Road to Net Zero: Bridging the investment gap in Europe

Macroeconomic spillovers of green investments

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"*This is Europe's man on the moon moment. The European Green Deal is very ambitious, but it will be very careful in assessing the impact of every single step we're taking*" Ursula von der Leyen, European Commission President, 2019

"*We are seeing the beginnings of the era of climate barbarism.* [...] *We have a once-in-a-century chance to tackle climate change*", Naomi Klein, The Guardian interview, 2019

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Introduction

Albert Einstein famously stated that we cannot solve our problems with the same thinking we used when we created them. In light of the impending environmental predicament, it is imperative for Europe to embrace a fresh perspective and intensify green funding to decarbonise the economy and ensure a sustainable future. It is from this context that the project titled "Road to Net Zero: Bridging the investment gap in Europe", is born. It is being undertaken by the Rousseau Institute, a think tank that is devoted to the ecological, social, and democratic reconstruction of our economies. The Green Alliance in the European Parliament has commissioned the think tank to estimate the amount of green investment required to decarbonize the European economy by 2050. This dissertation is based on my end-of-study internship within the project. One of the primary questions that the project raises and that serves as the foundation of this thesis is: What are the macroeconomic spillover effects of the green investments necessary to decarbonise the European economy? The firsthand objective of the internship, which will conclude in July, is to comprehend the macroeconomic consequences in terms of their impacts on the following variables: GDP, employment, productivity, private investment, and balance of payments. For this dissertation, I have opted to focus on the effects of green investment on GDP, employment, productivity, and private investment for the sake of time.

Allow us to establish a few concepts to aid in comprehending the undertaking:

- Investments: the meaning of "necessary investments" utilized here is influenced by the concept of "investment expenses" in a project or asset, pertaining to the initial expenses to be taken into account while implementing a change. This excludes the "operational" or "maintenance" expenses that occur throughout the project's lifespan. Nevertheless, this definition is not limited to a purely financial perspective, and, for the sake of simplicity, it is used here to refer to a wider range of economic objects and types of flows, particularly within the public sector. These include direct public spending (such as investments in public transport), public support for private investments (such as the car conversion bonus), transfer mechanisms between private entities that pass through public accounts (such as additional remuneration for renewable energy producers), reductions in tax revenue, and more.

- Net carbon neutrality: it refers to achieving a balance between the amount of greenhouse gases emitted, and the amount removed from the atmosphere, resulting in zero net emissions. This can be achieved through a combination of reducing emissions, investing in renewable energy and carbon sequestration, and offsetting remaining emissions through actions such as tree plantings.

- Macroeconomic spillover effects of investment: it refers to the indirect impacts that investment in one sector or country has on the wider economy, both domestically and internationally. These spillover effects can include changes in employment, income, trade, and productivity, as well as shifts in exchange rates, interest rates, and financial flows. The magnitude and direction of these spillovers depend on a range of factors, including the size and nature of the investment, the characteristics of the affected sectors or countries, and the broader macroeconomic conditions.

My research question is a topical question because there is currently a strong push towards decarbonizing the European economy, with many countries committing to ambitious targets for reducing greenhouse gas emissions. Green investments are seen as a key tool for achieving these targets, but there is a need to understand the broader macroeconomic

implications of these investments. Specifically, policymakers need to understand how green investments will affect employment, GDP, and productivity. By understanding the macroeconomic spillover effects of green investments, policymakers can design policies that promote sustainable economic target by advancing decarbonization goals.

To carry out my study, I have chosen to first estimate econometrically the relationships between the above-mentioned variables of interest. Therefore, I built a dataset with these variables for a panel of the 29 European countries on the 1995-2021 period. Then I used a Local Projection (LP) model, which is a statistical technique used to estimate the causal effects of a particular variable on another variable of interest. It is a non-parametric method that involves estimating a series of regression models, each of which captures the relationship between the considered variables over a different time horizon. The LP model is generally used to investigate the effects of various economic policies or events on different economic outcomes. For example, it can be used to estimate the impact of a monetary policy shock on inflation or the effect of a tax reform on GDP growth. One of the advantages of the LP model is that it allows researchers to estimate the causal effects of a specific variable while controlling for other factors that may be affecting the final result. This makes it a powerful tool for identifying causal relationships in complex economic systems. To be more specific, as argued by Jordà (2005) and Auerbach and Gorodnichenko (2017), there are various benefits to utilizing the LP approach:

1. it doesn't enforce dynamic limitations on the impulse response functions (IRFs) since it calculates distinct functions for each time horizon;

2. it's more resistant to misrepresentation;

3. it easily accommodates non-linearity. Many researchers have employed it to determine fiscal multipliers (Ramey, 2016; Auerbach and Gorodnichenko, 2017; Deleidi and Mazzucato, 2019; Deleidi et al., 2020)

From these results, I calculate the multiplier and cumulative multipliers of green expenditure to GDP and employment. Using my findings, I then approximate what could be the spillover effects of preliminary green investments estimations.

The thesis is organised as follows: Section (1) contextualise the thesis within the project of the Rousseau Institute, Section (2) provides an exploration of theoretical and methodological possibilities when it comes to studying the macroeconomic spillover effects of fiscal policies, Section (3) present the data and methodology used, Section (4) shows my findings and Section (5) provides first and non-exhaustive estimations of what could be the effect of the green investment needed to decarbonise the European economy.

Figure 1: Project Logo

1 Context

My master thesis took part of a broader project carried out by the Rousseau Institute, a think tank dedicated to the ecological, social and democratic reconstruction of our society. In 2022, the Institute published a reference study called "2% pour 2 °C". This study quantified the public and private investments needed to achieve carbon neutrality in France by 2050 and proposed a range of public policies to do so. Thanks to the political and media attention this report induced, the Green Alliance of the European Parliament commissioned them the same report at the European scale in order to build their arguments for the next European elections (2024). In light of this, the main goal of the thesis is to assess the macroeconomic spillover effects of the investments needed to decarbonize the European economy.

This assessment requires a series of steps. Firstly, people involved in the project have been divided by sectors since September 2022: energy, housing, carbon sink, industry, agriculture, transport, and waste. Each group has been studying the possible levers to decarbonize their sector. Once this is done, they will assess the cost of such policies, distinguishing between two types of investments: those that have already been planned, and the extra investments proposed by the Institute. It will then be possible to estimate the aggregate investment. Following this, the role of the report's "Finance team" is to answer the following questions: What are the tools deployed, and the institutions mobilized to finance the decarbonization? How will the funding burden be shared between private actors, Member States and the EU?[1] What will the macroeconomic spillovers of such investments be? To measure the spillovers and effects of investment on a given economy, it is important to know which type of investment we are talking about. Indeed, the transmission channels of the spillover and the magnitude of their impact depend on the choices made to finance the decarbonization. There are several possibilities and combination available in the current legal framework, namely the fiscal lever, government demand, public investment banks or savings mobilization. There also are unconventional solutions which can be defended at the borderline of what the Treaties allow, such as green quantitative easing or cancellation of public debt held by the central bank in exchange for green investments. However, the Institute also plans to promote more ambitious actions in order to complement the latter: reform EU's Treaties on the deficit rule and debt to GDP rule in order to increase the investment capacity, revise the rules on state aid or use free money as a pillar of ecological reconstruction or new green tax tools, just to mention a few of them.

The following literature review provides an analysis of theoretical background and existing tools which can be used to quantify the European fiscal multiplier and the effects of green investment on productivity, GDP, employment and private investment. In this literature review, I also justify the theoretical and methodological choices I have done in order to answer my research question.

2 Literature Review

While the United States' financial response to the Covid-19 pandemic has been more robust compared to the measures taken by European nations (Romer, 2021), the European

[1] Arbitrations will have to be defined here. For example, agriculture with the CAP is a sector largely financed by the EU, but industry is very national and may imply more responsibility in terms of carbon emissions

Union has presented a stimulus bundle amounting to around €2 trillion, with €1.2 trillion allocated for the EU's extended 2021-2027 budget and an €800 billion investment strategy funded by NextGenerationEU. One of the purpose of the project of the Rousseau Institute is to evaluate whether it will be sufficient or if more investment would be needed to face the challenge of the economy's decarbonization. It is therefore necessary to study the impacts of such investments on the economy, on growth, productivity, private investment or employment. Depending on the theoretical background used, different policy recommendations exist in order to achieve certain economic goals. It is thus important to set the different understanding of economic schools of thought in order to choose the most appropriate tools. For example, the neoclassical policy response concentrates on supply-side strategies to tackle secular stagnation, with emphasis on the significance of productivity and population dynamics in elucidating the decline in growth and implementation of budgetary consolidation. The primary objective of consolidation policies is to trim down government spending or augment taxes, with the expectation of boosting economic activity, private consumption, and investment by reducing the ratio of public debt to GDP and the spreads of sovereign debt bonds. Significantly, a substantial and trustworthy decrease in the ratio of public debt to GDP would result in decreased long-term interest rates and increased asset prices. This, in turn, was believed to encourage private spending, as per Ardagna (2004) analysis. The recommendation for this policy was based on the expectation that fiscal multipliers would be less than one or even close to zero, implying that fiscal consolidation policies would have non-Keynesian impacts.

However, the truth became clearer in the following years: implementing fiscal consolidations resulted in adverse effects on economic growth. It caused a significant increase in public debt-to-GDP ratios and unemployment rates. The long-lasting adverse effect on production were recently demonstrated by several researchers (Blanchard et al., 2015; Ball, 2014; Fatás and Summers, 2018).

Several economists and global organizations have raised doubts about the foundations of fiscal consolidation strategies and have recommended a well-crafted fiscal policy. They have emphasized that fiscal multipliers are frequently underestimated and should be taken into account. According to research-based literature, multipliers were undervalued by 0.7-1.3 units during the years 2010-2011 (Blanchard and Leigh, 2013), and austerity policies impeded growth, particularly during economic downturns (Jordà et al. (2016)). Recently, Fatás and Summers (2018) claimed that fiscal consolidation policies are likely to raise the public debt-to-GDP ratio due to their adverse long-term effects on GDP. Interestingly, neoclassical authors and institutions thus change their mind on public expenditure, especially when it comes to crisis recovery. For instance, the IMF and its ex-chief economist Olivier Blanchard emphasized the significance of employing fiscal stimulus as a means to revive economic expansion, combat unfavourable macroeconomic setbacks, and generate employment opportunities (Blanchard and Leigh, 2013)[2]. We thus naturally come to the other economic vision, that is demand-side approaches or heterodox approaches. These strategies propose the adoption of expansionary budgetary measures as a key instrument to enhance economic recuperation, particularly in a scenario where monetary policy is ineffective and limited by the zero-lower bound (Storm, 2020). As we will see afterwards, the key role played by demand in leading growth is no novelty in the Keynesian and especially post-Keynesian tradition with the study of multiplier and supermultiplier. Indeed, the idea of fiscal multiplier originates from conventional Keynesian macroeconomic analysis,

[2]See https://www.imf.org/en/Publications/FM/Issues/2020/09/30/october-2020-fiscal-monitor

where it signifies the impact of government spending on output. Specifically, the output multiplier is the quotient of the change in the output level and the exogenous alteration in the relevant fiscal variable. In this context, current income determines consumption and investment. When nominal rigidities and low resource utilization exist, an increase in government spending boosts aggregate demand and output. In fundamental Keynesian economics, the essential parameter for estimating the fiscal multiplier is the "marginal propensity to consume", which gauges the proportion of current income that is consumed instead of saved.

