A multi-regional general equilibrium model to assess policy effects at regional level

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Abstract

This paper develops a multi-regional general equilibrium model (MEG-R) to compare the social desirability of the CAP reform in the three Italian macro-regions: North, Center and South. The model employs a mixed complementary framework that allows for the decision of not producing a particular crop in one or more regions and presents an attempt to model interregional trade flows. The model incorporates the links between production and consumption that characterize farm household's behavior and allows for heterogeneous household responses across regions. Results show a general tendency to reallocations from cereal crops to forage that appear more severe in the South. In this region, the reduction in crops cannot be translated into an effective expansion of fodder and could lead to the "deactivation" of the land.

1. INTRODUCTION

Environmental, morphological and climate conditions vary significantly throughout the Italian territory with consequent effects on the distribution of agricultural and livestock activities. In this context, policy interventions in agriculture may produce diversified effects among Italian regions which should be taken into account to ensure that costs and benefits are adequately distributed within the country. It is in fact well established that "what appears to be good for the nation may not necessarily be good for each of its regions" (Bendavid-Val, 1983) which again suggests the need for a regional-disaggregated analysis in line with the overall purpose of an integration of regional and national developing objectives. The policy implications of this trade-off can be fully captured only if the macro model is developed with a regional detail as it is done in the present research.

In this paper we analyze the effects of the total decoupling scheme as introduced by the Fischler CAP Reform of June 2003 using a multi-regional general equilibrium model. The reform is aimed to decouple the payments from specific farming activities, safeguarding agricultural incomes by ensuring a certain income support. The choice of this particular reform, although dated 2003, is motivated by the possibility of comparing our regional disaggregated results with the national-level ones proposed in (Finizia et al., 2004). This exercise helps to highlight the advantages of a regional disaggregated policy impact analysis. The multi-regional general equilibrium model (MEG-R) employed in this study is designed to compare the social desirability of the total decoupling scheme proposed by the reform in the three Italian macro-regions: North, Center and South. Departing from the national general equilibrium model

(MEG) presented in (Finizia et al., 2004), the MEG-R add some important features that help to better represent farm household behavior. In contrast with the MEG and most of the general equilibrium models adopted by developed countries' governments, where the impact analysis is based on the assumption that all crops are produced in all regions, in the MEG-R the territorial distribution of agricultural activities is taken into account. Moreover, while it is common to model the representative farm using a unique aggregate production technology separated from the consumption decisions, this model incorporates the link between the production and consumption side of the farm household and allows, therefore, for heterogeneous household behavior across regions. A further contribution of the model is in the modeling of interregional trade flows of agricultural commodities, which exploits the current available information and helps to assess the regional implications of the reform.

Total decoupling gives the market back both the allocative and the redistributive function thus favoring greater efficiency in the use of resources in activities and areas of greater comparative advantage. Results show a general tendency to reallocations from cereal crops to forage in all the regions. The comparison of our results with the national level ones obtained in Finizia et al., (2004) reveals the advantages of a regional disaggregated analysis. The tendency to forage appears to be more severe in the South where, however, the reduction in crops may not be translated into an effective expansion of fodder, given the limited capacity to expand of the local livestock sector. This could lead to the "deactivation" of the land which could be left unproductive. Moreover the labor resources freed in this process may not find an efficient allocation in the other sectors of the economy, which is a major concern in the South of Italy.

This paper proceeds as follows: section 2 describes the regional differences and the main characteristics of the CAP reform, section 3 presents the main features of the regional general equilibrium model (MEG-R) which is fully reported in the appendix A. The regional disaggregation of the Italian agricultural SAM is reported in section 4 followed by the description of the data sources (section 5). The simulations conducted are shown in sections 6 while section 7 reports and discusses the results. Section 8 compares our regional disaggregated results with those obtained using the national general equilibrium model presented in Finizia et al. (2004). Finally, section 9 concludes.

2. THE REGIONAL CONTEXT AND THE CAP REFORM

The agricultural sector in Italy has recently experienced a contraction, in particular, with a negative tendency in the number of farm households[1] (Istat, 2002). In the northern regions, however, this trend is not accompanied by a correspondent reduction in cultivable land which implies a restructuring of the sector with larger firms as the result of fusions and mergers. In the Center and South of Italy, instead, the decline of the primary sector has been brought about by the reduction in the number and the size of the agricultural enterprises, enlarging the differences

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1. Farm households correspond to the 95% of total Italian enterprises in agriculture.

between the productive structures of the three macro-regions (Inea, 2003). As far as the agricultural products are concerned, cultivations are distributed along the country in accordance with a combination of environmental conditions and subsidies opportunities (Table 1). The 60% of cereal products is produced in the northern regions, although only the 39% of the land devoted to cereal production is located in the North. Moreover, while rice is predominantly grown in the North, durum wheat is scarcely cultivated. Livestock is also concentrated in the northern regions, with the exception of the sheep and goats farming. On the other hand, olives, citruses and vegetables are mainly produced in the southern regions.

The three macro-regions differ also in terms of the mode of organization of the agricultural activities. Individual entrepreneurship, which is the most adopted form of management, prevails in the South while companies and partnerships are mainly located in the north-eastern areas. Family labor is largely employed in all the territory; the percentage of agricultural firms employing only family members varies between the 79% of the southern regions to the 95% of the North-western ones. Moreover, while in southern Italy the married partner usually co-participates in the farming activities, in the North a large contribution from other family members and relatives is observed (Istat, 2002).

Table 1 - Regional Production Choices (in value, millions of Euros and in percentage)

	Products	North	Center	South
1	Soft Wheat	69%	22%	9%
2	Durum Wheat		24%	76%
3	Rice	100%		
4	Corn and Other Cereals	82%	8%	10%
5	Fodder (Maize Silage)	50%	12%	38%
6	Non Irrigated Fodder	74%	3%	23%
7	Potatoes	25%	10%	65%
8	Tomatoes	44%	8%	48%
9	Other Vegetables	26%	28%	45%
10	Sugar Beet	70%	13%	17%
11	Soy-Bean	100%		
12	Other Industrial Crops	16%	68%	16%
13	Raw Tobaccos	18%	35%	47%
14	Grapes	37%	19%	45%
15	Olives		8%	92%
16	Citruses, Fresh/Dry Fruit	42%	7%	51%
17	Floriculture	76%	10%	14%
18	Bovine Milk	73%	5%	21%
19	Bovine Meat Livestock	66%	8%	26%
20	Forestry	42%	39%	20%
21	Sheep and Goats	10%	23%	67%
22	Pork, Chicken, Rabbits	48%	23%	29%

The Fischler CAP Reform of June 2003 has introduced two main pillars: the decoupling of the direct aids to producers starting from year 2005 (cutting the link between subsidies and production) and the introduction of the single payment scheme. Part of the originality of this reform stands in the opportunity given to member States to choose between full decoupling or different partial decoupling options (up to 25 percent of the arable payment, for example, can remain tied to production), in order to contain the abandonment of land, which have to be

implemented between 2005 and 2007. This choice may be implemented at national or regional level and it is limited to the cereals, beef, sheep and goat sectors. Moreover by August 2004, member States may also decide to allocate payments at regional level. Regional ceilings are to be established and divided among the farmers in the region. All farmers may apply for *single farm payments*, annual income transfers independent of their production and supplementary to their income, which are based on the historical entitlement over the 2000-02 reference period. All direct payments given to farmers will be then reduced in the period 2005-2012 in the proportion of 3% in 2005, 4% in 2006, and 5% from 2007 to 2012. Premiums below EUR 5000 are exempted. Eligible farmers have to match entitlement rights with land in agricultural production (all land used for fruit and vegetables is excluded). Specific support schemes have, however, been introduced for particular product such as durum wheat, protein crops, rice, etc.. Therefore, the main aim of decoupling is to ensure greater income stability for farmers, allowing, at the same time, production being more market oriented. Particular conditions have also to be met; good agricultural conditions for land, environmental, food safety and animal welfare standards must be ensured and some compliance criteria (set-aside requirements for example) must be satisfied.

