumption, and represent the differences in price index of private and public spending. The relation is positive because when prices in sector one rise by more than in sector two, the government (and the economy) must spend more resources in the skilled intensive sector, increasing the relative income earned

by skilled workers. However, this effect is quantitatively unimportant as it is two orders of magnitude lower than υ_η.

Next, we study the role of government spending composition in the transmission of government spending to consumption and output in the model without the simplifying assumptions we made in this section.

5 Quantitative Results

In this section, we study quantitatively at what extent the the sectoral distribution of government spending affects inequality, consumption, and the fiscal multiplier. We first describe the calibriation we set to match the empirical facts presented in section 2. Then, we explore the role of government spending distribution and the role of financial constraints in explaining those facts.

5.1 Calibration

Household Problem Parameters. We set the inverse of the intertemporal elasticity of substitution γ, the inverse of the Frisch elasticity of labor supply φ, and the disutilities from labor χ_h, equal to one. We calibrate the shares of unskilled and skilled workers as $\mu = 0.35$ and $(1-\mu) = 0.65$, that we obtain from the CPS for period 2001-2020.[20] The discount factor β is set such that the interest rate is one-percent quarterly in steady state. We assume the shares of hand-to-mouth in each group of workers equal to $\lambda_u = 0.47$ and $\lambda_s = 0.18$. Additionally, we observe that skilled workers hold 83% of the total equity in the economy. Hence, we set $\vartheta_s = 0.83$ and $\vartheta_u = 0.17$.[21]

Production and Price Rigidities. We build two sectors that produce goods requiring different skill intensities. We assume sector one is the skilled intensive sector and set $\omega_1 = 0.7$; we assume sector two is the unskilled intensive sector and we set $\omega_2 = 0.3$.[22] We set the price adjustment cost parameters equal to 100 in both sectors ($\theta_1 = \theta_2 = 100$). We set the elasticity of substitution ϵ_1 and ϵ_2 equal to 10 for both sectors.[23] We calibrate the remainder of parameters symmetric between the two sectors, such that both are the same size and deliver the same aggregate income for both types of workers, as in Figure 4; i.e., the

[20] According to the CPS, these are the average shares (in hours) of the two types of workers for the period 2000-2019.

[21] According to the Survey of Consumer Finances 2016.

[22] We set $\omega_1 = 0.7$ because it is a midpoint between 0.58 and 1, and $\omega_2 = 0.3$ because it is in the midpoint between 0 and 0.5. These are the bounds for these parameters according to the data as shown in Figure 4.

[23] This calibration is equivalent to having a Calvo parameter given by 0.75, which is in the upper bound of the empirical estimates. According to this calibration, prices last 4 quarters. We use the correspondence between Calvo and Rotemberg proposed by Ascari et al. (2011) $\theta = \frac{(\varepsilon-1)\zeta}{(1-\zeta)(1-\beta\theta)}$, with ζ the Calvo probability of keeping prices.

productivities and the size of the sectors are equal in steady state. The purpose of this is to assume sectors that are symmetric on everything except from the share of income delivered to each type of worker driven by the ω_js, and the demands for each sector. With this calibration, and the household parameters, we obtain an earnings gap in steady state equal to 1.85, which is about the average of the period 1990-2018.

