TOWARDS SUSTAINABLE AGRI-FOOD SYSTEMS:
BALANCING BETWEEN MARKETS AND SOCIETY

Promoting the Bioelectricity Sector at the Regional Level: an Impact Analysis of Energy Tax Policy

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Abstract *The development of bioenergy, as a new business model integrated with environment and territory, may be a valuable opportunity for farmers with positive effects both in socio-economic and environmental terms. However, large-scale biomass plantations might increase pressure on the productive land and might cause a substantial increase of food prices.*
The main goal of the current study is to support the policy decision making in the renewable energy sector by quantitatively assessing impacts of alternative policy instruments at the sub-state regional level. The scenario analysis is performed using a multi-regional multi-sector Computable General Equilibrium (CGE) model applied to Basilicata region, Southern Italy, with, given the importance of agriculture in the area, a great deal attention on agricultural production level, food prices and land competition. Results shows that promoting bioenergy sector do not generate negative impact on food price, land use and welfare, supporting the continuation of policies to incentive the bioenergy sector, combining tax policies with other policy tools (e.g. agricultural or climate policies) in order to make the sector more competitive.

Keywords: CGE, biomass, tax energy policies, land use change, welfare

JEL Classification codes: E16 – E62 – Q42 – Q48 – R13

1. INTRODUCTION

Agriculture plays an important role in the rural economy and is considered to be one of the most important sectors to take into account in the rural development processes (Sánchez-Zamora et al., 2014). However, farmers face different challenges, mainly related to the climate change, global market instability and political decisions that frequently make them vulnerable (Eakin, 2005; Harvey et al., 2014). As a consequence, in several mostly rural and lagging regions, like Basilicata (in Southern Italy), marginal farmland areas are being increasingly abandoned due to their low productivity and as a result of the major reforms of the EU Common Agricultural Policy (Romano and Cozzi, 2008). Different studies suggest that farm diversification could be a possible solution to risk management and for increasing farm income (Barbieri and Mahoney, 2009; Gautam and Andersen, 2016; Meert et al., 2005)

In this context, the development of bioenergy, as a new business model integrated with environment and territory, may be a valuable opportunity with positive effects both in socio-economic and environmental terms (Chum et al., 2011). In the last years, bioenergies have received increasing attention since they are not only able to replace fossil fuels in the electricity, heat and transport sector (with the promise to decrease global greenhouse gas (GHG) emissions), but they can also provide local and regional benefits such as energy security, rural development, positive impacts on regional gross domestic product, and mitigation of local pollutant emissions (Chum et al., 2011; Franke et al., 2012; Martínez et al., 2013; Wicke et al., 2011).

Therefore, with the recent trend of local-regional development plans, regional decision makers are interested in the quantification of economic impacts of energy policies particularly in rural areas: the expectation is that "rural regions in particular can benefit from the establishment of bioenergy industries and the related production of biomass" (Berndes and Hansson, 2007: 5974; Trink et al, 2010).

To this purpose, there are several modelling approaches available in energy economics (Nakata, 2004). However, as argued by Kretschmer and Peterson (2010) the Computable general equilibrium (CGE) approach can be considered to be the most promising approach in the analysis of energy policies, especially if the energy sector is disaggregated directly in a Social Accounting Matrix. CGE models have been widely employed in order to study the effects of climate/energy policies at the national, or even more aggregated geographical scale (Kretschmer and Peterson, 2010; Nakata 2004), but to date there is a lack of multiregional analysis at the local, i.e. sub-state scale, treating economic implications within and among regions endogenously (Trink et al., 2010).

The main goal of the current study is to support the policy decision making in the renewable energy sector by quantitatively assessing the impacts of alternative policy instruments at the sub-state regional level. The scenario analysis is performed using a multi-regional multi-sector Computable General Equilibrium (CGE) model applied to the Basilicata region, Southern Italy. The region is rich in non-renewable and renewable resources, with a high potential to increase the share of electricity production from biomass resources (Cozzi et al., 2013, 2015). So, the focus is on the economic effects resulting from intensified bioelectricity production with, given the importance of agriculture in the area, a great deal attention on agricultural production level, food prices and land competition.

This paper is structured as follows. Section 2 presents the agricultural and energy sector of the Basilicata region, to better understand the motivations of the study. The model and the data are described in section 3, while the results are discussed in section 4. Final remarks close the paper.

2. AGRICULTURE AND ENERGY IN BASILICATA REGION

2.1. Agricultural sector

The regional economy of Basilicata was traditionally based on agriculture, but has evolved considerably since the early 1980s, when agriculture still accounted for around a quarter of GDP. A decade later the share of agriculture had fallen to 20 % of the economy and it has continued to shrink, reaching 8.2 % by 2014. Despite that, the agricultural sector continues to play an important role in the regional economy, thanks to the interaction with the regional and national food industry. As shown in Figure 1 and 2, the contribution of agriculture to total value-added is higher in Basilicata than in the rest of Italy (ISTAT, 2016).

In 2014, crop production contributes the largest share of agricultural GDP with 56.5%, followed by livestock production (18.1%) and agricultural services (25.5%). The major crops are vegetables and fruits and wheat that contribute respectively with 35% (-5.6% to 2010) and 16.6% (+6.1% to 2010) to agricultural GDP (Table 1).