3. THE MULTI REGIONAL GENERAL EQUILIBRIUM MODEL - MEG -R

The multi-regional general equilibrium model (MEG-R) includes 45 productive branches and places particular emphasis on the agricultural sector. As illustrated in Appendix, agriculture is disaggregated into 22 agricultural sectors at regional level (North, Centre, South). The agro-industry, divided in 9 sectors, the other industries, disaggregated into 7 sectors, and the services are instead considered only at national level. Each sector produces a single output, using intermediate goods and primary factors according to a two levels CES production function. The agricultural sectors use 5 production factors: land (distinguished in three types as shown in Appendix), agricultural capital, labour (distinguished in independent farm labour and dependent labour), and animals (distinguished in four types). Other sectors, instead, employ two production factors: non agricultural capital and labour. The MEG-R distinguishes two institutional sectors, the households and the government. Farm-household are disaggregated to represent the agricultural production-consumption specificities of the North, Center and South of Italy. Remaining households are distinguished into: 1 rural household type, and 3 urban classes (low, medium and high income). Although this classification permits an accurate distributional and welfare analysis of the impact of agricultural policies (Finizia et al., 2004), a special focus is placed on rural farm households which are disaggregated and modelled at regional level. International trade is introduced in the model by considering two trade areas: European Union (EU) and the rest of the world (RoW). The model incorporates the main features of the CAP reform (OECD, 1988; Weyerbrock, 1998; De Muro et al., 2001) and is designed to compare the social desirability of the total decoupling as proposed by the reform in the three Italian macro-regions.

The MEG-R model is comparable to other national models used for policy analysis such as the French MEGAAF (Gohin et al., 1999; Gohin, 2002) and distinguishes itself for the regional features and the modeling of the farm household unit. The entire model is reported in the Appendix A while, in this section, the most important features are summarized.

A. Production choice

In the MEG-R we adopt a mixed complementary framework (MCP) based on the Kuhn-Tucker theorem which allows for the decision of not producing a particular kind of crop in the different regions (Löfgren et al., 1999). The optimization problem includes both strict equality and inequality constraints. Each inequality is linked to a bounded variable with a slackness-complementary condition. This allows us to take into account the distribution of crop productions across regions, i.e some crops are not produced in all macro – regions. Changes in agricultural policies may alter the necessary conditions and affect the crop portfolio choice of a particular region. Production choices are based on the assumption that, in equilibrium, market prices equal the marginal costs of production in each sector and region. When the assumption is violated and marginal costs are greater than unit revenues, production does not occur. This is summarized by the following complementary condition where the slack variable, Xs_{ir} (production of commodity i in region r) is bounded to be positive and the marginal costs, $\partial C_{ir}/\partial Xs_{ir}$, cannot exceed the selling price of the product:

$$\left(\frac{\partial C_{ir}}{\partial Xs_{ir}} - Pd_i\left(1 - \tau_i^p + c_i^p\right) \right) Xs_{ir} = 0. \tag{1}$$

Where $\dfrac{\partial C_{ir}}{\partial Xs_{ir}} \geq Pd_i\left(1 - \tau_i^p + c_i^p\right)$ and $Xs_{ir} \geq 0$.

The selling price incorporates production taxes τ_i^p, subsidies and penalties c_i^p. This specification allows us to analyze how alternative reform regimes, which affect the selling price of the product and the marginal cost of production, influence farmer decisions of producing a particular type of crop given the technology and the factor of production available in the three macro-regions. When contributes are decoupled, for example, the effect is immediately transmitted to the cost of land and therefore indirectly to the marginal cost of production.

B. The farm household

The MEG-R includes 3 farm-household types describing the agricultural production-consumption specificities of the North, Centre and South of Italy. Farm households are modelled as small economies where the production and consumption sides are interlinked. The household maximizes utility, which is a function of leisure and good consumption, given a budget constraint which incorporates farm profits. Using the standard notation adopted in the agricultural household model literature (Sadoulet et al., 1995) the household problem can be summarized as followed:

$$\max U(c, c_l)$$
$$st \quad g(q, l) = 0$$
$$p_c c = p_q q + w(l^s - l)$$
$$c_l + l^s = E,$$

where U is utility, function of consumption good c and leisure c_l and g represents the technology adopted to produce q employing labor l. The household allocates the time endowment, E, between leisure and labor supply l^s remunerated at price w.

In the presence of perfect markets the model is separable and can be solved sequentially implying that consumption and leisure decisions are made given the optimal level of profits determined in a first stage. Whether or not production, consumption and labor allocation decisions are jointly determined (non-separability) has been discussed by several authors (Benjamin, 1992). The presence of imperfect substitutability between family and hired labor, as considered in our model, for example, can lead to the non-separability of the farm household problem. The price of family labor (shadow wage) is endogenously determined within the farm household by the matching of the demand and supply of labor interlinking the production and the consumption side of the household. The endogenous shadow wages differ across regions and allow for heterogeneous household behavior across the three areas.

The production structure adopted in this paper adds some complexity to the simple problem presented above; the imperfect substitutability is introduced using a multi-input nested CES production function. In the second stage, the value added is obtained as a combination of capital and labor where the latter is distinguish between family and hired labor to model the imperfect substitutability. The consumption structure of the household is also extended to a two stage procedure in which, in the first stage, the household chooses the optimal level of leisure and composite consumption given the budget constraint. The composite good is the combination of all the products consumed by the household aggregated using a CES function.

In most studies the simultaneous presence of both hired and off farm labor is not explained by theoretical models (Sadoulet et al., 1998). In our data, however this situation is rather frequent as it is in most developed economies. Our model allows for the simultaneity between hired and off farm labor by imposing imperfect substitutability between on farm and off farm labor, which means that household members exhibit preferences over working on and off farm, and by the weak complementarily between hired, family labor and the other factors of production[2].

C. Prices determination

We assume that goods are homogenous across regions implying that the prices of the agricultural products are determined endogenously at national level. We introduce the large country hypothesis (see Table 3 for the complete list) and we assume that domestic and foreign

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2. Considering a CES function in the form $f(L, H, K)$, $f(L, 0, K) > 0$ only if the elasticity of substitution is greater then 1. In the agricultural sectors the elasticities are set to be lower than the unit.

products are imperfectly substitutes following the Armington specification. In the factor markets, land, livestock and agricultural capital are assumed to be immobile across regions. Their prices are determined at regional level through the matching of the regional demand and supply of factors. While price of dependent labor is determined at national level, the shadow wage of independent labor is endogenously determined within the representative farm household.

D. The Common Agricultural Policy

The main features of the Common Agricultural Policy have been incorporated in the model. The mid-term review allows farmers to use the hectares declared for the single decoupled payment for any agricultural activity with the exception of vegetables and permanent crops. This determines a rigidity of land mobility across sectors belonging to the two groups. Farm producing wheat, durum wheat, corn, vegetables, soy-bean, and other industrial crops must set-aside a minimum of 10% of the land devoted to such crops. Farmers, therefore choose the land allocation that maximizes the total land remuneration given the 10% set-aside constraint. As far as milk quotas are concerned, production constraints can be introduced in the model fixing the supply to the maximum limit institutionally imposed by the quota system. As a matter of fact, the Italian milk sector is not implementing the quota system; the evidence shows that production exceeds the allowed limits. Farmers are therefore compelled to pay the penalties on the quantity exceeding the quota. The trade off between the higher production and the payment of a fine is incorporated in the profit function. Finally we also considered the presence of intervention prices. A MCP specification has been adopted to model the stocking target. In those sectors in which the CAP specifies a price floor (or intervention price, $\overline{P}_i$) when the domestic price, Pd_i, falls below the threshold, the excess supply is sold to the government and the government stock increases.

$$\left(Pd_i - \overline{P}_i\right) DStock_i = 0. \tag{2}$$

Where $\left(Pd_i - \overline{P}_i\right) \geq 0$ and $DStock_i \geq 0$ is the slack variable. The total stock equals the initial stock plus the flow variable $DStock_i$.

