MPRA
Munich Personal RePEc Archive

Productive government investment and the labor share

Bom, Pedro R.D. and Erauskin, Iñaki

Deusto Business School

21 June 2021

Online at https://mpra.ub.uni-muenchen.de/108381/
MPRA Paper No. 108381, posted 30 Jun 2021 06:40 UTC

Productive government investment and the labor share*

Pedro R. D. Bom[†] Iñaki Erauskin[‡]

June 2021

Abstract

A recent body of literature has sought to determine the causes of the global decline of the labor share. We study the role played by government investment—which has also fallen in many advanced economies over the past few decades—in the labor share decline. We first establish a theoretical link between government investment and the labor share using a general equilibrium macroeconomic model, where government capital enters the production function in a factor-augmenting fashion. Our analytic results show that a permanent cut to government investment causes a steady-state decline in the labor share if the elasticity of substitution between private capital and labor is less than one and public capital augments private capital. We then study the empirical relationship between these variables using two panel datasets covering 79 countries, both developing and developed, over the period 1970-2017. Using a system GMM estimator, we find a positive and statistically significant association between government investment and the labor share in advanced economies; for developing countries, however, we find no effect.

JEL codes: E25, E60, H54

Keywords: productive government investment, public investment, public capital, public infrastructure, factor income shares, labor share.

*Iñaki Erauskin acknowledges financial support from Programa de Movilidad del Personal Investigador del Departamento de Educación, Política Lingüística y Cultura del Gobierno Vasco and Programa de apoyo a los grupos del sistema universitario vasco del Departamento de Educación, Política Lingüística y Cultura del Gobierno Vasco (Grupo de investigación IT885-16). This paper was written in part while Iñaki Erauskin was visiting the University of Washington. The authors thank Stephen J. Turnovsky for his helpful comments. Any remaining errors and omissions are entirely the responsibility of the authors.

[†]Deusto Business School, University of Deusto. Address: Hermanos Aguirre Kalea 2, 48014 Bilbao, Spain. Tel.: +34-944-139290. E-mail: `pedro.bom@deusto.es`.

[‡]Deusto Business School, University of Deusto. Address: Pº Mundaiz 50, 20012 Donostia-San Sebastián, Spain. Tel.: +34-943-326600, E-mail: `inaki.erauskin@deusto.es`.

1 Introduction

A vast body of research has recently focused on the so-called 'functional distribution of income,' that is, the distribution of aggregate income between capital holders and wage earners. This literature has been largely sparked by the work of Karabarbounis and Neiman (2014) and Piketty (2014), who document global declines of the labor share of income since the 1980s. This empirical observation is important, not only because it disputes the constancy of factor shares as stylized facts, which have been enshrined in the macroeconomics literature since at least Kaldor (1957, 1961), but also because of its potential implications in terms of economic inequality. Despite some evidence that the decline of the labor share owes in part to measuring issues,[1] there is still a general consensus that it has genuinely and globally declined over the past few decades (Autor et al, 2020). Less consensual, however, are the causes of such decline. Some explanations recently put forward include, among others, the accumulation of private capital, changes in labor market institutions and policies, the global expansion of supply chains, and the rise in the market power of capital-intensive firms. In this paper, we argue, both theoretically and empirically, that changes in government investment have also contributed to movements in the labor share. Our hypothesis is motivated by Figure 1, which shows a positive correlation between the cross-country averages of government investment and the labor share over time, especially in advanced economies.[2]

We start by formalizing the relationship between government investment and the labor share using a general equilibrium model of a small open economy (Section 2). The defining feature of the model whereby government investment affects the labor share lies in the production technology. We employ a constant elasticity of substitution (CES) production function over private capital and labor, which departs from the more common Cobb-Douglas specification by allowing for elasticities of substitution different from one. We further assume that the stock of government capital enters the production function in a factor-augmenting fashion. The resulting production specification allows changes in government investment to be factor-biased—i.e., to affect the marginal products of private capital and labor in different proportions (Acemoglu, 2002; Bom, 2017)—thereby affecting the factor shares. We analytically derive the steady-state effect of a permanent change to government investment on the labor share. The resulting steady-state multiplier highlights the role of the elasticity of substitution and the type of factor-augmentation of government capital. In particular, we show that government investment increases the labor share in steady state if and only if government capital augments private capital and the elasticity of substitution is less than one. We argue that both conditions are empirically plausible. If so, the model predicts that declines

[1] Some issues involved in measuring the labor share include the treatment of mixed incomes (Mućk, McAdam, and Growiec, 2018; Cette, Koehl, and Philippon, 2020), housing capital (Rognlie, 2015), and intellectual properties rights (Koh, Santaeulàlia-Llopis, and Zheng, 2020).

[2] Section 3.1 provides a more detailed discussion of Figure 1. The sources and definitions of the data are given in Section 3.3.

in government investment spending should cause the labor share to decline as well.

The mechanism linking government investment with the labor share in our model is closely related with other neoclassical explanations of the labor share decline based on technical change. Karabarbounis and Neiman (2014) and Piketty (2014) offer explanations based on the accumulation of (private) capital: by decreasing the price of capital investment goods, technological progress induces a substitution effect from labor into capital, lowering the labor share. But this argument relies on the elasticity of substitution between capital and labor being larger than one, which is hardly supported by the available evidence. In fact, most empirical studies find elasticities much smaller than one (Chirinko, 2008; Gechert et al 2019; Knoblach and Stöckl, 2020). More in line with this evidence, a group of studies including, among others, Lawrence (2015), Alvarez-Cuadrado, Long, and Poschke (2018), and del Rio and Lores (2019), suggest that the labor share decline can be better explained by a combination of low substitutability between capital and labor and labor-augmenting technical change. Because technical change is then capital-biased, it lowers the labor share by raising the marginal product of capital relative to that of labor. In our model, likewise, government capital acts as a form of technical change, albeit one that augments private capital. With an elasticity of substitution smaller than one, government capital is then labor-biased. Therefore, a decline in government investment also lowers the labor share by raising the marginal product of capital relative to that of labor.

We then set out to empirically test whether government investment is related to the labor share (Section 3). We obtain panel data for government investment from the International Monetary Fund's 'Investment and Capital Stock Database 2019,' which covers 170 countries for the period 1960-2017 (IMF, 2019). For the labor share, we collect data from two main sources: The Conference Board (TCB) and the European Commission's AMECO database. The TCB data cover 79 developed and developing countries, starting in 1990. The AMECO data date back to 1970, but cover only 37 middle- and high-income countries. As a robustness check, we also use Karabarbounis and Neiman's (2014) data for the labor share. The main empirical specification consists of a panel-data regression model of the labor share on government investment. We also control for confounding factors, such as GDP per capita and trade openness, and allow, when applicable, for heterogeneous effects for developed and developing countries. We estimate the regression models with both the usual Fixed Effects estimator and the Generalized Method of Moments estimator, which further corrects for potential endogeneity. Our findings indicate a positive relationship between government investment and the labor share, in line with our theoretical model, but only for developed countries; for developing countries, the effect is small and statistically insignificant.[3] Our results are quite robust across estimation methods and datasets.

Apart from the aforementioned neoclassical arguments based on capital accumulation,

[3]Our results are also consistent with a recent study by Zhang, Wan, and Wang (2017), who find a positive correlation between the density of road infrastructure and the labor share in China's manufacturing sector.

several other explanations for the labor share decline have been proposed in the literature. One group of studies attribute an important role to changes in labor market institutions and policies, such as the globalization of labor supply (Jaumotte and Tytel, 2007), the deregulation of job protection (Ciminelli, Duval, and Furceri, 2020), and the declining bargaining power of workers (Stansbury and Summers, 2020). Another group of studies, including Dao et al (2017) and Schwellnus et al (2019), find that the expansion and integration of global value chains has also contributed to the labor share decline. In the same vein, Elsby, Hobijn, and Şahin (2013) find that the offshoring of labor-intensive production has caused the US labor share to fall. A third group of studies focus instead on the concentration of market power on a small number of capital-intensive firms with low labor shares. Autor et al (2017, 2020) show that the relocation of economic activity to a few 'superstar firms' has pushed the labor share down both in the US and in other OECD economies. Dixon and Lim (2018), Barkai (2020), and De Loecker, Eeckhout, and Unger (2020) also provide supporting evidence that the labor share decline is associated with an increase in markups or, equivalently, with a decrease in competition. Finally, recent research has found evidence that demographic factors such as the rate of natural increase and the net migration rate have also affected the labor shares of developed countries (d'Albis, Boubtane, and Coulibaly, 2021). We view our findings as complementary to these contributions.

The functional distribution of income is arguably an important factor behind the personal distribution of income and wealth (Atkinson, 2009; Glyn, 2011).[4] Hence, this paper also relates, albeit less directly, with a strand of the literature studying the effects of government investment on income and wealth inequality. At the theoretical level, this effect turns out to be ambiguous, depending on model assumptions and financing modes. Using an endogenous growth model driven by public capital with heterogeneous capital endowments, Chatterjee and Turnovsky (2012) find that public investment may reduce income inequality in the short run but exacerbate it in the long run, with pre- and post-tax income inequality being sensitive to the financing policy adopted. Moreover, public investment would lead to a persistent increase in wealth inequality over time, regardless of the financing mode. On the contrary, Getachew and Turnovsky (2015) find that public investment increases income inequality when the elasticity of substitution between private and public capital is less than one, in a model with idiosyncratic productivity shocks and initial heterogeneous endowments. More recently, Turnovsky and Erauskin (2021) show that public investment reduces income inequality in a standard Ramsey model, the opposite being true in an AK model. At the empirical level, the few available studies find mostly a negative relationship between government investment and income inequality; these include Servén and Calderón (2004), Calderón and Chong (2004), Furceri and Li (2017), and Doumbia and Kinda (2019). In contrast, Banerjee, Duflo, and Qian

[4]Empirical evidence supporting a negative correlation between the labor share and economic inequality is provided by Daudey and García-Peñalosa (2007), Bengtsson and Waldenström (2018), and Erauskin (2020). Francese and Mulas-Granados (2015), in contrast, find little evidence for this link.

(2020) find higher income inequality in Chinese regions with shorter distances to historical transportation networks.

The remainder of the paper is structured as follows. Section 2 describes the theoretical framework, including a brief description of the model (Section 2.1), the implied steady-state effect of government investment on the labor share (Section 2.2), and a simple graphical illustration (Section 2.3). The empirical analysis is presented in Section 3. After informally glancing at the relationship between government investment and the labor share in Section 3.1, we describe the empirical model in Section 3.2 and the data in Section 3.3. To assess the time series properties of the main variables in terms of stationarity, we conduct panel unit root tests in Section 3.4. Sections 3.5 and 3.6 present the main empirical results and some robustness checks, respectively. Section 4 provides further discussion on the results and Section 5 concludes the paper. Appendix A.1 provides further details on the mathematical derivations of the main theoretical results.

2 Theoretical framework

To provide a theoretical underpinning for the relationship between government investment and the labor income share, we build a small-scale model of a small open economy. Because the main purpose of the model is to highlight the long-run forces linking public capital accumulation and the labor share, we abstract from the transitional dynamics and focus instead on the comparative statics.