Figure 1: Agricultural share of total value-added (Basilicata region, years 2000 – 2014)

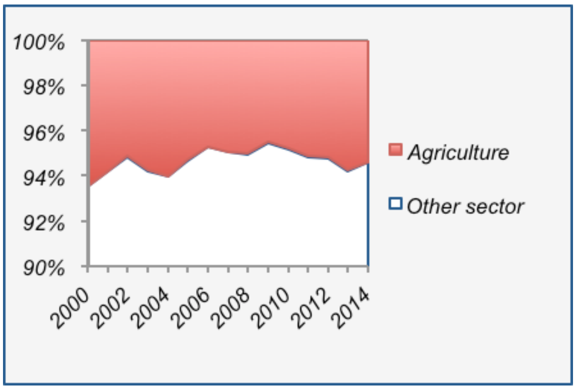
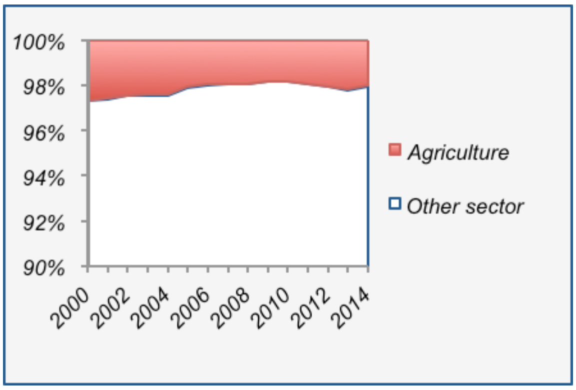


Figure 2: Agricultural share of total value-added (Italy, years 2000 – 2014)



Source: our elaboration on ISTAT data.

Table 1. Value and share of agricultural GDP by crop types (Basilicata region)

	2010		2014	
	M Euro	%	M Euro	%
Wheat	80.68	10.5	144.03	16.6
Cereal grains	5.66	0.7	9.07	1.0
Vegetables & fruits	310.69	40.6	304.47	35.0
Oilseeds	24.33	3.2	24.82	2.9
Sugar crops	1.22	0.2	0.32	0.0
Biomass	3.11	0.4	2.91	0.3
Total GDP	765.84		870.04	

Source: our elaboration on ISTAT data.

Comparing 2000-2010 Italian Agricultural Census data (ISTAT, 2016), a strong contraction occurred in land destined to arable and agrarian woody crops with an increase in permanent grassland areas and pastures. These results are certainly a direct consequence of the abandonment of agricultural land located in marginal areas and of the major reforms of the EU Common Agricultural Policy (Romano and Cozzi, 2008).

Also the remarkable contraction of the labour force should be highlighted, both in terms of work units (-15% in 2010 compared to 2000) and in the average numbers of days of farm work, in line with the reduction of the high number of companies and with an increased level of mechanization. It should be stressed that these figures are from a territorial reality where the number of employees decreased by approximately 5% over the period.

In this context, the abandoned arable lands offer good opportunities for biomass production, providing to diversify farm income and increase job opportunities, contributing at the same time to produce clean energy. According to Cozzi et al. (2015) results, in Basilicata region there are more than 250 thousand hectares of land suitable for poplar cultivation for energy purpose, 864 of which could be fertigated with urban wastewaters, providing approximately 72 GWh of electricity.

2.2. Energy sector

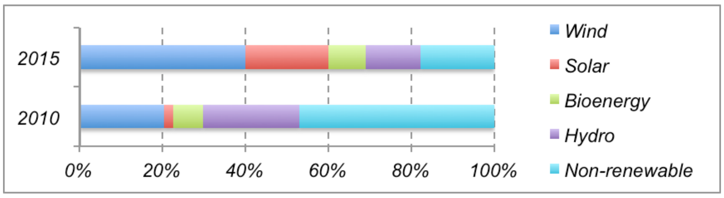
Oil and gas are dominant in the production of electricity in Italy. Around 61% of all electricity generated in the country comes from fossil fuels. In 2010, 302 thousand GWh of electricity were generated in Italy from which about 80 thousand GWh came from renewable energy. After five years, in 2015, an increase of the amount of renewable energy was observed, equal to 110 thousand GWh.

Despite Italy continues to be a net electricity importer, the increase of renewable energy has already led in 2012 to overcome the targets set by the “Burden Sharing” legislative decree, that fix the renewable share in total gross energy consumption to 14.3% by 2020.

In Basilicata the situation is different, in 2015 around 82% (1974 GWh) of all electricity generated in the region comes from renewable energy. Given the favourable geographical conditions in the region, the main source for green electricity is wind, with a share in total electricity production of 40%, followed by solar with a 20%. As first renewable source in the past, hydro produces only 318 GWh (13% in total production), while bioenergy only 212 GWh (9% in total production).

Between 2010 and 2015 a notable increase of the share of wind and solar in total electricity production (+109% and +955% respectively) was recorded, together with a decrease of hydro and non-renewable (-38% and -59% respectively) (Figure 3).

