CAP Implementation under Memorandum of Understanding bail-out conditionality: Impacts on business-oriented arable farms in Greece

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Jel codes: C61, Q12, Q18

Abstract

This paper examines the impacts of the national implementation of the CAP reform 2014-20 and the Third Memorandum fiscal-social insurance policy commitments of the Greek government, on the crop mix decisions and the viability of business oriented arable farming in Thessaly. Farmers' reactions to policy measures are assessed by means of mathematical programming models that maximize utility subject to agronomic, institutional and resource constraints. The main impacts emanating from the CAP reform are reduction for cotton and durum wheat as well as increase for set-aside and alfalfa cultivation areas. Similar crop mix is obtained by applying the scenario of CAP coupled with the fiscal-social insurance reform. Farm income is moderately sensitive in reform concerning reduction of subsidies but the combination with the Third Memorandum measures dramatically decreases their viability prospects.

Keywords: *mathematical programming, Common Agricultural Policy, Memorandum of Understanding, arable farming, Greece.*

Résumé

Dans cet article, nous allons examiner les impacts de la mise en place de la réforme de la PAC 2014-2020 en Grèce et des engagements pris par le gouvernement, dans le cadre du troisième protocole d'accord pour des mesures fiscales et sociales, sur les choix de cultures et sur la viabilité des grandes cultures commerciales en Thessalie. Les réactions des agriculteurs à ces mesures seront évaluées en s'appuyant sur des modèles de programmation mathématique qui maximisent les fonctions d'utilité par rapport à des contraintes agronomiques, institutionnelles et de ressources. Les conséquences principales de la refonte de la PAC sont la réduction des surfaces cultivées en blé dur et coton ainsi qu'une augmentation des surfaces affectées à la luzerne et à la jachère. Un plan de cultures pareil serait le résultat de l'application de la nouvelle PAC accompagnée des mesures de réforme fiscale et sociale. La baisse des aides prévue par la PAC à l'horizon 2020 aura de faibles effets sur le revenu agricole mais son adoption parallèlement à la mise en œuvre des mesures du troisième protocole d'accord réduira dramatiquement les perspectives de viabilité des agriculteurs.

Mots-clés: programmation mathématique, politique agricole commune, protocole d'accord, grandes cultures, Grèce.

1. Introduction

The Common Agricultural Policy(CAP), one of the main active common policies in the EU, has been a victim of its success due to undesirable side effects, namely excessive production surpluses and subsequent significant deadweight loss in the economy. Starting from the MacSharry reform, it is evolving through the Agenda 2000, the 2003 reform of decoupling subsidies from production, the "Health Check" agreement after the impact assessment of the reform in 2008. Among a range of measures, the agreement abolished arable set-aside, increased milk quotas gradually leading up to their abolition in 2015 also agreed to increase modulation, whereby direct payments to farmers were reduced and the money was transferred to the Rural Development Fund.

On the same track, the European Commission, the European Council and the European Parliament came to a political agreement on 26 June 2013 concerning CAP reform for the time period 2014-20. The maim aims of the new CAP scheme are the redistribution of direct payments among both EU members and regions of each EU member as well as the improvement of agriculture environmental performance. The Greek government has opted for the partial convergence of single farm payment (or decoupled payment) from 2015 until 2019 (European Commission, 2015a; Hellenic Ministry of Rural Development and Food, 2014)[1]. The partial convergence process is applied in five equal steps starting in 2015 and will be completed in 2019 (European Commission, 2015a; Hellenic Ministry of Rural Development and Food, 2014). Additionally, the partial convergence model is applied at regional level according to agronomic criteria. More specifically, the agronomic regions correspond to arable farming, tree crops and pastures. Farmers with relatively large farm size are obligated to fulfill greening requirements such as Crop Diversification and Ecological Focus Area in order to receive the greening payment (30% of single farm payment) (European Commission, 2015a; Hellenic Ministry of Rural Development and Food, 2014).

Also, after 2010 hard austerity policy measures have been applied to the Greek economy. These measures emanate from three consecutive 'Memoranda of Understanding' which have been signed by the Greek governments and the International Monetary Fund, the European Commission and the

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[1] The Greek government avoided to apply the full convergence model (flat rate model) in order to minimize the impacts of decoupled payments redistribution and to "protect" the farms with relatively high amounts of decoupled payments. The Greek agriculture is characterized by a significantly unequal decoupled payment system among farms. Member states of Southern Europe have also opted for the partial convergence model of decoupled payments, presumably for the same reasons (European Commission, 2015a).

European Central Bank[2]. In the context of the third Memorandum, which was signed in 2015, a series of measures have been established, concerning the agricultural sector: cessation of exemptions on diesel fuel, doubling of taxation on farm income which will reach 26% in 2017, payment of this tax on an anticipatory basis, and a significant increase in social welfare contributions (European Commission, 2015b).

It is worth mentioning that since the early 1990s, after each major CAP reform, the Greek agriculture has experienced serious reductions in farm income and a decline in international competitiveness (Karanikolas and Martinos, 2011). Therefore, of paramount importance is to assess the impacts of the abovementioned CAP reform, in relation to the Third Memorandum measures on Greek agriculture.

A significant number of various studies has been undertaken, concerning the impact assessment of CAP reform 2014-20 using models before (*ex-ante*) and during the policy action (Boere and van Kooten, 2015; Cimino *et al.,*2015; Donati *et al.,* 2015; Gallan-Martin *et al.,* 2015; Solazzo *et al*., 2015). Concerning the analytical tools, a commonly employed methodology is the use of variants of mathematical programming for two main reasons: firstly, the inadequacy of econometric models due to the frequency and extent of policy reforms and secondly, the policy shift from market instruments to agri-environmental and multifunctional support, which requires more detailed focus than estimating average reactions (Huylenbroeck *et al.,* 2006). Although mathematical programming is normative in nature, models used in agriculture can be identified as positive as empirical information on farmers' behaviour as well as validation against actual decisions most often used. Regarding Greek agriculture, a variety of mathematical programming sector models has been used in order to assess the impacts of CAP reform focusing on arable farming accommodating staple crops such as cotton, tobacco and wheat; partial equilibrium models incorporating downward sloping demand (Rozakis *et al*., 2008), multi-criteria methods with non-interactive elicitation of the utility function (Manos *et al*., 2009), interval linear programming to deal with uncertainty (Rozakis, 2011) and risk programming along with increasing cost functions by means of Positive Mathematical Programming (Petsakos and Rozakis, 2015).

[2] The three consecutive 'Memoranda of Understanding' include measures such as the increase of taxation rates on household income, business profits and heating oil. Increase of social insurance contributions and VAT (Value Added Tax) for specified products and services (e.g. food products and drinks, alcohol drinks, cigarettes, diesel oil, restaurants, tourism, etc.). Decrease of pensions, public sector salaries and handouts, abolishment of tax allowance of diesel oil in agricultural sector etc. It should be noted that specified measures for the agricultural sector are included for the first time in the Third Memorandum. Until 2015, agricultural sector "was relishing a beneficial handling" by the Greek government compared to the other sectors of the economy. Despite the expected reduction of Farm Income, some measures such as the abolishment of tax allowance of diesel oil, may motivate farmers to use alternative energy resources such as renewable energy (e.g. bioenergy, solar energy etc.).

