A Micro-Macro Economic Model for Assessment of Climate Change Impacts on the Agricultural Sector*

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Abstract

The stochastic impact of climate change on farmers' production plans may affect agricultural economic performance, by increasing uncertainty and thus affecting the choice of currently available production resources/input (water, land, labor and so on) that are needed to produce agricultural output. In this perspective, the paper presents a micro-macro integrated model/framework for the disaggregated quantitative assessment of the impacts of various shocks generated in different socio-economic and climate-driven simulations on the agricultural sector, with an application in the Italian Veneto region. Selected results report quantitative micro-macro computations. Under a "fragmented world scenario", a 50% decrease in the cattle stock negatively affects the milk sector (-36% of total production) in such a way that generates a 0.10% decrease in the regional value added. Under an "unequal world" scenario, a 10% increase of cultivated land positively affects the wine grape sector (+14.3% of total production) in such a way that generates a 0.12% increase in the regional value added. Under a "wealthier world" scenario, a 20% increase of agricultural labor positively affects the grains sector (+31.6% of total production) in such a way that generates a 0.23% increase in the regional value added.

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Keywords: value of the marginal product of agricultural input; agricultural production functions; ASAM; input-output; socio-economic/climate scenarios.

I. Introduction

The stochastic impact of climate change on farmers' production plans may affect agricultural economic performance, by increasing uncertainty and thus affecting the choice of currently available production resources/input (water, land, labor and so on) that are needed to produce agricultural output. In this perspective, the paper presents a micro-macro integrated model/framework for the disaggregated quantitative assessment of the impacts of various shocks generated in different socio-economic and climate-driven simulations on the agricultural sector, with an application in the Italian Veneto region. The model structure first analyzes the agricultural production technology by estimating the marginal productivity and the value of the marginal productivity of selected agricultural inputs. It then simulates changes in production input use, according to different socio-economic and climate scenarios, downscaled for Veneto in 2030. The simulations are instrumental to compute the (micro-based) monetary value of the shock and use those figures to simulate the impacts on the Veneto economy.

Agriculture, in fact, is a climate dependent sector with remarkable regional characteristics. Climate change affects agricultural climatic elements such as temperature, precipitation, and sunlight, while further influencing the arable, livestock, and hydrology sectors. In this perspective, the impacts of climate change on the arable and livestock sector mostly have a biological dimension and include, among other factors, the change of flowering and harvesting seasons, the possible change in quality, and shift of areas suitable for cultivation. The impacts of climate change on agricultural production can be distinguished between primary and secondary impacts. The primary impacts are the changes in the composition of the atmosphere due to increased greenhouse gases, which include the change in crop growth response and the change in energy and moisture balance in the farmland. The secondary impacts include the shift in suitable places for cultivation and physical and chemical changes in agricultural soil. In the livestock sector, climate change causes biological modifications in production stages such as fertilization and breeding and affects the growing pattern of pastures. Climate change also impacts the hydrology, including underground water level, water temperature, river flow, and water quality of lakes and marshes, by modifying precipitation, evaporation, and soil moisture content. Moreover, climate change generates a wide range of socio-economic impacts on rural economies, such as possible modification of agricultural productivity, revenues of the farm household and asset values. It also affects the agricultural infrastructure through the change in water sources available for agriculture.

It is, however, very complex to generalize impacts applications and dimension. Generally, based on the gathered evidence, they can be classified into positive and negative ones. The positive impacts might be reconducted to the increase in crop productivity due to fertilization effect caused by the increase in carbon dioxide concentration in the atmosphere; possible expansion of the areas available for production of tropical and/or subtropical crops, possible expansion of two-crop farming due to the increased cultivation period; reduction of damages of winter crops by low temperature, and reduction of heating cost for agricultural crops grown in the protected cultivation facilities. Negative impacts might include reduced crop quantity and/or quality, given the reduced growth period following high levels of temperature rise; reduced sugar content, bad coloration, and reduced storage stability in fruits; increase of weeds, blights, and harmful insects in agricultural crops; reduced land fertility due to the accelerated decomposition of organic substances; and increased soil erosion due the increased rainfall. In addition, each crop requires different climate and environmental conditions to grow. In this perspective, climate change might generate a delocalization and change of traditional cultivation and main areas of production, with subsequent costs and benefits linked to the sector re-organization. In sum, the impacts of climate change on the agricultural sector are ambivalent, generating opportunities (benefits) and limitations (costs) (IPCC, 2007).

The economic literature has broadly addressed the problem, by tackling the issue in four different perspectives: (1) microeconomic Ricardian approaches (Mendelshon*et al.* (1994, 2000); (2) agronomic models (Hanemann, 2000, Kurukulasurya and Mendelsohn (2008); (3) agro-climatic and global climate change models under different emission scenarios that include socio-economic aspects (Parry, 1990 and Parry *et al.*, 2004) and (4) computable general equilibrium (CGE) models (Darwin, 2004, Palatnik and Nunes, 2015 among the others[1]).