Figure 3: Share of total electricity production by sector (Basilicata region)



Source: our elaboration on TERNA (2016) data

The bioenergy increase is moderate (+31%): currently, in Basilicata, biomass is used mainly to generate heat. There are few working plants combining production of heat and electricity, mostly using forestry products. However, in the next future, it is expected that the biomass is going to play a larger role in the production of green electricity and contribute, with other renewable energy, to cover the amount of electricity imported (788 GWh in 2015). In fact, poplar is considered to have a high potential for use in electricity production (Cozzi et al., 2015), as well as forest residues (Cozzi et al., 2013).

The costs of biomass-based plants generating electricity are currently 2 to 3 times higher than similar plants fuelled by oil or gas (Ignaciuk and Dellink, 2006). However, within the coming years, the electricity sector has to undertake serious modernization in order to fulfill both efficiency and environmental standards (MIPAAF, 2014), with the possibility to create new and clean biomass-based plants. In particular, there will be a tendency to develop small-scale plants that can be placed based on availability of biomass in the region, thereby minimizing transport costs of biomass (Cozzi et al., 2013).

3. Material and Methods

To assess the impact of energy policies on land use allocation, sectoral production levels and prices of land, food, electricity and other commodities, the present study employs a multi-regional multi-sector Computable General Equilibrium (CGE) model to analyse the economic implications at the sub-state regional level of energy policies. The model is a modified version of REMES model (SINTEF TS, 2016) adapted for the Italian economy. The model focus on the Basilicata region and the Rest of Italy (RoI). Basilicata region is connected via trade flows to the Rest of Italy, and thus in turn to the international markets. The model is calibrated for the year 2010 using the data described in Section 3.2.

The model structure with respect to the two focus regions is described below, emphasizing production, consumption and trade specifications. The analysis was carried out in a comparative static mode, which allows to directly comparing the equilibrium with and without implementing a set of policy instruments (Section 3.3).

3.1. Model specification

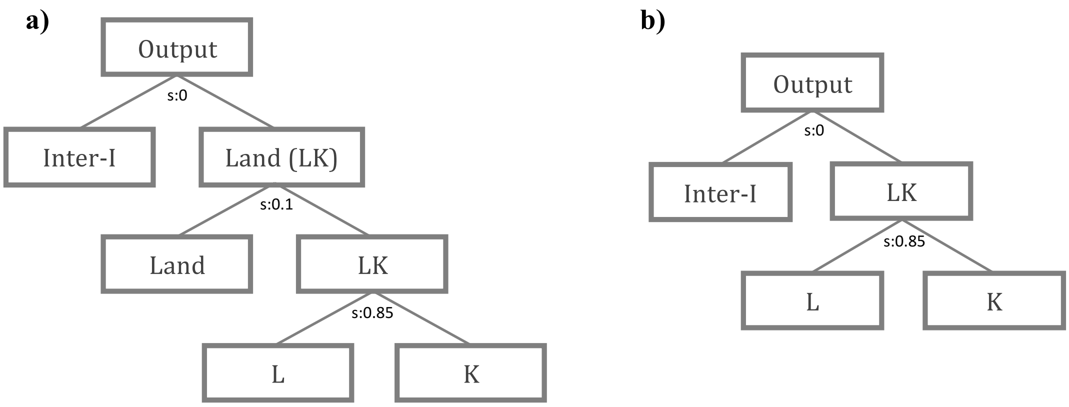
The model describes the entire economy for both focus regions, with explicit detail in the representation of agricultural and electricity production. The economy is disaggregated into 47 production sectors, of which seven are agriculture producing (wheat, cereal grains, vegetable and fruits, oil-seed, sugar crops, biomass, livestock and service) and six are electricity producing (non-renewable, hydro, wind, solar, geothermal, biomass). We want to highlight that electricity sectors produce the same commodity, electricity. In fact, in the actual Italian energy scenario, the consumer cannot choose the type of electricity based on type of source used in producing it. This choice influences the nesting structure of the production functions, since producers use electricity in production without the possibility to choose the energy source.

As in other general equilibrium models, all markets clear, which means that supply equals demand for all commodities through adjusting relative prices (Ginsburgh and Keyzer, 1997). For each focus region, each commodity can either be used as an intermediate input in production sectors, can be traded to the other region or to the Rest of the World (RoW), or consumed by one of two agents: households or Government (local and central).

Profit maximization and cost minimization are the basic assumptions used in modelling the behaviour of firms. Production makes use of three primary factors: capital and labour, which are perfectly mobile across sectors, and land in agricultural sectors, that is mobile across different crops but not across regions. Following Diedrich and Petersik (2001), factor endowments are assumed to be fully employed, which implies a complete wage flexibility. The production of each sector is described by a nested constant elasticity of substitution (CES) production function, with different elasticity of substitutions (Figures 4) (Trink et al., 2010). Production functions of different commodities have a three-level nesting structure for the agricultural sector (Figure 4a) and two-level nesting structure for the all other sectors (Figure 4b).

Considering consumers, households maximize utility under the condition that expenditures on consumption goods do not exceed income. Consumers own production factors and consume produced goods. Governments (local and central) collect taxes and use them to finance public expenditures and pay transfers to private households.