In this paper, we assess the impacts of the most recent CAP reform along with the Third Memorandum measures on a sample of arable farms of the regional unit of Karditsa, in Thessaly Region (Greece). The sample farms are considered business-oriented according to Greek standards. For the purpose of a policy analysis, we have implemented multi-criteria mathematical programming with individual utility functions elicited from decisions observed at farm level. More specifically, we examine the impacts of the partial convergence of decoupled payments (in combination with 'greening' requirements) and reformed taxation-social insurance contribution measures. Besides, this model considers the agri-environmental payments and obligations in the context of the CAP second pillar. Subsequently, we modify the parameters and constraints according to the new CAP scheme and the Third Memorandum measures to assess their impacts on crop mix and viability of farms. The results of this analysis can be useful, since they could be representative to a certain extent of similar business-oriented arable farms of Thessaly, Central Greece and Central Macedonia.

The paper is organized in five sections; section two describes the baseline model specification, the initial set of goals and model constraints as well as the scenarios model specification. The case study and sample information are described in section 3. Section four analyses the impacts of CAP reform and Third Memorandum measures on crop mix and viability of farms, and in the last section the result discussion concludes the paper.

2. Methodology

2.1. Model specification - Baseline (CAP 2007-13)

A bottom-up staircase model based on individual farm data is specified for arable agriculture to simulate the decision-making process at farm level. A modular structure allows for taking into account the diversity of the arable farm system and production technology to a large extent independent of time-series data, appropriate for policy analysis in the case of substantial policy reforms (Rozakis and Sourie, 2001). Each sub-model consists of multiple objective functions and a number of resource-, institutional- and agronomic constraints. More specifically, different objective functions correspond to different farmers' goals. The first goal is the gross margin maximization, considering that a business-oriented farm attempts to optimize its economic performance.

Despite the business orientation of farms, family labour covers almost 30% of the total labour requirements. Therefore, we assume that farmers attempt to maximize family labour through their crop mix decision. As for the third goal, we consider the working capital minimization, assuming that farmers attempt to minimize their variable expenses since they can receive decoupled payment by keeping the arable land (set-aside included) equal to land entitlements. Minimization of risk is an additional criterion found in the literature review (Amador *et al*., 1998; Petsakos *et al*., 2009). However, this specific criterion is not studied in this paper because we assume that the surveyed farms' expectations about unknown values of parameters (e.g. prices of non-contracted crops, crop yields) are based on the most recent experience. More specifically, in the case of non-contracted crops (e.g. cotton, maize, alfalfa, durum wheat) the value of expected price is considered to be the received price of the t-1 period. Regarding crop yields, farmers consider that they don't vary significantly from year to year, thus the data on yields of some previous years could be used to calculate an average representative expected yield for each farm.

In order to elicit the weights of decision-making criteria, we apply a non-interactive method that is based on weighted goal programming and it has been originally used for the utility function assessment of large farms in Spain (Amador *et al.,* 1998). In the case of Greek farming, this methodology has been applied to evaluate tobacco cultivation alternatives under the EU CAP (Manos *et al.,* 2009), to estimate milk supply from sheep farms (Sintori *et al.,* 2010) and for the elicitation of tree farmers' goals (Karanikolas *et al.*, 2013). Here, we use this methodology as it has been specified and applied in Mantziaris and Rozakis (2016) and Karanikolas *et al.* (2013).

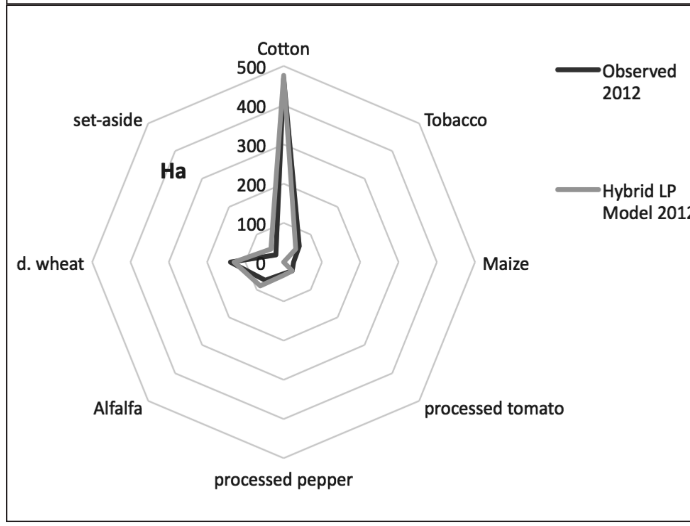
The application of the methodology for eliciting farmers' goals has yielded notable variations among the sample farmers. For 69% of the farms, only one criterion is important - 50% of the farms maximize only the gross margin, while 19% of the farms maximize only the family labour criterion (see also Mantziaris and Rozakis, 2016). Thus, these farms are represented by a single criterion objective function. However, for 27% of the farms, two sets of weights occur, the first one with weight distribution among criteria and a second one with the selection of one criterion only. In order to choose the suitable utility function, we will validate and compare the two different function types for each farm. For the remaining 4%, one set of weights with marginal distribution among criteria occurs, so these farms will be represented by a unique utility function.

In general, the model assigns major importance to the gross margin maximization criterion, because most of the farms are characterized as business-oriented according to Greek standards, and therefore they attempt to maximize their economic performance.

A farm-based mathematical programming model is characterized as useful for policy analysis if it can reproduce the base-year crop mix adequately. In order to measure the predictive capacity of the model we use two different distance measures, namely a relative distance index (Kazakci *et al.,* 2007) and the Finger-Kreinin index (Finger and Kreinin, 1979). For the purpose of measuring the predictive capacity in terms of farms, we apply the Finger-Kreinin index, while for measuring predictive capacity in terms of area, we apply both indices.

As it clearly appears in figure 1, the predictive capacity of the model is very high (for more details see Mantziaris and Rozakis, 2016). This hybrid linear programming model can be useful for policy analysis considering that mathematical programming models with similar predictive capacity have been used for policy analysis (Kazakci *et al*., 2009; Petsakos and Rozakis, 2009; Rozakis, 2011).

Figure 1 - *Illustration of the relation between reality and hybrid model results.*



Constraints are classified into three different categories, related to resources, First Pillar policy measures and Second Pillar policy measures. Resource constraints correspond to total land, irrigated land, family labour and working capital availability of each farm. First Pillar policy constraints include the land entitlements activation in order to receive the decoupled payment. Concerning cross-compliance obligations (20% cultivation of land entitlements with legumes or cultivation of three different crops), in practice these are ignored by the farmers (Mantziaris, 2013). The above two categories of constraints are included in all sub-models. Second Pillar policy constraints include the optional obligations of agri-environmental measures, namely nitrogen pollution reduction programme (A or B methodology, see below) and organic farming, in order to receive the agri-environmental subsidy.

2.2. Initial set of goals and model constraints

All crops cultivated are treated as alternative activities for every farm in the sample. For crops not present in a production plan, the sample average data concerning yield and family labour are used. As regards the crop cost prediction, in the case of agricultural inputs (e.g. fertilizers) and labour cost, the sample average cost is used, while in the case of mechanical operations costs, the farm's degree of mechanization is taken into consideration in order to estimate the possible rental rate of machinery and fuel costs with precision.