The present paper follows the first and fourth streams of research. It first takes a microeconomic/microeconometric analysis of climate change impacts on agricultural yields in order to compute micro-based shocks. It then uses the shock in order to assess and quantify the effects at sectoral and macroeconomic level. The paper attempts to build a methodology for analyzing the agricultural drivers and predicting the effects of climate change impacts, at micro, sectoral and macro level with selected applications (milk, grains, and wine grapes sectors) to the Veneto region in 2030. It is important to highlight that the projections are not intended to be a precise and exact prediction of the future but are a very precise and rigorous description of what is expected to happen under specific assumptions and circumstances. Therefore, the projections constitute a "neutral" scenario which serves as a reference scenario and starting point for the discussion of industrial policies and strategies.

The study is organized as follows. Section 2 contains a description of the proposed methodology. Section 3 presents the main results of the selected application. Section 4 concludes.

II. Material and Methods

In our setting, farms maximize profits through production choices in a standard neoclassical fashion. In addition, farms consider the stochastic impact of climate change on production plans, as in Equation (1)

$$(1)\ Max\,\pi = \{f(Q,p,C)|Q = g(i_1,..,i_n) + v + u\}$$

The terms v and u represent distinct error components. The random vector v is *iid* and captures unobserved heterogeneity related to climate shocks and farm specific capacities to adapt to climate changes.

The farm maximizes profits π depending on produced quantity Q, output price p and production costs C given the stochastic technological constraint combining n production inputs. Climate

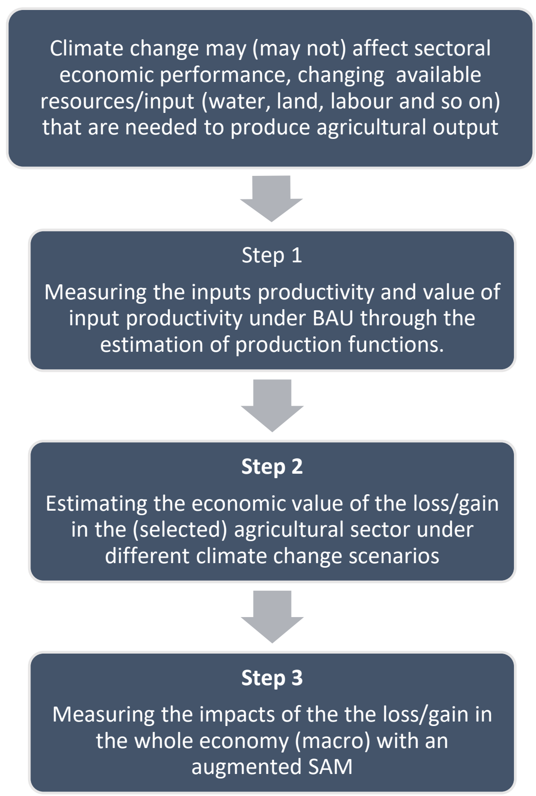
[1]See Onofri et al (2019) for a thorough survey.

change affects decisions also by influencing output, input availability and prices. Different "states of the world" associated with a climatic shock thus act through the stochastic component of the technology and place constraints on both the input and output possibility frontier due to climate-induced changes in agronomic conditions. Uncertainty stemming from climate change affects both the relative factor productivity and, for fixed but allocable factors such as land or family labor, the mix of best uses. Such uncertainty is captured through microsimulations that quantify the value of the marginal productivity of selected inputs and the value of agricultural output variations under different socio-economic climatic scenarios for Veneto.

Climate-driven changes in the farms' input use, output and related profits might generate an impact on the sector performance and ultimately have an impact on the whole economy performance.

To capture such effect, the outcome of the microsimulations of the forecasted climate change scenarios for each production sector is aggregated at the macro level. The macro simulations use the Veneto SAM spatially differentiated into mountains, hills, and planes to account for the significantly different climate impacts in each geographic area. The macro analysis estimates the impact of each scenario on each productive sector and the regional economy. Figure 1 summarizes the micro-macro conceptual steps.

Fig.1. Micro-macro prediction model for agriculture



A. *Inputs' Marginal Productivity and Marginal Productivity Value*

We model agricultural production functions to measure the marginal productivity of each factor used in the production of selected agricultural yields in Veneto (wine grapes, grains and milk) and, its marginal impact on production. We use Translog specifications, as in Equation (2).
The Veneto agricultural total output *q* (in logs) depends on a log-log linear combination of *n* production inputs, the *m* interactions of *n* production inputs and an error term.

$$\ln q = \beta_0 + \sum_{n=1}^{N} \beta_n \ln x_n + \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{N} \beta_{nm} \ln x_n \ln x_m + u \qquad (2)$$

The first step obtains a picture of the technological efficiency and productivity of each input used for producing wine grapes/grains and milk respectively in Veneto. It also assesses potential production changes when production inputs (e.g., land) change[2] and it allows attaching a monetary value to those variations (e.g. computing the value of the marginal productivity of each selected input).