It is now recognized that discussing the multipliers instead of the multiplier is more accurate. This is because the value of fiscal multipliers is dependent on various factors related to the fiscal shock itself, the economic environment, and economic policy regimes. These factors include the nature and composition of the fiscal shock (whether it is permanent or temporary), the economic situation, the situation of partner countries, and the stress in financial markets. According to the IMF (Spilimbergo et al., 2009, p.5), economist holds divergent views regarding the dependability of the multipliers, primarily due to methodological variances, and also because the scope of approximations, despite using similar methodologies, is frequently substantial. For them, the *"main empirical challenge is simultaneity bias. For example, a successful fiscal expansion in response to a negative exogenous shock would result in an increase in the deficit with little change in output (leading inappropriately to the conclusion that multipliers are low). The use of higher frequency data, in the presence of implementation lags in fiscal policy with respect to the output shock, reduces the risk of simultaneity bias"* (Spilimbergo et al., 2009, p.5). Comparing different estimates can be challenging and requires caution. For instance, empirical estimates obtained using Vector Auto-Regression (VAR) techniques typically focus on specific fiscal shocks in terms of composition and always consider temporary fiscal shocks. However, these shocks are not purely temporary, since fiscal variables have an autoregressive component. On the other hand, model-based evaluations such as those based on Dynamic Stochastic General Equilibrium (DSGE) models can range from purely temporary measures to fully permanent ones. Therefore, comparisons are not always accurate (2010, EC). In the next subsections, I will present the main theories and tools used to calculate and study fiscal multipliers.

2.1 New keynesian approach, DSGE and its limits

Advancements in economic theory, starting from the Hicksian IS/LM interpretation of the multipliers and extending to Mundell-Fleming's version for open economies, as well as the latest developments in New Keynesian theory, suggest that the marginal propensity to consume is not the only parameter that influences the value of the multipliers. Contemporary theory (DSGE models) proposes that there are various other factors that impact the multipliers. Based on (European Commission. Directorate General for Economic and Financial Affairs., 2012, p.131), these factors can be classified into the following groups:

1. structural features of the economy, like the presence of nominal or real rigidities;
2. the size of automatic stabilizers;
3. the composition of the fiscal shock;
4. factors that force consumers to base consumption choices on current revenues only, such as financial frictions;

5. factors concerning the nature of the fiscal shock, in particular the credibility of the shock and/or its permanent or temporary nature;

6. the type of monetary policy, and,

7. the exchange rate regime and the degree of openness of the economy.

The initial two elements on the list pertain to how future income prospects can affect present-day spending. According to neoclassical theory, forward-thinking individuals who base their decisions on permanent income may experience a negative wealth effect on their households due to an increase in the state deficit. Specifically, households anticipate that the government will cover the deficit in the future by raising taxes, causing them to reduce their spending and increase their labour output. This, in turn, drives down real wages and consumption. According to this theoretical framework, the decrease in private demand offsets most of the increase in public demand, resulting in a smaller increase in output than in public consumption (as outlined in Hall (2009) and Woodford (2010)). Consequently, the consumption and investment multipliers are negative, and the production expenditure multiplier is less than one, although its exact value hinges on the relative increase in labour output versus the decrease in consumption.

A neoclassical technique utilized is Real Business Cycle (RBC) models, in which prices are adaptable and competition is ideal. This approach suggests that the impact of fiscal policy on output primarily occurs through supply effects and produces small spending multipliers, which frequently fall below 0.5. The ability of households to make consumption choices based on their permanent income distinguishes Keynesian theory from modern theory. More particularly, and originally known as the *"Ricardo–de Viti–Barro equivalence theorem"* (Buchanan, 1976), the new classical economic school assumes that individuals are future-oriented and therefore consider the government's budget constraint when determining their spending habits. As a consequence, the means by which government spending is funded has no impact on the spending decisions of individuals or on overall demand. Indeed, under this assumption, if the government increases public spending through a higher deficit, the Ricardian consumers would forecast the future rise in tax supposed to diminish the higher deficit and would in consequence increase their saving and proportionally decrease their consumption. Therefore, the fiscal policy would have no effect on aggregate demand. The Ricardian equivalence has been the subject of numerous empirical studies, the first of which is Barro (1979) himself. In his study, he founds some confirmation of his theory in the post second world war period. Nonetheless, a very influential study from Summers et al. (1987) shows that the Ricardian equivalence theorem is refuted by its results. In their empirical study, they have proved the exact opposite of the expected results on the studied period (80's) in the US. As a matter of fact, the higher deficit of US government was followed by higher propensity to consume. This concept, was then introduced in Dynamic Stochastic General Equilibrium (DSGE) models by Galí et al. (2007) and originating from Mankiw and Campbell (1989), aiming to reintroduce some Keynesian features in consumption behaviour, in accordance with observed empirical patterns of the relationship between current income and consumption, and of consumption increase as outcome of higher government expenditure. Consumers make choices based on current income, either due to imperfect rationality or financial constraints such as credit rationing. The incorporation of this type of consumer, along with price rigidities, forms the foundation for the current mainstream theory, a fusion of RBC and Keynesian models known as "New Keynesian" (NK) models. As explained by Deleidi et al. (2020), NK frameworks yield greater fiscal multipliers compared to RBC

models through the incorporation of monopolistic competition and nominal rigidities, which permit potential demand-side impacts in the short term (and only short term). Consequently, the response of the labour market varies when government spending rises. According to Pappa (2009), companies raise labour demand beyond labour supply, resulting in an upsurge in actual wages that stimulates consumption positively.

The multipliers grounded on government investments possess the greatest value. Nevertheless, it is important to observe that levies and outlays also signify distinct long-term multipliers, with an unfavourable and growing effect on production from reductions in government expenditure, a surge in corporate duties and a favourable long-term effect on GDP from reductions in government handouts and acquisitions, and upsurges in housing taxes (see European Commission. Directorate General for Economic and Financial Affairs. (2010)).

The findings of QUEST[3] suggest that under this theoretical background, fiscal consolidations generally require a delicate balance between immediate hardship and eventual benefit. The hardship arises from the negative impact of decreased spending or increased taxes, while the benefit comes from reduced world interest rates and less distortionary taxes that result from decreased debt levels. The conclusions regarding both hardship and benefit are subject to important nuances, such as the specifics of the fiscal measures implemented. If the measures are well-designed, with incentives that encourage investment and labour, then the short-term hardship is only felt during a period of initial lack of credibility and is short-lived. Conversely, if the fiscal measures are poorly designed – for example, if income taxes are raised sharply or essential government investments are cut – the eventual benefit could be significantly reduced or non-existent, as the gains from lower interest rates are offset by higher distortions and/or productivity losses.

In line with this perspective, there are new conditions on multiplier based on public deficit, debt to output ratio or non-credibility. These conditions push policymakers to apply fiscal consolidation policies and budget cuts. And as seen above, these policies have long run adverse effects on growth and debt sustainability. With these apparent contradictions, it is therefore appropriate to leave this theory aside for our study.

Finally, in these models, the magnitude of the fiscal multiplier is also influenced by the response of the real interest rate. Some studies have estimated a multiplier greater than one by assuming the Zero Lower Bound (ZLB), which is when nominal interest rates remain constant and at zero (Eggertsson (2011); Ercolani and Valle e Azevedo (2018)). While the models discussed in this section generally suggest a positive impact from an expansionary fiscal policy, the exact size of the fiscal multiplier varies depending on the specific model assumptions and parameter values used in the analysis. Let us explore other theories of multiplier.

2.2 Multiplier and super multiplier

In 1936, Keynes introduced the concept of the multiplier in his "*The General Theory of Employment, Interest, and Money*". He pointed out that government spending could contribute to aggregate demand, and that this fiscal stimulus would create a "multiplier effect" by boosting consumer demand, creating a cycle of prosperity and employment, and

[3]See https://economy-finance.ec.europa.eu/economic-research-and-databases/economic-research/macroeconomic-models/quest-macroeconomic-model_en

an even greater increase in Gross Domestic Product (GDP). Therefore, a billion dollar government spending increases the country's GDP by more than the amount spent.

A simple multiplier model

For the sake of simplicity, I will first present a model[4] with these hypotheses:

- aggregate supply is ignored (flat/non-vertical aggregate supply curve),
- prices are fixed (specially for the business cycle analysis),
- real term variables,
- closed economy,
- no financial markets.

The output equilibrium is determined when spending (aggregate demand) matches the production. The different components of aggregate demand are consumption C (households), investment I_0 (firms) and public spending G_0 (government expenditures/consumption). While investment I_0 and public spending G_0 are assumed to be fully autonomous in this model, consumption (Eq.3) has both an autonomous and an induced component:

$$C = C_0 + cY^D \tag{1}$$

with C_0 the autonomous part of consumption and cY^D the induced one[5]. The government can do different policies: to spend directly G, to collect taxes tY[6], to make transfers Tr. We thus have at the equilibrium:

$$Y^D = Y - tY + Tr \tag{2}$$
$$C = (C_0 + cTr) + c(1-t)Y \tag{3}$$
$$Y = C + I_0 + G_0 \tag{4}$$

With Y, the total income, after trivial mathematical passages:

$$Y = \frac{1}{1 - c(1-t)} \left(C_0 + cTr + I_0 + G_0\right) \tag{5}$$

The equation Eq.5 is the final model with a multiplier $m = \dfrac{1}{1 - c(1-t)}$. The autonomous components of spending are $C_0 + cTr + I_0 + G_0$. With this multiplier and under our previous assumptions, it is possible to estimate total income rise due to autonomous expenditure rise (green public/EU investments in our case). There are automatic stabilizers, namely taxes that reduce the multiplier value and transfers (*e.g.*, to unemployed) that raise spending during bad times and lower it during good ones. These automatic economic stabilizers are counter-cyclic[7] but they also represent fiscal drag.

[4] Inspired by Andrew Rose's course on macroeconomics.

[5] Note that c is the propensity to consume and Y^D, the disposable income, see Eq.2

[6] With t, the "propensity to tax", taxes are considered to be proportional with a unique rate for all the population. And seigniorage is ignored

[7] Reducing business cycle volatility

Supermultiplier

Highlighting the role of autonomous components of demand in shaping the growth rate of output and productive capacity and following the intuition of the *Supermultiplier*[8] model, discussions focused on the role of autonomous demand components in macroeconomic models have gained momentum recently, with contributions from a variety of post-Keynesian theoretical backgrounds (Allain, 2015; Lavoie, 2016; Deleidi and Mazzucato, 2019; Barbieri Góes and Deleidi, 2022). Although companies may temporarily increase their capacity utilization to satisfy an increased level of demand, they ultimately align their capacity with demand by increasing their investments, depending on the durability of demand fluctuations. In this model, it is specifically the correlation between investment and demand that ensures the impact of demand on supply persists in the long term (Barbieri Góes and Deleidi, 2022). Let explore a bit further the model of Serrano (1995). Following Cesaratto (2015) explanation of the model, the model includes three main steps:

1. in line with the above explanation, the investment function, I, is induced. With ν_n normal capital coefficient, g^e, the expected growth rate of effective demand and X_n the normal level of output:

$$I = \nu_n g^e X_n \tag{6}$$

2. it should take into account the autonomous components of aggregated demand, called Z here;

3. Tie the development of predictions about future demand in the long run g^e to the rate of growth, g_z, of those autonomous elements; such that the linkage enables a gradual adaptation of predictions to g_z.

