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A Virtuous Cumulative Growth Circle among Innovation, Inclusion and Sustainability?

A Structuralist-Keynesian Analysis with an Application on Europe

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Abstract

The Europe 2020 Strategy has been built on three pillars: smart, sustainable and inclusive growth. The aim of the paper is to provide, thanks to Dynamic Panel data models, an econometric analysis of the potential cumulative circle among the abovementioned three pillars, with a specific focus on how labour productivity and environmental intensity interact with each other, and how they may help improving employment.

With reference to the effect of sustainable factors on smart factors, main results of this paper confirm the "dual externality principle": eco-innovations may both provide R&D spillovers and reduce environmental negative externalities; depending on the Porter's hypothesis, environmental regulations may stimulate eco-innovation in order to reduce regulation costs. Furthermore, an increase of energy intensity tends to stimulate cost-saving innovations. Concerning the effect of smart factors on sustainable factors, the "pollution haven hypothesis" is confirmed: trade openness increases pollution because of more relaxed environmental regulation, delocalization and specialization. Finally, the positive impact of smart and sustainability factors on employment depends on the complementarity between the first two pillars. Europe 2020 goals are essential in order to overcome the current economic, social, and ecological crisis: this paper highlights how this implies to go beyond the widely adopted "austerity policy framework" and to implement some proposals able to generate, stimulate and sustain the abovementioned cumulative circle. Main political points are: the proactive role of public institutions, to avoid innovation market failures and to generate an "innovation multiplier" starting from public investments; the territorial perspective of strategy; the coordination among macroeconomic policies on the one hand, and industrial, innovation, environmental, and trade policies on the other.

JEL code: O3, O4, Q5.

Keywords: inclusion, innovation, sustainability, Europe 2020 Strategy.

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1. Introduction

The international crisis started in 2008 has placed in serious difficulties the European Union construction and the currency unification project, and has led to a radical U-turn of the previously implemented economic policies. Indeed, focusing on austerity policies and the recovery of the public budget, European policymakers have denied the Europe 2020 paradigm, based on the strong involvement of public institution within huge investment programmes.

As it is well known, the correct intuition of that document was to set three political priorities: to develop an economy based on knowledge and innovation (*smart growth*); to promote a more resource efficient, greener and more competitive economy (*sustainable growth*); to foster a high-employment economy delivering social and territorial cohesion (*inclusive growth*). The aforementioned priorities are considered "mutually reinforcing".

The aim of our paper is to show how the recovery and implementation of such a growth-oriented approach is able to boost the economy as a whole. The core of the Europe 2020 Strategy is indeed a line of conduct of the economic policy explicitly based on investments, as a means to spread innovations within the economic system, with a focus on its ecological dimension, more specifically on its energy (efficiency) policies. The final goal is on employment, which needs organic wide-ranging programmes to make up leeway.

The Europe 2020 Strategy is currently running the risk to be dismissed as a dreamland because of two underlying lacks: first the definition of some consistent economic policy guidelines without both a sound theoretical substratum and an empirical validation of its foreseen causal linkages; secondly EU member States policy interventions may result as feasible with a good business climate, but prohibitive if to be implemented under severe public budget constraints. We will try to overcome the first handicap with both a theoretical and an empirical analysis.

The paper is organized as follows: section 2 shows the functional interrelations among the variables, from the theoretical point of view; section 3 analyses the developed model thanks to the Dynamic Panel data econometric tool; section 4 points put the main policy implications of the results; finally, some concluding remarks are drawn in section 5.

2. Theoretical Framework

The starting point of our explanatory analysis is a baseline Structuralist Keynesian framework, aimed at pointing out the potential virtuous circle among inclusion, innovation and sustainability.

The core of the growth process is the *dynamics of production structures*, defined as the co-dynamic paths of sectorial composition, intra and intersectorial linkages, market regimes, and institutions supporting all of them. These dynamics arise both at microeconomic and mesoeconomic level, but generate economic and social transformations that significantly interact with macroeconomic variables. These dynamics depend on three factors: innovations, complementarities and innovation elastic factor supplies. *Innovations* are classified in five typologies: "(1) the introduction of new goods and services or of new qualities of goods and services; (2) the development of new production methods or new marketing strategies; (3) the opening up of new markets; (4) the discovery of new sources of raw materials or the exploitation of previously known resources; and (5) the establishment of new industrial structures in a given sector" (Ocampo 2005 p.13). *Complementarities* regard linkages and networks among intrasectorial, intersectorial and between private sectors and institutions. Finally *Innovation elastic factor supplies* concern the capacity of labour and all others production inputs to positively react to the innovations.

The macroeconomic success of technological process depends on the *dynamic efficiency* of the system, that is the efficient interaction among innovations, complementarities and innovation elastic factor supplies. Dynamic efficiency may depend both on the *Schumpeterian efficiency*, namely the capacity of innovations generation able to transform economic system through diffusion, learning process, and externalities; and on the *Keynesian efficiency*, namely the capacity to increase production capacity by multiplier and accelerator principles (Cimoli, Porcile and Rovira, 2010). In a Schumpeterian view, a positive macroeconomic impact of innovations depends on the dynamics between "destructive" and "constructive" forces.

In order to analyse the interaction between macroeconomic dynamics and dynamics of production structures, growth processes may be studied through their dynamic interactions among income, employment and labour productivity, provided by internal and external factors, and nourished by feedback mechanisms. This interesting framework allows pointing out some relevant macroeconomic aspects concerning the interaction among social, technological and economic progress. Starting from the dynamic income identity

$$(1)\ y = n + g,$$

where y, n, g are the growth rates of income, employment, and labour productivity respectively, variables y and g are endogenised by building functions of demand regime and productivity regime respectively. In this view, the employment growth may be considered the result of the joint dynamics between demand and technological progress ($n = y - g$) (Corsi and Roncaglia 2002; Starm and Naastepad 2012).

