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The Effects of Public Investment in the Green and Care Economies and Public Infrastructure in South Africa

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Introduction

National Treasury (2023) has expressed concerns about South Africa's rising public debt-to-GDP ratio, which was 71.4% in 2022/23, slightly above the average of 69% for emerging markets and middle-income countries. However, the emphasis on this ratio ignores the investment needs of an emerging economy and the self-defeating effects of real cuts in public spending on a country's socio-economic development, environmental sustainability and innovation.

Childcare and elderly care remain far from being partially or fully "socialised", and a policy or strategy on care for people living with disabilities is missing (Valiani, 2022). Many schools in South Africa suffer from overcrowded classrooms and a lack of sanitation, laboratory and library facilities, internet access and even electricity (Amnesty International, 2021), and are unable to purchase basic learning materials due to financial constraints. In addition, South Africa suffers from significant power cuts by the public power utility, Eskom.[1] In its latest Budget Review, National Treasury (2024a) noted the challenges with reliable electricity and logistics and that government expenditures fall short of fostering private-sector investment. It supports reforms to increase infrastructure investment, and the Minister of Finance has stated that that the South African government aims to invest in the electricity sector and renewable energy (Gogongwana, 2023).

There is an urgent need to invest in the care economy, the green economy and other public infrastructure, as these categories of public spending have the potential to create jobs in South Africa. Furthermore, public spending in these three categories is partially self-financing due to strong multiplier effects on the country's gross domestic product (GDP).

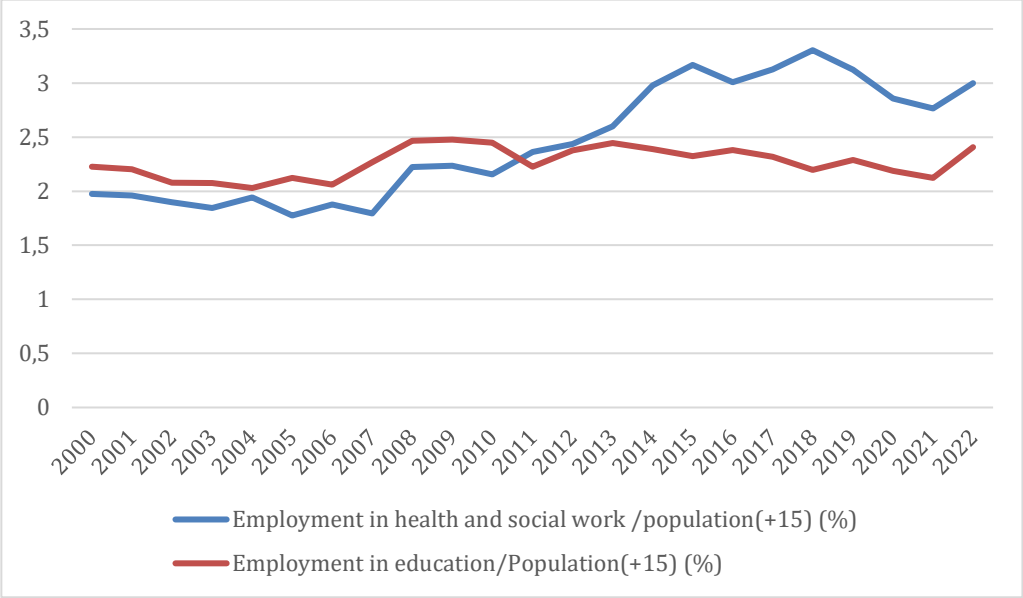
For the purpose of this paper, the care economy includes healthcare, social care, education and childcare, while the green economy includes renewable energy, energy efficiency and public transport (REEEPT). Public infrastructure spending refers to public gross fixed capital formation (GFCF) as reported in national accounts.

The care economy

In 2022, of South Africa's population over the age of 15 years, 3% worked in the health and social work sector and 2.4% worked in the education sector (Figure 1).

[1] BBC.2023. South Africa load-shedding: The roots of Eskom's power problem. 24 May 2023.

Figure 1: Employment in the health and social work and education sectors, as % of population +15 (2000–2021)

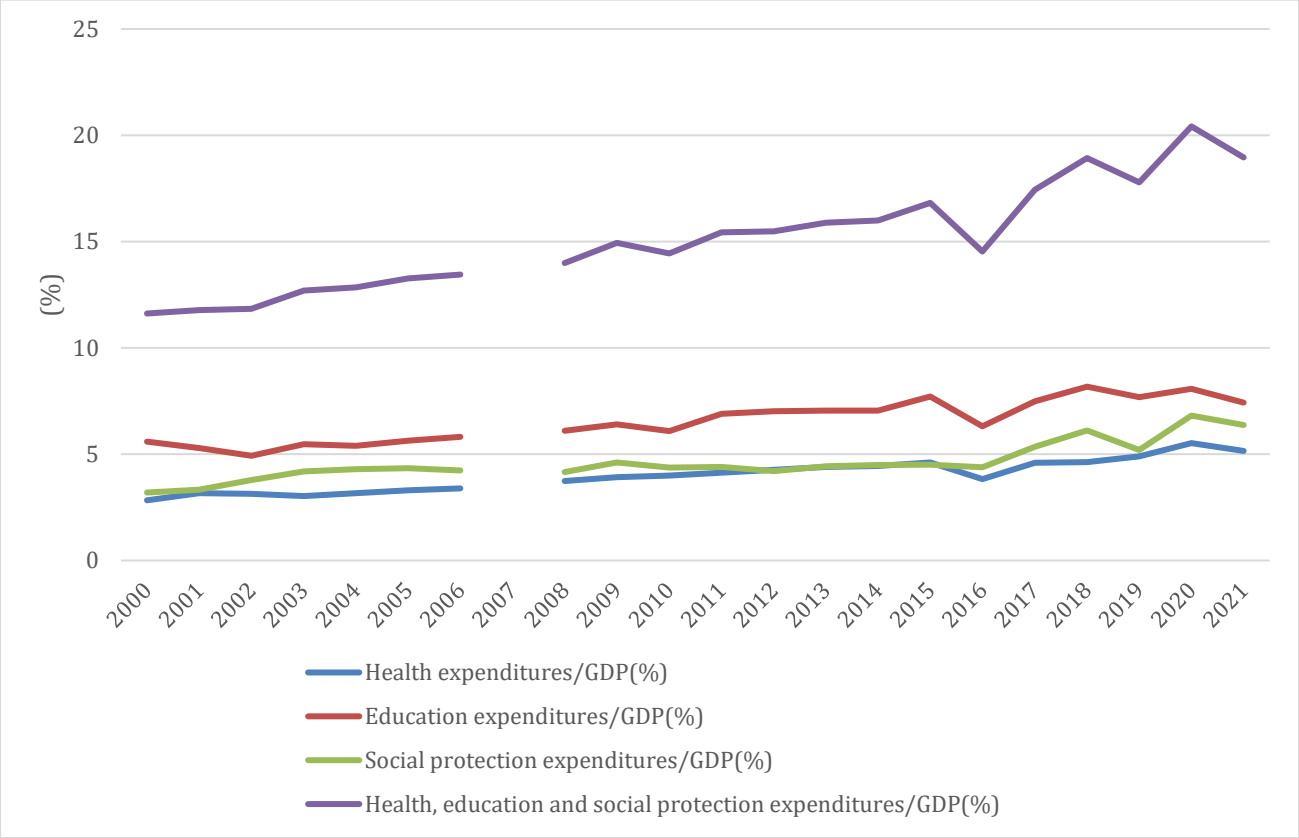


Source: Authors' calculations based on data provided by the ILO (2023, https://ilostat.ilo.org/) and World Bank (2023)

As Figure 1 shows, between 2000 and 2022, the education sector employed fewer than 2.5% of South Africa's population (+15). The ratio of population employed was lower in 2022 than in 2010, despite many schools suffering from overcrowded classrooms (Amnesty International, 2021).

In 2021, South Africa spent 5.2% and 7.4% of its GDP on public health and education respectively, and 6.4% of GDP on social protection, which includes social care and childcare (Figure 2).

Figure 2: Public expenditure on health, education and social protection, as % of GDP (2000–2021)



Source: IMF (2023) https://data.imf.org/?sk=a0867067-d23c-4ebc-ad23-d3b015045405).
Note: Data for 2007 is missing for South Africa in the IMF Government Finance Statistics.

Between 2011 and 2021, public expenditure on education, healthcare, and social protection increased by 3.5 percentage points. Since 2004/5, South Africa has implemented the Expanded Public Works Programme (EPWP) to address poverty and unemployment (Parenzee & Budlender, 2015), through public investments in infrastructure and education, healthcare and social protection (DPW&I, 2023), as well as early childhood development. Government has made a strategic decision to allocate funds to labour-intensive sectors, including health and education services, to target growth and employment (Godongwana, 2023).

Multiplier effects of public expenditure

National Treasury (2024b: 4) argues that the fiscal multipliers in South Africa are low, highlights the relevance of debt sustainability and proposes a "fiscal rule that commits government to achieving fiscal sustainability".

Studies have found that public expenditure could have a multiplier effect ranging from less than 1 to 3.5 in South Africa. Using a structural vector autoregressive (SVAR) analysis, Kemp (2020) estimated that the government spending multipliers are generally smaller than 1 but are higher when the economy is in a recession. Van Rensburg et al. (2022), based on a small quarterly macro-econometric model, estimated that between 2010 and 2019, the fiscal multiplier in South Africa declined from 1.5 to around zero, as a result of rising debt and tax levels. In their input-output analysis, Schröder and Storm (2020) found that a fiscal stimulus on consumption and

investment would have a multiplier effect of 1.87 for South Africa. Using a stock-flow consistent model, Makrelov et al. (2020) found government expenditures had strong multiplier effects, estimating up to 2.5 (if the output gap is large and negative) and 3.5 (if an inflow of foreign savings eases the domestic savings constraint).

In contrast, du Rand et al. (2023) estimated fiscal multipliers of 0.155 for government current spending and -0.118 for government investment in South Africa. This negative multiplier for public investment is not found in the international literature for a wide range of countries, including South Africa, other emerging economies and high-income economies (e.g., Batini et al., 2021; Gechert, 2015; IMF, 2020; Wildauer et al., 2021; Onaran et al., 2022a, 2023; Onaran and Oyvat, 2023). It raises questions about the specification of the estimation methodology (e.g., use of shares of components of aggregate demand in the VAR estimation), which is beyond the scope of this paper.

This paper focuses on the effects of public spending on the care economy, the green economy (REEEPT) and public infrastructure (GFCF) in South Africa. These three public spending categories have been shown to have a strong positive effect on the GDP and employment in both emerging and high-income economies. For the effects on the care economy, see Antonopoulos et al. (2010), İlkkaracan et al. (2015), İlkkaracan and Kim (2019), ITUC (2016, 2017), ILO, (2020), Oyvat and Onaran (2022), Onaran et al. (2022a, 2023), Onaran and Oyvat (2023); for the effects on the green economy, see Pollin et al. (2009, 2022), UNIDO and GGGI (2015), ILO (2018), Dafermos and Nikolaidi (2019), Dafermos et al. (2022), Ferroukhi et al. (2020), Batini et al. (2021), Onaran and Oyvat (2023); for the effects of public physical infrastructure investment, see the IMF (2020), Wildauer et al. (2021), Onaran et al. (2022a, 2023), Onaran and Oyvat (2023).