E. Land

Land is divided into three groups in accordance with the technical, climatic and institutional conditions (Table 2). In the medium run, land is not perfectly mobile within the three groups (A, B and C); this imperfect substitutability is introduced with a CET function. Because of the strong separability between the groups, land cannot move from one group to the other. In the intentions of the legislator, this scheme was devised to contain the effects on the delocalization and migration of crops and to safeguard this set of specialized productions from distortionary effects. Land devoted to grapes for wine production is maintained fixed in line with the wine common market organization which imposes maximum quotas for areas allocated to grapes plants. We model also constraints to the substitution possibilities of land across production activities. The constraints are imposed by the reform as in the case of farmers

receiving the single farm payment who are not allow to produce on their land permanent crops (e.g. fruits), vegetables and table potatoes.

F. Interregional trade

This section presents a first attempt to model the interregional trade flows of agricultural commodities. Because regions are in general relatively more open economies if compared to nations, interregional flows are of fundamental importance in multi-regional CGE models. In the MEG-R interregional flows are determined by the model, however little interactions are allowed with the rest of the endogenous accounts. This is due to the scarce availability of data which prevented us from modelling trade flows in a more detailed and endogenous fashion. Interregional trade is determined by region specific domestic trade balance and transport costs. Commodity prices are determined in a perfectly competitive national market as mentioned above. Intra-regional traded commodity prices are marked up by transports costs which depend on the distance between regions[3]. The regional surplus or deficit XB_{ir} is determined as the difference between region supply and demand of agricultural commodities:

$$p_{ir}^t XB_{ir} = Xs_{ir} + \alpha_{ir}^m M_i + XT_{ir} - Xd_{ir} - INT_{iy}^r - \alpha_{ir}^e E_i,$$

where Xs_{ir} is the regional output, $\alpha_{ir}^m M_i$ and $\alpha_{ir}^e E_i$ are regional imports and exports, XT_{ir} is the supply of transport services, Xd_{ir} is the final demand of agricultural commodities and INT_{iy}^r is the region demand for intermediate agricultural inputs. We assume homogenous products across regions such that two-way trade is not admitted; it follows that interregional flows are naturally determined from the region surpluses or deficits[4]. A deficit region will engage in trade with surplus region (or regions) such that:

$$p_{ir}^t XB_{ir} = \sum_{rr \in R} XR_{i,r,rr} p_i^{tax} (1 + tr_{r,rr}),$$

where p_{ir}^t is the aggregate price of interregional flows, p_i^{tax} is the national commodities price homogenous across regions, $tr_{r,rr}$ is the exogenous cost of transport per unit of commodity transported (function of the distance between macro-regions) and $XR_{i,r,rr}$ represents the quantity shipped from region *rr* to region *r*.

4. THE SAM STRUCTURE

A SAM is a system of social accounts which reproduces the economic flows in a particular area. It describes the relevant features of the socio-economic structure and the relationships between the structure of production, capital accumulation and the distribution of

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3. We considered the kilometric distance between the more centrally located towns within each macro region. The Center region is equally distant from both the North and the South, Perugia located in the Center is situated 447 kilometres far from Milan and 512 from Potenza in the South. The distance between Milano and Potenza is 875 kilometres.
4. The algorithm employed to determine bilateral flows is reported in the Appendix, equation 59.

income and expenditure among households in a particular area. Because it is the natural extension of an input-output table, it includes inter-industry transactions, payments of productive factors, household and government expenditure, as well as the transactions with the rest of the economy. Additional accounts report the distribution of income together with private and public transfers which are essential for welfare analyses and give a comprehensive representation of the circular flows of income within the economic area of interest.

Figure 1 – Multi-regional SAM

		Agriculture			Other sectors	Agricultural Factors			Factors	Farm Households			Other households	Gov	Capital account	RoW	Total
		NORD	CENTER	SOUTH		NORD	CENTER	SOUTH		NORD	CENTER	SOUTH					
Agriculture		IT	IT	IT	IT					C	C	C	C	PEX	INV	EXP	TOT
Other sectors		IT	IT	IT	IT					C	C	C	C	PEX	INV	EXP	TOT
Agricultural Factors	NORD	VA															TOT
	CENTER		VA														TOT
	SOUTH			VA													TOT
Factors					VA												TOT
Farm Households	NORD					FI			FI					TR			TOT
	CENTER						FI		FI					TR		II	TOT
	SOUTH							FI	FI					TR			TOT
Other households									FI					TR		II	TOT
Gov		PTAX	PTAX	PTAX	PTAX	FTAX	FTAX	FTAX	FTAX	ITAX	ITAX	ITAX	ITAX				TOT
Capital account										S	S	S	S	GB			TOT
Rest of the Wold			IMP		IMP				FIO								TOT
Total			TOT		TOT		TOT		TOT		TOT		TOT	TOT	TOT	TOT	

There are two approaches to the development of a multi-regional SAM. The first requires the integration of two (or more) previously constructed regional SAMs, while the second approach involves the disaggregation of a nation-wide SAM into the sub-regions of interest (Pyatt et al., 1984) and is employed in this study. However, because there are both conceptual and practical difficulties in the disaggregation of the SAM, in particular as regards interregional linkages, an acceptable solution is, departing from the national SAM, to distinguish several regions when classifying the most relevant variables (Keuning et al, 1998). Figure 1 reports the simplified SAM structure which accounts have been disaggregated at regional level using the micro data employed for the construction of the nation-wide SAM, as explained in the next section. The grey shaded accounts indicate the accounts that could not be regionalized. At this stage no information on interregional transactions is available, an attempt to derive and model interregional trade, given some additional information and assumptions, is done in the model. The SAM content is described below.

Agriculture. This account is disaggregated into 22 agricultural sectors. In the column the use of agricultural inputs is recorded by region. These three matrices (IT) report mainly transactions within the same branch (diagonal) with the exception of the livestock sectors. Other non-agricultural inputs are reported in the "Other sectors" row. Factors of production are distinguished into agricultural and non-agricultural factors; the first ones are disaggregated by region. Production taxes (PTAX), net of subsidies, are reported by region in the "Government" row. Finally, imports (IMP) of agricultural products are only available at national level. The

demand for intermediate (by the primary and the other sectors) and final agricultural products (by farm and non-farm households) is reported in the row. Public expenditure (PEX), investments (INV) and exports (EXP) are also included and are available only at national level.

Other sectors. This account includes 14 agri-food sectors, 7 industries and 2 service branches. In the row, goods are produced for intermediate and final consumption (C). Products are purchased by resident and non-resident agricultural and non-agricultural households and sectors and by the government. Non-agricultural sectors employ factors and non-factors inputs in the column. Production taxes, subsidies and imports are also included and reported in the last two accounts.

Agricultural factors. This account is disaggregated into 10 factors: dependent and independent agricultural labor, agricultural capital, 3 types of land and 4 types of animals. The formation of value added (VA) in agriculture by region is reported in the row. In the column, factor remunerations enter farm household income net of factor taxes (FTAX).

Factors. This account includes factors employed by non-agricultural sectors. It is disaggregated into 2 factors: labor and capital. The functioning of this account reproduced the one described above with the inclusion of factor income outflows (FIO) which represent the factor payments to non resident workers.

Farm households. Households engaged in agricultural activities obtain their income from the factors employed in the farm and in other sectors (FI), from government transfers (TR) and include incomes generated abroad (II). In the case of non agricultural factor incomes, it is not possible to determine whether they are generated inside or outside the region. In the column household income is allocated to consumption, taxes (ITAX) and savings (S) and distinguished by region.