B. Prediction Methodology and Microeconomic Shocks Computations

If the estimated marginal productivity of inputs does not change in the near future, we are mainly interested in knowing by how much the total use of land will vary due to climate-induced changes. We obtain the information about the likely climate scenarios for the Veneto region from the UNIVE-CREA Report (2017). This study follows the assumptions and methodology adopted by the International Panel on Climate Change Report (IPCC, 2000). The UNIVE-CREA Report shows how the IPCC future socio-economic-climate scenarios have been scaled down to the Veneto region. It consists of a narrative description (story line) and a series of quantitative estimates that show the evolution of some of the fundamental elements of society such as GDP and demographic growth over the course of the 21st century. The report assumes that:

1. The changes in the use of the land input depend on the occurrence of different socio-economic-climate scenarios that assume a distinctly different direction for future developments.
2. The occurrence of each scenario depends on a wide range of key "future" characteristics such as demographic change, economic development, and human capital change, among others. Such characteristics affect emissions that in turn affect temperature and climate change.

The UNIVE-CREA Report prospects five main scenarios for Veneto in 2030. The report assumes that Veneto will adapt to the international trends, emission levels and temperature changes as estimated by the IPCC report. The scenarios are summarized in Table 1.

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[2]Because the econometric model is assumed to hold for all observations, it also holds that: $y_0 = x_0'\beta + \varepsilon_0$, where ε_0 satisfies the same properties as all other error terms. The obvious predictor for y_0 is $\bar{y}_0 = x_0'b$.As E{b} = β it can be verified that this is an unbiased predictor. The different assumed values for $x_{0'}$ are then multiplied by the pooled OLS estimated coefficients for land marginal productivities (Verbeek 2004).

Tab. 1. *Synthesis of UNIVE-CREA Scenarios*

Selected Sectors	A Sustainable World (1)	Business as Usual BAU Scenario Baseline (2)	A Fragmented World (3)	An Unequal World (4)	A Wealthier World (5)
Population	+ 0/10%	/	+ 10/20%	-0/10%	- 0/10%
Economic Growth	+ 0/10%	/	--0/10%	+ 0/20%	+10/30%
Agricultural Land Use Change	20/30%	/	0/-20%	0/10%	0/5%
Cattle Stock Change	0/20%	/	-20/-50%	-10/+30%	10/50%
Labor Use Change	0/20%	/	-20/+20%	-50/+50	+10/30%
Human Development	++	/	-	+/-	+
Environment Concern	++	/	-	+/-	-
Rural/ Agricultural Development	++	/	-	+/-	+/-
Natural Resources Protection	++	/	-	-	-

C. Impacts on the Veneto Economy

The shock computed at the micro level is then aggregated at the macro level to generate the exogenous shocks for the SAM analysis (Adelman and Robinson, 1989). Such exercise allows computing the impacts of climate-driven changes on agricultural production on the Veneto economy. Input-output (I-O)/SAM methodology shows how (and how much) the changes (shocks) computed under point (2) propagate in the Veneto Region economy.

In particular, the Social Accounting Matrix (SAM) is constructed starting from the Veneto Supply Use Table, disaggregated for agricultural and agri-food sectors using the technology coefficients of the Italian Symmetric Input Output table realized by ISMEA. The SAM is balanced using the RAS method. The environmental satellite account is derived at the regional level using the coefficients from the World Input-Output Database (WIOD), by downscaling national aggregated matrices. We have linked the traditional SAM to satellite accounts, obtaining an augmented social accounting matrix (ASAM) for the Veneto Region. We have enlarged the matrix by adding insights on data and information on employment, environmental and other socio-economic data.

In developing a SAM multiplier model, we distinguished between endogenous and exogenous accounts. The former reflects the purpose of the analysis while the latter include those accounts that can be used as policy instruments (for instance regional administration), those generating long-term effects (e.g., capital account) and those that cannot be influenced by policy interventions. Exogenous shocks have been modelled on the basis of the scenarios described in Table 2.

Tab. 2. *The SAM Framework*

	Endogenous accounts				Total	Exogenous Accounts	TOTAL
	(1)	(2)	(3)	(4)		(5)	
(1) Sectors	T_{ij}		T_{ih}		N_1	X_1	Y_1
(2) Factors	T_{fj}				N_2	X_2	Y_2
(3) Households		T_{fh}	T_{hh}		N_3	X_3	Y_3
(4) Firms					N_4	X_4	Y_4
(5) Exogenous	E					V	Y_X
TOTAL	Y_1	Y_2	Y_3	Y_4		Y_X	

III. Selected Applications and Results

A. Microeconomic Estimates of Inputs' Marginal Products and Value of Inputs Marginal Products

We use a rich dataset (Farm Accountancy Data Network (FADN) that contains 9,220 farm budgets observed in the period 2009-2012. The dataset also contains information on the farms' produced output and on the use of production inputs. We apply the methodology to three important sectors in the Veneto agricultural system: (1) grains, (2) wine grapes and (3) milk.
Table 3 reports some descriptive statistics for selected variables.