According to the original Keynes thought, the adopted theoretical and empirical method is the "short causal chains", similar to the Marshallian partial equilibrium analysis (Sanfilippo 2011).[3] To this aim, the labour productivity function as well as the income impact and the employment impact of labour

[3] About the ceteris paribus clause, Keynes writes: "This does not mean that we assume these factors to be constant; but merely that, in this place and in this context, we are not considering or taking into account the effects and consequences of changes in them (CWK VII: 245).

productivity are separately dealt with in order to analyse the role played by labour productivity within the multiple links characterising the growth process.

The *Productivity Regime* is represented by the following equation

$$(2)\ g = g(A, y, w),$$

where g, y, w are the growth rates of labour productivity, income and labour cost respectively and A is an innovation parameter. According to equation (2), innovations may be stimulated by non-economic factors (exogenous innovations, such as R&D expenditure captured from parameter $A > 0$), and by economic factors (endogenous innovations) represented by y, w. These latter innovations are the core on labour productivity dynamics (Sylos Labini 1984; Hein and Tarassow 2010; Guarini 2009, 2013).

The partial derivative $g'(y,\cdot) > 0$ shows the Kaldor effect about increasing returns and economies of scale (static and dynamic). *Static increasing returns* depend on: the *Thirwall cube law,* linked with the dimension of plant, according to which, given the tridimensionality of space, the production capacity increases faster than costs (Thirwall 2002); the *indivisibility*, according to which for some production facilities there is a minimum level of production below the which they are useless not economic convenient; the *threshold effect* according to which units fixed costs become decreasing after a given threshold. Both the last two effects may are caused by several technological, institutional and organisational effects. Moreover, these effects arise at different level, since they may regard: specific inputs within production process at firm level; services activities and intermediate intra and inter sectorial goods provision; and productive links between private and public sectors, both at local or national level. *Dynamic increasing returns* depend on; *learning by doing*; *learning by using*; and *network externalities*. The first two are related to learning process from the experience on a given activity and on using of a specific input. According to the last effect, when the number of companies adopting a particular technology increases, the economic advantage in terms of the reduction of usage costs grows. Notably, network externalities are linked with economies of agglomeration, mainly concerning reduction of transports and transaction costs, and economies of scope (or of specialisation) related to a horizontal division of labour (Arthur, 1994; Fajnzjbler 1990).

The partial derivative $g'(w,\cdot) > 0$states the Wage push effect related to the investments for labour cost saving. In literature, the incentive to investment may stem from different dynamics of labour cost: according to Sylos Labini approach, with reference on Ricardo thought, the investments on efficiency are stimulated by the increase of nominal wages, relatively of the prices of machinery (*Ricardo effect*) (as it is described in Sylos Labini 1984 and Guarini 2009, 2013). Wage push effect is connected then to the *incentive effect* or *Marxian Hicks effect*, according to which investment are driven by the real wages growth because firms react to the increase of the bargaining power of employees (Hein and Tarassow 2010). The increase of labour cost may have an organisation effect on labour productivity, due to a better labour division or an increase of workers efforts, through the enhancement of their motivation. This last effect, so called *wage efficiency effect*, is typical of a labour market analysis within a Post-Keynesian growth approach (Millemaci and Ofria 2014; Lavoie and Stockhammer 2013).

The *Demand Regime* is stated by the following equation

$$(3)\ y = y(g),$$

where y, g are the growth rates of income and labour productivity, respectively. Derivative $y'(g) > 0$ is the *Innovation Expansive effect*: in dynamic terms, labour productivity may affect positively income through several main channels. Firstly, the production innovations increase supply, by generating new final and intermediate goods. Secondly, innovations generate new opportunities for investment and thereby stimulate aggregate demand. Thirdly, with reference to the Kaleckian price formation, process innovations, through labour productivity, tends to reduce prices and therefore stimulate both intermediate and final consumption, and an increase of effective demand investments. Finally, labour productivity, by improving international competition thanks to the decrease of relative prices, may improve trade balance (Ocampo, 2005).

Finally, the employment impact of labour productivity is analysed through the following function

$$(4)\ n = n(g),$$

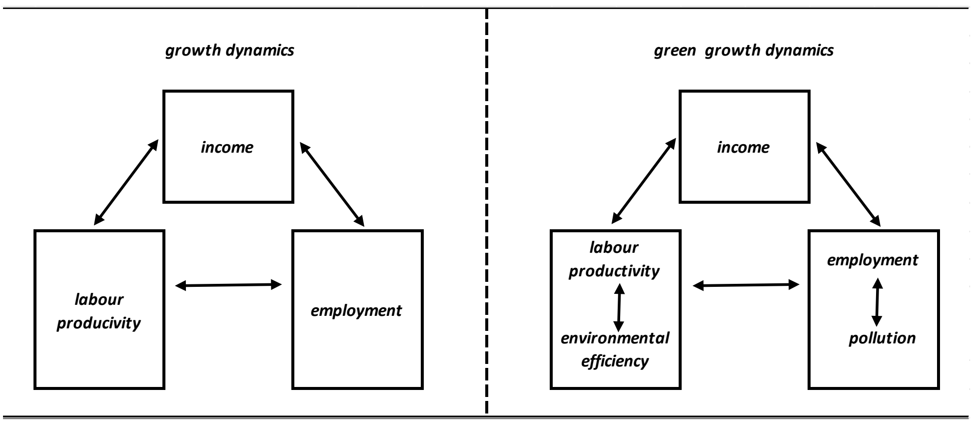
where n, g are the growth rates of employment and labour productivity, respectively. Even if the analysis is at macro level, it is recommendable to summarize the main potential effects of innovation on employment (Dachs and Peters 2014). Product innovations may positively affect employment by generating new products that increase total demand either directly (direct demand effect) or through the demand of existing complementary goods (indirect demand effect); at the same time they may negatively influence employment either by generating new products labour saving or by decreasing the demand of existing substitutes goods. On the other hand the innovation process may positively affect employment by increasing demand trough prices reduction (price effect) or negatively simply by the reduction of labour units for a given output unit. In a Schumpeterian view of competition, technological progress tends to have positive (negative) employment effects on firms and sectors that are (not) able to react and adequate to the new technological stimulus given by the market.