2.1 Model

We model a small open economy with perfect capital mobility across borders. The model is set up in continuous time and specified in real terms. To keep the notation as simple as possible, we drop the time indices whenever confusion does not arise.

Production technology Consider an economy composed of many identical firms operating under perfect competition. Firms produce output (Y) using as private inputs the stock of private capital (K) and labor services (L). Private capital and labor are optimally chosen by firms and thus referred to as 'private' inputs. But firms also use a third input, government capital (K_G), which, in contrast to the private inputs, is provided by the government as a pure public good.[5] Inputs are transformed into output according to a production technology

[5]The modeling of public capital as an extra input in the production function, now standard in macroeconomic models, dates back to Arrow and Kurz (1970). A large empirical literature, stimulated by Aschauer (1989) and reviewed by Bom and Ligthart (2014a), estimates the productivity of public capital using this production function approach.

with a constant elasticity of substitution (CES) (Arrow et al, 1961):

$$Y = \left[\left(A_K K_G^{\eta_K} K \right)^{\frac{\sigma-1}{\sigma}} + \left(A_L K_G^{\eta_L} L \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where A_K and A_L are efficiency parameters, $\eta_K \geq 0$ and $\eta_L \geq 0$ are factor-augmentation elasticities of government capital, and $\sigma > 0$ is the elasticity of substitution between private capital and labor.

Notice how the stock of public capital enters the production technology in a factor-augmentation fashion (Acemoglu, 2002; Bom, 2017). We refer to public capital as K-augmenting (or Solow-neutral) whenever $\eta_K > 0$ and as L-augmenting (or Harrod-neutral) whenever $\eta_L > 0$. Public capital is thus potentially factor-biased, increasing the marginal product of one private factor relative to the marginal product of the other. For example, public capital increases the marginal product of capital relative to that of labor (in which case it biased towards capital) if $\eta_K > \eta_L$ and $\sigma > 1$, or if $\eta_K < \eta_L$ and $\sigma < 1$. Conversely, public capital increases the marginal product of capital relative to that of labor (in which case it is biased towards labor) if $\eta_L > \eta_K$ and $\sigma > 1$, or if $\eta_L < \eta_K$ and $\sigma < 1$. Under a unitary elasticity of substitution (i.e., $\sigma = 1$), the CES technology reduces to a Cobb-Douglas specification, in which public capital affects neither the relative marginal products of the private factors nor their shares of income.

Denote the marginal products of private capital and labor by $Y_K \equiv \partial Y / \partial K$ and $Y_L \equiv \partial Y / \partial L$, respectively. Because the production function exhibits constant returns to scale—i.e., homogeneity of degree one—over the private factors, Euler's theorem applies and $Y = Y_K K + Y_L L$. This feature is important when studying the income shares, as it implies that aggregate income is fully appropriated by the private factors if they are paid their marginal products. The output elasticities to the private inputs are then defined as $\theta_K \equiv \frac{Y_K K}{Y} > 0$ for private capital and $\theta_L \equiv \frac{Y_L L}{Y} > 0$ for labor, so that $\theta_K + \theta_L = 1$.

By augmenting the private factors, public capital gives rise to a positive production externality. The magnitude of this externality is governed by the output elasticity of public capital, denoted by $\eta \equiv \frac{\partial Y}{\partial K_G} \frac{K_G}{Y}$, which can be easily shown to depend on the output elasticities to the private inputs and on the augmentation elasticities according to

$$\eta = \theta_K \eta_K + \theta_L \eta_L \geq 0. \tag{2}$$

That is, the output elasticity of public capital is composed of the sum of the factor-augmentation elasticities of government capital with respect to each private input multiplied by the corresponding output elasticities.

Firms The representative private firm maximizes the net present discounted value of its cash flow subject to the capital accumulation constraint

$$\dot{K} = I - \delta K, \tag{3}$$

where I denotes gross private investment and δ is the rate of depreciation of private capital. Note that a dot over a variable denotes its time derivative; hence, $\dot{x} \equiv dx/dt$ for any variable x. The first-order conditions of the firm's problem simply equate the marginal costs to the marginal products of the private factors:

$$r + \delta = A_K K_G^{\frac{\eta_K(\sigma-1)}{\sigma}} \left(\frac{Y}{K}\right)^{\frac{1}{\sigma}} \equiv Y_K, \tag{4}$$

$$w = A_L K_G^{\frac{\eta_L(\sigma-1)}{\sigma}} \left(\frac{Y}{L}\right)^{\frac{1}{\sigma}} \equiv Y_L, \tag{5}$$

where r is the interest rate and w is the wage rate. Because the economy is small and open and capital is internationally mobile, the interest rate is determined in world markets and taken as given by the domestic representative firm. Labor, in turn, is immobile across borders. The wage rate is thus endogenously determined in the domestic labor market (see below).

Government To foot the bill on public capital investment, I_G, the government levies a lump-sum tax on households, T. To keep the government sector as simple as possible, we assume that the government's budget is permanently balanced, implying that $T = I_G$. The stock of public capital accumulates according to

$$\dot{K}_G = I_G - \delta_G K_G \tag{6}$$

where δ_G denotes the depreciation rate of public capital.

Households Standard models of a small open economy are prone to hysteresis unless some stationarity-inducing device is built in (Schmitt-Grohé and Uribe, 2003). We adopt the Blanchard-Yaari formulation of finitely-lived households (Yaari, 1965; Blanchard, 1985) in order to generate an endogenously-determined (non-hysteretic) steady state. This property is convenient since we focus our analysis on steady-state comparative statics. The household sector consists of infinitely-many generations of individuals, who face a constant instantaneous probability of death β. New individuals are also born at the instantaneous rate β, so that the population size is kept constant over time. We use the subindex v to track the vintage of an individual born at time v. At time t, an individual household of vintage $v \leq t$ chooses the level of goods consumption (C_v) and allocates one unit of time into either labor (L_v) or leisure $(1 - L_v)$ in order to maximize her lifetime utility

$$\int_t^{\infty} \ln\{C_v(\tau)^{\varepsilon} [1 - L_v(\tau)]^{1-\varepsilon}\} e^{(\alpha+\beta)(t-\tau)} d\tau, \tag{7}$$

where ϵ is the utility weight of consumption and α denotes the pure discount rate. Households insure against the mortality risk by purchasing actuarially-fair annuities, which pay the effective return $r + \beta$ on financial wealth while the household is alive in exchange for the existing financial wealth when the household passes away. Hence, in terms of equation (7), the fully-insured risk of death implies that households discount future utility at the effective rate $\alpha + \beta$.

Individual financial wealth, $\dot{A}_v$, accumulates according to

$$\dot{A}_v = (r + \beta)A_v + wL_v - T - C_v, \tag{8}$$

where a few remarks are in order. First, as discussed above, the effective return on financial wealth is $r + \beta$. Second, households are equally productive, implying that the wage rate is independent of age. Finally, the consumption good is used as the numeraire, so that its price is set to one.

Denote individual 'full consumption' by X_v and define it as the market value of goods consumption and leisure; that is, $X_v \equiv C_v + w(1 - L_v)$. The household's problem consists of maximizing (7) subject to (8) and a no-Ponzi game condition. The first-order conditions of this problem are:

$$\dot{X}_v = (r - \alpha)X_v, \tag{9}$$

$$C_v = \varepsilon X_v, \tag{10}$$

$$w(1 - L_v) = (1 - \varepsilon)X_v. \tag{11}$$

The first of these conditions governs the intertemporal behavior of full consumption. We assume patient households (i.e., $\alpha > r$), so that individual consumption profiles rise over time. The static equations (10) and (11), in turn, dictate the intratemporal split of full consumption into goods consumption and leisure, according to the preference parameter ε.

Aggregation At time t, each cohort v of households represents a fraction $\beta e^{\beta}(v - t)$ of the population. Using these cohort sizes, we can aggregate an household variable x at time t across living households as $x = \int_{-\infty}^{t} x_v(t)\beta e^{\beta(v-t)} dv$. Doing so for goods consumption and leisure, given by (10) and (11), results in similar expressions at the aggregate level:

$$C = \varepsilon X, \tag{12}$$

$$w(1 - L) = (1 - \varepsilon)X. \tag{13}$$

Aggregating the dynamic equations for financial wealth and full consumption gives

$$\dot{A} = rA + wL - T - C, \tag{14}$$
$$\dot{X} = (r-\alpha)X - \beta(\alpha+\beta)A, \tag{15}$$

which take a different form than their individual counterparts, given by equations (8) and (9). Notice, for example, that the extra return β does not show up in (14), since β does not represent an increase in aggregate financial wealth but merely a transfer of financial wealth between generations. This transfer of wealth also causes aggregate full consumption to rise over time at a lower rate than individual full consumption, as implied by the last (negative) term on the right-hand side of (15). Notice that, without this term (i.e., if $\beta = 0$), an aggregate steady state would require $r = \alpha$, implying histeresis.

Equilibrium In the aggregate equilibrium, $Y = C + I + I_G + NX$, where NX denotes net exports. The stock of net foreign assets thus evolves according to $\dot{F} = rF + NX$. Hence, the stock of financial wealth consists of the stock of private capital plus the stock of net foreign assets, that is, $A = K + F$.

2.2 The steady-state effect of government investment on the labor share

We now use the model outlined in the previous section to study the steady-state effects of government investment on the labor share of income. The economy is assumed to be initially at rest in some (pre-shock) steady-state equilibrium where $\dot{K} = \dot{K}_G = \dot{X} = \dot{A} = 0$. Upon a permanent government investment shock, the economy is diverted from the initial equilibrium towards a new (post-shock) steady-state equilibrium where, again, $\dot{K} = \dot{K}_G = \dot{X} = \dot{A} = 0$. We characterize the marginal general-equilibrium effects of the government investment impulse on the labor income share across steady states by means of the labor share multiplier.[6]

To find the labor share multiplier of government investment, we start by fully differentiating $\theta_L = wL/Y$ with respect to I_G:

$$\frac{d\theta_L}{dI_G} = \frac{\theta_L}{w}\frac{dw}{dI_G} + \frac{\theta_L}{L}\frac{dL}{dI_G} - \frac{\theta_L}{Y}\frac{dY}{dI_G}, \tag{16}$$

which simply decomposes the total effect of government investment into the partial effects on the components of the labor share: wages (w), labor (L), and output (Y). If the two first terms on the right-hand side exceed the last term, then the effect of government investment on labor

[6] Bom and Ligthart (2014b) and Bom (2017, 2019) study the transitional dynamics of a permanent public investment impulse in similar models. With capital adjustment costs and under plausible parameter values, these models tend to be saddle-path stable, in which case the economy jumps upon the shock and then gradually transits towards the new steady state. Without capital adjustment costs, the transition between steady states is instantaneous.

income (wL) dominate the effect on total income (Y), and the labor share goes up. To find the reduced-form expression of the labor share multiplier, we thus need to find the impact of government investment on wages, labor, and output. In general equilibrium, however, government investment may also affect the labor share indirectly through full consumption and financial wealth. Hence, finding the reduced-form expression of the labor share multiplier requires solving a linear system of multipliers. Appendix A.1 derives and solves this system. The reduced-form multipliers of labor, wages, and output are given by equations (A.7), (A.8), and (A.11), respectively.

