The Effects of Public Social Infrastructure and Gender Equality on Output and Employment: The case of South Korea

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ABSTRACT

This paper examines the short-run and medium-run impact of public spending in social infrastructure, defined as expenditure in education, childcare, health and social care on aggregate output and employment of men and women for the case of South Korea. We present a gendered Post-Kaleckian feminist macroeconomic theoretical model. We estimate the macroeconomic effects of social expenditure using a vector autoregression (VAR) analysis for the period of 1970-2012. The results show that an increase in the public social infrastructure significantly increases the total non-agricultural output and employment in South Korea both the short and medium-run. Moreover, we find that higher social infrastructure expenditure increase female employment more than male employment in the short-run and raise both male and female employment in the medium-run due to increasing aggregate output. Finally, our estimates show that South Korean economy is wage-led and gender equality-led in the short-run, hence overall equality-led, although the effects are economically small in comparison to the strong effects of increases social infrastructure spending, and become insignificant in the medium-run. The results indicate that sustainable equitable development and a substantial increase in employment requires a mix of both labour market and fiscal policies.
1. Introduction

This paper aims at analysing the effects of public spending in education, childcare, health and social care and gender pay gap in South Korea on aggregate output and employment of men and women based on a Post-Kaleckian feminist macroeconomic model. According to the Global Gender Gap Index of the World Economic Forum (2018), South Korea is one of the lowest ranked countries in the world in terms of “Economic Participation and Opportunity” (124th out of 149 countries) as of 2018. Global Gender Gap Index also shows that South Korea ranks 88th in terms of female labour force participation and 121st in terms of gender wage equality for similar work. The average wages of women in South Korea are on average 36.7% lower than average male wages (as of 2012, own calculations based on World Klem's (2014) database). These statistics reflect that there is a significant economic gender gap in South Korea despite the fact that the country is now classified as a high-income economy. Moreover, the underdeveloped care infrastructure and reliance on unpaid care labour of women is posing serious demographic and social sustainability challenges in an aging society.

Empirical research on the effects of public spending, show a stronger positive effect of public spending in social care and education on female employment as well as total employment compared to public investment in physical infrastructure (Antonopoulos et al., 2010; Ilkkaracan, Kim and Kaya, 2015; Ilkkaracan and Kim, 2018; De Henau et al., 2016; Onaran, Oyvat and Fotopoulou, 2019a). These employment effects have further effects on the economy and the wellbeing of the society, as microeconomic studies across the board attest that a larger share of women’s income compared to that of men’s, is spent to satisfy the needs of the household (Blumberg, 1991; Antonopoulos et al, 2010; Pahl, 2000) and a possible increase in their income leads to increased spending on children’s education and wellbeing (Vogler and Pahl, 1994; Lundeberg et al. 1997; Cappellini, Marilli and Parsons, 2014). Onaran, Oyvat and Fotopoulou (2019a) confirm this finding at the macroeconomic level for the case of the UK. These consequently have further demand and supply side effects on output, productivity and employment (Onaran, Oyvat and Fotopoulou, 2019a; Seguino, 2017).

With respect to the effect of gender equality on output, there are potentially both positive effects on consumption and investment, and negative effects on net exports
and investment due to both demand and supply side effects; the effects differ in the short and medium-run and crucially depend on the structure of the economy (Onaran, Oyvat and Fotopoulou, 2019a, b; Braunstein, Bouhia and Seguino, 2018; Seguino, 2010, 2012, 2017; Braunstein, Stavaren, Tavani, 2011). In the case of South Korea, Seguino (1997) finds that higher gender pay gaps increase the exports in manufacturing by lowering unit labour costs of export goods. Overall, Seguino (2000) empirically estimates that gender pay gaps positively contributed the economic growth in nine Asian economies including South Korea in 1975-95. In contrast, Onaran, Oyvat and Fotopoulou (2019a) find that gender equality leads to higher output in the UK in both the short and the medium-run. Empirical research based on post-Kaleckian macroeconometric models on the impact of the share of wages in national income indicate that a higher wage share leads to higher output in the case of South Korea (Onaran and Stockhammer, 2005; Onaran and Galanis, 2014; Oyvat, Elgin and Öztunalı, 2018); however these studies do not analyse the effects of gender distribution of wage income.

We use a post-Kaleckian feminist theoretical model to analyse the effects of public social expenditure and gender gaps on output and employment building on Onaran, Oyvat and Fotopoulou (2019a, b). Empirically, we use a vector autoregression (VAR) analysis to estimate the impact of an increase in social infrastructure spending, female and male wages and closing gender pay gap on aggregate output and employment of men and women in South Korea based on data provided by World Klems (2014) for the period of 1970-2012. Our results show that social infrastructure spending has a positive effect on aggregate non-agricultural output both in the short-run and medium-run in South Korea and it contributes to closing the gender employment gap in the short-run through generating substantial employment for women. Moreover, rising female and male wages and closing gender pay gap stimulate aggregate demand in the short-run, and South Korea is overall equality-led. However, the positive effect of higher wages or higher gender equality becomes insignificant over the medium-run. The effects of higher wages and gender equality are also economically small in comparison to the strong effects of increases social infrastructure spending. The results point at the importance of using more than one policy tool combining wage and fiscal policies to create a substantial increase in decent jobs for both men and women with decent wages and higher equality.
The second section presents the post-Kaleckian feminist demand-led growth model that we use in this paper. Section three analyses theoretically the effects of an increase in the public social expenditure through increasing employment or closing the gender pay gap via increasing wages of women in the social sector. The fourth section presents the econometric estimation results and the final section concludes.

2. A feminist post-Kaleckian Model with public and private social expenditure, paid and unpaid labour

In this section, we present a feminist post-Kaleckian theoretical model which forms the basis of our analysis of the effects of gender inequalities in pay and employment and social infrastructure investment. The model is based on Onaran, Oyvat and Fotopoulou (2019b), which extends earlier theoretical models by Braunstein, Stavaren and Tavani (2011) and Seguino (2010, 2012), incorporating both demand and supply side analysis within post-Kaleckian theoretical models, albeit without an empirical analysis. The theoretical model is a general model, allowing for both positive and negative effects of gender equality on the demand side depending on the structural features of the economy and incorporates the positive effects on the supply side.

The model introduces two types of workers, female and male, which are respectively demonstrated by scripts F and M. We disaggregate profit share into its components: output, female and male wage rates, and female and male paid employment. The profits are earned by the capitalists, who are genderless for simplicity in our model.

The model has two sectors, public social sector, which consists of the expenditure of the government in education, childcare, healthcare, and social care (demonstrated with script H), and the rest of the economy (demonstrated with script N). The public spending in the social sector is defined as investment in social infrastructure in line with the feminist economics literature (Elson, 2016, 2017; Women’s Budget Group, 2015). İlkkaracan (2013) defines this as purple investment. We also introduce household’s spending in marketized social services. Both public and household’s social expenditure have short-run demand effects and influence labour productivity in the medium-run. Appendix 1 presents the list of the variables in the model.
Aggregate output \((Y_t)\) is the sum of total male wage bill \((WB_t^M)\), total female wage bill \((WB_t^F)\) and profits \((R_t)\).

\[
Y_t = WB_t^M + WB_t^F + R_t
\]  

(1)

The total wage bill for female workers \((WB_t^F)\) is a function of female wages in the social sector \((w_t^{HF})\), female employment in the social sector \((E_t^{HF})\), female wages in the rest of the economy \((w_t^{NF})\), and female employment in the rest of the economy \((E_t^{NF})\):

\[
WB_t^F = w_t^{HF}E_t^{HF} + w_t^{NF}E_t^{NF}
\]  

(2)

Similarly the total wage bill for male workers \((WB_t^M)\) is a function of male wages in the social sector \((w_t^{HM})\), male employment in the social sector \((E_t^{HM})\), male wages in the rest of the economy \((w_t^{NM})\), and male employment in the rest of the economy \((E_t^{NM})\):

\[
WB_t^M = w_t^{HM}E_t^{HM} + w_t^{NM}E_t^{NM}
\]  

(3)

The data for South Korea show that average hourly male wage rate are significantly higher than average hourly female wage rate (own calculations based on World Klems (2014) discussed in more detail in Section 4). For the period of 1970-2012, the average hourly male wages in the non-agricultural sector in South Korea are on average 62% larger than the average hourly female wages (based on period average), although the gender pay gap declined during this period. The gender pay gap is larger in N during 1970-1985 and is larger in H during 1991-2012.

In South Korea, there is also significant occupational/sectoral segregation with women constituting the majority in the social sector in the post-1998 period and are substantially underrepresented in the rest of the economy during the whole period of 1970-2012. During the period of 1977-2012, the share of women in hours of work in the social sector is larger and increased through time, which indicates that occupational/sectoral segregation increased. As of 2012, the share of women in hours of work in N and H in South Korea are respectively 30.5% and 68.0% (own calculations based on World Klems (2014) database presented in more detail in Section 4).
We define gender wage gaps ($\alpha_t$) in H and N as below:

$$\alpha_t^N = \frac{w_{tNM}}{w_{tNF}}, \quad \alpha_t^H = \frac{w_{tHM}}{w_{tHF}} \quad (4)$$

In South Korea $\alpha_t^N > 1$ and $\alpha_t^H > 1$ (own calculations based on World Klem's data discussed in Section 4) similar to a variety of other emerging as well as developed economies (Onaran, Oyvat, Fotopoulou, 2019a, b).

The aggregate output in the market economy (GDP, excluding unpaid activities) is

$$Y_t = C_t^N + C_t^H + I_t + G_t^H + G_t^C + I_t^G + X_t - M_t \quad (5)$$

where $C_t^H$ is households’ social expenditure\(^1\), $C_t^N$ is consumption in the rest of the economy, $I_t$ is private investment expenditure, $G_t^H$ is government’s social infrastructure expenditure, $G_t^C$ is government’s consumption expenditure, $I_t^G$ is public investment other than investment in the social sector\(^2\), $X_t$ is exports of goods and services and $M_t$ is imports of goods and services. The public social expenditure is a fiscal policy decision targeted as a share of aggregate output ($\kappa_t^H$), and constitutes the public social sector output ($Y_t^H$)\(^3\). The rest of the GDP is the market output in the rest of economy ($Y_t^N$):

$$Y_t^H = G_t^H = \kappa_t^H Y_t \quad (6)$$

$$Y_t^N = Y_t - G_t^H = Y_t (1 - \kappa_t^H) \quad (7)$$

\(^1\) While theoretically household consumption of social services amount to investment in human infrastructure as well and affects productivity in our model, as discussed below, we preserved the term “consumption” for this category consistent with the definitions in national accounts.

\(^2\) Government’s social infrastructure expenditures are classified as current spending on labour services in the national accounts. The physical infrastructure associated with providing social infrastructure such as schools and hospitals are counted as physical infrastructure. Hence part of $I_t^C$ also contributes to social infrastructure. However, our classification is important for a gendered analysis of the employment impact of different fiscal policy decisions as $G_t^H$ is very female labour intensive while construction, just as most other parts of $I_t^C$ is male labour intensive.