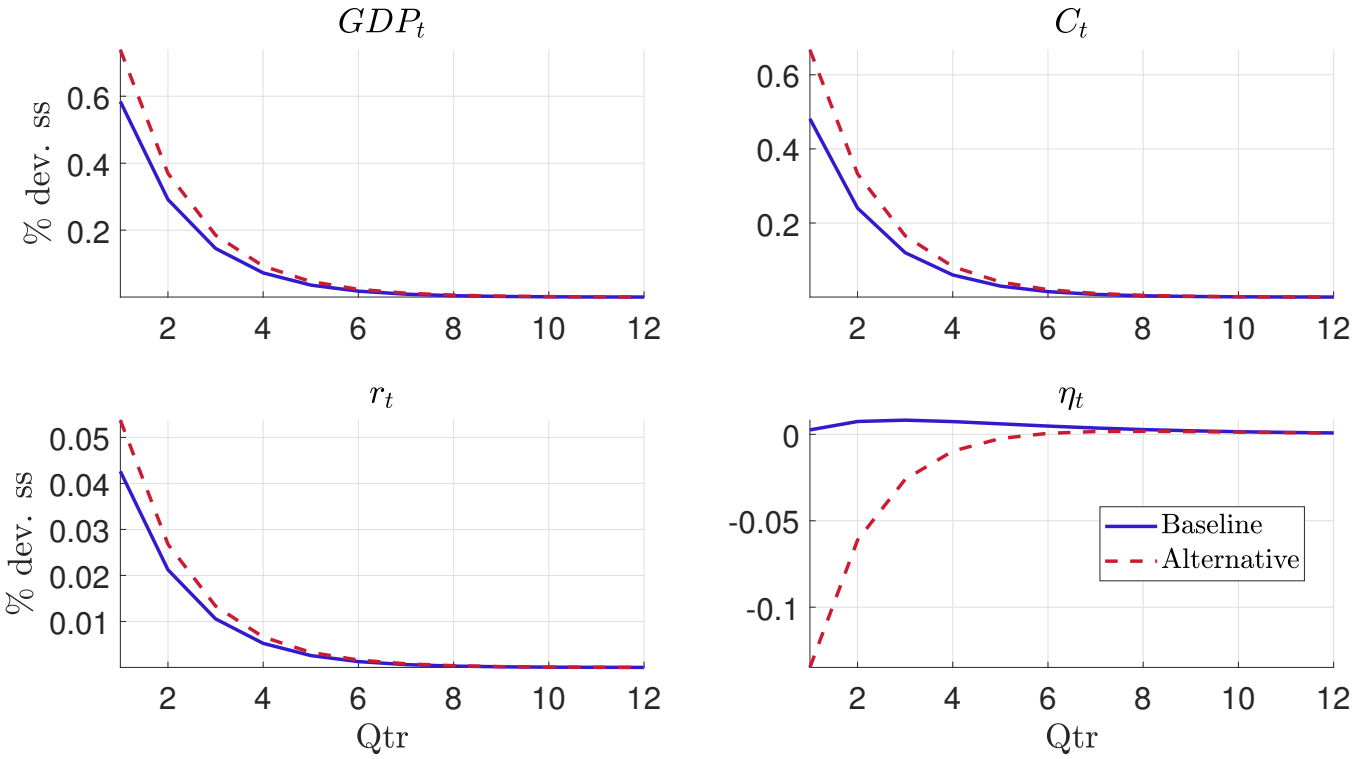
Demand for Goods. In the baseline calibration, we set the share of spending of government in sector one $\aleph$ according to Figure 4, to satisfy $0.58 = \aleph\omega_1 + (1-\aleph)\omega_2$. That implies that in the baseline calibration the share of government spending in the skilled intensive sector is given by $\aleph = 0.7$. Similarly, we set the private spending share ξ according to $0.5 = (1-\gamma_g)(\xi\omega_1 + (1-\xi)\omega_2) + \gamma_g 0.58$, which with $\gamma_g = 0.2$, gives $\xi = 0.45$.

Government and Monetary Policy. Monetary policy follows a Taylor rule with $\phi_\pi = 1.5$. We assume that government spending as a share of GDP γ_g equal to 0.2. Then, we calibrate the labor tax rate in steady state to satisfy the budget constraint of the government with zero debt, and let it adjust in response to shocks to government spending. The persistence parameter of the exogenous government spending shock is set to $\rho_g = 0.5$.

5.2 How Government Spends Matters

The first exercise we make is to show that the way the government spends matters. To do so, we compare two different calibrations. One in which the economy is in the *baseline* calibration, with $\aleph = 0.7$, which as we mentioned above, implies that the average share of skilled workers in government spending is equal to 0.58. Another, which we call the *alternative* calibration where we assume that the government takes the extreme stance in which it spends only on the unskilled intensive sector $\aleph = 0$. We compare these two calibrations maintaining the remainder of parameters. The idea is to compare a case in which government preferences switch from the actual spending distribution to one in which it spends all in the unskilled intensive sector, all else equal.

Figure 5: IRFs to a one-percent increase in government spending. Baseline and Alternative calibrations.