Tab. 3. *Descriptive Statistics*

Variable	Mean	Standard Deviation	Min	Max
Wine grape quantity	1,046.106	2,527.952	0	28,444
Milk quantity	5,356.79	9,146.75	0	83,502
Grains quantity	567.03	1,847.75	0	46,523,
Machinery	675.6204	3,782.912	0	104,000
Labor	1,971.898	5,490.362	0	136,000
Land	7.4	18.53	0.04	229.93
Water	196.30	133.9	0	400
Electricity	338.833	3,076.795	0	64,900
Seeds	113.5998	1,213.871	0	25,280
Treatment	21.40	67.92	0	1687.2
Livestock Number	78.81	119.82	0	941

Forage	12,360	31,814,03	0	335,096
Fertilizers	1,517.427	4,334.785	0	45,330

Table 4 presents selected estimates of the Translog production functions and the inputs' marginal productivity for the wine grapes, milk, and grains sectors respectively.

Tab. 4. *Pooled OLS Estimates of Marginal Input Productivities*

Explanatory Variables	Dep. Variable: Wine Grapes Output	Dep. Variable Milk Output	Dep. Variable: Grains Output
(Log)machinery	-	-	1.21***
(Log)labor	0.57***	1.90***	1.58***
(Log)seeds	-	-	1.49***
(Log)water	0.17*	0.84***	-
(Log)land	1.43***	-	2.44***
(Log)livestock number	-	0.72***	-
(Log)forage	-	0.17	-
(Log)machinery^2	-	-	0.05***
(Log)labor^2	0.08	0.002	0.014***
(Log)seeds^2	-	-	0.36***
(Log)water^2	0.04	0.02	
(Log)land^2	0.01	-	0.40***
(Log)forage^2	-	0.05*	-
(Log)livestock number^2	-	0.007	-
(Log) machinery*labor	-	-	0.02
(Log) machinery*seeds	-	-	-0.20**
(Log)machinery*land	-	-	0.19**
(Log)labor*seeds	-	-	0.31***
Log)labor*land	-0.01	-	-0.34***
(Log)land*seeds	-	-	-0.35***
(Log)labor*water	0.01	-0.26***	-
(Log)land*water	-0.07*	-	-
(Log)water*livestock number	-	0.72***	-
(Log) water*forage	-	-0.10***	-
Constant	6.89***	-16.14***	6.74***
R-squared	0.78	0.82***	0.75

For the wine grapes sector, a 1% increase in the use of labor, water and land generates an increase of 0.57% , 0.17% and 1.43% of yields respectively.

The estimate of the "crossed" effects does not produce coefficients with an acceptable level of significance, with the exception of the crossed effect of the interaction term land*water, which produces an estimated negative coefficient. This implies that a marginal increase in land reduces the effect of water on yields (for a value of 0.07%).

For the milk sector, a 1% increase in the use of water, labor, livestock and forage generates an increase of 0.84%, 1.90%, 0.72% and 0.17% respectively in the final output.
The estimate of the "crossed" effects indicates "negative" and statistically significant synergies in the case of the interaction term livestock number*forage cattle. This implies that a marginal increase in livestock input reduces the effect of forage on milk yields.
For the grains sector, a 1% increase in the use of machinery, labor, seeds and land generated an increase of 1.21%, 1.58%, 1.49% and 2.44% in the yields respectively. The estimate of the "crossed" effects indicates positive and statistically significant synergies in the case of the interaction terms of work *seeds, and negative effects in the case of the interaction terms machinery*seeds, land*seeds, work*land.
Finally, we use the estimated coefficients of the marginal productivities for computing the value of the marginal productivity (VMP) of selected inputs (labor, livestock and land) and scale the value to fit the UNIVE-CREA scenarios in the three selected agricultural sector. We have computed the value by multiplying the total produced quantity under each scenario selected times the 2030 price of wine grapes/milk and grains per quintal/liter/mil[3].

[3]Following a study conducted by the TESAF observatory on wine grapes prices (TESAF, 2014) monitoring the wine grapes prices' trends, we did not observe significant changes in real prices that remained stable during the last 30 years. Therefore, we have assumed that wine grapes prices do not change in the middle-term future. As for milk and grains we have taken a strong assumption of no dramatic changes in current prices and a 0%discount factor. The values are reported in the Table

Sector	**Labor VMP (Euro per quintal)**	**Land VMP (Euro per quintal)**	**Livestock VMP (Euro per hectoliter)**
Grains	24.8	38.3	-
Wine Grapes	37.05	92.95	-
Milk	59.85	-	22.68

B. *Macroeconomic Simulations*

Table 5 displays the macro baseline scenario, the BAU (business-as-usual) starting point, where no climate-driven changes in production input occur (idle world). The Table reports the value added of the sector and the percentage impact on the Veneto economy.