\(^3\) For simplicity, we assume that H sector only consists of the public social sector. The employment and supply in this sector is entirely financed by public social expenditures. The households’ private social consumption (see equation 20) is supplied by the private market output in the rest of economy ($Y_t^N$). Hence, private social consumption does not directly contribute to the generation of employment in H sector; however, they affect labour productivity in the next period positively as discussed below.
The share of government’s consumption expenditure \( G^C_t \) and public investment other than social infrastructure investment in the social sector \( I^G_t \) are also determined by government as a share of aggregate output and are respectively \( \kappa^C_t \) and \( \kappa^G_t \):

\[
G^C_t = \kappa^C_t Y_t
\]

\[
I^G_t = \kappa^G_t Y_t
\]

The employment in the N sector is output over labour productivity in the N sector \( T^N_t \):

\[
E^N_t = \frac{Y^N_t}{T^N_t} = \frac{(1 - \kappa^H_t) Y_t}{T^N_t}
\]

In our model, the share of female employment in N is exogenous and institutionally and socially determined leading to occupational segregation, and is demonstrated by \( \beta^N_t \). The male workers in N constitute \((1 - \beta^N_t)\) of the sector:

\[
E^{NF}_t = \frac{(1 - \kappa^H_t) Y_t}{T^N_t} \beta^N_t = \frac{Y^N_t}{T^N_t} \beta^N_t
\]

\[
E^{NM}_t = \frac{(1 - \kappa^H_t) Y_t}{T^N_t} (1 - \beta^N_t) = \frac{Y^N_t}{T^N_t} (1 - \beta^N_t)
\]

The number of male workers is greater than the number of female workers in N for all the years reported; hence, \( \beta^N_t < 0.50 \) in South Korea (own calculations based on World Klems (2014) presented in Section 4). Moreover, \( \beta^N_t < \beta^H_t \) in all years except the few years in the pre-1977 period. Therefore, we expect that a rise in the share of social sector in aggregate output would also increase the share of female workers in total employment.

We assume that the wage paid to male and female workers in the social sector constitutes the public social expenditure and the social sector is not making profits. Any

\--\footnote{For simplicity, we abstract from the presence of trans workers and classify them as either male or female in our model.}
non-labour inputs used constitute part of government consumption \((G^C)\). Following this, the public social expenditure can be written as a function of employment \((E^H)\), average female wage \((w^{FH})\), average male wage \((w^{MH})\), female employment share \((\beta^H)\) and male employment share \((1 - \beta^H)\) in the social sector.

\[
G^H_t = \kappa^H_t Y_t = \beta^H_t E^H_t w^{FH}_t + (1 - \beta^H_t)E^H_t w^{MH}_t \tag{13}
\]

Using equations (13) and (4), we can write the total employment \((E^H_t)\), female employment \((E^{HF}_t)\) and male employment \((E^{HM}_t)\) in the social sector as a function of public social expenditure and female wages in the social sector.

\[
E^H_t = \frac{G^H_t}{w^{FH}_t(\beta^H_t + \alpha^H_t - \beta^H_t \alpha^H_t)} = \frac{\kappa^H_t Y_t}{w^{FH}_t(\beta^H_t + \alpha^H_t - \beta^H_t \alpha^H_t)} \tag{14}
\]

\[
E^{HF}_t = \frac{\beta^H_t \kappa^H_t Y_t}{w^{FH}_t(\beta^H_t + \alpha^H_t - \beta^H_t \alpha^H_t)}, \quad E^{HM}_t = \frac{(1 - \beta^H_t) \kappa^H_t Y_t}{w^{FH}_t(\beta^H_t + \alpha^H_t - \beta^H_t \alpha^H_t)} \tag{15a,b}
\]

Therefore, we can expect that a rise in the share of social sector in aggregate output increases the share of female workers in total employment.

We model the unpaid domestic care labour \((U_t)\) within the households as

\[
\log U_t = q_0 + q_G \log G^H_t + q_F \log E^{NF}_t + q_M \log E^{NM}_t \tag{16}
\]

For a given demographic structure defining the care needs of a society, \((q_0)\) the higher male and female paid employment is expected to have some negative impact on the supply of unpaid labour, since it decreases the time that could be allocated for unpaid care \((q_F < 0, q_M < 0)\). Higher government expenditure in the social sector is also expected to reduce the need in the households for care; therefore, it leads to lower unpaid labour \((q_G < 0)\). We specify the equation in logarithms, since the impact of employment in N and public social expenditure on the time spent on unpaid domestic care might be non-linear (the negative impact might be decreasing in absolute values as it gets increasingly more difficult to decrease unpaid care at lower levels of unpaid care).

Next, we define the profits \((R)\) in the N sector. The profits are the income in the N sector after wage payments.
\[ R_t = Y_t^N - w_t^{NF} E_t^{NF} - w_t^{NM} E_t^{NM} = Y_t^N - E_t^N (\beta_t^N + \alpha_t^N - \beta_t^N \alpha_t^N)w_t^{NF} \]
\[ = (1 - \kappa_t^N) Y_t - E_t^N (\beta_t^N + \alpha_t^N - \beta_t^N \alpha_t^N)w_t^{NF} \]  

(17)

The profit share in the N sector is the share of profits in output in N. Therefore, the profit share could also be written as a function of female wages and labour productivity in the N sector:

\[ \pi_t = \frac{Y_t^N - w_t^{NF} E_t^{NF} - w_t^{NM} E_t^{NM}}{Y_t^N} = 1 - \frac{(\beta_t^N + \alpha_t^N - \beta_t^N \alpha_t^N)w_t^{NF}}{T_t^N} \]  

(18)

The next set of equations present the behavioural equations defining the demand side of the model. Consumption of households in goods and services other than social expenditure is a function of after tax wage income of female and male workers in H and N and profit income of capitalists. \( t_t^W \) is the rate of tax on wages and \( t_t^R \) is the rate of tax on profits. Following previous empirical literature (e.g. Hein and Vogel, 2009; Molero-Simarro, 2011; Onaran and Galanis, 2014; Onaran and Obst, 2016) we define consumption in logarithms. The non-linearities in the relationship between sources of incomes and consumption might be an outcome of changing propensities to consume with changing incomes.

\[ \log C_t^N = c_0 + c_R \log[R_t (1 - t_t^R)] + c_{NF} \log[w_t^{NF} E_t^{NF} (1 - t_t^W)] + c_{HF} \log[w_t^{HF} E_t^{HF} (1 - t_t^W)] + c_{NM} \log[w_t^{NM} E_t^{NM} (1 - t_t^W)] + c_{HM} \log[w_t^{HM} E_t^{HM} (1 - t_t^W)] \]  

(20)

The marginal propensity to consume in N and H is assumed to be different for male and female workers, reflecting the gender pay gaps as well as differences in behaviour.

The households’ social expenditure \( (C_t^H) \) is also a function of after tax profit and wage income of female and male workers in N and H sectors, and governments’ social expenditure:

\[ \log C_t^H = z_0 + z_R \log G_t^H + z_{NF} \log[w_t^{NF} E_t^{NF} (1 - t_t^W)] + z_{HF} \log[w_t^{HF} E_t^{HF} (1 - t_t^W)] + z_{NM} \log[w_t^{NM} E_t^{NM} (1 - t_t^W)] \]  

(20)
The marginal propensity to consume in H is different for male and female workers in the N sector. We assume that the marginal propensity to consume in H is the same for male and female workers working in the social sector in an attempt to simplify the model. Following this assumption, governments’ social expenditure ($G^H_t$) can i) increase households’ social expenditure by providing wage income in the social sector, ii) decrease households’ social expenditure by reducing the need for these expenditures. We assume that the demand for $C^H_t$ is provided by the private sector in the market economy as part of the output in the N sector, as mentioned above.

Next, private investment ($I_t$) is

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

(21)

where $D$ is the public debt. The private investment is expected to increase as a result of higher aggregate output ($i_1 > 0$). $\pi_t (1 - t^R)$ is the after tax share of profits in the N sector. Following Bhaduri and Marglin (1990) and Blecker (1989), we expect the profit share to have a positive direct impact on private investment ($i_2 > 0$). Last, we use the ratio of public debt to GDP, $(D/Y)_t$, to consider the possible negative crowding out effects of rising public debt on the interest rate and thereby, private investment ($i_3 < 0$).

The public debt at time $t$ ($D_t$) is the public debt accumulated from the public debt in the previous period ($D_{t-1}$) with an interest rate of $r_{t-1}$, plus the total government expenditure at $t$, minus the taxes collected from profits and wages at time $t$ (Obst, Onaran, Nikolaidi (2019)).

$$D_t = (1 + r_{t-1}) D_{t-1} + G^H_t + G^C_t + I^C_t - t^W (WB^F_t + WB^M_t) - t^R R_t$$

(22)

$$D_t = (1 + r_{t-1}) D_{t-1} + Y^N_t (k^H_t + k^C_t + k^G_t) \cdot \frac{1 - k^H_t}{1 - k^H_t} - w^N (\alpha^N_t \varepsilon^N_t M + \varepsilon^NF_t) Y^N_t - w^H (\alpha^H_t \varepsilon^HM_t + \varepsilon^HF_t) Y^N_t \cdot \left( Y^N_t - w^N (\alpha^N_t \varepsilon^N_t M + \varepsilon^NF_t) \right)$$

(22'')

5 As the majority of the workers in H are women, the impact of this simplification is not very important. The assumption helps to simplify the model by using only $G^H_t$ to reflect the demand effect while at the same time capturing the substitution effect of public social infrastructure provision on private demand for social expenditure.
Exports are shown by $X$:

$$\log X_t = x_0 + x_1 \log Y_t^{\text{World}} + x_2 \log \pi_t + x_3 \log \epsilon_t \quad (23)$$

The income of the trading partners ($Y_t^{\text{World}}$) and the depreciation in currency ($x_3$) increases the exports ($x_1, x_3 > 0$). A rise in the profit share is equivalent to a fall in real unit labour costs, and hence would increase the export competitiveness and hence exports of an economy ($x_2 > 0$).

Imports are shown by $M$:

$$\log M_t = n_0 + n_1 \log Y_t^{\text{N}} + n_2 \log \pi_t + n_3 \log \epsilon_t \quad (24)$$

Higher domestic demand in the N sector would stimulate the demand for imported goods and services ($n_1 > 0$) and real depreciation in currency ($x_3$) reduces the imports ($n_3 < 0$). A rise in the profit share would decrease imports, because it would increase the competitiveness of the economy.

This is a reduced form modelling of the relative price effects on exports and imports. Domestic prices and export prices are functions of nominal unit labour costs, based on a mark-up pricing model in an imperfectly competitive economy. Exports are a function of relative prices of exports to imports, and imports are a function of domestic prices relative to import prices. As nominal unit labour costs are real unit labour costs multiplied by domestic prices, and the wage share is identical to real unit labour costs, a fall in the wage share, i.e. a rise in the profit share, leads to a fall in relative prices and improves net exports, depending on the labour intensity of exports, the pass through from labour costs to export prices and domestic prices and the price elasticity of exports and imports. To simplify the model we do not present the price equations and relative price effects on net exports. Our claim on the impact of the profit share on net exports is also supported by the previous empirical literature. For South Korea, Onaran and Galanis (2014) find that an increase in the profit share increases exports and reduces imports.

Finally on the supply side of the model, labour productivity is constant in the short run and changes endogenously in the medium run in the rest of the economy, as
we assume technological change or adoption of new techniques take time. Labour productivity in the N sector \((T^N_t)\) is

\[
\log T^N_t = h_0 + h_1 \log a^H_{t-1} + h_2 \log I^C_{t-1} + h_3 \log G_{t-1} + h_4 \log Y_{t-1} + h_5 \log w^N_{t-1} + h_6 \log(a^N_{t-1} w^N_{t-1}) + h_7 \log C^H_{t-1} + h_8 \log U_{t-1} + h_9 \log T^N_{t-1} \tag{25}
\]

In the medium run, the labour productivity is likely to be positively influenced by lagged values of government’s social infrastructure investment as well as government’s consumption expenditure and other public investment \((h_1, h_2, h_3 > 0)\). We also expect households’ consumption expenditure in marketized social services \((C^H)\) and domestic unpaid care labour to affect labour productivity positively \((h_7, h_8 > 0)\). Nevertheless, we expect the effects of these to be realised over the medium-run, namely in the next period. Higher output also leads to higher labour productivity due to Verdoorn effect (Naastepad, 2006; Hein and Tarassow, 2010), as greater scale can lead to more efficient allocation of sources \((h_4 > 0)\). Moreover, following Marx (1867) and later the theoretical contributions and empirical findings of Naastepad (2006) and Hein and Tarassow (2010), we consider that higher female and male wages in N leads to capitalists’ preference towards labour-saving technologies, which increases the labour productivity \((h_5, h_6 > 0)\). This is also consistent with the new Keynesian efficiency wage theories (Shapiro and Stiglitz, 1984). Higher output and higher wages have also a lagged effect, since the change in technology and/or techniques pushed by these factors would require time. Finally, the labour productivity in the previous period is also positively related with the productivity in the current period, since part of the technology from the last period is transferred to the following period \((h_9 > 0)\). The next period is a sufficiently long time period for these effects to be realised, e.g. five years or more; furthermore the time required for these different factors to affect productivity is an empirical question; e.g. the impact of public investment in childcare may take longer than the impact of other types of government spending or higher wages. In the theoretical model, we abstract from differences in the lag structure of the effects.