The goals and constraints used in this analysis and their mathematical expressions are given below (see also table A1 in the Appendix for the indices, parameters and decision variables)
1. Maximization of gross margin (in euros)

$$f(1) = \mathrm{Max}[(lg\_land \ * pay) + (lg\_organic * orgpay) + (lg\_nitro\_A * nitropay\_A) + (lg\_nitro\_B * nitropay\_B) + \sum_{n=1}^{N} \left[\left(yield_n \ * \ price_n \right) + ls_n - var\_cost_n \right] X_n] \qquad (1)$$

2. Maximization of family labour (in hours)

$$f(2) = \text{Max}\,[\,\sum_{n=1}^{N} \text{fl}_n X_n\,] \tag{2}$$

3. Minimization of working capital (in euro)

$$f(3) = \text{Min}\,[\,\sum_{n=1}^{N} var\_cost_n\, X_n] \tag{3}$$

Resource constraints
4. Available arable land:

$$\sum_{n=1}^{N} X_n = tot\_land \tag{4}$$

The sum of cropping area equal to total land.
5. Available irrigated land:

$$\sum_{n=1}^{N} irr_n X_n \leq irr\_land \tag{5}$$

The sum of irrigated crops area cannot exceed irrigated land available.
6. Available working capital:

$$\sum_{n=1}^{N} var\_cost_n X_n \leq working\ capital \tag{6}$$

The sum of variable expenses cannot exceed working capital available.
7. Available family labour:

$$\sum_{n=1}^{N} \text{fl}_n X_n \leq tot\_family\ labour \tag{7}$$

The sum of family labour cannot exceed family labour available.

Policy constraints-First pillar
8. Land entitlement activation:

$$\sum_{n=1}^{N} \text{lg}_n X_n \geq \text{lg}\_land \tag{8}$$

The sum of eligible crops area must be at least equal to land entitlements area.

Policy constraints-Second pillar
9. Nitrogen pollution reduction programme – Methodology A:

$$\sum_{n=1}^{N} Irr\_Nitrogen_n X_n \geq 0.75\ \text{lg}\_nitro\_A \tag{9}$$

The sum of eligible crops area for irrigated rotation must be at least equal to 75% of land entitlements of nitrogen reduction pollution programme for methodology A.

$$X_{st} \geq 0.25\ \text{lg}\_nitro\_A \tag{10}$$

The set-aside area must be at least equal to 25% of land entitlements of nitrogen reduction pollution programme for methodology A.

10. Nitrogen pollution reduction programme – Methodology B:

$$\sum_{n=1}^{N} Irr\_Nitrogen_n X_n \geq 0.75\ \text{lg}\_nitro\_B \tag{11}$$

The sum of eligible crops area for irrigated rotation must be at least equal to 75% of land entitlements of nitrogen reduction pollution programme for methodology B.

$$\sum_{n=1}^{N} NIrr\_Nitrogen_n X_n \geq 0.2\ \text{lg}\_nitro\_B \tag{12}$$

The sum of eligible crops area for non-irrigated rotation must be at least equal to 20% of land entitlements of nitrogen reduction pollution programme for methodology B.

$$X_{st} \geq 0.05\ \text{lg}\_nitro\_B \tag{13}$$

The set-aside area must be at least equal to 5% of land entitlements of nitrogen reduction pollution programme for methodology B.

11. Organic farming programme:

$$\sum_{n=1}^{N} Organic_n X_n \geq \text{lg\_organic} \tag{14}$$

The sum of eligible crops area for organic farming must be at least equal to land entitlements of organic farming programme.

2.3. New CAP (2014-20) and model specification

This section describes the adjustments of the hybrid linear programming model 2012, concerning CAP 2014-20 in order to estimate the impacts of the reform in the last year of subsidies convergence (2019). The Greek government has opted for the partial convergence scheme for direct payments deployed between 2015 and 2019 (European Commission, 2015a; Hellenic Ministry of Rural Development and Food, 2014). The entire UAA has been divided in three agronomic regions, namely arable farming, tree crops and pastures. Focusing on the arable farming region, the average entitlement value per hectare for the period 2015-19 equals 420 euros/ha (Hellenic Ministry of Rural Development and Food, 2014). This value is compared to the initial value of decoupled payment per hectare of each farm to calculate the new CAP decoupled payment. The initial value of decoupled payment is detailed in formulation 15:

$$Initial\ value\ of\ decoupled\ payment/ha(2015) = \frac{Decoupled\ payment(2014)*0.85}{New\ CAP\ land\ entitlements} \quad (15)$$

The decoupled payment value of 2014 was decreased by 15%, because of the transfer of economic resources to the Second Pillar of CAP. Additionally, each hectare receiving the decoupled area payment in the year 2015 can claim the new CAP land entitlement (Hellenic Ministry of Rural Development and Food, 2014).

If a farm's Initial value of decoupled payment is lower than 90% of average region entitlement value per hectare (420 euros/ha), then this Initial value will rise by 33% of the difference between Initial value and 90% of average entitlement value of the region, reaching at least 60% of the average region entitlement value per hectare until 2019. If a farm's Initial value of decoupled payment is higher than average region entitlement value per hectare, then this Initial value will decrease by 30% until 2019 (European Commission, 2015a; Hellenic Ministry of Rural Development and Food, 2014). In all these cases, the convergence process is linear, thus farms lose or gain a fixed amount each year (Hellenic Ministry of Rural Development and Food, 2014).

In our analysis, the most recent data concerning decoupled payments correspond to the year 2012. Consequently, we apply the above formulation to the year 2012. Additionally, the total hectares for the year 2012 are considered as the new CAP land entitlements for each farm since each hectare corresponds to a new CAP land entitlement.

After calculating the new CAP decoupled payment per hectare for each farm that will apply in 2019, we adjusted accordingly the parameters of decoupled payment per hectare and land entitlement of the hybrid linear programming model 2012. Also, we added four constraints to represent the obligations that farms have to fulfill, in order to receive the total amount of the new CAP decoupled payment, i.e. both the 'Basic' and 'Greening' payment (Hellenic Ministry of Rural Development and Food, 2014) (see also Table A1 in the Appendix).

CAP 2014-20 constraints (Entitlements activation and greening requirements)

1. New CAP entitlements activation obligation for each farm:

$$X_{st} \leq 0.5 \text{ lg\_land} \quad (16)$$

The set-aside area cannot exceed 50% of the new CAP land entitlements area in order to receive the Basic Payment (70% of new CAP decoupled payment).

2. Crop Diversification obligation for farms with new CAP land entitlements area > 10 hectares:

$$X_n \leq 0.75 \text{ lg\_land} \quad , \quad n=1, 2, 3....N \quad (17)$$

Farmers should cultivate at least two different crops (set-aside included) and the cropping area of each crop cannot exceed 75% of the new CAP land entitlements area in order to receive the Greening Payment (30% of new CAP decoupled payment).