Figure 4: Nested CES function structure for agriculture (a) and all other sectors (b)



Following Ignaciuk and Dellink (2006), we assume that Italy (Basilicata plus Rest of Italy) is a small open economy. It follows that neither domestic prices nor traded quantities affect the world market prices. The international market is assumed to be large enough to absorb any quantities of goods produced in Italy and it can satisfy any Italy import demand. Trading partners are not explicitly modelled and are addressed, as the Rest of the World. The demand by the RoW represents Italy exports and its supply represents Italy imports. The macro-economic closure of the model is assured assuming the Armington specification for traded goods, with domestic and foreign goods that are imperfect substitutes (Armington, 1969). This allows for a difference in prices between domestically produced goods and their international substitutes. Hence, an increase in domestic prices leads to a shift in demand towards the competitive imports, but only to a limited extent. Similarly, a change in domestic prices will have a limited impact on exports.

3.2. Data

The REMES model was developed calibrating production, consumption, other economic activity and trade to data obtained from Norwegian statistics bureau (SSB) and from the CREEA project (Compiling and Refining Environmental and Economic Accounts, creea.eu/). In our analysis, we used the Exiobase database (Wood et al., 2015) as a Social Accounting Matrix (SAM) for Italy combined with information on regional economic accounts obtained from National Institute for Statistics (ISTAT, 2016). All statistical information as well as the SAM are referred to year 2010, used as benchmark in calibration. Respect to the original database, we included also information on land rent, obtained for Italy and Basilicata region from the FADN public database (European Commission, 2016).

3.3. Policy simulation

The liberalization of electricity markets in most advanced economies has profoundly changed the behavior of supply and demand (Joskow, 2008). On the supply side, liberalization engendered competition and unleashed new entrepreneurial forces. On the demand side, it empowered the consumer and aligned with customers' increased awareness of environmental and climate change issues (Blazquez et al., 2016). Although the new electricity markets have made possible a formidable spread of renewables, as pointed out by Blazquez et al. (2016), promoting renewable energies in liberalized electricity markets can create a paradox: renewables could fall victim to its own success as the deployment of renewables tends to decrease spot electricity prices and, at the same time, increase their volatility (Clò et al., 2015; Dillig et al., 2016; Paraschiv et al., 2014). With low and even negative electricity prices, investors would be discouraged from entering the market and they would require more incentives to continue to operate. So, it's very important that policy makers choose the more effective policy tool to promote renewables.

Among others, tax policies are often assumed to be more effective in promoting renewables without increasing the government expenditure for subsides (Kancs and Wohlgemuth, 2008). In the case of bioenergy, there is also a possibility to promote the domestic production of raw materials in order to satisfy the internal demand for biomass in electricity production and increase the positive impacts on territory. In fact, as highlighted in the Bioenergy Sector Plan (MIPAAF, 2014), the use of imported biomass (more easily available and cheaper) should be one of the main problems linked to diffusion of bioenergy.

Compared to the Common Agricultural Policy (CAP) 2007-2013, which provided direct incentives for the cultivation of energy crops, the new CAP 2014-2020 does not explicitly rule on the agro-energy issue. The choice depends not just on the willingness to make the bioenergy sector self-sufficient but also to avoid problems related to large-scale bioenergy production, such as pressure on land and fuel vs. food competition. However, national or regional government could choose to adopt a tax policy in order to increase the biomass production or consumption.

In this context, we present a set of policy scenarios to support the bioenergy sector through different combinations of changes in the level of taxation of energy production, biomass production and biomass consumption, both at the national (N) and the regional (R) level. In particular, we chose two different national policies, and, for each one, three different regional policies. The following scenarios are adopted:

- N1: 50% increase in non-renewable electricity production tax
    - R1: 50% decrease in bioelectricity production tax
    - R2: 50% decrease in biomass production tax

    - R3: 50% decrease in biomass commodity tax
- N2: 50% decrease in bioelectricity production tax
    - R1: 50% increase non-renewable electricity production tax
    - R2: 50% decrease in biomass production tax
    - R3: 50% decrease in biomass commodity tax

4. Results

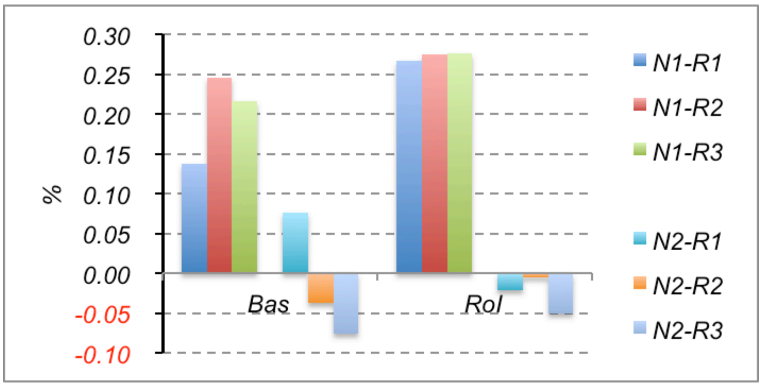
In this section, we present simulations' results of the different energy policies and discuss their implications on the regional and national economic system. In order to make the modelled simulations more understandable, we decompose the total policy impacts into quantity, price and land use, focusing in detail on agriculture and electricity sectors and commodities. Lastly, we describe changes in Consumer Price Index (CPI) and households' consumptions to better understand the welfare implications of different simulated policies.