Tab. 5. *Baseline Scenario*

	BASELINE SCENARIO - VENETO SAM	Total resources/use	% on total activities
Activities	Agriculture, mountain	194	0.06
	Agriculture, hill	1,036	0.34
	Agriculture, plain	3,588	1.18
	Fishing	210	0.07
	Mining and quarrying	315	0.10
	Food products, beverages and tobacco	13,431	4.43
	Textile, clothing, leather and accessories	15,439	5.10
	Timber industry	2,580	0.85
	Paper Printing and Recording	5,592	1.85
	Manufacture of coke and refined petroleum products	1,603	0.53
	Manufacture of chemicals and chemical products	6,075	2.00
	Production of pharmaceuticals, medicinal chemical and botanical	1,283	0.42
	Manufacture of rubber and plastics	5,059	1.67
	Other products in the processing of non-metallic mineral	5,395	1.78
	Manufacture of basic metals and processing of metal products	22,068	7.28
	Manufacture of computer, electronic and optical	2,432	0.80
	Manufacture of electrical equipment	7,826	2.58
	Manufacture of machinery and equipment n.e.c.	16,595	5.48
	Manufacture of transport equipment	3,819	1.26
	Other manufacturing, repair and installation of machines	13,524	4.46
	Supply of electricity, gas, steam and air conditioning	4,989	1.65
	Water supply; sewerage, waste treatment	3,407	1.12
	Construction	21,428	7.07
	Wholesale and retail trade, repair of motor vehicles and motorcycles	31,136	10.28
	Transportation and storage	15,894	5.25
	Accommodation and food services	12,309	4.06
	Publishing, audiovisual and broadcasting activities	1,469	0.48
	Telecommunications	2,972	0.98
	IT services and other information services	3,968	1.31
	Financial and insurance activities	10,610	3.50
	Real estate activities	19,178	6.33
	Legal, accounting, management consulting, architecture	8,501	2.81
	Scientific research and development	3,879	1.28

	Other service activities	5,642	1.86
	Public administration and defense; compulsory social security	8,084	2.67
	Education	5,437	1.79
	Health and social work	10,198	3.37
	Arts, entertainment and recreation	1,798	0.59
	Other service activities	4,041	1.33
Value added	Wages and salaries	44,453	
	Social contributions load employers	16,928	
	Mixed income, net operating income, depreciation and amortization	68,876	
	Net indirect taxes on production	14,066	
Institutions	Households	182,762	
	Local and National PA	25,289	
	Private Social Institutions	703	
Capital	Capital	68,352	
Rest of the world	Interregional	58,048	
	Rest of Italy and rest of the world	50,605	

Finally, Table 6 presents selected results of the application of the micro-macro model and reports the impact on the regional economy in 2030 of the micro-estimates/scenario-based variations of wine grapes production on three selected agricultural sectors (milk, wine grape and grains) under different selected scenarios.

Tab. 6*. Selected Micro-Macro Results: Milk, Wine Grapes, Grains Sectors*

Agricultural Sector	**Selected Scenario UNIVE-CREA**	**% Input Variation**	**Effect of Input Variation on Sector Production**	**Value of Variation on Sector (in mill €)**	**Impact on the Veneto Economy (in million €)**	**% impact on the Veneto Economy**
	Business as Usual BAU (Baseline)	-	-	-	-	-
Milk	**Scenario 3 Fragmented World**	-20/-50% (Cattle Stock)	-36%	- 90.6	-455	- 0.10
Wine Grape	**Scenario 4 Unequal World**	0/10% (Agricultural Cultivated Land)	+14.3%	+117	+587	+ 0.12
Grains	**Scenario 5 Wealthier World**	0/20% (Labor)	+31.6	+203,3	+1020	+ 0.23

In Table 6, row 3, we report the impacts for the Veneto milk sector under the “Fragmented world” scenario. Under such scenario, there is a strong, non-coordinated regionalization of world areas, that, in turn, leads to a reduction in trade flows and technology transfer. Environmental degradation is serious, with high levels of polluting emissions that have strong repercussions on human health and the ecosystem. Security problems push to use non-traditional energy resources. In this perspective, it is assumed that the regional cattle stock halves. Under a "fragmented world scenario", a 50% decrease in the cattle stock negatively affects the milk sector (-36% of total production) in such a way that generates a 0.10% decrease in the regional value added. Row 4 reports the impacts for the Veneto wine grape sector under the scenario "Unequal world". This envisages a highly unequal world both within and between the countries, where a relatively small and wealthy global elite is responsible for a large part of the emissions but is able to easily mitigate them. Food trade is a global need and the trade of expensive elite products, including agro-food, increases. Under an "Unequal world" scenario", a 10% increase of cultivated land positively affects the wine grape sector (+14.3% of total production) in such a way that generates a 0.12% increase in the regional value added. Finally, row 5 reports the impacts for the Veneto grains sector under the "Wealthier world" scenario. In this case, per capita income increases rapidly and inter- and intra-regional income distributions tend to converge. Economic growth is driven by global markets exchange dynamics and the intensive use of resources. Under a "Wealthier world" scenario, a 20% increase of agricultural labor positively affects the grains sector (+31.6% of total production) in such a way that generates a 0.23% increase in the regional value added (see Appendix).