Considering the above mentioned identity $y = n + g$ and therefore that $n = y - g$ and the partial derivative $y'(g,\cdot) > 0$, the partial derivative $n'(g,\cdot) = [y'(g,\cdot) - 1]$ arise. Thus, the employment impact of labour productivity depends on the extent of its value added impact; thereby $n'(g,\cdot)$ captures the *innovation elasticity of labour*.

Starting from the following environmental identity, the described Structuralist-Keynesian approach is going to be applied to the issue of ecological sustainability:

$$(5)\ h = y - e,$$

where h, y, e are the growth rates of pollution, income and environmental efficiency, respectively; environmental efficiency is defined as the ratio between income and pollution. According to the identity (5), the *win-win strategy* for ecological sustainability is to increase the environmental efficiency, that is the core of the Europe 2020 Strategy. Environmental efficiency is the result of eco-innovations, defined as the innovations able to "reduce the environmental impact of an organisation in terms of resource use and environmental loads" (Mazzanti and Zoboli 2008 pp.18-19). In a macroeconomic analysis, eco-innovations and *normal* innovations (all the others) are a sort of latent variables, and environmental efficiency and labour productivity are their proxies respectively.



Eco-innovations, as normal innovations, may be classified in three types, according to how they concerns product, process and organisation. Notably, there are two kinds of process eco-innovations: end-of-pipe technologies; and cleaner production technologies. In the former case, a firm reduces pollution with a new or updated technical apparatus at the end of its production process, without affecting it: an *ex post* intervention such as filters, dust removal techniques or desulphurization equipment. In the latter case a firm reduces pollution by transforming its production process: an *ex ante* intervention for an integrated changes concerning the core of the firm activity, such as inputs substitution or alternative process (Oltra 2008). Examples of end of pipe technologies range from the optimisation of processes and the switching to less polluting raw materials and fuels, to the replacement of coolants, encapsulation of equipment and dosage of chemical use. Examples of clean technologies are: filters, scrubbers, cyclones, centrifuges; coolers and condensers; equipment for thermal and catalytic combustion; restriction of dust problems; measurement equipment (Hammer and Lofgren 2010).

In order to analyse the inter-dynamic process between environmental efficiency and macroeconomic dynamics a Green Productivity Regimes, a Green Dynamic Regimes, and a Eco-Innovation Elasticity of Labour are provided. Finally the green identity (5) has been turned into a green efficiency dynamic function.

The *Green Productivity Regime* is stated by the following equation:

$$(6)\ e = e(B, y, w, o),$$

where variables e, y, w, o are growth rates of environmental efficiency, income, labour cost and trade openness, respectively; $B > 0$ is a eco-innovations parameter. Eco-innovations may be either directly caused by environmental regulations (exogenous eco-innovations captured by parameter B), or stimulated by the above mentioned economic variables (endogenous eco-innovations). The environmental economic literature mainly focuses on exogenous eco-innovations determined by the implementation of environmental policy instruments by studying economic and regulatory instruments, the existence and anticipation of environmental regulations, the regulatory design in terms of stringency, flexibility, time frame (Arundel and al. 2007). On the contrary, this paper focuses on endogenous eco-innovations, whose drivers are demand and supply factors.

The partial derivative $e'(y,\cdot) > 0$ shows the *Green Kaldor effect*. The first element is the *dual externality* (or double externalities) of eco-innovations: they may not only produce benefits in terms of improvement of environmental conditions but generate technological spillovers also, for instance the R&D activity among firms, regions and countries (Jaffe et al., 2003; Rennings, 2000). Another element is the *economies of scope* (Johnston et al. 2008): firm may prefer to invest in the cleaner technologies instead of end of pipe technologies. Indeed, it is possible to reduce pollution thanks to two strategies: either changing the production process, with complementarities between innovations and eco-innovations that realise the economies of scope; or adopting end of pipe technologies, assuming no linkages between the abatement process and the production process. However, also the abatement strategies may create the economies of scope, for instance the reduction of a given pollutant may induce the decrease of another one (Hartman et al., 1997).

In general, the dimension and significance of these kind of economies depend on the capabilities of firm and of effective public interventions. Because of their complexity and novelty features, eco-innovations are strictly correlated with learning processes, technological capability and cumulativeness (Horbach, 2008). A specification of the Green Kaldor effect is the *Green Engel effect*: together with the economic growth the structure of final and intermediate consumptions also changes, more addressed towards environmental friendly goods and services. This may be related with the concept of green goods as luxury goods: in this case, the value of the income elasticity is more than one. The straightness of regulation may be positively related with economic growth: in this view, also part of the effect of regulation may by endogenised in the development process. Since environmental friendly goods may present a price premium compared to the others, this effect may be significant when private and public costumers may individuate the benefits: to this aim, environmental marketing and environmental certification may be fundamental (Florida 1996; Popp et al. 2007). Finally, the pressure of costumers and institutions may positively affect the process of adoption and diffusion of eco-innovations (Taylor et al. 2006). The Green Engel effect enlarges the role of eco-industry[4] within

[4]According to the Action Plan for sustainable consumption and production and sustainable industrial policy of European Commission, we define eco-industries small and innovative companies operating in the renewable energy, waste

the production system, generating environmental efficiency improvements within the economy as a whole. As in the original Kaldor effect, in the Green Kaldor effect multiple causes of static and dynamic economies of scale are singled out.