4.1. Prices

We start the discussion by examining changes in relative prices (compared to the benchmark equilibrium), mainly related to agricultural and electricity commodities, as the biggest concern about the bioenergy development is the competition between biomass and food production.

Let us first consider the impact on electricity price (Figure 5). As argued before, in the current national electricity market, consumers can't choose the electricity based on the energy sources, so the electricity price increases in all scenarios where production tax is increased by 50% for the non-renewable electricity sector at the national level (scenarios N1-R*), due to the preeminent role that non-renewable sources have in electricity production in Italy.

Figure 5. *Change in relative price for electricity compared to benchmark (%)*



Only when bioelectricity production is supported at the national level (scenarios N2-R*), the price for electricity decreases in Italy, although the Basilicata regional disincentive to the use of non-renewable sources in producing electricity (scenario N2-R1) seems able to counterbalance the positive incentive to energy production from biomass, leading to a relative increase in the electricity prices in Basilicata in scenario N2-R1.

This results stress the importance to combine the right regional and national policies to increase their effectiveness. In fact, promoting the bioenergy sectors as a whole, both at the national and the regional level, makes possible to reduce the electricity price in both regions (Basilicata and Rest of Italy) (scenarios N2-R2 and N2-R3). The scenario N2-R3 leads to the larger reduction in electricity price, up to -0.08% in Basilicata and -0.05% in the Rest of Italy, due the reduction in tax on production for bioelectricity sector at national level and on biomass product at regional level.

Agriculture, in producing biomass, uses more land. However, the competition with other agricultural productions seems small (Figure 6 and 7), especially for those goods that are very important in agrifood industry in Basilicata region (Vegetables&fruits and wheat). Overall, the direct and indirect support to bioenergy production seems able to reduce the price of agricultural commodities in the Basilicata, even though with differentiated patterns among commodities.

At the regional level (Figure 6), the price increases in an appreciable extent only in the case of cereal grains (+0.16 % in N1-R1 scenario), followed by wheat with an increase of 0.07% in N2-R2 scenario. At the national level (Figure 7), the pressure on other agricultural commodities is recorded only in N2-R2 scenario, with an increase of 0.08% for cereal grains and 0.06% for wheat and vegetable and fruits.

Figure 6: Change (%) in relative price for agricultural good compared to benchmark (Basilicata)

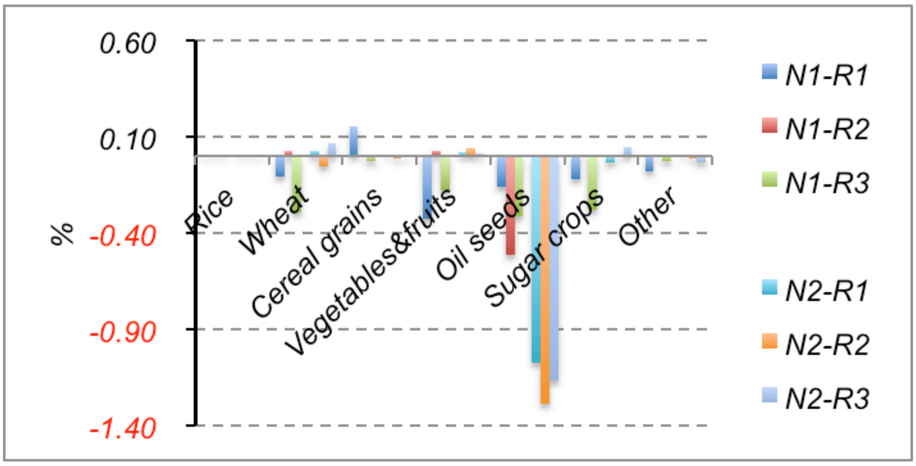
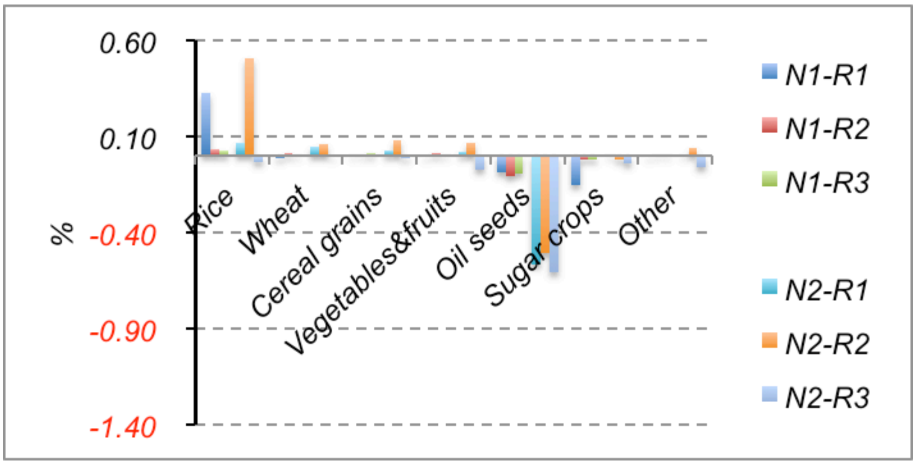


Figure 7: Change (%) in relative price for agricultural good compared to benchmark (Rest of Italy)



Very interesting is the observed reduction in price of oil seed for either regions, up to 1.29 % in N2-R2 scenario and 0.61% in N2-R3 at regional and national level respectively. This effect is likely to be generated by the substitution among different crops generated by changes in relative prices. In any case, the oilseed production has decreased over the years, especially in the Basilicata region, although it could be interesting to evaluate their potential use for biodiesel production.