3. Ecological Focus Area obligation for farms with new CAP land entitlements area > 15 hectares:

$$0.7 \left[\!\left[\sum_{n=1}^{N} Legume_n\, X_n \right]\!\right] + X_{st} \geq 0.05\, lg\_land \quad (18)$$

Seventy percent of the sum of legume crops area[3] plus set-aside area must be at least equal to 5% of the new CAP land entitlements area in order to receive the Greening Payment (30% of new CAP decoupled payment). Farms with new CAP land entitlements area larger than 15 hectares are also obligated to apply the constraint 2.

4. Crop Diversification obligation for farms with land entitlements area > 30 hectares:

$$X_{OPT\,L1} + X_{OPT\,L2} \leq 0.95 \text{ lg\_}land \quad (19)$$

Farmers should cultivate at least three different crops (set-aside included) and the sum of the cropping area of the two largest crops cannot exceed 95% of the new CAP land entitlements area in order to receive the Greening Payment (30% of new CAP decoupled payment). In order to find the two largest crops (in terms of land coverage) for farms with land entitlements greater than 30 hectares, we optimize the model adding the above three constraints (equations 16, 17, 18). After optimization, we obtain results concerning the two largest crops and we add the fourth constraint (19). Then we ran the model once more. Farms with land entitlements area larger than 30 hectares are also obligated to apply the constraints 17 and 18.

It should be noted that farmers are not obligated to apply the greening requirements in the organic cropping area.

Except for the decoupled payment adjustment and the inclusion of new policy constraints, we also modified the availability of resources, namely the working capital. According to 2012 data, 62.5% of the farms cover their working capital requirements by using the decoupled payment (Mantziaris, 2013). Thus, we tried to predict the working capital levels in the last year of convergence (2019), according to the formulations below. For farms with working capital larger than decoupled payment the formulation 1 applies, while the formulation 2 applies to farms with the opposite relation. Hence, we adjusted accordingly the parameter that concerns the working capital. For the remaining farms (37%), the working capital was assumed invariable with respect to 2012 levels.

1. *Projected working capital_2019 = working capital (2012) + added value /or removal) of projected decoupled subsidy_2019* (20)

[3] 1 hectare of legume crop corresponds to 0.7 hectare in the Ecological Focus Area.

$$2.\ Projected\ working\ capital_{2019} = \frac{working\ capital(2012)}{decoupled\ subsidy(2012)}\ projected\ decoupled\ subsidy\_2019 \quad (21)$$

Another significant model modification concerns the coupled subsidies for the year 2019 which equal 750 euros/ha for cotton, 55 euros/ha for durum wheat, 167 euros/ha for alfalfa and 402 euros/ha for processed tomato (Hellenic Ministry of Rural Development and Food, 2014). The rest of the parameters and constraints that apply to the hybrid linear programming model 2012 were assumed invariable at 2012 levels.

2.4. Third Memorandum measures and model specification

In August 2015, the Third Memorandum was incorporated in the Greek Law. A series of reforms in the fields of taxation and social insurance in agriculture have been enacted, which are expected to affect the viability of Greek farms. More specifically, in late 2016 the tax exemption for diesel oil will be abolished, while the tax rate for Farm Family Income (FFI)[4] will increase from 13% in 2015 to 26% in 2017(Agronews,2015; Niforopoulos and Papadimitriou, 2016). Moreover, the rate of prepaid FFI tax will rise from 55% in 2014 to 100% in 2016; additionally, social welfare contributions will be calculated according to Taxable FFI using social insurance contribution rate (Niforopoulos and Papadimitriou, 2016) (see also table A2 in the Appendix).

Consequently, we estimate the impacts of the combined scenario which contains both the CAP reform 2014-20 and the Third Memorandum measures. More specifically we adjust the CAP reform model that was described in section 2.3 above, taking into account the abolishment of the tax allowance for diesel oil, the profit tax rate and the social insurance contribution estimation that will stand in 2019.

Regarding the diesel oil cost, we applied the abolishment of tax allowance and we predicted and adjusted the variable cost of each candidate crop for each farm. In the process of cost prediction, we also took into consideration the level of owned machinery of each farm, assuming that the increase in diesel cost will also affect the rental rates of machinery. Thus, we adjusted the rental rate of machinery accordingly. Concerning the calculation of the FFI Tax we used the formulas below:

Taxable FFI = Gross Revenue – Farmland rentals rates-Depreciations[5] (22)

*FFI Tax = Taxable FFI * Tax rate (26%)* (23)

It should be noted that the tax-free threshold for subsidies corresponds to 12,000 euros. The prepaid tax was not included in our analysis, since its estimation is based on time-series data that are not compatible with the comparatively static nature of the model used in our analysis.

The social insurance contribution of each farmer is calculated according to Taxable FFI as follows:

Social Insurance Contribution = Taxable FFI Social Insurance Contribution rate (27,45%)* (24)

In the cases of Hybrid LP model 2012 and CAP reform scenario (without Third Memorandum measures) we applied the taxable FFI rate of 13%[6] and the tax allowance of diesel oil. Concerning the social insurance contribution (SIC) calculation, we used the available diversified amounts of SIC (see also table 1)[7].

Table 1 - *Taxation and social insurance measures for each policy scenario.*

	Tax rate of taxable FFI	*Tax allowance of diesel oil*	*Social insurance contribution (SIC) calculation*
Hybrid LP model 2012	13%	Yes	SIC categories (from 753 to 1635 euros)
CAP 2019	13%	Yes	SIC categories (from 753 to 1635 euros)
CAP 2019 & Memorandum measures	26%	Abolishment	Taxable FFI* *SIC rate (27.45%)* (In cases of taxable FFI ≤ 5,626 euros then SIC = 1,544 euros In cases of taxable FFI ≥ 70,330 euros then the SIC = 19,305 euros

The abolishment of tax allowance affects the farmers' crop mix decision-making since it increases the production cost. On the other hand, the tax rate increase and the new way of calculating the social insurance contribution affect the farm economic performance. Also, the current SIC categories are characterized by small variability (from 753 to 1635 euros).

3. Case study

3.1. Data

Sample characteristics

Surveyed farms are located in the plain of Regional unit of Karditsa, one of the most important arable farming regions in Greece. Farm data concerning the years 2005 and 2006 are derived from the database of the research project PILOTEC (PILOTEC, 2009). Updated farm data, concerning the year 2012, were collected through personal interviews (Mantziaris, 2013), and correspond to 48 farms (out of 70

[4] Farm Family Income = Gross Revenue-Cash Expenses (working capital, farm land rental rates, taxes, social insurance contribution)-Depreciations.

[5] Depreciations are estimated according to the following formulations: 1) Agricultural Machinery depreciation=Acquisition value * 0.1, 2) Facility depreciation= Acquisition value * 0.04 (Niforopoulos and Papadimitriou, 2016)

[6] A 13% taxable FFI rate of has been applied since 2014. In our analysis, the most recent data correspond to the year 2012. Consequently, we apply the specific rate for the year 2012. The tax rate is applied only in positive taxable FFI.

[7] In the case of SIC, farms which reveal negative taxable FFI are obligated to pay amounts according to SIC categories for Hybrid LP model 2012 and CAP 2019 scenarios, and 1,544 euros for CAP 2019 & Memorandum measures scenario.