After describing the definitions and data used for the three categories of government spending (the care and green economies and infrastructure), the theoretical macroeconomic framework is presented with the channels through which public spending affects output and employment of women and men. This is followed by econometric estimation results for the three categories, looking at the fiscal multipliers of public spending and their effects on GDP, and the impact of increasing public spending on the primary budget balance in the absence of any changes in tax rates. The paper ends with a conclusion and implications for policy.

Definitions and Data

The definitions and data sources for public spending in the care economy, green economy and public infrastructure, which are presented here, come from Onaran and Oyvat (2023). Appendix 2 presents the data sources and availability of variables for South Africa.

Public spending in the care economy is defined as the total output in the sectors of education (including childcare), health and social care (including long-term care).[2] In national accounts, spending on education, childcare, health and social care are categorised as current spending (government consumption). However, in feminist economics literature, this spending is referred to as social infrastructure investment, due to its positive effects on productivity and the positive externalities as a public good (Elson, 2016, 2017; WBG and SWBG, 2015; Onaran et al., 2019, 2022a). İlkkaracan (2013) coined the term "purple economy" to describe the care economy.

Public infrastructure spending is defined as public gross fixed capital formation (GFCF) as reported in national accounts. Examples include spending on buildings for schools and hospitals, and machinery and equipment not included in current spending data for the care economy, social housing, transport and energy infrastructure. Transport and energy infrastructure refers to capital spending in the green economy, e.g., in rail transport or the renewable energy sector (wind farms, solar farms or hydropower plants) and infrastructure for energy distribution.

Public spending in the green economy (REEEPT) is defined as spending on renewable energy (e.g., solar, wind, geothermal and hydro), on energy efficiency (e.g., weatherproofing and installing heat pumps, etc. in public and private buildings, industrial energy efficiency, grid upgrades) and on public transport (excluding air transport but including infrastructure and current spending on other transport services, with a larger weight allocated to rail transport infrastructure). This public spending includes the purchase of goods and services produced in various industries, such as construction (including construction services), manufacturing (e.g., based on ISIC3 Rev3 classification plastic products, glass products, cement and plaster and concrete products, non-ferrous metals, fabricated metal products, general purpose machinery, special purpose machinery, domestic appliances, electrical machinery and apparatus, electronic valves, tubes, etc., locomotives and rolling stock, other transport equipment,[3] and transport services, but not air transport).

Public spending on REEEPT combines current spending and GFCF in the national accounting categories and overlaps with public infrastructure spending.

- Public spending on transport or energy efficiency includes infrastructure investment (construction of the railways, manufacture of the rail transport vehicles or investment in the grid) and current spending (labour compensation or other inputs) to provide public transport or insulation services.
- Public spending on renewal energy includes only capital spending to produce assets (such as wind or solar farms, hydropower plants and geothermal plants) but not the labour compensation (or other inputs) to produce energy using renewable sources.

[2] The definition of the output in the care economy is consistent with the ILO (2020) definition of care sectors. Informal domestic care workers and unpaid domestic care work are not part of this analysis.
[3] UNIDO data on value added.

The simulation estimated the effects of increasing public spending by 1 percentage point as a ratio to GDP in the care economy (education, childcare, health and social care), in REEEPT and in GFCF. For REEEPT, it was not possible to disaggregate public GFCF by industry because long-time series data for private or public spending on renewal energy, energy efficiency or even public transport GFCF is not available. Therefore, the spending stimulus was distributed as follows:

- 50% to renewal energy, shared equally across wind, solar, geothermal and hydropower.
- 20% to energy efficiency, with 50% to weatherproofing/energy efficiency in public and private buildings, 25% to industrial energy efficiency and 25% to grid upgrades.[4]
- 30% to public transport,[5] with 10% to rail transport vehicles, 18% to building the infrastructure and 72% to providing transport services.[6] See Appendix 3, Table A3.2 for details.

The ratios used for simulations in this study should be regarded as plausible examples. The distribution of spending across different types of renewable energy, energy efficiency and public transport is intended to provide an indicative policy simulation and can be adjusted based on the specific needs or resources of South Africa.

Public spending is defined broadly and includes spending by municipalities and local authorities, not just central government, depending on the nature of the sector and the governance preferences in the country. Different industries may also have different ownership structures, such as central government or municipal ownership, and cooperatives bringing together producers and/or users. Similarly, public spending may take the form of public investment, public employment programmes, contracting or public subsidies, particularly in areas where private capital already exists and public capital accumulation may take time.

Theoretical framework

To analyse public spending in the care economy, REEEPT and GFCF, a theoretical framework is used that is based on a gendered structuralist post-Keynesian demand-led growth model. This model builds on Onaran et al. (2022a; 2022b; 2023), Oyvat and Onaran (2022) and Onaran and Oyvat (2023), which synthesises and furthers the models by Braunstein et al. (2011) and Seguino (2010; 2012), incorporating explicit analysis of both demand- and supply-side components, the government and employment.

[4] The ratios for renewable energy and energy efficiency allocation are based on the proposal in UNIDO and GGGI (2015).

[5] The data in the national accounts for transport industry includes both private and public transport services. Due to the lack of data to disaggregate the industry value added by providers, one unit of stimulus spent in this sector is assumed to have the same effect on employment, whether the spending is private or public. Air transportation is excluded.

[6] These weights are based on APTA (2020).

Unlike standard neoclassical growth models that assume full employment, this theoretical framework acknowledges several key factors:

- Demand-side constraints in the economy, which lead to excess capacity and involuntary unemployment.
- The short-run and medium-run effects of different types of public spending on demand, income distribution and employment; and the medium-run effects on productivity on the supply side.
- The effects of wages on not only production costs but also aggregate demand.
- The effects on both demand and productivity of the distribution of wealth and income between wages and profits, as well as gender gaps in wages and employment.
- The effects of the structural features of the economy in terms of sectoral composition, oligopolistic price setting, import dependency, gender differences in the distribution of unpaid and paid labour in different sectors, and bargaining power between labour and capital and between different genders.

The model incorporates four types of government spending:

i. Current spending in the care economy (education, childcare, healthcare and social care).
ii. Current spending in REEEPT.
iii. Capital spending in GFCF (which includes capital spending in the care economy and REEEPT).
iv. Other government spending.

Appendix 1 presents the structure of the model.[7]

This theoretical framework is used to explore how changes in public spending affect the output and employment of women and men.

In the care economy, public spending can rise through increased jobs and/or higher wages in the public social sector.[8] For REEEPT and GFCF, public spending can rise through public sector contracting or subsidies to private providers for the provision of goods and services, or increased jobs and/or wages in direct public employment programmes and the rest of the economy. Put simply, public spending in REEEPT and GFCF increases because more employees are hired (direct effect) and wages increase, as a result of the bargaining power of labour (indirect effect).[9]

[7] For the full theoretical model in three different versions, see Onaran et al. (2022a; 2023) and Onaran and Oyvat (2023).

[8] In the short run (within a year), the assumption is that care employment can be expanded with the existing capital stock (e.g., hospitals, care homes, schools, etc.). The model and the estimation methodology allow for growth in the capital stock in the care economy in subsequent years. The combined effects of expanding both care employment (and wages) and public GFCF are estimated. GFCF encompasses investments in public buildings, such as hospitals, care homes, nurseries and schools. To overcome labour shortages in this sector, education and training spending is crucial, albeit with potential time lags.

[9] In the model, if wages increase as part of the public spending programme, they will have direct effects on the profit share, and thereby investment and net exports, which is an extension to the analysis presented later in the paper.

The vector autoregression (VAR) analysis discussed later in the paper captures the effects of increased public spending on growth in employment and wages and estimates the cumulative effects on output and employment. Hence, in the analysis, the increase in public spending can also take the form of paying higher wages to public sector employees.

Short-run effects

All three categories of public spending are expected to have direct positive effects on total output and multiplier effects, as more employment and aggregate income increase household consumption and private investment due to demand effects. The magnitude of these multiplier effects will depend on various factors:

- The labour intensity of the sectors that receive additional spending.
- The marginal propensity to import out of the new spending.
- The impact of public spending on household consumption by substituting private spending.
- The influence of public infrastructure provision on private investment.
- The gender composition of newly created employment.

The gendered effect of public spending is different in the care economy compared to REEEPT and GFCF. This is because women make up a higher proportion of the labour force in the care economy and often receive little or no pay (TIPS, 2021). In 2022, women accounted for 68% of employment in education and 73.4% in health and social work, compared to 39.5% for the rest of the non-agricultural sector in South Africa.[10] The care economy is also characterised by high rates of informal employment – in 2022, 21.5% of education and 29.7% of human health and social work employment were informal.[11]

Therefore, an increase in the social sector's share of aggregate output would be expected to lead to a greater share of women workers in total employment. Moreover, an increase in social expenditures providing childcare or elderly care is expected to increase women's labour force participation and their employment in the rest of the economy, if matched with an increase in output and labour demand. In turn, these effects on the gender composition of employment would influence the consumption patterns and average marginal propensity to consume in the economy. The marginal propensity to consume on social services is larger for women than men (Onaran et al., 2022a, 2022b; Seguino & Floro, 2003; Morrison et al., 2007; Lee & Pocock, 2007).

The increased employment of men and women (as a ratio to their labour supply) will result in higher wage rates both for men and women. Changes in the wage rates of men and women also affect each other.

If the multiplier effects are not very high, increased public spending, coupled with constant tax rates, could increase the public debt as a ratio to GDP. This could result in

[10] Authors' calculations based on data provided by the ILO (2023) https://ilostat.ilo.org/.
[11] ibid.

interest rates rising, especially if monetary policy does not actively accommodate fiscal policy. Therefore, depending on the interest elasticity of investment, the public spending could crowd out private investment. The impact would be minimal if private investment is not highly responsive to interest rates, and public borrowing does not influence the interest rate substantially. However, an excessive increase in interest rates coupled with uncertainty could negatively affect private investment if a conservative central bank narrowly targets an unrealistic, very low inflation rate (without targeting employment or transition in a catch-up economy) and contradicts fiscal policy by unnecessarily tightening monetary policy. Monetary policy would need to accommodate expansionary fiscal policy, alongside well-defined development targets and coordinated fiscal, monetary, industrial, labour and social policies.

Medium-run effects

Over the medium term, labour productivity (output/worker) in the rest of the economy is expected to increase in response to an increase in output, wages and private and public spending in the care economy, REEEPT and GFCF.

A rise in public social expenditure is expected to directly enhance labour productivity through contributing to increased human capabilities. This could be due to the positive influence of education and childcare on skills or of healthcare on health outcomes. The indirect impacts on productivity could be through improving the social fabric, social security and welfare, as well as allowing unpaid domestic carers to realise their full potential. In all three types of care spending, the increased participation of women in the labour force would have a positive effect on productivity, as these women would otherwise have provided the majority of the domestic unpaid social care. Increased public spending on care could alleviate certain types of unpaid care in the household, in particular unpaid supervisory, if not emotional, labour (Folbre, 2006). Both paid and unpaid care enhance the productive capabilities/skills of recipients (England, 2005; Folbre, 2006; Folbre & Heintz, 2017) and could foster productivity-enhancing knowledge (Folbre & Heintz. 2019).

In the case of all three categories of public spending, labour productivity improves as a result of higher economic output, which facilitates a more efficient allocation of resources and the consumption of social services by households with a higher income.

