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A Macroeconomic Analysis of the Effects of Gender Inequality, Wages, and Public Social Infrastructure: The Case of the UK

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ABSTRACT

The aim of this study is to develop a model to analyze the macroeconomic effects of two dimensions of inequality – gender inequality and functional income distribution – and public spending, in particular on social infrastructure, on output, productivity, and hours of employment of men and women. This study estimates the model econometrically using an IV-GMM estimator and time series data for the period of 1970–2016 for the UK. For the estimation of productivity, the article uses IV-GMM estimations based on panel data for eighteen industries for the period of 1970–2015. The study finds that output in the UK is both gender equality-led and wage-led, and hence generally equality-led. Public social infrastructure investment has a high positive effect on both output and employment. Despite a strong positive effect on productivity, the employment of both men and women increases in the medium run.

KEYWORDS

Gender wage gap, functional income distribution, social infrastructure, productivity, employment

JEL Codes:: E1, E2, E62

HIGHLIGHTS

- Output in the UK is gender equality-led and wage-led; hence the UK is equality-led.
- An upward convergence in wages by closing gender pay gaps leads to higher output.
- Public social infrastructure spending has a positive effect on output and productivity.
- Public social infrastructure leads to higher employment for both men and women.
- A mix of labor market and fiscal policies can achieve both equality and employment.

INTRODUCTION

The aim of this study is to develop a model to analyze the effects of multiple dimensions of inequality and fiscal policies on macroeconomic outcomes. The theoretical novelty is to integrate (i) the impact of gender inequality, functional income distribution, and their interaction; (ii) the impact of wage and fiscal policies, focusing in particular on the effects of government spending in social infrastructure; (iii) the demand and supply-side effects; (iv) the effect on output and employment; and (v) gendered behavioral differences, contributing to gendering macroeconomics.

We extend the theoretical models by Elissa Braunstein, Irene van Staveren, and Daniele Tavani (2011) and Stephanie Seguino (2010, 2012), who incorporate a demand and supply-side within structuralist, post-Keynesian/post-Kaleckian feminist theoretical models allowing for positive and negative effects of gender equality. Post-Keynesian/post-Kaleckian demand-led macroeconomic models allow for positive and negative effects of a fall in the labor share on aggregate demand (Bhaduri and Marglin 1990; Naastepad and Storm 2006; Hein and Vogel 2008; Stockhammer, Onaran, and Ederer 2009; Onaran and Galanis 2014; Onaran and Obst 2016). Extensions of these models integrate the impact of public spending and taxes (Mott and Slattery 1994; You and Dutt 1996, Blecker 2002; Seguino 2010, 2012; Palley 2013; Commendatore, Panico, and Pinto 2011; Allain 2015; Tavani and Zamparelli 2017a; Ko 2018; Hein 2018; Obst, Onaran, and Nikolaidi 2020). Going beyond the short-run demand effects, a series of post-Keynesian models integrate the changes in productivity (Palley 1996, 2013, 2014; Casetti 2003; Stockhammer and Onaran 2004; Dutt 2006, 2010; Naastepad 2006; Setterfield 2006; Seguino 2010, 2012; Hein and Tarassow 2010; Tavani and Zamparelli 2017b).

Elissa Braunstein, Rachid Bouhia, and Stephanie Seguino (2020) empirically analyze how care regimes, globalization, and macroeconomic policies shape development trajectories using a principal component analysis. Another body of empirical research focusing on the demand effects of gender gaps, use input–output tables to analyze the impact of public spending in social care and education, and show their stronger effect on women's and men's employment compared to investment in physical infrastructure (Antonopoulos et al. 2010; İlkkaracan et al. 2015; İlkkaracan and Kim 2019; De Henau et al. 2016). Rania Antonopoulos et al. (2010) and İpek İlkkaracan et al. (2015) extend this analysis using micro household data to match the macro labor demand with personal characteristics of individuals. However, these studies are static and do not take the medium-run productivity effects into account.

Hector Pollitt et al. (2017) use a demand-led post-Keynesian econometric model to simulate the impact of gender pay gaps on growth. In their analysis, changes in income distribution have only supply-side effects and

do not impact consumption and demand directly; similarly wages or government spending in social infrastructure does not affect productivity. Hannah Bargawi and Giovanni Cozzi (2017) use a global demand-led model without gendered variables to assess the impact of government expenditure in social infrastructure.

Neoclassical macroeconomic models do not analyze the gendered demand side effects and constraints, but rather focus on the supply-side effects of gender inequality and intrahousehold bargaining on fertility, savings, and the accumulation of human capital (Becker, Murphy, and Tamura 1990; Benhabib, Rogerson, and Wright 1991; Doepke and Tertilt 2016; Agenor and Agenor 2014; Cavalcanti and Tavares 2016; Heathcote, Storesletten, and Violante 2017; Fukui, Nakamura, and Steinsson 2019). Cross-country reduced form estimations of mainstream growth models focus on the supply-side effects of equality in education and labor force participation, via the direct and indirect/intergenerational effects on productivity, because women are assumed to spend more on children's education and health relative to men (Lundberg and Pollak 1996; Phipps and Burton 1998; Knowles, Lorgelly, and Owen 2002; Morrison, Raju, and Sinha 2007; Klasen and Lamanna 2009; Cuberes and Teignier 2014). Reductions in labor market imperfections such as wage discrimination and occupational segregation are expected to stimulate growth. However, Stephanie Seguino (2017) highlights that most of these models do not account for the lack of labor demand matching the increases in female education and labor force participation.

Synthesizing these different strands, this study aims at developing a novel gendered macroeconomic analysis building on post-Kaleckian feminist economics. We estimate the model econometrically using IV-GMM (instrumental variable- generalized method of moments) estimators and time series data for the period of 1970–2016 for the UK. For the medium-run estimation of productivity we use IV-GMM estimations based on panel data of eighteen industries for the period of 1970–2015. The use of IV-GMM with an innovative set of instruments to control for endogeneity and the synthesis of time series and panel data econometrics to specify short-run and medium-run effects are methodological novelties of the study. We nevertheless acknowledge that the endogeneity between wages, employment, demand, and productivity is challenging and within these limitations our results indicate associations rather than strong causal links.

Finally, using the estimated parameters we analyze the effects of wages, the gender pay gap, and public spending in social infrastructure on output, employment of men and women, public debt, and productivity. The analysis of women's and men's employment and inequality aims at broadening the scope of analysis beyond the narrow focus on GDP.

THE MODEL

We present a three-sector model: the social sector (health, social care, education, childcare; H); the rest of the market economy (N); and the unpaid care sectors. There are three types of factors of production: men's labor, women's labor, and capital. On the demand-side, we model behavioral equations determining consumption, private investment, exports, imports, and government spending. On the supply-side, productivity in the rest of the economy changes in the medium run as an outcome of changes in wages, public and private expenditure, and unpaid care. Hours of employment are determined by output and labor productivity and the distribution of employment between women and men depends on occupational segregation.

In the model hourly wage rates are determined exogenously by bargaining power and labor market institutions. Gender pay gap is determined exogenously by the relative bargaining power of women, social norms, occupational segregation, labor market institutions, and a set of personal characteristics (such as education) which are also affected by social norms.

Functional income distribution is determined endogenously, as the wage share of men and women and the profit share change when wages, output, employment, and productivity change.

The model integrates gendered behavior, and the effects of social norms, which determine the distribution of unpaid domestic care between men and women, and job segregation (for example, women's association with paid care work). A change in the gender pay gap or public spending in social versus physical infrastructure have gendered short and medium-run impacts on employment and income.

Online Appendix I presents the list of variables and definitions.

Aggregate output (Y_t) is the sum of male and female wage bill ($WB_t^F \, and \, WB_t^M$), and profits (R_t).

$$Y_t = WB_t^M + \ WB_t^F + R_t \tag{1}$$

WB_t^F and WB_t^M are determined by female and male hourly wage rates and hours of employment in H and N (w_t^{HF}, w_t^{HM}, w_t^{NF}, w_t^{NM}, E_t^{HF}, E_t^{HM}, E_t^{NF}, E_t^{NM} respectively):

$$WB_t^F = w_t^{HF} \, E_t^{HF} + w_t^{NF} E_t^{NF} \tag{2}$$

$$WB_t^M = w_t^{HM} \, E_t^{HM} + w_t^{NM} E_t^{NM} \tag{3}$$

Working with hours rather than a headcount of employment is important for a gendered analysis to reflect the high share of women in part-time work.

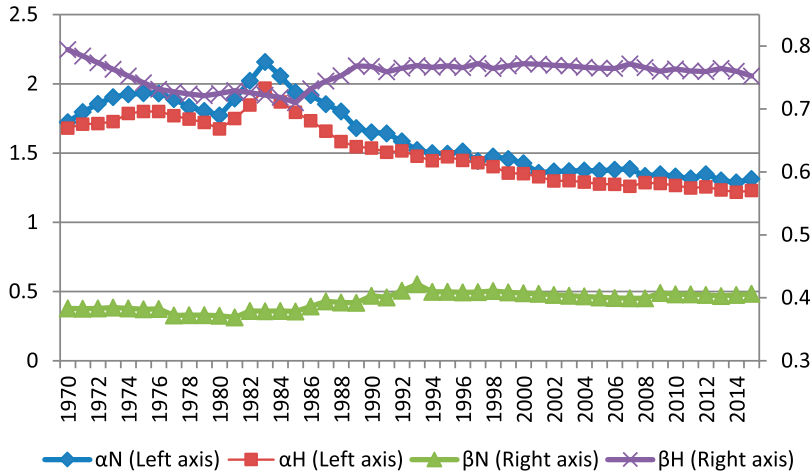

Figure 1 The ratio of hourly wage rate of men/women (α) and share of women in hours worked (β) in the social sector (H) and the rest of the economy (N) in the UK

Sources: Own calculations based on EU KLEMS database (EU KLEMS 2009, 2012, 2018).