The *Green Wage Push effect* is the partial derivative $e'(w,\cdot) > 0$. As for the Wage Push effect, labour cost may be represented by the growth rate of real wages or by the difference between the growth rate of nominal wages (*Green Marxian-Hicks effect*) and the growth rate of price of machineries (*Green Ricardo effect*). Thus, several causes may explain how eco-innovations are related with labour cost dynamics,such as the *embodiment hypothesis* or *vintage effect*, according to which eco-innovations may be embodied in new capital goods fulfilling new environmental standards; thereby labour cost saving investment will contribute to increasing energy-productivity growth via technological change (Howarth et al., 1991; Mulder et al., 2003). A reinforcement of the bargaining power of workers, represented by the growth rate of real wages, according to the Marxian-Hicks effect may contribute to the improvement of workplace regulations (Weil, 2010). Thereby, since health status of workers is linked with the rate of pollution of the production process, increases of environmental efficiency through eco-innovations allow the firm to implement a win-win strategy that contemplates the requirements of both workers and entrepreneurs. In this view, according to the Porter' hypothesis (Porter and Van der Linde, 1995), environmental regulation obviously create costs in the short term for the firm, but it may stimulate processes of innovation for cost saving, making production process not only cleaner but also more efficient in the medium term. This virtuous mechanism may provide benefits that overcompensate the initial costs. Regulation may give signals for kept opportunity of improvements: if pollution is considered an indicator of inefficient use of resources, the policy could stimulate investments for eco-saving. Policy makers may offer or demand useful information for eco-

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recycling, environmental auditing and consultancy, and capital intensive firms providing good and services in specific areas, e.g. waste, wastewater, transport.

innovations that otherwise firms had not produced and adopted because information is a public good. Rules and standards about environment may make possible the internalisation of eco-investments payoffs: because learning by doing process is relevant for those eco-innovation affected by regulations, technological changes may give rise to some "first mover advantages" (Jaffe et al., 2003), that is *workplace effect*. According to the Wage Push effect, labour saving activities may also regard normal organisational innovations to increase the efficient use of workers. The Green Wage Push effect may capture the complementarities between organisational normal innovations and organisational eco-innovations. The latter, through an increase of job satisfaction (Delmas and Pekovic 2013), may be implemented to react to wage pressure by increasing labour productivity. The organisational eco-innovations positively improve the performance of eco-innovations process: for instance Environmental Management Systems make more effective the implementation of cost-saving cleaner technologies (Horbach et al. 2012).

Finally, the *Globalisation effect* is represented by the partial derivative $e'(o,.)$. In the literature, the sign is debateable. With $e'(o,.) < 0$ the *Pollution Haven Hypothesis* may be validated, according to which trade openness increases pollution because of more relaxed environmental regulation, delocalization and specialization (Mazzanti et al. 2008).

The theoretical consequence of this type of endogenisation is that a positive relationship between labour productivity and environmental efficiency may occur; namely, given the function $e(g)$, arises $e'(g) > 0$, the main result of several contribution of evolutionary theory on eco-innovations (Mazzanti and Zoboli 2008).

The *Green Demand Regime* is stated by the following equation:

$$(7)\ y = (e).$$

The derivative $y'(e) > 0$ shows the *Eco-Innovation Expansive effect*. The sign of equation (5) may be positive for at least two main reasons. The eco-innovations that generate new products and services positively affect consumption and effective demand as a sort of green multiplier. Moreover, the increase of energy productivity, defined as the value added per unit of energy, has potentially a twofold effect: it increases environmental efficiency and reduces energy prices; the latter effect may stimulate intermediate and final consumption with positive effect on value added. Notably, with reference to energy consumption, the energy savings that increase environmental efficiency produce the so-called rebound effect, according to which the reduction of energy costs may stimulate an increase of energy consumption. Several types of rebound effect may occur (Greening et al. 2000; Gavankar and Geyer 2010). *Direct rebound effect*, when energy efficiency gains for a specific good or service induces its further consumption, since the reduction of energy unit costs enables end users and producers to buy or use more units with the same expenditure (income effect), and furthermore since end users and producers may substitute more expansive energy service with cheaper energy service – substitution effect. *Indirect rebound effect* when energy efficiency gains for a specific good or service induces the consumption of another good or service (*primary effect*), since these gains derive from energy savings in the latter (secondary effect) and since energy savings is embodied in a machinery that need energy (embodied effect). *Economic wide rebound effect:* energy consumption is generated by energy efficiency enhancements caused by labour productivity improvements. Even if several empirical studies verify that the dimension of rebound effect is significant the net impact of energy productivity on environmental efficiency seems to be positive and the twofold effect arises. The extent of rebound effect depends on price and income elasticities, cross price elasticities and saturation effects (European Commission, 2011).

From the analysis of the Green Productivity Regimes and the Green Demand Regimes, the green identity (5) may be transformed in the following function

$$(8)\ h = y(g) - e(g) \rightarrow h(g) = [y'(g) - e'(g)]g.$$

Equation (8) stated the problem of de-growth of emissions by focusing on labour productivity dynamics and its complementarity with environmental efficiency. According to the original model we may assume $y'(g) > 0$, as in the Demand Regime, and $e'(g) > 0$, as in the Green Productivity Regime. Thus, coevolution of normal innovations and eco-innovations is fundamental for ecological sustainability: the reduction of pollution may result if the dynamics of Green Productivity Regime exceeds the Demand regime one. Coming back to the dynamic efficiency of a system, *green dynamic efficiency* is defined as the capacity of a system to generate eco-innovations, complementarities between them and normal innovations, and to make production inputs elastic to eco-innovations.

