The geography of green inventions and green house gas emission dynamics-A closer look on provincial Italian data

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Introduction

The advancement of science and technology are considered to be a key issue in resolving current environmental issues and tackling climate change (Abbott, 2009; Thomas, 2008). Despite that, the literature on the effect of technical change and especially green innovation on the environment is still rather scarce. This paper seeks to fill this gap taking a 'local perspective'.

Regional analyses of environmental topics are useful for several reasons. Firstly, regional frameworks allow focusing the investigation on structural and idiosyncratic features compared to national averages; secondly, a disaggregated approach provide useful insights on specific environmental and economic development dynamics, which might be useful for regional policy makers; Thirdly, the provide political economy implications which can be differentiated across different regions and territory. This is especially relevant in a country like Italy which is characterised by high disparities, like the famous North-South Divide. Moreover, it has to be noted that this infra-country heterogeneity do not only involve economic aspects, but also environmental performances which are highly heterogenous across coutry and tend to favour northern industrial regions, as confirmed by previous studies based on the national accounting matrix for environmental accounts (NAMEA) (Mazzanti et al., 2010). However, while several works at national level based on hybrid environmental accounts are well established in literature (De Haan, 2004; Mazzanti and Montini, 2010), analysis based on the sub national/regional level are much more rare.

Starting from these premises, the preliminary evidence presented in Fig. 1 and Fig.2 confirm previous expectation on north – south disparities. For what concern CO2 emissions, Piemonte and Lombardia are the two regions associated with an higher level of total production, while the other areas generally have a similar total emission. Similarly, Tab 2 show the descripancies in term of total patenting, which confirms the predominant role of northern regions, like Lombardia, Piemonte, Veneto and Emilia-Romagna.

Summarising, this paper investigates the role of inventions aimed at reducing carbon dioxide as a factor that compensates growth and population effects within a STIRPAT framework. The paper is formed by 5 sections, the first presents a literature review, future research direction and an overview of Italian trends of CO2 emissions and patenting, section 2

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presents theoretical framework, section 3 describes the empirical approach, section 4 discusses the main results and section 5 draws conclusions.

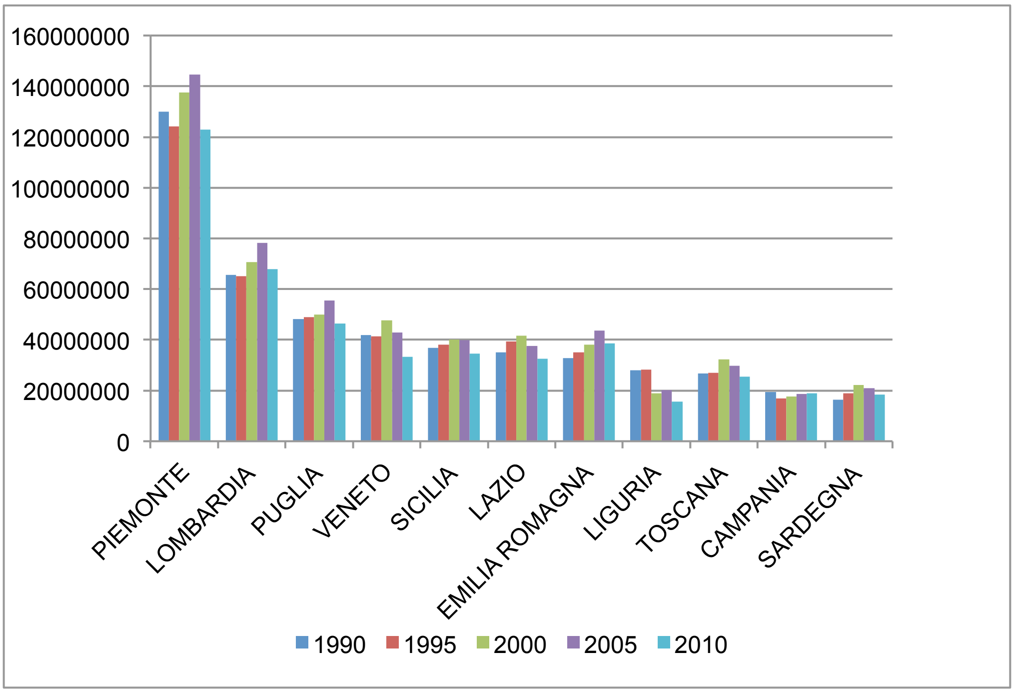

Fig 1. The CO2 emission of 11 Regions in Italy for 5 selected years (Unit: Mg)[4]