The wages in both H and N are significantly larger for male workers in most countries, as in the UK (see Figure 1). Gender wage gaps (α_t) in H and N are

$$\alpha_t^N = \frac{w_t^{NM}}{w_t^{NF}} > 1,\ \alpha_t^H = \frac{w_t^{HM}}{w_t^{HF}} > 1 \tag{4}$$

Output in the market economy (GDP, excluding unpaid activities) is

$$Y_t = C_t^N + C_t^H + I_t + G_t^H + G_t^C + I_t^G + X_t - M_t \tag{5}$$

where C_t^H denotes household social expenditure, C_t^N is consumption in N,I_t is private investment, G_t^H is the government's expenditures in health, social care, education, and childcare, G_t^C is the government's consumption expenditures, I_t^G is public physical infrastructure investment, X_t is exports, and M_t is imports. In line with feminist economics emphasizing the importance of the government's social expenditures on productivity and the social fabric, we refer to G_t^H as public social infrastructure investment (Elson 2017). G_t^H is a policy decision targeted as a share of Y_t (κ_t^H) and constitutes the social sector output (Y_t^H). The rest of the GDP is the market output in N (Y_t^N):

$$Y_t^H = G_t^H = \kappa_t^H Y_t \tag{6}$$

$$Y_t^N = Y_t - G_t^H = Y_t(1 - \kappa_t^H) \tag{7}$$

G_t^C and I_t^G are also determined by government as a share of $Y_t(\kappa_t^C, \kappa_t^G)$:

$$G_t^C = \kappa_t^C Y_t \tag{8}$$

$$I_t^G = \kappa_t^G Y_t \tag{9}$$

Hours of employment in H and economy (E_t^H, E_t^N) are determined by output and labor productivity in the relevant sectors.

E_t^N is output over labor productivity in N (T_t^N):

$$E_t^N = \frac{Y_t^N}{T_t^N} \tag{10}$$

The share of women in sector N(β_t^N) is exogenously determined by social norms determining occupational segregation, hence

$$E_t^{NF} = \frac{Y_t^N}{T_t^N}\beta_t^N \tag{11}$$

$$E_t^{NM} = \frac{Y_t^N}{T_t^N}(1 - \beta_t^N) \tag{12}$$

We assume that the wage bill of men and women in H constitutes G_t^H and H is non-profit. Any non-labor inputs used constitute part of G^C. Hence, G_t^H is

$$G_t^H = \kappa_t^H Y_t = \beta_t^H E_t^H w_t^{HF} + (1 - \beta_t^H) E_t^H w_t^{HM} \tag{13}$$

Based on the empirical data in Figure 1 below, we assume that $\beta_t^H > \beta_t^N$.

Using equations (11)-(13) and (4), E_t^H, E_t^{HF} and E_t^{HM} are

$$E_t^H = \frac{G_t^H}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \tag{14}$$

$$E_t^{HF} = \frac{\beta_t^H \kappa_t^H Y_t}{w_t^{FH}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \tag{15}$$

$$E_t^{HM} = \frac{(1 - \beta_t^H)\kappa_t^H Y_t}{w_t^{FH}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \tag{16}$$

We model the per capita unpaid domestic care labor $(\frac{U_t}{N_t})$ within the households as

$$\log \frac{U_t}{N_t} = q_0 + q_G \log \frac{(G_t^H + C_t^H)}{N_t} \tag{17}$$

For a given demographic structure and population (N_t), which determines the exogenous care needs, (q_0), higher per capita government or household expenditures in H are expected to reduce the need for unpaid

care ($q_G < 0$). We specify the equation in logs, since this effect might be non-linear, that is, might be decreasing in absolute values as it gets increasingly difficult to substitute unpaid care at lower levels of unpaid care. The potential squeeze in unpaid care due to paid employment is excluded to simplify the model. The effect of G_t^H and C_t^H as determinants of employment only partially reflects this effect.

The profit income (R) is the operating surplus in N after wage payments:

$$R_t = Y_t^N - w_t^{NF} E_t^{NF} - w_t^{NM} E_t^{NM} \tag{18}$$

The profit share (π_t) is the share of R in N and depends on productivity in N:

$$\pi_t = \frac{Y_t^N - w_t^{NF} E_t^{NF} - w_t^{NM} E_t^{NM}}{Y_t^N} \tag{19}$$

On the demand-side household consumption is a function of after-tax female and male wage income and profits. Consumption in two types of goods and services produced in H and N depends on the differences in the marginal propensities to consume (MPC) out of female and male wage income and profits. Accounting for gendered income in the consumption function are novel features.

Consumption in N is

$$\begin{aligned} \log C_t^N = {} & c_0 + c_R \log[R_t(1 - t_t^R)] \\ & + c_F \log[(w_t^{NF} E_t^{NF} + w_t^{HF} E_t^{HF})(1 - t_t^W)] \\ & + c_M \log[(w_t^{NM} E_t^{NM} + w_t^{HM} E_t^{HM})(1 - t_t^W)] \end{aligned} \tag{20}$$

where t_t^R is the implicit tax rate (ITR) on profits and t_t^W is ITR on wages. The MPC in N is different for men and women workers, reflecting the gender income gap as well as differences in behavior. C_t^H is a function of after-tax profits, female and male wage income, and G_t^H:

$$\begin{aligned} \log C_t^H = {} & z_0 + z_R \log[R_t(1 - t_t^R)] \\ & + z_F \log[(w_t^{NF} E_t^{NF} + w_t^{HF} E_t^{HF})(1 - t_t^W)] \\ & + z_M \log[(w_t^{NM} E_t^{NM} + w_t^{HM} E_t^{HM})(1 - t_t^W)] \end{aligned} \tag{21}$$

The MPC in H is different for profits, and male and female wage income. G_t^H is part of the wage bill in H and can increase C_t^H by providing wage income or decrease C_t^H by reducing the need for these expenditures. We assume that C_t^H is provided by the private sector in the market economy as part of the output in N.

An alternative specification, where relative prices in N and H also affect C_t^H and C_t^N is not presented, as empirical analysis shows that price

elasticities are insignificant. C_t^H is likely to be very inelastic and is a very small part of household spending (3.6 percent in 2017). The aggregate price deflator is dominated by prices in N. Finally, as prices depend on unit labor costs, the effects of wages and their ratio to profits (and output) capture the price effects of higher wages as well. The exclusion of the insignificant explicit price elasticities in the model also helps to reduce the complexity in the analytical solution.

Private investment (I_t) is a function of the after-tax π_t, GDP, and public debt/GDP ($(D/Y)_t$):

$$logI_t = i_0 + i_1 \log Y_t + i_2 log\ [\pi_t(1 - t_t^R)] + i_3 \log \left(\frac{D}{Y}\right)_t \tag{22}$$

I_t is expected to increase as a result of higher demand ($i_1 > 0$), and higher after-tax π_t reflecting expected profitability and availability of internal funds ($i_2 > 0$). $(D/Y)_t$ captures the possible negative crowding-out effects of public debt on the interest rate and investment ($i_3 < 0$). However, there is also a potentially positive crowding-in effect in the medium run, if productivity increases due to public spending, which in turn leads to higher π_t.

The public debt (D_t) is determined by the public debt in the previous period (D_{t-1}), the interest rate (r_{t-1}), plus the total government expenditures in t, minus the taxes collected on profits, wages, and consumption:

$$\begin{aligned} D_t = (1 + r_{t-1})D_{t-1} + G_t^H + G_t^C + I_t^G - t_t^W(WB_t^F + WB_t^M) - t_t^R R_t \\ - t_t^C(C_t^N + C_t^H) \end{aligned} \tag{23}$$

where t_t^C is the ITR on consumption.