\footnote{Increasing productivity in H is less related to the availability of technology or better skills, as the quality of these services is more important and is in many cases requires more hours of nurses, care workers, teachers per patient or student. Productivity in H is determined by female wage rate, gender pay gap, and occupational segregation in H.}
Unpaid domestic care labour, $U$ is shared between women ($U^F$) and men ($U^M$), where $\beta_d$ is the share of $U^F$ in $U$, and is exogenous and institutionally and socially determined:

$$U_t^F = \beta_d U_t$$

(26)

$$U_t^M = (1 - \beta_d) U_t$$

(27)

In case of extreme gender inequality $\beta_d = 1$.

If employment grows faster than the labour force for a particular type of worker, unemployment rate decreases, and vice versa. If demand for employment, $E$, for a particular type of worker is not met by an increase in labour supply due to constraints in supply, e.g. a low female labour supply due to lack of provision of public social infrastructure for care, either there will be an exogenous increase in labour supply due to migration, or gender norms and occupational segregation coefficients will change or wages will adjust. While in the theoretical model we ignore the feedback effects of changes in labour supply and consequently unemployment on wages for simplicity, it is realistic to assume that in the medium run changes in labour demand vs. labour supply can lead to changes in wages. Changes in population via increased migration, to relax labour supply constraints in the care economy due to rising need for care work along with rising female employment is also not analysed in this model, and is assumed to be exogenous.

Similarly a rise in wages in a particular sector, e.g. H as an outcome of higher public social infrastructure, or a faster increase in wages in the social sector compared to wages in the rest of the economy is likely to lead to higher labour supply of both men and women, leading to also changes in the sectoral segregation ratios in the social sector and the rest of the economy, as well as a change in social gender norms and the distribution of unpaid domestic labour.

While these are interesting extensions, they are outside the scope of this theoretical model, where our primary aim is to analyse the impact of public social spending and exogenous changes in gender pay gap on employment of women and men.
3. The effects of the public social infrastructure expenditure on output and employment

In this section, we analyse the impact of a change in the share of public social infrastructure investment on GDP and employment in the short and medium-run based on the theoretical model. We first examine the effect of an increase in the share of public social infrastructure investment with constant wages \((w_{t}^{HM} = w_{t}^{HM*}, w_{t}^{HF} = w_{t}^{HF*})\) with an increase in female and male employment in the social sector. We first examine the effect in the short-run. Next, we examine the impact in the medium-run, via the effects on labour productivity. Next, we analyse the case where the share of public social expenditure increase due to increasing female wage rate with a constant male wage rate and closing gender pay gap with constant female and male employment in H \((E_{t}^{HF} = E_{t}^{HF*}, E_{t}^{HM} = E_{t}^{HM*})\).
3.1 The effect of a change in the share of public social infrastructure investment on output and employment with constant wages

We start our analysis with the short-run impact of the share of public social infrastructure investment in GDP ($\kappa^H_t$) on output and employment for the case in which wages in H are constant and new employment in H is generated. Details of the short-run impact on output are shown in Appendix A2.1 and are summarised in Figure 1.

Figure 2: The medium-run impact of an increase in the share of public social infrastructure expenditure in GDP on total output

Notes: All variables without time represent the current period.
* The impact of total output on imports is positive and the impact of imports on total output is negative.
The increase in public social infrastructure investment has a direct positive effect on total output. Moreover, it generates female and male employment in H, which stimulates consumption in both social and other expenditure. However, higher social public expenditure may have a negative impact on private investment in the short-run due to increasing public debt/GDP due to the crowding out effect. However, this negative effect will be moderated as tax revenues also increase alongside the demand stimulated by public spending. An increase in public social expenditure/GDP also increases the denominator of the public debt/GDP ratio. Finally, if the effect of public social expenditures on aggregate output is positive, this leads to a positive effect on private investment.

Next, we discuss the medium-run effect of an increase in the share of public social infrastructure expenditure in GDP, which is summarised in Figure 2. The medium-run effects of higher public social expenditure work through its effects on labour productivity and public debt/GDP. An increase in social expenditure has a direct positive impact on labour productivity in the next period through its contributions on human capital as summarised in Figure 3 below. However, higher social expenditure is also expected to increase output in the short-run, which affects labour productivity positively due to the Verdoorn effects. Moreover, higher output in the short-run leads to an increase in the social expenditure of households, government's consumption expenditure, and public investments other than social investment, which are all expected to increase the labour productivity in the next period. Finally, we expect higher social expenditure to reduce the unpaid care work. However, the decline in unpaid care is unlikely to have a large negative impact that would reverse the positive effects of public social expenditure on labour productivity.

The effect of public social infrastructure expenditure on labour productivity also affects employment in N in the next period, which has further effects on consumption. Moreover, for constant wages in N, higher public social expenditure leads to an increase in the profit share, which affects private investments and net exports in the next period positively.

---

7 The medium-run effects of an increase in the share of public social expenditure in GDP on total output are shown in detail in Appendix A2.2
However, an increase in public social expenditure can lead to an increase in public debt which may have a negative effect on the private investments in the next period. However, as public social expenditure also affects the labour productivity in the next period, which in turn affects the denominator of the public debt/GDP ratio, and the overall effect on public debt/GDP may be eased or reversed in the next period.

A higher share of public social expenditure in GDP is expected to increase total employment in the short-run through an increase in output and its direct impact on employment in the social sector (Figure 4). In South Korea the female employment share is on average significantly larger in H than in N (own calculations based on data described in Section 4). Therefore higher public social expenditure is expected to reduce the gender employment gap. However, the effect of public social expenditure on female and male employment in the next period depends on the magnitude of its effect on output and labour productivity in the next period. If the effect on labour productivity is smaller than its possible positive effect on output in the next period, total employment increases in the next period.

---

8 The effects of an increase in the share of public social expenditure in GDP on employment are shown in detail in Appendix A2.1 and Appendix A2.2.
Figure 4: The summary of the impact of an increase in share of public social infrastructure expenditure as a share of GDP on total employment in the short-run and in the next period

3.2 The effects of closing the gender wage gap in H on output and employment

Public social expenditure can also increase through increasing female wages in H with a constant employment in H \((E_t^{HF} = E_t^{HF^*}, \ E_t^{HM} = E_t^{HM^*})\). As Figure 5 shows, the short-run effects of this policy on aggregate output are similar to the case where public social expenditure increases through generating employment in H. The main difference between two policies is that, in the case in which the average female wage rate in H increases, public social expenditure would only have a direct positive impact on female wage bill, whereas in the case where employment in H increases, public social expenditure has a direct positive impact on the wage bill of both female and male workers. Considering that the marginal propensity to consume in H and N are different for men and women, the magnitude of the short-run impact of these different policies on consumption in N and H and hence aggregate output will be different. Following Vogler and Pahl (1994), Lundeberg et al. (1997), Cappellini, Marilli and Parsons (2014), Onaran, Oyvat, and Fotopoulou (2019a), and Seguino and Floro (2013), we expect the short-run effect of rising female wages in H to be larger on consumption in H for the same amount of an increase in public social expenditure, since the marginal propensity to consume in H is larger for female workers. The medium-run impact of an increase

---

9 The short-run and medium-run impact of closing the gender wage gap in H on output and employment is discussed in detail in Appendix A3.1 and Appendix A3.2.
in the share of public social expenditure in GDP through closing the gender pay gap in H is similar to the case described in Figure 2. An increase in the female wage rate in H affects aggregate output in the next period through productivity and public debt. The impact of closing the gender pay gap in H on productivity would be slightly different, as its short-run effect on aggregate output is slightly different and its short-run effect on private social expenditure is slightly larger.

**Figure 5: The short-run effect of closing gender pay gap in H on total output**

4. **Empirical Analysis**

4.1 **Estimation methodology**

In this section, we estimate the impact of an increase in the total social infrastructure expenditure, wages and closing the gender pay gap on output and employment of men and women in South Korea using a vector autoregression (VAR) analysis.
VAR estimations regarding the effect of functional income distribution or wages on output has been applied by Onaran and Stockhammer (2005), Stockhammer and Onaran (2004), Barbosa-Filho and Taylor (2006), Kiefer and Rada (2015), Tavani et al. (2011) and Jump and Mendieta-Muñoz (2017). The advantage of this approach is that the interaction between the variables can be incorporated and it allows for tracing effects through an entire system rather than analysing one equation at a time. Also, it is more suitable to deal with endogeneity bias. However, using this approach requires a substantial simplification of the model since it cannot handle more than five endogenous variables (Onaran and Galanis, 2014; Onaran and Obst, 2016; Blecker, 2015).

For the purpose of the VAR analyses, we simplify our model and reduce the number of equations defined in Section 2. We use the total social expenditure (in real terms) rather than only the public social expenditure in line with data availability. Thus, we redefine $Y^H$ as the sum of both public social infrastructure and private household consumption in the social sector as $G^H + C^H$. For robustness control, we conduct our analysis using two alternative VAR specifications that include i) average hourly real female and male wage rate in the non-agricultural sector and ii) average hourly real wage rate along with the gender pay gap measured as the ratio of average hourly female wage to male wage rate. Moreover, we test the robustness of our results based on two alternative ways of ordering the variables in our VAR specifications based on the expectations of our theoretical model presented in Section 2.

The average female and male wages used in this analysis are hourly real wage rates. The other variables in the VAR specification are total value added (in real terms), and hours of employment of men and women. Our analysis focuses on the value added, wages and employment in the non-agricultural economy only, as a large part of the agricultural sector might be subsistence farming and highly dominated by self-employed and unpaid family workers. South Korea could be considered as a developing economy for most of the early years of our estimation period and experienced a significant structural transformation during this period (Oyvat, 2014). By focusing on the non-agricultural sector, we aim at reducing the biases due to transformation from the subsistence to capitalist sector, considering that extra hours worked (or reported) in the subsistence sector might not contribute to extra income for the female and male self-employed.
We first estimate our equations based on the following specification:

\[ AX_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + e_t \]  

(28)

which could be written in the reduced form as

\[ X_t = C_0 + C_1 X_{t-1} + C_2 X_{t-2} + u_t \]

(29)

where

\[
X_t = \begin{bmatrix}
\Delta \log(Y_t^H) \\
\Delta \log(E_t^F) \\
\Delta \log(E_t^M) \\
\Delta \log(w_t^F) \\
\Delta \log(w_t^M) \\
\Delta \log(Y_t)
\end{bmatrix}
\]

(30)

\[ X_t \] is a 6x1 vector of six variables consisting of the logarithmic change in the total social expenditure \((Y^H = G^H + C^H)\), female employment \((E^F)\), male employment \((E^M)\), average female wage rate \((w^F)\), average male wage rate \((w^M)\), real value added \((Y)\) (all in the non-agricultural sector) and \(e_t\) are structural shocks. From (28) and (29), we have \(Au_t = e_t\) which is expanded as:

\[
\begin{pmatrix}
1 & 0 & 0 & 0 & 0 & 0 \\
a_{21} & 1 & 0 & 0 & 0 & 0 \\
a_{31} & a_{32} & 1 & 0 & 0 & 0 \\
a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\
a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\
a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1
\end{pmatrix}
\begin{bmatrix}
u_1 \\
u_2 \\
u_3 \\
u_4 \\
u_5 \\
u_6
\end{bmatrix}
= 
\begin{bmatrix}
e_1 \\
e_2 \\
e_3 \\
e_4 \\
e_5 \\
e_6
\end{bmatrix}
\]

(31)

We use the logarithmic differences of our variables as the Augmented Dickey Fuller tests show that our variables are non-stationary and integrated of order one. We use two lags of our variables based on Final Prediction Error (FPE) criterion. The restrictions imply that the causal ordering in our model is \(\Delta \log(Y_t^H) \rightarrow \Delta \log(E_t^F) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(w_t^F) \rightarrow \Delta \log(w_t^M) \rightarrow \Delta \log(Y_t)\). The variables in this ordering have a contemporaneous effect on the variable(s) that are on their ‘right’. A causal effect from right to left only exists through the effects of the lags of the variables on the right rather than a contemporaneous effect. Hence, the total social expenditure \((Y^H)\) is the
most exogenous variable, since majority of the social expenditure are determined by public institutions as a policy decision in South Korea. Next, higher social expenditure generate employment in H for men and women\(^{10}\). Creation of employment in H changes the gender composition of hours of work, and consequently average female and male wages in the economy, as the average wages in N and H are different. Finally, the changes in social expenditure, employment and average wage rate of men and women affect non-agricultural value added.