Let us then have a look at the hypothesis. To draw the characteristics of a capitalist economy and following Kaleckian features, (Serrano, 1995, p.18-24) assumes that "*Capitalist get what they spend when workers spend what they get*"[9]. While capitalists save all their earnings[10], workers' propensity to save is null. Hence, capitalists spend their autonomous consumption (Z) plus their decided investment, which are induced by the expected demand in accordance with the accelerator principle depicted in equation (6). As a part of their earning is used for their autonomous consumption, only a part will be saved. When it comes to workers, Serrano (1995) simplifies and assumes that they can only spend what they have[11]. Therefore, the marginal propensity to consume is equal to the wage share of income wl with w the real wage and l, the labour to output ratio. Taking W as the wage bill, and S, the savings, we get:

$$P = X_n - W = Z + I \tag{7}$$

$$S = s_c P - Z = I \tag{8}$$

[8] In supermultiplier model is a multiplier model for which there is also an induced component of investment, generally build on Kaleckian investment function depending on the rate of capacity utilization. See for instance Serrano (1995)

[9] Based on Kalecki's famous aphorism "*capitalists get what they spend, workers spend what they get*" but stressing "*the fact that if the workers save, capitalists will get less than what they spend (i.e. realised profits equal capitalist expenditure minus workers' savings)*" (Serrano, 1995, p.6).

[10] Which implies that $s_c = 1$, that is the marginal propensity to save. Note that it does not mean that capitalist does not consume at the beginning of the considered period.

[11] In other words, they do not have access to credit.

$$s = s_c \frac{P}{X_n} \tag{9}$$

Leads to the average propensity to save:

$$\frac{S}{X_n} = s - \frac{Z}{X_n} \tag{10}$$

as the difference between the marginal propensity[12] to save and the autonomous consumption share of output[13]. Summing up, (Serrano, 1995, p.126) says that: "*whenever we take into consideration the presence of autonomous expenditures, as we do in our Sraffian supermultiplier, there simply cannot be any univocal and direct relation between the distribution of income and the share of savings in the economy, even if all saving comes from profits*".

In his analysis, Cesaratto (2015) then explains the induced limits of demand-led growth under this theoretical corpus. The aggregate demand, AD, is defined as following:

$$AD = Z + I + C \tag{11}$$

with $I = \nu_n g^e X_n$ and $C = wlX_n$. Stipulating the aggregated demand principle, we have $AD = X_n$ and can formulate the supermultipler model[14] as:

$$X_n = \frac{1}{(1 - wl) - \nu_n g_z} Z \tag{12}$$

This last equation (12) therefore supposes that the output growth is governed by the growth of Z[15]. Following (Cesaratto, 2015, p.27), the equation (12) is meaningful only under these two conditions:

$$wl + \nu_n g_z < 1 \tag{13}$$

$$Z > 0 \tag{14}$$

The first interpretation to be made out of these conditions corresponds to the case where $wl + \nu_n g_z = 1$. In this case, there is no room for autonomous component of aggregated demand, namely $Z = 0$. This implies an only equilibrium rate $g^e = \frac{s}{\nu_n}$, back to the Say's law and the Harrod's model[16]. The second limit drawn by Serrano (1995) appears when rewriting condition (13) as:

$$g^e < \frac{s}{\nu_n} \tag{15}$$

If the warranted growth rate is too high, the share of induced investment will also be too high, thus reaching *"the upper limit of feasible rates of demand-led capacity growth"* (Serrano, 1995, p.40). Or in other words, *"given the capital-output ratio, a higher rate of growth of capacity will necessarily require that a higher share of current level capacity*

[12] Or profit share

[13] Or share of dissaving

[14] Assuming that the growth expectations and investment decisions of the firms are done on the basis of the supposedly known growth rate of autonomous consumption Z, *i.e.* $g^e = g_z$

[15] Called growth of *"external markets"* by Seranno.

[16] expressly the overall propensity to spend is equal to one.

output be dedicated to capacity-generating investment" (Serrano, 1995, p.32). This would signify progress from the rigid Harrodian framework, in which the specified savings and investment determine a singular and guaranteed growth trajectory. By factoring in the independent elements of total demand, it is theoretically possible to have multiple viable paths for normal growth, each determined by specific values of Z and g_z based on the given s and ν_n.

I wanted to highlight a last point still generating debates among economist when it comes to supermultiplier literature: technical change. On the one hand, some economists, such as Garegnani (1962) or de Juan (2005), suggest that the autonomous investment has to be associated with technical change. On the other hand, authors such as Cesaratto et al. (2003) argue that all overall investment is induced such that, other things being equal, in the extended period, autonomous investment substitutes an equivalent amount of induced investment. Therefore, they do not attribute to autonomous investment the Schumpeterian responsibility of the primary catalyst of growth. In this respect, Camara-Neto and Vernengo (2012) or Cesaratto (1996) suggest that even technical advancements are primarily influenced by demand. Contrary to the Schumpeterian belief, innovation is not driven by economic downturns but rather by expansions. Additionally, product innovations are crucial in maintaining the marginal propensity to consume, and autonomous consumption fuelled by credit. In short, (Cesaratto, 2015, p.37-38) concludes by saying: *"supermultiplier approach to be an important step forward in non-orthodox growth theory, not just because it overcomes the formal deficiencies of previous models, but because by assigning a central role to Kalecki's external markets (or Garegnani's final demand) it opens the way to a richer description of real capitalism."*.

In the light of the above discussion, my aim is to establish connections between these various components, particularly in relation to the role of autonomous demand in influencing output with a flexible accelerator mechanism and a multiplier. The ensuing empirical strategy will be shaped by this theoretical framework, and will assess the degree to which multipliers linked to overall demand and its constituents are present, as well as their ability to sustain output. This approach seems reasonable since the validity of the Supermultiplier has been established through empirical studies conducted in the United States (Girardi and Pariboni, 2016; Haluska et al., 2021), Brazil (Braga, 2020), European economies (Bareille and Letort, 2018; Gallo et al., 2018; Pérez-Montiel and Erbina, 2020), and 20 OECD countries (Girardi and Pariboni, 2020). Therefore, it serves as a strong theoretical foundation to scrutinize these relations empirically.

2.3 Empirical approaches, VAR, SVAR and LP

VAR (Vector Autoregression), SVAR (Structural Vector Autoregression) and LP (Local Projection) models are three statistical tools commonly used to analyse the relationships between several economic variables. They represent methods based on empirical data to study these relationships. In this section, I will present their features.

2.3.1 VAR model

A VAR model is a statistical model that allows the analysis of the dynamics of several economic variables that evolve simultaneously over time. It is an econometric model that uses simultaneous equations to estimate the relationships between the different variables. VAR models are often used to forecast short-term economic trends. The main issues with VAR model is that it prevents the possibility of any structural limitation such as time.

Coenen et al. (2012) has done a more systematic review of seven neoclassical DSGE using VAR model to measure multipliers for EU and the US, differentiating the effect of fiscal multiplier by the type of fiscal shocks. The following table represents the average of the results of those models:

		US	EU
Government consumption:	2 years, 2-years accommodation	1.55	1.52
	1 year, 2-years accommodation	1.20	0.90
Government investment		1.59	1.48
Targeted transfers		1.30	1.12
Consumption taxes		0.61	0.66
General transfers		0.42	0.29
Corporate income taxes		0.24	0.15
Labour income taxes		0.23	0.53

Table 1: Average First-Year Instantaneous Multipliers from Different Types of Fiscal Stimulus
Source: Coenen et al. (2012)

2.3.2 SVAR model

A structural VAR model is an expansion of the VAR model that considers the influence of external impacts on economic variables. In contrast to the VAR model, the structural VAR model presumes that some variables are exogenous, meaning that they are impacted by external shocks that are not caused by other variables in the model. This model provides a more comprehensive explanation of the causal relationships between different economic variables. To illustrate why a structural VAR is preferable to a VAR for certain scenarios, consider the following example. Assume that fiscal authorities anticipate a decrease in private demand. In response, they increase public expenditure, resulting in a higher deficit while total output continues to decline for a period. This could lead to an incorrect conclusion that the fiscal multiplier is negative, since public spending caused the output to decrease. However, the fiscal response was endogenous, and this is not the proper approach to assess the impact of public spending on the economy. Comparing variables and their effects is not feasible if one variable responds to another. Therefore, identifying exogenous shocks to the variable of interest is crucial to capturing its dynamic effects (input responses). To accomplish this, identifying the structural model (identification) is critical, and it is the primary objective of the structural VAR. Sims (1986) said on this process that: "*Identification is the interpretation of historically observed variation in data in a way that allows the variation to be used to predict the consequences of an action not yet undertaken*".

In practical terms, a SVAR model is first made of a reduced form VAR estimation:

$$y_t = c + \sum A_i y_{t-p} + u_t \tag{16}$$

where y_t is a vector of the variables of interest, c, a constant, A_i the matrix of reduced-form coefficients, and u_t, the vector of error terms. By using the relations $A_i = B_0 - -1B_i$ and $u_t = B_0^{-1} w_t$ with B_0, the matrix of contemporaneous relationships of y_t variables, B_t, the matrix of autoregressive slope coefficients and w_t, the structural innovation vector,

we get the equation (17) of the structural VAR (SVAR):

$$B_0 y_t = c + \sum B_i yt - p + w_t \tag{17}$$

The whole process of identification consists in imposing conditions to the reduce-form VAR in order to get the structural VAR. In particular, it would mean triangular 0-restrictions on B_0 in order to consider purely exogenous shock.

2.3.3 LP, Local Projection

Finally, there is a last empirical method often used for the same purpose: the local projection LP. A local projection (LP) model is a statistical technique used to estimate the causal effects of a particular variable on another variable of interest. It is a non-parametric method that involves estimating a series of regression models, each of which captures the relationship between the two variables over a different time horizon. The LP model is generally used to investigate the effects of various economic policies or events on different economic outcomes. For example, it can be used to estimate the impact of a monetary policy shock on inflation or the effect of a tax reform on GDP growth. One of the advantages of the LP model is that it allows researchers to estimate the causal effects of a specific variable while controlling for other factors that may be affecting the final result. This makes it a powerful tool for identifying causal relationships in complex economic systems. To be more specific, as argued by Jordà (2005) and Auerbach and Gorodnichenko (2017), there are various benefits to utilizing the LP approach:

1. it doesn't enforce dynamic limitations on the impulse response functions (IRFs) since it calculates distinct functions for each time horizon;

2. it's more resistant to misrepresentation;

3. it easily accommodates non-linearity. Many researchers have employed it to determine fiscal multipliers (Ramey, 2016; Auerbach and Gorodnichenko, 2017; Deleidi and Mazzucato, 2019; Deleidi et al., 2020)

The method of Local Projections (Jordà, 2005) involves computing a solitary equation wherein the particular variable of concern is analysed in every timeframe after the occurrence of the sudden event. The following equation embodies the formalized model :

$$y_{i,t+f} = \alpha_i + \delta_\tau + \beta^h shock_{i,t} + \theta_1^h z_{i,t-1} + \epsilon_{i,t+h} \tag{18}$$

where we have α_i and δ_τ the country and time fixed effects, y the variable of interest considered at each horizon $h = 0, 1, ..., H$, $shock_{i,t}$ the identified shocks, $z_{i,t-1}$ the control variables included their lags.