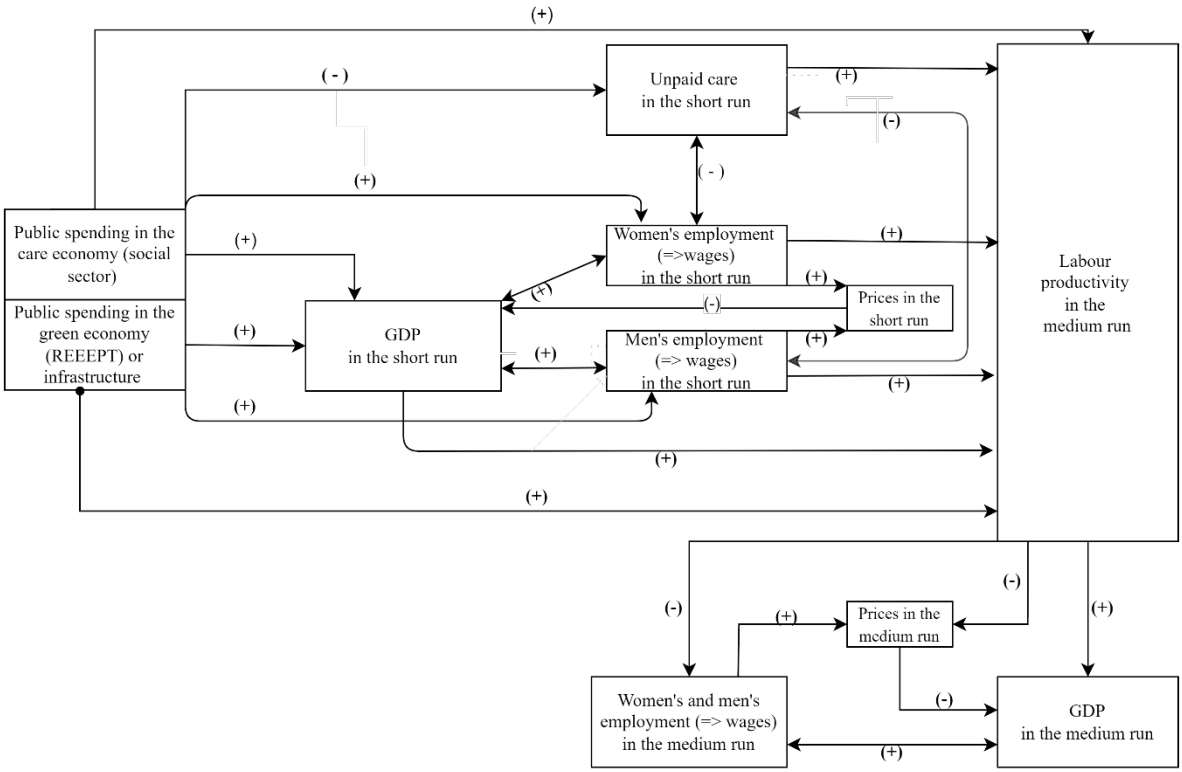
Public spending in GFCF is expected to increase labour productivity directly through improved infrastructure and indirectly through its effect on private investment. The rise in labour productivity further influences output through its positive effect on the profit share, which in turn stimulates private investment. Higher productivity is also expected to raise exports and decrease imports due to low unit-labour costs, enhancing the international competitiveness of the economy. The change in labour productivity could also affect consumption by changing the distribution of income between wages and profits, each of which have different marginal propensities to consume.

In both the short and medium run, an increase in public spending can lead to a change in public debt/GDP, which would influence private investments. However, as public

social expenditure also affects labour productivity, the possible crowding-out effects may be mitigated or even reversed in the medium run.

The medium-run effect of public spending on employment depends on the size of the increase in output and labour productivity. Output is expected to rise proportionately more than productivity in response to all three public spending categories, resulting in a positive medium-run effect on employment, albeit with gender differences. Figure 3 provides an overview of the effects of public spending on employment, output and labour productivity.

Figure 3: The effect of public spending on employment, output and labour productivity



Source: Onaran and Oyvat (2023)

Estimation results and policy simulations

This section presents the estimation results in Onaran and Oyvat (2023)[12] for South Africa on the impact of public GFCF, the care economy and the green economy (sub-industries providing inputs to REEEPT) on GDP and the employment of women and men in the non-agricultural sector, based on a VAR analysis. Appendix 4 summarises the estimation methodology, and Appendix 5 presents the estimated effects (cumulative orthogonalised impulse response functions).

[12] Onaran and Oyvat (2023) covers eight emerging economies for a report for the International Trade Union Confederation (ITUC) and Friedrich Ebert Foundation.

The effects of public GFCF

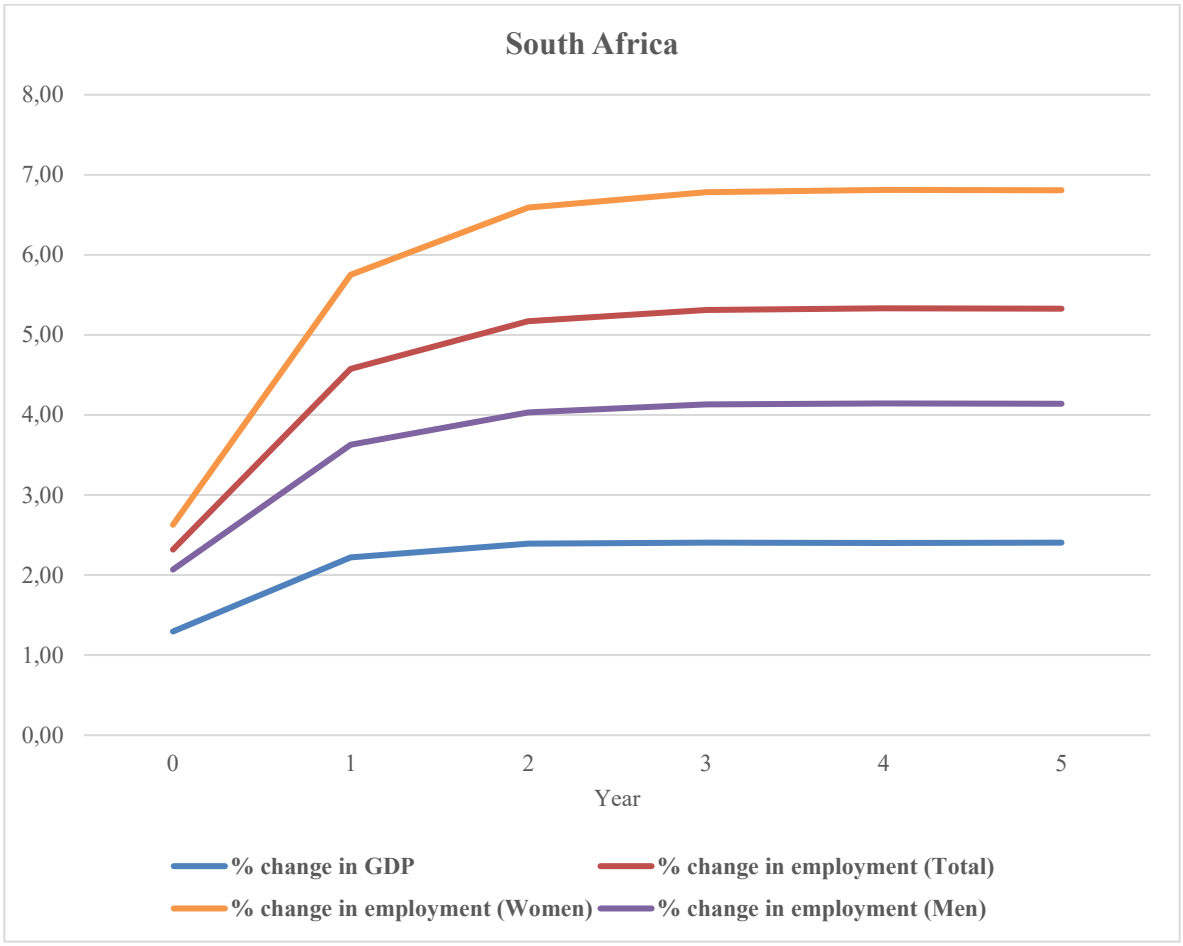
A one percentage point increase (as a ratio of GDP) in public GFCF increases South Africa's GDP by 1.3% contemporaneously and by 2.4% in five years (Figure 4). In other words, a R1 increase in public spending on GFCF would increase GDP by R2.4 at the end of five years. This multiplier effect also reflects the change in GDP in response to a one-unit change in the public spending category (both measured in local currency). These effects are comparable to the findings in the international literature on public GFCF multipliers.

The same increase in public GFCF (as a ratio of GDP) increases employment of women and men in the non-agricultural sector[13] by 6.8% and 4.1%, respectively. Urbanisation and informal employment in the non-agricultural sector are possible explanations for the impact being greater on employment than on GDP. In addition, public spending on infrastructure may have positive effects on urban output and employment that attract rural dwellers to urban areas, leading to non-agricultural employment growing at a higher rate than in the rest of the country. Furthermore, GDP data tends to underestimate the informal economy's output, whereas employment data captures informal employment better, being based on household labour force surveys. The estimations are based on data for the post-1991 period – before 1991, the mobility of black South African population was severely restricted, keeping the urban share of population at low levels. Therefore, the estimations may be capturing the increase in urbanisation after the end of migration restrictions during the apartheid (Bakker et al., 2020). These results are robust when controlling for urbanisation and informal economy share, as discussed in greater detail in Appendix 4.[14]

[13] Henceforth, the employment figures refer to the change in the non-agricultural sector.

[14] As a memo item, Onaran and Oyvat (2023) also estimate the elasticity of employment (total, non-agricultural) to GDP (based on specification 1 and only significant coefficients), which in the medium run (year five) is 0.2 in South Africa.

Figure 4: The impact of a one-time one percentage point increase in public GFCF spending on GDP and employment after five years



Source: Onaran and Oyvat (2023)
Notes: Simulations are based on coefficients from VAR estimations for specification 1 in Appendix 4, and impulse response function figures are in Appendix 5.

If public spending on GFCF were to increase by one percentage point (as a ratio of GDP) every year for five years, the cumulative increase in GDP would be 13.9% and 31.5% in total (non-agricultural) employment. Women's employment would grow by 40.9% and men's employment by 24.3%, while the employment rate (as a ratio of the population aged 15+ years) increases by around 11 percentage points.