Exports are a function of prices of exports relative to foreign prices and foreign income (Y_{world}) and the exchange rate (ε); imports are a function of Y^N and domestic prices relative to import prices. For simplicity we assume that marginal propensity to import in H is zero. The wage share is equivalent to the real unit labor cost; therefore, when the profit share decreases (wage share increases), exports decrease and imports increase. The magnitude of the effect depends on the pass through from the wage share to nominal unit labor costs and prices, and the price elasticity of exports and imports. Hence, to simplify the model, exports and imports are reduced form functions of π:

$$logX_t = x_0 + x_1 logY_t^{World} + x_2 log\pi_t + x_3 log\varepsilon_t \tag{24}$$

$$logM_t = n_0 + n_1 logY_t^N + n_2 log\pi_t + n_3 log\varepsilon_t \tag{25}$$

Labor productivity is constant in the short run (SR) and changes endogenously in the medium run (MR) in N, as we assume technological

change takes time. We assume productivity in H is constant, and simply equal to output per hour of employment in both SR and MR.[1] Labor productivity in N (T_t^N) is

$$\log T_t^N = t_0 + t_1 \log \frac{(G_{t-1}^H + C_{t-1}^H)}{N_{t-1}} + t_2 \log \frac{I_{t-1}^G}{N_{t-1}} + t_3 \log Y_{t-1}^N + t_4 \log w_{t-1}^{NF} + t_5 \log(\alpha_{t-1}^N w_{t-1}^{NF}) + t_6 \log \frac{U_{t-1}}{N_{t-1}} \quad (26)$$

In MR, T_t^N is likely to be positively affected by lagged values of per capita G^H, C^H, and $I^G (t_1, t_2 > 0)$. We also expect per capita unpaid care to affect T_t^N positively ($t_6 > 0$). Substituting equation (17) for $\frac{U}{N}$, we are able to model the effect indirectly via the effect of G^H and C^H.[2] Higher output would also lead to higher productivity due to Verdoorn effect (Naastepad 2006; Hein and Tarassow 2010), as greater scale can lead to more efficient allocation of sources ($t_3 > 0$). Moreover, we expect that higher female and male wages in N lead to labor-saving technologies and increases productivity ($t_4, t_5 > 0$). This is also consistent with the efficiency wage theories. We expect these effects to be realized over a longer time period, defined as the medium run, which is a sufficiently long time period, for example, five years or more. Using (17) and (26) we can further simplify productivity as in (27):

$$\log T_t^N = h_0 + h_1 \log \left(\frac{G_{t-1}^H + C_{t-1}^H}{N_{t-1}} \right) + h_2 \log \left(\frac{I_{t-1}^G}{N_{t-1}} \right) + h_3 \log Y_{t-1}^N + h_4 \log w_{t-1}^{NF} + h_5 \log \alpha_{t-1}^N \quad (27)$$

where $h_0 = t_0 + g_0 t_6$ and $h_1 = t_1 + g_G t_6$.

For simplicity we do not model the impact of G^H and unpaid care on labor supply, fertility, migration or the effects of changes in labor supply, and unemployment on wages. Similarly, a rise in wages in H as an outcome of higher G^H is likely to lead to changes in occupational segregation and social norms. While these are interesting extensions, they are outside the scope of this article.

THE EFFECTS OF INCREASING WOMEN'S WAGES IN THE REST OF THE ECONOMY

We first analyze the effects of closing the gender wage gap in the rest of the economy (N). This can be achieved via an upward convergence, that is, women's wages increasing faster than men's wages or downward convergence, or with only women's wages increasing. In what follows, we focus on the latter.

We define two demand regimes in the short run as follows. First, a *women's wage-led* or *gender equality-led* regime in the short run is when a decreasing gender pay gap (due to a rise in women's wages in N) leads to a higher aggregate output in the short run. Alternatively, if this leads to lower output in the short run, the demand regime is defined as *gender inequality-led* in the short run.

We expect rising women's wages to have a positive partial impact on consumption in both sectors in the short run, since we expect the MPC out of women's wages to be larger than that out of profits. This is based on previous aggregate macro-econometric estimations which find that MPC out of wages in the UK is higher than MPC out of profits (Hein and Vogel 2008; Onaran and Galanis 2014; Onaran and Obst 2016; Obst, Onaran, and Nikolaidi 2020).

Higher women's wages in N is expected to have a partial negative impact on private investment for a constant output because it squeezes the profits share (π) in the short run. Moreover, as the composition of taxes collected on profits and wages affect the public debt/GDP, there is a further potentially small impact on private investment.

Finally, higher women's wages in N and a falling profit share also imply an increasing real unit labor costs and have a partial negative effect on exports and a positive effect on imports in the short run. The magnitudes of these positive and negative effects are elevated further through the multiplier effects.

In the medium run, a rise in women's wages in N affect labor productivity and has further effects on output through changes in consumption in both sectors, private investment, export, imports, government expenditures, and the consequent multiplier effects. Figure 2 summarizes the effects on productivity. As discussed, we expect higher women's wages in N to increase labor productivity. There are further lagged effects due to the changes in output in the previous period. If demand is led by women's wages in the short run, higher women's wages in N leads to higher labor productivity in the medium run due to the Verdoorn effects of higher output. Moreover, we expect increasing consumption in H, public social expenditures, and other public expenditures to have positive effects on productivity. These effects via output work in the opposite direction if demand is gender inequality-led in the short run.

If the effect of women's wages on labor productivity is positive, labor-saving technological change reduces labor demand and leads to a negative partial effect on both women's and men's employment in N in the medium run for a given output. Under these conditions, the medium-run partial effect of higher women's wages in N on the profit share is also positive due to declining unit labor costs. However, if demand is gender inequality-led in the short run and the effect of output on productivity are sufficiently

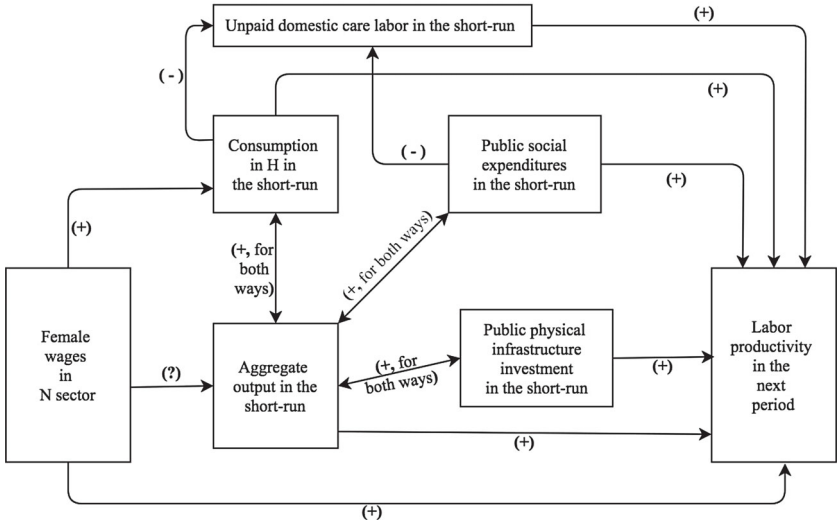

Figure 2 The effects of women's wages in N on labor productivity in the medium run

large, higher women's wages in N could also have a negative medium-run partial impact on productivity and the profit share.

The effect of higher women's wages in N on aggregate output in the medium run is ambiguous depending on its effect on productivity and the profit share. If demand is women's wage-led in the short run, the medium-run effects on investment and net exports are more likely to be positive as the effects of higher wages on the profit share are partially offset, and public debt/GDP decreases. The medium-run partial effects on consumption depends on the changes in productivity, women's and men's employment and wage income, and profits.

The analytical solution of the model and further details of the comparative statistics are presented in Online Appendix II. This can be used to check our simulation results for the UK and to replicate the empirical analysis using estimated parameters of another economy.

Table 1 summarizes different regimes in both the short and medium run. The size of the effect on consumption relative to investment and net exports determines the type of the growth regime. If the sum of the effects in short run and the next period is positive, we define this regime as *women's wage-led or gender equality-led* in the medium run. If the total effect is negative, the regime is *gender inequality-led* in the medium run. As the impact of women's wages in N on productivity and the profit share in the medium run is ambiguous, we cannot predict the effects on each component of demand in the medium run without knowing the size of these effects.

Table 1 The regimes and their conditions in the case of an increase in women's wages in N with a declining gender wage gap

Case	*Growth regime*	*Condition*
Rising (declining) female wages increase (reduce) aggregate output in the short run	Female wage-led/gender equality-led in the short run	|Impact of w_t^{NF} on total consumption| > |Impact of w_t^{NF} on investment + net exports|
Rising (declining) female wages reduce (increase) aggregate output in the short run	Gender inequality-led in the short run	|Impact of w_t^{NF} on total consumption| < |Impact of w_t^{NF} on investment + net exports|
Rising (declining) female wages increase (reduce) aggregate output in the medium run	Female wage-led/gender equality-led in the medium run	Ambiguous due to effects on labor productivity
Rising (declining) female wages reduce (increase) aggregate output in the medium run	Gender inequality-led in the medium run	Ambiguous due to effects on labor productivity

For example, an economy that is *women's wage-led* in the short run could theoretically be *gender inequality-led* in the medium run, if higher wages lead to a significant shift to labor-saving techniques, which would substantially reduce employment and hence labor income.

With respect to the effects on employment, an increase in women's wages in N increases women's and men's employment in both N and H in the short run, if the economy is women's wage-led (see Figure 3). In the medium run employment is determined by changes in both output and productivity. Therefore, an economy that is women's wage-led in the medium run could experience a decline in women's and/or men's employment if the medium-run impact of higher women's wages on productivity in N more than offsets its positive effect on output.