Notes: this figure shows the responses of GDP, consumption the real interest rate, and the Earnings Gap in response to a 1% increase in government spending in the quantitative model. We show the percent deviations from the steady state at a quarterly frequency. This case compares the baseline calibration and the alternative in which all government consumption is on the unskilled intensive sector, $\aleph = 0$.

Figure 5 shows the responses of GDP, consumption, the real interest rate, and the earnings gap to a one-percent government spending shock in the model. We omit government spending responses as they are exogenous and equal in all the exercises we make below. In both calibrations, consumption increases in response to the government spending shock. In both cases, the interest rate and GDP also rise. The earnings gap has different responses: in the baseline, it rises in response to the government spending shock, while in the alternative, it falls. This means that when the government spends more in unskilled intensive sectors, labor income inequality falls. Therefore, the government in the baseline calibration generates inequality, consistently with the empirical findings.

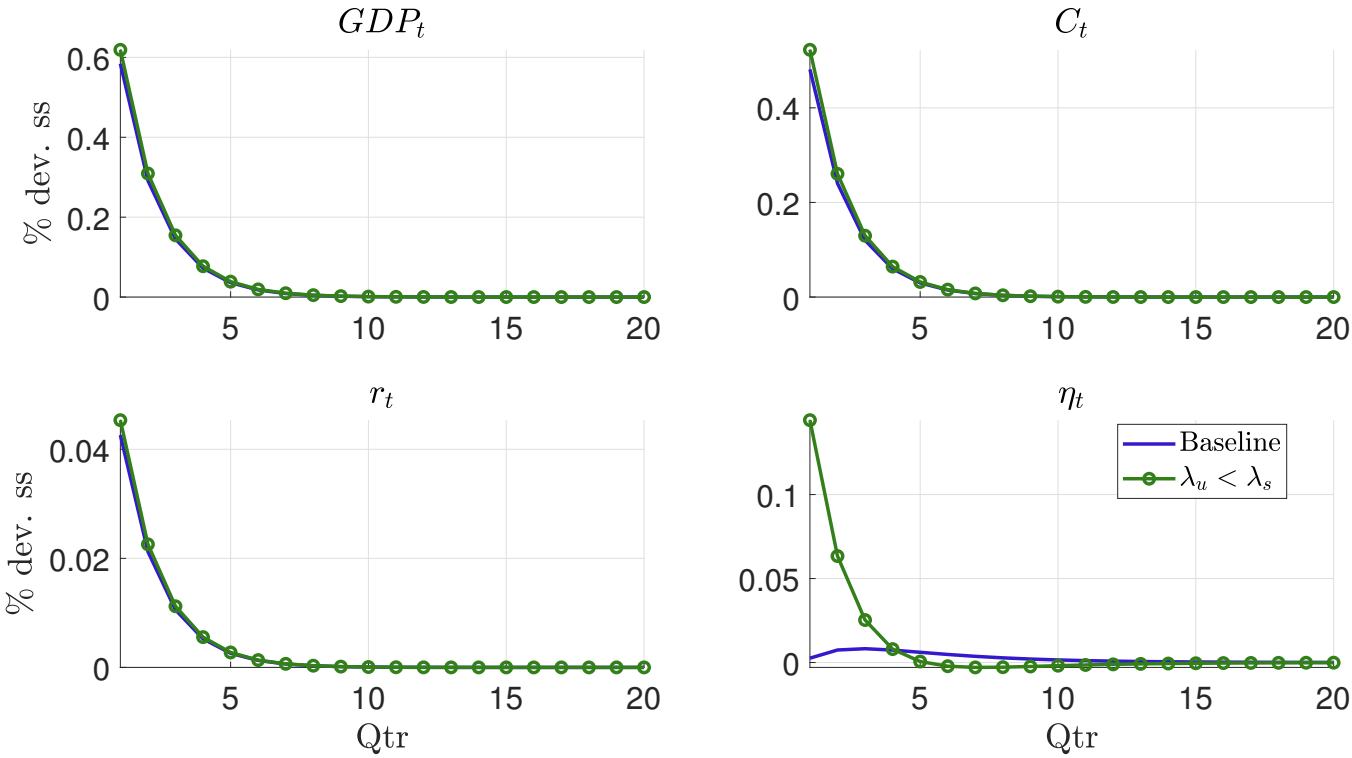
The previous result matters for what we showed in the empirical evidence: there is a negative relationship between the earnings gap and consumption in the presence of incomplete markets. That implies that when the earnings gap rises by more, consumption increases by less, which is what we observe in Figure 5. When the government reverts the way it spends, the consumption response is stronger than