IV. Discussion and Conclusion

The paper has proposed a micro-macro integrated model/framework for the disaggregated quantitative assessment of the impacts of various shocks generated in different socio-economic and climate-driven simulations on the agricultural sector with an application in the Italian Veneto region. In particular, the model structure first analyzes the agricultural technology by estimating marginal productivity and the value of the marginal productivity of selected agricultural inputs. It then simulates changes in production input use, according to different socio-economic and climate scenarios, downscaled for Veneto in 2030. The simulations are instrumental to compute the (micro-based) monetary value of the shock and use those figures to simulate the impacts on the Veneto economy. Selected results report quantitative micro-macro computations. Under a "fragmented world scenario", a 50% decrease in the cattle stock negatively affects the milk sector (-36% of total production) in such a way that generates a 0.10% decrease in the regional value added. Under an "unequal world" scenario, a 10% increase of cultivated land positively affects the wine grape sector (+14.3% of total production) in such a way that generates a 0.12% increase in the regional value added. Under a "wealthier world" scenario, a 20% increase of agricultural labor positively affects the grains sector (+31.6% of total production) in such a way that generates a 0.23% increase in the regional value added.

Different climate change driven scenarios cause different impacts in the selected agricultural sector. Those impacts generate consequences that can be positive or negative and that are measured in terms of output/yields increase/decrease. Such measurements can guide policy making in a very effective way. The micro-macro integrated model predicts realistic and meaningful impacts of climate change on the agricultural sector. It is still a "work-in-progress" model. At the present stage, the model already presents several interesting features. It is based on rigorous micro-founded macroeconomic theory and is an extremely flexible tool adaptable to heterogeneous scenarios and simulations because it measures the impacts at sector and economy-wise level. Future research will focus on improving the prediction accuracy of the model through counterfactual simulations. The model is also highly dependent on the quality of the data and still fundamentally invariant to policy and climate changes.

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APPENDIX:

SCENARIO 3

Fig. 2. *Impact on value added and Veneto institutions*

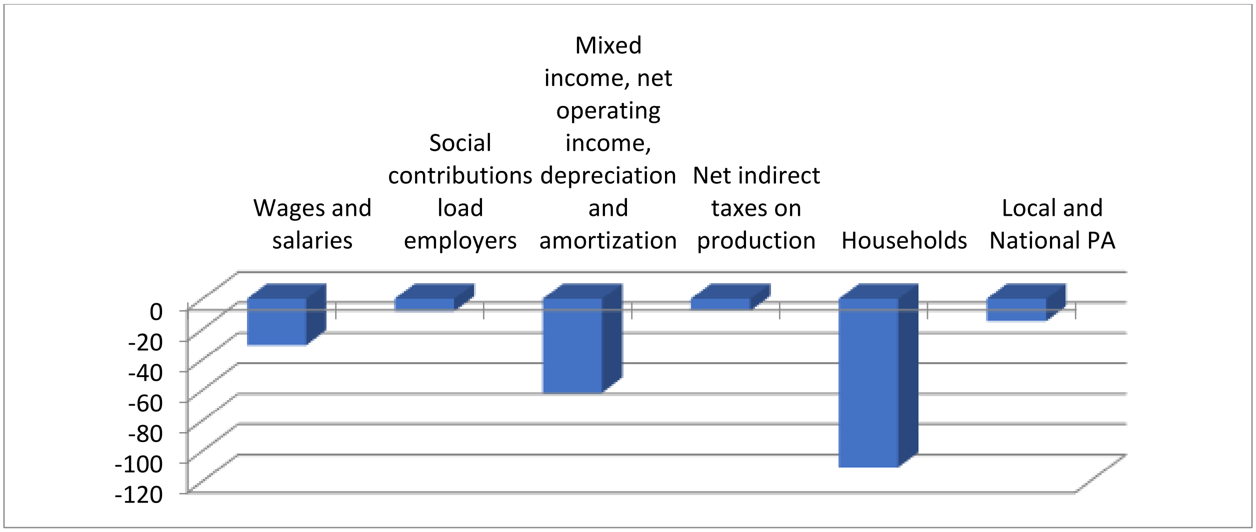
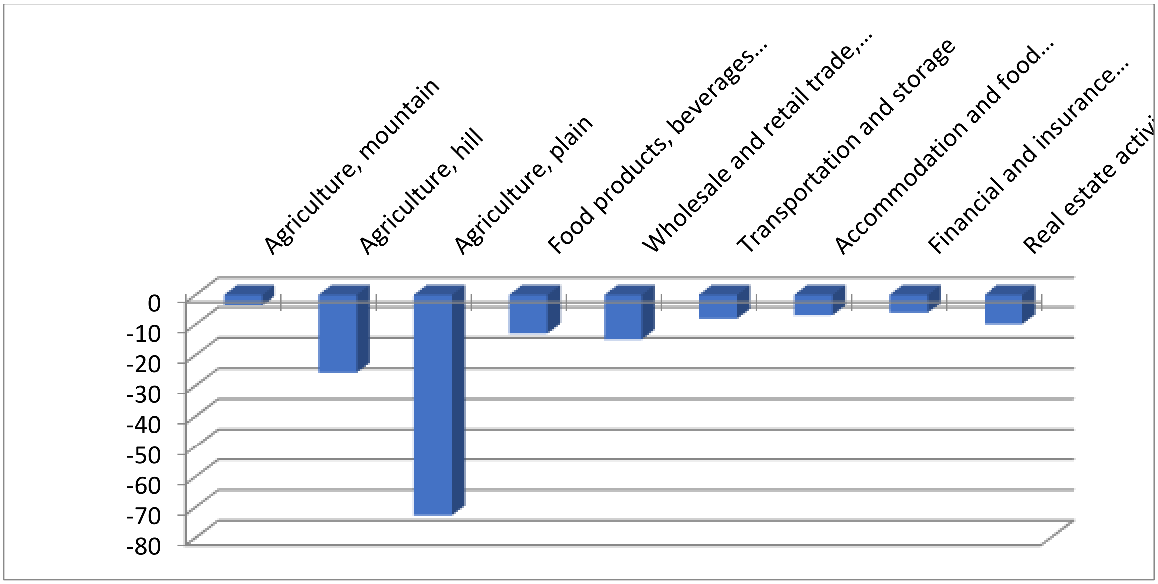