Table 1: The effects of a repeated annual increase of one percentage point in public spending in GFCF, the care economy and REEEPT at the end of five years

Public spending category	Increase in GDP	Increase in non-agricultural employment after five years			Change in employment (percentage points) after five years		
		Total	Women	Men	Total	Women	Men
GFCF	13.85%	31.48%	40.93%	24.27%	11.09	12.55	9.71
Care economy	6.91%	8.75%	13.96%	4.71%	3.08	4.28	1.88
REEEPT	4.98%	9.40%	10.75%	7.73%	3.31	3.30	3.09

Source: Onaran and Oyvat (2023)

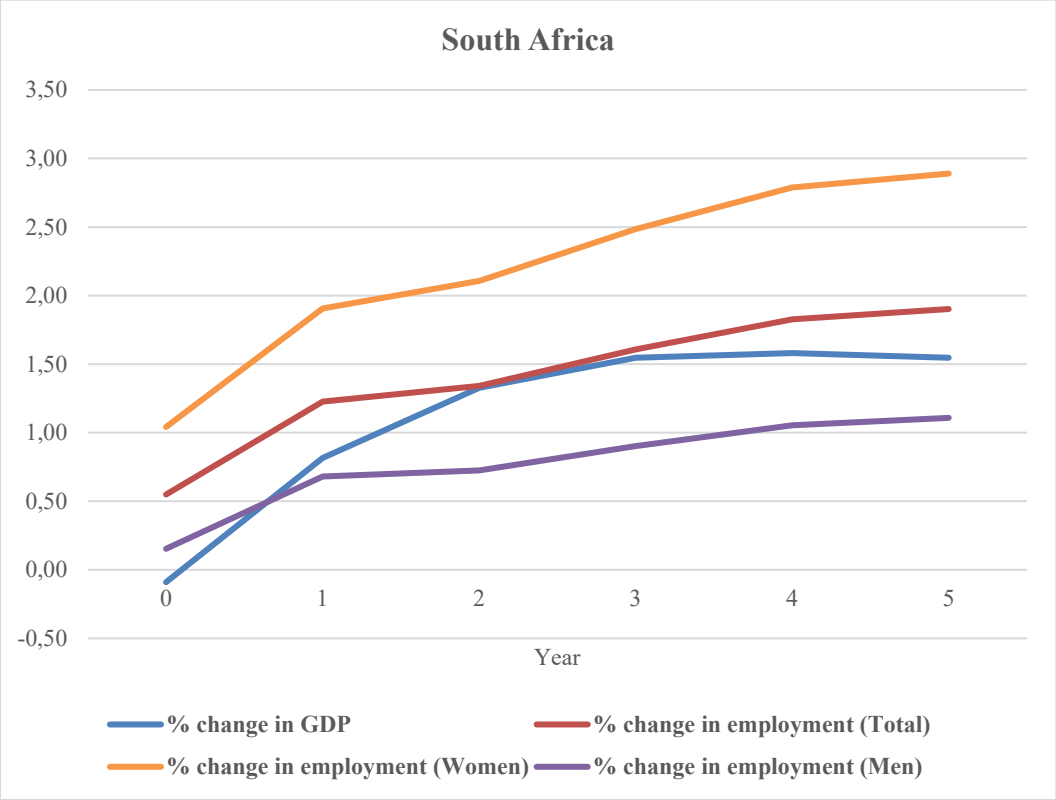
It should be emphasised that these results are not comparable to the short-run multiplier estimates of one-off shocks, as the effects of GFCF reported here include

both the cumulative effect at the end of five years and the effect of a repeated stimulus every year rather than a one-off shock.

The effects of public spending in the care economy

A one percentage point increase (as a ratio of GDP) in public spending on the care economy increases South Africa's GDP by 1.6% after five years. In other words, increasing public spending on the care economy by R1 would increase GDP by R1.6 at the end of five years. Employment of women and men grows by 2.9% and 1.1%, respectively. Again, the multiplier impact on employment is greater than on GDP, possibly due to urbanisation and growing urban informal employment.

Figure 5: Cumulative change in GDP and employment in response to a one-time increase of one percentage point in public spending on the care economy



Source: Onaran and Oyvat (2023)
Notes: Simulations are based on coefficients from VAR estimations for specification 1 explained in Appendix 4 and impulse response function figures are in Appendix 5.

Increasing public spending in the care economy by one percentage point (as a ratio of GDP) every year for five years increases GDP by 6.9% and total (non-agricultural) employment by 8.8%. Jobs would be created for both women (14%) and men (4.7%), contributing to the employment rate increasing by 3.1 percentage points (as a ratio of the population aged 15+ years).

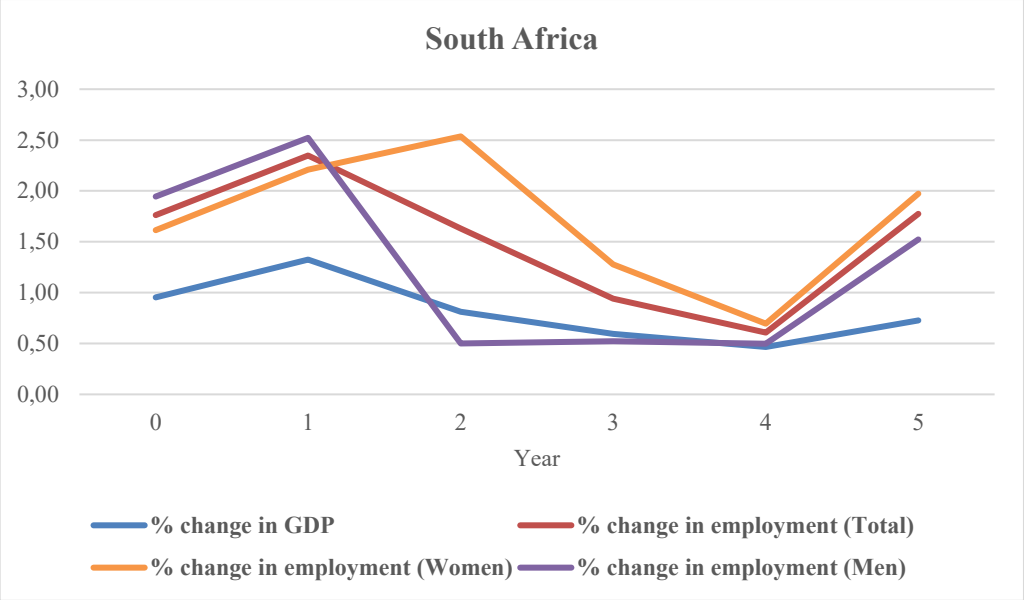
The effects of public spending in the green economy

Increasing public spending in the green economy (REEEPT) by one percentage point (as a ratio of GDP) increases South Africa's GDP by 1% contemporaneously and by 0.7% after five years (Figure 6). The cumulative multiplier impact of public spending n the green economy peaks at 1.3% within one year.

A partial explanation for the differences in multipliers is the differences in the import dependency of manufacturing, and specifically REEEPT industries. Increased public spending could result in a higher demand for imports, leading to a smaller upturn in domestic production compared to the original increase in stimulus. Another possible reason is the degree of informality, as the increased public spending could lead to increased informal economy production, which is not captured by the formal GDP measure in the national accounts compared to other countries. However, controlling for the share of informal economy in GDP where significant only marginally improved the multiplier effects, if at all.[15]

Employment of women and men increases contemporaneously by 1.6% and 1.9% respectively, and by 2.0% and 1.5% over a five-year period. The impact on employment again surpasses that on GDP possibly due to effects of urbanisation and informality, as discussed earlier.

Figure 6: Cumulative change in GDP and employment in response to a one-time increase of one percentage point in public spending in the green economy (REEEPT)



Source: Onaran and Oyvat (2023)
Notes: Simulations are based on coefficients from VAR estimations for specification 2 explained in Appendix 4 and impulse response function figures are in Appendix 5.

If public spending in the green economy increased by one percentage point (as a ratio of GDP) every year for five years, the cumulative increase in GDP would be 5% and 9.4% in total (non-agricultural) employment (10.8% for women's employment and 7.7% for men's employment). The employment rate (as a ratio of the population aged 15+ years) increases by approximately 3.3 percentage points (Table 2).

[15] If public spending substitutes private consumption or investment (e.g., by providing alternatives) or crowds out private investment by increasing borrowing costs, the magnitude of the multiplier may get smaller. Nevertheless, historical data presents less evidence of the former, and previous econometric analysis indicates that investment is not overly sensitive to borrowing costs (Onaran and Galanis, 2014, Onaran, Oyvat, Fotopoulou, 2022a). The VAR methodology employed in Onaran and Oyvat (2023) does not provide evidence of these specific channels, and further macroeconometric research utilising single equation estimations of the full macroeconomic model is required to shed light on such differences.

Public finance and further policy simulation

Onaran and Oyvat (2023) examine the impact of public spending on the primary budget balance in the absence of any changes in the tax rates and analyse what proportion of public spending is self-financing. The high multiplier effects make public spending partially self-financing in South Africa. The negative effect on the primary budget balance/GDP (excluding interest payments) ranges from 0.8 (the care economy) to 0.9 (GFCF) and 0.9–1.0 (REEEPT) percentage points.

A policy mix of increasing public spending in each of the three categories (care economy, REEEPT and GFCF) by one percentage point (as a ratio of GDP) every year for five years would lead a cumulative increase of 27.8% in GDP and 57% in total (non-agricultural) employment, corresponding to nine million new jobs.

Table 2. Impact on GDP and employment of increasing public spending in GFCF, the care economy and REEEPT by one percentage point every year at the end of five years

Increase in GDP	Increase in non-agricultural employment after five years			Number of new jobs after five years		
	Total	Women	Men	Total	Women	Men
27.8%	57.0%	77.9%	40.2%	9 013 000	5 503 000	3 511 000

Source: Onaran and Oyvat (2023)

See Appendix 3.3 for additional average annual low-carbon energy investment requirements for the period 2016–2050, to limit global warming to 1.5°C compared to current policies based on Bertram et al. (2021) and McCollum, et al. (2018).[16] In South Africa, the additional average annual low-carbon energy investment requirement (as a ratio to GDP) is 2.1%.[17]

See Appendix 3.4 for estimates of additional spending requirements in the care economy in other selected emerging economies in ILO (2020). The ILO (2020; based on İlkkaracan and Kim, 2019) estimates the additional spending requirements per year as a ratio to GDP in the care economy in the "high road" scenario compared to the "status quo" in 45 countries but does not include South Africa.[18]

[16] Net-Zero 2050 is a scenario that limits global warming to 1.5°C through climate policies and innovation, reaching net zero CO2 emissions around 2050, which is compatible with the long-term temperature goal of the Paris Agreement (Bertram et al. 2021). Current Policies assumes that only currently implemented policies are preserved, leading to a global warming by up to three °C by 2100 and high associated climate impacts.

[17] Country specific estimates are provided based on the GCAM5.3_

[18] In the "high road" scenario care services are expanded by 2030 in terms of the extent of population coverage as well as the quality of services provided and employment created to meet the requirements of Sustainable Development Goals (SDGs) for the provision of public care services, health and well-being, quality education, and full and productive employment and decent work (ILO, 2020). The "status quo" scenario is the baseline case, which assumes that care services will expand in line with population increases but with the current coverage rates, quality standards and working conditions in care sectors remaining constant, with the result that both care deficits and decent employment deficits persist into 2030.

Conclusion and policy implications

A one-time increase in public spending in the care economy, REEEPT or GFCF has positive and substantial multiplier effects on South Africa's GDP and employment. At the end of five years, the cumulative multiplier is 1.6 for the care economy and 2.4 for infrastructure (GFCF). In other words, after five years, the GDP increases by R1.6 for every R1 of increased spending in the care economy and by R2.4 for every R1 of increased spending in GFCF. For the green economy, the cumulative multiplier of increased public spending is 1.3 within a year and 0.7 at the end of five years.

Increasing public spending by one percentage point of GDP every year for five years also has positive multiplier effects:

- For the care economy, at the end of five years, GDP increases by 6.9% and total non-agricultural employment increases by 8.8%, creating jobs for both women and men, albeit at a faster rate for women (14.0%) compared to men (4.7%).
- For physical infrastructure (GFCF), at the end of five years, GDP increases by 13.9% and total non-agricultural employment by 31.5% (40.9% for women and 24.3% for men).
- For the green economy, at the end of five years, GDP increases by 5% and total non-agricultural employment by 9.4% (10.8% for women's and 7.7% for men).

A policy mix, where public spending is increased by one percentage point of GDP every year for five years in all categories, results in GDP increasing by 27.8% and total non-agricultural employment increasing by 57.0%, corresponding to nine million new jobs, at the end of the five years.