Plugging in the reduced-form multipliers of labor, wages, and output into (16) gives, after some simplifying steps, the reduced-form multiplier of the labor share as

$$\frac{d\theta_L}{dI_G} = \frac{\theta_K \eta_K (1-\sigma)}{I_G}. \tag{17}$$

A few important results emerge from this expression. First, because the capital income share (θ_K) and government investment (I_G) are both positive, a necessary condition for the government investment impulse to affect the labor share in the long run is that public capital augment private capital, i.e. $\eta_K > 0$. Some types of government investment, such as core infrastructure spending on transportation, energy systems, or telecommunications, are likely to be of this sort, since they direct complement the stock of capital employed by private firms. It is therefore not the productive nature of government investment per se but the extent to which it directly augments private capital that matters for the labor share. Even if highly productive, public investment does not affect the labor share if public capital only augments the labor factor.

Second, assuming that $\eta_K > 0$, the magnitude of the effect depends on whether the elasticity of substitution between private factors (σ) is less or greater than one; in particular, the effect of public investment on the labor share is positive if private factors are gross complements (i.e., $\sigma < 1$) and negative if they are gross substitutes (i.e., $\sigma > 1$). Of course, the factor incomes shares are fixed under a Cobb-Douglas technology (i.e., $\sigma = 1$) and thus unaffected by public investment. Hence, taking into account that the empirical evidence overwhelmingly supports the hypothesis that $\sigma < 1$ (Chirinko, 2008; Gechert et al, 2019; Knoblach and Stöckl, 2020), one would expect public investment to exert a positive effect on the labor income share. Finally, although one might have expected the preference parameter ε or the initial amount of labor employment (L)—which, after all, determines the labor supply elasticity—to affect the labor share, this turns out not to be the case. The key factors determining the general-equilibrium impact of public investment on the labor share in the model are the technology parameters η_K and σ.

2.3 Graphical illustration

Figure 2 provides a graphical illustration of the effect of a permanent increase in government investment on the labor share. Panel (a) represents the case in which private capital and labor are (strong) gross complements in production (i.e., $\sigma \ll 1$), whereas panel (b) depicts the case in which they are gross substitutes (i.e., $\sigma > 1$). Intermediate cases in which the private factors show a small degree of complementarity (i.e., σ slightly smaller than one) are harder to illustrate graphically, but are no different than the case of strong complementarity in terms of the final effect on the labor share. Both graphs plot the production frontier in terms of the labor input, that is, the amount of output produced as a function of the labor input given the stocks of private and public capital.

Prior to the government investment impulse, the economy rests at the equilibrium E_0 in the production frontier PF_0, employing $L = L_0$ to produce $Y = Y_0$. The slope of PF_0 at E_0 represents the marginal product of labor, which determines the wage rate $w = w_0$. Hence, the pre-shock labor share is $w_0 L_0 / Y_0$. The government investment shock affects the production frontier in two ways. First, for a given stock of private capital, the increment in public capital directly shifts the production frontier up to the dashed curve PF'. This is a direct productivity effect, which increases output for any amount of the labor input, irrespective of σ. Second, private capital itself changes in general equilibrium, which further shifts the production frontier. But this indirect private-capital effect does depend on σ, as is clear from the reduced-form multiplier of private capital (A.9) in Appendix A.1. If the elasticity of substitution is sufficiently smaller than unity (i.e., $\sigma \ll 1$), then private capital falls in the long run, which shifts the production frontier down to PF_1 in panel (a). If the elasticity of substitution is greater than one (i.e., $\sigma > 1$), then private capital increases in the long run, which shifts the production frontier up to FP_1 in panel (b).[7]

Irrespective of whether private capital ultimately increases or decreases over the long term, the marginal product of labor increases, which pushes up wages and employment. In fact, the steady-state effects on wages and labor positively depend on the output elasticity of public capital but depend neither on the elasticity of substitution nor on the particular type of factor augmentation, as revealed by the reduced-form multipliers (A.7) and (A.8) in Appendix A.1. Hence, the increase in labor (from L_0 to L_1) and the increase in wages (from w_0 to w_1) are of equal magnitude in panel (a) and in panel (b). Given that two of the inputs (L and K_G) increase by the same amount in both panels, the ultimate effect on output is determined by the change in the third input, private capital, which decreases in panel (a) and increases in panel (b). Hence, the long-run output increase (from Y_0 to Y_1) is much larger in panel (b) than in panel (a).

To understand the effects of the public capital impulse on the labor share of income,

[7] For values of the elasticity of substitution not smaller than but close to one, private capital increases in the long run but the ultimate effect on the labor share is still as shown in panel (a).

note that $Y = Y_K K + Y_L L$; that is, aggregate income is fully exhausted in remunerating the two private factors of production, private capital (K) and labor (L). This follows from the constant returns-to-scale assumption on the production technology coupled with competitive factor markets. Hence, since $Y_L = w$, the labor share of income is given by $\theta_L = wL/Y$. If $\sigma \ll 1$ (panel (a)), aggregate income (Y) goes up but capital income ($Y_K K$) goes down (since Y_K is constant in the long run and K falls). So, labor income (wL) must go up relative to Y, meaning that the labor share of income ($\theta_L = wL/Y$) increases. If, on the contrary, $\sigma > 1$ (panel (b)), then the increase in aggregate income is much larger than in panel (a), but the difference is fully employed in remunerating capital. So, Y goes up relative to wL and the labor income share falls.

3 Empirical analysis

We now turn to estimating the effect of government investment on the labor share using panel data for developed and developing countries. To motivate our analysis, we first take a quick informal glance at the evolution of the two variables and their relationship over time. Subsequently, we describe the formal empirical model to estimate, the data, the properties of the variables in terms of unit roots, and the estimation results.

3.1 Government investment and the labor share: a glance at the data

Figure 1 plots the evolution of the cross-country average labor share (solid line, left axis) and government public investment (dashed line, right axis) over time. Panels (a) to (c) use TCB data for the labor share, which include both developed and developing countries but only cover the period 1990-2017 (Section 3.3 describes the sources and definitions of the data in more detail). In panel (a), the average labor share across all countries (TCB data) declined gradually from 1990 to 2007, when the Great Recession hit, but increased somewhat afterwards. Over the whole sample period, however, the general pattern indicates a global decline of the labor share. Government investment followed a similar pattern, showing a general decline up to 2005, increasing between 2005 and 2009, only to fall again until 2017. The relationship between the labor share and government investment is clearly positive for most of the sample, but seems to weaken somewhat after the Great Recession.

But this overall pattern hides different patterns for developed and developing countries. As depicted in panel (b), both the labor share and government investment have generally trended downwards in developed countries over the period 1990-2017, with noticeable spikes after the Great Recession. As shown in panel (c), however, the profiles of the labor share and government investment for developing countries are strikingly different. The labor share in these countries generally declines up to 2005, and increases afterwards. Government investment follows an even more erratic pattern, generally declining up to 2007, then experiencing a large increase until 2010, and slightly falling after that. The co-movement between the labor share and government investment seems to be stronger in developed countries than in developing countries.

Finally, panel (d) plots the same variables but using labor share data from the AMECO database, which extends the sample back to 1960 but only includes developed countries. This figure reveals that the labor share was roughly stable during the 1960s, starting to decline in the late 1970s and, more strongly, in the early 1980s. Government investment in these countries was actually rising in the 1960s and started to fall in the mid 1970s. As in panel (b), there is a clear positive association between the labor share and government investment in developed countries. Overall, Figure 1 suggests that the labor share is positively correlated with government investment, and that this relationship may be weaker in developing countries. For this reason, we incorporate this distinction between the two groups of countries into our formal empirical analysis.

3.2 Specification and estimation

To estimate the impact of government investment, GI, on the labor share, LS, in our panel, we specify the following regression equation for country i in year t:

$$LS_{it} = a_0 + a_1 GI_{it} + Controls + u_{it}, \tag{18}$$

where a_0 is either a constant or, if country fixed effects are assumed, a vector of country-specific constants, and u_{it} is the error term. The coefficient of interest is a_1, which measures the marginal effect of government investment on the labor share. When allowing for heterogeneous effects of government investment for developed and developing countries, we include the interaction term $GI_{it} \cdot D_i$, with coefficient α_2, as an additional variable on the right-hand side, where D_i is a binary variable indicating whether country i is a developing country (one if so, zero otherwise). With this variable included, the marginal impact of government investment for developed countries ($D_i = 0$) is still measured by a_1, while the marginal effect for developing countries ($D_i = 1$) is measured by $a_1 + a_2$. We also control for confounding factors by including a set of control variables, which are discussed below. Note that government investment is scaled by GDP. All variables are expressed in levels.

Standard estimation methods, such as OLS, may lead to spurious results if the variables in the regression model are non-stationary. Spurious results arise whenever the non-stationary variables possess unrelated stochastic trends, which dominate the behavior of the variables over time and are thus picked up by the regression model as (erroneously) indicating a relationship between them. The exception is the special case when there is some linear combination between the non-stationary variables that is itself stationary. Because, in this case, the variables share the same stochastic trend, they are said to be cointegrated. When applied to cointegrated variables, standard methods such as OLS result become superconsistent, approaching the true parameters values at a faster rate. It is thus important to assess the stationarity properties of the variables before estimating the regression model. We do so by means of panel unit root tests in Section 3.4.

We extend the regression model to include several control variables and deterministic terms. First, since the labor share shows quite some persistence over time, as shown below in Section 3.4, we include one lag of the dependent variable as an additional explanatory variable. Although it may introduce a bias in the presence of fixed effects (see below), allowing for dynamics in the dependent variable may capture the partial adjustment of the dependent variable towards the steady state (see, e.g., Baltagi, Demetriades, and Law, 2009). Second, because the relationship between the labor share and government investment may be confounded by the countries' level of economic development and economic structure even within the country groups considered (i.e., developed and developing), we also consider GDP per capita and trade openness (i.e., the sum of imports and exports as a share of GDP) as control variables. Finally, we include a deterministic time trend in the model. Given the presence of negative trends in the labor share and government investment over the sample period, which are found to be deterministic in Section 3.4, allowing for a deterministic time trend is important to reduce the probability of finding spurious relationships.

We estimate the regression model using two methods. First, we employ the standard Fixed Effects (FE) estimator, which models the unobserved heterogeneity across countries in an additive fashion by means of country-specific constant terms (collected in vector a_0). Any country-specific effects are thus picked up by these country-specific constant terms, implying that the identification of the remaining parameters of the model is achieved through the variation in the data over the time dimension. But the FE estimator may be biased in our model, given the inclusion of the lagged dependent variable (Nickell, 1981). Moreover, some of the explanatory variables may be endogenous with respect to the labor share. To address these endogeneity issues, we also use the system Generalized Methods of Moments (GMM) estimator (Arellano and Bover, 1995; Blundell and Bond, 1998), which is preferable to the first-difference GMM estimator (Arellano and Bond, 1991) when the dependent variable exhibits time persistence and the number of observations over the time dimension is relatively small. As instruments, we employ the second lag of the labor share and the first lag of government investment, which are the latest valid instruments under the assumptions of the model.