Next, we estimate an alternative VAR specification, using the gender pay ratio and the average wage rate in which we define \(X_t\) vector as:

\[
X_t = \begin{bmatrix}
\Delta \log(Y^H_t) \\
\Delta \log(E^F_t) \\
\Delta \log(E^M_t) \\
\Delta \log(\omega^F_t) \\
\Delta \log(w_t) \\
\Delta \log(Y_t)
\end{bmatrix}
\]  

(32)

where \(\omega^F_t\) is the ratio of average female wages to average male wages \((\omega^F_t = \frac{1}{\alpha^F_t} = \frac{w^F_t}{w^M_t})\) and \(w_t\) is the average wage rate of men and women in the non-agricultural sector. The restrictions in our second specification imply that the causal ordering in our model is \(\Delta \log(Y^H_t) \to \Delta \log(E^F_t) \to \Delta \log(E^M_t) \to \Delta \log(\omega^F_t) \to \Delta \log(w_t) \to \Delta \log(Y_t)\). The changes in the female and male employment through employment generation in H also affect \(\omega^F_t\), as the ratio between female and male wages in H and N are different. Furthermore, beyond the simplification of exogenous gender norms and wage rates in the theoretical model, more employment in H can also transform gender norms and bargaining power of women and reduce gender pay gaps. The changing gender pay ratio \((\omega^F_t)\) in turn effects the average wage rate, and finally the changes in the social expenditure, employment of men and women, gender pay gap and average wage rate are likely to affect the non-agricultural value added.

Our theoretical analysis in Section 3.2 also examines the case of rising social expenditure through increasing the wage rate or reducing gender pay gap with increasing wage rate of women in H. Considering this case, we estimate a third VAR

---

\(^{10}\) The case that higher social expenditure increase wages in H will also be estimated in the following specifications below.
specification in which the causal ordering is \( \Delta \log(Y_t^H) \rightarrow \Delta \log(w_t^F) \rightarrow \Delta \log(w_t^M) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F) \) and the \( X_t \) vector is:

\[
X_t = \begin{bmatrix}
\Delta \log(Y_t^H) \\
\Delta \log(w_t^F) \\
\Delta \log(w_t^M) \\
\Delta \log(Y_t) \\
\Delta \log(E_t^M) \\
\Delta \log(E_t^F)
\end{bmatrix}
\]  

(33)

In this model, we consider that rising total social expenditure takes the form of increasing the wage rate of women and men in \( H \) and consequently the average wage rates of men and women in the economy increase. The increase in social expenditure and consumption of workers in \( H \) effect non-agricultural value added, which in turn affect female and male employment.

Finally, we estimate a fourth VAR specification that again examines the case of rising social expenditure through increases in the wage rates in \( H \) and follows the causal ordering \( \Delta \log(Y_t^H) \rightarrow \Delta \log(\omega_t^F) \rightarrow \Delta \log(w_t) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F) \)”. The \( X_t \) vector is:

\[
X_t = \begin{bmatrix}
\Delta \log(Y_t^H) \\
\Delta \log(\omega_t^F) \\
\Delta \log(w_t) \\
\Delta \log(Y_t) \\
\Delta \log(E_t^M) \\
\Delta \log(E_t^F)
\end{bmatrix}
\]  

(34)

In this case, the increase in the social expenditure takes the form of closing the gender pay gap in \( H \) (either with increasing the female wage rate with a constant male wage rate or an upward convergence with a higher rate of increase in the female wage rate than the male wage rate), which then leads to an increase in the average wage rate. Finally, an increase in the social expenditure affects aggregate non-agricultural value added, which then affects male and female employment.
4.2 Data

We use data from the World Klems (2014) database for South Korea which is available for the period of 1970-2012. The total non-agricultural output ($Y$) is the total real value added (in millions of Korean Won) in all sectors excluding agriculture, forestry and fishing. The total social output ($Y^H$) is the sum of real value added (in millions of Korean Won) in education, health and social work sectors, and corresponds to both public expenditure and private household consumption in H.

The female and male employment are defined as total number of hours worked by women and men engaged in the non-agricultural sector (all sectors excluding agriculture, forestry and fishing). Average female wage rate ($w^F$), average male wage rate ($w^M$) and average wage rate ($w$) are average hourly real wage rate in the non-agricultural sector calculated using the total non-agricultural labour compensation (in millions of Korean Won, deflated by the price index) and hours of employment for female and male workers in World Klems database. Both labour compensation and hours of employment data is adjusted by the Klems database to account for the labour income and hours of work of the self-employed women and men in the non-agricultural sector.

4.3 Estimation results

We first estimate the impact of social infrastructure expenditure, and female and male wage rates using our first VAR specification following the causal order $\Delta \log(Y^H_t) \rightarrow \Delta \log(E^F_t) \rightarrow \Delta \log(E^M_t) \rightarrow \Delta \log(w^F_t) \rightarrow \Delta \log(w^M_t) \rightarrow \Delta \log(Y_t)$. Figure 6 shows the cumulative impact of a one standard deviation increase in social infrastructure expenditure, and female and male wage rates on output and employment of men and women over a period of 10 years. A one standard deviation increase in the social expenditure significantly increases the aggregate output in non-agricultural sector in South Korea in the short-run. The cumulative positive effect of social expenditure on aggregate output increases over the 10 years. The contemporaneous short-run impact of a standard deviation increase in the social expenditure on female employment is positive and significant; however, the effect on male employment is insignificant albeit positive. However, due to the positive effect of the increased social expenditure on
labour productivity, the impact of social expenditure on female employment becomes insignificant for years 1 to 5. Nevertheless, the cumulative impact on both female and male employment is significantly positive starting from year 6 onwards due to the strong and long lasting effect on aggregate output.

Figure 6: Cumulative orthogonalized impulse response functions (IRF)  
(Specification 1: $\Delta \log(Y_t^F) \rightarrow \Delta \log(E_t^F) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(w_t^F) \rightarrow \Delta \log(w_t^M) \rightarrow \Delta \log(Y_t)$)

Note: Estimation period: 1970-2012

The results also show that both higher average male and female wages increase aggregate output in the short-run contemporaneously and in the next year, which shows
that the South Korean economy is *wage-led in the short-run*\(^\text{11}\). This is consistent with previous empirical estimations on the effect of functional income distribution on output in South Korea (Onaran and Stockhammer, 2005; Onaran and Galanis, 2014; Oyvat et al., 2018). However, the cumulative impact of an increase in both male and female wage rates on aggregate output is insignificant starting from the second year.

Based on Figure 6, Figures 7-8 show the impact of a 1% increase in social expenditure \((Y^H)\) on aggregate non-agricultural output \((Y)\) and employment \((E)\) in South Korea respectively. A 1% increase in the social expenditure increases aggregate output in non-agricultural sector by 0.5% contemporaneously, and in total by 1.4% over five years and 2.4% over ten years. A 1% increase in social expenditure increase female and male employment contemporaneously by 0.7% and 0.2% respectively. The short-run impact is larger for female employment as the share of women is significantly greater in the social sector compared to the rest of the non-agricultural sector. A 1% increase in social expenditure increases female and male employment over the ten years by 1.2% and 2.3% respectively.

**Figure 7: The cumulative impact of a 1% increase in social expenditure \((Y^H)\) on aggregate non-agricultural output \((Y)\) in South Korea**

\[
\begin{align*}
\text{% change in } Y \\
\text{(Models 1 \\ & 3)} \\
\text{% change in } Y \\
\text{(Models 2 \\ & 4)}
\end{align*}
\]

Note: Calculated based on the IRFs reported in Figure 6, 9, 10, 11.

\(^{11}\) According to Onaran, Oyvat and Fotopoulou (2019a), in economic regimes, which are wage-led (profit-led) in the short-run, a simultaneous increase in female and male wage rates with a constant gender wage gap also increases (decreases) the aggregate output in the short-run. Moreover, Onaran, Oyvat and Fotopoulou (2019a) defines the economic regimes in which the cumulative effect of a simultaneous increase in female and male wage rates with a constant gender wage gap on output is positive (negative), as wage-led (profit-led) in the medium-run.
Next, Figure 9 shows the cumulative orthogonalized impulse response functions (IRF) for our second VAR specification, which includes average wage rate and gender pay ratio and follows the causal ordering $\Delta \log(Y^H_t) \rightarrow \Delta \log(\omega^F_t) \rightarrow \Delta \log(w_r) \rightarrow \Delta \log(Y_r) \rightarrow \Delta \log(E^M_t) \rightarrow \Delta \log(E^F_t)$. As shown in Figures 7-8, the impact of an increase in social expenditure on aggregate output, female and male employment are very similar. A 1% increase in social expenditure increases the aggregate output in the same period by 0.5%, and in total by 1.3% in five years and by 2.3% in ten years. In this specification female and male employment increases by 0.8% and 0.3% respectively in the same period, and over 10 years by 1.2% and 2.3% respectively.

Figure 8: The cumulative impact of 1% increase in social expenditure $(Y^H)$ on female employment $(E^F)$ and male employment $(E^M)$ in South Korea

![Graph showing the cumulative impact of 1% increase in social expenditure on female and male employment in South Korea](image)

Note: Calculated based on the IRFs reported in Figure 6, 9, 10, 11.

Figure 9 also shows that a one standard deviation increase in average wages has a significant positive effect on aggregate output contemporaneously as well as the next year. Based on the results in Figure 9, we calculate that a 1% increase in average wages leads to 0.3% increase in aggregate output contemporaneously. Therefore, consistent with the results in specification 1 in Figure 6, we can conclude that South Korean economy is wage-led in the short-run. However, the positive impact becomes again
insignificant starting from year 2. This is possibly because rising average wages are followed by the implementation of labour saving technologies, which increase productivity and the profit share but reduce employment in the medium-run. A decrease in gender pay gap, i.e. an increase in average female wage to average male wage ratio also has a significant positive impact on aggregate output contemporaneously; however, the positive impact becomes insignificant starting from the year 1.

Figure 9: - Cumulative orthogonalized impulse response functions (IRF) (Specification 2: $\Delta \log(Y_t^H) \rightarrow \Delta \log(\omega_t^F) \rightarrow \Delta \log(w_t) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F)$)

Note: Estimation period: 1970-2012
Figure 10: Cumulative orthogonalized impulse response functions (IRF) (Specification 3: $\Delta \log(Y_t^H) \rightarrow \Delta \log(w_t^F) \rightarrow \Delta \log(w_t^M) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F)$)

Note: Estimation period: 1970-2012

The short-run positive impact of gender equality on aggregate output is economically small: a 1% increase in the ratio of female wage to male wage rate increases aggregate output in the same period only by 0.04%. Hence, following the terminology developed in Onaran, Oyvat and Fotopoulou (2019a), we can conclude that the South Korean economy is female wage-led/gender equality-led in the short-run
although the effect is small\textsuperscript{12}. Hence overall the economy is equality-led, although the effects of both average wages and gender pay gap are economically small in comparison to the strong effects of increases social spending, and become insignificant in the medium-run. The results indicate that sustainable equitable development and a substantial increase in employment requires a mix of both labour market and fiscal policies.