The analysis is based on historical data for the impact of public investment in South Africa on output and employment. If public spending is channelled to private companies via auctions rather than direct public investment, the multiplier effects are expected to be smaller due to the leakage to private profit, which is an income category with low marginal propensity to consume. As discussed in Section 3, the analysis did not include the future revenue generation potential of green investments. For example, if the renewable energy companies are publicly owned, and so profits are used only to cover the cost of capital and then retained and reinvested in the public sector. Accounting for these would substantially increase the positive macroeconomic effects of public investment.

The findings clearly indicate the potential of public investment in physical infrastructure, the care economy and the green economy for creating new decent formal jobs with adequate pay, working conditions, rights and social security. Expanding care economy is not only needed in its own right but also offers opportunities for an equitable green transition. The care economy is a low-carbon sector with a high potential for employment creation, given its labour intensity. The high job creation potential of public spending also highlights the role of government in redeploying from the fossil fuel-based sectors. The transition across sectors unavoidably creates new education and training needs, which in turn add to the need

for further public spending in the care economy. However, we acknowledge the difficulties involved in overcoming skill mismatch issues during the short-term transition period (skills required in the new jobs in the green economy and the care economy compared to skills of the existing workforce in the fossil-fuel based sectors, which will need to be phased out). A just transition plan needs to consider voluntary retirement packages without loss of lifetime income for the older cohort of workers, while reskilling is more relevant for most of South Africa's young labour force.

In 2022/23, South Africa's public debt-to-GDP ratio was 71.4%, which is slightly above the average of 69% for emerging markets and middle-income countries, and has been increasing since 2008/09 (IEJ, 2023). National Treasury (2023) has expressed concerns about South Africa's rising public debt. However, emphasising only this ratio ignores the investment needs of an emerging economy and the self-defeating effect of real cuts in public spending on GDP and on the country's long-term economic, financial, social and environmental sustainability and innovation. Real cuts to public infrastructure spending may both lead to higher public debt/GDP ratio and undermine development potential.

Concerns about public debt does not justify austerity but requires any public investment plan to address the question of how to finance public investment in physical infrastructure, the care and the green economy. Public spending, even without any increases in the tax rates, is partially self-financing thanks to the strong multiplier effects. Therefore, the negative effect on primary budget balance/GDP (excluding interest payments) ranges from 0.8 (care economy) to 0.9 (GFCF) and 0.9–1.0 (construction, public transport and manufacturing sub-sectors of the green economy) percentage points. The care economy spending has a slightly higher rate of self-financing. The self-financing structure of the care economy, GFCF and the green economy, enhanced by large multiplier effects, strongly justify increasing these expenditures.

All policy tools are needed for the big push required to mobilise a sufficient and urgent amount of public investment to tackle the intersecting crises of inequalities, care and climate change. This mobilisation requires a combination of progressive taxation of both income and wealth.[19] A study in the UK found that increasing the tax rate on wealth has a high positive impact on output (employment and the budget) because it decreases wealth concentration, which in turn reduces the financialisation of non-financial companies, market concentration and barriers to entry, and thereby stimulates private investment (Onaran et al., 2023). As such, wealth taxation is a particularly effective policy to fund purple and green public spending, while tackling income, gender and wealth inequalities.[20]

However, the scale and urgency of spending needs and the time lags required to implement changes to tax legislation implies that using public borrowing to fund some

[19] See Hoy and Sumner (2020) for a discussion on the potential of redistributive tax policies in emerging economies such as South Africa.
[20] See Tippet et al. (2021) for the tax revenue potential of a progressive scheme of wealth taxation, aimed at the top 1% of the wealthiest households in the UK.

of this spending can be justified. This is because of the positive externalities and public good benefits resulting from spending in these sectors. Therefore, refocusing monetary policy to accommodate a well-targeted long-term public investment programme is justified, while national development banks have been historically very effective in funding large-scale public infrastructure projects.

Coordinating fiscal policies with labour market policies strengthens the effects of fiscal spending and eases the funding pressures, as higher wages lead to higher tax revenues by increasing aggregate demand further (Onaran, 2016; Obst et al., 2020; Onaran et al., 2019). Strong pro-labour institutions are good for an equality-led and sustainable development, i.e., well-coordinated trade unions, equal pay legislation, increased job security, permanent contracts, higher minimum wages, equitable parental leave and a shorter working week.

Last but not least, the high-income countries of the global North have an important role to play. For an emerging economy such as South Africa, international policy coordination can make a big difference. If the large high-income economies lead the way by pushing the global demand through increasing public expenditures, this eases the constraints on the import-dependent, balance of payments-constrained emerging economies. If policies are implemented simultaneously in many countries, the effects of public spending are stronger and negative current account balance effects are moderated (Onaran, 2016; Obst et al., 2020; Wildauer et al., 2021). Capital controls and foreign direct investment policies may also help to manage short-run constraints on the balance of payments. Transfer of technology through foreign direct investment to support large-scale investment in solar panels, turbines or batteries for storing renewable energy is key to tackle climate change in the context of global climate justice.

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Appendix 1. The theoretical model

The model is based on Onaran and Oyvat (2023), which extends Onaran et al. (2022b, 2023) with public spending in renewable energy, energy efficiency and public transport. The model also presents endogenous labour force participation and wage bargaining equations, as discussed in Oyvat and Onaran (2022). See Onaran et al. (2022b, 2023) for a more detailed technical presentation of an earlier version of the model without these extensions.

The economy has three sectors:

i) The social sector, which consists of the current expenditure of the government in the care economy, i.e., provides the public services in education, childcare, healthcare, and social care (contributing to the development of human capabilities using paid labour, as defined by Braunstein et al., 2011).
ii) The rest of the market economy.
iii) The unpaid care sector.

The model introduces two types of workers: women and men, and the profits are earned by the employers, who are genderless for simplicity in the model.

Aggregate output and income are equivalent to the sum of the wage income of men and women and profits.

The total wage income of women workers is a function of women's wage rate in the social sector, women's employment in the social sector, women's wage rate in the rest of the economy, and women's employment in the rest of the economy.

Similarly, the total wage income of men workers is a function of men's wage rates in the social sector, men's employment in the social sector, men's wage rates in the rest of the economy, and men's employment in the rest of the economy. Gender wage gaps are the ratio of men's wage rate to women's in each sector.

The aggregate output in the market economy (GDP, excluding unpaid activities) is the sum of household social expenditure; household consumption in the rest of the economy; private investment expenditure; government's social expenditure in the care economy; government's current spending in renewable energy, energy efficiency and public transport; public investment (gross fixed capital formation, GFCF); government's other expenditures; and net exports of goods and services.

Government's social expenditure in the care economy comprises the public social sector output. The rest of the GDP is the market output in the rest of economy, which provides the goods and services to meet both private demand (household consumption, private investment and exports) and government demand for spending in REEEPT and public transport, public infrastructure investment (GFCF) and other expenditures. Economic activity in the rest of the economy provides output for both spending in the green economy and the rest of economic activities.

The share of government's current expenditure in the care economy, in REEEPT, public infrastructure investment and other spending are all determined as a fiscal policy decision as a share of aggregate output.

Employment in the rest of the economy is determined by output and labour productivity in the rest of the economy (and is equal to output divided by productivity).

The share of women in employment in each sector is socially determined by occupational segregation.

The wage paid to men and women workers in the social sector constitutes the public social expenditure, and the social sector is not making profits. Any non-labour inputs used constitute part of other government expenditure. Thus, public social expenditure is a function of women's and men's wage rate and employment in the social sector.

Profits, i.e., the operating surplus in the rest of the economy, is income minus wage payments. The profit share is the share of profits in output in the rest of the economy. It is a negative function of men's and women's wages and employment and a positive function of labour productivity in the rest of the economy.

Next, the model introduces unpaid domestic care labour within the households. For a given demographic structure defining the care needs of society, higher-paid employment by men and women is expected to have some negative impact on the supply of unpaid labour. An increase in government expenditure in the social sector (in education, childcare, health and social care) is also expected to reduce the need in the households for care; therefore, it leads to lower unpaid labour. The impact of employment and public social expenditure on time spent on unpaid domestic care might be non-linear, and this negative impact might be decreasing in absolute values, as it gets increasingly more difficult to decrease unpaid care at lower levels of unpaid care. Unpaid domestic care labour is shared between women and men and is exogenous and institutionally and socially determined.

On the demand side of the model, components of aggregate demand are defined by behavioural equations.

Consumption of households in goods and services other than social expenditure is a function of after-tax wage income of men and women workers in both sectors and profit income of capitalists. The households' social expenditure is also a function of after-tax profit and wage income of women and men workers in the two sectors, albeit with different parameters and government's social expenditure. The marginal propensity to consume in goods and services produced in the social sector and the rest of the economy is assumed to be different for men and women workers, who make separate decisions albeit interdependent and within the same household,[21] reflecting

[21] Previous research shows that the marginal propensity to consume on social services is larger for women than men and the marginal propensity to consume in the rest of the goods and services is larger for men than women (Onaran, Oyvat, and Fotopoulou, 2022a, b; Seguino and Floro, 2003; Morrison, Raju, and Sinha, 2007; Lee and Pocock, 2007).

the gender pay gaps as well as gendered differences in behaviour. Government's social expenditure can, on the one hand, increase households' social expenditure by providing wage income in the social sector and, on the other hand, decrease households' social expenditure by reducing the need for these expenditures. Government's current or capital spending in REEEPT also affect consumption of the households in two opposite directions, e.g., on the one hand, the provision of public transport may reduce the demand for private cars and, on the other hand, government spending leads to indirect rebound effects by increasing household income available for other consumption goods (See Dafermos et al., 2022).

Private investment is expected to increase due to higher aggregate output and after-tax profit share in the rest of the economy. Government's infrastructure investment may have further positive direct effects on private investment by improving infrastructure and business expectations or substituting private investment in infrastructure. The model also introduces the effect of public debt-to-GDP on investment to consider the possible negative crowding-out effects of rising public debt on the interest rate and, thereby, private investment (See Dafermos et al., 2022).

Public debt at a point in time is the public debt accumulated in the previous period plus interest on this debt, plus the total government expenditure in the current period and minus the taxes collected from profits in the current period.

Exports are expected to increase with the income of the trading partners and the depreciation in currency and to decrease with an increase in relative prices of exports to imports.

Imports increase when domestic demand in N or domestic prices relative to import prices increase and decrease with the deprecation in currency. For simplicity, we assume that the marginal propensity to import in the social sector is negligible.

Domestic prices and export prices are set as a mark-up on nominal unit labour costs and other imported input costs depending on the oligopolistic market power of firms in an imperfectly competitive market. 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 (corrected for the ratio of GDP at factor cost to GDP at market prices), 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.

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.[22]

[22] Increasing productivity in the social sector is less related to the availability of technology, as the quality of these services is more important and, in many cases, requires more nurses, care workers, teachers per patient or student. Productivity in the social sector is determined simply by definition by output per employee.

In the medium run, labour productivity is likely to be positively influenced by government's spending in the social sector, REEEPT and public investment with some time lag. We also expect households' consumption expenditure in marketised social services and domestic unpaid care labour to positively affect labour productivity. Higher output also leads to higher labour productivity due to Verdoorn effect (Naastepad, 2006; Hein & Tarassow, 2010), as greater scale can lead to more efficient allocation of sources. Moreover, we consider that higher wages lead to labour-saving technologies as well as higher effort, which increases the labour productivity. Finally, the labour productivity is expected to be path-dependent and related to its past values, since part of the technology from the last period is transferred to the following period. We expect the effects of these to be realised over the medium run. The medium run in the model is a sufficiently long period for these effects on productivity 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.