the baseline. That occurs because when the government spends in the sector that hires unskilled workers in a higher proportion, it is transferring resources towards workers with higher MPCs. That means that government spending translates into consumption in a stronger way. In this stylized exercise, the strength of government spending in stimulating consumption rises by about 39 percent on impact. We find that generating inequality, for this reason, can reduce the government spending multiplier as well. By switching the way government spends, the effect on output can rise by about 26 percent on impact, even tough we assume a responsive interest rate.[24]

Therefore, the pattern of access to financial markets skilled and unskilled workers have may be why there is a negative relationship between the responses of consumption and the earnings gap in the data. To explore the quantitative importance of this feature, we switch the pattern of financial access. We take the baseline calibration and compare it with the situation in which the MPCs of the different classes of workers is switched: now $\lambda_u < \lambda_s$, such that the group with higher MPC is the group of skilled workers.

[24] As **?** shows, all these results, especially the fiscal multiplier, depend on the monetary policy response. Woodford points out that the multiplier is maximized when monetary policy follows a constant real rate rule. In our case, the differences between the baseline and the alternative calibrations are also maximized if monetary policy follows that kind of rule.

Figure 6: IRFs to a one-percent increase in government spending. Different distribution of HtM.



Notes: this figure shows the responses of GDP, consumption the real interest rate, and the Earnings Gap in response to a 1% increase in government spending in the quantitative model. We show the percent deviations from the steady state at a quarterly frequency. This case compares the baseline calibration with an scenario in which $\lambda_u < \lambda_s$.

In Figure 6 we show the simulations for that exercise. The responses of the relevant variables are similar to those shown in Figure 5; however, the responses of consumption and the earnings gap are not negatively related. The relationship is the opposite: when the earnings gap rises by more, consumption increases by more. This result contradicts the empirical findings shown above that there is a negative relationship between consumption and the earnings gap responses to a government spending shock. Therefore, having heterogeneity in asset markets participation in which the unskilled group is more financially constrained than the skilled group is essential for explaining the empirical facts we showed before.

6 Conclusion

In this paper, we revisit the effects of government purchases on consumption by considering its effects on inequality. We show three empirical results in this regard. First, we estimate a SVAR following Blanchard and Perotti (2002) identification augmented by labor income inequality and show that government spending

increases this indicator strongly and persistently. Second, we estimate a time-varying structural VAR as in Primiceri (2005) and uncover that the responses of the earnings gap and consumption to the government spending shock are negatively related. And third, we show that government spending is concentrated towards sectors that hire skilled workers in a higher proportion than the economy as a whole.

To rationalize these facts, we build a two workers, two agent, two sector model in which we assume skilled and unskilled workers work in different sectors, and crucially, have different access to financial markets (where the unskilled worker is more financially constrained than the skilled worker). We show both analytically and quantitatively that the responses of labor income inequality and consumption to a government spending shock can be explained by the patterns of financial constraints (in which unskilled workers are more financially constrained) and the pattern of spending of the government, which is more concentrated towards sectors that hire skilled workers in a higher proportion. The reason is that when the government spends more on the skilled intensive sector, it is distributing resources towards the workers with lower marginal propensity to consume. This implies that the response of consumption is lower than when the government spends on the unskilled intensive sector. The previous result implies that the effects of government spending on consumption can rise as much as 45% if the sectoral spending pattern switches to spend on the unskilled intensive sector. That alone would raise the government spending multiplier by 32 percent.

While the distribution of spending across sectors is a political decision, it is important to emphasize that how government spends matters. And matters a great deal especially if policymakers are interested in inequality and its aggregate consequences.