2.3.4 Identification

Both SVAR and LP methodology needs another step: the identification of exogenous shock. To get significant and relevant analysis of the data, it is important to consider exogenous shocks of the studied variable. Indeed, if they are not exogenous but endogenous, as a reaction to other variables, it is impossible to study the relative relations of each variable. In order to consider purely exogenous shocks, it is therefore important to identify them. To do so, there are two main different identification strategies, the standard Blanchard and Perotti strategy (Blanchard and Perotti, 1999)and the narrative approach

(Devries et al., 2011; Alesina et al., 2012). The implied constraints of such identification will depend on the chosen econometric approach (*i.e.* SVAR or LP).

The first identification method lies in the assumption that governments do implement fiscal policies as a response to the macroeconomic environment. Considering the different n variables of interest, (*e.g.* GDP, public expenditure, interest rate, private consumption etc) it is then important to level the exogeneity of each variable, with first, second, ..., n order of exogeneity. In a second phase, it is necessary to introduce lagged variables in order to take into account possible forecasts (Auerbach and Gorodnichenko, 2017). The incorporation of these specific variable enables us to filter out the expected element of public spending shocks, thereby allowing to distinguish unanticipated fiscal spending shocks as per the defined criteria. The narrative approach attains identification by merging VAR models with dummy variables that are recognized through a more qualitative and subjective evaluation of the nature of fiscal episodes that are expected to be unrelated to the economic cycle (Ramey and Shapiro, 1998). For instance, Devries et al. (2011) and Alesina et al. (2012) used fiscal consolidation episodes to identify their fiscal exogenous shocks. They have chosen the ones prompted through a willingness to lessen public deficit and make sure long-time period monetary sustainability. Indeed, the diagnosed economic consolidation episodes are argued or verified to be exogenous and systematically uncorrelated with output dynamics.

Even if the positive effect of fiscal policies (through public investment or public consumption) is usually recognised (Bilbiie et al., 2008; Deleidi et al., 2020; Burriel et al., 2010; Blanchard, 2005), the variety of identification generally leads to different estimation when it comes to evaluate fiscal multiplier. For instance, Blanchard and Perotti (1999); Pappa (2009) and Ramey (2011) have respectively found a fiscal multiplier estimation of 0.84, 1 and 0.76. It has also been shown that multipliers are different across countries. As a matter of fact, studying five developed countries, Perotti (2005) has found a spending multiplier range of -0.3/0.36. Considering empirical studies using the Local Projection (LP) methodology, estimations also diverge. Auerbach and Gorodnichenko (2017), using this approach with annual data, found a general government spending multiplier of 0.663. Public investment multipliers are generally more important than public consumption multiplier and larger than one. For example, Abiad (ADB) estimated a public investment multiplier of 1.4 on medium term.

2.3.5 Exogeneity of fiscal shocks

As already mentioned before, in order to get robust, coherent and analysable estimations, it is of the utmost importance to analyse pure exogenous fiscal shocks. Otherwise, the analysis would have a possible endogeneity bias. The exogeneity of public fiscal policy has to be drawn by doing a distinction between automatic and discretionary fiscal policy (Bernoth et al., 2015). Since I use every year records on a large pattern of European countries, my goal is thus to evaluate whether or not green public expenditure and particularly green public investment may be taken into consideration independently of the GDP growth rate in the year. Considering general fiscal and monetary policies, it is important to specify institutional and political factors which might also additionally have an effect on economic coverage decisions. Usually, economic government are not prompted to put into effect discretionary economic guidelines on every occasion there may be a cyclical fluctuation of GDP. Fiscal authorities' actions depend on the movement of economic coverage and automatic stabilizers.

Especially, the inclination for involvement of monetary policy has been defended by highlighting that a discretionary monetary policy could be executed more expeditiously than a decision on fiscal policy. Monetary policy is considerably less susceptible to implementation delays than fiscal policy, and it is much more agile than fiscal policy, particularly when it comes to reversing policy actions (Fontana and Sawyer, 2016). In this line, (Deleidi et al., 2020, p.5) argues that: *"This argument is strengthened by the way in which monetary policy has been conducted in the last few years and by the fact that discretionary fiscal stimulus has been effected when monetary policy became powerless in boosting the economic activity. For example, at the beginning of one of the major economic crises of the last decades in 2008, the European Central Bank and other worldwide central banks (e.g. the FED), implemented expansionary monetary policies before the implementation of discretionary fiscal policies by governments. More specifically, it was only when the Zero Lower Bound was reached by monetary authorities that fiscal authorities acted with a set of discretionary instruments for boosting the depressed economic activity"*. In addition, Taylor (2000) has shown that the correlation between discretionary fiscal measures and economic fluctuations is weaker compared to the link between automatic stabilizers and the cycle. These claims suggest that fiscal policy is less effective as a counter-cyclical instrument. Consequently, fiscal authorities tend to take discretionary actions only in response to significant and enduring shifts in output levels or broader macroeconomic conditions. Moreover, the econometric literature provides evidences of the exogeneity of fiscal policies (Beetsma et al. (2009) or Born and Müller (2012).

These arguments are all the more true when considering green investments for several reasons. We can reasonably state that green investments are triggered by the empirical evidence of the anthropogenic nature of climate change IPCC (2000); Ipcc (2022) and biodiversity extinction (Díaz et al., 2019). Moreover, the notion of the "EKC" or "environmental Kuznets curve" proposes that as economies progress and shift towards information-based industries and services, as well as relocation of manufacturing operations, greater awareness of environmental issues, and stricter enforcement of environmental regulations, there should be an increase in environmental expenditures and a gradual decrease in environmental degradation. Nonetheless, the theoretical foundations of the EKC have been the subject of extensive discussion and analysis (Stern, 2004). Even if certain economic conditions may reinforce them, the main purposes of green investments should be the decarbonisation of the economy, the protection of the environment or the pollution abatement. As a matter of fact, these incentives are disconnected from usual economic reasoning. The intention of a green policy is not to react to a bad economic health of the society, but to achieve new ecological standards in order to be in phase with the Paris Agreement. They are thus discretionary and do not come as a response to economic fluctuations. When it comes to analysing the determinants of green investment, the majority of research has concentrated on the advantages and disadvantages of reducing harm to the environment (Stiglitz, 2005; Stokey, 1998). In addition, Eyraud et al. (2013) has done an empirical study of the macroeconomic drivers of green investment using data from BNEF on 35 countries over 2004-2010 period. He found that generally, public investment strongly influences green investments. The rise of green investment is directly linked to the reduction of its cost compared to conventional fossil fuel technologies, which is influenced by the increase in oil prices. Thus, imposing higher taxes on fossil fuels to counteract their harmful externalities or cutting down subsidies can aid in promoting the development of green investment. These findings are in the same vein as Newell et al. (1998)'s article, in which he demonstrated that the rise in petroleum costs has encouraged

advancements in eco-friendly technologies, resulting in the enhancement of air conditioning systems' energy efficiency. Popp (2002) findings also substantiate the influence of energy prices on the creation of patents for energy-conserving innovations.Interestingly, green investment level depends on the GDP growth of the economies. However, they do not appear as a reaction to an economic recession, reversely, it is when growth is steady and positive that green investment is fostered. Furthermore, particular governmental actions aimed at promoting green investments can prove effective. As per the statistical analysis of Eyraud et al. (2013), the implementation of feed-in-tariffs and carbon pricing mechanisms typically bolsters green investments. Among these, feed-in-tariffs emerges as a crucial tool for advancing the growth of renewable energy, as green investments increase by two to three times when countries adopt this policy (*ceteris paribus*).

3 Data and methodology

This section is dedicated to the data and methodology I used for my analysis. In order to be coherent with the final purpose of the thesis[17], I chose exclusively European countries. The methodology used was selected in light of the literature review.

3.1 Data

To detect the effects of green fiscal policies on GDP, employment, worked hours, productivity and private investment, I used yearly data provided by Eurostat[18] and the IMF database[19]. My analysis is based on 29 European countries, the choice of the countries was based on data availability: Austria, Belgium, Bulgaria, Switzerland, Czech Republic, Cyprus, Croatia, Germany, Denmark, Estonia, Lithuania, Spain, Finland, France, Hungary, Ireland, Iceland, Italia, Luxembourg, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, and Slovakia. The analysis was conducted using yearly macroeconomic panel data considered for the 1995-2021 period. The relatively short timeframe is compensated by the relatively large amount of country studied. The variables of interest are total green public expenditure[20] (*Public expenditure for environment*), GDP (*GDP*), employment (*Thousand people working*), worked hours (*Thousand worked hours*), productivity (*Value added per worker*), private investment (*Private gross fixed capital formation*). The different control variables I have used are: total green public expenditure (*Public expenditure for environment*), total public expenditure[21] *Public expenditure* and GDP (*GDP*). The economic variable are expressed in real terms and were deflated using a 2015 deflator ($p(2015) = 100 euros$). The variable are at logarithmic levels. Details on the construction of the different variables and sources used are provided in the following table:

3.2 Methodology

I apply Local Projections (LP)[22] following Jordà (2005) to evaluate the dynamical effect of public green expenditure shocks on our macroeconomic variables of interest, *i.e.*

[17] Which is to estimate what would be the macroeconomic consequences (GDP, employment, productivity and private investment) of the calculated investment needs to decarbonise the European economy.
[18] See https://ec.europa.eu/eurostat/data/database
[19] See https://data.imf.org/?sk=a0867067-d23c-4ebc-ad23-d3b015045405
[20] considered as the sum of green public consumption and green public investment
[21] As the sum of public consumption and public investment
[22] Also known as the single equation approach

Variable	Source	Database code	Item	Unit	Comment
Public expenditure for environment	Eurostat	*gov_10a_exp/GF05*	P3/P51G	million eu, constant price 2015	Sum of green consumption and investment
GDP	Eurostat	*nama_10_gdp*	B1GQ	million eu, constant price 2015	
Thousand people working	Eurostat	*nama_10_a10_e*	THS_PER	thousand persons	
Thousand worked hours	Eurostat	*nama_10_a10_e*	THS_WH	thousand hours	
Value added per worker				eu/person	Calculated with GDP and working people
Private gross fixed capital formation	IMF and Eurostat	IFS/*gov_10a_exp*	NFI_XDC and P51G	million eu, constant price 2015	Difference between total GFCF and public GFCF
Public expenditure	Eurostat	*gov_10a_exp*	P3/P51G	million eu, constant price 2015	Sum of public investment and consumption

Table 2: Variables of the built dataset

the present and following time frames after the occurrence of the sudden event, the LP computes individual regressions that scrutinize the impact of an outside influence on the targeted variables from the current time t until time t + h:

$$y_{i,t+f} = \alpha_i + \delta_\tau + \beta^h shock_{i,t} + \theta_1^h z_{i,t-1} + \epsilon_{i,t+h} \tag{19}$$

A dynamic two-way fixed-effect model where we have α_i and δ_τ the country and time fixed effects, y the variable of interest considered at each horizon $h = 0, 1, ..., H$, $shock_{i,t}$ the identified green fiscal shocks, $z_{i,t-1}$ the control variables including their lags and the error terms $\epsilon_{i,t+h}$. The different control variable for the analysis are the *Public expenditure for environment*, the total *Public expenditure* and the *GDP*.