Women's and men's labour force participation rates (labour force as a ratio to population) are positive functions of average wages, benefits and social infrastructure and negative functions of unpaid domestic care labour. For simplicity, we assume that population is exogenously determined, as changes in fertility and mortality take a much longer period than our medium-term theoretical and empirical analysis in this paper. If employment grows faster than the labour force for a particular type of worker, unemployment rate decreases, and vice versa. If demand for employment 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, there will either be an exogenous increase in labour supply due to migration, or gender norms and occupational segregation coefficients will change, or wages will adjust. Similarly, a rise in wages in a particular sector, e.g., in the social sector 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 also to 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 the wage rates in the social sector are exogenously determined by the government as a policy decision, we allow the wage rates for men and women in the rest of the economy to be determined endogenously as an outcome of a bargaining process between employers and workers. The bargaining power of women and men workers depends on the changes in labour demand in each sector and labour supply of men and women, as well as exogenous factors determined by labour market institutions and legislation, social wage (determined by public social expenditure or parts of public infrastructure, such as public transport or social housing), social norms, and occupational segregation effected by these norms, as well as personal characteristics, such as education which in turn are affected by social norms. For simplicity, we assume expected prices are equal to actual prices. Hence, the real wage rates in the rest of the economy are functions of the employment (or unemployment)

rate for men and women, spill-over effects from wages in the social sector and across genders, and a set of exogenous factors affecting the bargaining relations. The spill-over effects of wage setting in the social sector are twofold: Wage setting in the public sector affects the wage norm and negotiations in the rest of the economy, too. Moreover, public spending in the social sector provides the social wage and improves the bargaining power of the workers in the rest of the economy.

Finally, the gendered distribution of labour, i.e., women's share in labour in both the paid economy in the social sector and the rest of the economy and in the unpaid economy, changes endogenously with changes in wages and employment of men and women and unpaid labour requirements with a lag in the medium run.

Appendix 2: List of variables in the econometric estimations, data sources and period

Variable†	Source	Period
Care sector output (education, health care, social care expenditures), constant local currency)	Public education: World Bank, World Development Indicators for 2000–2019; UN Data for 1993–1999*; UN Data for 1970–1992*‡. Healthcare: WHO Global Health Expenditures for 2000–2019; UN Data for 1993–1999*; UN Data for 1970–1992*‡.	1970–2019
Public gross fixed capital formation (general government, constant local currency)	IMF Investment and Capital Stock Dataset, 1960–2019	1970–2019
Construction value added (constant local currency)	UN Data for 1970-2019.	1970–2019
Transportation (excluding air transportation) value added (constant local currency)	UN Data for 1970-2019±.	1970–2019
GDP (constant local currency)	World Bank, World Development Indicators	1970–2019
GDP deflator	World Bank, World Development Indicators	1970–2019
Employment (total, men, women)	World Bank, World Development Indicators for 1991–2019. Employment data for 1976–1990 calculated based on registered unemployment data for 1976–1990 and labour force participation data interpolated from World Bank, World Development Indicators data for 1970, 1980, 1985, 1991.	1976–2019
Non-agricultural employment (total, men, women)	ILO for 1991–2019	1991–2019

Non-agricultural employment (total, men, women) -cont.		
Employment-to-population ratio (15+; total, men, women)	Employment (15+; total, men, women)/total population (15+; total, men, women) World Bank, World Development Indicators for total population (15+; total, men, women) for 1970–2019.	1976–2019
Population (15+; total, men, women)	World Bank, World Development Indicators for total population (15+; total, men, women) for 1970–2019. UNDESA, World Population Prospects 2019 for population (15+; total, men, women) projections for 2024.	1970-2024
Manufacturing sub-industries, value added (constant local currency)	UNIDO Industrial Statistics Database Manufacturing, South Africa has only 2-digit ISICRev3 data: plastic products (code 2520), glass products (2610), cement and plaster (2694) and concrete products (2695), non-ferrous metals (2720), fabricated metal products (all sub-industries, i.e., 281, 289), general purpose machinery (291), special purpose machinery (292), domestic appliances (2930), electrical machinery and apparatus (31, all sub-industries), electronic valves, tubes, etc. (3210), railway/tramway locomotives & rolling stock (3520), Manufacture of other transport equipment n.e.c. (3599)	1970-2018

Source: Onaran and Oyvat (2023)

†All nominal variables for value added and output are deflated by GDP deflator

** Output data including total other community, social and personal services linked to series on education or health and social care provided by the database for the later period.*

ǂ Value added data linked with the series for the later period

± Data on all transportation, storage and communications industry value added linked with the series for the later period

Appendix 3: Tables A3.1 to A3.4

Table A3.1 The distribution of public spending for the care economy, public infrastructure, and green transition across industries (RE+EE+PT) as a ratio to GDP

			South Africa							
						Ratio to GDP				
Care: Health and social care + Education & childcare						0.01000				
Public infrastructure: Public gross fixed capital formation						0.01000				
			Industry	Manufacturing Industry code (ISIC4 Rev3 code)	Industry share in RE, EE or PT	Ratio to GDP				
Green (REEEPT)						0.01000				
	Share in REEEPT	Share in RE								
Renewable energy (RE)	0.50					0.00500				
Solar		0.25				0.00125				
			Electrical machinery	31 (total)	0.51	0.00064				
			Glass products	2610	0.08	0.00010				
			Non-ferrous metals	2720	0.08	0.00010				
			Structural metal produc	281	0.10	0.00013				
			Engines, turbines	2911	0.07	0.00009				
			Construction		0.16	0.00020				
Wind		0.25				0.00125				
			Construction		0.13	0.00016				
			Construction services		0.13	0.00016				
			Plastic products	2520	0.13	0.00017				
			Other fabricated metal	289	0.13	0.00017				
			General machinery	291	0.38	0.00048				
			Lifting equipment	2915	0.04	0.00006				
			Electrical machinery	31 (total)	0.04	0.00006				
Geothermal		0.25				0.00125				
			Construction		0.60	0.00075				
			Pumps, compressors	2912	0.40	0.00050				
Hydro		0.25				0.00125				
			Plaster, cement	2694	0.33	0.00041				
			Construction		0.18	0.00023				
			Engines, turbines	2911	0.21	0.00027				
	Share in REEEPT	Share in EE	Electrical machinery	31 (total)	0.28	0.00035				
Energy efficiency (EE)	0.20					0.00200				
Public and private buildings		0.5				0.00100				
			Construction		0.50	0.00050				
			Construction services		0.50	0.00050				
Industrial energy efficiency		0.25				0.00050				
			Special machinery	292	0.40	0.00020				
			General machinery	291	0.20	0.00010				
			Engines, turbines	2911	0.20	0.00010				
			Construction		0.10	0.00005				
			Construction services		0.10	0.00005				
Grid upgrades		0.25				0.00050				
			Construction		0.13	0.00006				
			Construction services		0.13	0.00006				
			General machinery	291	0.25	0.00013				
			Electrical machinery	31 (total)	0.50	0.00025				
	Share in REEEPT	Share in PT								
Public transport (PT)	0.30					0.00300				
Public transport vehicles: locomotives, rolling stock		0.10			0.10	0.00030				
Public transport services		0.72			0.72	0.00216				
Construction		0.18			0.18	0.00054				

Table A3.2 The distribution of green public spending in industries (RE+EE+PT) as a ratio to GDP

South Africa							
Industry	ISIC4 Rev3 code	ISIC4 rev4 code	Ratio to GDP				
Plastic products	2520	2220	0.00017				
Glass products	2610	2310	0.00010				
Plaster, cement	2694	2394	0.00041				
Non-ferrous metals	2720	2420	0.00010				
Structural metal produc	281	251	0.00013				
Other fabricated metal	289	259	0.00017				
General machinery	291	281	0.00071				
Engines, turbines	2911	2811	0.00045				
Pumps, compressors	2912	2813	0.00050				
Lifting equipment	2915	2816	0.00006				
Special machinery	292	282	0.00020				
Electrical machinery	31 (total)	27	0.00130				
Locomotives, rolling stock	352	3020	0.00030				
Sum of manufacturing sub-industries providing input to REEEPT/GDP			0.00458				
Construction			0.00327				
Public transport services			0.00216				
Total: (manufacturing+consr uction+public transport services)/GDP			0.01000				

Source: Onaran and Oyvat, 2023

Notes: How an increase in spending in REEEPT by 1% as a ratio to GDP is allocated to manufacturing sub-industries and construction is based on Table A.3 in UNIDO and GGGI (2015) based on input-output tables for renewable energy and energy efficiency (REEE) spending (excluding biofuel). The allocation of spending in public transport to construction, manufacturing of rail transport vehicles (3520) and transport services is based on APTA (2020). Mining has a weight of 0.10 in geothermal industry in UNIDO and GGGI (2015) which we allocated to construction to simplify the systems estimation. Research and development (R&D) are distributed to manufacturing to simplify the systems estimation and due to lack of long time series on R&D which starts after 1995 or even in 2000s in some cases.

Table A3.3 Average annual low-carbon energy investment requirement as a ratio to GDP (%) for the period of 2016–2050 under different scenarios estimated by different models

Table A3.4 Average annual low-carbon energy investment requirement as a ratio to GDP (%) for the period of 2016-2050 under different scenarios estimated by different models

County/Region	Model	Current Policies	Net zero 2050 (1.5°C)	Additional low-carbon investment required to limit global warming to 1.5°C compared to current policies
South Africa*	GCAM5.3_NGFS	0.58	2.69	2.11
Middle East and Africa**	AIM/CGE	0.22	4.08	3.86
	IMAGE	0.61	1.57	0.96
	MESSAGEix-GLOBIOM	0.24	1.65	1.41
	POLES	0.52	3.12	2.60
	REMIND-MAgPIE	1.18	5.88	4.70
	WITCH-GLOBIOM	0.66	9.10	8.44

*Source: *Ratios to GDP are own calculations based on required investment amount reported in Bertram et al. (2021).*
Net-Zero 2050 is a scenario that limits global warming to 1.5°C through climate policies and innovation, reaching net zero CO2 emissions around 2050, which is compatible with the long-term temperature goal of the Paris Agreement.
Current Policies assumes that only currently implemented policies are preserved, leading to a global warming by up to 3°C by 2100 and high associated climate impacts.
Country specific estimates are provided based on the GCAM5.3_NGFS Model.
***McCollum, et al. (2018) Supplementary Data Tables, which provides country estimations only for India among the countries analysed in this report and regional estimates, which we list as an indicative reference.*

Table A3.4 The cost of expansion of care services under the "status quo"* vs. "high road"** scenarios as a ratio to GDP (%)

Table A3.3 The cost of expansion of care services under the "status quo"* vs. "high road"* scenarios as a ratio to GDP (%)

	"Status quo" scenario	"High road" scenario	Additional spending in care services required by 2030 for the "high road" scenario compared to current policies: "high road" - "status quo"	
India	3.6	8.6	5	
Indonesia	3.9	12.5	8.6	
Philippines	14.1	19.6	5.5	
South Korea	11	12.3	1.3	

Source: : İlkkaracan and Kim, 2019, also reported in ILO 2020
Note:
**In the "high road" scenario, care services are expanded by 2030 in terms of the extent of population coverage, as well as the quality of services provided and employment created, to meet the requirements of SDGs; in particular, SDG 5, target 5.4, calling for the provision of public care services; SDG 3 on health and well-being; SDG 4 on quality education; and SDG 8 on full and productive employment and decent **work.*
The "status quo" scenario is the baseline case, which assumes that care services will expand in line with population increases but with the current coverage rates, quality standards and working conditions in care sectors remaining constant, with the result that both care deficits and decent employment deficits persist into 2030.