**Figure 11:** - Cumulative orthogonalized impulse response functions (IRF)  
(Specification 4: $\Delta \log(Y_{t}^{H}) \rightarrow \Delta \log(\omega_{t}^{F}) \rightarrow \Delta \log(w_{t}) \rightarrow \Delta \log(Y_{t}) \rightarrow \Delta \log(E_{t}^{M}) \rightarrow \Delta \log(E_{t}^{F})$)

\textsuperscript{12} Onaran, Oyvat and Fotopoulou (2019a) define the economies where an increase (decrease) in the female wage rate (with a constant male wage rate) leads to an increase (decrease) in aggregate output as \textit{female wage-led/gender equality-led} (\textit{gender inequality-led}).
Next, Figure 10 shows the cumulative orthogonalized impulse response functions for the third VAR specification that follows the causal ordering $\Delta \log(Y_t^H) \rightarrow \Delta \log(w_t^F) \rightarrow \Delta \log(w_t^M) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F)$. The impact of social expenditure on aggregate output, female and male employment is the same as in Specification 1. The magnitude of the contemporaneous impact of female wage rate on aggregate output is slightly lower compared to Specification 1.

Finally, Figure 11 exhibits the cumulative orthogonalized impulse response functions for the fourth VAR estimation that includes average wages and gender pay ratio and follows the causal ordering $\Delta \log(Y_t^H) \rightarrow \Delta \log(\omega_t^F) \rightarrow \Delta \log(w_t) \rightarrow \Delta \log(Y_t) \rightarrow \Delta \log(E_t^M) \rightarrow \Delta \log(E_t^F)$. The impact of social expenditure on aggregate output, female and male employment is the same as in Specification 2. The response of output to an increase in the wage rate again shows that the South Korean economy is wage-led in the short-run consistent with the previous estimates. However, the impact of an increase in gender equality is insignificant in this specification in the short-run as well as the medium-run.

We also estimated structural VAR specifications with alternative restrictions and the results are very robust.

5. Conclusion

In this paper, we examine the impact of an increase in social infrastructure expenditure, wages and gender equality on output and employment of men and women in South Korea using a post-Kaleckian feminist model, which we estimate using VAR for the period of 1970-2012. We find that higher social infrastructure expenditure has a positive cumulative effect on aggregate output as well as female and male employment (hours of work) in the non-agricultural sector in South Korea both in the short-run and medium-run.

In South Korea the positive effects of higher public spending in education, childcare, health and social care due to higher demand and productivity appear to offset any potentially negative impact due to possibly higher borrowing. Moreover, the results also show that the short-run and medium-run effect of higher social expenditure on total non-agricultural output is larger than the effect on non-agricultural employment, which
indicates that higher social expenditure leads to significant productivity gains in South Korea.

Finally, our results show that an equitable development path in which both average wages increase and gender gaps close via an upward convergence in the wages of men and women is possible in South Korea. The results show that South Korean economy is wage-led and female-led/gender equality-led in the short-run and higher female and male wages do not have significant long-run negative effects on aggregate output in South Korea. Hence overall the economy is equality-led, although the effects are economically small in comparison to the strong effects of increases social spending, and become insignificant in the medium-run. The results indicate that sustainable equitable development and a substantial increase in employment requires a mix of both labour market and fiscal policies.
References


World Klems (2014). World Klems data: Korea, Available at: http://www.worldklems.net/data.htm
### Appendix A1: Definitions of variables

<table>
<thead>
<tr>
<th>VARIABLE SYMBOL</th>
<th>VARIABLE NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Aggregate output / GDP</td>
</tr>
<tr>
<td>WB</td>
<td>Total wage bill</td>
</tr>
<tr>
<td>WB^F</td>
<td>Total wage bill for female workers</td>
</tr>
<tr>
<td>WB^M</td>
<td>Total wage bill for male workers</td>
</tr>
<tr>
<td>E^H</td>
<td>Total employment in the public social sector</td>
</tr>
<tr>
<td>E^N</td>
<td>Total employment in the rest of the economy</td>
</tr>
<tr>
<td>E^HF</td>
<td>Employment of women in the public social sector</td>
</tr>
<tr>
<td>E^HM</td>
<td>Employment of men in the public social sector</td>
</tr>
<tr>
<td>E^NF</td>
<td>Employment of women in the rest of the economy</td>
</tr>
<tr>
<td>E^NM</td>
<td>Employment of men in the rest of the economy</td>
</tr>
<tr>
<td>w^HF</td>
<td>Average female wage in the public social sector</td>
</tr>
<tr>
<td>w^HM</td>
<td>Average male wage in the social sector</td>
</tr>
<tr>
<td>w^NF</td>
<td>Average female wage in the rest of the economy</td>
</tr>
<tr>
<td>w^NM</td>
<td>Average male wage in the rest of the economy</td>
</tr>
<tr>
<td>w^F</td>
<td>Average female wage in the whole economy</td>
</tr>
<tr>
<td>w^M</td>
<td>Average male wage in the whole economy</td>
</tr>
<tr>
<td>α^H</td>
<td>Ratio between male and female wages in the public social sector</td>
</tr>
<tr>
<td>α^N</td>
<td>Ratio between male and female wages in the rest of the economy</td>
</tr>
<tr>
<td>α</td>
<td>Ratio between male and female wages in the whole economy</td>
</tr>
<tr>
<td>C^H</td>
<td>Households’ private social expenditures</td>
</tr>
<tr>
<td>C^N</td>
<td>Private consumption of goods and services in the rest of the economy</td>
</tr>
<tr>
<td>I</td>
<td>Private investment</td>
</tr>
<tr>
<td>G^C</td>
<td>Government’s consumption expenditures</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$I^G$</td>
<td>Public investments other than investments in the social sector</td>
</tr>
<tr>
<td>$G^H$</td>
<td>Government’s social infrastructure expenditures</td>
</tr>
<tr>
<td>$M$</td>
<td>Imports</td>
</tr>
<tr>
<td>$X$</td>
<td>Exports</td>
</tr>
<tr>
<td>$Y^H$</td>
<td>Total expenditure in the social sector</td>
</tr>
<tr>
<td>$Y^N$</td>
<td>Total expenditure in the rest of the economy</td>
</tr>
<tr>
<td>$\kappa^H$</td>
<td>Share of government spending on the social sector in total output</td>
</tr>
<tr>
<td>$\kappa^C$</td>
<td>Share of government’s consumption expenditures in total output</td>
</tr>
<tr>
<td>$\kappa^G$</td>
<td>Share of government spending on public investment in fixed capital in total output</td>
</tr>
<tr>
<td>$T^N$</td>
<td>Productivity in the rest of the economy</td>
</tr>
<tr>
<td>$\beta^N$</td>
<td>Share of women employed in the rest of the economy</td>
</tr>
<tr>
<td>$\beta^H$</td>
<td>Share of women employed in the public social sector</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Share of women employed in the whole economy</td>
</tr>
<tr>
<td>$U$</td>
<td>Unpaid domestic care labour</td>
</tr>
<tr>
<td>$R$</td>
<td>Gross operating surplus</td>
</tr>
<tr>
<td>$\pi$</td>
<td>Profit share in the rest of the economy</td>
</tr>
<tr>
<td>$t^W$</td>
<td>Implicit tax rate on labour</td>
</tr>
<tr>
<td>$t^R$</td>
<td>Implicit tax rate on capital</td>
</tr>
<tr>
<td>$D$</td>
<td>General government consolidated debt</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>Real exchange rate</td>
</tr>
<tr>
<td>$Y_{World}$</td>
<td>Rest of the world income</td>
</tr>
<tr>
<td>$Y^H$</td>
<td>Total social expenditures</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$\omega^F$</td>
<td>Ratio between female and male wages</td>
</tr>
<tr>
<td>$\psi^k_{tt}$</td>
<td>Short-run impact of rising share of social expenditures in GDP on total output</td>
</tr>
<tr>
<td>$d^k_{tt}$</td>
<td>Partial effect of rising share of social expenditures in GDP on public debt/GDP in the short-run</td>
</tr>
<tr>
<td>$\psi^k_{t(t-1)}$</td>
<td>Impact of rising share of social expenditures in GDP on total output in the next period</td>
</tr>
<tr>
<td>$d^k_{t(t-1)}$</td>
<td>Partial effect increase rising share of social expenditures on public debt/GDP in the next period</td>
</tr>
<tr>
<td>$\psi^H_{tt}$</td>
<td>Short-run impact of increase in female wages (decline in gender wage gap) in the H sector on total output</td>
</tr>
<tr>
<td>$d^H_{tt}$</td>
<td>Partial effect of increase in female wages (decline in gender wage gap) in the H sector on public debt/GDP in the short-run</td>
</tr>
<tr>
<td>$\psi^H_{t(t-1)}$</td>
<td>Impact of increase in female wages (decline in gender wage gap) in the H sector in the next period</td>
</tr>
<tr>
<td>$d^H_{t(t-1)}$</td>
<td>Partial effect increase in female wages (decline in gender wage gap) in the H sector on public debt/GDP in the next period</td>
</tr>
</tbody>
</table>
Appendix A2. The impact of the rising public social expenditures (with constant H sector wages and increasing employment in H) on output and employment

A2.1 The short-run effect of a change in public social infrastructure investment/GDP on aggregate output and employment

We start our analysis with the short-run impact of the share of public social infrastructure investment \((\kappa_t^H)\) in GDP on output. The short-run overall impact on GDP \((\Psi_{tt}^k)\) is:

\[
\Psi_{tt}^k = \frac{dY_t}{d\kappa_t^H} = \frac{dY_t}{dY_t^N} \frac{dY_t^N}{d\kappa_t^H} + \left| \frac{dY_t}{d\kappa_t^H} \right|_{\kappa_t^H} ^N
\]

\[
= \left( \frac{\frac{\partial C_t^N}{\partial \kappa_t^H} \big|_{\kappa_t^H} + \frac{\partial C_t^H}{\partial \kappa_t^H} \big|_{\kappa_t^H}}{1 - \varphi_k} \right)
\]

\[
\Psi_{tt}^k \times \frac{1}{(1 - \kappa_t^H)} + Y_t
\]

(A2.1)

where

\[
\varphi_k = \left| \frac{\partial C_t^N}{\partial Y_t^N} \right|_{\kappa_t^H} + \left| \frac{\partial C_t^H}{\partial Y_t^N} \right|_{\kappa_t^H} + \left| \frac{\partial I_t}{\partial Y_t^N} \right|_{\kappa_t^H} - \left| \frac{\partial M_t}{\partial Y_t^N} \right|_{\kappa_t^H} + \left| \frac{\partial C_t^H}{\partial Y_t^N} \right|_{\kappa_t^H}
\]

\[
+ \left| \frac{\partial G_t^S}{\partial Y_t^N} \right|_{\kappa_t^H} + \left| \frac{\partial G_t^C}{\partial Y_t^N} \right|_{\kappa_t^H}
\]

(A2.2)

The term \(\frac{1}{(1-\varphi_k)}\) is the income multiplier for the total output in the N sector and is further examined in Appendix 4.