Other households. In this accounts households are distinguished into rural and urban (high, middle and low income) households. The functioning of this account reproduced the one of farm households.

Government. National government revenues are constituted by taxes on agricultural (distinguished by region) and other products. They also include factor and income taxes reported in the row. Taxes on products are reported net of subsidies. In the column, government budget is allocated to public expenditure and to pensions and other social transfers. When government budget exhibits a surplus (GB), government savings are positive.

Capital account. Households and public savings are reported in the row while the investments formation, which disaggregation at regional level is not possible, is recorded in the column.

Rest of the World. Imports and exports are reported in the row and in the column respectively. In both case regional disaggregation is not possible. This account includes also the inflow and outflows of incomes.

From another perspective, the regional accounts can be organized in order to form three regional agricultural SAMs that sum up to the national one and which equilibrium at aggregate level is ensured by a "closure" account including all the non-disaggregated flows. The statistical consistency across levels of aggregation is ensured by the peculiar design of the underlying information source which is the same across levels. This representation helps to highlight the link between individual regional performances and policy impacts and the national aggregated outcomes.

5. DATA

The nation-wide SAM for 2003 is based on the Input – Output table of the Italian economy (1995) updated to 2003 which has been extended, as regard the non agricultural sectors and households, using information from the national statistics institute (Istat, 2003) and the central bank (Banca d'Italia, 2003). As far as the agricultural sector is concern, information refers to the Socio-economic Survey of Italian farm households conducted by ISMEA in 1995. The ISMEA data set comprises 5 survey types in one: (a) Farm budget data (b) Input - Output table (c) Stylized Time Use Budget (d) Household Consumption Survey (e) Household Income Survey. The ISMEA survey was designed to build the Input-Output table of agriculture for the Italian economy and include the budget of the farming business along with the expenditure, income, wealth and time-use component. The other nationwide sources of information, that is the household expenditure survey conducted by the Italian Statistical Institute (ISTAT), the household income and wealth survey run by the Bank of Italy and the time use survey implemented by Eurisko, are needed to extend the agricultural SAM to the SAM of the whole Italian economy.

Given the heterogeneity of the information sources used, the initial nation-wide SAM was not balanced and the matrix accounts has been harmonized using the *Cross Entropy Method* (Robinson et al., 1998). This method exploits the information contained in the initial matrix and allows for submatrices and aggregates to be fixed to specific targets. In particular, we collected disaggregate and complete information on imports and export from and to Europe and the Rest of the World, taxes and contributes, value of production, value added components for non agricultural sectors and household income and consumptions. Agricultural data, e.g. inter-sector transactions and value added components has been derived from the 1995 Input – Output table rescaled in accordance with available data in 2003. The initial unbalanced SAM, therefore, has been obtained combining data released in 2003 and constructed data based on 1995 information. The *Cross Entropy Method* has been applied fixing the cell contents, when disaggregated information was accessible (see above), and including some more aggregated targets such as value added in agriculture and in the agri-food sectors. The balanced nation-wide SAM for 2003 maximizes the contribution of initial disaggregated information ensuring the correspondence with national aggregate statistics.

Table 2 - Regional SAM in millions of Euros

	Agriculture			Agricultural factors	Farm Households			Closure	Total
	North	Center	South		North	Center	South		
Agriculture	1610	545	874		1028	374	843	72633	77908
Others sector	7045	2693	4708		34130	20605	25162		94343
Agricultural factors	11665	4356	11491						27511
Farm Households North				11665				48022	59687
Center				4356				36293	40648
South				11491				35965	47455
Government	-169	-267	56		19697	13414	15660		48391
Capital account					4833	6255	5790		16878
Closure		33301							33301
Total		77908		27511	59687	40648	47455	192912	

During the regional disaggregation process, three matrices of weights, representing the contribution of each region to the national agricultural production, have been used. These matrices have been constructed using micro data collected by the 1995 ISMEA survey. They contain the shares, in terms of inputs and factors of production employed and outputs produced, of each region and referred to the 22 branches in which the agricultural sector has been divided. They also include the shares of consumption expenditure by farm households in the three regions. No information is available on the proportions of imports and exports of each region therefore, at the moment, these accounts have not been disaggregated and are considered only at national level. Further development may involve the disaggregation of imports and exports on the basis of data released by the national statistic institute also to account for inter-regional trade. The nation-wide SAM 2003 has been multiplied by each respective matrix of weights to obtain the three RSAM. As far as the agricultural sector is concerned, the three RSAM aggregate exactly in the sense that they add up to the national SAM. A "closure account", which contains imports, exports, non agricultural sectors accounts and non farm household accounts, is needed to obtain the entire national SAM. The aggregate SAM is reported in Table 2.

6. SIMULATION OF THE CAP REFORM

The present work simulates the impacts of the policy scenarios delineated in the mid-term review of the CAP as approved at the end of June 2003. As it is well known, the aim of the reform is to substitute payments "coupled to specific farm activities" with a lump-sum payment which has no distortive effects on the markets and farmers' allocation decisions. In essence, a price subsidy and/or an income subsidy coupled to a specific production is substituted with a decoupled income subsidy which in fact transfers support from the products to the producers. Farmers can thus optimize the activity portfolio according to the allocative information conveyed through the market, ensuring Pareto efficiency. The single farm payment is the mean of the payments received by the farm during the reference period 2000-02 for cereals; protein crops; oilseeds; rice; dried fodder; beef; sheep and goats and, from 2008, milk. Permanent crops are not eligible. Further, there is a specific payment for the area at set-aside. The eligible land has to be kept in good agronomic and environmental condition and cannot be utilized to produce fruit, vegetables and table potatoes. The implementation of the reform requires adjustments to

the common market organization mainly for certain arable crops (cereals, oilseeds, protein crops), and dairy products. Other products interested by the reform are dried fodder, seeds, energy crops and nuts. In the simulation we consider these two main aspects of the CAP reform: a) modifications of the market policies through variations of the intervention prices, variations of the existing premiums and introduction of new premiums for specific products (Table 3); b) decoupling of the premiums: decoupling introduces a single payment per farm starting from 2005, whose amount equals the mean of the total direct payments received by the farm during the years 2000-2002, for some productions (cereals, proteicn crops, oil seeds, rice, livestock, sheep and goats and, from 2008, milk as well). The payment corresponding to the set-aside area during the reference period is attributed separately.

Table 3 - Simulated intervention and import prices

Sector	Shocks
Rice	50% reduction intervention price to EUR 150/tonne 6% reduction import price
Milk	Payment proportional to the quota owned by the farm 6.1% reduction import price of dairy products
Butter	25% reduction intervention price
Sugar	25% reduction intervention price 35% reduction import price

7. RESULTS

The reform is expected to reduce the general level of activity by providing incentives to extensive production techniques reducing, at the same time, the use of polluting inputs and the aggressive pressure over the environment. In certain situations, the reform may also induce shrinkage to minimum costs farming operations leading the farm into a "disactivated" status.

Our results are in line with the spirit of the reform and are reported in Table 4. In terms of activity portfolio, there is a general tendency to reallocations from cereal crops to forage in all the regions. The impact is particularly unfavourable for soft and durum wheat, soy-bean and other industrial crops with the exception of corn production. In the center region of Italy cereal farmers traditionally face the choice of planting either soft or durum wheat. In the pre-reform situation, coupled premiums were giving durum wheat a comparative advantage over soft wheat in terms of a lower cost to returns ratio. Under a decoupled scheme, the terms of convenience are inverted. However both durum and soft wheat productions are penalized by the reform in comparison with other products.

Results in the fourth column of Table 4 show a decrease in the production of both soft and durum wheat and a notable increase in forages in the Center region. It is, in fact, more electively efficient to switch to low cost pasture production while receiving the lump-sum payment based on the cereal production of the reference situation. The same pattern is observed also in the South (column 6); the production of dry hay increases considerably whereas both soft and durum wheat suffer a decrease of 72 and 18 percent respectively.