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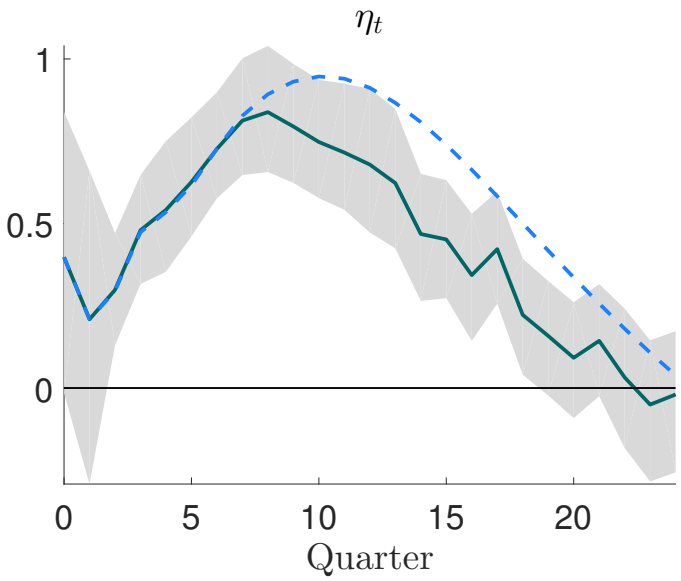
A The Effect of Government Spending on the Earnings Gap using Ramey News shocks

In this section, we estimate the effects of government spending shocks on the earnings gap by considering the News Shocks by Ramey (2011), that are claimed to be exogenous. We use the method proposed by Miranda-Agrippino and Ricco (2017) who propose the Bayesian Local Projection, which is a method that combines the estimation of a Bayesian VAR with Local Projection in an optimal way, to account for the problems these two method alone have. This allows us to estimate a instrumental variable VAR using the Ramey news shocks as instruments.[25]

We estimate the model including the same variables considered in the body of the paper: The earnings gap, government expenditures in consumption and investment, government receipts, GDP, consumption of non-durables and services, fixed non-residential investment, and unemployment. Figure 7 shows the responses of the earnings gap to a one-percent increase in government spending. In green-solid we plot the BLP and in blue-dashed the IV-BVAR. We observe in this picture that the earnings gap also rises in response to the government spending shock. If anything, this response is stronger than the one estimated with Blanchard and Perotti (2002) and has a very similar shape. Unfortunately, as Ramey (2016) point out, her exogenous shocks do not pass the test for weak instruments for the period we have the earnings gap available (1980-2018). Therefore, we stick with Cholesky identification in the main analysis.

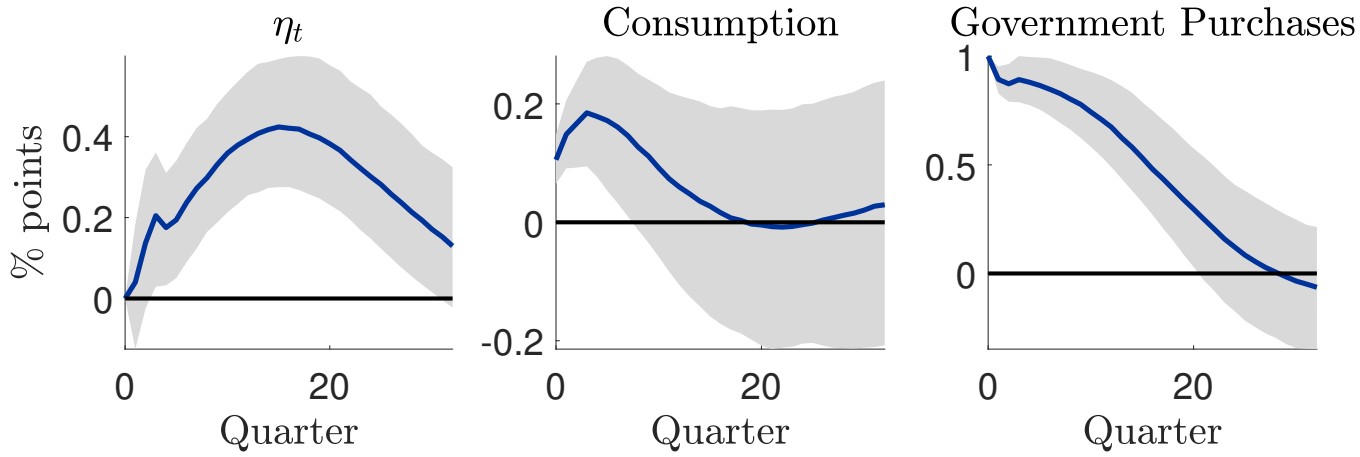
Figure 7: Response of the earnings gap to a unitary shock to government spending in with BLP using Ramey News about military spending shocks.