In the case of a simultaneous increase in both women's and men's wages in the rest of the economy, the direction of the partial effects on consumption, investment, exports, and imports are similar to those described above for the case of increasing women's wages only; however, the absolute value of the magnitude of the partial effects is larger when both the male and female wage bill increase, and there is a greater squeeze on the profit share. We define a demand regime as *wage-led* in the short run if the impact of a simultaneous increase in female and male wages in

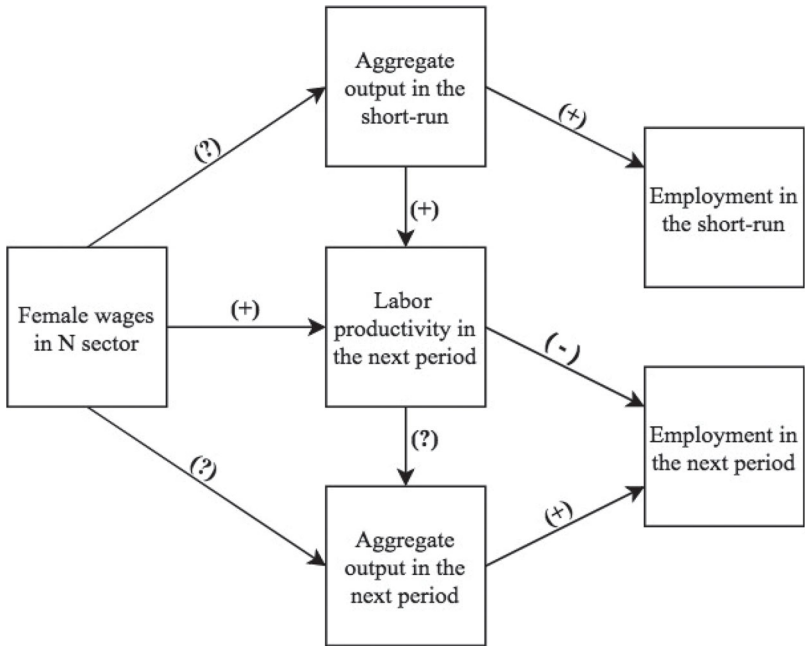

Figure 3 The effects of an increase in women's wages in N on total employment in the short run and in the medium run

N on aggregate demand is positive. If the impact is negative, we define it as *profit-led* in the short run.

Table 2 summarizes the demand regimes in the short run. If an economy is both wage-led *and* women's wage-led/gender equality-led, we define it as an *equality-led demand regime* in the short run. Alternatively, the economy could be profit-led and gender inequality-led. However, an economy could also be wage-led and gender inequality-led or profit-led and gender equality-led in the short run at the same time depending on the MPC out of women's and men's wages and profits and the sensitivity of investment and net exports to unit labor costs.

The effect of a simultaneous rise in women's and men's wages in N in the medium run again works mainly through the effect on productivity in N. The magnitude of the effect of a simultaneous rise in wages (that is, an increase in both men's and women's wages) on productivity is expected to be larger than a closing of the gender pay gap due to only an increase in women's wages. This is because higher men's wages create additional incentives for labor-saving technological change. Similarly, the effects on consumption in both sectors, investment, and net exports are also larger. Consequently, we expect the medium-run effect on aggregate output to

Table 2 The demand regimes in the short run

	Wage-led in the short run	*Profit-led in the short run*
Female wage-led/ gender equality-led in the short run	|Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on total consumption| > |Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on investment + net exports| & |Impact of w_t^{NF} on total consumption| > |Impact of w_t^{NF} on investment + net exports|	|Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on investment + net exports| > |Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on total consumption| > |Impact of w_t^{NF} on total consumption| > |Impact of w_t^{NF} on investment + net exports|
Gender inequality- led in the short run	|Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on total consumption| > |Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on investment + net exports| > |Impact of w_t^{NF} on investment + net exports > |Impact of w_t^{NF} on total consumption|	|Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on total consumption| < |Impact of w_t^{NF} & w_t^{NM} (constant α_t^N) on investment + net exports| & |Impact of w_t^{NF} on total consumption| < |Impact of w_t^{NF} on investment + net exports|

be larger. We define an economy in which the sum of the short-run and medium-run effects of an increase in women's and men's wages in the rest of the economy on output is positive as *wage-led* in the medium run. The case in which the sum of the short-run and medium-run effects is negative is defined as *profit-led* in the medium run.

While the definition of short-run demand regimes is comparable to the previous literature based on Amit Bhaduri and Stephen Marglin (1990), the medium-run effects combine both demand and supply-side effects, and therefore refers to the properties of the economy rather than just the demand regime. The effect of wages on productivity further complicates the picture in the medium run as the cumulative effect of wages on output and employment may move in the opposite direction as discussed in Servaas Storm and Ro Naastepad (2013). Ro Naastepad (2006) presents a two-by-two classification of growth regimes based on the nature of productivity regime and demand regime, both of which can be either wage-led or

profit-led. We define an economy that is both wage-led and women's wage-led in the medium run, as an *equality-led demand regime* in the medium run.

In summary, closing the gender pay gap as well as simultaneously increasing women's and men's wages in the rest of the economy affects three macroeconomic variables: aggregate output and each component of aggregate demand; productivity; and employment of women and men in the short and medium run. Different growth regimes could exist in the short and medium run depending on the following parameters: the MPCs of the capitalists and women and men workers; the magnitudes of the sensitivity of investment and net exports to the profit share; and the effect of output and women's and men's wages on productivity in the rest of the economy.

THE EFFECTS OF PUBLIC SPENDING IN SOCIAL INFRASTRUCTURE

Next, we examine the effects of increasing public spending in social infrastructure. This spending can be used either to increase the wage rate of women or all employees in the social sector, or to hire more employees. We analyze each of these mechanisms and their impact on reducing gender inequality in employment.

We first analyze the case where public spending in social infrastructure as a share of GDP (κ^H) increases solely through new public employment in H (keeping wages constant). In the UK, the share of women's employment in the social sector (H) is significantly larger than the share of women's employment in the rest of the economy (N). Therefore, we expect that with this policy more women's employment is generated in the short run in the public social sector.

The short-run effect of higher public social infrastructure investment (as a share of GDP, κ^H) on aggregate output depends on the effects on consumption in both sectors, private investment and public expenditures, and the consequent multiplier effects. An increase in the public social infrastructure investment affects women's and men's employment in N and profit share only through the multiplier effects of changes in aggregate output in the short run; that is, the partial (pre- multiplier) effects are zero. An increase in public social infrastructure investment has a direct positive effect on aggregate output in the short run.

The generation of new employment in the public social sector stimulates consumption in both sectors in the short run. Higher public social infrastructure investment κ^H has a positive impact on private investment in the short run due to rising aggregate output. However, an increase in κ^H may partially crowd-out investment if public debt/GDP (D/Y) increases in the short run. This will occur if this leads to an increase in interest rates

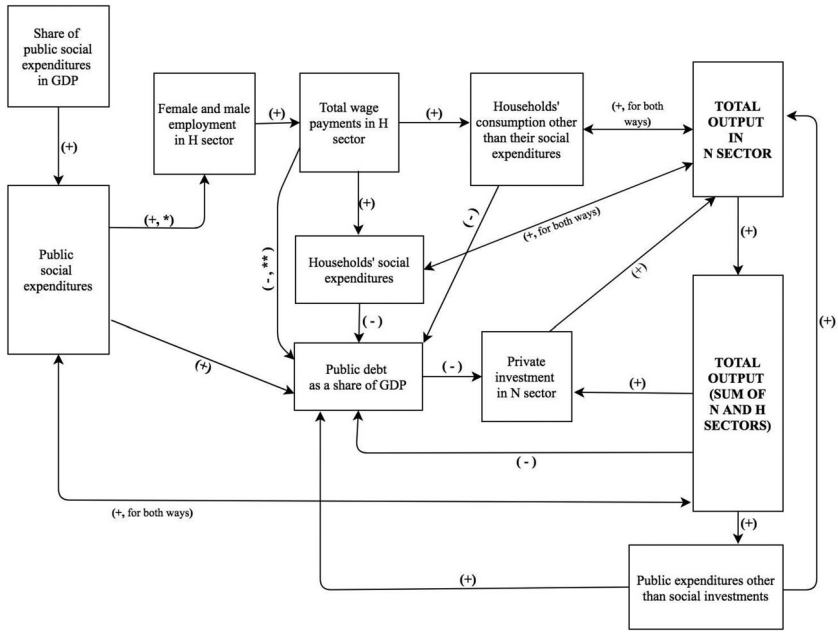

Figure 4 The effects of an increase in public social infrastructure investment on total output in the short run
Notes: * Based on Figure 1, the positive partial impact of public social expenditures is expected to be relatively larger for women's employment compared to the partial impact from expenditures in N sector. ** The impact of total wage payments in H sector is through its impact on wage taxes.

and investment is sensitive to interest rates. Higher κ^H has an ambiguous effect on D/Y as both debt and GDP increase. D/Y may fall if the effect on GDP is sufficiently large as the rise in GDP increases both the denominator and tax revenues. These short-run effects are summarized in Figure 4.

Next, Figure 5 in Online Appendix V summarizes the effect of public social infrastructure investment on productivity in the medium run, which is expected to increase through both direct and indirect effects. The indirect effects are due to changes in aggregate output depending on whether the effects of public spending on output are positive or negative in the short run. If higher public social infrastructure investment stimulates aggregate output, it also leads to an increase in households' social expenditures and public physical infrastructure investment in the short run, which may also increase labor productivity in the medium run.

An increase in κ^H affects aggregate output in the medium run through changes in labor productivity and public debt/GDP as summarized in Figure 6 in Online Appendix V. If higher public social infrastructure

increases labor productivity in the medium run, its partial effect on women's and men's employment is negative in the medium run (for a constant output in the rest of the economy, prior to the multiplier effects), and the effect on the profit share is positive. This also affects consumption in both sectors, private investment, exports, and imports in the medium run. If D/Y increases in the short run, these effects are further transmitted to the medium run, which may partially crowd-out private investment unless there is a sufficient increase in GDP and tax revenues to offset the increase in debt.