Table 4 - % Change in production (Xs) and Domestic Consumption Prices (Pd) - Detailed and aggregate results for the North, Center and South of Italy

	North		Center		South	
	Output	Domestic Price	Production	Domestic price	Production	Domestic price
Soft wheat	-2.9		-26.5		-72.3	
Durum wheat			-15.2		-18.7	
Rice	-3.2	-11.66		-11.66		-11.66
Corn	4.2	-4.42	6.1	-4.42	-0.1	-4.42
Fodder	18.3	-13.78	7.1	-13.78	2.4	-13.78
Dry hay	-5.3	-21.18	113	-21.18	72.8	-21.18
Sugar beet	-12.6		-6.4		-25.7	
Soy beans	-100	-23.58		-23.58		-23.58
Other crops	-48.8	2.85	9.1	2.85	-41.6	2.85
Tobacco	-23.4	40.17	-33.2	40.17	-18.3	40.17
Floriculture	3	-2.04	5.6	-2.04	2.1	-2.04
Forestry	-3	-2.28	9.7	-2.28	1.3	-2.28
Total crops						
Potatoes	4.5	-2.06	3	-2.06	3	-2.06
Tomatoes	1	-2.20	2.6	-2.20	4	-2.20
Other vegetables	-0.7	0.37	0.5	0.37	-1.3	0.37
Grapes	0.5	-0.35	0.6	-0.35	0.1	-0.35
Olives		-0.22	5.5	-0.22	-0.2	-0.22
Fresh/dry fruits	0.2	-0.30	4	-0.30	0	-0.30
Tot fruit/vegetable						
Milk	2.1	-1.84	1.4	-1.84	1.5	-1.84
Beef	4.8	-2.40	2.8	-2.40	-1.6	-2.40
Sheep and goats		-3.44	9.4	-3.44	3.2	-3.44
Other livestock	-0.8	-1.37	2	-1.37	5.4	-1.37
Total livestock						

While it is reasonable to expect that in the Center and in the North regions the reduction in crops can be translated into an effective expansion of fodder, given the possibility of using it in the beef and milk sector, in the South this conversion is less probable given the limited capacity to expand of the local livestock sector constituted mainly by sheep and goat farming. This could lead to the "deactivation" of the land which could be left unproductive although maintained in good agricultural conditions. The higher availability of forages should slightly encourage the livestock production given the consequent costs reduction. An increased of 5 and 3 percent in beef production is registered in the North and Center regions while positive effects are found in the other livestock sectors in the Center and southern regions. The sheep and goat farming sector also shows positive responses both in the Center and in the South. The drop in rice production in the North is mainly due to the reduction in the intervention and import prices. The indirect impact has been limited by the implementation of the constraints imposed by the reform that excludes the possibility to produce fruit and vegetables on land with rights to the single payment and by accounting for normative and/or technical constraints limiting the variation. Despite this, productions not affected by the reform, such as grapes, fruits and

vegetable sectors, have taken moderate advantage mainly from the availability of cheaper factors of productions in all the regions. The aggregate effects by product category and region show an overall negative impact of the reform on crop production in all regions with a negative standout result for the South. Fruit and vegetables register slightly positive effects only in the Center regions while the livestock and milk sectors perform positively in all regions.

Table 5 - Impact on interregional trade (quantity)

	North		Center		South	
	Base	Reform	Base	Reform	Base	Reform
Soft wheat	69	88	-72	-74	4	-14
Durum w.	-528	-456	125	109	403	346
Rice	126	110	-49	-43	-78	-67
Corn,others	123	132	-51	-51	-72	-81
Fodder	-108	-80	4	-6	105	85
Dry fodder	103	22	-36	-26	-67	3
Potatoes	-60	-62	-17	-17	77	79
Tomatoes	-175	-182	-34	-36	210	218
Other veg	-974	-969	52	61	922	908
Sugar beet	-1	1	4	5	-2	-7
Soy-bean	-8	-43	5	14	3	29
Other crops	-321	-357	370	414	-48	-58
Tobaccos	-103	-96	27	15	76	81
Grapes	-844	-845	186	188	658	658
Olives	-1474	-1477	-105	-96	1578	1573
Fresh/dry fruit	-598	-602	-137	-132	735	734
Floriculture	147	150	-63	-63	-84	-86
Milk	156	162	-222	-226	66	65
Meat	-72	-38	-122	-125	193	164
Forestry	-82	-91	69	78	13	13
Sheep/goats	-401	-415	84	93	316	321
Pork, others	-1039	-1107	525	538	514	569

Note: negative values indicate imports while the positive ones represent the amount of exports.

The impacts on domestic prices are modest. In an open economy, variations on domestic supply affect both prices and the level of international trade. As it is reasonable to expect, the price changes are marked for non-traded products such as forages and industrial crops. Further, price adjustments are small in sectors where Italy is a "small country", because the domestic price follows the international price.

The effects on agricultural production are transmitted to interregional trade flows between the three macro-regions. Changes in the quantity traded are reported in Table 5. Although, given the strong assumptions underlying the modeling of interregional trade flows, one might be concerned about the reliability of the conclusions, the results can give a broad understanding of the response of domestic trade to production shocks. The contraction of the soft wheat sector, for example, transforms the South into a net importer while the North increases the trade toward the other regions to satisfy their domestic demand. As a consequence of the positive performances of the fodder sector in the southern and center regions, net importers of dry hay, trade volumes shrink; at the same time the decrease in the production of dry fodder in the North further contributes to the reduction of interregional trade flows.

The impact on the portfolio of agricultural activities in terms of value added captures the dynamics of both the revenues and the costs of production. Firstly, the three regions differ significantly in terms of the baseline portfolio: while in the North, vegetables, fruit, livestock and cereals enjoy equal importance, in the Centre and in the South there is a clear dominance of the vegetables (38%) and of the Fruit oil and grapes sector (45%). In the Center and in the Southern regions, cereals for human consumption loose importance; the negative effects are, however, limited by the positive performance of the corn sector. In the North, where corn is mainly produced, this latter effect overcomes the shrinkages observed in the soft wheat and rice sectors. Industrial crops, including sugar beets and tobacco, loose importance in all regions and in particular in the Center (-2%). The livestock industry, including feed, gains about 1 percentage point in the Center and in the South; a slighter increase is also observed in the North (+0.5%).

Table 6 - Percentage Changes in labor demand and factor prices and income

	% Change in labour demand		
	North	Center	South
Dependent labor	-1.36	-4.45	-1.49
Family labor	-0.21	0.56	-0.47
	% Change of Factor Prices		
	North	Center	South
Dependent Labor		-0.09	
Agricultural Capital	-8.57	-13.95	-7.88
Land (average 15.31)	15.30	15.84	15.07
	Farm households		
	North	Center	South
Equivalent variation	0.88	-0.72	-0.06
Change in income	0.96	-0.71	-0.07
Change in consumption	1	-0.7	-0.07
Change in leisure	0.6	-0.75	-0.06

Changes in agricultural labor demand are presented in Table 6. The imperfect substitutability between family and hired labor, incorporated in the model, implies a different response in the demand for dependent and independent labor. Family labor, although relatively mobile across agricultural sectors, is less transferable to non agricultural activities. The contraction of the cereal and industrial crop sectors results in an excess of family labor supply; this leads to a reduction in the (shadow) wages which prevent the demand for family labor from falling. On the other hand, dependent labor, more mobile, suffers a decrease in the demand which is particular relevant in the Center. The new configuration, therefore frees labor resources in surplus for more efficient uses in other sectors of the economy. The lack of capability to absorb such excess supplies by other economic sectors may, however, be a concern in particular for the South of Italy.