Figure 2 - *Average cultivated area per crop (2005-2012).*

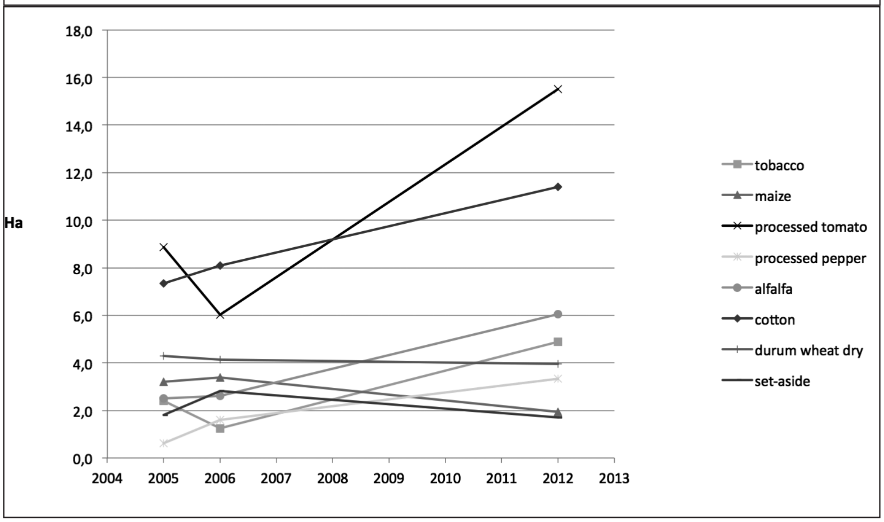
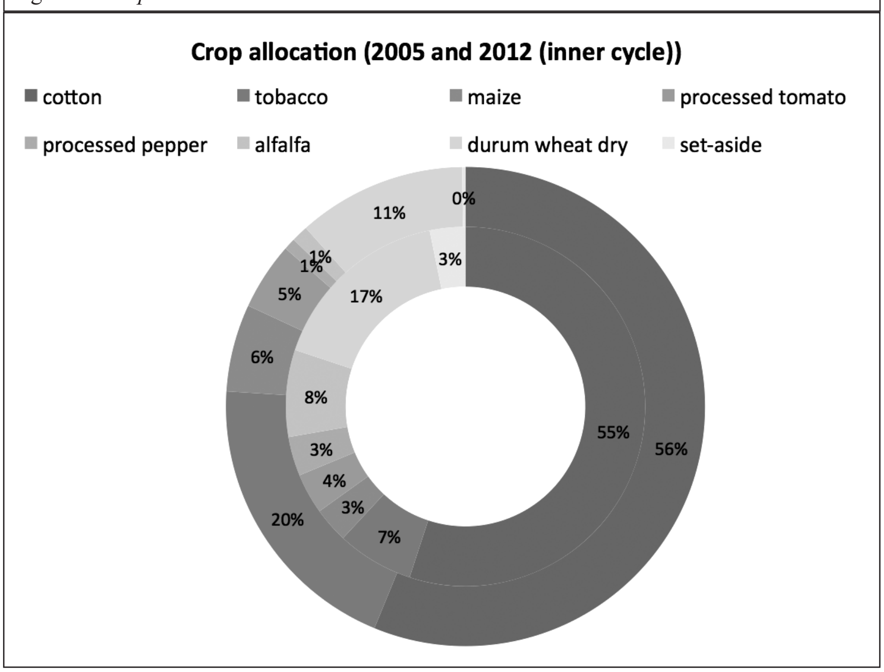


Figure 3 - *Crop allocation in 2005 and 2012.*



initially surveyed in 2005-06), specializing in arable farming. Furthermore, between 2005/2006 and 2012, one third of the initially surveyed 70 farms have gone out of business (most of them retired and a few passed away without succession); their land has passed to the remaining 48 farms which have thus been enlarged (average farm area increased from about 12 ha to 17.6 ha and individual crop cultivated area has also increased, see figure 2). The most important crop for the period 2005-12, in terms of land coverage, is cotton (figure 3, see also table A3 in the Appendix).

Up until 2005, tobacco (Virginia variety) held the lion's share in terms of revenue stream, representing a significant percentage of total cultivated land (19.2%). In 2006, following the full decoupling of subsidies, tobacco cultivation was abandoned as the variable cost exceeded the farm gate market price of tobacco (almost 1 euro/kg and 0.3 euros/kg, respectively, see also table A4 in the Appendix). However, in 2012, tobacco cultivation covered 6.7% of the total land (fig. 3) because of farm gate price that had increased since 2010 up to 2 euros/kg. All tobacco farmers have replaced the diesel boilers for kiln drying with biomass boilers due to the high cost of diesel oil.

Another major evolution for the period 2005-2012 is the considerable increase of alfalfa cultivation due to the partial and full decoupling of subsidies for cotton and maize respectively, which resulted in a revenue reduction for these two crops. Consequently, alfalfa cultivation has become more competitive since it is characterized by similar variable costs compared to cotton and maize (see also table A4 in the Appendix).

The set-aside increase is mainly due to the fact that a significant number of farmers participate in the nitrogen reduction agri-environmental programme within the Second Pillar of CAP for the 2007-13 programming period. Participants are obligated to keep a percentage of irrigated arable land in set-aside.

Focusing on the most recent data (2012), the irrigated land covers approximately 80% of total land, compared with the respective national average of 37%. In comparison with farm structures at the national level, the sample farms are superior in terms of both average size (UAA 4.8 ha and 17.65 ha, respectively) and distribution of farms in classes of economic size (European Commission, 2016) (see also figure 4).

Furthermore, 60% of the gross revenue of the sample farms is derived from the market, 25% from decoupled payments, 11% from coupled payments and 3% from agri-environmental payments.

The average single farm payment value per entitlement of the sample farms corresponds to 1780 euros, an amount much higher than the national average of 657 euros/ha (Agrenda, 2013). What is more, 61% of total land corresponds to land entitlements. More than 90% of farms own the machinery for all operations except for harvesting. The rate of harvesting equipment ownership varies widely, from 22% for cotton, to 45% for alfalfa and 100% for processed tomato. Also, 60% of the total land is rented. Although the farms surveyed are presumably business-oriented, the observed family labour use covers more than 30% of their total labour needs.

Moreover, 31% of the sample farms participate in optional agri-environmental measures of the Second Pillar. More