[25]For more details, we refer the reader to Miranda-Agrippino and Ricco (2017).

B Alternative Ordering in the BSVAR

Figure 8: IRF's to a unitary shock to government spending BSVAR with Cholesky identification ordering η_t first, then government spending. Sample: 1981Q1-2018Q4



C Robustness to the Hyperparameters

Figure 9: 1991Q3-2018Q4

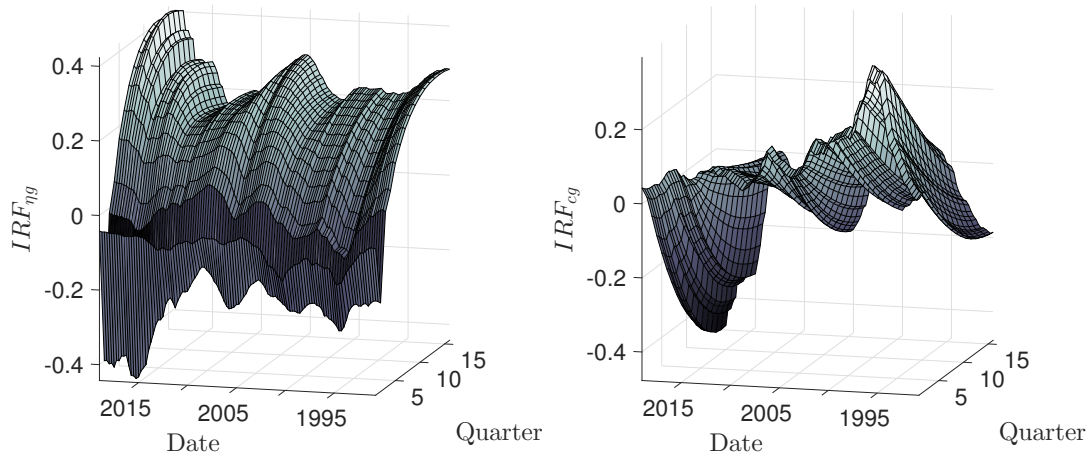
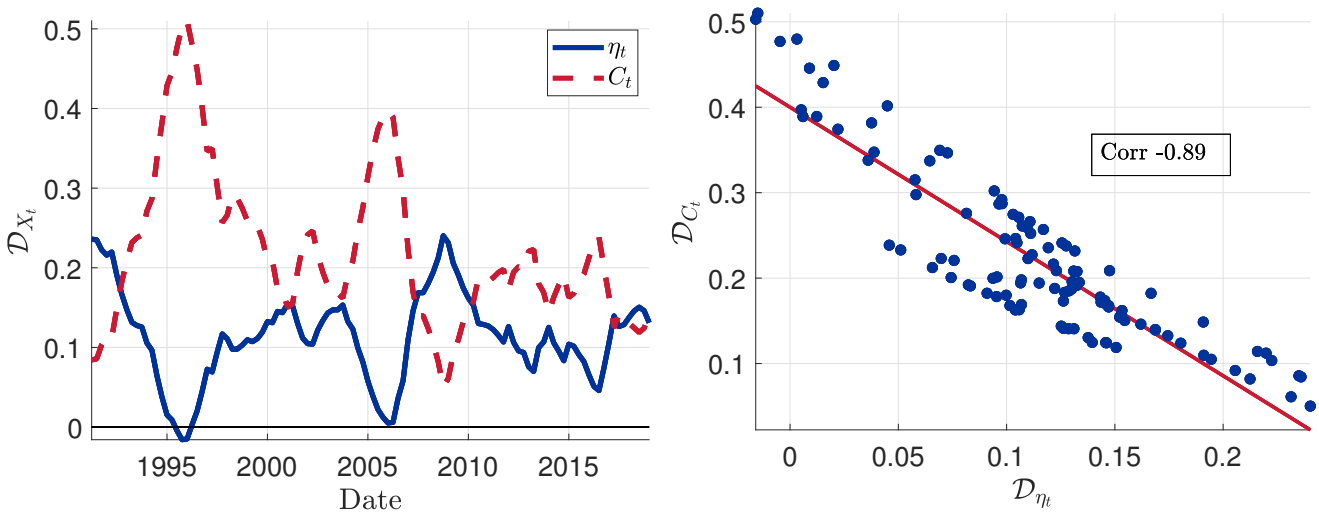