The impacts on factor demands affect factor remuneration (Table 6). We observe negligible effects on the remuneration of dependent labor. The negative impact on the remuneration of agricultural capital is quite significant and reaches -13% in the Center. A politically sensitive impact of the reform is the one affecting the price of land. The elimination of coupled subsidies, *per se,* is expected to reduce the value of land. However, the single farm

"lump-sum" payment represents an income effect which "over-compensates" the loss by an estimated 15 percent. Land prices respond similarly in all the regions. The final relevant effect of the reform is on household incomes and involves both agricultural and other rural and urban households not engaged in agriculture. As Table 6 shows, the effects on agricultural household income and consumption differ across regions. Northern households enjoy an increase of about 1 percentage point in their available income while opposite effects, although not economically significant, are found in the Center where income is reduced by 0.7%. Incomes remain almost unchanged in the South. Negligible effects are observed on rural households not involved in agriculture, available income and consumption increase by 0.20 and 0.24 percent respectively.

8. A COMPARISON WITH THE NATIONAL AGGREGATED MODEL

In this section we borrow the results obtained with the national general equilibrium model (MEG), reported in Finizia et al. (2004)[5], to show how the regional disaggregation can add useful insights to the analysis of the impact of policy reforms. The comparison is here limited to the impact on agricultural output.

Table 7 – Comparison between MEG and MEG-R results.

| | MEG-R | | | | MEG |
Products	North	Centre	South	Average	Italy
Soft wheat	-2.9	-26.5	-72.3	-33.9	-27.8
Durum wheat		-15.2	-18.7	-11.3	-36.8
Rice	-3.2			-3.2	0.2
Corn	4.2	6.1	-0.1	3.4	-0.7
Fodder	18.3	7.1	2.4	9.3	16.3
Dry hay	-5.3	113	72.8	60.2	30.4
Sugar beet	-12.6	-6.4	-25.7	-14.9	2.5
Soy beans	-100			-100.0	-80.7
Other crops	-48.8	9.1	-41.6	-27.1	-20.7
Tobacco	-23.4	-33.2	-18.3	-25.0	2.2
Floriculture	3	5.6	2.1	3.6	2.3
Forestry	-3	9.7	1.3	2.7	2.2
Potatoes	4.5	3	3	3.5	1.8
Tomatoes	1	2.6	4	2.5	1.9
Other veg	-0.7	0.5	-1.3	-0.5	-0.5
Grapes	0.5	0.6	0.1	0.4	0.2
Olives		5.5	-0.2	1.8	0.4
Fruits	0.2	4	0	1.4	0.3
Milk	2.1	1.4	1.5	1.7	
Beef	4.8	2.8	-1.6	2.0	1.2
Sheep/goats		9.4	3.2	4.2	-2.5
Other livest.	-0.8	2	5.4	2.2	2.4

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5. This paper simulate several scenarios. We report those related to scenario D1 that corresponds to the simulation conducted here.

Table 7 compares the average variations obtained aggregating the regional results of the MEG-R with the overall impact simulated using the national general equilibrium model MEG in Finizia et al. (2004). The comparison shows that, in general, the national average effects obtained with the MEG-R are in line with the predictions of the MEG. When analyzing the results in more detail, however, it is possible to notice some important regional differences. Considering, for example, the production of both soft and durum wheat, the large negative effect observed at national level appears to be much less severe in the North of Italy. Similarly, the positive effects in the beef sector are mostly enjoyed by the households in the North of Italy while in the South the effect is even negative. Most of the differences in the results seem to be explained by the lack of regional detail that characterises the national MEG. The contrasting results in the case of the production of rice, corn, sugar beet and tobacco, for example, are likely driven by the regional availability of land, labour and capital that are not taken into account in the national aggregated model.

Another interesting result is that related to the production of soy-beans. The use of a mixed complementary framework in our MEG-R allows for the choice of not-producing a particular crop in a particular region. The production of soy-beans in the North (column 2) is, in fact, suspended. On the contrary the national MEG does not allow for zero-solutions and the negative effect on this sector, although large, is underestimated.

9. CONCLUSIONS

This paper explores the social desirability of the total decoupling scheme proposed by the Fischler CAP reform in the three Italian macro-regions, North, Center and South, employing a multi-regional general equilibrium model (MEG-R). The model allows for the decision of not producing a particular product adopting a mixed complementary specification in the production decision process. The farm household unit is modeled as a small economy incorporating the link between production and consumption choices and interregional trade flows are endogenously determined by the model.

Results show a general tendency to a reallocation from cereal crops to forage in all the regions. This tendency appears to be more severe in the South where, however, the reduction in crops may not be translated into an effective expansion of fodder, given the limited capacity to expand of the local livestock sector. This could lead to the "deactivation" of the land which could be left unproductive. The reform induces a decrease in labor demand largely driven by a decrease in hired labor. As regard the South of Italy, the labor resources freed in this process may not find an efficient allocation in the other sectors of the economy. An increase in land price is observed in all the regions since the single farm payment effect "over-compensates" the loss due the elimination of coupled subsidies. Little effects are, instead, observed on household incomes. It is worth noting, however, that the simulations conducted do not consider the quality premiums and other product specifics aids which are included in the reform and which could moderate the observed impact.

The comparison of our results with the national level ones obtained in Finizia et al., (2004) reveals the advantages of a regional disaggregated analysis. A national level analysis neglects the regional distribution of the factors of production and provides average effects that fail to capture the severity of the impact in particular macro-regions.

The model could be further developed to consider the partial use of certain factors of production. For instance, decisions regarding the allocation of land, labor and capital should consider also the possibility of idle factors. Moreover, the MEG-R does not model the entry and exit from the market of regional household farms. It would be contradictory since the representative household cannot exit the market. This problem, which is of particular interest, should be addressed at micro level considering the possibility of exit of each household in the sample employing a mixed complementary framework akin to the one presented in this paper. These aspects will be developed in future research.

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APPENDIX – THE MODEL

	Sectors definitions		Type of land
	Sectors definitions		**Type of land**
1		Soft wheat	A1
2		Durum wheat	A3
3	CEREALS	Rice	A
4		Corn and other cereals	A1
5		Fodder (maize silage)	A1
6		Non irrigated fodder	A3
7		Potatoes	B
8	VEGETABLES	Tomatoes	B
9		Other vegetables and legumes	B
10		Sugar beet	A
11	INDUSTRIAL CROPS	Soy-bean	A1
12		Other industrial crops	A3
13		Raw tobaccos	A
14	VITICULTURE	Grapes	C
15	OLIVE	Olives	B
16	FRUIT	Citruses, fresh and dry fruit	B
17	FLORICOLTURE	Floriculture and other products	A
18	MILK	Bovine Milk	A2
19	BEEF	Bovine meat livestock	A2
20	FORESTRY	Forestry	A
21	OTHER LIVESTOCK	Sheep and goats	A2
22		Pork, chicken, rabbits	A2
23	FISH	Fish and other sea products	
	Agrifood sector		
24	BOVINE	Fresh and preserved bovine meat	
25	MILK PRODUCTS	Milk and milk products	
26	TRASF. CEREALS	Cereal products	
27	BREAD	Bread products	
28	PASTA	Pasta products	
29	VEG-FRUIT	Processed and preserved fruit and vegetables	
30	OIL	Olive oil	
31	FATS	Other vegetal oils, fats	
32	FEED	Feeds	
33	TOBACCO	Cigarettes	
34	SUGAR	Sugar	
35	WINE	Wine	
36	OTHER AGRO-FOOD IND	Alcoholic beverages, beer, non alcoholic beverages	
	Other industries and services		
37	FUEL AND LUBRIF	Fuel and oils	
38	ENERGY	Electric power	
39	WATER	Water	
40	FERTILIZERS	Fertilizers	
41	PESTICIDES	Pesticides	
42	OTHER CHEM. PROD.	Other chemical and pharmaceutical products	
43	HEAVY INDUSTRY	Maintenance, machinery, constructions etc.	
44	TRCOMUNCRINS	Transports and communication, credit and insurance	
45	OTHER SERVICES	Other services	