Appendix 4: Estimation methodology

This report presents the estimation results in Onaran and Oyvat (2023) for South Africa. Onaran and Oyvat (2023) use a systems approach, based on vector autoregression (VAR), as the estimation methodology in order to tackle the multi-dimensional complex causal relations between public spending, output and employment as described in Section 3.

In previous literature, Oyvat and Onaran (2022) use VAR to estimate the effects of public spending in the care economy in South Korea. Batini et al. (2020) estimate the effects of public spending in clean renewable energy and alternatives on GDP using semi-structured VAR for a panel of countries. Wildauer et al. (2021) estimate a VAR model on the effect of public gross fixed capital formation on GDP in the European Union. Onaran and Stockhammer (2005) estimate the effect of functional income distribution on output and employment using VAR for the cases of Turkey and South Korea. Stockhammer and Onaran (2004), Barbosa-Filho and Taylor (2006), Kiefer and Rada (2015), and Jump and Mendieta-Muñoz (2017) estimate the effect of the wage share or wages on output and/or employment for the USA, UK or France. The advantage of this approach is that the interaction between public spending, wages, employment, demand and productivity can be incorporated, and it is more suitable to deal with the endogeneity issues and accounting for dynamic endogenous changes in wages, labour supply, occupational segregation, productivity and unpaid work. VAR allows for tracing the effects through an entire system rather than analysing one equation at a time. However, using this approach requires a focus on a subset of the variables in the theoretical model, since degrees of freedom in the estimations could quickly erode with extra variables due to use of multiple lags (Enders, 2015).

Onaran and Oyvat (2023) used in this report, carry out country-specific estimations using time series data. The estimation period is determined by data availability for each country. We estimate the impact of an increase in public spending in public infrastructure (public GFCF), the care economy, sub-industries providing inputs to REEEPT, on employment of men and women in the non-agricultural sector and GDP. Combining the effects on employment of men and women in the non-agricultural sector, we calculate the effects on total non-agricultural employment. The employment indicator in the econometric estimations is based on the non-agricultural sector to avoid potential biases due to the high share of informal or self-employed or unpaid family workers in agricultural employment.

Technically, we estimate the VAR model based on the following specification:

$$AX_t = A_0 + A_1 X_{t-1} + e_t \quad \text{(A4.1)}$$

which can be written in reduced form as

$$X_t = C_0 + C_1 X_{t-1} + u_t \quad \text{(A4.2)}$$

X_t is a vector of endogenous variables consisting of the logarithmic change in the public expenditure items, employment of men and women in the non-agricultural sector (E_t^M *and* E_t^F), and GDP (Y).

We estimate alternative specifications with different combinations of public spending variables:

1) Specification (1) consists of five variables in the system in the following order: public GFCF, output in the social sector (education, childcare, health and social care), employment of men and women in the non-agricultural sector, and GDP. We do not include REEEPT together with public GFCF in the same specification to reduce double counting, as most of the infrastructure spending involves construction and inputs from manufacturing. This specification accounts for public spending in REEEPT as part of the total public GFCF and excludes the current spending in REEEPT.

2) Specification (2) includes the sub-industries providing input to REEEPT, existing of six variables with the following order: value added in construction, public transport services (excluding air transport), the value added of a synthetic sector consisting of the sum of the value added of manufacturing sub-industries providing input to REEEPT,[23] employment of men and women in the non-agricultural sector, and GDP. We use the value added in public transport services, construction, and manufacturing sub-industries as separate variables rather than using their sum for REEEPT, as they are expected to have different multiplier effects due to differences in their labour intensity and imported input content.

X_t for the first specification with five variables is as follows:

$$X_t = \begin{bmatrix} \log(I_t^G) \\ \log Y_t^H \\ \log(Y_t) \\ \log(E_t^M) \\ \log(E_t^F) \end{bmatrix} \qquad \text{(A4.3)}$$

where I_t^G is public GFCF, Y_t^H is output in the social sector (alternatingly referred as the care economy: education, childcare, health and social care), Y_t is GDP, and E_t^M *and* E_t^F is employment of men and women in the non-agricultural sector.

From (1) and (2), $Au_t = e_t$:

$$a_{41}\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{52} & a_{52} & 1 \end{pmatrix}\begin{pmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \end{pmatrix} = \begin{pmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \end{pmatrix} \qquad \text{(A4.4)}$$

where e_t are structural shocks. Equation (4) defines the contemporaneous effects.

X_t for the second specification with six variables is as follows:

[23] For South Africa, this is the sum of value added in manufacturing sub-industries 2520, 2610, 2694, 2720, 28 (all sub-industries, i.e., 281, 289), 291, 292, 31 (all sub-industries), 3210, 352. The names of the industries are listed in Section 2 and further details are in Appendix 3. When taking the sum of sub-industries, we use value added rather than output to avoid double counting. Similarly, as the VAR methodology accounts for the effect of an increase in demand in one industry on the others, we also use the value added in construction and public transport services.

$$X_t = \begin{bmatrix} \log Y_t^C \\ \log Y_t^{PT} \\ \log Y_t^{MRE} \\ \log(Y_t) \\ \log(E_t^M) \\ \log(E_t^F) \end{bmatrix} \qquad \text{(A4.5)}$$

where $Y_t^C$is value added in construction, $Y_t^{PT}$is the value added of transport services, $Y_t^{MRE}$is sum of value added in manufacturing sub-industries providing input to REEEPT (see Section 3), Y_t is GDP and E_t^M *and* $E_t^F$is employment of men and women in the non-agricultural sector**.**

The contemporaneous effects for specification two are defined in Equation (A4.6):

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \end{pmatrix} = \begin{pmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \\ e_6 \end{pmatrix} \qquad \text{(A4.6)}$$

All variables are in logarithms.

We estimate VAR with Cholesky decomposition imposing a triangular structure for the contemporaneous effects for simplicity, given the low number of observations and the relatively high number of variables in the systems. In the VAR estimations, public spending variables are the most exogenous variables, as they are part of a policy decision. In specification (1), public gross fixed capital formation comes at the top of these exogenous public spending variables due to the time lags required to plan and implement these projects. Public spending in the care economy (social sector) is affected by GFCF but is contemporaneously exogenous to GDP and employment. In specification (2), value added in construction comes at the top of these exogenous public spending variables, followed by public transport services, which depends on construction but is otherwise contemporaneously exogenous, while value added in manufacturing sub-industries are affected by the value added in construction and public transport contemporaneously. In all specifications, an increase in any public expenditure affects aggregate output (GDP) contemporaneously. Finally, public spending categories and aggregate output (GDP) affect the employment of men and women contemporaneously. As VAR specification allows limited number of contemporaneous effects, the rest of the interactions in the VAR specification are through lagged effects of all the variables affecting each other.

Both specifications (1) and (2) are estimated by introducing total employment instead of employment of men and women as two separate variables to test for robustness, and the results are largely robust.

To test for further robustness or to improve the significance and explanatory power, we also estimate the systems i) in first differences of the variables; ii) for alternative orders of different public spending categories; iii) two or three lags; iv) with a time trend to account for structural change and other variables that we do not account for in

the system estimations (e.g., wage rates, labour market institutions, terms of trade, imported input prices) or other exogenous control variables such as population (+15), informal economy share in GDP, level of urbanisation, real exchange rates, world GDP, trade openness/GDP, oil rent/GDP in the world, mineral rent/GDP in the world. The details of the specifications chosen as the baseline for simulations are summarised in Table A4.1-2.

We calculate the effects of a 1%-point increase in GFCF, the care economy output and the value added of the three sub-industries providing input to REEEPT in terms of the percentage change in GDP, and employment of women and men by using the cumulative impulse response function coefficients[24] which report the response of GDP, and employment of women and men (in logarithms) to a one standard deviation increase in changes in public spending categories (all in logarithms, reported in Figure A5.1 and A5.2) for five periods. Figures 2-8 present these effects. The transformations use data of the last year of the estimation period for GDP, employment and public spending categories. In the case of REEEPT in Figure 6, we report the sum of the statistically significant effects in response to an increase in the value added of manufacturing sectors providing input to REEEPT, construction and transport based on separate estimates of impulse responses to the increase in each sector; i.e., the total effects of an increase in the value added in construction by 0.327%-point, public transport services by 0.216%-point, manufacturing sub-industries providing input to REEEPT by 0.458%-point, all as a ratio to GDP (based on the weights presented in Appendix Table A3.2). As we consider the sum of only the significant effects for each sub-sector providing input to REEEPT in each period, the effects in Figure 6 are more volatile from year to year.

Next, we calculate the cumulative effects of repeating these stimuli for five years.[25]

Based on these estimations, we calculate the effects of public spending on the employment rate (total as well as for men and women) for the projected rate of growth of population (applying the rate of growth in non-agricultural employment to total employment).

Finally, we calculate the sum of the employment effect of an increase in care, REEEPT and public gross fixed capital formation. Alternative specifications (1 and 2) discussed above are used to present the cumulative effects on employment and GDP.

A note about the issue that our RE category does not include current spending for energy production using renewable energy is in place here. The VAR methodology partly addresses this issue by accounting for the lagged multiplier effects of capital investment in RE on total employment. We also do not explicitly estimate the effects of

[24] Due to the short estimation period, we report only the impulse responses for five years after the shock. In specification 1 in the following periods and countries, we take some statistically insignificant effects into account when calculating the cumulative effects where we failed to find statistically significant effects (within 90% confidence interval). In South Africa in year 0 the response of women's employment to public GFCF, in year 0 response of GDP, year 0–3 response of women's employment and year 0–5 of men's employment to care sector.

[25] Five years is realistic as a new term of policy change in the government policies as well as allowing policies to meet the urgency of the required investment by 2030.

disinvestment in the fossil fuel-based activities, but the theoretical channels allow for the possibility for green (REEEPT) investment to substitute or decrease fossil fuel-based/high-carbon investment or consumption demand as far as historical data captures such relationships, albeit in a limited sense given that the transition to renewables is a relatively new process. Nevertheless, our results show the employment potential of green economy and care economy to open space for policy discussion for redeployment in low-carbon sectors away from the high-carbon sectors.[26]

Table A4.1. Details of specification 1

	Estimation period	**Lags**	**Level / difference**	**Control variables**	**Order of variables**
South Africa	1993–2018	1	Difference	Δurban; Δinformal; Δrent_gdp_w; Δlog(population_15)	output in the social sector, public GFCF, GDP, E_t^M, E_t^F

Source: Onaran and Oyvat (2023)

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Table A4.2. Details of specification 2