Figure 4 - *Structure of farms by economic size (Standard Output).*

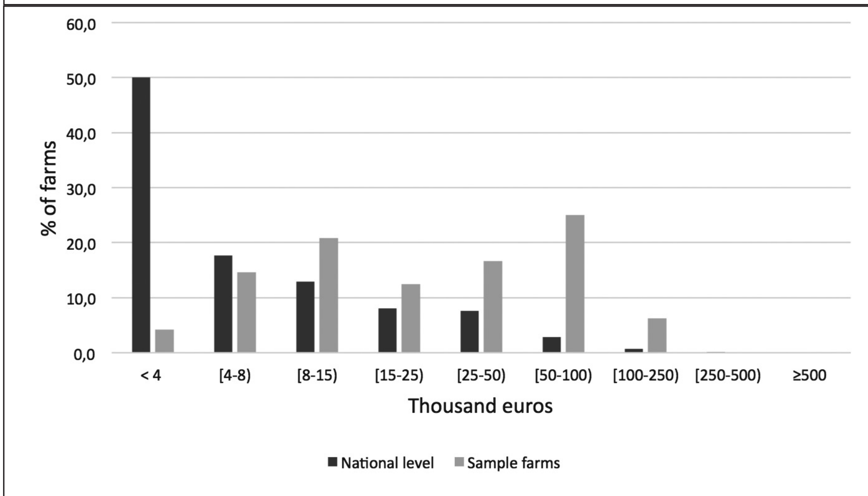
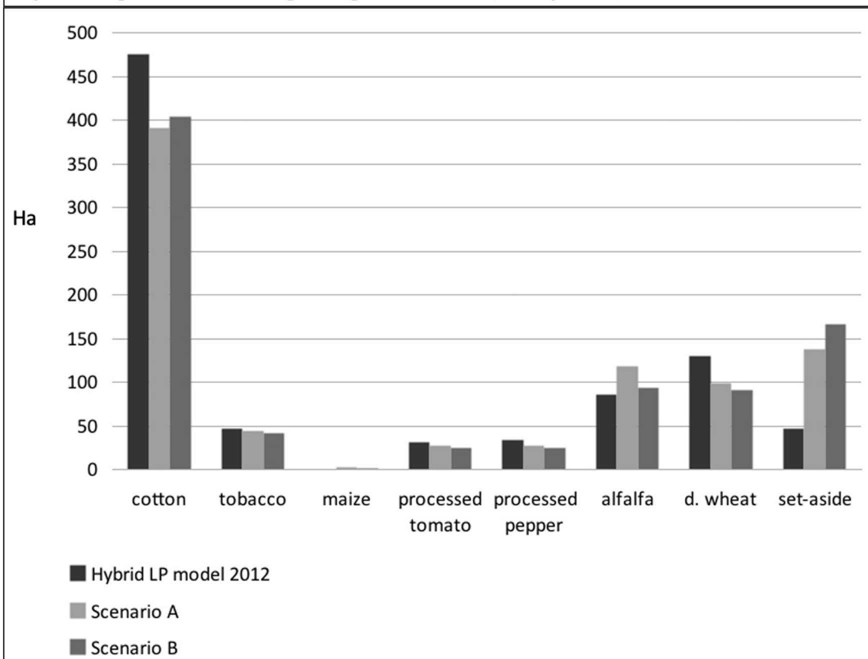


Figure 5 - *Optimization results per crop and scenario (acreage in ha).*



specifically, 23% of the farms participate in nitrogen pollution reduction programme (methodology B), 4% in nitrogen reduction programme (methodology A) and 4% in organic farming. The size of the land intended for the application of agri-environmental measures corresponds to 30% of the total land.

4. Results

The hybrid linear programming model 2012 is used to evaluate the impacts of CAP 2019 and the Third Memorandum measures, focusing on the last year of decoupled payments convergence (2019). The model has been modified accordingly for each of the two scenarios, namely *CAP 2019* scenario ('scenario A') and *CAP 2019 plus Memorandum Measures* scenario ('scenario B'). The scenario impact analysis corresponds to comparative static analysis since the model does not allow for total land variability. Before analysing the impacts of each scenario on crop mix and viability of farms, we would like to present the impacts on the model parameters that were affected by each scenario.

Concerning decoupled payments, 100% of the sample farms will totally lose 304 thousand euros; on average, decoupled payments per entitlement will decrease from 1,780 euros to 710 euros. Apparently, this evolution could affect farmers' decision- making since 62.5% of the farms seek the decoupled payment to cover working capital needs. Forecasts indicate that 62.5% of the farms will lose 163 thousand euros of their working capital. For the rest of the farms, the working capital will remain invariable since they use decoupled payment to cover alternative costs (e.g. family expenses [18.7%], investment loans [12.5%], and home loans [6.2%] (Mantziaris, 2013).

Regarding the diesel oil cost, we applied the abolishment of tax allowance at 2012 data and we estimated an increase of diesel cost by 38.7% for scenario B. Consequently, in the case of cotton, variable cost increased by an average of 5% for the farmers who own the harvesting machinery and 10% for the rest. In the case of tobacco, the variable cost increased by an average of 5% for the owners of biomass boilers for kiln drying and by 16% for the owners of diesel oil boilers. In the case of alfalfa, variable cost increased by an average of 4% for the owners of harvesting machinery and 19% for the rest. In the case of processed tomato, variable cost increased by an average of 3% for the owners of harvesting machinery and 10% for the rest. Finally, in the case of crops where only rented harvesting machinery was used, namely durum wheat, maize, and processed pepper, variable cost increased on average by 13%, 7%, and 2% respectively.

After optimizing the two variants of the hybrid linear programming model 2012, the overall crop mix for each scenario is determined. For scenario A, a significant decrease for the cotton, along with a significant increase for the set-aside is observed. The decrease in cotton's area could be attributed to: 1) obligation for farmers with land entitlements larger than 10 ha to diversify their land according to the new CAP greening constraints; 2) higher profitability of alfalfa due to the new CAP land subsidy; and 3) abandonment of cotton cultivation by farmers with decreased working capital, who replace it with set-aside. On the other hand, possible reasons for set-aside increase are, firstly, the obligation

Table 2 - *Optimization results per crop and scenario (in Ha).*

Scenario	Hybrid LP Model 2012 (Baseline)	Scenario A	Scenario B
cotton	475.32	390.92	403.43
tobacco	46.10	44.08	41.28
maize	0.00	3.12	1.36
processed tomato	30.97	27.79	25.12
processed pepper	33.50	27.00	24.87
alfalfa	85.70	118.45	93.73
d. wheat	129.29	98.82	91.12
set-aside	46.60	137.27	166.54

for farmers with land entitlements larger than 15 hectares to keep an Ecological Focus Area on their farm, either cultivating legumes or keeping land in set-aside; secondly the replacement of cotton or/and durum wheat with set-aside, for farmers with unsufficient working capital.

As regards scenario B, in general, no significant variations compared to scenario A are observed. A noteworthy exception is an additional increase in set-aside, maybe due to the considerable cost increase of durum wheat and alfalfa.

More importantly, within both scenarios irrigated land decreases, thus indicating savings of a scarce resource and a moderation of a series of irrigation negative impacts, such as salinization, nitrogen pollution etc.

As regards the distribution of farms in economic size classes, it seems that, compared to the baseline scenario (2012), the application of scenario A brings about some changes in middle-sized farms (8-15, 15-25 and 25-50 thousand €), leaving unaffected the classes under 8 th. € and above 50 th. € (fig.6). Nevertheless, with scenario B there seems to take place a clear restructuring of farms, with a doubling of shares of very small (<4) and small ones (4-8), along with a significant reduction in shares of middle classes (8-15 and 15-25). Interestingly, scenario B doesn't seem to affect large and very large farms (25-50 and 100-250), while a small reduction is observed in large farms of 50-100 th. €. Large farms are least affected because they had already participated in agri-environmental schemes, including requirements similar to those of new 'greening'; despite the reduction of decoupled payments, their working capital is not going to be reduced, since they use these payments for on-farm investments rather than variable expenses.