Sets	Descriptions
$i, y \in I, Y$	Sectors/products
$a \in A \subset I$	Agricultural sectors
$n \in N \subset I$	Non agricultural sectors
$s \in S \subset I$	Sectors belonging to small country hypothesis
$l \in L \subset I$	Sectors belonging to large country hypothesis
$f \in F$	Factors
$F^M \in F$	Mobile factors
$F^I \in F$	Immobile factors
$t \in TA \in F$	Subcategories of land type A
$j \in J$	Households
$r, rr \in R$	Regions

Parameters	
$BOND_j$	Treasury bill owned by households
c_i^p	Production payments
$c_{i,f}$	Payment received per unit of factor f employed
c_i^{land}	Set-aside payment
$Cfix_j$	Decoupled payments
$const$	Fixed ratio of government expenditure to GDP
$\overline{E}_r^A$	Endowment of land type A by region
m_i	Fee applied on the quantity of milk exceeding the quota
$\overline{P}_i$	Intervention price
P_i^{Eu}	Price level in the European market
P_i^{row}	Price level in the rest of the world market
τ	Direct tax rate
τ_i^M	Tariff rate
τ_i^p	Indirect tax rate on production
τ_i^{IVA}	Indirect consumption tax rate
$TOTtime_j$	Total time available
$tr_{r,rr}$	Unit transport cost from region r to region rr
$\overline{Xs}_i$	Production quota

N.	Equation	Domain	Variables	Description
		Agricultural production		
1	$\left(\dfrac{\partial C_{a,r}}{\partial Xs_{a,r}} - Pd_a \left(1 - \tau_a^p + c_a^p\right) \right) \leq 0$	$a \in A$ $r \in R$	$Xs_{a,r} \geq 0$	FOC for profit maximization
2	$VA_{a,r} = f\left[\dfrac{Pd_a \cdot \left(1 - \tau_a^p + c_a^p\right)}{Pva_{ar}} \right]$	$a \in A$ $r \in R$	$VA_{a,r}$	Value added
3	$VA_{milk,r} = f\left[\dfrac{Pd_{milk} \cdot \left(1 - \tau_{milk}^p + c_{milk}^p - m \cdot \lambda_r / 1 + \lambda_r\right)}{Pva_{milk,r}} \right]$	$i = milk$ $r \in R$	$VA_{milk,r}$	Value added (milk sector)

#	Equation	Domain	Variable	Description
4	$Pva_{a,r} \cdot VA_{ra} = \sum_f (w_f - c_{a,f}) FACTd_{a,f,r}$	$a \in A$ $r \in R$	$Pva_{a,r}$	Implicit price of value added
5	$INTtot_{a,r} = f\left[\dfrac{Pd_a \cdot (1 - \tau_a^p + c_a^p)}{P\mathrm{int}_i}\right]$	$a \in A$ $r \in R$	$INTtot_{a,r}$	Aggregate intermediate input
6	$INTtot_{milk,r} = f\left[\dfrac{Pd_{milk}(1 - \tau_{milk}^p + c_{milk}^p - m \cdot \lambda_r / 1 + \lambda_r)}{P\mathrm{int}_{milk,r}}\right]$	$i = milk$ $r \in R$	$INTtot_{milk,r}$	Aggregate intermediate input (milk)
7	$P\mathrm{int}_{ar} \cdot INTtot_{a,r} = \sum_y P_y^{tax} \cdot INT_{y,a,r}$	$a \in A$ $r \in R$	$P\mathrm{int}_{ar}$	Implicit price of aggregate intermediate input
8	$FACTd_{a,f,r} = f\left(\dfrac{Pva_{a,r}}{w_f - c_{a,r,f}}\right)$	$a \in A$ $f \in F$ $r \in R$	$FACTd_{a,f,r}$	Factor demand
9	$INT_{a,y,r} = f\left(\dfrac{P\mathrm{int}_{a,r}}{P_y^{tax}}\right)$	$a \in A$ $y \in Y$ $r \in R$	$INT_{a,y,r}$	Demand for intermediate inputs
11	$\lambda_r = \dfrac{Xs_{a,r}}{\overline{Xs}_a} - 1$	$r \in R$	λ_r	Excess production as a percentage of the quota

Land (type A only, type B and C not reported)

#	Equation	Domain	Variable	Description
12	$LANDA_{t,r} = f\left(\dfrac{w_{t,r}^A}{wE_r^A}\right)$	$t \in TA$ $r \in R$	$LANDA_{t,r}$	First stage land allocation, land A by subcategories
13	$wE_r^A \cdot \overline{E}_r^A = \sum_t w_{t,r}^A LANDA_{t,r}$	$r \in R$	wE_r^A	Average regional price of land type A
14	$LandT_{a,r} = f\left(\dfrac{wT_{a,r}}{w_{t,r}^A}\right)$	$r \in R$ $a \in A$	$wT_{a,r}$	Second stage of land allocation
15	$w_{t,r}^A LANDA_r = \sum_{a \in t} wT_{a,r} LandT_{a,r}$	$r \in R$ $t \in TA$	$w_{t,r}^A$	Average price of land by subcategory

Land – set aside

#	Equation	Domain	Variable	Description
16	$FACTd_{r,Land,a} = f\left(\dfrac{w_{a,r}^{land}}{wT_{a,r}}\right)$	$a \in A$ $r \in R$	$w_{a,r}^{land}$	Remuneration of the land allocated in the production of good a
17	$Land_{a,r}^{inut} = f\left(\dfrac{c_a^{land}}{wT_{a,r}}\right)$	$a \in A$ $r \in R$	$Land_{l,r}^{inut}$	Quantity of agricultural land in each sector allocated to set-aside
18	$wT_{a,r} \cdot LandT_{a,r} = w_{a,r}^{land} FACTd_{a,land,r} + c_a^{land} Land_{q,r}^{inut}$	$a \in A$ $r \in R$	$LandT_{a,r}$	Quantity of agricultural land in each sector

Non – agricultural production

#	Equation	Domain	Variable	Description
19	$\left(\dfrac{\partial C_n}{\partial Xs_n} - Pd_n(1 - \tau_n^p + c_n^p)\right) \le 0$	$n \in N$	$Xs_n \ge 0$	FOC for profit maximization
20	$VA_n = f\left[\dfrac{Pd_n \cdot (1 - \tau_n^p + c_n^p)}{Pva_n}\right]$	$n \in N$	VA_n	Value added
21	$Pva_n \cdot VA_n = \sum_f (w_f - c_{n,f}) FACTd_{nf}$	$n \in N$	Pva_n	Implicit price of value added
22	$INTtot_{i,r} = f\left[\dfrac{Pd_i \cdot (1 - \tau_i^p + c_i^p)}{P\mathrm{int}_{ir}}\right]$	$n \in N$	$INTtot_{i,r}$	Aggregate intermediate input

23	$P\operatorname{int}_n \cdot INTtot_n = \sum_y P_y^{tax} \cdot INT_{yn}$	$n \in N$	$P\operatorname{int}_n$	Implicit price of aggregate intermediate input
24	$FACTd_{n,f} = f\left(\dfrac{Pva_n}{w_f - c_{nf}}\right)$	$n \in N$ $f \in F$	$FACTd_{n,f}$	Factor demand
25	$INT_{n,y} = f\left(\dfrac{P\operatorname{int}_n}{P_y^{tax}}\right)$	$n \in N$ $y \in Y$	$INT_{n,y}$	Demand for intermediate inputs

Intervention price				
26	$\left(Pd_i - \overline{P}_i\right) \geq 0$	$i \in I$	$DStock_i \geq 0$	Government Stock