As Deleidi and Mazzucato (2019); Auerbach and Gorodnichenko (2017); Ramey (2016), I integrate the Local Projection methodology with the identified green fiscal shocks. Specifically, I initially recognize government expenditure shocks and subsequently integrate this shocks variables in the LP equation (19) with a single equation for each estimation assuming that green expenditure is exogenous. By means of this identification technique and according to the arguments developed in subsection (2.3.5), I adhere to the conventional process that assumes green government spending does not react immediately to macroeconomic conditions.

It is then possible to estimate equation (19) in order to assess the spillover effects of green public expenditure on the different variables of interest, which are *GDP*, *Private gross fixed capital formation*, *Thousand worked hours*, *Thousand working persons*, and *Value added per worker*. The β^h of the equation (19 gives me the corresponding elasticities of the studied variables to the public green expenditure y[23] from which I can derive my analysis. Since I get elasticities, I need to calculate the conversion factor to estimate

[23] G_{green} in the following equation (20)

the green fiscal multiplier pursuing the following method:

$$\beta = \frac{\frac{\Delta GDP}{GDP}}{\frac{\Delta G_{green}}{G_{green}}} \tag{20}$$

$$Multiplier_{green} = \frac{\Delta GDP}{\Delta G_{green}} = \frac{GDP}{G_{green}}\beta \tag{21}$$

To do so, I thus take the average value of GDP and green public expenditure G_{green} in the whole dataset. Then I estimate the cumulative multiplier of green investment in GDP following Spilimbergo et al. (2009); Ramey and Zubairy (2018); Ciaffi et al. (2022). The cumulative multiplier, which is frequently the most fitting gauge, usually surpasses the impact or peak multipliers. In particular, the cumulative coefficients (Equation (22)) are derived by dividing the cumulative response of the variable of interest y (GDP or Thousand persons employed) by the cumulative change in green expenditure that took place during the observed period multiplied by the already mentioned conversion factor. Thus, the cumulative impacts enable me to examine the response of GDP or employment per added unit of green government expenditure:

$$Multiplier_{cumul} = \frac{\sum_{t=0}^{h} \Delta GDP(t+h)}{\sum_{t=0}^{h} \Delta G_{green}(t+h)} \tag{22}$$

4 Results

In this section, I report the finding of the different estimations regarding the spillover effects of green public expenditure on our variables of interest. More particularly, I analyse the outcomes in terms of Impulse Response Functions, the multiplier of green public expenditure and the associated cumulative multiplier. The panel data used for this purpose is composed of 29 European countries The construction of the database has been done using R and the computation of The Local Projection estimations using Stata.

4.1 Findings on GDP

In this first subsection of results, I focus the investigation on the relation between green public expenditure and GDP through the Local Projection. Thanks to the elasticities found, it is possible to calculate the associated multiplier and cumulative multiplier. For the robustness of the methodology, a Wald test is not needed because instead of using first-difference values I used log-level variable which enable me to include long term variable co-interactions.

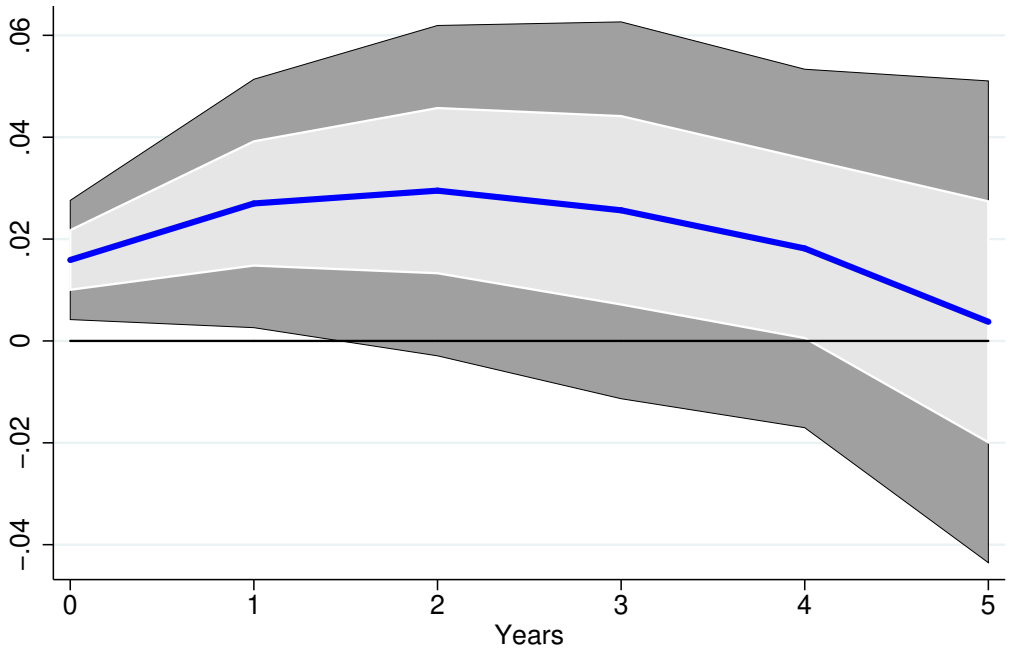

Figure 2: Impulse Response Function of Green public expenditure on GDP (elasticity) shaded areas represent 68% and 95% confidence intervals

The IFR in the above figure (2) represents the elasticity of the first variable of interest GDP to the green public expenditure shock. Note that here, it is the response to shock at $t = 0$. From this plot, we can observe that the elasticity is positive, already ensuring that the green fiscal multiplier will also be positive.

In addition, the response shows a certain degree of persistence in green public policies. As a matter of fact, the elasticity still exhibits positive value five year after the fiscal shock. This finding can be interpreted as a persistent macroeconomic effect of green policies. The light grey and dark surfaces respectively represent the 68% and 95 % confidence intervals of the response. In view of these intervals, the elasticity is highly significant for the first two years, and significant until the fourth year. Details on this first estimation are provided in the following table (3):

elast.\variable	$log(GDP)_{t=0}$	$log(GDP)_{t=1}$	$log(GDP)_{t=2}$	$log(GDP)_{t=3}$	$log(GDP)_{t=4}$	$log(GDP)_{t=5}$
$log(G_{green})$	0.0159	0.027	0.0295	0.0256	0.0182	0.00376
std errors	(0.00585)	(0.0122)	(0.0162)	(0.0185)	(0.0176)	(0.0236)
N(Observ)	772	770	740	710	680	650

Table 3: Estimations synthesis GDP-Green public expenditure

It is now possible to obtain the cumulative green fiscal multiplier. To do so, I used the methodology explained in the subsection (3.2) with the elasticities in the above table (3). As detailed before, I calculate the conversion factor, namely the average of $\frac{GDP}{G_{green}}$ on the whole panel data. As a result, we get 266.85, which is then multiplied on the cumulative elasticities to obtain the cumulative multipliers for our different time horizon $t \in \{0; 1; 2; 3; 4; 5\}$. Details on cumulative multiplier are given in the following table:

Time horizon	0	1	2	3	4	5	Mean
Cumulative elas.	0.0159	0.0243	0.0320	0.0365	0.0389	0.0358	0.0306
Cumulative mult.	4.24	6.49	8.55	9.75	10.37	9.55	8.16

Table 4: Estimations synthesis GDP-Green public expenditure

As a result, the panel data of the 29 European countries shows a multiplier of 4.24 (at $t = 0$), suggesting that one euro of green public expenditure would represent 4.24 euros of GDP. The five-year cumulative multipliers' average is way higher: 8.16. This high values can be interpreted saying that economic growth in the short term can be promoted by fiscally investing in green initiatives, since they encourage the formation of fresh industries and employment. The backing of green technologies and renewable sources of energy, like hydroelectric power, solar and wind, enables companies to establish and provide eco-friendly products and services, which leads to an escalation in the demand for skilled labour, thereby boosting employment rates and salaries. Furthermore, green investments can help to lessen energy expenses for households and businesses, giving them more spending power for other goods and services and thereby stimulating economic activity even more.

Interestingly, after five years of the shock, the effect seems to diminish. We qualitatively argue that even if green investments might create an economic boom on the short run, their purpose should not be long term growth. Indeed, their goal is not economic but environmental. On top of that, we can notice that the elasticities reach a peak at the second year. One may ask why the peak is not at the first year. This aspect can be due to the fact that there are structural lags in the implementation of a policy. Indeed, the distribution effect associated with the fiscal policy are not automatic and might reach their most important effect few years after the policy enforcement.

When it comes to study cumulative multipliers, it is however important to have a look at the Impulse Response Function of the exogenous variable shock on itself (Spilimbergo et al., 2009; Ramey, 2016; Ramey and Zubairy, 2018; Ciaffi et al., 2022). Indeed, the cumulative multipliers calculated below represent the cumulative responses on our time horizon of a single shock of green public expenditure at $t = 0$. Nevertheless, the fact remains that a shock of green public expenditure can have an effect on itself the following years. By plotting it for the exact same observations as those used for the study of the effect on GDP, I obtain the following graphic:

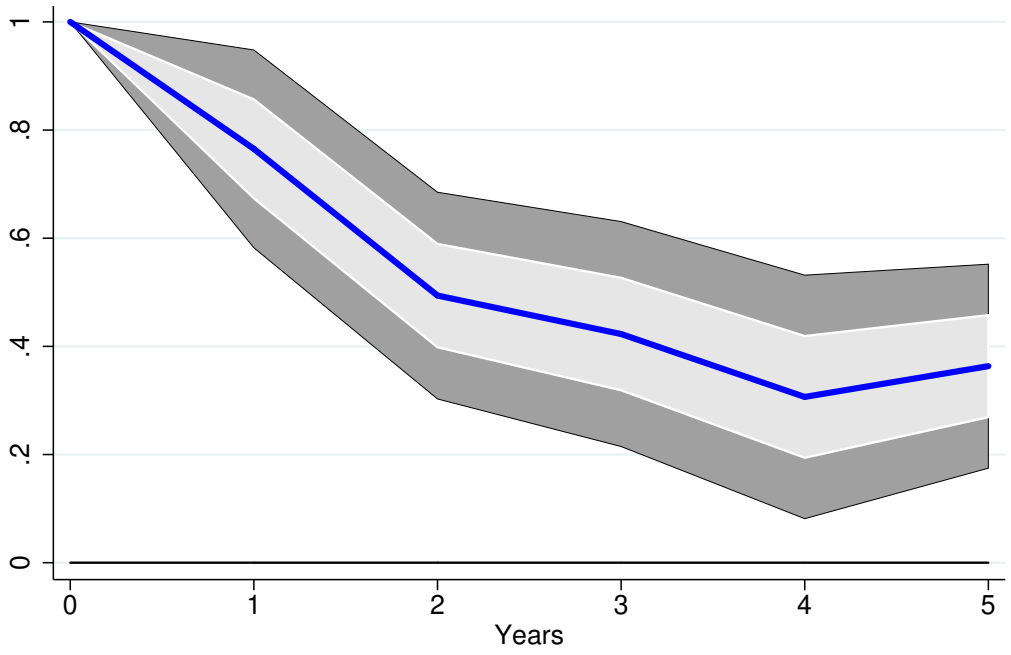

Figure 3: Impulse Response Function of Green public expenditure on Green public expenditure (elasticity) - shaded areas represent 68% and 95% confidence intervals

Even if the effect of green public expenditure on itself is decreasing among the five-year displayed, there is a clear auto-effect (Figure (3)). This finding therefore suggests that the cumulative multiplier previously calculated represent in reality underestimations, since there would be shocks (even smaller than the one at $t = 0$) on the following years induced by the first green fiscal shock.