Fig. 3. *Impact on Veneto economic activities*



SCENARIO 4

Fig. 4. *Impact on value added and Veneto institutions*

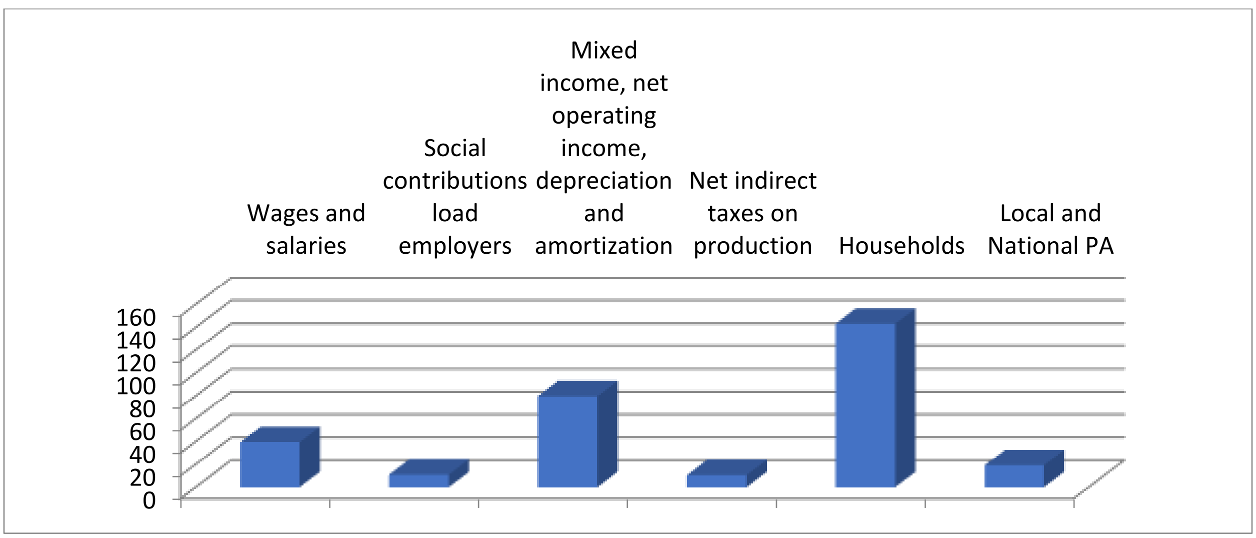
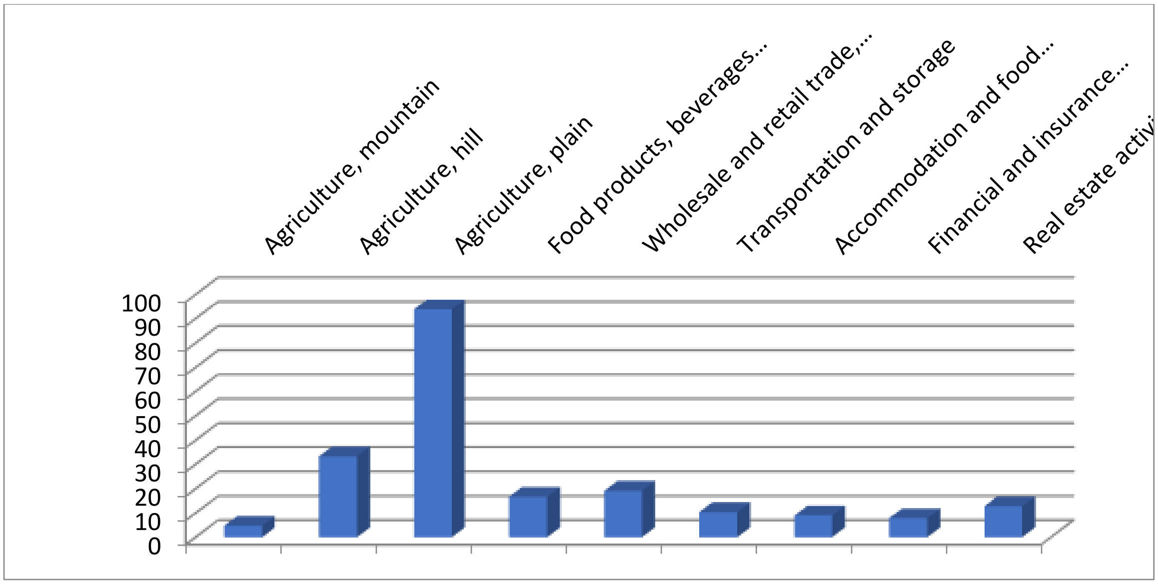