3.3 Data definitions and sources

The data on government investment are obtained from the International Monetary Fund's "Investment and Capital Stock Dataset, 1960-2017" (January 2019 version). This dataset includes annual data on investment flows and capital stocks of both the private and the public sectors for 170 developed and developing countries over the period 1960-2017 (IMF, 2019). We construct the government investment variable from this dataset by taking gross fixed capital formation (GFCF) of the general government (variable 'igov_rppp' in the dataset), which includes both the central government and subnational government layers, and dividing it by GDP (variable 'GDP_rppp' in the dataset), both measured at constant 2011 international dollars. To make the data comparable across countries, the dataset definition of government investment excludes alternative modes of investment, such as investment grants, loan guarantees, tax concessions, operations of public financial institutions (e.g., development banks), and government-backed saving schemes (IMF, 2019). In terms of allocation, public investment is mostly spent in the functioning of economic affairs, such as transportation and energy (with an average share of 34.4% across OECD countries in 2017), followed by defence (15.4%), and education (15.1%) (OECD, 2019). Other functions include general public services (9.3%), health care (8.4%), and, to a smaller degree, housing (5.1%), environmental protection (4.5%), public order and safety (3.5%), and social protection (1.6%) (figures from 2015; see OECD, 2017). No major changes have taken place in the allocation of public investment across different functions in recent years (for 2007 figures, see Jäger and Schmidt, 2016). Hence, despite including also elements of social spending, we view our measure of government investment as a convenient proxy for public infrastructure.

For the labor share, we obtain data from different sources based on different methodologies. A first measure of the labor share is obtained from the "Total Economy Database", provided by The Conference Board (TCB); it covers 130 countries and ranges from 1990 to 2017.[8] The TCB's labor share data measure the proportion of labor income relative to total income based on the compensation of employees and mixed income data from the national accounts. Accounting for mixed incomes, a convenient adjustment that is standard in the literature, requires the assumption that self-employed workers have the same wage rate as employees.[9] In the case of data unavailability, some adjustments are also made based on common wages and hours or, if this is not possible, on estimates from the Penn World Tables or the Asian Productivity Organization. The TCB data also assume a labor share of 50% for countries with missing data. However, we eliminate these assumed values from the data. After combining the TCB's labor share data with the IMF's government investment data, we obtain a panel dataset encompassing 79 countries (38 developed and 41 developing) over the period 1990 to 2017, which yields a sample of 2,156 observations (see Table 1 for a description of the countries included in the panel).

A second measure of the labor share used in this paper comes from the AMECO database,

[8]We use the version from May 2019. See https://www.conference-board.org/data/economydatabase/ for more details.

[9]Guerriero (2019) compares up to six different measures of the labor share, based on different criteria concerning the accounting for the remuneration of the self employed, finding that all measures behave quite similarly over time. The correlation coefficients between these measures is always higher than 0.75 and around 0.9 for most cases. Our definition of the labor share corresponds to definition 4 in her paper.

the Annual Macro-ECOnomic database of the European Commission's Directorate General for Economic and Financial Affairs. One advantage of the AMECO data is its longer time dimension, dating back to 1960 for some countries. This advantage comes at the cost of a much smaller country dimension, however, covering only 41 developed countries. In the AMECO's database, the labor share is defined as the adjusted wage share as a percentage of GDP at current prices and measured by the compensation per employee (including wages, salaries, and the employer's social contributions) as a fraction of GDP at market prices per employed person (variable ALCD0 in the database). Again, this measure requires assuming that self-employed workers have the same wage rate as employees. The correlation coefficient between the overlapping labor share data in the AMECO database and in the TCB database amounts to 0.66 (counting only those observations for which government investment data are also available). After combining the AMECO's labor share data with the IMF's government investment data, we obtain a panel of 37 developed countries over the period 1970 to 2017, yielding a sample of 1,513 observations (see Table 1 for a description of the countries included in the panel).

Finally, we also use the labor share data provided by Karabarbounis and Neiman (2014), which cover 59 countries for various years in the period 1975-2012. However, most observations correspond to developed countries in more recent years. When combined with the available data for government investment, this third measure gives rise to a panel containing 868 observations for 37 countries. Given this much smaller sample size, we employ the TCB and AMECO data in our baseline estimations and use the Karabarbounis and Neiman's data only as a robustness check. Note that the correlation coefficient between the overlapping labor share data from Karabarbounis and Neiman and from the TCB database is only 0.55; between Karabarbounis and Neiman's and AMECO's labor share data it is even lower, at 0.35 (counting only those observations for which government investment data are also available). Notwithstanding these data differences, however, the results are broadly consistent across the three measures of the labor share (see Sections 3.5 and 3.6).

The World Bank classifies countries into five income groups, as indicated in the numbered categories in Table 1. We define a country as developed if it belongs to one of the first two income groups (high income developed OECD countries and other high income countries), and as developing otherwise. As mentioned above, some models include GDP per capita and trade openness as control variables. GDP per capita is simply aggregate real GDP divided by population. Trade openness is defined as the total value of international trade (i.e., the sum of exports and imports) as a fraction of aggregate GDP. We obtain data for both variables from the World Development Indicators of the World Bank.

A few remarks on the data are in order before we proceed with the analysis. First, recent research has identified some measuring issues that could cause a decline in the labor share as a statistical artifact. These issues include the treatment of capital depreciation, indirect taxes, and housing capital (Rognlie, 2015; Bridgman, 2018; Cette et al, 2020), self-employment (Gollin, 2002; Elsby et al, 2013; Cette et al, 2020), and intangible capital (Koh et al, 2020). Although some of these factors may imply relatively large effects on the data, they typically account for a modest share of the labor share decline. Second, government investment data are often of poor quality in developing countries (Gurara et al, 2017), which raises the possibility of measurement error in this variable. Measurement error is more serious in government investment (the explanatory variable) than in the labor share (the dependent variable), since it may cause attenuation bias (i.e., a bias towards zero) in the effect of the former on the latter. In view of these limitations, our results should be taken with some caution.

3.4 Time series properties of the main variables

As discussed in Section 3.2, it is important to assess whether the variables are stationary before estimating the regression model. This section conducts panel unit root (PUR) tests on government investment and the labor share, the main variables in the model. The presence of a trend in the data is clear from a quick inspection of the time plot, especially in the case of the labor share in developed countries, as discussed in Section 3.1. The question now is whether this trend should be treated as deterministic or stochastic. If, when allowing for a linear time trend, the PUR tests indicate no unit root in the data, then we conclude that the variables are stationary around a deterministic linear trend. If, on the contrary, the PUR tests suggest the presence of one unit root in the data, then we conclude that the trend is stochastic and the variables are non-stationary. This last case would require some respecification of the model, usually involving first-differencing the variables and possibly allowing for cointegration in the context of an error correction model. As shown below, however, most PUR tests strongly suggest that the variables are (trend) stationary over the sample period, implying that the regression model (18) can be estimated using standard estimation methods.

We employ three PUR tests, namely the Im-Pesaran-Shin (IPS) test, the Fisher-augmented Dickey-Fuller (Fisher-ADF) test, and the Levin-Lin-Chu (LLC) test.[10] The null hypothesis in the IPS and Fisher-ADF tests is that all countries contain unit roots in their time series (i.e., non-stationarity), whereas the alternative hypothesis is that there is no unit root in the time series of least one country (i.e., stationarity). The LLC test estimates a single common autoregressive coefficient for all countries. The null hypothesis is then that this autoregressive coefficient is one (i.e., one unit root), against the alternative hypothesis that it is less than one (i.e., no unit root). Note that these tests assume cross-sectional independence. In view of the macroeconomic links between countries, this assumption may not hold true in our data. One way of accounting for this issue involves demeaning the data prior to conducting the test. Hence, we conduct all PUR tests with and without demeaning the variables.

Table 2 reports the results of the PUR tests for the labor share variable (LS). We organize

[10]The LLC test requires the sample to be strongly balanced, which implies using less observations.

the results according to the source of data, presenting the results for the TCB data in panel (a) and the results for the AMECO data in panel (b). In both cases, all tests are conducted with only a constant, and with both a constant a time trend. We find the latter procedure more sound, however, in view of the possibility of trend stationarity. When using the TCB data, we also perform the tests separately for developed and developing countries. As shown in Table 2, the results overwhelmingly suggest that the labor share is (trend) stationary, with most p-values falling below the 1% significance level. The evidence for stationarity of the labor share is weaker when the demeaned TCB data are used for all countries, developed and developed. When considered separately, however, all tests for developed countries and all but the Fisher-ADF test for developing countries indicate stationarity at conventional significance levels. It is important to note this distinction, since it is explicitly incorporated into our regression analysis.

We follow the same procedure for the government investment variable (GI). The results are displayed in Table 3, following a similar structure to those presented in Table 2. First, notice that the results are very similar for the unadjusted and the demeaned data, suggesting a lesser role of cross-sectional dependence in the government investment data than that found for the labor share data (see Table 2). Second, with the single exception of the Fisher-ADF test applied to the panel of developed countries, all tests clearly reject the null hypothesis of non-stationary in all cases. Hence, the results suggest, by and the large, that government investment is also stationary. We proceed to estimate the regression model under this assumption.

3.5 Estimation results

We now turn to estimating the regression equation (18). Table 4 reports the estimation results using the FE estimator, whereas Table 5 presents the results using the system GMM estimator. Both tables are organized in the same way. Columns (1) to (3) report the results using the TCB data for all countries, first with no controls and without distinguishing between developed and developing countries (i.e., implicitly setting $\alpha_2 = 0$), then with no controls but allowing for different effects of government investment in developed and developing countries, and, finally, also with controls. Columns (4) and (5) report the results for the TCB data only for developed countries with and without controls, respectively. The analogous results for developing countries are presented in columns (6) and (7). Finally, columns (8) and (9) show the results for the AMECO data (only developed countries) with and without controls, respectively. All regressions include one lag of the dependent variable (Lagged LS), a linear time trend, and fixed country effects (not reported). For each variable in each regression, we report the corresponding coefficient estimate and its standard errors in parentheses. All reported standard errors are clustered at the country level.

Starting off with the FE estimates in Table 4, the effect of government investment on the labor share is generally positive and statistically significant. The effect seems to be weak and borderline significant when pooled for all countries using TCB data (column (1)). However, when estimated separately for developed and developing countries (column (2)), one finds that government investment only affects the labor share in the former group; in developing countries, in contrast, the effect is close to nil ($-0.019 = 0.183 - 0.202$). Controlling for GDP per capita and trade oppenness further increases the estimated effect in developed countries (column (3)). Very similar results emerge from estimating the full regression only for developed countries (columns (4) and (5)), and only for developing countries (columns (6) and (7)). The effect of government investment on the labor share using TCB data for developed countries is also consistent with that based on the AMECO data, as shown in columns (8) and (9), which is slightly smaller but still highly significant.