4.2. Production

Changes in prices, induced by tax policies, are linked to the market equilibrium resulting in new output levels for each good and service. According to simulations (Table 2 and 3), the larger increase in the aggregate output of the bioenergy sector (+0.89%) is reached at the regional level when non-renewable production tax is increased by 50% at the national level and bioenergy production tax is reduced by 50% at the regional level (scenario N1-R1) (Table 2).

However, as discussed before, non-renewable tax policy, although leading to an increase of production of all renewables, increases also the electricity price. An increase in electricity price inevitably leads to an increase of production cost in other sectors. This in turn decrease the competitiveness of domestic products against imports, resulting in an overall, though small (-0.01%) decrease of domestic production of all other industries. Only promoting the bioenergy sectors by itself makes possible to maintain stable the price of electricity (scenarios N2-R2 and N2-R3) without negative impacts on other industries (Table 3).

Table 2. Change (%) in sectoral output compared to the benchmark (scenarios N1-R*)

	N1					
	N1-R1		N1-R2		N1-R3	
	Bas	RoI	Bas	RoI	Bas	RoI
Primary sectors						
Paddy rice	-	0.11	-	0.02	-	0.02
Wheat	0.05	0.05	-0.01	0.00	0.00	0.00
Cereal grains	0.01	0.01	0.01	0.00	0.02	0.01
Vegetables, fruit, nuts	-0.02	-0.01	-0.01	0.00	0.00	0.00
Oil seeds	-0.20	-0.01	-0.82	-0.01	-0.26	-0.01
Sugar crops	0.08	0.07	0.01	0.01	0.01	-0.01
Biomass	0.08	0.13	0.26	0.12	0.08	0.12
Other Agriculture	0.00	0.00	0.00	0.00	0.00	0.00
Electricity sector						
Non-renewable	-0.24	-0.07	-0.12	-0.07	-0.12	-0.07
Hydro	0.02	0.06	0.04	0.06	0.04	0.05
Wind	0.01	0.03	0.02	0.03	0.02	0.03
Biomass	0.89	0.10	0.08	0.12	0.11	0.11
Photovoltaic	0.01	0.01	0.01	0.01	0.01	0.01
Geothermal	-	0.01	-	0.01	-	0.01
Other sector						
Other industry	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Other services	0.00	0.00	0.00	0.00	0.00	0.00

Nevertheless, promoting bioenergy sector, biomass production and biomass product causes more impacts on the other agricultural productions, given the competition for factor inputs (especially for labour and capital).

Table 3. Change (%) in sectoral output compared to the benchmark (scenarios N2-R*)

	N2					
	N2-R1		N2-R2		N2-R3	
	Bas	RoI	Bas	RoI	Bas	RoI
Primary sectors						
Paddy rice	-	0.02	-	0.23	-	-0.07
Wheat	-0.02	-0.03	0.02	0.00	0.01	0.01
Cereal grains	0.00	-0.01	0.08	0.05	-0.06	-0.05
Vegetables, fruit, nuts	0.00	0.00	-0.01	0.00	-0.01	-0.01
Oil seeds	-1.62	-0.03	-1.64	0.02	-1.96	-0.08
Sugar crops	0.00	-0.02	0.03	-0.03	-0.04	-0.01
Biomass	0.55	0.66	0.64	0.64	0.56	0.67
Other Agriculture	0.00	0.00	0.02	0.01	-0.02	-0.02
Electricity sector						
Non-renewable	-0.16	-0.02	-0.05	-0.01	-0.10	-0.04
Hydro	0.03	-0.01	-0.03	-0.01	-0.01	0.00
Wind	0.02	0.00	-0.01	-0.01	-0.01	0.00
Biomass	0.76	0.65	0.60	0.62	0.64	0.67
Photovoltaic	0.01	0.00	-0.01	0.00	0.00	0.00
Geothermal	-	0.00	-	0.00	-	0.00
Other sector						
Other industry	-0.01	0.00	0.01	-0.01	0.00	0.01
Other services	0.00	0.00	0.01	0.01	0.00	0.00

4.3. Land use

According to our results, tax policies leads to a moderate increase of bioenergy production, using more labor and capital, without a remarkable increase in the pressure on land use.

Simulations generate a land use changes especially when bioenergy sector is promoted as a whole (N2-R*) (Table 4), due to the increased demand for biomass resulting from an increase of bioelectricity production, with a consequent small increase in land price (+ 0.4% in N2-R2 scenario at the regional level).

In the scenario N2-R2 the increase of land allocated to biomasses is maximum (+1.67%). However, the substitution among crops is small in absolute value, resulting in an increase of about 50 ha of areas cultivated with biomasses in the most effective policy mix (N2-R2), well beyond the area more suitable for biomass production estimated at the regional level (see Section 2.1).