Households				
27	$C_j = f\left(\dfrac{Pu_j}{Pc_j}\right)$	$j \in J$	C_j	Aggregate consumption
28	$LEIS_j = f\left(\dfrac{Pu_j}{w_{lab}}\right)$	$j \in J$	$LEIS_j$	Leisure
29	$Pu_j U_j = Pc_j C_j + w_{lab} LEIS_j$	$j \in J$	Pu_j	Implicit price of utility
30	$P_i^{tax} = P_i + \tau_i^{IVA}$	$i \in I$	P_i^{tax}	Gross price comprehensive of indirect consumption tax
31	$Xd_{i,j} = f\left(\dfrac{Pc_j}{P_i^{tax}}\right)$	$i \in I$ $j \in J$	$Xd_{i,j}$	Demand for consumption good
32	$Pc_j \cdot C_j = \sum_i P_i^{tax} \cdot Xd_{j,i}$	$j \in J$	Pc_j	Implicit price of aggregate consumption
33	$LABOUR_j + LEIS_j = TOTtime_j$	$j \in J$	$LABOUR_j$	Total labor supply
34	$FACTs_{j,labdip} = f\left(\dfrac{w_{labdip}}{w_{lab,j}}\right)$	$j \in J$ $f = labdip$	$FACTs_{j,labdip}$	Supply of off farm labor
35	$FACTs_{j,labind} = f\left(\dfrac{w_{labind,j}}{w_{lab,j}}\right)$	$j \in J$ $f = labind$	$FACTs_{j,labind}$	Supply of on farm labor
36	$w_{lab,j} \cdot LABOUR_j = w_{labdip} \cdot FACTs_{j,labdip}$ $+ w_{labind} \cdot FACTs_{j,labind}$	$j \in J$	$w_{lab,j}$	Opportunity cost of leisure
37	$YH_j = \sum_f (1-\tau) w_f FACTs_{j,f} + (1-\tau) PENS_j$ $+ (1-\tau) \cdot r \cdot Pg \cdot BOND_j + Cfix_j$	$j \in J$	YH_j	Available income

Investment				
38	$INV_i = f\left(\dfrac{Pinv}{Ptax_i}\right)$	$i \in I$	INV_i	Investment
39	$Pinv \cdot INVEST = \sum_i P_i^{tax} \cdot INV_i$	$i \in I$	$Pinv$	Implicit price of aggregate investment
40	$INVEST = GOVsav + \sum_j YH_j - C_j$		$INVEST$	Gross investment

Government				
41	$Ggov_i = f\left(\dfrac{Pg}{Ptax_i}\right)$	$i \in I$	$Ggov_i$	Government expenditure
42	$Pg \cdot G = \sum_i Ptax_i \cdot Ggov_i$		Pg	Aggregate price of government expenditure

43	$G = const \cdot \sum_i VA_i$		G	Aggregate government consumption
44	$GOVsav = \sum_i \left(\tau_{p_i} - c_{p_i}\right) \cdot Pd_i \cdot Xs_i + \sum_i \left(\tau_i^{IVA} + \tau_i^M\right) \cdot P_i \cdot X_i +$ $\tau \cdot \sum_f \sum_j w_f \cdot FACTs_{j,f} - (1-\tau) \cdot \sum_j PENS_j - Pg \cdot G$ $-(1-\tau) \cdot \sum_j r \cdot Pg \cdot BOND_j - \sum_i c_{land_i} Land_{i,inut}$		$GOVsav$	Government savings

International trade				
45	$Xxd_i = f\left(\dfrac{Pd_i}{Pxs_i}\right)$	$i \in I$	Xxd_i	Domestic sales
46	$Eeu_i = f\left(\dfrac{P_i^{Eu}}{Pxs_i}\right)$	$i \in I$	Eeu_i	Production exported in Europe
47	$Erow_i = f\left(\dfrac{P_i^{row}}{Pxs_i}\right)$	$i \in I$	$Erow_i$	Production exported in the rest of the world
48	$P_s \cdot X_s = P_s^{Eu} \cdot Xxxd_s + P_s^{row} \cdot Erow_s + DStock_s$	$s \in S$	P_s	Aggregate price, small country hypothesis
49	$Xxxd_s = f\left(\dfrac{P_s}{P_s^{row} \cdot EXR \cdot \left(1 + \tau_{m_{si}}\right)}\right)$	$s \in S$	$Xxxd_s$	Composite quantity of imports from EU and domestic good
50	$Mrow_s = f\left(\dfrac{P_s}{P_s^{row} \cdot EXR \cdot \left(1 + \tau_{m_{si}}\right)}\right)$	$s \in S$	$Mrow_s$	Imports from the EU, small county hypothesis
51	$Meu_s = Xs_s - Erow_s - Xxxd_s$	$s \in S$	Meu_s	Imports from the Row, small county hypothesis
52	$P_l \cdot X_l = Pd_l \cdot Xxd_l + P_l^{Eu} Eeu_l + P_l^{row} Erow_l + DStock_l$	$l \in L$	P_i	Imports from the EU, large county hypothesis
53	$Xxd_l = f\left(\dfrac{P_l}{Pd_l}\right)$	$l \in L$	Xxd_l	Domestic demand
54	$Meu_l = f\left(\dfrac{P_l}{P_l^{Eu}}\right)$	$l \in L$	Meu_l	Imports from the EU, large county hypothesis
55	$Mrow_l = f\left(\dfrac{P_l}{P_i^{row} \cdot EXR \cdot \left(1 + \tau_l^m\right)}\right)$	$l \in L$	$Mrow_l$	Imports from the RoW, large county hypothesis
56	$Xs_l = Xxd_l + Eeu_l + Erow_l + DStock_l$	$l \in L$	Pd_l	Domestic price, large country hyphothesis

Interregional trade				
57	$p_{ir}^t XB_{ir} = \sum_R XR_{i,r,rr} p_i^{tax} (1 + tr_{r,rr})$	$i \in I$ $r \in R$	p_{ir}^t	Aggregate price of domestic balance
58	$p_{ir}^t XB_{ir} = Xs_{ir} + \alpha_{ir}^m M_i + XT_{ir} - Xd_{ir} - INT_{iy}^r - \alpha_{ir}^e E_i$	$i \in I$ $r \in R$	XB_{ir}	Regional domestic balance
59	$XR_{i,r,rr} p_i^{tax} (1 + tr_{r,rr}) = XB_{ir} \dfrac{\max\left(0; p_{ir}^t XB_{ir}\right)}{\sum_R \max\left(0; p_{ir}^t XB_{ir}\right)}$	$i \in I$ $r,rr \in R$	$XR_{i,r,rr}$	Bilateral trade from region rr to region r

Clearing conditions				

60	$\sum_R X_i = \sum_R \sum_y INT_{iy} + \sum_j Xd_{j,i} + Ggov_i + INV_i$	$i \in I$	X_i	Goods market
61	$P_i^{Eu} \cdot Eeu_i = P_i^{Eu} \cdot Meu_i + CapEu \cdot w_{cap}$		$CapEu$	Balance of payment with the EU – Foreign capital
62	$P_i^{RoW} \cdot Erow_i = P_i^{RoW} \cdot Mrow_i + CapRow \cdot w_{cap}$		$CapRow$	Balance of payment with the Row- Foreign capital
63	$\sum_R \sum_i FACTd_{i,f} = \sum_R \sum_j FACTs_{j,f}$	$f \in F^M$	w_f	Market price for mobile factors
64	$\sum_R \sum_i FACTd_{i,cap} = \sum_R \sum_j FACTs_{j,cap} + capEU + CapRow$		w_{cap}	Market price for capital
65	$\sum_i FACTd_{i,f} = \sum_j FACTs_{j,f}$	$f \in F^I$	w_f	Market price for immobile factors
66	$\sum_i FACTd_{i,ind} = FACTs_{j,f}$	$j \in J$	$w_{ind,j}$	Price of family labor