The coefficients of the remaining variables are quite stable across regressions. First, the dependent variable is quite persistent, as measured by the coefficient of the lagged dependent variable (above 0.8 in most cases). Second, the time trend slopes downwards, as expected, and is almost always statistically significant (the exception being in developing countries). Third, regarding the controls, GDP per capital is almost always statistically insignificant and only trade openness seems to matter. In any case, the inclusion of the controls makes little difference to the estimated effect of government investment on the labor share.

Despite addressing the biases that may arise from the simultaneous inclusion of fixed effects and a lagged dependent variable and from the potential endogeneity in the regressors (see Section 3.2), the system GMM estimates reported in Table 5 are broadly consistent with the FE estimates shown in Table 4. Again, we find a positive and statistically significant effect of government investment on the labor share for developed countries, but not for developing countries, where the effect is close to nil. The system GMM estimates differ from the FE estimates in two important ways, however. First, the magnitude of the effect of government investment in developed countries is almost twice as large. Second, the time trend looses its explanatory power. The system GMM estimator thus attributes a larger role to government investment and a lesser role to other causes embedded in the time trend (e.g., technological change) in explaining the decline of the labor share in developed countries.

Regarding the diagnostic tests of the system GMM approach, displayed at the bottom of Table 5, the Hansen test of over-identifying restrictions safely accepts the additional instruments in all cases. We also generally find first-order autocorrelation (as expected) and no second-order autocorrelation (which is important to validate the instruments). The exceptions are the regressions estimates with TCB data for developed countries reported in columns (4) and (5), where we reject the null of no second-order autocorrelation. This may invalidate the use of the instruments and introduce some bias. We find reassuring, however, the fact that no anomaly is detected for the AMECO data, while giving rise to almost identical estimates.

3.6 Robustness

We check the robustness of our results along two dimensions. First, we re-estimate the regression models described in Section 3.5 using a robust-regression method, which accounts for the presence of outliers by assigning less weight to those observations that lie farther from the regression line.[11] The results are shown in Table 6. Except for some small quantitative differences, our main results from Section 3.5 are largely unaffected.

Second, we re-estimate the regressions employing the labor share data compiled by Karabarbounis and Neiman (2014). The FE estimates are reported in Table 7, whereas the system GMM estimates are provided in Table 8. Again, we do not find any major change to our previous results. We find again a positive and statistically significant effect of government investment on the labor share in developed countries—which slightly increases in magnitude—but not in developing countries.

4 Discussion

Our empirical analysis uncovers a positive effect of government investment on the labor share in developed economies. This result is consistent with our theoretical model, which predicts a positive steady-state relationship between public investment and the labor share if (i) public capital augments private capital and (ii) the elasticity of substitution is less than one. These conditions are empirically plausible. Although we are unaware of empirical evidence regarding the type of factor-augmentation of public capital, some types of public investment are likely to augment private capital, at least in part. This may be especially the case for some types of so-called 'core' infrastructure capital—such as roads and highways, water systems, or energy systems—which directly complement the stock of capital of private firms. For example, building a new highway (or improving an existing one) may directly augment the productivity of private cargo trucks. Regarding the elasticity of substitution, the bulk of empirical evidence indeed suggests values well below one (Chirinko, 2008; Gechert et al, 2019; Knoblach and Stöckl, 2020).

A positive effect of government investment on the labor share naturally implies that cuts in government investment lower the labor share. As noted in Section 3.1, government investment has gradually declined in many advanced economies since the 1970s. Hence, our results suggest that cuts in government investment may explain, at least in part, the labor share declines in developed countries. Although this explanation for the decline of labor shares is theoretically incompatible with those based on capital accumulation by Karabarbounis and Neiman (2014) and Piketty (2014), which require elasticities of substitution greater than one, it potentially complements others based on labor-augmenting technical progress (Lawrence, 2015; Alvarez-Cuadrado, Long, and Poschke, 2018; del Rio and Lores, 2019), changes in labor market

[11] We implement this method using the command 'rreg' in Stata.

institutions (Jaumotte and Tytel, 2007; Ciminelli, Duval, and Furceri, 2020; Stansbury and Summers, 2020), and concentration of market power in 'superstar firms' (Autor et al, 2017, 2020; Dixon and Lim, 2017; Barkai, 2020; De Loecker, Eeckhout, and Unger, 2020). Given the link between changes in the labor share and the personal distribution of income, the low ratios of government investment to GDP may have contributed to the rise in income inequality observed in developed economies over the last few decades (e.g., Piketty, 2014).

We do not find any effect of government investment on the labor share in developing countries, however. Our analytic result (17) allows us to explore a few tentative explanations for this result. One possible reason concerns the productivity of government investment in developing countries. Pritchett (2000) shows that these countries generally face serious bottlenecks associated with government investment, whereby a given investment effort does not translate into an equivalent increment in the stock of public capital (see also Dabla-Norris et al, 2012; and Gupta et al, 2014). The effective stock of public capital is thus much lower than what can be inferred from the accumulation and depreciation of the government investment flows. By lowering the economic returns to government investment in developing countries, these inefficiencies also decrease its effect on the labor share, according to equation (17). Moreover, public capital might be less capital-augmenting in developing countries. Although we are not aware of any empirical study explicitly focusing on the factor-bias of public capital in these countries, indirect evidence for this hypothesis is provided by An, Kangur, and Papageorgiou (2019), who find that public capital is more substitutable (i.e., less complementary) to private capital in emerging and low-income economies than in advanced countries.

A second reason that may explain the absence of an effect in developing countries concerns the elasticity of substitution between private capital and labor, which could be larger and closer to one in these countries. But it is unclear whether this is a plausible empirical possibility. Some studies using data at the firm or industry level often find smaller elasticities of substitution in industries with a larger proportion of high-skilled workers (Schwellnus et al, 2018) and larger elasticities of substitution in the agriculture sector (Herrendorf, Herrington, and Valentinyi, 2015). According to this evidence, one would expect those economies with proportionally larger sectors that are intensive in unskilled labor, which is typically the case in developing countries, to also feature larger aggregate elasticities of substitution. However, some direct evidence based on country-level data suggests otherwise. Duffy and Papageorgiou (2000), for instance, find that the elasticitiy of substitution in developing countries is not only lower than one but also lower than in advanced economies.

As alluded to in Section 3.3, one last reason for the statistically insignificant effects found in developing countries is purely statistical and involves measurement error in government investment. Given the general poor quality of macroeconomic data in developing countries, it is likely that government investment is measured with error in these countries (see, e.g., Gurara et al, 2017). If present, measurement error causes attenuation bias, which means that the effect of government investment on the labor share is biased towards zero. In our view, this is a particularly plausible explanation for the lack of an effect in developing countries.

5 Conclusions

This paper has analyzed the relationship between government investment and the labor share. Motivated by the observation that both variables have shown similar declining patters over the last decades, especially in developed countries, we have argued that there is a fundamental link between them. At a theoretical level, we have shown how a simple analytic steady-state relationship arises from a general equilibrium model embedding a production function with a constant elasticity of substitution and factor-biased government capital. At an empirical level, we have provided strong reduced-form evidence of a positive association between the ratio of government investment to GDP and the labor share in developed countries. For developing countries, in contrast, we have found a weak and statistically insignificant relationship.

According to our results, government investment spending may be an important determinant of the labor share. A lower labor share, in turn, has been found to be strongly associated with lower welfare, higher inequality, and lower growth. Thus, our results suggest that, besides its well-documented efficiency role in sustaining economic growth, government investment may also play an important role in promoting economic equity.

This paper has also opened some avenues for future research. The finding of no clear effect between government investment and the labor share in developing countries, in particular, may owe to several factors that deserve closer theoretical and empirical scrutiny. Perhaps government investment is yet too inefficiently allocated in these countries. Or the high borrowing costs typically faced by these countries hinder its effectiveness. Or the quality of the data does not allow for a proper assessment of its role. From a theory perspective, maybe we should model these economies differently, relaxing the small open economy assumption and allowing, for instance, for imperfect capital mobility and restricted access to international financial markets. Future research should delve into these questions.

Appendix

A.1 Reduced-form multipliers

To derive the steady-state multipliers of public investment in reduced form, start by fully differentiating equations (4) and (5) with respect to I_G using the chain rule:

$$\frac{1}{K}\frac{dK}{dI_G} = \frac{\eta - \eta_K(1-\sigma)}{\theta_L K_G}\frac{dK_G}{dI_G} + \frac{1}{L}\frac{dL}{dI_G} \tag{A.1}$$

$$\frac{\sigma}{Y_L}\frac{dw}{dI_G} = \frac{\theta_K}{K}\frac{dK}{dI_G} + \frac{\eta - \eta_L(1-\sigma)}{K_G}\frac{dK_G}{dI_G} - \frac{\theta_K}{L}\frac{dL}{dI_G}. \tag{A.2}$$

Similarly, fully differentiating equation (13) with respect to I_G gives

$$(1-L)\frac{dw}{dI_G} - w\frac{dL}{dI_G} = (1-\varepsilon)\frac{dX}{dI_G}. \tag{A.3}$$

Imposing the conditions $\dot{A} = 0$ and $\dot{X} = 0$ in (14) and (15) while noting that $wL - C = w - X$ and $T = I_G$ (in the former) results in two equations that jointly describe the steady-state equilibrium in the household subsystem:

$$X = rA + w - I_G,$$
$$X = \frac{\beta(\alpha+\beta)}{r-\alpha}A.$$

These equations can be fully differentiated with respect to I_G as follows:

$$\frac{dX}{dI_G} = r\frac{dA}{dI_G} + \frac{dw}{dI_G} - 1, \tag{A.4}$$

$$\omega_A\frac{dX}{dI_G} = r\omega_X\frac{dA}{dI_G}, \tag{A.5}$$

where $\omega_X \equiv X/Y$ is ratio of full consumption to output and $\omega_A \equiv rA/Y$ is the ratio of financial income to output. For future reference, note that $\omega_X - \omega_A > 0$, since $X - rA = w - I_G = w - T > 0$.

Equations (A.1)-(A.5) form a system of five equations in five unknowns, which can be represented in matrix notation as

$$\begin{bmatrix} w & -(1-L) & 0 & 1-\varepsilon & 0 \\ \frac{\theta_K}{L} & \frac{\sigma}{Y_L} & -\frac{\theta_K}{K} & 0 & 0 \\ -\frac{1}{L} & 0 & \frac{1}{K} & 0 & 0 \\ 0 & 1 & 0 & -1 & r \\ 0 & 0 & 0 & \omega_A & -r\omega_X \end{bmatrix} \begin{bmatrix} \frac{dL}{dI_G} \\ \frac{dw}{dI_G} \\ \frac{dK}{dI_G} \\ \frac{dX}{dI_G} \\ \frac{dA}{dI_G} \end{bmatrix} = \begin{bmatrix} 0 \\ \frac{\eta-\eta_L(1-\sigma)}{I_G} \\ \frac{\eta-\eta_K(1-\sigma)}{I_G} \\ 1 \\ 0 \end{bmatrix}, \tag{A.6}$$

where we have used that $dK_G/dI_G = K_G/I_G$.