At the regional level the increase of areas allocated to biomass is counterbalanced by losses in hectares allocated to Oilseeds and Vegetables&fruits whatever the policy mix adopted. Smaller reductions are recorded also for wheat and sugar beet, but not in all scenarios. Oilseeds are the crops more likely to be negatively affected by support of bioenergy, with changes of allocated land up to 0.13% (N2-R3). The same scenario shows also the maximum decrease in land allocated to Vegetables&fruits, a reduction that, given the relevance of the sector within the regional agriculture, represent a larger decrease in absolute terms (- 47 ha).

In the rest of Italy the impacts on land allocation among different crops are similar in relative terms, even though the substitution affects all crop groups. Again, the Vegetables&fruits is the sector loosing the largest share of land in favour of biomass production.

Table 4. Land use change (%) compared to benchmark (Basilicata)

	Benchmark (Surface - ha)	N1-R1	N1-R2	N1-R3	N2-R1	N2-R2	N2-R3
Rice	-						
Wheat	143880	0.04	-0.01	0.00	-0.02	0.00	0.01
Cereal grains	50444	0.00	0.00	0.00	0.00	0.01	-0.01
Vegetables & fruits	58723	-0.11	-0.02	-0.01	-0.02	-0.10	-0.08
Oil seeds	825	-0.01	-0.06	-0.02	-0.11	-0.11	-0.13
Sugar crops	459	0.26	0.03	0.02	-0.01	0.03	-0.17
Biomass	3025	0.20	0.69	0.22	1.47	1.67	1.50

Table 5. Land use change (%) compared to benchmark (Italy)

	Benchmark (Surface - ha)	N1-R1	N1-R2	N1-R3	N2-R1	N2-R2	N2-R3
Rice	245824	-0.01	0.00	0.00	-0.01	0.00	-0.03
Wheat	1961980	0.03	0.00	0.00	-0.03	-0.01	0.00
Cereal grains	1550813	0.00	0.00	0.00	-0.01	0.00	-0.02
Vegetables & fruits	2671243	-0.04	-0.01	-0.01	-0.04	-0.06	-0.05
Oil seeds	304432	0.00	-0.01	-0.01	-0.01	0.02	-0.05
Sugar crops	58650	0.11	0.01	-0.01	-0.05	-0.05	-0.03
Biomass	136872	0.25	0.25	0.24	1.35	1.27	1.41

4.4. The welfare impacts

The different mix of national and regional policy measures, combined with the interdependencies between the two regions lead to quite differentiated outcomes in terms of welfare. The CGE approach shows here one of its more interesting features, representing the complexity of interaction and feedbacks likely to affect the impact of energy policy.

The economic impact on welfare is measured as the Hicksian equivalent variation expressed in percentage terms. In figures 8 and 9 the welfare index is plotted against the percentage change in the production of bioenergy for both focus regions. The two graphs provide a representation of trade-offs between effectiveness and efficiency in the six scenarios.

Figure 8. Bioelectricity production and welfare effects of energy policy (Basilicata)

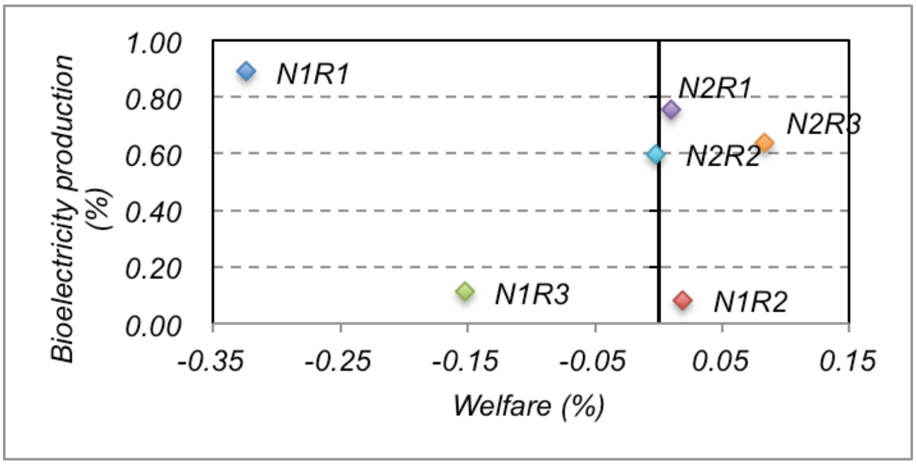
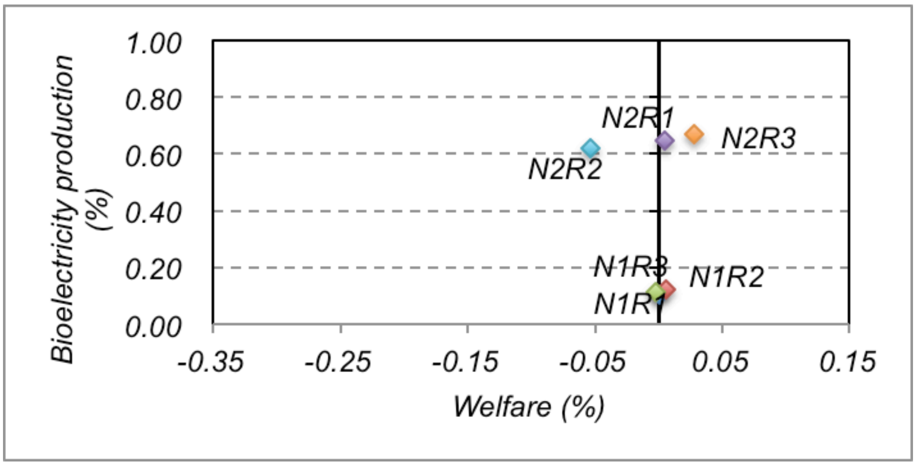


Figure 9. Bioelectricity production and welfare effects of energy policy (Rest of Italy)



Overall, impacts are more differentiated at the regional level, both on the effectiveness and the efficiency side. This is an expected result, given the presence of regional policies affecting only the Basilicata's economy.