Fig. 5. *Impact on Veneto economic activities*



SCENARIO 5

Fig. 6. *Impact on value added and Veneto institutions*

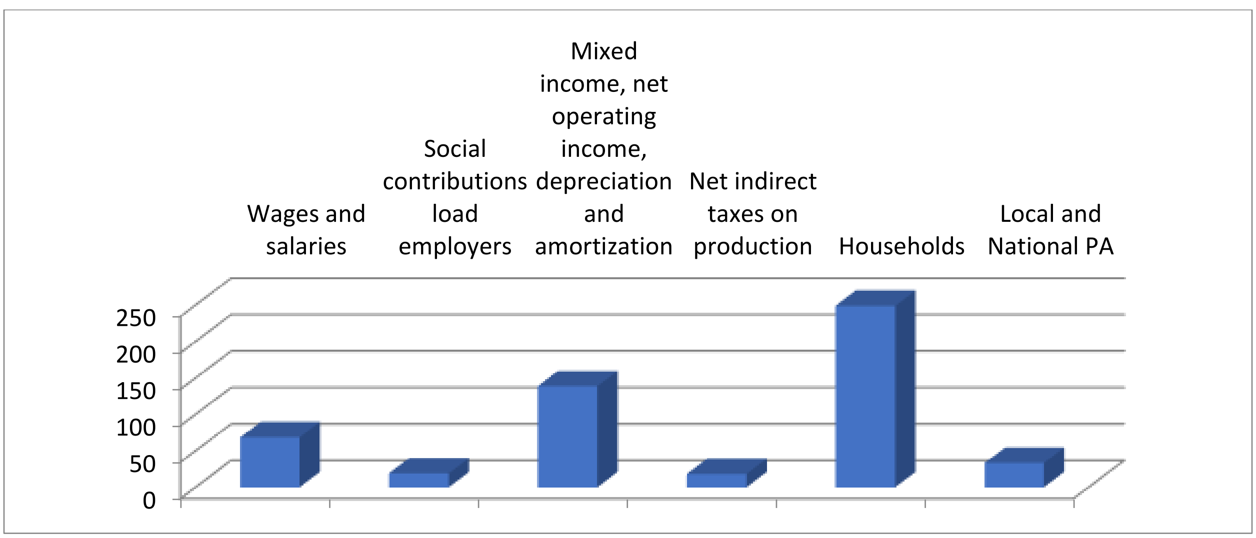
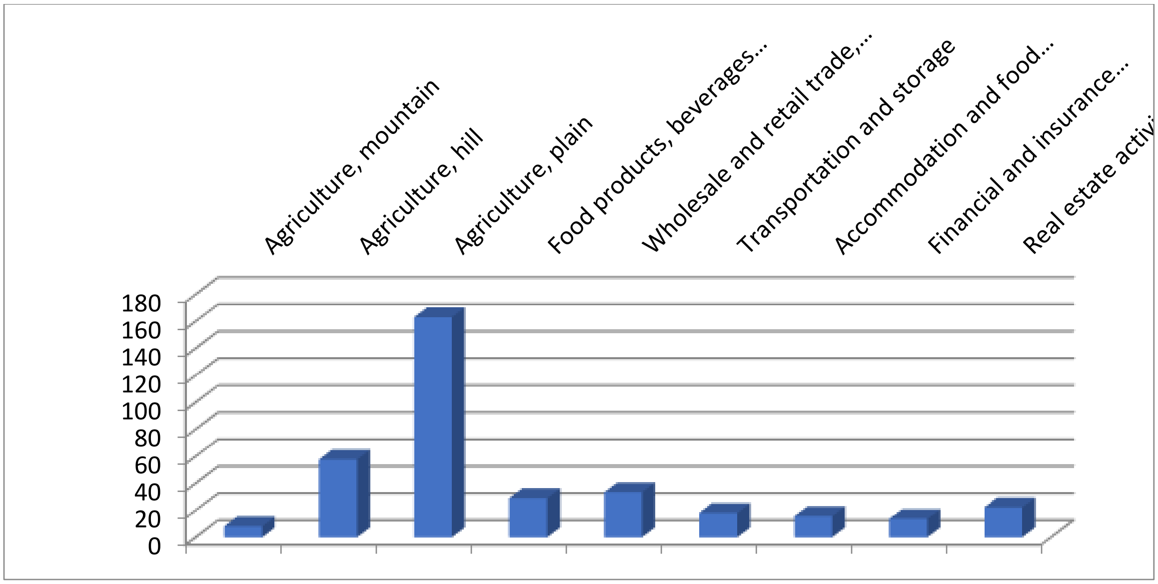


Fig.7. *Impact on Veneto economic activities*


Agriculture, mountain
Agriculture, hill
Agriculture, plain
Food products, beverages…
Wholesale and retail trade,…
Transportation and storage
Accommodation and food…
Financial and insurance…
Real estate activi
180
160
140
120
100
80
60
40
20
0