3. The Econometric analysis.

In the following empirical analysis, we estimate the environmental efficiency, the macroeconomic impact of normal innovations and eco-innovations considering their interactions and finally the pollution dynamic in terms of innovations

3.1 Data and Methodology

A dynamic econometric analysis has been carried out, for two reasons. Firstly, according to the Structuralist-Keynesian framework, innovation is a dynamic process, so that empirical studies within this perspective use only the growth rates of the selected variables. Secondly, the current environmental studies, both theoretical and empirical, use a dynamic approach since ecological matters are characterised by the continuous ecological transformation, which implies economic and social structural changes (Gilli et al. 2013). According to the mainstream approach, a one-step difference GMM Dynamic panel-data methodology has been adopted:, it allows to take into account the endogeneity issues and compared to the system GMM, it is more suitable with a moderate number of groups (countries or regions), in terms of saving of instrumental variables (Roodman 2006). In all equations, the error term of regressions ε_{it} consists of both unobserved country-specific effects u_i, with $iid(0,\sigma_u^2)$, and observation-specific errors v_{it} , with $iid(0,\sigma_v^2)$, where subscripts i and t mean country and time respectively.

3.2 The estimated econometrics models

The first estimated model is the Post Keynesian Environmental Efficiency (EE) function[5] (6) of the model. Given the debate about the Pollution Haven Hypothesis,, the first version of the model does not consider the trade openness variable:

$$(9.a)\quad e_{i,t} = \alpha_0 + \alpha_1 e_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 w_{i,t-1} + \mu\tau_i + \varepsilon_{i,t}$$

$$(9.b)\quad e_{i,t} = \alpha_0 + \alpha_1 e_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 w_{i,t-1} + \alpha_4 o_{i,t} + \mu\tau_i + \varepsilon_{i,t}$$

where e, y, w, o are the growth rates of environmental efficiency, value added at constant prices, labour cost and trade openness, respectively. Finally, τ_i states the temporal trend and ε_{it} the error term.

The environmental efficiency is defined as the inverse of pollution intensity (Mazzanti and Zoboli 2008):

$$(10)\ E = Y/H,$$

where Y is the level of total value added at constant prices, and H is and index of the level of total greenhouse gas emissions[6]. Index H is a proxy of the implemented political strategy because it is one of the indicators for the EU Sustainable Development Strategy and a target of Europe 2020 also, with

[5] In the estimations of environmental efficiency function Switzerland is not considered, because of the lack of data on wages.
[6] Namely, H is total greenhouse gas emissions (excluding aviation) as thousand tonnes of carbon dioxide (CO_2) equivalent. Eurostat publishes the indicator H basing on data from the European Environment Agency. For further information see http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.

particular reference to the Resource Efficiency initiative. Variable w is calculated in two different ways: w^{*} the growth rate of the difference between nominal wage and price of machinery, namely the deflator of fixed capital formation; w^{**}, the growth rate of real wages. Finally, trade openness is the ratio between the sum of exports and imports of goods and services, and the Gross Domestic Product at current prices.

Parameter $\alpha_2 > 0$ captures the *Green Kaldor* (GK) effect, directly related to eco-innovations and indirectly related to normal innovations. Eco-innovations are strongly integrated with the innovation system (sectorial, regional and national), therefore externalities among different firms generate increasing returns (Smith et al. 2005). Parameter $\alpha_3 > 0$ states the *Green Wage Push* (GWP) effect. Both variables are lagged since firm need time to react positively to the increase of labour cost. Parameter α_4 indicates the *Globalisation effect*. Condition $\alpha_4 < 0$ satisfies the Pollution Haven Hypoythesis, but the sign of this effect is uncertain.

As Table 1 shows, all parameters are significant and Green Kaldor effect, Green Wage Push effect and Pollution Haven Hypothesis are verified.

Table 1

a)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.118	0.072	-1.630	0.103
y_{it}	0.285	0.115	2.470	0.013
w^{*}_{it-1}	0.353	0.168	2.100	0.036
τ_i	0.000	0.001	-0.230	0.818
Observations				363
Test				
AR(1)	*z =-2.59*	*Pr>|z| =0.010*		
AR(2)	*z =-1.24*	*Pr>|z| =0.213*		
Hansen test	*chi2 =22.70*	*Pr>|chi2| =0.946*		

b)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.223	0.080	-2.780	0.005
y_{it}	0.259	0.115	2.260	0.024
w^{**}_{it-1}	0.425	0.218	1.950	0.051
τ_i	0.001	0.001	0.560	0.576
Observations				366
Test				
AR(1)	*z =-2.47*	*Pr>|z| =0.014*		
AR(2)	*z = -1.47*	*Pr>|z| = 0.141*		
Hansen test	*chi2 = 24.74*	*Pr>|chi2| = 0.902*		

c)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.255	0.092	-2.790	0.005
y_{it}	0.521	0.245	2.120	0.034
w^{*}_{it-1}	0.155	0.078	1.990	0.046
o_{it}	-0.293	0.115	-2.550	0.011
τ_i	0.000	0.001	-0.380	0.705
Observations				363
Test				
AR(1)	*z =-2.98*	*Pr>|z| =0.003*		
AR(2)	*z =-1.26*	*Pr>|z| =0.207*		
Hansen test	*chi2 =23.48*	*Pr>|chi2| =0.890*		

d)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.336	0.095	-3.540	0.000
y_{it}	0.533	0.244	2.180	0.029
w^{**}_{it-1}	0.193	0.108	1.780	0.075
o_{it}	-0.307	0.120	-2.560	0.010
τ_i	0.000	0.001	0.240	0.811
Observations				366
Test				
AR(1)	*z =-2.60*	*Pr>|z| =0.009*		
AR(2)	*z =-1.41*	*Pr>|z| = 0.157*		
Hansen test	*chi2 = 24.00*	*Pr>|chi2| = 0.874*		

This endogenisation of environmental efficiency may lead to a positive impact of labour productivity on environmental efficiency, tested through the following equations:

$$\text{(11.a)}\quad e_{i,t} = \beta_0 + \beta_1 e_{i,t-1} + \beta_2 g_{i,t} + \mu\tau_i + \varepsilon_{i,t};$$

$$\text{(11.b)}\quad e_{i,t} = \beta_0 + \beta_1 e_{i,t-1} + \beta_2 g_{i,t-1} + \mu\tau_i + \varepsilon_{i,t};$$

$$\text{(11.c)}\quad e_{i,t} = \beta_0 + \beta_1 e_{i,t-1} + \beta_2 g_{i,t} + \beta_3 g_{i,t-1} + \mu\tau_i + \varepsilon_{i,t}.$$

The impact of normal innovation on eco-innovation is analysed with a time lag, by taking into account the process of adjustment and adaptation between different types of innovations. As table 2 shows, the coevolution dynamics seems to work with one lagged variables.