Figure 10: Time-Varying Dynamic Multipliers of C_t and η_t



D Derivations

Shares of sectors in the symmetric steady state. In a symmetric equilibrium, the share of sector one in the total economy is given by

$$Y_1 = \xi \left(\frac{P_1}{P^C}\right)^{-1} C + \aleph \left(\frac{P_1}{P^G}\right)^{-1} G$$

$$n = \frac{Y_1}{Y} = \xi \left(\frac{P_1}{P^C}\right)^{-1} \frac{C}{Y} + \aleph \left(\frac{P_1}{P^G}\right)^{-1} \frac{G}{Y} \tag{22}$$

In a symmetric equilibrium (where $P_1 = P_2$), the share of sector 1 in total production is given by

$$n = \xi(1 - \gamma_g) + \aleph\gamma_g \tag{23}$$

where $\gamma_g = \frac{G}{Y}$ is the share of government spending in total output.

The symmetric equilibrium is attained when wages are equal. This can be attained by setting χ_s and χ_u, such that:

$$w_s = \chi_s N_s^{\varphi} C_s^{\gamma} = \chi_u N_u^{\varphi} C_u^{\gamma} = w_u. \tag{24}$$

When $w_s = w_u$, the marginal costs in both sectors are the same. And then, if $\varepsilon_1 = \varepsilon_2$, prices are equal in both sectors. That allows us to ignore prices in the steady state and in the deviations from the steady state.

Under the assumptions of section 2, the condition for a symmetric equilibrium is:

$$\frac{\chi_s}{\chi_u} = \frac{(\omega_1 n + \omega_2(1-n))(\varepsilon - 1)}{(\omega_1 n + \omega_2(1-n))(\varepsilon - 1) + 1} \tag{25}$$

Share of labor in the different sectors. In steady state the demands for skilled labor are given by:

$$w_s = \omega_1 \frac{Y_1}{n_{1s}} mc_1, \quad w_s = \omega_2 \frac{Y_2}{n_{2s}} mc_2$$

With these demands, we can obtain the total demanded labor for skilled workers

$$n_s = \omega_1 mc_1 \frac{Y_1}{w_s} + \omega_2 mc_2 \frac{Y_2}{w_s}$$

Then,

$$\kappa_{1s} = \frac{\omega_1 mc_1 \frac{Y_1}{w_s}}{\omega_1 mc_1 \frac{Y_1}{w_s} + \omega_2 mc_2 \frac{Y_2}{w_s}} = \frac{\omega_1 mc_1 Y_1}{\omega_1 mc_1 Y_1 + \omega_2 mc_2 Y_2}$$

Asumming a symmetric equilibrium $mc_j = \frac{p_j}{\mathcal{M}_j^p} = \frac{p}{\mathcal{M}^p}$, and $n = \frac{Y_1}{Y}$

$$\kappa_{1s} = \frac{\omega_1 n}{\omega_1 n + \omega_2(1-n)}, \quad \kappa_{2s} = \frac{\omega_2(1-n)}{\omega_1 n + \omega_2(1-n)} \tag{26}$$

$$\kappa_{1u} = \frac{(1-\omega_1)n}{(1-\omega_1)n + (1-\omega_2)(1-n)}, \quad \kappa_{2s} = \frac{(1-\omega_2)(1-n)}{(1-\omega_1)n + (1-\omega_2)(1-n)}. \tag{27}$$

which implies that the share work in the different sectors (the κs) depend on the technology parameters and sizes of the different sectors.