4.2 Employment, Worked hours

The next variables of interest of the analysis are working peoples and worked hours. The main purpose of studying the relation between green public expenditure and employment is to see if such investment is valid under the Schumpeter creative-destruction theory. Specifically, I was interested in seeing whether green investment had created more jobs than it has destroyed on the studied period in Europe: 1995-2021. Indeed, it is clear that green public expenditure is supposed to create greener capital industries and less energy-intensive and emission-intensive technologies, but it is also about shutting fossil fuel industries down, which still represent, for instance, half of employed people in the energy sector[24]. Using the same methodology, here is the Impulse Response Function of green public expenditure to working people for our 29 European countries panel:

[24] See https://www.iea.org/data-and-statistics/charts/energy-employment-in-fossil-fuel-and-clean-ene

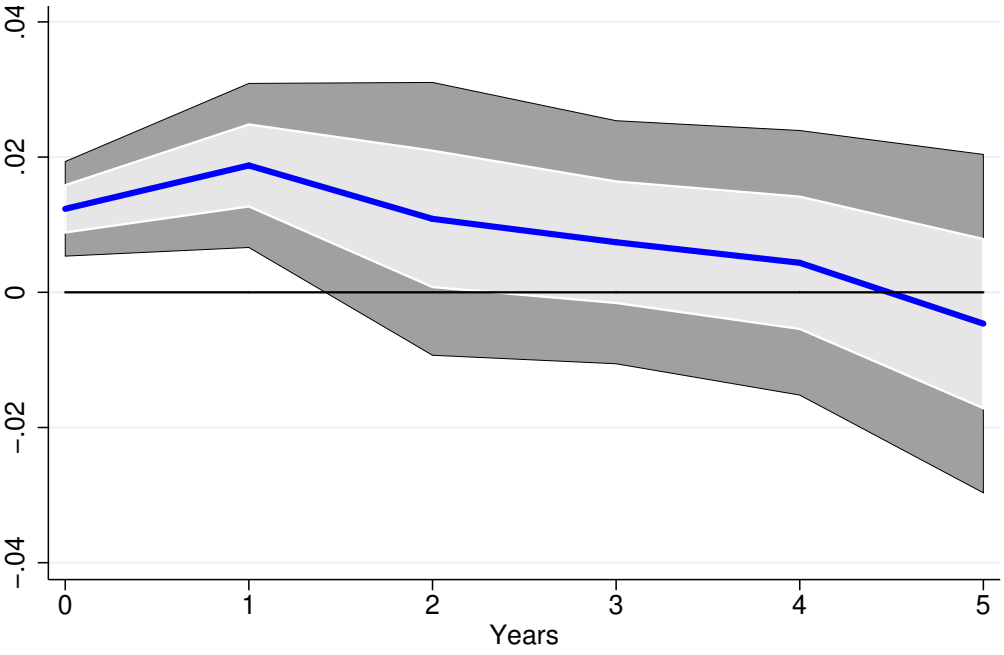

Figure 4: Impulse Response Function of Green public expenditure on the amount of working people (elasticity) - shaded areas represent 68% and 95% confidence intervals

As response, the elasticities found are highly significative (95%) for the first two years and significative for the first three years. The response of working people (Wp) to green public expenditure is positive on the significant interval. Details on this second estimation are providing in the following Table (5):

elast.\variable	$log(Wp)_{t=0}$	$log(Wp)_{t=1}$	$log(Wp)_{t=2}$	$log(Wp)_{t=3}$	$log(Wp)_{t=4}$	$log(Wp)_{t=5}$
$log(G_{green})$	0.0123	0.0188	0.0109	0.00741	0.00437	-0.00464
std errors	(0.00350)	(0.00607)	(0.0101)	(0.00899)	(0.00978)	(0.0125)
N(Observ)	772	770	740	710	680	650

Table 5: Estimations synthesis Working people-Green public expenditure

Using the same approach as for GDP estimation, I can then calculate the corresponding multiplier and cumulative multiplier for employed people in order to see how much jobs are to be created for a 100 000 euro green public expenditure. I obtain the following Table (6):

Time horizon	0	1	2	3	4	5	Mean
Cumulative elas.	0.0123	0.0176	0.0186	0.0184	0.0180	0.0147	0.0166
Cumulative mult.	4.03	5.77	6.09	6.03	5.89	4.80	5.43

Table 6: Estimations synthesis Working people-Green public expenditure with the cumulative multiplier corresponding of number of worker added per 100 000 eu of green public expenditure

In light of these results, 100 000 euros of green public expenditure correspond to 4.03 of new jobs created for our 29 European countries panel. This is in line with the literature (Ciaffi et al., 2022; Schuknecht, 1998). Input-output frameworks indicate that environmental expenditure can result in substantial employment opportunities (Bezdek et al., 2008). Moreover, there are indications that investments in clean energy generate greater

employment than those in fossil energy (IPPR, 2009, p.6). The cumulative multipliers average suggests that 100 000 euros of green public expenditure should imply around five job creation per year for the following five years. Note that the reasoning of the under-estimation of the results for the precedent subsection on GDP still hold here, since the shock of green public expenditure has also an effect on itself.

In order to add a layer of robustness on these first findings, I also had a look at the effect of such a shock on the number of worked hours. The Impulse Response Function is as following:

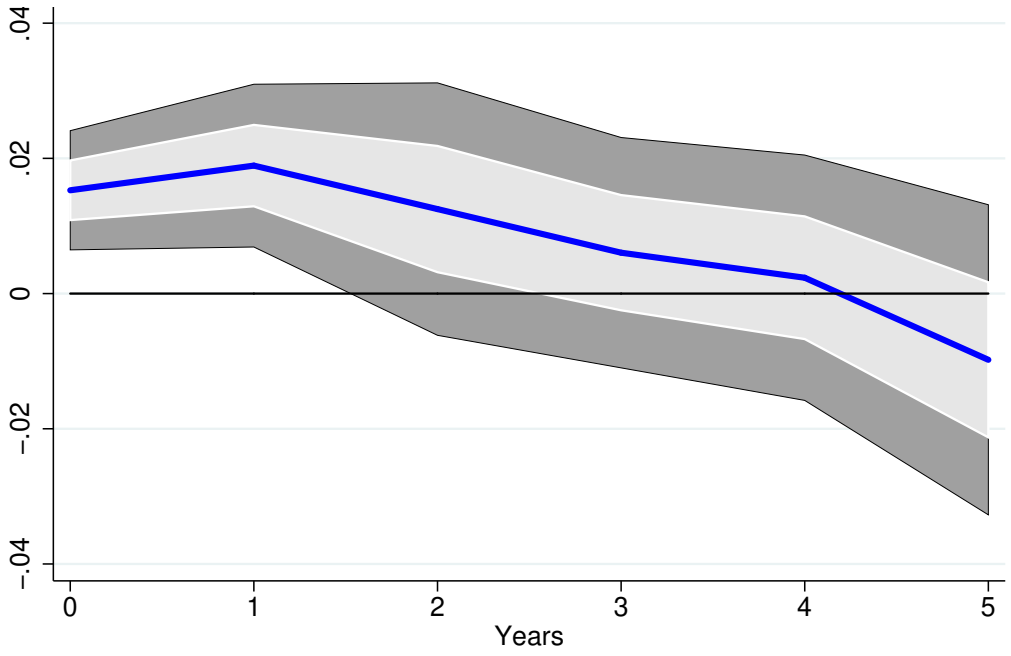

Figure 5: Impulse Response Function of Green public expenditure on the amount of worked hours (elasticity) - shaded areas represent 68% and 95% confidence intervals

And here is the synthesis of this estimation, with Wp corresponding to the variable Worked Hours:

elast.\variable	$log(Wh)_{t=0}$	$log(Wh)_{t=1}$	$log(Wh)_{t=2}$	$log(Wh)_{t=3}$	$log(Wh)_{t=4}$	$log(Wh)_{t=5}$
$log(G_{green})$	0.0153	0.0189	0.0125	0.00605	0.00234	-0.00980
std errors	(0.00441)	(0.00602)	(0.00934)	(0.00852)	(0.00907)	(0.0115)
N(Observ)	772	768	738	708	678	648

Table 7: Estimations synthesis Worked hours-Green public expenditure

The results' significance is slightly better in this case. The results are entirely consistent with the impact of green government spending on employment figures. This indicates that our initial conclusions were accurate and that green fiscal strategies have a definite beneficial influence on short-term employment. Furthermore, if these policies were coupled with a reduction in legal working hours, the impact on employment would be further enhanced.

4.3 Productivity

A fascinating discussion has arisen as people become more aware of how climate change and biodiversity issues are impacting productivity in the 21st century Delmas and Pekovic (2013); Stern (2013); Ahmed (2020). Productivity has traditionally been viewed as a measure of a strong economy, linked to advancements in technology and efficient economic systems. Nevertheless, with the current emphasis on creating sustainable economies, the focus can sometimes differ from efficiency, productivity, or growth. This conversation involves exploring whether workers using green capital instead of brown capital can still be productive. Therefore, we must examine the impact of green public policies on productivity within the past 25 years to gain a more accurate understanding through empirical research.