Table 2

a)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.287	0.118	-2.430	0.015
g_{it}	-0.150	0.159	-0.940	0.346
τ_i	-0.002	0.001	-1.550	0.121
Observations				397
Test				
AR(1)	*z = -2.61*	*Pr>|z| =0.009*		
AR(2)	*z =-1.55*	*Pr>|z| =0.121*		
Hansen test	*chi2 =25.40*	*Pr>|chi2| =0.856*		

b)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.197	0.126	-1.570	0.116
g_{it-1}	0.814	0.260	3.130	0.002
τ_i	0.000	0.001	0.010	0.991
Observations				391
Test				
AR(1)	*z =-2.72*	*Pr>|z| =0.007*		
AR(2)	*z = -1.37*	*Pr>|z| = 0.171*		
Hansen test	*chi2 = 22.95*	*Pr>|chi2| = 0.880*		

c)

Dependent variable: the growth rate of environmental efficiency (e_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
e_{it-1}	-0.139	0.129	-1.080	0.281
g_{it}	-0.134	0.163	-0.820	0.412
g_{it-1}	0.672	0.253	2.650	0.008
τ_i	-0.001	0.001	-0.800	0.426
Observations				389
Test				
AR(1)	*z =-2.88*	*Pr>|z| =0.004*		
AR(2)	*z =-1.20*	*Pr>|z| =0.229*		
Hansen test	*chi2 =24.56*	*Pr>|chi2| =0.701*		

Estimations provided so far about the environmental efficiency function and the positive impact of labour productivity on environmental efficiency, show the complementarity between normal innovations and eco-innovations.

Starting from the green identity (5) $h = y - e$, and recalling that $e = e(g)$ in order to take into account its endogeneity issues, the *value added green function* has been derived: $y = e(g) + h$ The corresponding estimated model is the following:

$$(12)\ y_{i,t} = \delta_0 + \delta_1 y_{i,t-1} + \delta_2 g_{i,t-1} + \delta_3 h_{i,t-1} + \mu\tau_i + \varepsilon_{i,t},$$

with lagged values of variable g, given the previous environmental efficiency estimation results. Parameters $\delta_2, \delta_3 > 0$ indicate the impact of labour productivity on the economic growth through the complementarity with environmental efficiency.

Inserting the income identity (1) $y = n + g$ into the green identity (5) $h = y - e$, arises $h = g + n - e$, and recalling that $e = e(g)$, the *employment green function* has been derived: $n = h + e(g) - g$. The corresponding estimated model is the following:

$$(13)\ n_{i,t} = \theta_0 + \theta_1 n_{i,t-1} + \theta_2 g_{i,t-1} + \theta_3 h_{i,t-1} + \mu\tau_i + \varepsilon_{i,t},$$

with lagged values of variable g, given the previous environmental efficiency estimation results.

Parameters $\theta_2, \theta_3 > 0$ indicate the impact of labour productivity on employment through the complementarity with environmental efficiency. According to the equations (12) and (13), macroeconomic goals may be achieved by unsustainable road of pollution or/and by the sustainable road of innovations ecological friendly. The *sustainability function* derives from the expression (8) $h(g) = [y'(g) - e'(g)]g$. The corresponding estimated model is the following:

$$(14)\ h_{i,t} = \varphi_0 + \varphi_1 h_{i,t-1} + \varphi_2 g_{i,t-1} + \mu\tau_i + \varepsilon_{i,t}.$$

with $\varphi_2 < 0$. As Table 3 shows, empirical results confirm the theoretical hypothesis that complementarity between labour productivity and environmental function is fruitful in term of economic growth, employment growth and sustainability.

Table 3

a)

Dependent variable: the growth rate of value added (y_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
y_{t-1}	-0.269	0.162	-1.660	0.097
g_{t-1}	0.589	0.258	2.280	0.023
h_{t-1}	0.149	0.075	1.980	0.048
τ_i	-0.002	0.001	-3.600	0.000
Observations				392
Test				
AR(1)	*z = -3.44*	*Pr>|z| =0.001*		
AR(2)	*z =-1.53*	*Pr>|z| =0.125*		
Hansen test	*chi2 =25.61*	*Pr>|chi2| =0.921*		

b)

Dependent variable: the growth rate of employment (n_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
n_{it-1}	0.086	0.125	0.690	0.492
g_{t-1}	0.365	0.102	3.570	0.000
h_{t-1}	0.097	0.052	1.870	0.061
τ_i	0.000	0.000	0.460	0.645
Observations				392
Test				
AR(1)	*z =-2.10*	*Pr>|z| =0.036*		
AR(2)	*z = -0.23*	*Pr>|z| = 0.820*		
Hansen test	*chi2 = 22.95*	*Pr>|chi2| = 0.971*		

c)

Dependent variable: the growth rate of pollution (h_{it})

	Coef.	Robust Standard. Error	z	Pr>|z|
h_{it-1}	-0.113	0.123	-0.910	0.360
g_{t-1}	-0.398	0.203	-1.960	0.050
τ_i	-0.002	0.001	-2.290	0.022
Observations				397
Test				
AR(1)	*z = -2.79*	*Pr>|z| =0.005*		
AR(2)	*z =-1.64*	*Pr>|z| =0.101*		
Hansen test	*chi2 =23.98*	*Pr>|chi2| =0.951*		

4. Policy implications

As outlined in paragraph 2, although the Europe 2020 Strategy is well structured, it needs some interventions to be relaunched. Indeed it lacks about some theoretical and econometric foundations to the political agenda as those provided in the last two paragraphs. Furthermore, it foresees policy interventions which may be feasible with a good business climate, but prohibitive under severe public budget constraints.