The best performance in terms of bioenergy production (+0.89%) is achieved at the regional level by the N1-R1 scenario but at the cost of the largest decrease (-0.32%) in the welfare index. Conversely the best compromise between effectiveness and efficiency is represented by the N2-R1 scenario, where a fiscal support to bioelectricity production at the national level is combined with a regional disincentive to produce electricity at the regional level: a 0.76% increase biomass electricity is combined with a small but positive increase in the welfare index (+0.01). The performance of N2-R3 scenario is quite similar but with a composition of impacts more favorable in terms of welfare, as expected given the combined reduction of taxation both at the national (bioelectricity production) and the regional (biomass consumption) level.

5. Conclusion

Agriculture is a key factor in the development of rural economy. Extreme weather events, due to the current climate changes, the price volatility of raw materials, primarily of oil, and political decisions make the agricultural sector increasingly vulnerable, leading, in some cases, to the abandonment of cultivated lands, especially in marginal rural areas. This calls for measures directed to strengthening the agricultural sector, by promoting, for example, income diversification or the capacity of achieving independence from fossil fuels. Bioenergy is a unique solution to solve the problem on both sides. However, large scale bioenergy production has entailed different environmental and economic problems associated with land grabbing, deforestation, competition in land use with the main agricultural products (food, feed, fibre).

As a consequence, it is important to get a better understanding of the economy-wide impacts of enhanced bioenergy production and especially its impact on land use competition and on agricultural and ultimately food prices. Furthermore, with the recent trend of local-regional development plans, regional decision makers are interested in the quantification of economic impacts of energy policies particularly in rural areas, characterised by a high share of agriculture, low income and job scarcity.

In our study, using a multi-regional multi-sector Computable General Equilibrium (CGE) model we analysed the impacts of alternative combinations of energy tax policies (both at the national and regional level) in the Basilicata region, a rural region in the South of Italy, paying specific attention to agricultural production level, looking at the price of land and food and to land competition among different crops.

According to our results, increasing taxes on non-renewable production, although promoting an increase of all renewable energy production, leads also to an increase of electricity price with a reduction, although moderate, of the domestic output for all industries. This result can be explained considering the actual energy scenario in Italy. The presence of liberalized electricity markets has made possible a formidable spread of renewables but, at the moment the consumers cannot choose the electricity based on the type of source. So, an increase in taxation of energy production from the main energy source (non-renewable for Italy) results in an increase of electricity price. A consequent overall loss of welfare follows. Only directly promoting the bioenergy sector is possible to increase the share of bioelectricity while reducing the price of electricity good both at the national and the regional level. As in other studies, we have pressure on land and competition of biomass production with other agricultural commodities. Competition impacts also sectors with a relevant role within the Basilicata's agriculture, but are small in absolute terms. The energy policies simulated in our study affect in different ways welfare at regional and national level. Increasing taxes on non-renewable electricity production tax shows, a worst impact on welfare at the regional level (together with an almost neutral impact on welfare at the national level), in comparison with the support (via a de-tax national policy) of bioenergy production.

To summarize, promoting the bioelectricity production at national level and biomass consumption at regional level, seems to be the best policy mix to support bioenergy development without negative impacts on welfare. In fact, this policy mix generates a decrease in the electricity price, increasing, at the same time, output and welfare, not only at regional but also at national level, with a moderate pressure on agricultural land. The analysis supports the continuation of policies to incentive the bioenergy sector, combining tax policies with other policy tools (e.g. agricultural or climate policies) in order to make the sector more competitive. Furthermore, in a liberalized electricity market, it should be interesting to give consumers the possibility to choose electricity based on energy source used to produce it so as to move toward a more clean energy economic system.

A few words should be added on the limitation of this study. The availability of bi-region CGE model supported an interesting policy analysis at the regional level but scenarios, showing the possible implication of different mixes of taxing policy. However, the hypothesized scenarios are quite simple and designed to highlight tradeoffs between efficiency and effectiveness that regional policy makers should expect in supporting the bioelectricity industry. Policy simulations designed to represent policy option actually available in the current policy context would provide a valuable information and should be developed.

Furthermore, taxation is only one among the policy tools that could be adopted in promoting bioenergy. An interesting development of the analysis may assess the potential impact of a re-orientation of regional agricultural policy towards a direct support of biomass production (as in the 2007-2013 rural development programming period). Furthermore, a development of the model may include in the policy mix also the support of consumption of bioenergy production. Even though the current regulation of electricity sector doesn't allow consumers to choose among electricity produced using different energy sources, a consumer-oriented support policy would likely reduce policy distortion and tradeoffs between effectiveness and efficiency at the macroeconomic level.

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