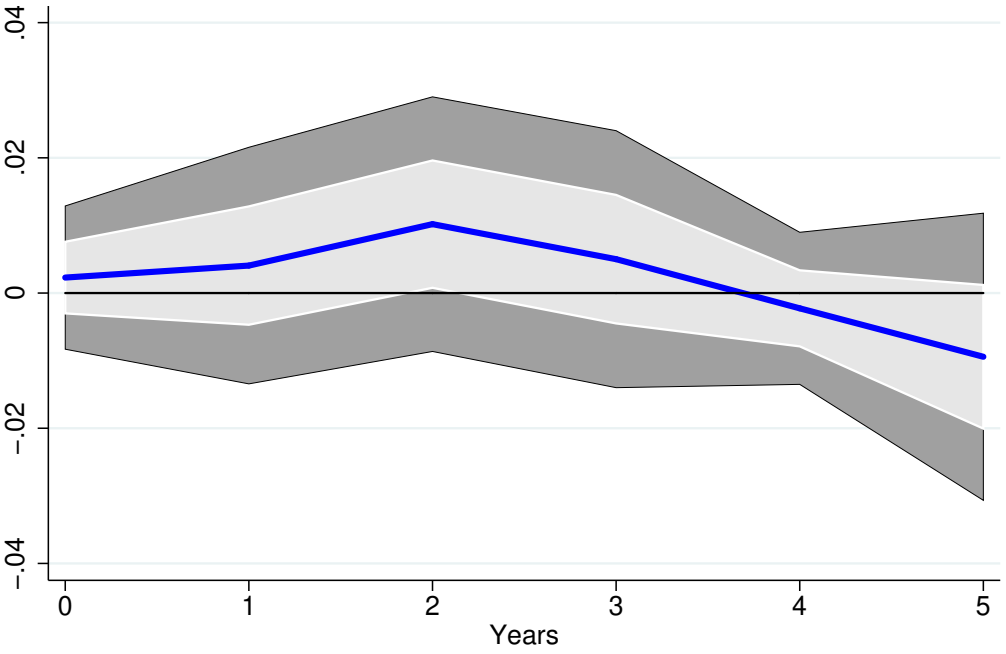

Figure 6: Impulse Response Function of Green public expenditure on value-added per worker (elasticity) - shaded areas represent 68% and 95% confidence intervals

The synthesis of the estimation is provided in the following Table (8) with W_va the variable Value Added per worker. Note that to obtain this variable, I simply divided the number of employed persons by the associated GDP.

elast.\variable	$log(W_va)_{t=0}$	$log(W_va)_{t=1}$	$log(W_va)_{t=2}$	$log(W_va)_{t=3}$	$log(W_va)_{t=4}$	$log(W_va)_{t=5}$
$log(G_{green})$	0.00229	0.00406	0.0102	0.00501	-0.00226	-0.00943
std errors	(0.00441)	(0.00602)	(0.00934)	(0.00852)	(0.00907)	(0.0115)
N(Observ)	772	770	740	710	680	650

Table 8: Estimations synthesis Worked hours-Green public expenditure

Regrettably, solely the assessment for the year t=2 holds significance (with a confidence interval of 68%), thus making it challenging to arrive at a highly reliable conclusion. Nonetheless, based on this outcome, it seems that employee productivity, or better, the value added per worker, intensifies in the short term with green government expenditures. This outcome aligns with the findings of Ahmed (2020) that have demonstrated a favourable association between green expenses and worker productivity.

4.4 Private investments

The last variable of interest of my study is private investments. The interest in studying the effect of green public spending on investment arises from the intense debate between neoclassical economists and heterodox economists about the crowding-out effect or crowding-in effect of public spending (Carlson and Spencer, 1975; Friedman, 1978; Afonso and St. Aubyn, 2009; Ahmed and Miller, 1999; Fiebiger, 2021; Neto and Vernengo, 2005; Tcherneva, 2008). According to neoclassical theory, the public spending crowding out effect pertains to the circumstance where an increase in government spending results in a reduction in private sector spending. This is believed to happen because when the government spends more, it frequently needs to borrow funds by issuing bonds, which could cause interest rates to rise. Increased interest rates can make borrowing more expensive for businesses and individuals, which could lower their desire to invest and spend. Consequently, based on the existing assumptions, the rise in government spending might not lead to an overall growth in economic activity as the decrease in private sector spending offsets the favourable effects of government spending. The crowding out effect is a critical factor in discussions concerning the appropriate level of government spending and its influence on the economy. It has validated policies for consolidation, budget cuts, and the deterioration of the welfare state.

Post-Keynesian economists hold a different view on the concept of crowding out. They argue that it is based on a flawed assumption that the economy functions under conditions of full employment, and that government expenditure competes with private sector expenditure for a limited pool of resources. In reality, the economy is often characterized by underemployment and excess capacity, and government spending can actually trigger private sector activity through the crowding-in effect. The crowding-in effect arises when increased government spending generates new income and demand, which in turn encourages businesses to invest and hire more workers. This can result in a multiplier effect, where each unit of government spending generates more than one unit of additional economic activity. Additionally, government expenditure can also provide public goods and services, such as education, infrastructure, and research and development, which are crucial for private sector growth. To sum up, the crowding-in effect of public spending refers to the potential for government spending to boost private sector activity and promote overall economic growth, particularly in times of underemployment and excess capacity. To see the empirical relation between green public expenditure and private investment, I thus estimate the elasticities using the same methodology as before:

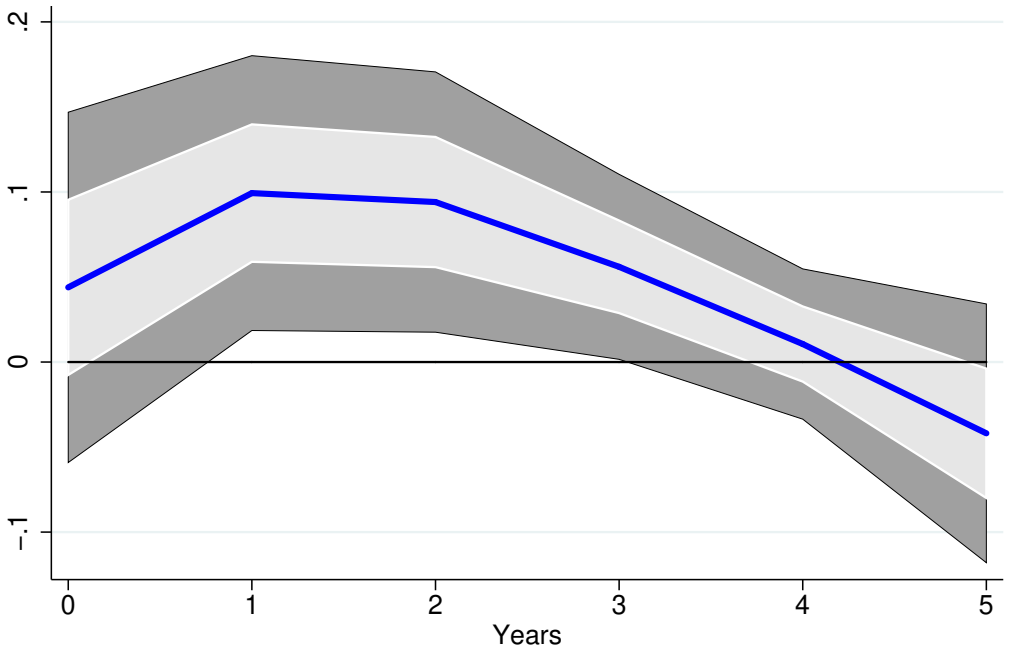

Figure 7: Impulse Response Function of Green public expenditure on private investment (elasticity) - shaded areas represent 68% and 95% confidence intervals

The synthesis of the estimation is provided in the following Table (9) with P_inv the variable Value Added per worker. Note that to obtain this variable, I have subtracted the variable public Gross Fixed Capital Formation to Total Gross Fixed Capital Formation.

elast.\variable	$log(P_inv)_{t=0}$	$log(P_inv)_{t=1}$	$log(P_inv)_{t=2}$	$log(P_inv)_{t=3}$	$log(P_inv)_{t=4}$	$log(P_inv)_{t=5}$
$log(G_{green})$	0.0439	0.0993	0.0941	0.056	0.0106	-0.0419
std errors	(0.0515)	(0.0404)	(0.0383)	(0.0272)	(0.0221)	(0.038)
N(Observ)	746	717	688	659	630	601

Table 9: Estimations synthesis Worked hours-Green public expenditure

The findings are reliable only for the year $t \in \{1, 2, 3\}$ with a high significance (95% confidence interval). On this range of values, the elasticities are clearly positive suggesting a crowding-in effect, namely the of green public expenditure is fostering private expenditure. This outcome is in phase with the European Commission strategy, since it proposed increasing the InvestEU budget and doubling funding for sustainable infrastructure to €20 billion out of the total €75 billion guaranteed from the EU budget. The program receives €26.2 billion in guarantees from the EU budget and is expected to attract around €400 billion of private investment, aimed to supporting sustainable projects[25].

[25] See Next Generation EU https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590732521013&uri=COM:2020:456:FIN

5 Estimation of the macroeconomic spillover effects of investment calculated by the Institute

The aim of this section is to evaluate the potential impact of green investments required to achieve decarbonization of the European economy by 2050. As clarified in the introduction, this thesis is a component of a larger project being undertaken at the Rousseau Institute: *Road to Net Zero: Bridging the investment gap in Europe*. The project involves identifying and assessing the costs of various measures that could be implemented to achieve decarbonization across different sectors of the economy. As the project is still underway, the results are not yet available, and it is not possible to determine the exact amount of green public expenditure needed to achieve decarbonization. However, estimates provided by the European Commission and data from a study of similar investments in France[26] can be used as a proxy. By combining these estimates with my previous findings based on panel data from 29 European countries, I am able to provide an initial estimate of the potential employment and GDP spillover effects of green public expenditure required to achieve decarbonization of the European economy. In the initial section, I will consequently exhibit these initial statistics and endeavour to contextualize them with the alternative financial resources that the Rousseau Institute proposes to advocate for to policymakers. This phase holds significance since the selected funding mechanisms have an impact on the level of the fiscal multiplier[27]. In the second part, I'm going to draw up some initial estimates of the spillover effects of such green investment on employment and GDP.

5.1 Green investment in Europe

5.1.1 Investments already programmed

The European Union has committed to becoming the world's first carbon-neutral block by 2050. This will require significant investment from both the EU, national public and private sectors. The European Green Deal investment plan (Commission, 2019) announced in 2020 will help mobilize public investment and unlock private capital through EU financial instruments, especially with InvestEU[28]. This will enable an investment of at least €1 trillion. All Member States, regions and sectors must contribute to the transition, but the scale of the challenge is not the same for all. Some regions will be particularly affected and undergo profound economic and social changes. The Just Transition Mechanism will provide coordinated financial and practical support to aid workers and generate needed investment in these areas. In the same vein, the European climate law makes reaching the EU's climate goal of reducing EU emissions by at least 55% by 2030 a legal obligation, it is included in the "*Fit for 55 package*"[29]. This section proposes a brief overview of the fiscal, monetary and tax tools implied in these programs.

The first one is the Just Transition Fund. The goal of this fund is to help countries and regions particularly dependent on fossil fuels. For instance, the EU's coal sector still employs thousands of people in more than 100 European regions. Six countries still rely

[26] Published by the Rousseau Institute (2022)

[27] For instance, if the fiscal policies is implemented using tax ressources, the effect will be way lower than if it would have been financed issuing bonds.

[28] See https://www.europarl.europa.eu/news/en/headlines/priorities/eu-s-long-term-budget/20210225STO98708/investeu-eu-programme-to-encourage-investment

[29] See https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

on coal to meet at least 20% of their energy demand (Commission et al., 2018). The agreement reached with the Council[30] mentions a package of €17.5 billions 2021 and 2027[31]. During May of 2020, the European Commission recommended a boost in the InvestEU budget and a twofold increase in financing for environmentally friendly infrastructure, amounting to €20 billion from the overall €75 billion secured by the European Union budget under the Next Generation EU initiative[32]. The InvestEU program is backed by €26.2 billion in EU budget guarantees and is anticipated to draw in roughly €400 billion worth of investments to promote sustainable initiatives.

Additional funding comes from the public sector loan facility, grants from the long-term budget of about 1.5 billion euros and EIB loans up to 10 billion euros. Moreover, public authorities will provide an investment of around €25-30 billion to assist the regions that have been hit the hardest by the expenses of decarbonization. The funds will be allocated towards investments encompassing energy, transportation, district heating networks, and public transportation. Furthermore, the Council of EU environment ministers has concurred on the negotiating stance to establish the Social Climate Fund by June 2022. They agreed that the fund would be part of its EU budget and would be funded from externally allocated revenues of up to €65 billion. The Social Climate Fund proposal aims to address the social and distributional impacts of the proposed new emissions trading scheme's building and road transport. The fund aims to provide support and investment to vulnerable actors such as households, micro businesses or road users.