This paragraph does not focus on interventions, but rather on the institutional framework EU member countries need to effectively implement a wide-ranging investment programme aimed at the productivity and employment growth. More specifically, two key points will be stressed: firstly, the (re)orienteering of the EU policies towards the real economy, manufacturing system in particular and some tertiary services also. To this concern, the adopted slogan by (this time allied) Italian and German industry associations advocated an “Industrial compact” implementation, against a more formidable Fiscal compact). Secondly, regarding the financing of real economy (outside those circles addressed rather to the brokers support), a common intervention is necessary. To this aim, in front of the current international crisis, should an investment programme be supported by the European Investment Bank (whose shareholders are just the EU member countries), it could meet a two-fold goal, both structural and countercyclical at the same time.

Some policy implications may be drawn thanks to the results of the analysis:

Mechanisms supporting inclusive green growth are incompatible with austerity EU policies.

With reference to Green Kaldor effect, due to economies of scale, growth is mainly a precondition for both eco-innovation and normal innovation processes, and for improvements of (environmental) efficiency; in the austerity, the inverse relation is stressed. As Kaldor argued, the market is mainly an instrument of creation of resources rather than an instrument of allocation of resources.[7] Furthermore,

[7] According to Kaldor the market "... not primarily an instrument for allocating resources. It is primarily an instrument for transmitting impulses to change; it would be truer to say that the market mechanism creates or generates resources than it allocates them." (Kaldor, 1979, p. 280). http://growth-distribution.ec.unipi.it/fullT/Ricoy_Lucca.pdf This view is alternative to the standard neoclassical economic theory “

increase of wages is conducive of eco-innovations while, in the austerity, labour market policies focus on the containing of the labour cost, running the risk a wage decrease.

Public Institutions must sustain eco-innovations. With reference to Green Kaldor effect (Mazzanti 2009), the spillover effects of eco-innovation, in R&D terms for instance, may disincentive firms to innovate. In fact, some environmental goods are defined impure public goods and the public institutions should sustain firms to appropriate part of the gains. Complementarity is a strong instrument for macro benefits of innovations and eco-innovations in terms of employment and economic growth. With reference to Green Wage push effect, environmental regulations can enable firms to innovate in the green fields by prospecting gains opportunities, mainly in term of cost-saving, that otherwise they do not be aware due to lack of information or imperfect information (market failure).

Globalization may be a disincentive to the eco-innovations.

With reference to the Pollution Haven effect, European institutions should include environmental issues within the international trade agreements, otherwise international deregulations and the heterogeneous environmental law regimes will reinforce the trade-off between international competition and ecological sustainability by the practice of green dumping.

5. Concluding remarks

Thanks to a green growth dynamic model this paper show how labour productivity and environmental intensity interact to each other and how they may improve employment.

With reference to the effect of sustainable factors on smart factors, "dual externality principle" is confirmed: eco-innovations may both provide R&D spillovers, and reduce environmental negative externalities (Jaffe et al., 2003; Rennings, 2000); depending on the Porter's hypothesis, environmental regulations may stimulate eco-innovation in order to reduce regulation costs (Porter and Van der Linde, 1995). Furthermore, an increase of energy intensity tends to stimulate cost-saving innovations. With reference to the effect of smart factors on sustainable factors, main results confirm the "pollution haven hypothesis": trade openness increases global pollution because of more relaxed environmental regulation, delocalization and specialization (Ederington et al. 2004). Finally, the positive impact of smart and sustainability factors on employment depends on the complementarity between the first two pillars. Main political points are: the proactive role of public institutions, to avoid innovation market failures (Martin S., Scott J.T. 2000) and to generate an "innovation multiplier" starting from public investments; the coordination among macroeconomic policies on the one hand, and industrial, innovation, environmental, and trade policies on the other.

The achievement of the Europe 2020 goals is essential for overcoming the economic, social, and ecological crisis in Europe. However, this implies to go beyond the actual "austerity policy framework" and to implement some proposals in order to generate, stimulate and sustain the abovementioned cumulative green circle.

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Appendix

Table A.1

a)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.045	-0.162	0.207	N = 363
	between		0.011	0.013	0.057	n = 25
	within		0.044	-0.158	0.203	T = 14.52
e_{it-1}	overall	0.032	0.046	-0.162	0.207	N = 363
	between		0.011	0.013	0.056	n = 25
	within		0.044	-0.155	0.210	T = 14.52
y_{it}	overall	0.023	0.035	-0.156	0.106	N = 363
	between		0.011	0.008	0.043	n = 25
	within		0.034	-0.171	0.089	T = 14.52
w^{*}_{it-1}	overall	0.028	0.048	-0.150	0.417	N = 363
	between		0.025	-0.007	0.083	n = 25
	within		0.042	-0.205	0.363	T = 14.52

b)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.046	-0.162	0.207	N = 366
	between		0.012	0.013	0.057	n = 25
	within		0.044	-0.164	0.204	T = 14.64
e_{it-1}	overall	0.031	0.046	-0.162	0.207	N = 366
	between		0.011	0.013	0.056	n = 25
	within		0.045	-0.157	0.210	T = 14.64
y_{it}	overall	0.024	0.035	-0.156	0.106	N = 366
	between		0.011	0.008	0.043	n = 25
	within		0.033	-0.171	0.089	T = 14.64
w^{**}_{it-1}	overall	0.021	0.045	-0.247	0.280	N = 366
	between		0.019	0.002	0.065	n = 25
	within		0.041	-0.281	0.246	T = 14.64