Solving this system gives, after some algebraic simplifications, the following steady-state multipliers for labor employment and wages:

$$\frac{dL}{dI_G} = \frac{\omega_{LL}}{w}\left(\frac{\theta_L - \eta}{\omega_X - \omega_A}\right), \tag{A.7}$$

$$\frac{dw}{dI_G} = \frac{\eta(1+\omega_{LL})}{\omega_G}, \tag{A.8}$$

where $\omega_{LL} \equiv (1-L)/L$ is the leisure-labor ratio and $\omega_G \equiv I_G/Y$ is the ratio of public investment to output. According to these expressions, the wage multiplier is unambiguously positive, whereas the labor multiplier can, in theory, take on any sign, depending on the relative magnitudes of θ_L and η (recall that $\omega_X - \omega_A > 0$). From a practical point of view, however, it is reasonable to assume that $\theta_L > \eta$, in which case the labor multiplier is positive. Importantly, although both multipliers depend on the output elasticity of public capital (η), they depend neither on the particular type of factor augmentation (η_K and η_L) nor on the elasticity of substitution (σ). Hence, while the overall spillover effect of public capital matters for the labor market, its factor-bias potential does not.

The reduced-form multiplier of private capital is

$$\frac{dK}{dI_G} = \frac{\omega_K}{\theta_L}\left[\frac{\eta - \eta_K(1-\sigma)}{\omega_G} + \omega_{LL}\left(\frac{\theta_L - \eta}{\omega_X - \omega_A}\right)\right], \tag{A.9}$$

where $\omega_K \equiv K/Y$ is the ratio of private capital to output. This multiplier can be negative or positive depending on the relative sizes of the two terms inside brackets. Assuming that the second term is positive (which holds if the labor multiplier is positive), the multiplier of private capital is also positive if, moreover, $\eta_K = 0$ or $\sigma \geq 1$. But if public capital is K-augmenting ($\eta_K > 0$), the multiplier can be negative for an elasticity of substitution sufficiently below one ($\sigma \ll 1$), as depicted in panel (a) of Figure 2.

The reduced-form multipliers of full consumption (X) and financial wealth (A) are given by

$$\frac{dX}{dI_G} = \frac{\omega_X}{\omega_X - \omega_A}\left[\frac{\eta(1+\omega_{LL})}{\omega_G} - 1\right],$$

$$\frac{dA}{dI_G} = \frac{\omega_A}{r(\omega_X - \omega_A)}\left[\frac{\eta(1+\omega_{LL})}{\omega_G} - 1\right],$$

which can also be negative or positive, depending on the sign of the term in brackets.

Finally, we can use these multipliers to find the reduced-form multiplier of output. Fully differentiating the production function (1) with respect to I_G gives

$$\frac{dY}{dI_G} = \theta_K \frac{Y}{K}\frac{dK}{dI_G} + \theta_L \frac{Y}{L}\frac{dL}{dI_G} + \eta \frac{Y}{K_G}\frac{dK_G}{dI_G}. \tag{A.10}$$

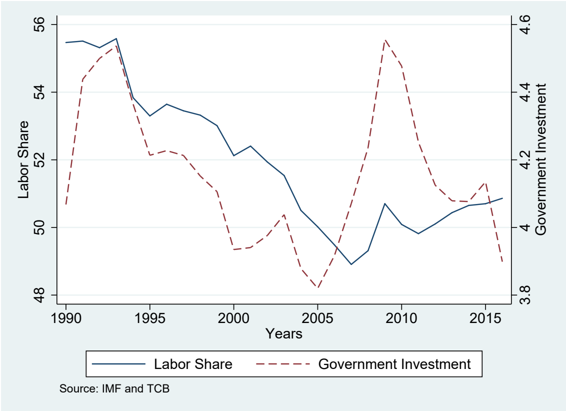
After substituting the reduced-form expressions (A.7) and (A.9) into (A.10) and performing some algebraic simplifications, one arrives at

$$\frac{dY}{dI_G} = \frac{\eta - \eta_K(1-\sigma)\theta_K}{\theta_L \omega_G} + \frac{\omega_{LL}}{\theta_L}\left(\frac{\theta_L - \eta}{\omega_X - \omega_A}\right), \tag{A.11}$$

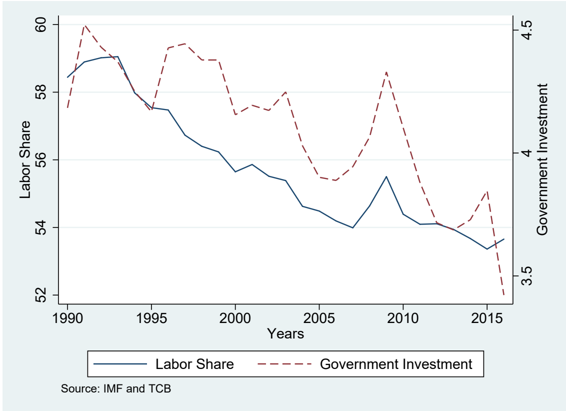
whose sign is unambiguously positive if public capital is not K-augmenting ($\eta_K = 0$) or the elasticity of substitution is greater or equal than one ($\sigma \geq 1$), provided that $\theta_L \geq \eta$ (in which case the labor multiplier is also positive). However, it can be negative if public capital augments private capital ($\eta_K > 0$) and the elasticity of substitution is sufficiently smaller than one ($\sigma \ll 1$). The important aspect to retain from this result is that, for a given output elasticity of public capital, larger degrees of K-augmentation (large η_K) and lower substitutability between factors (small σ) lead to smaller steady-state output effects of public investment.

Figure 1: The evolution of government investment and the labor share: cross-country averages

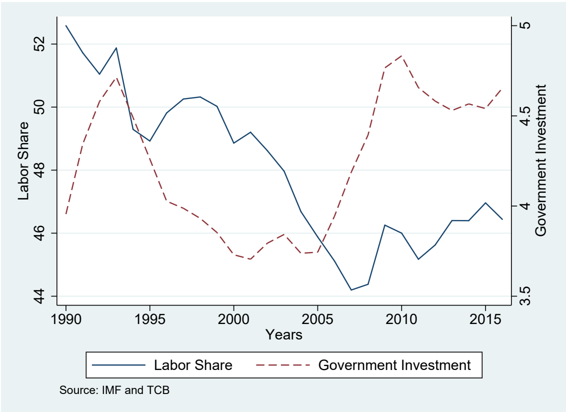
(a) All countries, IMF and TCB, 1990-2017



(b) Developed countries, IMF and TCB, 1990-2017



(c) Developing countries, IMF and TCB, 1990-2017



(d) All countries, IMF and AMECO, 1960-2017

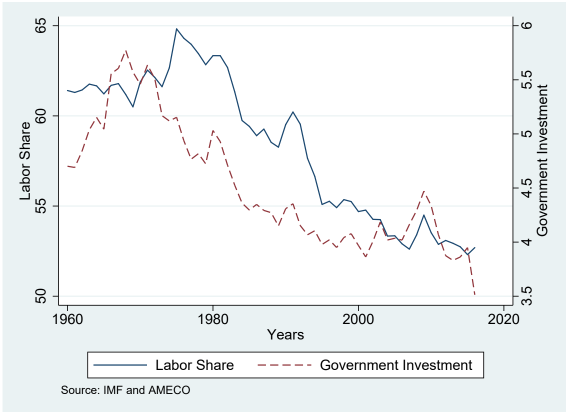


Figure 2: The long-run effects of a permanent K-augmenting public investment increase

(a) Gross complementarity ($\sigma \ll 1$) (b) Gross substitutability ($\sigma > 1$)

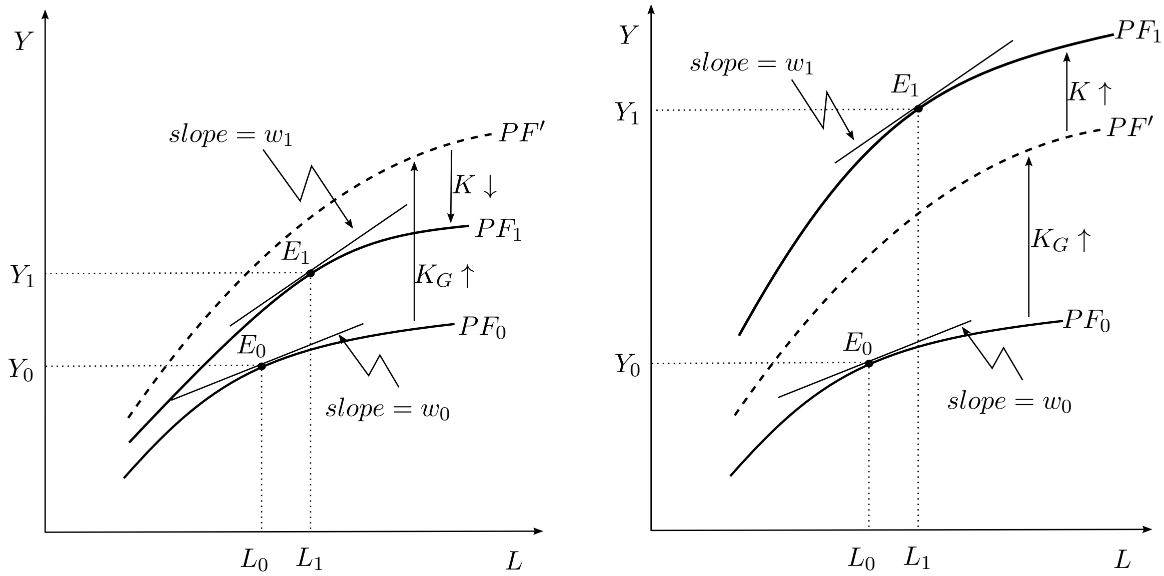


Table 1: Countries and periods included in the TCB and AMECO data

	TCB	AMECO
Countries	(1) OECD high income countries:	(1) OECD high income countries:
	Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States	Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States
	(2) Other high income countries:	(2) Other high income countries:
	Chile, Croatia, Cyprus, Hong Kong, Malta, Romania, Singapore, Taiwan	Croatia, Cyprus, Malta, Romania
	(3) Upper-middle income countries:	(3) Upper-middle income countries:
	Armenia, Azerbaijan, Belarus, Brazil, Bulgaria, China, Colombia, Costa Rica, Ecuador, Georgia, Indonesia, Iran, Jordan, Kazakhstan, Macedonia FYR, Malaysia, Mexico, Per, Russian Federation, Serbia, South Africa, Thailand, Turkey	Bulgaria
	(4) Lower-middle income income countries:	
	Bangladesh, Bolivia, Cambodia, Egypt, India, Moldova, Morocco, Nigeria, Pakistan, The Philippines, Senegal, Sri Lanka, Tanzania, Tunisia, Vietnam	
	(5) Low income countries:	
	Burkina Faso	
No. of countries	79	37
Time period	1990-2017	1970-2017
Observations	2156	1513

Table 2: Panel unit root tests on the labor share (LS).