Regarding the employment effects, higher public social infrastructure directly generates female and male employment in the social sector in the short run. Furthermore, it is also likely to generate employment in the rest of the economy by increasing the GDP in the short run (see Figure 7 in Online Appendix V). It is also expected to increase the labor productivity in the rest of the economy in the medium run. This however has a direct negative effect on employment in the rest of the economy and might lead to an increase or decrease in women's or men's employment depending on the magnitude of the effects on aggregate output in the medium run.

As discussed above, the second reason why public social spending could rise is due to an increase in both women's and men's wages in the social sector, with a constant gender gap. The effects of this change are very similar to the case above, where public social spending increases due to hiring new employees: for the same amount of increase in κ^H the wage bill in H will increase by the same amount. However, less employment will be created in the social sector in the short and medium run.

Finally, comparing the effects of a simultaneous rise in wages in the social sector with the effects of closing the gender wage gap (by increasing women's wages with a constant men's wage), the short-run effects of the latter on consumption in both sectors are smaller. However, since women constitute a larger part of employment in H, the difference between the effects of these two cases on consumption is smaller compared to the difference between the effects of a simultaneous increase in wages versus closing the gender gap in N.

The analytical solution of the effects of a change in κ^H and further details of the comparative statistics are presented in Online Appendix III.

DATA, ESTIMATION METHODOLOGY, AND RESULTS

The behavioral specifications are econometrically estimated using time series data for the UK. The data sources are in the Online Appendix I. The hourly wage and hours of work are calculated based on EU KLEMS database for the period of 1970–2015. The national accounts data is based on the Annual Macro Economic database of the European Commission

(AMECO) and the OECD for the period of 1970–2016. The tax rates are based on Eurostat. The ratio of C^H to total consumption is based on ONS (2016a).

The stylized facts of our data are presented in Online Appendix IV and Figure 1. Despite an improvement in gender equality since the early 1980s, the ratio of the hourly wage rate of men/women in H and N are still as high as 1.313 and 1.230 respectively in 2015. The share of women in hours worked in N is still as low as 40.6 percent and women constitute the majority of employment in H (75.2 percent) in 2015.

The share of wages in national income (labor compensation/GDP at factor cost, adjusted for self-employment) fell from its peak of 0.706–0.584 in 1996 and despite a recovery since then, it is 4 percentage points below its peak at 0.665 in 2016 (own calculations based on Ameco data).

There is no time series data dating back to 1970s for unpaid care work; however, there is time use survey data for selected years. In 2014 women carried out 69.3 percent of the unpaid care work in the UK (ONS 2016b), which resembles the composition of paid care work.

All behavioral equations for consumption in H and N, investment, exports, and imports are estimated using IV-GMM (instrumental variable-generalized method of moments) estimations in order to address endogeneity issues.[3] The use of IV-GMM with an innovative set of instruments to address endogeneity is a methodological innovation of the study and is facilitated by the presence of gendered occupational segregation and pay gap ratios at sectoral level within the data set and the model, which provided stronger instruments for wage bill or profit share. Robert Blecker, Michael Cauvel, and Yun Kim (2020) present aggregate Kaleckian econometric estimations utilizing IV for the US, and Michalis Nikiforos and Duncan Foley (2012) rely on lagged variables of the wage share as IV. We also present the OLS results for comparison, and while the signs of the coefficients are robust, they are not always statistically significant. Nevertheless, the overall direction of the simulation results discussed below are very robust with respect to different estimators.

Endogeneity issues could also be tackled by using Vector Autoregression; however, this would require a large number of observations, and make it difficult to individually specify each behavioral equation and the interpretation of the results are less straightforward (Onaran and Obst 2016).

Overall, we acknowledge that establishing a causal nexus between distribution and demand is challenging and can only be partially addressed in a time-series framework, given the strong endogeneity problems in the model and the possibility that the exclusion restrictions may fail for the specific instruments used. Given this limitation, our empirical work is an attempt at addressing this complex issue and we refrain from making strong

causal statements and interpreted the estimations as associations in our discussion of the econometric estimation results.

Unit root tests suggest that all our variables are integrated of order one. We first estimate an ARDL (autoregressive distributed lag model) specification and find no cointegration and proceed with estimating the equations in first differences for consumption in H and N, investment, exports, and imports.[4]

The productivity in N is estimated using panel data of eighteen industries based on EU KLEMS for the period of 1980–2015 by IV-GMM.[5] In order to reflect medium-term effects, a non-overlapping five years average of explanatory variables (starting from 1980) and of the dependent variable (starting from 1981) are used. The use of panel data helps to model the medium-run effects, which is difficult to detect using short time series. Sector-level clustered standard errors are used. Different from equation (27) for the aggregate economy, the sector's own investment per hours of labor (I_{it}/E_{it}) is also included. This is because the industrial level value-added (Y_{it}) does not include industry's investment, while at the aggregate level Y^N includes investment.[6] As an instrument for Y_{it}, I_{it}/E_{it}, sectoral gender pay gap, and female wage, we use the first lag of strike days as a ratio to employment, the sectoral value added in each sectors in the US and the EU (as the main trade partners of the UK), gender pay gap in the rest of the economy[7] and 11 year lags (two five year periods) of Y_{it}, I_{it}/E_{it}, sectoral gender pay gap, and female wage. We do not use first differences, as unit root is less relevant with five-year period averages over a short period and the test results for the validity of the instruments for differences were poor. The synthesis of time series and panel data econometrics to specify short-run and medium-run effects is another methodological novelty of the article.

Estimation results

Estimation results for social and other consumption (equations 20-21) are in Table 3. Multiplying elasticities with consumption as a ratio to the relevant income category, we find that the MPC in N out of women's wage income (0.924) is larger than the MPC out of men's wage income (0.865), which in turn is larger than the MPC out of profits (0.193). MPC in H is also highest out of women's wage income (0.030), followed by MPC out of men's wage income (0.021), and the MPC in H out of profits is again the smallest (0.004). To the best of our knowledge, this is the first empirical comparison of the MPC out of women's and men's wages and profits. The results are consistent with other estimations showing that the MPC out of wages are higher than that out of profits (see Onaran and Galanis [2014] for a review) as well as micro-level evidence that women tend to devote a larger share of their income on social expenditures like education and healthcare

Table 3 IV-GMM and OLS estimation results for consumption in N and H

	GMM-IV				*OLS*			
Dependent variable	$\Delta logC^{N}_{t}$		$\Delta logC^{H}_{t}$		$\Delta logC^{N}_{t}$		$\Delta logC^{H}_{t}$	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Constant	0.008	0.000	0.007	0.014	0.008	0.018	0.011	0.049
$\Delta\log(R_t(1\text{-}t^{R}_{t}))$	0.081	0.000	0.040	0.064	0.107	0.000	0.030	0.479
$\Delta\log(WB^{F}_{t}(1\text{-}t^{W}_{t}))$	0.277	0.000	0.204	0.003	0.254	0.001	0.209	0.136
$\Delta\log(WB^{M}_{t}(1\text{-}t^{W}_{t}))$	0.441	0.000	0.243	0.060	0.443	0.000	0.126	0.611
R^2	0.697		0.083		0.710		0.096	
Kleibergen-Paap rk Wald F statistic for weak identification	28.06		28.06		–		–	
Hansen J overidentification test (*p*-value)	0.315		0.203		–		–	
Durbin-Wu-Hausman test for endogeneity (*p*-value)	0.012		0.977		–		–	
Sample	1973–2015		1973–2015		1973–2015		1973–2015	

Notes: Robust standard errors used. Stock-Yogo weak ID critical test values for GMM-IVs are 19.94 for a 10 percent maximal IV size, 10.70 for a 15 percent maximal IV size, 5.91 for a 20 percent maximal IV size, and 4.24 for 25 percent maximal IV size. We use contemporaneous, one-year, and two-year lagged differences of $\log \alpha^{N}$,$\log \alpha^{H}$,$\log \iota^{R}$, $\log \iota^{W}$,$\log \beta^{N}$, $\log \beta^{H}$,$\log Y^{W}$, logarithm of strike days as a ratio to employment as instruments for all independent variables.

compared to men (Stotsky 2006; Morrison, Raju, and Sinha 2007; Seguino and Floro 2003). However, we find that the overall propensity to save for women is not higher than men. This is at odds with the micro-evidence for developing counties, which suggest that the propensity to save is higher for women due to the higher uncertainty they face. The explanatory power of the estimations for C in H is rather low.

Table 4 presents the estimation results for investment based on equation (22). After-tax π is significant and positively associated with investment. Investment is negatively associated with public debt/GDP, which reflects some negative crowding-out effects of public borrowing on investment. There is a strong significant effect of GDP on investment.

Tables 5 and 6 present the estimation results for exports and imports based on equations 24-25. Y_{world} has a statistically significant positive impact on exports, and an increase in π is associated with higher international competitiveness. The increase in Y^{N} leads to a significant increase in imports. A higher π is associated with lower imports, again reflecting

Table 4 IV-GMM and OLS estimation results for private investment

	GMM-IV		*OLS*	
Dependent variable	$\Delta logI_t$		$\Delta logI_t$	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Constant	− 0.028	0.000	− 0.026	0.007
$\Delta\log(\pi_t(1\text{-}t^R_t))$	0.192	0.000	0.172	0.110
$\Delta\log Y_t$	2.379	0.000	2.264	0.000
$\Delta\log(D/Y)_t$	− 0.217	0.000	− 0.140	0.152
R^2	0.663		0.675	
Kleibergen-Paap rk Wald F statistic for weak identification	8.68		–	
Hansen J overidentification test (*p*-value)	0.359		–	
Durbin-Wu-Hausman test for endogeneity (*p*-value)	0.692		–	
Sample	1974–2016		1974–2016	

Notes: Robust standard errors used. Stock-Yogo weak ID critical test values for GMM-IVs are 20.31 for a 10 percent maximal IV size, 10.78 for a 15 percent maximal IV size, 5.87 for a 20 percent maximal IV size, and 4.16 for 25 percent maximal IV size. We use contemporaneous, one-year, and two-year lagged differences of $\log \alpha^N$,$\log t^R$, $\log t^W$, $\log \beta^N$, $\log \kappa^H$,$\log Y^W$, logarithm of strike days as a ratio to employment and one to three year lagged differences of $\log(D/Y)$ as instruments for all independent variables.

the impact of higher international competitiveness. Exchange rates are insignificant and are excluded.