In addition, in order to assess the economic impacts of the above scenarios, it would be useful to assess the farms' viability. The farms' viability index applied is the return on working capital that has already been used in order to estimate the impacts of CAP reform 2003 on Greek cotton farmers (Rozakis *et al.,* 2008). The index is formulated as follows:

$$\text{Return on working capital} = \frac{\textit{Farm Family Income} - \textit{Decoupled payment} + \textit{Depreciations}}{\textit{Working capital}} \qquad (25)$$

If for two consecutive years the return on working capital is lower than the interest rates for regular bank deposits, rational farmers would not keep on cultivating, given that they receive a significant amount in the form of decoupling payment. The average interest rate in July 2016 for one-year term deposit in Greek banks corresponds to 0.86 % (Bank of Greece, 2016). Consequently, we compare the return on working capital (for scenarios A and B) with the 0.86% interest rate. In the case of baseline scenario (2012), we compare the return on working capital with the 4.8% interest rate (Bank of Greece, 2012).

According to the baseline scenario, 21% of the farms are non-viable. In scenario A, the sample farms are not affected enough by CAP reform that might reduce decoupled payment, since only 27% of them are considered non-viable. This insignificant increase of non-viable farms is due to the fact that most gross revenue (60%) is received by the market. In the case of scenario B, the sample farms are less viable compared to baseline and A scenario, because of the increase of FFI tax rate from 13% to 26%, the increase of diesel oil cost by 38.7% (after abolishment of tax allowance) and mainly due to the significant increase of social insurance contributions (see also Table A5 in the Appendix). As a result, in this scenario 42% of the sample farms are non-viable. One half of non-viable farms are medium-size farms, 15% are very small, 15% are to small and 15% are large-sized.

Consequently, the combination of CAP reform with the Third Memorandum measures could dramatically reduce the viability of the sample farms and accelerate the farm exit rates.

Figure 6 - *Structure of sample farms by economic size and policy scenario (Standard Output).*

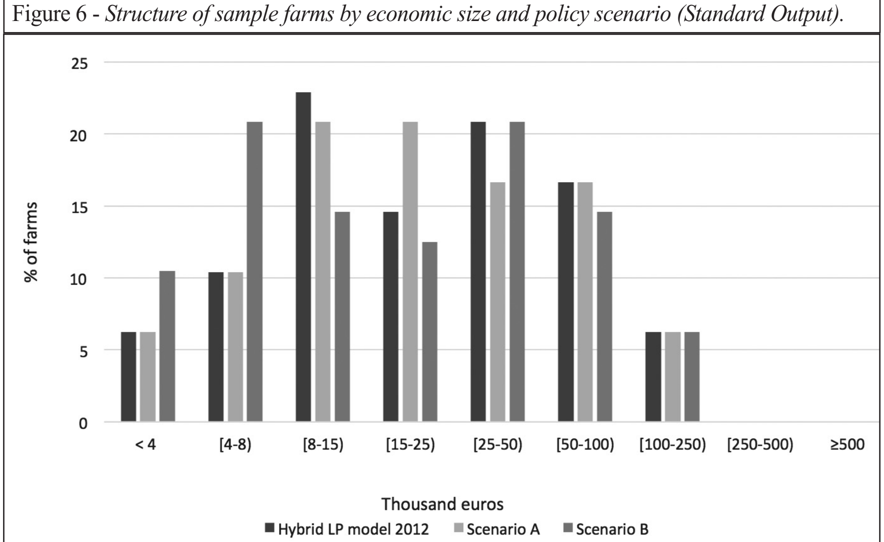
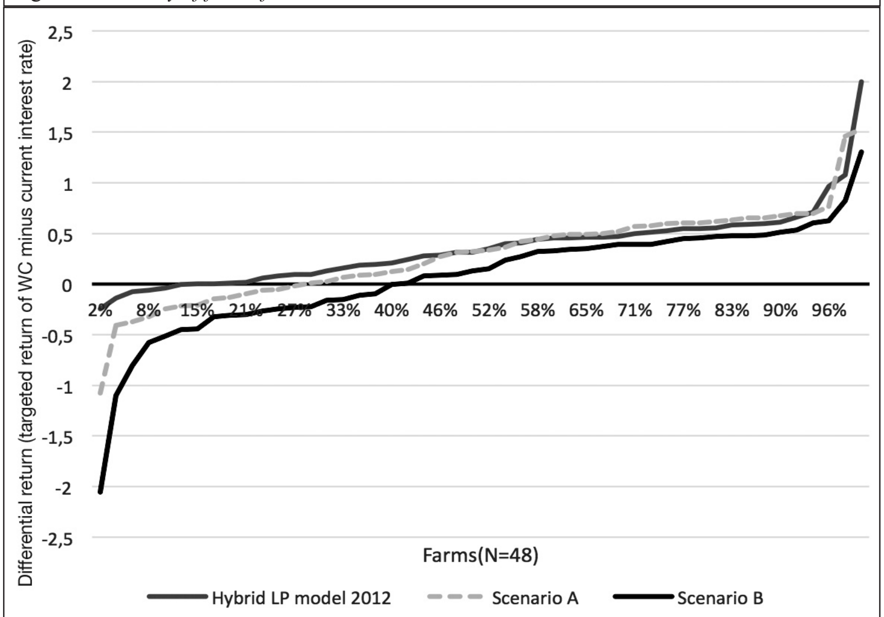


Figure 7 - *Viability of farms for each scenario.*



5. Conclusions

The aim of this study was to estimate the impacts of CAP reform and Third Memorandum measures in crop mix and viability of Greek business-oriented arable farms. A multi-criteria mathematical programming model has been used in order to estimate the utility functions that represent the crop mix decision-making of a sample of farms located in the regional unit of Karditsa, Thessaly. The model validation results confirm that most of the business-oriented farms are willing to optimize their economic performance, namely their gross margin. Despite their business orientation, the model results reveal that almost 20% of the farms still rely mostly on family labour in the process of crop mix decision-making. Generally, the sample farms are in practice focused on one goal when they plan the crop mix for the following year.

Regarding the impacts of CAP 2019 scenario on crop mix, a reduction for cotton and durum wheat is observed, while set-aside and alfalfa are increased. From the environmental point of view, it seems that CAP reform could reduce the degradation of water resources that is observed in Greek intensively grown regions like Thessaly, Central Greece, and Central Macedonia. Also, farm viability is moderately deteriorated (from 21 to 27% of the sample) since the main revenue source component comes from sales in the market.

In the case of the CAP 2019 plus Third Memorandum scenario, the crop mix remains almost the same but the farms' viability prospects are expected to worsen dramatically as non-viable farms represent 42% of the sample farms. Consequently, farm exit rates will further accelerate, and radical changes are expected to take place in the distribution of farms, most importantly a reduction of middle-sized farms in parallel with a substantial increase in small and very small farms, while large farms seem to be least affected. This finding could indicate an enhancement process of a dual farm structure, with further consolidation of large farms along with an increase in the number of small farms.

The latter will survive only if they integrate farming activities into a broader livelihood strategy, which includes off-farm employment as the main source of household income, and apparently, requires the existence and/or creation of jobs in non-agricultural sectors of the economy. Given that within the ongoing crisis of the Greek economy more than a million jobs have been lost, the prospects of survival of the small farms are rather gloomy. Therefore, the whole context for the design of agricultural policy in Greece becomes much more challenging; along with the long-standing decline in farm incomes and the worsening of international competitiveness of Greek agriculture, as our analysis has shown, the restrictive macroeconomic environment within the serious crisis results in a further weakening of farm structures and a worsening of farms' viability prospects.