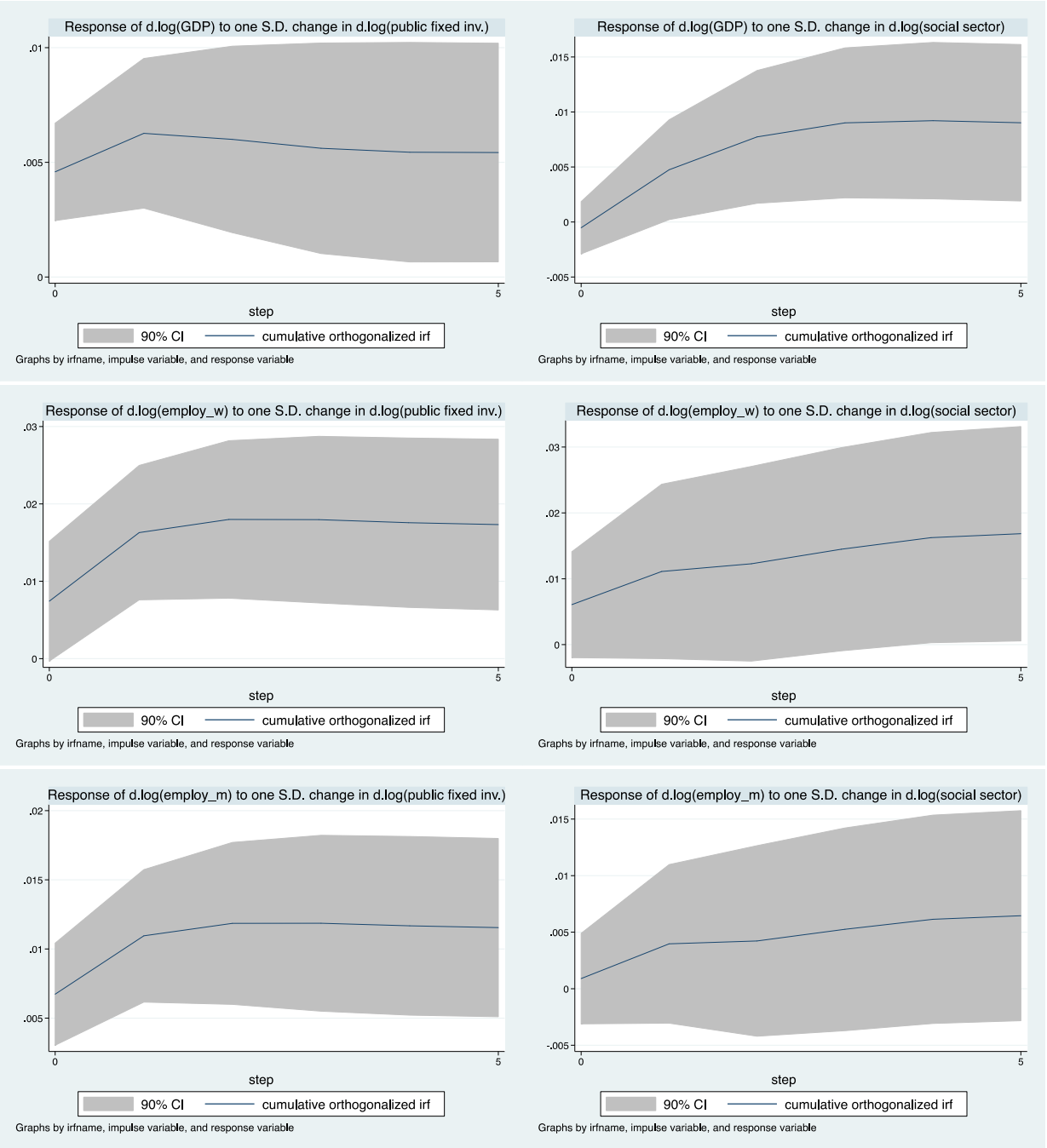
	Estimation period	**Lags**	**Level / difference**	**Control variables**	**Order of variables**
South Africa	1994–2018	2	Difference	Δrer; Δlog_population_15; Δrent_gdp_w; Δinformal; durban	as in A4.5

Source: Onaran and Oyvat (2023)
Notes: See Note in Table A4.1

[26] The effects of renewable energy investment on emissions depend on what happens with high-carbon spending. The emission reduction will be much higher in the case in which the investment in renewables increases and the investment in fossil fuels declines, compared to the case in which the investment in renewables increase and the investment in fossil fuel remains unchanged.

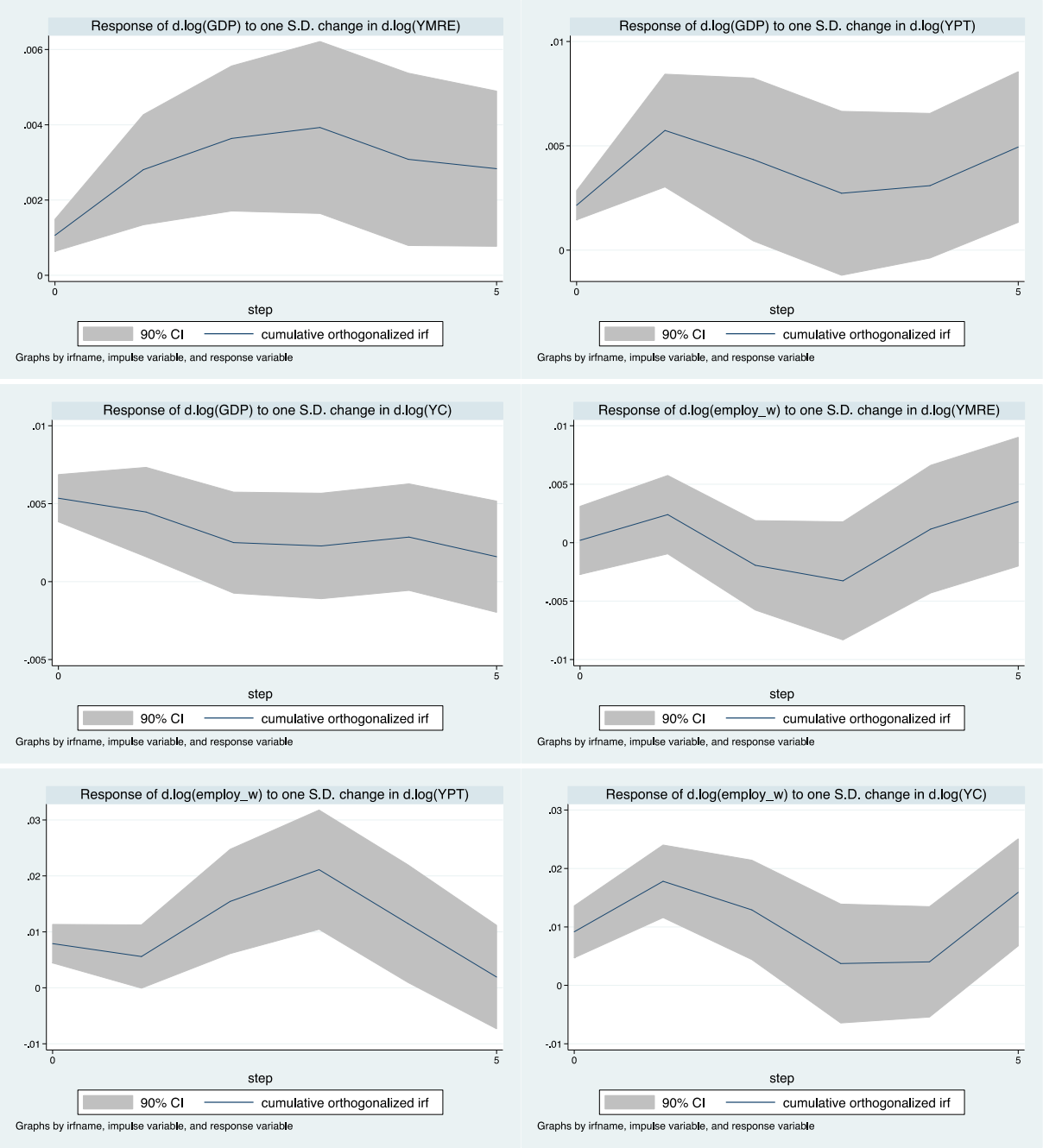
Appendix 5

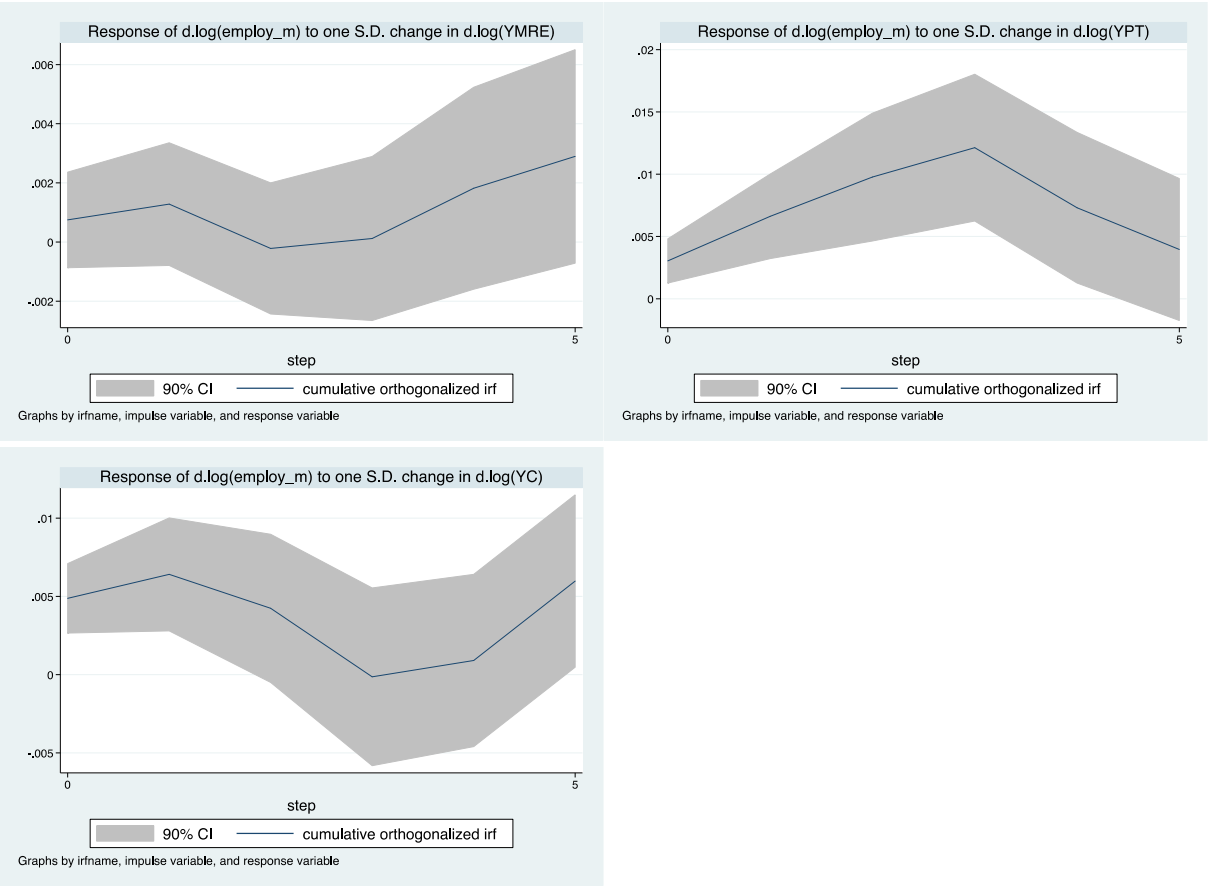
Figure A5.1. Cumulative orthogonalised impulse response functions based on specification 1: the response of GDP and women's and men's employment (employ_w and employ_m, in non-agricultural sector) to a one-standard deviation increase in public gross fixed capital formation and social sector output (care economy)



Source: Onaran and Oyvat (2023)

Figure A5.2. Cumulative orthogonalised impulse response functions based on specification 2: the response of GDP and women's and men's employment (employ_w and employ_m, in non-agricultural sector) to a one-standard deviation increase in value added in manufacturing sector that supplies inputs to REEEPT (YMRE), transportation (air transportation excluded, YPT), construction (YC)





Source: Onaran and Oyvat (2023)