The short-run partial impact of public social expenditures \((\kappa_t^H)\) on consumption in N is given below for a given level of output in N sector \((Y_t^N = Y_t^{N^*})\).

\[
\left| \frac{\partial C_t^N}{\partial \kappa_t^H} \right|_{Y_t^N} = C_t^N \left( c_{HF}^H \frac{e_t^H}{W_t^H} + c_{HM}^H \frac{e_t^H}{W_t^H} \right) > 0
\]

(A2.3)

where the short-run partial effect of the public social expenditures on female and male employment are.
\[ e_{kt}^{HF} = \left| \frac{\partial E_t^{HF}}{\partial \kappa_t^H} \right|_{Y_t^N} = \frac{\beta_t^H \gamma_t^N}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \frac{1}{(1 - \kappa_t^H)^2} > 0 \] (A2.4)

\[ e_{kt}^{HM} = \left| \frac{\partial E_t^{HM}}{\partial \kappa_t^H} \right|_{Y_t^N} = \frac{(1 - \beta_t^H) \gamma_t^N}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \frac{1}{(1 - \kappa_t^H)^2} > 0 \] (A2.5)

\[ e_{kt}^{N_F} = 0 \] (A2.6)

\[ e_{kt}^{N_M} = 0 \] (A2.7)

The short-run partial impact of public social expenditure \((\kappa_t^H)\) on consumption in \(H\) is

\[ \left| \frac{\partial C_t^H}{\partial \kappa_t^H} \right|_{Y_t^N} = C_t^H \left( z_n \frac{1}{(1 - \kappa_t^H)^2} \right) \] (A2.8)

\[ \left| \frac{\partial I_t}{\partial \kappa_t^H} \right|_{Y_t^N} = I_t \left( i_1 \frac{1}{1 - \kappa_t^H} + i_2 \frac{\left| \frac{\partial \pi_t}{\partial \kappa_t^H} \right|_{Y_t^N}}{\pi_t} + i_3 \frac{\left| \frac{d_t^k}{D_t} \right|}{(Y_t)_{\gamma_t}^2} \right) \] (A2.9)

where

\[ \left| \frac{\partial \pi_t}{\partial \kappa_t^H} \right|_{Y_t^N} = 0 \] (A2.10)

The impact through higher public debt is shown by \(d_t^k\) and is

\[ d_t^k = \left| \frac{\partial (D/Y)_t}{\partial \kappa_t^H} \right|_{Y_t^N} = \frac{\left| \frac{\partial D_t}{\partial \kappa_t^H} \right|_{Y_t^N}}{Y_t^2} - \left| \frac{\partial (Y_t^N/(1 - \kappa_t^H))}{\partial \kappa_t^H} \right|_{Y_t^N} D_t \] (A2.11)

\[ d_t^k = \left| \frac{\partial (D/Y)_t}{\partial \kappa_t^H} \right|_{Y_t^N} = \frac{(1 + \kappa_t^F + \kappa_t^D)}{(1 - \kappa_t^H)^2} - \frac{t_t^w \omega_t^{HF}(\alpha_t^H e_{kt}^{HF} + e_{kt}^{HF})}{Y_t} - \frac{D_t}{Y_t^N} \] (A2.11')
The short-run partial impact of public social expenditures on exports and imports is zero for a constant output in N, because its partial impact on the profit share is zero in the short-run.

\[
\frac{\partial X_t}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} = X_t \left( x_2 \frac{\partial \pi_t}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} \right) = 0 \quad (A2.12)
\]

\[
\frac{\partial M_t}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} = M_t \left( n_2 \frac{\partial \pi_t}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} \right) = 0 \quad (A2.13)
\]

A rising share of public social expenditures has a positive effect on all types of public investment is positive as shown in equations (A2.14)-(A2.16).

\[
\frac{\partial G_t^H}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} = \frac{Y_t^N}{(1 - \kappa_t^H)^2} > 0 \quad (A2.14)
\]

\[
\frac{\partial G_t^C}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} = \frac{\kappa_t^C Y_t^N}{(1 - \kappa_t^H)^2} > 0 \quad (A2.15)
\]

\[
\frac{\partial I_t^C}{\partial \kappa_t^H} \bigg|_{\gamma_t^N} = \frac{\kappa_t^C Y_t^N}{(1 - \kappa_t^H)^2} > 0 \quad (A2.16)
\]

A higher share of public social expenditure in GDP affects total female employment through rising aggregate output and its direct impact on creating employment in social sector:

\[
\frac{dE_t^F}{d\kappa_t^H} = \left( \beta_t^N \frac{1 - \kappa_t^H}{T_t^N} + \beta_t^H \frac{\kappa_t^H}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \psi_t^k \right) + \frac{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)(1 - \kappa_t^H)^2}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)(1 - \kappa_t^H)^2}
\]

(A2.17)
Similarly, a higher share of social expenditures increases total male employment through aggregate output and its direct impact on creating employment in the social sector:

\[
\frac{dE_t^M}{d\kappa_t^H} = \left(1 - \beta_t^N\right)\frac{(1 - \kappa_t^H)}{T_t^N} + \left(1 - \beta_t^H\right)\frac{\kappa_t^H}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \Psi_t^k_t + \frac{(1 - \beta_t^H)Y_t^N}{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)(1 - \kappa_t^H)^2}
\]

\[(A2.18)\]

**A2.2 The effect of a change in the share of public social infrastructure investment on GDP and employment in the next period**

The effect of a rising share of social expenditures in GDP on aggregate output in the next period is:

\[
\Psi_t^k(t-1) = \frac{dY_t}{d\kappa_{t-1}^H} = \frac{dY_t^N}{d\kappa_{t-1}^H}
\]

\[
\frac{\partial C_t^N}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N} + \frac{\partial C_t^H}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N} + \frac{\partial T_t}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N} + \frac{\partial X_t}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N} - \frac{\partial M_t}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N}
\]

\[
= \Psi_t^k(t-1) \left(1 - \varphi_t \right) \left(1 - \kappa_t^H \right)
\]

\[
(A2.19)
\]

To derive the partial effect of \(\kappa_{t-1}^H\) on each component of GDP, we first exhibit its influence on labour productivity as the public social investments affect the profit share and employment in the next period through labour productivity.

\[
\frac{\partial T_t^N}{\partial \kappa_{t-1}^H} \bigg|_{Y_t^N} = T_t^N \left( \frac{h_1 + h_7 z_G + h_8 q_G}{\kappa_{t-1}^H} + \frac{h_1 + h_2 + h_3 + h_4}{Y_{t-1}} \Psi_t^k + \frac{h_7 (z_G + z_R + z_M) h_7 + (q_G + q_Z + q_M) h_8}{1 - \kappa_{t-1}^H} \right)
\]

\[
(A2.20)
\]

Next, we demonstrate the partial long-run impact of public social investment on each component of aggregate output. First, higher public social investment changes total wage bills and profits through employment, which in turn affect \(C_t^N\) and \(C_t^H\):

**43**
\[
\frac{\partial C_t^N}{\partial \kappa_{t-1}^H} = C_t^N \left( \frac{e_k^{NF}(t-1)w_t^{NF}}{WB_t^{NF}} + \frac{c_R^{NM} \left( e_k^{NM}(t-1)w_t^{NF} \right)}{R_t} \right) - c_R \left( \frac{e_k^{NM}(t-1)\alpha_t^{N} + e_k^{NF}(t-1)w_t^{NF}}{R_t} \right) \tag{A2.21}
\]

\[
\frac{\partial C_t^H}{\partial \kappa_{t-1}^H} = C_t^H \left( \frac{z_F^{NF} \left( e_k^{NF}(t-1)w_t^{NF} \right)}{WB_t^{NF}} + \frac{z_M^{NM} \left( e_k^{NM}(t-1)w_t^{NF} \right)}{WB_t^{NM}} \right) - z_R \left( \frac{e_k^{NM}(t-1)\alpha_t^{N} + e_k^{NF}(t-1)w_t^{NF}}{R_t} \right) \tag{A2.22}
\]

\[e_{k(t-1)}^{NF} \text{ and } e_{k(t-1)}^{NM} \text{ are respectively the partial effect of the share of public social expenditures in GDP on female and male employment in N sector in the next period.}\]

\[e_{k(t-1)}^{NF} = \frac{\partial E_t^{NF}}{\partial \kappa_{t-1}^H} = -\frac{\beta_t^{NF}y_t^N}{\left( \tau_t^N \right)^2} \left( \frac{\partial T_t^N}{\partial \kappa_{t-1}^H} \right) \tag{A2.23}\]

\[e_{k(t-1)}^{NM} = \frac{\partial E_t^{NM}}{\partial \kappa_{t-1}^H} = -\frac{(1 - \beta_t^{NM})y_t^N}{\left( \tau_t^N \right)^2} \left( \frac{\partial T_t^N}{\partial \kappa_{t-1}^H} \right) \tag{A2.24}\]

The share of public social expenditures affects private investment through the effects on the profit share and public debt/GDP in the long-run:

\[
\frac{\partial I_t}{\partial \kappa_{t-1}^H} = I_t \left( i_2 \frac{\partial \pi_t}{\partial \kappa_{t-1}^H} \frac{1}{\pi_t} + i_3 \frac{d_t^{k(t-1)}}{\left( \frac{D}{\bar{Y}} \right)_t} \right) \tag{A2.25}\]

\[d_t^{k(t-1)} \text{ is the partial effect of rising public social expenditures on public debt/GDP.}\]
\[
\begin{aligned}
d^k_{t(t-1)} &= \frac{\partial (D/Y)_t}{\partial \kappa^H_{t-1} |_{Y^N_t}} = \frac{\partial D_t}{\partial \kappa^H_{t-1} |_{Y^N_t}} \frac{1 - \kappa^H_t}{Y^N_t} \\
&= \left( \frac{\partial D_t}{\partial \kappa^H_{t-1}} (1 + \kappa^C_{t-1}) - t^W_t (e^{N_M}_{k(t-1)} \alpha^N_t + e^{NF}_{k(t-1)}) w^{NF}_t \right) \\
&\quad + t^R_t (e^{N_M}_{k(t-1)} \alpha^N_t + e^{NF}_{k(t-1)}) w^{NF}_t \frac{1 - \kappa^H_t}{Y^N_t} \\
&\quad + t^W_t (e^{N_M}_{k(t-1)} \alpha^N_t + e^{NF}_{k(t-1)}) w^{NF}_t \left( \frac{1 - \kappa^H_t}{Y^N_t} \right)
\end{aligned}
\]

where

\[
\begin{aligned}
e^{HF}_{k(t-1)(t-1)} &= \left( \frac{\partial E^{HF}_{t-1}}{\partial \kappa^H_{t-1} |_{Y^N_t}} \right) = \frac{\partial E^{HF}_{t-1}}{\partial \kappa^H_{t-1} |_{Y^N_t}} \frac{\beta^H_{t-1} Y^N_t}{w^{HF}_t (\beta^H_{t-1} + \alpha^H_{t-1} - \beta^H_{t-1} \alpha^H_{t-1})} \frac{1}{(1 - \kappa^H_{t-1})^2} > 0 \\
e^{HM}_{k(t-1)(t-1)} &= \left( \frac{\partial E^{HF}_{t-1}}{\partial \kappa^H_{t-1} |_{Y^N_t}} \right) = \frac{\partial E^{HF}_{t-1}}{\partial \kappa^H_{t-1} |_{Y^N_t}} \frac{(1 - \beta^H_{t-1}) Y^N_t}{w^{HF}_t (\beta^H_{t-1} + \alpha^H_{t-1} - \beta^H_{t-1} \alpha^H_{t-1})} \frac{1}{(1 - \kappa^H_{t-1})^2} > 0
\end{aligned}
\]

Higher public social expenditures affect the profit share in the next period through labour productivity:

\[
\begin{aligned}
\frac{\partial \pi_t}{\partial \kappa^H_{t-1} |_{Y^N_t}} &= \left( \frac{\beta^N_t \beta^N_t + \beta^N_t w^{NF}_t}{(T^N_t)^2} \right) \frac{\partial T^N_t}{\partial \kappa^H_{t-1} |_{Y^N_t}}
\end{aligned}
\]

The share of public social expenditures in aggregate output affects exports and imports through the changes in the profit share, which is in turn affected through labour productivity:

\[
\begin{aligned}
\frac{\partial X_t}{\partial \kappa^H_{t-1} |_{Y^N_t}} &= X_t \left( \frac{\partial \pi_t}{\partial \kappa^H_{t-1} |_{Y^N_t}} \right)
\end{aligned}
\]
\[
\left| \frac{\partial M_t}{\partial \kappa_{t-1}^H} \right| = M_t \left( n_2 \frac{\partial \pi_t}{\partial \kappa_{t-1}^H} \right)_{Y_t^N} \quad (A2.32)
\]