Additionally, serious concerns are expressed about the overall effectiveness of these austerity policies for the agricultural sector, especially for the new tax policy: since 2014 to 2015 the total revenue from taxation of agricultural income in Greece declined from 187 million € to 179 million €, a trend which is expected to worsen after the application of the Third Memorandum measures (Panagos, 2016). Therefore, contrary to their stated objectives, these policies could also result in increased tax evasion by the Greek farmers.

Finally, concerning the analytical tools, further research could be undertaken, in order to estimate the impacts of policy *via* a sequential mathematical programming model which takes into consideration the deployment of farms' decisions in time, illustrating crop mix and economic indicators in the medium term.

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Appendix

Table A1 - *Indices, parameters and decision variables*[1]

Indices	
n	Crop (cotton, tobacco, processed pepper, processed tomato, alfalfa, maize, durum wheat, set-aside)
st	Set-aside
$_{OPT\ L1}$	Largest crop in hectares after model optimization
$_{OPT\ L2}$	Second largest crop in hectares after model optimization
Decision Variables	
X_n	cropping area of each crop in hectares
X_{st}	set-aside area in hectares
$X_{OPT\ L1}$	cropping area of largest crop in hectares after model optimization
$X_{OPT\ L2}$	cropping area of second largest crop in hectares after model optimization
Parameters	
$yield_n$	expected crop yield of each crop in tn/ha (Data on yields of 2005 & 2006 are used in order to calculate the average expected crop yields)
$price_n$	expected price of each crop in euros/ton Average t-1 price (2011) for non-contracted crops (Cotton price=530 euros/ton, maize price=180 euros/ton, alfalfa price=220 euros/ton, durum wheat price =210 euros/ton.)
ls_n	indicative coupled subsidy of each crop in euros/ha (cotton=805 euros/ha, durum wheat=90euros/ha)
var_cost_n	variable cost of each crop in euros/ha
fl_n	provided family labor for each crop in hours/ha
irr_n	irrigated arable crop (cotton, tobacco, processed pepper, processed tomato, alfalfa, maize)
lg_n	eligible crop for entitlement activation (cotton, tobacco, processed pepper, processed tomato, alfalfa, maize, durum wheat, set-aside)
$Irr\_Nitrogen_n$	eligible crop for irrigated rotation in the context of nitrogen reduction program (cotton)
$NIrr\_Nitrogen_n$	eligible crop for non-irrigated rotation in the context of nitrogen reduction program (durum wheat)
$Organic_n$	eligible crop for organic farming (alfalfa)
$Legume_n$	Legume crop (alfalfa)
$\lg\_land$	land entitlements area in hectares
pay	single payment in euros/ha
$\lg\_organic$	land entitlements of organic program in hectares
$orgpay$	organic payment in euros/ha
$\lg\_nitro\_A$	land entitlements of nitrogen pollution reduction program in hectares- methodology A
$nitropay\_A$	nitrogen pollution reduction program methodology A payment in euros/ha
$\lg\_nitro\_B$	land entitlements of nitrogen pollution reduction program in hectares- methodology B
$nitropay\_B$	nitrogen pollution reduction program payment in euros/ha -methodology B
tot_land	Available arable land
irr_land	Available irrigated land
$working\ capital$	Available working capital
$family\ labour$	Available family labor

[1] In parentheses are described the possible choices of sample farms.

Table A2 - *Third Memorandum measures.*

Third Memorandum-Taxation measures	**Third Memorandum-Social insurance contribution (SIC) measures**
Taxable FFI rate from 13% in 2015 to : • 20% in 2016 • 26% in 2017 Prepaid tax rate from 55% in 2014 to: • 75% in 2015 • 100% in 2016 Tax allowance of diesel oil : • Decrease by 50% in 2015 • Abolishment in 2016 Maintenance of the non-taxable limit for subsidies up to 12,000 euros	Abolishment of social insurance contribution categories in 2017 : • SIC (2017)=taxable FFI* 21.45% • SIC (2018)=taxable FFI* 24.45% • SIC (2019)=taxable FFI* 27.45% • In cases of taxable FFI ≤ 5,626 euros or ≥ 70,330 euros then the SIC corresponds to a fixed amount.

Table A3 - *Crop patterns in the sample farms (2005-2012).*

Year	**2005 (n=70)**		**2006 (n=70)**		**2005 (n=48)**		**2006 (n=48)**		**2012 (n=48)**	
Crop	**Area (Ha)**	**Number of farms**	**Area (Ha)**	**Number of farms**	**Area (Ha)**	**Number of farms**	**Area (Ha)**	**Number of farms**	**Area (Ha)**	**Number of farms**
Cotton (irrigated)	451.5	66	506.8	68	337.4	46	371.7	46	467.9	41
Tobacco (irrigated)	159.1	70	2.5	2	115.7	48	2. 5	2	58.6	12
Maize (irrigated)	47.4	24	48.8	18	44.7	14	40.5	12	27	14
Processed Tomato (irrigated)	36.6	4	34.1	4	26. 6	3	24.1	4	31	2
Processed Pepper (irrigated)	6.4	7	14.7	7	3.7	6	9.6	6	30	9
Alfalfa (irrigated)	9.0	4	11.6	4	5.0	2	7.8	3	66.5	11
Durum Wheat (non-irrigated)	91.5	28	168.4	49	68.5	16	119.6	29	142	36
Set-aside (non-irrigated)	1.8	1	27.8	10	1.8	1	25.3	9	27.2	16
Total	**803.4**	**70**	**814.9**	**70**	**603.5**	**48**	**601.2**	**48**	**847.2**	**48**
Average farm size(Ha)	**11.4**	**-**	**11.6**	**-**	**12.5**	**-**	**12.5**	**-**	**17.6**	**-**

Table A4 - *Techno-economic data per crop (2012).*

Crop	Average variable costs per ha (euros)	Average yield per ha (tons)	Average price per ton (euros)	Coupled subsidy per ha (euros)	Average family labor per ha (hours)
Cotton	1213.1	3.17	380	720	13.17
Tobacco	5118.2	4.59	2000	-	177.62
Maize	1311.6	10.78	200	-	12.07
Processed Tomato	4660.1	96.06	75	-	28.54
Processed Pepper	6050	29.41	330	-	117.77
Alfalfa	978.8	10.12	150	-	14.32
Durum Wheat	558.8	3.53	210	90	9.73

Table A5 - *Basic economic results and parameters in the sample farms for each scenario (in million euros).*

Scenario	Gross Revenue	Decoupled Subsidies	Coupled Subsidies	Agri-environmental subsidies	Working Capital	Farmland rental rates	Depreciations	Taxable FFI	FFI Tax	Social Insurance Contribution	FFI
Hybrid LP model 2012	3.07	0.78	0.35	0.10	1.34	0.29	0.79	0.34	0.045	0.039	0.55
Scenario A	2.57	0.48	0.32	0.10	1.18	0.29	0.79	0.24	0.031	0.039	0.23
Scenario B	2,47	0.48	0.33	0.10	1.18	0.29	0.79	0.19	0.051	0.11	0.046