Furthermore, the European Commission has created a new independent emissions trading scheme for buildings and road transport to help Member States achieve their national targets under the Effort Sharing Rule in a cost-effective manner. It has also launched a comprehensive package of changes to the existing EU Emissions Trading System, 'EU ETS'. This should reduce overall emissions in affected sectors by 61% by 2030 compared to 2005. The European Commission's proposal for a Carbon Boundary Adjustment Mechanism (CBAM) aims to "*prevent - in full compliance with international trade rules - that the emissions reduction efforts of the EU are offset by increasing emissions outside its borders through relocation of production to non-EU countries (where policies applied to fight climate change are less ambitious than those of the EU) or increased imports of carbon-intensive products.*" (2022, European Council). The CBAM is intended to work in parallel with the EU Emissions Trading Scheme (EU ETS), reflecting and complementing the EU ETS's functioning for imports, gradually replacing existing EU mechanisms to address the risk of carbon leakage, especially the free allocation of EU ETS quotas.

However, several reports[33] have pointed out that the efforts proposed by the European Commission are not enough, and that there is a significant financial gap to be bridged if carbon neutrality is to be achieved. To bridge this gap, the Rousseau Institute recommends the use of other financial tools, which is the subject of the next subsection.

[30] See Parliament (2021)

[31] €7.5 billion from the EU's budget for 2021-2027 and €10 billion from the EU Recovery Instrument.

[32] See https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590732521013&uri=COM:2020:456:FIN

[33] Summarised in this Policy Brief: https://feps-europe.eu/publication/how-to-address-europes-green-investment-gap/

5.1.2 Non-conventional financing tools

There are many difficulties and uncertainties regarding the overall financing of this plan. The first of these concerns the overall level of proposed funding. In December 2019, the Commission estimates that, in order to achieve the current climate and energy goals by 2030, additional annual investments of €260 billion of public and private money, or about 1.5% of 2018 GDP, are needed, i.e., nearly €2.6 trillion over 10 years (Baechler, 2021). A number that contradicts the €1 trillion figure repeated many times by Mrs Van der Leyen and largely reported in the press. It could have been assumed that Mrs Van der Leyen only meant public investment through the 1 000 billion euros and that, thanks to the leverage effect on private investment, the final sum expected would be 2 600 billion euros. But even taking 2 600 billion euros as reference, it seems that it is still far from what is needed. According to (Baechler, 2021; Claeys et al., 2019; Storm, 2020), at least €3 to €5 trillions are required in order to make the European Green Deal work. In this section, I present a non-exhaustive list of levers that can be used to attain the net-zero emission goal. The financial crisis of 2007-2008 and its worsening in the euro area in the early 2010s led the ECB to launch programmes to buy back public debt securities on the secondary markets. Such programmes are a major departure from the principle of independence, as they can be seen as indirectly "solicited" by Member States and European institutions, and many economists have perceived them as a form of "monetization of public debt" (Sinn, 2014). Moreover, according to Pennesi (2016), the ECB's new non-conventional policies have led to a "*hidden constitutional shift*" in the ECB's mandate. Therefore, green quantitative easing whereby central banks "tilt" their balance sheets towards bonds issued by firms in "clean" or non-polluting sectors is a solution which is coherent in this framework. The efficiency of such policy has been assessed by European Central Bank. (2022). By forgetting the monetary neutrality to which the Union is attached to and by making these practices conventional, the European Central Bank could then encourage the purchase of and stimulate the price of the assets it wants, *i.e.* green assets while, simultaneously, increasing the cost and discouraging the purchase of other assets, for example, assets from polluting companies. One further step would be the cancellation of national debt owned by the ECB in exchange for green investments. This represents the non-negligible sum of €2.5 trillions[34]. It should also be noted that unlike a default of payment between economic agents, which affects the savings of the agents and sometimes even the creditors in the case of accounting bankruptcy, the ECB cannot go bankrupt (Archer and Moser-Boehm, 2013). The ECB has a banknote printing press and no agent lends its central money, which means that the ECB has no debt. This is why debt cancellation as a financial tool is only suggested for the central bank. The cancellation has no accounting effect in this case.

Treaties' 3% rule on deficit and 60% rule on debt to output ratio are a judicial and budgetary straitjacket which has pushed countries to structural adjustments, massive budget cuts and privatizations. This framework impedes countries to publicly invest into the ecological transition. It has to be reformed. For example, net investment could be excluded from the calculation of the 3% public deficit rule. A green flexibility clause could thus be introduced to broaden the list of deductible deficit expenditure according to the objectives of the new Commission's Green Pact for Europe (Dufrêne et al., 2020).

Another fundamental area is the rules on state aid. State aid is in principle prohibited by Article 107 of the Treaty on the Functioning of the European Union in the name

[34]See https://www.ecb.europa.eu/mopo/implement/app/html/index.en.html

of free competition[35]. State aid for the ecological transition should become legal by including it as an imperative in the second paragraph of Article 107 TFEU. Other authors such as Dyson et al. (2016) push the idea of "free money" to finance the transition, *i.e.* without debt and without liabilities, and to inject it into the economic circuit in a targeted manner for the sake of ecological reconstruction. This idea would be a breakthrough in the traditional rules of money creation, whereby money is usually created when a monetary financial institution finances a non-banking agent by granting it a loan or purchasing an asset, according to the mechanisms of double-entry accounting in which a loan (or an asset) is necessarily associated with a debt (or a liability). Other authors such as (Dufrêne et al., 2020) associated this idea of "free money" with the creation of an *European Credit Council, and national credit councils, operating on a principle of collective governance involving all social partners and public institutions to decide on the level and destination of the free money created by the central bank*"[36].

5.1.3 EU extrapolation of the French case made by Rousseau Institute

The Institute Rousseau's 2022 report on France reveals that a total investment of €182 billion per year is required, combining both public and private investments. Of this amount, €57 billion per year is for supplementary investment, which is essential to redirect ongoing spending and accommodate current "green" spending. These added investments represent 2.3% of France's GDP in 2021. It is crucial to note that these "investments" should not be perceived in a strict economic sense. Rather, they signify all the public and private expenses required to achieve the set targets, which may include hard investments, subsidies, tax credits, tax exemptions, installation or reforestation assistance, property acquisition by households, and so on. Out of the €57 billion additional investment, the State must cover €36 billion, equivalent to 1.5% of France's GDP in 2021. Overall, there have calculated that €70 billions[37] of public investment would be needed each year in France. The EU's GDP in 2021 was €14.5 trillion, by taking the same figure as for France for a first estimation, 2021's green public investments should represent €421 billion.

5.2 Few spillover effects of 2021's green fiscal shock

In this subsection, I look only at the effect of a shock corresponding to the investment needed in the first year on GDP and employment. This initial exercise will be used as an example to calculate the cumulative effects over the period 2022-2050 in greater detail when the Rousseau Institute report is drawn up. The aim is therefore not to carry out an in-depth, detailed study, but only to provide a first approximation that will enable us to obtain orders of magnitude by putting into practice the results obtained using the Local Projection method. Retaking my previous finding in subsection (4.1), the green fiscal multiplier in terms of GDP was 4.24. By multiplying the quasi-arbitrary amount of green public expenditure chosen above by the multiplier, I obtain a GDP's increase of about 1.8 trillion euros and thus 12% increase in terms of growth, which is quite substantial. This has to be counterbalanced saying that these first investments fostering on the short run the creation of new industries and jobs, is likely to destroy other industries in job (fossil based industries) on the medium run. In terms of person employed, the cumulative multipliers were as following:

[35] See https://www.europe-en-france.gouv.fr/sites/default/files/article_107_et_suivants_du_tfue.pdf

[36] Own translation from French

[37] Which represents 2.9 % of France's GDP in 2021

Time horizon	0	1	2	3	4	5	Mean
Cumulative elas.	0.0123	0.0176	0.0186	0.0184	0.0180	0.0147	0.0166
Cumulative mult.	4.03	5.77	6.09	6.03	5.89	4.80	5.43

Table 10: Estimations synthesis Working people-Green public expenditure with the cumulative multiplier corresponding of number of worker added per €100 000 of green public expenditure

Using these figures and the approximated amount of European green investment needed for 2021, I obtain that the first year, the investment might create about 16 millions jobs the first year, which represents an 8% variation of people employed in 2021[38]. The same counterbalancing reasoning as before can be done for employment. Nonetheless, as explained in the subsection (4.2), a green economy is more labor-intensive than a brown one because it involves the use of renewable energy sources, such as wind and solar power, which require more labour to install, operate, and maintain than traditional fossil fuel-based energy sources. Additionally, the transition to a green economy requires the development of new infrastructure, such as public transportation systems and energy-efficient buildings, which also creates new job opportunities. The shift towards sustainable agriculture and waste management practices also requires more labor-intensive processes. Overall, the green economy creates more jobs in areas that require human labour and skills, while reducing the demand for jobs in industries that rely heavily on automation and machinery.

[38]See https://www.statista.com/topics/4095/employment-in-europe/#topicOverview

6 Conclusion

To the research question: "What are the macroeconomic spillover effects of the green investments necessary to decarbonise the European economy?", I started an analysis on a few variables: GDP, employment, worked hours, productivity and private investment. To do so, I built a panel data of 29 European countries based empirical data on the 1995-2021 period. I then estimated the relation between green public expenditure and the variables of interest previously mentioned. It turns out that on the short run, green public expenditure has a positive effect on all the studied variables. The findings show a pretty high fiscal and employment multiplier (about 4) which can be interpreted saying that economic growth in the short term can be promoted by fiscally investing in green initiatives, since they encourage the formation of fresh industries and employment. Another interpretation holds in the fact that a green economy might be more labour-intensive, implying more job creation than destruction and as consequence a higher aggregate demand due to the increased capacity of people to consume.

My contribution is thus twofold: bridging the literature gap in terms of spillover effects of green investments in Europe, providing a first way to estimate what would be the impacts of the investment needed to decarbonise the European economy calculated by the Rousseau Institute. To my knowledge, there is no other panel data analysis studying the green investment effect in the 29 European countries on the considered period. When it would come to the Rousseau Institute project, a larger benchmark will be needed before using my estimations.

My approach and methodology contains several limitations. Econometric models are based on a set of assumptions that may not hold true in the future. The accuracy of the model depends on the validity of these assumptions. Econometric models assume that the relationships between variables are stable over time. However, structural changes in the economy can affect these relationships and render the model inaccurate. Econometric models cannot account for unexpected events, such as natural disasters or political upheavals, which can have a significant impact on the economy.

This starting work opens a room for future researches. I would like to add an analysis on the balance of payment, which would need the integration of the exchange rate as control variable. It would have been interesting to divide the panel into two groups of countries, namely north Europe and South Europe, in order to see whether green public expenditure affects homogeneously the Euro area. In addition, we can imagine using other models to estimations the relations, a first possibility would be to look at the variation rate of variable instead of their log-level. The presentations of different method's results would enhance the findings' robustness.

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