The panel data estimation results for productivity in N based on equation (27) are in Table 7. The hourly wage rates in the sector and per capita public and private spending in the social sector are statistically significant and are associated with higher productivity in N. The high effect of public spending in H on productivity N provides supporting evidence that this spending serves the purpose of infrastructure investment. The value-added in the sector has a positive albeit insignificant coefficient. In the simulation analysis, we treat this coefficient as non-zero as the *p*-value of the t-statistic is less than 0.30.[8] The effect of the sector's own investment per worker and per capita public physical infrastructure investment are statistically highly insignificant and are treated as zero in the simulations.

POLICY ANALYSIS

We use the estimated parameters outlined previously to simulate the effects of changes in wages, the gender pay gap, and public spending in social infrastructure. The simulations assume that the change takes place in the

Table 5 IV-GMM and OLS estimation results for exports

	GMM-IV		*OLS*	
Dependent variable	$\Delta logX_t$		$\Delta logX_t$	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Constant	− 0.025	0.008	− 0.018	0.108
$\Delta\log(\pi_t)$	0.230	0.018	0.127	0.301
$\Delta\log Y^{World}{}_t$	2.167	0.000	1.930	0.000
R^2	0.503		0.473	
Kleibergen-Paap rk Wald F statistic for weak identification	26.94		–	
Hansen J overidentification test (*p*-value)	0.434		–	
Durbin-Wu-Hausman test for endogeneity (*p*-value)	0.6204		–	

Notes: Robust standard errors used. Stock-Yogo weak ID critical test values for GMM-IVs are 20.25 for a 10 percent maximal IV size bias, 11.39 for a 15 percent maximal IV size bias, 6.69 for a 20 percent maximal IV size bias, and 4.99 for 25 percent maximal IV size bias. We use one-year and two-year lagged differences of $\log \kappa^H$,$\log Y^N$, logarithm of strike days as a ratio to employment and Chinn-Ito capital account openness index as instruments for $\Delta\log(\pi_t)$.

Table 6 IV-GMM and OLS estimation results for imports

	GMM-IV		*OLS*	
Dependent variable	$\Delta logM_t$		$\Delta logM_t$	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Constant	0.001	0.751	0.008	0.238
$\Delta\log(\pi_t)$	− 0.307	0.001	− 0.227	0.074
$\Delta\log Y^N{}_t$	1.836	0.000	1.643	0.000
R^2	0.627		0.622	
Kleibergen-Paap rk Wald F statistic for weak identification	11.98		–	
Hansen J overidentification test (*p*-value)	0.295		–	
Durbin-Wu-Hausman test for endogeneity (*p*-value)	0.692		–	
Sample	1973–2016		1973–2016	

Notes: Robust standard errors used. Stock-Yogo weak ID critical test values for GMM-IVs are 20.33 for a 10 percent maximal IV size bias, 11.00 for a 15 percent maximal IV size bias, 6.14 for a 20 percent maximal IV size bias, and 4.43 for 25 percent maximal IV size bias. We use contemporaneous, one-year and two-year lagged differences of $\log \alpha^N$, $\log \beta^N$, $\log \kappa^H$,$\log Y^W$, logarithm of strike days as a ratio to employment and Chinn-Ito capital account openness index as instruments for all independent variables.

Table 7 IV-GMM estimation results for labor productivity in N

	GMM-IV		*OLS*	
Dependent variable	$logT_{it}$		$logT_{it}$	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*
$logY_{i(t-1)}$	0.141	0.297	0.253	0.005
$logI_{i(t-1)}/\ E_{i(t-1)}$	− 0.025	0.806	− 0.104	0.091
$logw^{F}{}_{i(t-1)}$	0.650	0.000	0.603	0.000
$log\alpha_{i(t-1)}$	0.622	0.000	0.553	0.000
$log(G^{H}{}_{t-1} + C^{H}{}_{t-1})/N_{t-1}$	0.402	0.014	0.487	0.002
$log(I^{G}{}_{t-1})/N_{t-1}$	− 0.069	0.336	− 0.126	0.014
R-squared	0.913		0.917	
Kleibergen-Paap rk Wald F statistic for weak identification	7.509		-	
Hansen J overidentification test (*p*-value)	0.146		-	
Durbin-Wu-Hausman test for endogeneity (*p*-value)	0.217		-	
Number of observations	126		126	
Number of sectors	18		18	
Sample	1981–2015		1981–2015	

Notes: Both regressions include yearly fixed effects. The time indicator t refers to five-year non-overlapping average of explanatory variables starting from 1980 and of the dependent variable starting from 1981. One-year lags of $logY_i$, $logI_i/\ E_i$, $logw^{F}{}_i$, $log\alpha_i$ are instrumented by one-year lags of strike days as a a ratio to employment for six broad sectors, logarithms of sectoral value added in each of the eighteen sectors in the US, logarithms of sectoral value added in each of the eighteen sectors in the EU-12, logarithms of α^{N} for the UK; eleven year lags of $logY_i$, $logI_i/\ E_i$, $logw^{F}{}_i$, $log\alpha_i$.

first period, and then the relevant variables (for example, the wage rate) stay constant in the next period.

Table 8 shows the total (post-multiplier) effects of changes in wages and the gender pay gap. While overall the direction of the simulation results is very robust with respect to different estimators, it is in place here to note that the magnitude of the effects should be seen as indicative due to the limitations of the estimation methodology discussed earlier. The details of the calculations are in Online Appendices 2 and 3.[9] The medium run (MR) effects are calculated as the sum of the effects in the short run (SR) and the period when productivity in N changes endogenously. In our theoretical model, the time period for different factors to affect productivity is an abstract matter, for example, the impact of public investment in childcare may take longer than the impact of other types of government spending or higher wages. In the empirical estimations of productivity, the medium run is captured by using five-year averages. Hence, one limitation of our study

Table 8 The total (post-multiplier) effects of changes in wages and gender pay gap on the components of aggregate demand (as a ratio to GDP), GDP, employment, and public debt/GDP

	%-point change in consumption in N /GDP	*%-point change in consumption in H /GDP*	*%-point change in private investment /GDP*	*%-point change in exports /GDP*	*%-point change in imports in N /GDP*	*%-point change in public social infrastructure investment /GDP*	*%-point change in government current expenditure /GDP*	*%-point change in public physical infrastructure investment /GDP*	*% change in GDP*	*% change in total employment*	*% change in female employment*	*% change in male employment*	*%-point change in public debt /GDP*
	$\Delta C^{N}/Y$	$\Delta C^{H}/Y$	$\Delta I/Y$	$\Delta X/Y$	$\Delta M/Y$	$\Delta G^{H}/Y$	$\Delta G^{C}/Y$	$\Delta I^{G}/Y$	$\Delta Y/Y$	$\Delta E/E$	$\Delta E^{F}/E^{F}$	$\Delta E^{M}/E^{M}$	$\Delta D/Y$
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*[i]	*(10)*	*(11)*	*(12)*	*(13)*
A. The effects of a 1% increase in female and male wages in N													
SR (ii)	0.400	0.011	0.040	− 0.084	0.209	0.026	0.022	0.006	0.213	0.224	0.230	0.219	− 0.156
MR (ii)	0.081	0.000	0.008	− 0.018	0.042	0.005	0.004	0.001	0.038	− 0.641	− 0.564	− 0.704	− 0.075
B. Closing gender pay gap in N by 1%: the effects of a 1% increase in only female wages in N (1% decline in α^{N})													
SR	0.137	0.004	0.021	− 0.025	0.072	0.010	0.009	0.003	0.086	0.091	0.093	0.089	− 0.061
MR	0.080	0.003	− 0.003	− 0.023	0.041	0.003	0.002	0.001	0.021	− 0.049	− 0.040	− 0.055	− 0.037
C. The effects of a 1% increase in female and male wages in H													
SR	0.336	0.050	0.249	0.000	0.239	0.160	0.065	0.019	0.640	0.673	0.691	0.660	− 0.257
MR	0.064	0.041	0.212	0.054	0.094	0.140	0.049	0.014	0.480	− 0.057	0.019	− 0.118	− 0.163
D. Closing gender pay gap in H by 1%: the effects of a 1% increase in only female wages in H (1% decline in α^{H})													
SR	0.229	0.036	0.170	0.000	0.164	0.107	0.044	0.013	0.436	0.459	0.471	0.449	− 0.212
MR	0.044	0.030	0.145	0.037	0.065	0.094	0.033	0.010	0.328	− 0.040	0.013	− 0.081	− 0.118

(*Continued*)

Table 8 Continued.