c)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.045	-0.162	0.207	N = 363
	between		0.011	0.013	0.057	n = 25
	within		0.044	-0.158	0.203	T = 14.52
e_{it-1}	overall	0.032	0.046	-0.162	0.207	N = 363
	between		0.011	0.013	0.056	n = 25
	within		0.044	-0.155	0.210	T = 14.52
y_{it}	overall	0.023	0.035	-0.156	0.106	N = 363
	between		0.011	0.008	0.043	n = 25
	within		0.034	-0.171	0.089	T = 14.52
w^{*}_{it-1}	overall	0.028	0.048	-0.150	0.417	N = 363
	between		0.025	-0.007	0.083	n = 25
	within		0.042	-0.205	0.363	T = 14.52
o_{it}	overall	0.032	0.057	-0.173	0.398	N = 363
	between		0.018	-0.001	0.080	n = 25
	within		0.054	-0.185	0.386	T = 14.52

d)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.046	-0.162	0.207	N = 366
	between		0.012	0.013	0.057	n = 25
	within		0.044	-0.164	0.204	T = 14.64
e_{it-1}	overall	0.031	0.046	-0.162	0.207	N = 366
	between		0.011	0.013	0.056	n = 25
	within		0.045	-0.157	0.210	T = 14.64
y_{it}	overall	0.024	0.035	-0.156	0.106	N = 366
	between		0.011	0.008	0.043	n = 25
	within		0.033	-0.171	0.089	T = 14.64
w^{*}_{it-1}	overall	0.021	0.045	-0.247	0.280	N = 366
	between		0.020	0.002	0.065	n = 25
	within		0.042	-0.288	0.240	T = 14.64
o_{it}	overall	0.031	0.056	-0.173	0.398	N = 366
	between		0.018	-0.001	0.080	n = 25
	within		0.054	-0.185	0.386	T = 14.64

Table A.2

a)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.031	0.046	-0.162	0.207	N = 397
	between		0.012	0.013	0.057	n = 26
	within		0.045	-0.181	0.205	T =15.30
e_{it-1}	overall	0.032	0.048	-0.162	0.229	N = 397
	between		0.012	0.013	0.053	n = 26
	within		0.046	-0.182	0.213	T =15.30
g_{it}	overall	0.018	0.030	-0.086	0.169	N = 397
	between		0.015	-0.002	0.049	n = 26
	within		0.027	-0.117	0.151	T =15.30

b)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.046	-0.162	0.207	N = 391
	between		0.012	0.013	0.057	n = 26
	within		0.045	-0.182	0.204	T = 15.04
e_{it-1}	overall	0.032	0.047	-0.162	0.207	N = 391
	between		0.011	0.013	0.053	n = 26
	within		0.046	-0.182	0.210	T = 15.04
g_{it-1}	overall	0.020	0.030	-0.086	0.169	N = 391
	between		0.015	0.001	0.052	n = 26
	within		0.027	-0.118	0.157	T = 15.04

c)

Variable		Mean	Std. Dev.	Min	Max	Observations
e_{it}	overall	0.030	0.046	-0.162	0.207	N = 389
	between		0.012	0.013	0.057	n = 26
	within		0.045	-0.182	0.204	T = 14.96
e_{it-1}	overall	0.032	0.047	-0.162	0.207	N = 389
	between		0.011	0.013	0.053	n = 26
	within		0.046	-0.182	0.210	T = 14.96
g_{it}	overall	0.018	0.030	-0.086	0.169	N = 389
	between		0.015	-0.002	0.051	n = 26
	within		0.027	-0.119	0.151	T = 14.96
g_{it-1}	overall	0.020	0.030	-0.086	0.169	N = 389
	between		0.015	0.001	0.052	n = 26
	within		0.027	-0.118	0.156	T = 14.96

Table A.3

a)

Variable		Mean	Std. Dev.	Min	Max	Observations
y_{it}	overall	0.024	0.035	-0.156	0.106	N = 392
	between		0.011	0.008	0.044	n = 26
	within		0.033	-0.170	0.090	T = 14.15.08
y_{it-1}	overall	0.026	0.035	-0.156	0.107	N = 392
	between		0.011	0.011	0.049	n = 26
	within		0.033	-0.171	0.091	T = 14.15.08
g_{it-1}	overall	0.02	0.030	-0.086	0.169	N = 392
	between		0.015	0.001	0.052	n = 26
	within		0.027	-0.118	0.157	T = 14.15.08
h_{it-1}	overall	-0	0.049	-0.180	0.229	N = 392
	between		0.009	-0.023	0.014	n = 26
	within		0.048	-0.192	0.221	T = 14.15.08

b)

Variable		Mean	Std. Dev.	Min	Max	Observations
n_{it}	overall	0.006	0.024	-0.143	0.160	N = 392
	between		0.009	-0.011	0.035	n = 26
	within		0.023	-0.127	0.173	T = 15.08
n_{it-1}	overall	0.006	0.024	-0.143	0.160	N = 391
	between		0.009	-0.009	0.035	n = 26
	within		0.023	-0.128	0.174	T = 15.04
g_{it-1}	overall	0.02	0.030	-0.086	0.169	N = 391
	between		0.015	0.001	0.052	n = 26
	within		0.027	-0.118	0.156	T = 15.04
h_{it-1}	overall	-0	0.049	-0.180	0.229	N = 391
	between		0.010	-0.027	0.014	n = 26
	within		0.048	-0.192	0.221	T = 15.04

c)

Variable		Mean	Std. Dev.	Min	Max	Observations
h_{it}	overall	-0.01	0.048	-0.180	0.229	N = 322
	between		0.012	-0.025	0.022	n = 25
	within		0.047	-0.185	0.216	T = 12.88
h_{it-1}	overall	-0	0.048	-0.180	0.229	N = 322
	between		0.012	-0.020	0.028	n = 25
	within		0.047	-0.193	0.207	T = 12.88
g_{it-1}	overall	0.018	0.029	-0.086	0.169	N = 322
	between		0.016	-0.001	0.055	n = 25
	within		0.025	-0.119	0.133	T = 12.88

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