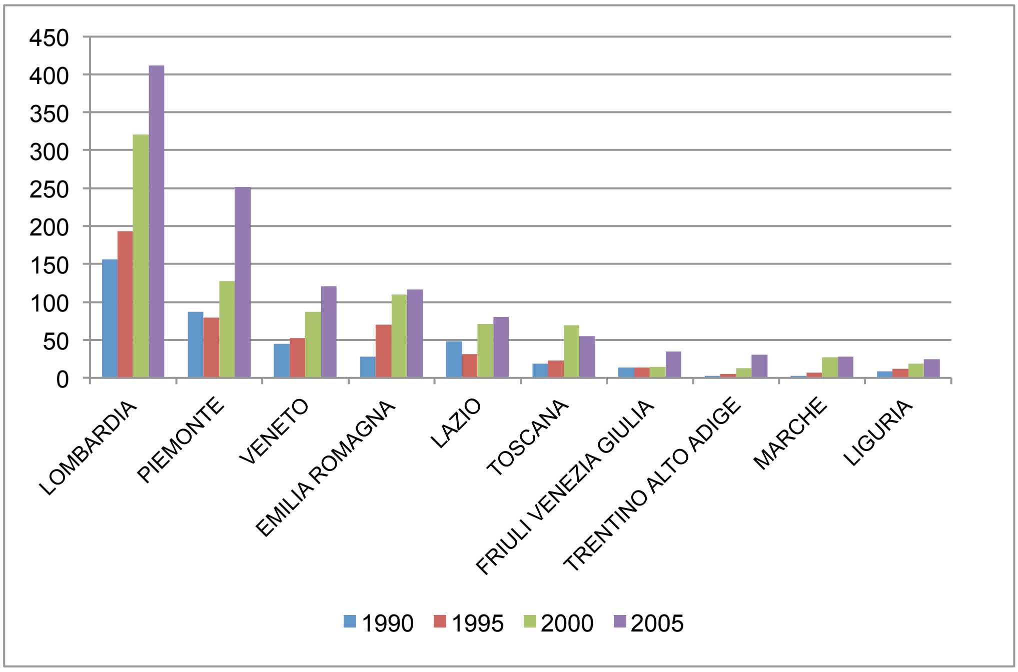

Fig 2. The amount of green patent in 10 Italian regions for 4 selected years[5]

Methodology

Commoner (1971) and Ehrlich and Holdren (1971) proposed the IPAT model:

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[4] The other 9 areas' emission are all below 20,000,000Mg these 5 years.

[5] The other 10 areas' amount of green patent is all below 20 these 5 years.

$I = P \cdot A \cdot T$ were I represents environmental impact and other three key driving forces, population size (P), affluence (A, per capita consumption or production) and technology (T, impact per unit of economic activity). However, to overcome the limitation of this model, in this paper we use the stochastic equations-STIRPAT model (Cramer, 1998; Dietz and Rosa, 1994, 1997; Jia et al., 2009; Shi, 2003; York et al., 2003a), which allows to do a non-proportional impact analysis of all factors.

$$I_{it} = aP_{it}^{b} \cdot A_{it}^{c} \cdot T_{it}^{d} \tag{1}$$

that into Logarithmic form reads as:

$$\ln I_{it} = \ln a + b \ln P_{it} + c \ln A_{it} + d \ln T_{it} \tag{2}$$

Where t indicates the year, b, c, d represent the impact elasticity of population number, per capita real GDP and technology indicator effect on carbon dioxide emissions respectively. In this paper we adopt green patent data as technology indicator to test the relationship between innovative activity and CO2 emission. In order to investigate whether there is an inverted U shape relationship between carbon dioxide emissions and economic growth, we decompose the $\ln A_{it}$ into $\ln A_{it}$ and $(\ln A_{it})^2$, while for testing the different types of green innovations, which include 6 types of patents[6], we divide $d \ln T_{it}$ into $d_1 \ln T_{it}^{1}, d_2 \ln T_{it}^{2}, \text{L}\ , d_6 \ln T_{it}^{6}$. The final equation becames:

$$\ln I_{it} = \ln a + b \ln P_{it} + c_1 \ln A_{it} + c_2 (\ln A_{it})^2 + \sum_{j=1}^{6} d_j \ln T_{it}^{j} \tag{4}$$

According to the model of the symbols q and c2, we can determine the relationship between several typical of carbon dioxide emissions and economic growth.

Describe of data

The final panel data set derives from merging original data sources covering all the Italian provinces over the period 1990-2010. The dimension analised are the following:

Environmental impact defined by CO2 emissions, measured as the stock of net emissions from 11 sectors. (Unit: Mg).

Population measured as the total number of inhabitants, data taken from the National institute of statistics website (http://demo.istat.it/archive.html).

Affluence Per capita GDP, which was use as variable to examine variations in the district's affluence, data taken from the National institute of statistics website.

Technology measured as the amount of green patent filed at the EPO, Source OECD.

Result and discussion

Result of empirical test

This paper use a Ridge regression method to test the theoretical prediction summarised above, while we account for the potential endogeneity of inventions using an IV approach

[6] 6 types include: Energy generation from renewable and non-fossil sources, Combustion technologies with mitigation potential, Energy efficiency in buildings and lighting, General Environmental Management, Technologies specific to climate change mitigation, Emissions abatement and fuel efficiency in transportation

imploying as exclusion restrictions social capital and institutional variables. Preliminary results confirm the predominant role of green technologies in mitigating the impact of economic activity through the reduction of CO_2 emissions.