	%-point change in consumption in N /GDP	*%-point change in consumption in H /GDP*	*%-point change in private investment /GDP*	*%-point change in exports /GDP*	*%-point change in imports in N /GDP*	*%-point change in public social infrastructure investment /GDP*	*%-point change in government current expenditure /GDP*	*%-point change in public physical infrastructure investment /GDP*	*% change in GDP*	*% change in total employment*	*% change in female employment*	*% change in male employment*	*%-point change in public debt /GDP*
	$\Delta C^N/Y$	$\Delta C^H/Y$	$\Delta I/Y$	$\Delta X/Y$	$\Delta M/Y$	$\Delta G^H/Y$	$\Delta G^C/Y$	$\Delta I^G/Y$	$\Delta Y/Y$	$\Delta E/E$	$\Delta E^F/E^F$	$\Delta E^M/E^M$	$\Delta D/Y$
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*[(i)]	*(10)*	*(11)*	*(12)*	*(13)*
E: The effects of a 1% increase in female and male wages in both N and H (iii)													
SR	0.736	0.061	0.289	− 0.084	0.447	0.186	0.087	0.025	0.852	0.898	0.921	0.879	− 0.413
MR	0.145	0.041	0.221	0.036	0.136	0.145	0.053	0.016	0.519	− 0.699	− 0.545	− 0.822	− 0.239
F. Upward convergence: The effects of a 2% increase in female wages and 1% increase in male wages in both N and H (closing gender pay gaps by 1%; 1% decline in α^H (i) and α^N (iv))													
SR	1.101	0.102	0.479	− 0.109	0.683	0.303	0.140	0.041	1.374	1.447	1.485	1.417	− 0.686
MR	0.269	0.074	0.363	0.049	0.243	0.241	0.088	0.026	0.867	− 0.787	− 0.573	− 0.959	− 0.394

Notes: (i) Column (9) = (1) + (2) + (3) + (4)-(5) + (6) + (7) + (8). In each column, the effects in Appendices 2–3 are multiplied by the wage rate in the relevant sector and divided by Y.

(ii) SR: short run. MR: medium run, defined as the cumulative of the effects in the short run and the period when productivity changes.

(iii) Sum of the effects in simulations (A) and (C).

(iv) Sum of the effects in simulations (A), (B), (C) and (D).

is that our estimations and simulations do not capture the very long-run effects of changing variables.[10]

Scenario (A) presents the effects of a 1 percent increase in both women's and men's hourly wage rate in the rest of the economy (N); (B) presents the effects of a 1 percent increase in only the women's hourly wage rate while keeping men's wages constant in N, that is, closing the gender pay gap in N by 1 percent. In both cases, all components of demand except exports increase both in the SR and MR (except for private investment in the MR in B). The multiplier is 3.628.[11] In (A), GDP increases by 0.213 percent in the SR and by 0.038 percent in the MR; hence the economy is wage-led, although the effect is small. The increase in GDP in the MR in all scenarios is smaller than in the SR because in the medium run the increase in productivity in N leads to a decline in employment in N. In (B), GDP increases by 0.086 percent in the SR and by 0.021 percent in the MR; hence the economy is gender equality-led, but the effects are even smaller than in the case when both wages increase. Hours of employment of both men and women increase in the SR in both (A) and (B), but decrease in the MR (by 0.641 percent in A and 0.049% in B), as the productivity increase in N in the MR (0.780 percent in A and 0.080 percent in B) is stronger than the increase in GDP.

(C) presents the effects of a 1 percent increase in both women's and men's hourly wage rate in the public social sector. (H)[12] and (D) presents the effects of a 1 percent increase in only women's wages in H while keeping men's wages constant; that is, closing the gender pay gap in H by 1 percent. Demand increases again in the SR and MR. Compared to (A), the total effects on GDP are higher for various reasons: the increase in C^H is higher because the effect on women's income is more substantial and the MPC in H out of female wages is higher compared to men. The increase in investment is higher because a rise in wages in the public social sector (H) does not squeeze profits. For this reason, exports do not fall in the SR, as a rise in productivity in N by 0.645 percent increases π. The multiplier is 3.651. In (C) GDP increases by 0.640 percent in the SR and 0.480 percent in the MR, and in (D) GDP increases by 0.436 percent in the SR and 0.328 percent in the MR. In both scenarios, female employment increases in both the SR and MR albeit by a small amount in the MR (0.019 and 0.013 percent, respectively), but male employment increases only in the SR and decreases slightly in the MR (0.118 and 0.081 percent, respectively) due to productivity gains in N.

(E) presents the effects of a 1 percent increase in all wages in both the social sector and the rest of the economy (N and H), which is the sum of the effects in (A) and (C). (F) presents an upward convergence scenario, that is., a 2 percent increase in women's wage rate and 1 percent increase in men's wage rate in N and H, which is the sum of the effects in (A), (B), (C), and (D). An example of the latter scenario is to increase average wages via

an increase in the minimum wage or collective bargaining coverage while at the same time enforcing equal pay legislation and aiming at higher rates of increases in occupations at the bottom end of the pay scale, where women constitute a large share of the workforce. In the upward convergence scenario (F), GDP increases by 1.374 percent in the SR and 0.867 percent in the MR, but both women's and men's employment decreases in the MR (by 0.573 and 0.959 percent, respectively). Both women's and men's employment are wage-led and gender equality-led in the SR but not in the MR when wages increase in both sectors.

Public debt/GDP decreases in all scenarios, including (C)-(F), all of which include a direct increase in public social spending; for example, in (F) public debt/GDP decreases by 0.686 percentage points in the SR and 0.394 percentage points in the MR.

The results in (A) are comparable to previous research which find that the UK is a wage-led economy, although these previous results are based on the impact of the profit share on aggregate output only (Bowles and Boyer, 1995; Stockhammer and Onaran 2004; Naastepad and Storm 2006; Hein and Vogel 2008; Onaran and Galanis 2014; Onaran and Obst 2016; Jump and Mendieta-Muñoz 2017; Obst, Onaran, and Nikolaidi 2020; Oyvat, Öztunalı, and Elgin 2020). Based on our SR results for the rise in both wages in N, a 1 percentage-point fall in π leads to 0.331 percent increase in GDP after the multiplier, which is comparable to the previous research for the UK.

We should note that given our estimated parameters, an increase in men's wage rate only with a constant women's wage rate, that is, increasing gender inequality, would also have positive effects on output. In the short run in N the effect of an increase in only men's wage rate would create larger positive effect on output (0.127 percent) compared to the effect of an increase in the women's wage rate, as can be seen in the difference of the effect on Y in scenario (A) minus (B). This is because of the high employment share of men in N as well as their high MPC in N that is only slightly lower than MPC for women workers in N. However, the positive impact of a 1 percent increase in men's wage rate on GDP is smaller than the effect of a 1 percent increase in women's wage rate in the medium run in N (0.017 percent) as well as both in the short run and medium run in H (0.204 and 0.152 percent, respectively). The stronger impact of women's wage rate in H is because of the high share of women in H and therefore the substantial effect on the wage income when women's wages are increased. To summarize, in a wage-led economy an increase in either men's or women's wage rate leads to higher output. Our definition of women's wage-led growth is consistent with this finding as it is defined in relation to the positive effect on output of a rise in women's wage rate with a constant men's wage rate.

Table 9 shows the total (post-multiplier) effects of a 1 percentage-point increase in public spending in social infrastructure as a share of GDP (G^H/GDP), that is, hiring new employees with a constant wage in the social sector (H). With higher public social spending, GDP increases substantially in both the SR (5.947 percent) and MR (4.481 percent). A 1 percentage-point increase in G^H/GDP increases productivity in the rest of the economy (N) by a substantial amount of 5.570 percent in the MR. This is mostly due to the strong direct positive impact of public social spending on productivity as well as the higher rate of increase in household consumption in the social sector, as more jobs are created for women in H which predominantly hires women.

GDP and employment effects of public spending in social infrastructure are substantially higher than the effects of increasing wages. Despite productivity increases in the rest of the economy, both female and male total employment increases in the MR. However, the increase in women's employment is much stronger compared to men in the case of hiring new employees in the public social sector due to concentration of women in this sector. Women's employment increases by 9.273 percent in the SR and 3.373 percent in the MR while men's employment increases by 6.873 percent in the SR and only 0.063 percent in the MR.[13]

Comparing the effects of social infrastructure with physical infrastructure, three findings are worth emphasis: (1) The effects of public investment in social infrastructure on output is higher than that of public investment in physical infrastructure both in the short and medium run.[14] (2) The effect on women's employment is much stronger compared to men's employment with social infrastructure due to gendered occupational/sectoral segregation in employment. (3) The effect on productivity in the rest of the economy is also substantially higher in the case of social infrastructure compared to physical infrastructure. This is both due to the strong direct positive impact of social infrastructure on productivity which is absent in the case of physical infrastructure in the UK, as well as higher increase in household consumption in the social sector with more social infrastructure investment, which creates more jobs for women with a higher MPC in H.

Our SR results are comparable to the input–output table-based analysis in Jermone De Henau et al. (2016) for the UK, suggesting that the positive impact of social infrastructure investment on men's employment is substantial; however, when the increase in productivity in the MR is included in our analysis, the effect on men's employment is substantially smaller. The magnitudes of the effects are not comparable as De Henau et al. (2016) focus on only childcare and social care for social infrastructure.