	Unadjusted data			Demeaned data		
	IPS	Fisher-ADF	LLC	IPS	Fisher-ADF	LLC
			Panel (a): TCB data			
Only constant						
All countries	-3.41***	309.21***	-7.67***	-0.45	192.53*	-5.11***
Developed countries	-2.90***	173.35***	-6.85***	-2.23**	134.22***	-3.89***
Developing countries	-1.95**	135.85***	-3.97***	-1.54*	105.32	-3.41***
Constant and time trend						
All countries	-2.76***	291.47***	-6.43***	-3.36***	183.82	-5.40***
Developed countries	-1.99**	158.52***	-4.67***	-3.38***	112.13**	-4.48***
Developing countries	-1.92**	133.04***	-4.43***	-5.24***	119.83**	-4.73***
			Panel (b): AMECO data			
Only constant	-1.65**	68.94	-3.28***	-4.71***	119.85***	-2.54***
Constant and time trend	-3.92***	100.10**	4.37***	-6.15***	132.50***	-4.49***

Notes: The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3: Panel unit root tests on government investment (GI).

	Unadjusted data			Demeaned data		
	IPS	Fisher-ADF	LLC	IPS	Fisher-ADF	LLC
Only constant						
All countries	-5.87***	322.25**	-4.26***	-5.49***	323.31**	-3.03***
Developed countries	-3.25***	86.50	-2.25**	-2.50***	82.24	-1.97**
Developing countries	-4.89***	235.74**	-3.73***	-4.59***	228.79**	-2.65***
Constant and time trend						
All countries	-7.43***	325.37***	-6.69***	-6.22***	314.60**	-8.33***
Developed countries	-3.91***	83.49	-3.02***	-4.06***	83.70	-3.67***
Developing countries	-6.32***	241.89***	-6.05***	-6.00***	249.25***	-7.78***

Notes: The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4: Fixed Effects estimates of the effect of government investment on the labor share. Dependent variable: labor share (LS).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TCB	TCB	TCB	TCB	TCB	TCB	TCB	AMECO	AMECO
	All countries	All countries	All countries	Developed	Developed	Developing	Developing		
GI	0.079*	0.183***	0.226***	0.191***	0.241***	-0.178	-0.000	0.131***	0.162***
	(0.043)	(0.063)	(0.084)	(0.044)	(0.056)	(0.076)	(0.078)	(0.037)	(0.046)
$GI \cdot D$		-0.202**	-0.236**						
		(0.088)	(0.105)						
GDP_{pc}			4.020*		2.689		3.454		2.631
			(2.174)		(1.843)		(12.342)		(1.403)
$Trade$			-1.299***		-0.569**		-2.636***		-0.217
			(0.295)		(0.253)		(0.613)		(0.294)
Lagged LS	0.815***	0.813***	0.813***	0.784***	0.759***	0.821***	0.824***	0.884***	0.868***
	(0.012)	(0.012)	(0.013)	(0.019)	(0.021)	(0.018)	(0.019)	(0.011)	(0.013)
Trend	-0.028***	-0.025***	-0.020*	-0.031***	-0.036***	-0.022	-0.009	-0.020***	-0.035***
	(0.007)	(0.007)	(0.011)	(0.007)	(0.013)	(0.014)	(0.022)	(0.004)	(0.010)
R^2	0.756	0.757	0.749	0.753	0.724	0.758	0.758	0.898	0.881
Observations	1,926	1,926	1,723	989	854	937	869	1,365	1,121
Countries	79	79	78	38	37	41	41	37	37

Notes: All regressions include country dummies. The values in parentheses are standard errors clustered at the country level. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 5: System GMM estimates of the effect of government investment on the labor share. Dependent variable: labor share (LS).

	(1) TCB All countries	(2) TCB All countries	(3) TCB All countries	(4) TCB Developed	(5) TCB Developed	(6) TCB Developing	(7) TCB Developing	(8) AMECO	(9) AMECO
GI	0.101	0.314***	0.429***	0.384***	0.516***	0.007	0.088	0.281*	0.513***
	(0.095)	(0.119)	(0.147)	(0.098)	(0.128)	(0.123)	(0.118)	(0.144)	(0.192)
$GI \cdot D$		-0.26*	-0.328*						
		(0.148)	(0.171)						
GDP_{pc}			0.352		-0.147		13.028*		0.032
			(1.655)		(0.876)		(6.666)		(0.581)
$Trade$			-0.724***		-0.504*		-1.457**		-0.457*
			(0.246)		(0.259)		(0.617)		(0.239)
Lagged LS	0.885***	0.873***	0.862***	0.891***	0.900***	0.875***	0.847***	0.905***	0.898***
	(0.042)	(0.038)	(0.043)	(0.038)	(0.035)	(0.043)	(0.046)	(0.018)	(0.020)
Trend	-0.008	-0.010	-0.004	-0.004	0.006	-0.007	-0.020	-0.017***	-0.012
	(0.012)	(0.011)	(0.015)	(0.010)	(0.009)	(0.019)	(0.022)	(0.006)	(0.009)
Observations	1,926	1,926	1,723	989	854	937	869	1,389	1,141
Countries	79	79	78	38	37	41	41	37	37
Instruments	108	108	106	81	80	81	80	147	146
Hansen test	35.99	77.80	76.55	37.72	36.19	40.35	36.85	36.07	35.69
	(0.91)	(0.97)	(0.95)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
1st-order autocorrel.	-3.11	-4.71	-4.38	-3.24	-3.84	-3.90	-3.75	-1.86	-1.63
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.10)
2nd-order autocorrel.	-1.51	-0.36	-0.10	-3.03	-3.33	0.18	0.46	-0.51	0.05
	(0.13)	(0.72)	(0.92)	(0.00)	(0.00)	(0.85)	(0.64)	(0.61)	(0.96)

Notes: The values in parentheses are standard errors clustered at the country level in the upper part of the table, and p-values in the lower part of the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6: Robust-regression estimates of the effect of government investment on the labor share. Dependent variable: labor share (LS).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TCB	TCB	TCB	TCB	TCB	TCB	TCB	AMECO	AMECO
	All countries	All countries	All countries	Developed	Developed	Developing	Developing		
GI	0.078***	0.146***	0.192***	0.155***	0.174***	-0.007	0.006	0.143***	0.165***
	(0.029)	(0.042)	(0.058)	(0.031)	(0.042)	(0.061)	(0.060)	(0.031)	(0.041)
$GI \cdot D$		-0.193***	-0.210***						
		(0.060)	(0.072)						
GDP_{pc}			5.181***		4.595***		36.622***		3.803***
			(1.495)		(1.394)		(9.430)		(1.201)
$Trade$			-0.647***		-0.286		-0.974**		-0.066
			(0.203)		(0.191)		(0.469)		(0.252)
Lagged LS	0.885***	0.880***	0.877***	0.846***	0.821***	0.866***	0.891***	0.889***	0.882***
	(0.008)	(0.008)	(0.009)	(0.013)	(0.016)	(0.014)	(0.014)	(0.009)	(0.011)
Trend	-0.011**	-0.009*	-0.017**	-0.013***	-0.034***	-0.011	-0.042**	-0.017***	-0.037***
	(0.005)	(0.005)	(0.008)	(0.005)	(0.010)	(0.011)	(0.017)	(0.003)	(0.009)
R^2	0.978	0.978	0.979	0.974	0.973	0.963	0.966	0.973	0.972
Observations	1,926	1,926	1,723	989	854	937	869	1,365	1,121
Countries	79	79	78	38	37	41	41	37	37

Notes: The values in parentheses are standard errors clustered at the country level in the upper part of the table, and p-values in the lower part of the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7: Fixed Effects estimates of the effect of government investment on the labor share using Karabarbounis and Neiman's (2014) data. Dependent variable: labor share (LS).

	(1) All countries	(2) All countries	(3) Developed	(4) Developed	(5) Developing	(6) Developing
GI	0.133***	0.125***	0.204***	0.260***	0.053	0.029
	(0.038)	(0.040)	(0.043)	(0.064)	(0.067)	(0.058)
GDP_{pc}		0.475		1.816		48.230***
		(1.640)		(1.763)		(15.297)
$Trade$		-0.539		-0.666**		-0.020
		(0.346)		(0.339)		(0.750)
Lagged LS	0.743***	0.761***	0.799***	0.788***	0.686***	0.713***
	(0.017)	(0.018)	(0.018)	(0.020)	(0.031)	(0.032)
Trend	-0.009	0.000	-0.004	-0.009	-0.008	-0.056**
	(0.006)	(0.012)	(0.005)	(0.014)	(0.019)	(0.026)
R^2	0.622	0.617	0.751	0.712	0.513	0.540
Observations	1,382	1,264	844	743	538	521
Countries	79	78	37	36	42	42

Notes: The values in parentheses are standard errors clustered at the country level in the upper part of the table, and p-values in the lower part of the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 8: System GMM estimates of the effect of government investment on the labor share using Karabarbounis and Neiman's (2014) data. Dependent variable: labor share (LS).

	(1) All countries	(2) All countries	(3) Developed	(4) Developed	(5) Developing	(6) Developing
GI	0.103	0.199	0.427**	0.667***	0.063	0.134
	(0.113)	(0.127)	(0.187)	(0.233)	(0.120)	(0.109)
GDP_{pc}		0.008		5.722**		3.684
		(2.320)		(2.873)		(6.378)
$Trade$		-0.117		-0.939**		-0.005
		(0.130)		(0.395)		(0.423)
Lagged LS	0.920***	1.002***	0.731***	0.672***	0.957***	1.020***
	(0.075)	(0.060)	(0.058)	(0.058)	(0.054)	(0.057)
Trend	-0.005	0.014	-0.022	-0.038**	0.027	0.012
	(0.019)	(0.011)	(0.014)	(0.019)	(0.020)	(0.025)
Observations	1,382	1,264	844	743	538	521
Countries	79	78	37	36	42	42
Instruments	41	43	41	43	40	42
Hansen test	49.39	53.11	34.09	31.29	23.44	27.07
	(0.09)	(0.06)	(0.60)	(0.73)	(0.95)	(0.86)
1st-order autocorrel.	-4.11	-4.96	-3.64	-3.52	-3.11	-3.93
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2nd-order autocorrel.	-1.01	-1.22	-2.441	-2.34	-0.62	0.32
	(0.31)	(0.22)	(0.04)	(0.04)	(0.54)	(0.75)

Notes: The values in parentheses are standard errors clustered at the country level in the upper part of the table, and p-values in the lower part of the table. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

References

Acemoglu, D. (2002): "Directed Technical Change," *Review of Economic Studies*, 69, 781–809.

Alvarez-Cuadrado, F., N. V. Long, and M. Poschke (2018): "Capital-Labor Substitution, Structural Change and the Labor Income Share," *Journal of Economic Dynamics and Control*, 87, 206–231.

An, Z., A. Kangur, and C. Papageorgiou (2019): "On the Substitution of Private and Public Capital in Production," *European Economic Review*, 118, 296–311.

Arellano, M. and S. Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58, 277–297.