Finally, the impact of a higher share of social expenditures on the female and male employment in the next period are:

\[
\frac{dE_t^F}{d\kappa_{t-1}^H} = \frac{dE_t^{NF}}{d\kappa_{t-1}^H} + \frac{dE_t^{HF}}{d\kappa_{t-1}^H} = \left| \frac{\partial E_t^{NF}}{\partial Y_t} \right| \frac{dY_t}{d\kappa_{t-1}^H} + \left| \frac{\partial E_t^{HF}}{\partial Y_t} \right| \frac{dY_t}{d\kappa_{t-1}^H} + \frac{\partial E_t^{HF}}{\partial Y_t} \frac{dY_t}{d\kappa_{t-1}^H} \quad (A2.33)
\]

\[
\frac{dE_t^M}{d\kappa_{t-1}^H} = \frac{dE_t^{NM}}{d\kappa_{t-1}^H} + \frac{dE_t^{HM}}{d\kappa_{t-1}^H} = \left| \frac{\partial E_t^{NM}}{\partial Y_t} \right| \frac{dY_t}{d\kappa_{t-1}^H} + \left| \frac{\partial E_t^{HM}}{\partial Y_t} \right| \frac{dY_t}{d\kappa_{t-1}^H} + \frac{\partial E_t^{HM}}{\partial Y_t} \frac{dY_t}{d\kappa_{t-1}^H} \quad (A2.35)
\]

\[
\frac{dE_t^M}{d\kappa_{t-1}^H} = e_{k(t-1)}^{NM} + \left( \frac{1 - \beta_t^N}{T_t^N} \right) \left( 1 - \kappa_t^H \right) \frac{1}{T_t^N} + \frac{w_t^{HF}(\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)}{T_t^N} \Psi_t^{k(t-1)} \quad (A2.36)
\]
Appendix A3. The impact of closing the gender wage gap in the H sector on output and employment

A3.1 The short-run effect of a change in closing the gender wage gap in the H sector on aggregate output and employment

In this appendix, we examine the case where the gender wage ratio in H is a function of female wages in H ($\alpha_t^H = f(w_t^{HF})$) and the female and male employment in H sector is constant for constant aggregate output in N sector. The impact of rising female wage in H on gender wage gap in H is

$$\frac{d\alpha_t^H}{dw_t^{HF}} = -\frac{\alpha_t^H}{w_t^{HF}}$$  \hspace{1cm} (A3.1)

Moreover, we can show that rising female wage in H has the following partial positive impact on the share of public social expenditures in output ($\kappa_t^H$):

$$\left| \frac{\partial \kappa_t^H}{\partial w_t^{HF}} \right| w_t^{HM}, Y_t^N, E_t^H \leq \left(1 - \kappa_t^H\right)^2 E_t^H \beta_t^H Y_t^N > 0$$  \hspace{1cm} (A3.2)

Since we examine the case where closing gender wage gap in the social sector do not affect the employment in H sector in the short-run, we can define the following equations:

$$e_t^{HF} = \left| \frac{\partial E_t^{HF}}{\partial w_t^{HF}} \right|_{Y_t^N} = 0, \quad e_t^{HM} = \left| \frac{\partial E_t^{HM}}{\partial w_t^{HF}} \right|_{Y_t^N} = 0$$  \hspace{1cm} (A3.3)

Moreover, the partial effect of closing gender wage gap in H on N is

$$e_t^{NF} = \left| \frac{\partial E_t^{NF}}{\partial w_t^{HF}} \right|_{Y_t^N} = 0, \quad e_t^{NM} = \left| \frac{\partial E_t^{NM}}{\partial w_t^{HF}} \right|_{Y_t^N} = 0$$  \hspace{1cm} (A3.4)

Using the partial effects of closing gender wage gap in H, we can write the short-run impact of closing gender wage gap in H as
The partial effect of closing gender wage gap on exports and imports are zero, since the public social expenditures also does not increase in the share of public social expenditures in total output (\(\kappa^H\)) as

\[
\frac{\partial C^N}{\partial w_t^H} = \frac{\partial C^N}{\partial Y_t} \left(1 - \varphi_t\right) + \frac{\partial C^N}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. + \frac{\partial I_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. + \frac{\partial X_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. \nonumber \\
= \left(1 - \varphi_t\right) + \frac{\partial C^N}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. + \frac{\partial I_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. + \frac{\partial X_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. \ (A3.5)
\]

\[
+ Y_t \left( \frac{\partial \kappa^H}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. \right) \times \left(1 - \kappa^H\right) \nonumber
\]

The rising female wages in H would increase the consumption in N, since the income of female workers in H rises:

\[
\frac{\partial C^N}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. = c_{HF} C^N_t \left( \frac{E_t^{HF}}{W_t^{HF}} \right) > 0 \quad (A3.6)
\]

Moreover, closing gender wage gap in H would affect the social expenditures of households through increasing the public expenditures in H sector.

\[
\frac{\partial C^H}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. = c_{HF} C_t^H \left( \frac{z_G}{G_t^{HF}} \right) \left( \frac{\partial G_t^{HF}}{\partial w_t^H} \right) \left|_{Y_t^N, w_t^H, e_t^H} \right. = c_{HF} \left( \frac{z_G}{G_t^{HF}} \right) \left( \frac{\partial \kappa_t}{\partial w_t^H} \right) \left|_{Y_t^N, w_t^H, e_t^H} \right. = c_{HF} \left( \frac{z_G}{G_t^{HF}} \right) \beta_t E_t^{HF} \quad (A3.7)
\]

The decline in gender wage gap in H influences private investments through increase in the share of public social expenditures in total output (\(\kappa^H\)) as

\[
\frac{\partial I_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. = \frac{\partial I_t}{\partial \kappa_t} \left|_{Y_t^N, w_t^H, e_t^H} \right. \frac{\partial \kappa_t}{\partial w_t^H} \left|_{Y_t^N, w_t^H, e_t^H} \right. \nonumber \\
= I_t \left( \frac{1}{1 - \kappa_t} + i_3 \frac{D_t^{HF}}{Y_t^N} \right) \left(1 - \kappa_t^2\right) \left( \frac{E_t^H}{\beta_t} \right) \quad (A3.8)
\]

The partial effect of closing gender wage gap on exports and imports are zero, since the public social expenditures also does not affect exports and imports.
The increasing female wages in $H$ (with constant male wages) has a positive partial impact on the public social:

\[
\frac{\partial G_t^H}{\partial w_t^H} \bigg|_{Y_t^N, w_t^{HM}, E_t^H} = \frac{\partial G_t^H}{\partial \kappa_t^H} \bigg|_{Y_t^N} \frac{\partial \kappa_t^H}{\partial w_t^H} \bigg|_{w_t^{HM}, Y_t^N, E_t^H} = \beta_t^H E_t^H > 0 \quad (A3.11)
\]

Moreover, other types of public expenditures increase as below:

\[
\frac{\partial G_t^C}{\partial w_t^H} \bigg|_{Y_t^N, w_t^{HM}, E_t^H} = \frac{\partial G_t^C}{\partial \kappa_t^H} \bigg|_{Y_t^N} \frac{\partial \kappa_t^H}{\partial w_t^H} \bigg|_{w_t^{HM}, Y_t^N, E_t^H} = \kappa_t^C \beta_t^H E_t^H > 0 \quad (A3.12)
\]

\[
\frac{\partial I_t^G}{\partial w_t^H} \bigg|_{Y_t^N, w_t^{HM}, E_t^H} = \frac{\partial I_t^G}{\partial \kappa_t^H} \bigg|_{Y_t^N} \frac{\partial \kappa_t^H}{\partial w_t^H} \bigg|_{w_t^{HM}, Y_t^N, E_t^H} = \kappa_t^G \beta_t^H E_t^H > 0 \quad (A3.13)
\]

Next, we examine the short-run impact of closing gender wage gap in $H$ on employment. We can show this effect as

\[
\frac{dE_t^F}{dw_t^H} = \left( \frac{dE_t^{NF}}{d\kappa_t^H} + \frac{dE_t^{HF}}{d\kappa_t^H} \right) \bigg|_{Y_t^N, w_t^{HM}, E_t^H} \frac{\partial \kappa_t^H}{\partial w_t^H} \bigg|_{Y_t^N, w_t^{HM}, E_t^H}
\]

\[
= \left( \frac{dE_t^{NF}}{d\kappa_t^H} \bigg|_{Y_t} + \frac{dE_t^{NF}}{dY_t} \frac{dY_t}{d\kappa_t^H} \bigg|_{Y_t} + \frac{dE_t^{HF}}{d\kappa_t^H} \bigg|_{Y_t} + \frac{dE_t^{HF}}{dY_t} \frac{dY_t}{d\kappa_t^H} \bigg|_{Y_t} \right)
\]

\[
+ \frac{dE_t^{HF}}{dY_t} \frac{dY_t}{d\kappa_t^H} \bigg|_{Y_t} \bigg|_{Y_t^N, w_t^{HM}, E_t^H}
\]

\[
\frac{dE_t^F}{dw_t^H} = \Psi_{tt}^k \left( \beta_t^N \left( 1 - \kappa_t^H \right) \frac{T_t^N}{\kappa_t^H} + \beta_t^H \kappa_t^H \frac{\kappa_t^H}{w_t^{HF} (\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \right) \left( \frac{1 - \kappa_t^H}{Y_t^N} \right)^2 \beta_t^H E_t^H > 0 \quad (A3.14')
\]
Similarly, the impact of closing gender wage gap in H on male employment is

\[
\frac{dE^M_t}{dw_{HF}^t} = \left( \frac{dE^NM_t}{d\kappa^H_t} + \frac{dE^HM_t}{d\kappa^H_t} \right) \left| \frac{\partial \kappa^H_t}{\partial w_{HF}^t} \right|_{Y_t, w_{HF}^t, E_t^H} \\
= \left( \frac{\partial E^NM_t}{\partial \kappa^H_t} \right)_{Y_t} + \frac{dE^NM_t}{dY_t} \frac{dY_t}{d\kappa^H_t} + \left| \frac{\partial E^HM_t}{\partial \kappa^H_t} \right|_{Y_t} \\
+ \frac{\partial E^HM_t}{\partial Y_t} \frac{dY_t}{d\kappa^H_t} \left| \frac{\partial \kappa^H_t}{\partial w_{HF}^t} \right|_{Y_t, w_{HF}^t, E_t^H} \tag{A3.15}
\]

\[
\frac{dE^N_t}{dw_{HF}^t} = \Psi_t^k \left( 1 - \beta_t^N \right) \left( 1 - \kappa_t^H \right) \left( 1 - \phi_k \right)(1 - \kappa_t^H) \\
+ (1 - \beta_t^H) \frac{\kappa_t^H}{w_{HF}^t (\beta_t^H + \alpha_t^H - \beta_t^H \alpha_t^H)} \left( 1 - \kappa_t^H \right)^2 E_t^H \beta_t^H \tag{A3.15'}
\]

A3.2 The effect of a change in closing the gender wage gap in the H sector on aggregate output and employment in the next period

Next, we examine the impact of closing gender wage gap in H on output in the next period:

\[
\psi_{t+1} = \frac{dY_t}{dw_{HF}^t} = \frac{dY_t}{dY_t} \frac{dY_t}{dw_{HF}^t} \\
= \frac{\partial C_t^N}{\partial w_{HF}^t Y_t w_{HF}^t E_t^H} + \frac{\partial C_t^H}{\partial w_{HF}^t Y_t w_{HF}^t E_t^H} + \frac{\partial I_t^N}{\partial w_{HF}^t Y_t w_{HF}^t E_t^H} + \frac{\partial X_t^N}{\partial w_{HF}^t Y_t w_{HF}^t E_t^H} \tag{A3.16}
\]

(1 - \phi_k)(1 - \kappa_t^H)