Public debt/GDP decreases in both the SR and MR (by 0.790 percentage point). Even in the MR, increasing public spending in social infrastructure funds itself due to higher output and tax revenues even though tax rates

Table 9 The total (post-multiplier) effects of changes in public spending in social infrastructure as a share of GDP (κ^{H}) on the components of aggregate demand (as a ratio to GDP), GDP, employment, and public debt/GDP

	%-point change in consumption in N /GDP	*%-point change in consumption in H /GDP*	*%-point change in private investment /GDP*	*%-point change in exports /GDP*	*%-point change in imports in N /GDP*	*%-point change in public social infrastructure investment /GDP*	*%-point change in government current expenditure /GDP*	*%-point change in public physical infrastructure investment /GDP*	*% change in GDP*	*% change in total employment*	*% change in female employment*	*% change in male employment*	*%-point change in public debt /GDP*
	$\Delta C^{N}/Y$	$\Delta C^{H}/Y$	$\Delta I/Y$	$\Delta X/Y$	$\Delta M/Y$	$\Delta G^{H}/Y$	$\Delta G^{C}/Y$	$\Delta I^{G}/Y$	$\Delta Y/Y$	$\Delta E/E$	$\Delta E^{F}/E^{F}$	$\Delta E^{M}/E^{M}$	$\Delta D/Y$
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*[(i)]	*(10)*	*(11)*	*(12)*	*(13)*
SR (ii)	3.168	0.087	2.288	0.000	2.101	1.722	0.605	0.178	5.947	7.941	9.273	6.873	− 2.478
MR (ii)	0.779	0.006	1.911	0.466	0.816	1.544	0.456	0.134	4.481	1.536	3.373	0.063	− 0.790

Notes: (i) Column (9) = (1) + (2) + (3) + (4)-(5) + (6) + (7) + (8). In each column, the effects in Appendix 3 are divided by Y.
(ii) SR: short run. MR: medium run, defined as the cumulative of the effects in the short run and the period when productivity in N changes endogenously.

remain constant. Private investment increases overall due to the positive demand and productivity effects and lower public debt/GDP.

CONCLUSION

This article develops a gendered macroeconomic model to analyze the effects of changes in wages, gender pay gaps, and public investment in social infrastructure on output, employment of women and men, productivity, and public debt/GDP. The results indicate that there is a significant interaction between gender and functional income inequality. Closing gender pay gaps with upward convergence leads to an increase in the wage share. Similarly, public spending affects inequality as well by effecting employment and wage income.

Changes in inequality have crucial effects on output, employment, productivity, and government budget balances. We find that an upward convergence in wages, that is, increasing wages by closing gender pay gaps in both the social sector and the rest of the economy, leads to higher output in both the short and the medium run. The UK is both gender equality-led and wage-led, and hence equality-led. However, the positive impact on productivity is stronger in the medium run than on output, which leads to a fall in employment of both men and women.

Public spending in education, childcare, healthcare, and social care has a high positive effect on productivity in the rest of the economy. The positive impact of public social infrastructure investment on both output and employment is very strong, and despite a strong positive effect on productivity, employment of both men and women increase in the medium run. Public debt/GDP falls as an outcome of this policy even with constant tax rates.

To summarize, achieving higher wages, gender equality and employment for both men and women at the same time would require a policy mix of upward convergence in wages and an increase in demand, for example, via public investment in social infrastructure.

One caveat of using time series analysis to address the causal nexus between distribution and demand is the strong endogeneity between wages, employment, and demand and our results should be regarded as indicative of associations which can guide further research.

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NOTES

[1] Productivity in H is $w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)$.

[2] This simplification is also imposed by the unavailability of time series data for $\frac{U}{N}$.

[3] In the estimations for C^N and C^H, we use contemporaneous, one-year and two-year lagged differences of $\log \alpha^N$,$log\alpha^H$,$\log t^R$, $\log t^W$,$\log \beta^N$, $\log \beta^H$,$\log Y^W$, logarithm of strike days as a ratio to employment as instruments for all independent variables. In investment estimations we use contemporaneous, one-year and two-year lagged differences of $\log \alpha^N$,$\log t^R$,$\log t^W$,$\log \beta^N$, $\log \kappa^H$,$\log Y^W$, logarithm of strike days as a ratio to employment and one to three-year lagged differences of $\log(D/Y)$ as instruments for all independent variables. In export estimations we use one-year and two-year lagged differences of $\log \kappa^H$,$\log Y^N$, logarithm of strike days as a ratio to employment and Chinn-Ito capital account openness index as instruments for $\Delta\log(\pi_t)$. In import equation, we use contemporaneous, one-year and two-year lagged differences of $\log \alpha^N$, $\log \beta^N$, $\log \kappa^H$,$\log Y^W$, logarithm of strike days as a ratio to employment and Chinn-Ito capital account openness index as instruments for all independent variables. The choice of instruments is based on tests for satisfying exogeneity and relevance conditions based on tests for weak identification, overidentification and endogeneity, reported at the end of the estimation tables. Kleibergen-Paap rk Wald F values in regressions for C^N, C^H, X are greater than Stock-Yogo values for a 10 percent maximal IV size bias; and for M and I they are respectively larger than Stock-Yogo values for 15 percent maximal IV size bias and 20 percent maximal IV size bias, which show that the selected instruments are strong. To test for robustness, we estimated 3SLS/ Seemingly Unrelated Regressions (SUR)-IV regressions in which consumption in N, consumption in H, investment, exports, and imports are estimated in a system; however, the equations fail rank condition for identification, hence the system is not identified. As an alternative we considered GMM-3SLS regressions; however, the number of parameters exceeded the number of observations. We preferred not to use SUR without instruments, as this does not address the endogeneity and reverse causality issues.

[4] Engle Granger and ARDL Bounds tests show that there is no cointegration in any of the regressions, therefore we did not proceed with Error Correction Model (ECM) and Autoregressive Distributed Lag (ARDL).

[5] The last year is determined by data availability. Electricity, gas, and water; construction; public administration and defense; compulsory social security; agriculture, forestry and fishing; and mining and quarrying (as well as education and health and social work) are excluded due to the complications in measuring productivity in these sectors. The results are rather robust to the inclusion of these sectors. The results are also robust to excluding the post-2008 crisis period.

[6] The use of five-year sum (average) serves as a proxy for capital stock in terms of both private and public human and physical capital.

[7] The strike days as a ratio to employment reflects the bargaining power of workers and serves as an instrument for women's wages. Due to lack of long-term comparable data, we use strike days/employment for three broad sectors (manufacturing, market services, non-market services). The gender pay gap for the whole N sector reflects the changes in the gender norms in the UK and serves as a good instrument for sectoral gender pay gaps. The sectoral value added in the US and the EU-12 are expected to influence the sectoral value added and investment in the UK as they reflect the growth of markets for these sectors in the UK`s two major trade partners.

[8] We follow this methodology because in our simulations we do not prefer to treat our variables that have intuitively expected signs and are statistically insignificant (at 10 percent) as zero. The problems of dismissing the effects coming through variables that are statistically insignificant at commonly accepted levels are discussed in Ziliak and McCloskey (2004, 2008).

[9] Wherever required, the elasticities in the estimations in Tables 3–7 are converted to marginal effects using the averages of the relevant variables for the estimation period.

[10] In the theoretical model, the medium run is not an econometric concept related to data or time lags, What distinguishes the medium run from the short run is the change in productivity which triggers further effects on employment, total wage bill, the profit share and thereby consumption, investment, exports, and imports. See Online Appendix A2.1.2, A2.2.2, A3.1.2, A3.2.2, and A3.3.2 for the calculations.

[11] The multiplier shows the increase in Y as a ratio to an increase in demand, in this case due to a rise in the wage rates in N and is equal to $(1/(1-\varphi_{NF}))$, where φ_{NF} is calculated as in Equations A2.2 in the Online Appendix. This is on the high end of the estimates of multipliers compared with the estimations by Thomas Obst, Ozlem Onaran, and Maria Nikolaidi (2020) using a Post-Kaleckian model with government without gendered effects, who report multipliers in the range of 1.13 and 4.84. The high multiplier value in our case is particularly driven by the high elasticity of investment to output (i_1 in Equation 22 estimated in Table 4). There is also evidence that demand-led models deliver higher estimates (Gechert 2015). See also Walid Qazizada and Engelbert Stockhammer (2015) and Engelbert Stockhammer, Walid Qazizada, and Sebastian Gechert (2019) for high multiplier during down-turns. Nevertheless, we note that our estimates should be used to interpret the direction of the effects and the magnitudes of the effects are indicative.

[12] The increase in hourly real wage rate in N and H in GBP is comparable. A 1 percent increase in female wages in H and N are £0.18 and £0.17 respectively, and a 1 percent increase in male wages in H and N are £0.24 and £0.21 respectively in 2015.

[13] A 1 percentage-point increase in G^H/GDP is a rather substantial increase given that as of 2016 G^H/GDP in the UK is 0.13. This partly explains the high magnitude of the effects. The other reason is the high multiplier implied by the estimated elasticities, in particular output elasticity of investment, as discussed above. In terms of aggregate employment effects being positive despite a high productivity increase, it is worth noting that estimated productivity increase figure refers to the rest of the economy not the aggregate economy and the social sector is a very labor intensive sector.

[14] With higher public physical investment, GDP increases in the SR by 3.399 percent and MR by 2.933 percent. Detailed results available upon request and are not reported here due to space limitations.

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed https://doi.org/10.1080/13545701.2022.2044498..

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