Arellano, M. and O. Bover (1995): "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics*, 68, 29–51.

Arrow, K. J., H. B. Chenery, B. S. Minhas, and R. M. Solow (1961): "Capital-Labor Substitution and Economic Efficiency," *Review of Economics and Statistics*, 43, 225–250.

Arrow, K. J. and M. Kurz (1970): *Public Investment, the Rate of Return, and Optimal Fiscal Policy*, Baltimore: John Hopkins University Press.

Aschauer, D. A. (1989): "Is Public Expenditure Productive?" *Journal of Monetary Economics*, 23, 177–200.

Atkinson, A. B. (2009): "Factor Shares: The Principal Problem of Political Economy," *Oxford Review of Economic Policy*, 25, 3–16.

Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen (2017): "Concentrating on the Fall of the Labor Share," *American Economic Review*, 107, 180–185.

——— (2020): "The Fall of the Labor Share and the Rise of Superstar Firms," *Quarterly Journal of Economics*, 135, 645–709.

Baltagi, B. H., P. O. Demetriades, and S. H. Law (2009): "Financial Development and Openness: Evidence from Panel Data," *Journal of Development Economics*, 89, 285–296.

Banerjee, A., E. Duflo, and N. Qian (2020): "On the Road: Access to Transportation Infrastructure and Economic Growth in China," *Journal of Development Economics*, 145, 102442.

Barkai, S. (2020): "Declining Labor and Capital Shares," *Journal of Finance*, 75, 2421–2463.

Bengtsson, E. and D. Waldenström (2018): "Capital Shares and Income Inequality: Evidence from the Long Run," *Journal of Economic History*, 78, 712–743.

Blanchard, O. J. (1985): "Debt, Deficits, and Finite Horizons," *Journal of Political Economy*, 93, 223–247.

Blundell, R. and S. Bond (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, 87, 115–143.

Bom, P. R. D. (2017): "Factor-Biased Public Capital and Private Capital Crowding Out," *Journal of Macroeconomics*, 52, 100–117.

——— (2019): "Fiscal Rules and the Intergenerational Welfare Effects of Public Investment," *Economic Modelling*, 81, 455–470.

Bom, P. R. D. and J. E. Ligthart (2014a): "What Wave We Learned from Three Decades of Research on the Productivity of Public Capital?" *Journal of Economic Surveys*, 28, 889–916.

——— (2014b): "Public Infrastructure Investment, Output Dynamics, and Balanced Budget Fiscal Rules," *Journal of Economic Dynamics and Control*, 40, 334–354.

Bridgman, B. (2018): "Is Labor's Loss Capital's Gain? Gross Versus Net Labor Shares," *Macroeconomic Dynamics*, 22, 2070–2087.

Calderón, C. and A. Chong (2004): "Volume and Quality of Infrastructure and the Distribution of Income: An Empirical Investigation," *Review of Income and Wealth*, 50, 87–106.

Cette, G., L. Koehl, and T. Philippon (2020): "Labor share," *Economics Letters*, 188, 108979.

Chatterjee, S. and S. J. Turnovsky (2012): "Infrastructure and Inequality," *European Economic Review*, 56, 1730–1745.

Chirinko, R. S. (2008): "σ: The Long and Short of it," *Journal of Macroeconomics*, 30, 671–686.

Ciminelli, G., R. Duval, and D. Furceri (2020): "Employment Protection Deregulation and Labor Shares in Advanced Economies," *Review of Economics and Statistics*, forthcoming.

Dabla-Norris, E., J. Brumby, A. Kyobe, Z. Mills, and C. Papageorgiou (2012): "Investing in Public Investment: An Index of Public Investment Efficiency," *Journal of Economic Growth*, 17, 235–266.

d'Albis, H., E. Boubtane, and D. Coulibaly (2021): "Demographic Changes and the Labor Income Share," *European Economic Review*, 131, 103614.

Dao, M. C., M. Das, Z. Koczan, and W. Lian (2017): "Why is Labor Receiving a Smaller Share of Global Income? Theory and Empirical Evidence," IMF Working Paper 17/169, International Monetary Fund.

Daudey, E. and C. García-Peñalosa (2007): "The Personal and the Factor Distributions of Income in a Cross-Section of Countries," *Journal of Development Studies*, 43, 812–829.

De Loecker, J., J. Eeckhout, and G. Unger (2020): "The Rise of Market Power and the Macroeconomic Implications," *Quarterly Journal of Economics*, 135, 561–644.

del Río, F. and F. X. Lores (2019): "The Decline in Capital Efficiency and Labour Share," *Economica*, 86, 635–662.

Dixon, R. and G. C. Lim (2018): "Labor's Share, the Firm's Market Power, and Total Factor Productivity," *Economic Inquiry*, 56, 2058–2076.

Doumbia, D. and T. Kinda (2019): "Reallocating Public Spending to Reduce Income Inequality," IMF Working Paper 19/188, International Monetary Fund.

Duffy, J. and C. Papageorgiou (2000): "A Cross-Country Empirical Investigation of the Aggregate Production Function Specification," *Journal of Economic Growth*, 5, 87–120.

Elsby, M. W. L., B. Hobijn, and A. Şahin (2013): "The Decline of the US Labor Share," *Brookings Papers on Ecoomic Activity*, Fall, 1–63.

Erauskin, I. (2020): "The Labor Share and Income Inequality: Some Empirical Evidence for the Period 1990-2015," *Applied Economic Analysis*, 28, 173–195.

Francese, M. and C. Mulas-Granados (2015): "Functional Income Distribution and Its Role in Explaining Inequality," IMF Working Paper 15/224, International Monetary Fund.

Furceri, D. and B. G. Li (2017): "The Macroeconomic (and Distributional) Effects of Public Investment in Developing Economies," IMF Working Paper 17/217, International Monetary Fund.

Gechert, S., T. Havránek, Z. Havránková, and D. Kolcunova (2019): "Death to the Cobb-Douglas Production Function," IMK Working Paper 201, Hans-Böckler-Stiftung, Institut für Makroökonomie und Konjunkturforschung (IMK).

Getachew, Y. Y. and S. J. Turnovsky (2015): "Productive Government Spending and Its Consequences for the Growth-Inequality Tradeoff," *Research in Economics*, 69, 621–640.

Glyn, A. (2011): "Functional Distribution and Inequality," in *The Oxford Handbook of Economic Inequality*, ed. by B. Nolan, W. Salverda, and T. M. Smeeding, Oxford: Oxford University Press.

Gollin, D. (2002): "Getting Income Shares Right," *Journal of Political Economy*, 110, 458–474.

Guerriero, M. (2019): "The Labor Share of Income around the World: Evidence from a Panel Dataset," ADBI Working Paper 920, Asian Development Bank Institute.

Gupta, S., A. Kangur, C. Papageorgiou, and A. Wane (2014): "Efficiency-Adjusted Public Capital and Growth," *World Development*, 57, 164–178.

Gurara, D., V. Klyuev, N. Mwase, A. Presbitero, X. C. Xu, and G. Bannister (2017): "Trends and Challenges in Infrastructure Investment in Low-Income Developing Countries," IMF Working Paper 17/233, International Monetary Fund.

Herrendorf, B., C. Herrington, and Á. Valentinyi (2015): "Sectoral Technology and Structural Transformation," *American Economic Journal: Macroeconomics*, 7, 104–133.

IMF (2019): "FAD Investment and Capital Stock Database 2019: Manual & FAQ – Estimating Public, Private, and PPP Capital Stocks," International Monetary Fund.

Jäger, P. and T. Schmidt (2016): "The Political Economy of Public Investment when Population is Aging: A Panel Cointegration Analysis," *European Journal of Political Economy*, 43, 145–158.

Jaumotte, F. and I. Tytell (2007): "How Has the Globalization of Labor Affected the Labor Income Share in Advanced Countries," IMF Working Paper 07/298, International Monetary Fund.

Kaldor, N. (1957): "A Model of Economic Growth," *Economic Journal*, 67, 591–624.

——— (1961): "Capital Accumulation and Economic Growth," in *The Theory of Capital*, ed. by D. C. Hague, 177–222.

Karabarbounis, L. and B. Neiman (2014): "The Global Decline of the Labor Share," *Quarterly Journal of Economics*, 129, 61–103.

Knoblach, M. and F. Stöckl (2020): "What Determines the Elasticity of Substitution Between Capital and Labor? A Literature Review," *Journal of Economic Surveys*, 34, 847–875.

Koh, D., R. Santaeulàlia-Llopis, and Y. Zheng (2020): "Labor Share Decline and Intellectual Property Products Capital," *Econometrica*, 88, 2609–2628.

Lawrence, R. Z. (2015): "Recent Declines in Labor's Share in US Income: A Preliminary Neoclassical Account," NBER Working Paper 21296, National Bureau of Economic Research.

Mućk, J., P. McAdam, and J. Growiec (2018): "Will the "True" Labor Share Stand Up? An Applied Survey on Labor Share Measures," *Journal of Economic Surveys*, 32, 961–984.

Nickell, S. (1981): "Biases in Dynamic Models with Fixed Effects," *Econometrica*, 49, 1417–1426.

OECD (2017): *Government at a Glance 2017*, Paris: OECD Publishing.

——— (2019): *Government at a Glance 2019*, Paris: OECD Publishing.

Piketty, T. (2014): *Capital in the Twenty-First Century*, Cambridge, MA: Harvard University Press.

Pritchett, L. (2000): "The Tyranny of Concepts: CUDIE (Cumulated, Depreciated, Investment Effort) Is Not Capital," *Journal of Economic Growth*, 5, 361–384.

Rognlie, M. (2015): "Deciphering the Fall and Rise in the Net Capital Share: Accumulation or Scarcity?" *Brookings Papers on Economic Activity*, 2015, 1–54.

Schmitt-Grohé, S. and M. Uribe (2003): "Closing Small Open Economy Models," *Journal of International Economics*, 61, 163–185.

Schwellnus, C., M. Pak, P.-A. Pionnier, and E. Crivellaro (2018): "Labour Share Developments over the Past Two Decades: The Role of Technological Progress, Globalisation and "Winner-Takes-Most" Dynamics," OECD Economics Department Working Papers 1503, Organisation for Economic Co-operation and Development.

Servén, L. and C. Calderón M. (2004): "The Effects of Infrastructure Development on Growth and Income Distribution," WPS 3400, The World Bank.

Stansbury, A. and L. H. Summers (2020): "The Declining Worker Power Hypothesis: An Explanation for the Recent Evolution of the American Economy," NBER Working Paper 27193, National Bureau of Economic Research.

Turnovsky, S. J. and I. Erauskin (2021): "Productive Government Expenditure and its Impact on Income Inequality: Evidence from International Panel Data," *Review of World Economics*, forthcoming.

Yaari, M. E. (1965): "Lifetime, Life Insurance, and the Theory of the Consumer," *Review of Economic Studies*, 32, 137–150.

Zhang, X., G. Wan, and X. Wang (2017): "Road Infrastructure and the Share of Labor Income: Evidence from China's Manufacturing Sector," *Economic Systems*, 41, 513–523.