To analyse overall long-run impact of closing gender wage gap in H, we first examine the impact of closing gender wage gap in H on labour productivity in the next period:
\[
\frac{\partial T_t^N}{\partial w_{t-1}^{H FM}} = \frac{\partial T_t^N}{\partial \mathcal{K}_t^{H}} \quad \frac{\partial \mathcal{K}_t^{H}}{\partial w_{t-1}^{HF}}
\]

\[
= T_t^N \left( \frac{h_1}{\mathcal{K}_t^{H}} + \frac{h_2 + h_3 + h_4}{Y_t^{N}} \right) \psi_t^{k} + \left( (z_G + z_R + z_F + z_M) h_7 + (q_G + q_F + q_M) h_8 \right) \psi_t^{k} \]

\[
= \frac{h_7 (z_F + z_M - z_R) + h_8 (q_F + q_M)}{1 - \mathcal{K}_t^{H}} \left( \frac{(1 - \mathcal{K}_t^{H})^2 E_{t-1}^{H} \beta_t^{H}}{Y_t^{N} + \Psi_t^{H}} \right) \]

(A3.17)

As an outcome of this, the long-run partial impact of closing gender wage gap in H on female employment in N (\(e_{N(t-1)}^{NF}\)) and male employment in N (\(e_{N(t-1)}^{NM}\)) are also ambiguous as in (A3.18) and (A3.19).

\[
e_{N(t-1)}^{NF} = \frac{\partial E_{t}^{NF}}{\partial \mathcal{K}_t^{H}} \quad \frac{\partial \mathcal{K}_t^{H}}{\partial w_{t-1}^{HF}} \quad \frac{\partial w_{t-1}^{HF}}{Y_t^{N}}
\]

\[
= - \frac{\beta_t^{N} Y_t^{N}}{(Y_t^{N})^2} \left( \frac{(1 - \mathcal{K}_t^{H})^2 E_{t-1}^{H} \beta_t^{H}}{Y_t^{N} + \Psi_t^{H}} \right) \]

(A3.18)

\[
e_{N(t-1)}^{NM} = \frac{\partial E_{t}^{NM}}{\partial \mathcal{K}_t^{H}} \quad \frac{\partial \mathcal{K}_t^{H}}{\partial w_{t-1}^{HF}} \quad \frac{\partial w_{t-1}^{HF}}{Y_t^{N}}
\]

\[
= - \left( 1 - \beta_t^{N} \right) Y_t^{N} \left( \frac{(1 - \mathcal{K}_t^{H})^2 E_{t-1}^{H} \beta_t^{H}}{Y_t^{N} + \Psi_t^{H}} \right) \]

(A3.19)

Moreover, the long-run partial effect of public social expenditures on employment in H is zero.

\[
e_{H(t-1)}^{HF} = 0 \quad \text{(A3.20)}
\]

\[
e_{H(t-1)}^{HM} = 0 \quad \text{(A3.21)}
\]

Next, closing gender wage gap in H sector would have a long-run partial effect on \(C_t^N\) and \(C_t^H\) through influencing employment and hence the wage bill in the following period.
\[ \frac{\partial C^N_t}{\partial w^H_{t-1}} y^N_t w^H_{t-1} \]
\[ = C^N_t \left( \frac{c_{NF} (e^N_{H(t-1)} w^N_{t-1})}{w^N_{t-1}} + \frac{c_{NM} (e^N_{H(t-1)} w^N_{t-1})}{w^N_{t-1}} \right) \]
\[ + c_R \left( \frac{e^N_{H(t-1)} w^N_{t-1}}{R_t} \right) \] (A3.22)

\[ \frac{\partial C^H_t}{\partial w^H_{t-1}} y^N_t w^H_{t-1} \]
\[ = C^H_t \left( \frac{z_F (e^N_{H(t-1)} w^N_{t-1})}{w^N_{t-1}} + z_M \frac{e^N_{H(t-1)} w^N_{t-1}}{w^N_{t-1}} \right) \]
\[ - z_R \left( \frac{e^N_{H(t-1)} w^N_{t-1}}{R_t} \right) \] (A3.23)

The long-run impact on \( I_t \) is

\[ \frac{\partial I_t}{\partial w^H_{t-1}} y^N_t w^H_{t-1} \]
\[ = I_t \left( \frac{\partial \kappa^H_{t-1}}{\partial \kappa^H_{t-1}} y^N_t w^H_{t-1} \right) \]
\[ = I_t \left( \pi_t \right) \] (A3.24)

Last, closing gender wage gap in \( H \) influences exports and imports in the next period through its effect on the share of public social expenditures in total output.

\[ \frac{\partial X_t}{\partial w^H_{t-1}} y^N_t \]
\[ = X_t \left( \frac{\partial \pi_t}{\partial \kappa^H_{t-1}} y^N_t \right) \]
\[ = X_t \left( 2 e^H_{t-1} \right) \] (A3.25)

\[ \frac{\partial M_t}{\partial w^H_{t-1}} y^N_t \]
\[ = M_t \left( \frac{\partial \pi_t}{\partial \kappa^H_{t-1}} y^N_t \right) \]
\[ = M_t \left( 2 e^H_{t-1} \right) \] (A3.26)
Closing the gender wage gap in \( H \) does not have a direct impact on employment in the next period. The effect is through the share of public social expenditures in total output. The effect of closing the gender wage gap in \( H \) on female and male employment in the next period are:

\[
\frac{dE_t^F}{dw_{t-1}^F} = \left( \frac{dE_t^{NF}}{d\kappa_{t-1}^H} + \frac{dE_t^{HF}}{d\kappa_{t-1}^H} \right) \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \\
= \left( \frac{\partial E_t^{NF}}{\partial \kappa_{t-1}^H} \frac{\partial \kappa_{t-1}^H}{\partial Y_t} \right) + \frac{\partial E_t^{HF}}{\partial Y_t} \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \tag{A3.27}
\]

\[
\frac{dE_t^M}{dw_{t-1}^F} = \left( \frac{dE_t^{NM}}{d\kappa_{t-1}^H} + \frac{dE_t^{HM}}{d\kappa_{t-1}^H} \right) \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \\
= \left( \frac{\partial E_t^{NM}}{\partial \kappa_{t-1}^H} \frac{\partial \kappa_{t-1}^H}{\partial Y_t} \right) + \frac{\partial E_t^{HM}}{\partial Y_t} \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \tag{A3.28}
\]

\[
\frac{dE_t^M}{dw_{t-1}^F} = \left( \frac{dE_t^{NM}}{d\kappa_{t-1}^H} + \frac{dE_t^{HM}}{d\kappa_{t-1}^H} \right) \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \\
= \left( \frac{\partial E_t^{NM}}{\partial \kappa_{t-1}^H} \frac{\partial \kappa_{t-1}^H}{\partial Y_t} \right) + \frac{\partial E_t^{HM}}{\partial Y_t} \left| \frac{\partial \kappa_{t-1}^H}{\partial w_{t-1}^F} \right|^{-1}_{y_t^N} \tag{A3.28'}
\]
Appendix A4: Multiplier for aggregate output when the share of social expenditures in GDP changes

The income multiplier for the N sector is the impact of output in the N sector on each component of demand multiplied by the impact of output in the N sector on aggregate output:

\[ \text{Income multiplier for } N = \frac{1}{1 - \varphi_k} \]  

(A4.1)

where \( \varphi_k \) is

\[ \varphi_k = \left| \frac{\partial C^N_t}{\partial Y^N_t} \right| \kappa^h_t + \left| \frac{\partial G^H_t}{\partial Y^N_t} \right| \kappa^h_t + \left| \frac{\partial \gamma^N_t}{\partial Y^N_t} \right| \kappa^h_t + \left| \frac{\partial M^N_t}{\partial Y^N_t} \right| \kappa^h_t + \left| \frac{\partial G^H_t}{\partial Y^N_t} \right| \kappa^h_t + \left| \frac{\partial \gamma^H_t}{\partial Y^N_t} \right| \kappa^h_t \]  

(A4.2)

The impact of total output in N sector on female and male employment in N and H are:

\[ \frac{\partial E^N_{NF}}{\partial Y^N_{t}} = e^N_{YN_{t}} = \frac{\beta^N_{t}}{T^N_{t}} > 0 \]  

(A4.3)

\[ \frac{\partial E^N_{NM}}{\partial Y^N_{t}} = e^N_{YN_{t}} = \frac{(1 - \beta^N_{t})}{T^N_{t}} > 0 \]  

(A4.4)

\[ \frac{\partial E^H_{HF}}{\partial Y^N_{t}} = e^H_{YN_{t}} = \frac{\beta^H_{t} \kappa^h_t}{w^H_t (\beta^H_{t} + \alpha^H_{t} - \beta^H_{t} \alpha^H_{t}) (1 - \kappa^H_{t})} > 0 \]  

(A4.5)

\[ \frac{\partial E^H_{HM}}{\partial Y^N_{t}} = e^H_{YN_{t}} = \frac{(1 - \beta^H_{t}) \kappa^h_t}{w^H_t (\beta^H_{t} + \alpha^H_{t} - \beta^H_{t} \alpha^H_{t}) (1 - \kappa^H_{t})} > 0 \]  

(A4.6)

The rising total output in N is also expected to increase the consumption of N goods through rising total wage payments and profits:

\[ \frac{\partial C^N_t}{\partial Y^N_t} = c^N_t \left( e^N_{YN_{t}} e^N_{YN_{t}} + e^N_{YN_{t}} e^N_{YN_{t}} + e^H_{YN_{t}} e^H_{YN_{t}} + c^H_{t} \frac{1 - \alpha^H_{t} w^H_t e^N_{YN_{t}} - w^N_{t} e^N_{YN_{t}}}{R_t} \right) > 0 \]  

(A4.7)
Higher total output in N influences consumption of social goods through rising public social expenditures, wages and profits in N sector:

$$\frac{\partial C_t^H}{\partial Y_t^N} = C_t^H \left( z_G \frac{1}{Y_t^N} + z_F \frac{w_t^N}{E_t^F} + z_M \frac{w_t^M}{E_t^M} + z_R \frac{1 - \alpha_t^N w_t^N e_t^M}{R_t} \right)$$  \hspace{1cm} (A4.8)

The short-run impact of total output in N affects private investment:

$$\frac{\partial I_t}{\partial Y_t^N} = I_t \left( i_1 \frac{1}{Y_t^N} + i_2 \frac{\partial \pi_t}{\partial Y_t^N} + i_3 \frac{\partial \left( \frac{D_t}{Y_t} \right)}{\partial Y_t^N} \right)$$  \hspace{1cm} (A4.9)

The first term inside the parenthesis is the direct impact of the output in the N sector on private investment. The effect on profit share is zero in the short-run.

$$\frac{\partial \pi_t}{\partial Y_t^N} = 0$$  \hspace{1cm} (A4.10)

The impact of the output in the N sector on public debt/GDP is

$$\frac{\partial \left( \frac{D_t}{Y_t} \right)}{\partial Y_t^N} = \frac{\partial D_t}{\partial Y_t^N} \frac{Y_t}{1 - \kappa_t^H} = \frac{\partial D_t}{\partial Y_t} \frac{1}{Y_t} - \frac{D_t}{Y_t^2} \frac{1}{1 - \kappa_t^H}$$  \hspace{1cm} (A4.11)

$$\frac{\partial \left( \frac{D_t}{Y_t^N} \right)}{\partial Y_t^N} = \left( \frac{\kappa_t^H + \kappa_t^C + \kappa_t^G}{1 - \kappa_t^H} - \tau_t^R \right) \frac{1}{Y_t^N(1 - \kappa_t^H)}$$  \hspace{1cm} (A4.11')

Finally, the total output in the N sector does not affect exports in the short-run as its effect on profit share is zero and the total output in the N sector increases imports through generating demand for import goods.

$$\frac{\partial X_t}{\partial Y_t^N} = X_t \left( \frac{\partial \pi_t}{\partial Y_t} \right) = 0$$  \hspace{1cm} (A4.12)
\[
\frac{\partial M_t}{\partial Y_t^N} = M_t \left( \frac{n_1}{Y_t^N} + n_2 \left( \frac{\partial \pi_t}{\partial Y_t} \right) \right) = \frac{M_t n_1}{Y_t^N} > 0
\] (A4.13)
## Appendix A5: Stylised facts of the data

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