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Foreword

Food security issue in Tunisia is developed by the authors *Jeder*, *Hattab and Frija* through the Vector Error Correction Model approach (VECM). The results confirm that the issue of food security in Tunisia is a question of threat in the short and long-term instability. So, it is important today to readjust some factors to ensure food security in Tunisia like controlling inflation and lowering the food importation as short-term measures and preserving and improving the fertility of land under cereals and adopting climate change as long-term measures.

Azizi analyses the mechanism through which natural resource abundance leads to a poor agricultural performance and a rapid urbanization in African countries. The results show that natural resources rents have a negative impact on agricultural performance and a positive impact on food import dependency. In addition, the results show a significant positive impact of resource rents on rural-urban migration and on urbanization rate. We argue that these findings can be explained by the government choice to specialize in primary commodities to the detriment of the development of other productive sectors, especially agriculture.

Poverty, human health and food crisis are the main concerns of the paper of *Bechir et al*. The authors conducted a study regarding the regional disparity that may exist between provinces in the south of Tunisia. The results following a Principal Component Analysis (PCA) show that the South West region is poorly developed and this is evidenced by several determining variables which are mainly social variables such as the unemployment rate, the schooling rate, the balance migration, poverty and social exclusion.

Kendi, *Radjef and Hammoudi* analyse the distribution chains of large agrifood companies and impact their efficiency. Poor adaptation to fluctuations in demand, imperfect control of production and transport costs and poor location of distribution centers is the main factors affecting the economic performances. The authors propose, through a case study of the agro-food group Cevital (Algeria), a solution to the problem of restructuring supply and distribution networks, at a stage of development of this company.

Mozas-Moral et al. deals with the emergence of second-tier cooperatives to enhancing the commercialization of olive oil through greater concentration and integration of supply. This improved commercialization is made possible in part by the greater capacity of these

companies to invest in information and communication technologies (ICTs) and human capital specialized in managing these ICTs. The authors show that age, size, the management's ICT training, social network activity, and outsourced ICT management are associated with greater online sales of olive oil by second-tier cooperatives.

Paper by *Papić et al*. analyses the technical efficiency of arable farms in Serbia and its determinants using a two-stage double bootstrap Data Envelopment Analysis (DEA) approach on the Farm Accountancy Data Network (FADN). The results suggest that the future potential shift of the Serbian agricultural support towards the Common Agricultural Policy (CAP)-like area based payments is expected to have a minimal but likely positive impact on farms technical efficiency in Serbia.

Petruzzella et al. through data and information collected by the international network, namely, the Mediterranean Innovation Partnership describe the scenario on youth innovation and entrepreneurship in agrifood sector in Mediterranean countries. They argued that social and institutional innovation are key drivers of the development of Innovation Ecosystems. The authors highlight that while in the field of institutional innovation there are signs of official activity, in the field of social innovation there is no or very limited attempt to embody social innovation into national policy frameworks.

Aydın Can and Engindeniz conducted a study to determine the tendency of the youth who study agriculture to invest in agriculture and their opinions and suggestions on the Young Farmer Grant Project in Turkey. According to results of logistical regression, age, the situation of being a farmer in the family and having a family-owned farmland positively affect the probability of students benefiting from the Young Farmer Grant Project.

Ferreira et al. deal with the trend of sales and consumption of Port wine. The authors analyse the profile and behaviour of domestic Port wine consumers, identifying homogeneous market segments. Three profiles of purchasers/consumers emerged by survey: experienced, less experienced and inexperienced consumers. This segmentation shows that Port wine consumers can be grouped according to their involvement with the product, consumption occasion and price they are willing to pay.

An econometric analysis for food security in Tunisia

Houcine Jeder*, Sabrine Hattab**, Iheb Frija***

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Abstract

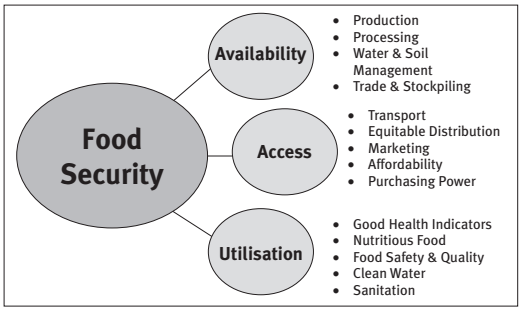
Food security issue is getting more attention in middle-income countries such as Tunisia after the revolution 2011, where many factors affecting its food security are multiplied. An econometric analysis of food security was done through the Vector Error Correction Model approach (VECM). The result of this approach shows that there is a significant long-term causality between the dependent variables and the explanatory variables. Some signs of variables like land under cereals assert the hypothesis of Ricardo's land rent theory and also attract attention for the preservation of land fertility in climate change context. However, there is a short-term causal relationship between food security and independents variables like: land under cereals, inflation and food imports. These results confirm that the issue of food security in Tunisia is a question of threat in the short and long-term instability. So, it is important today to readjust some factors to ensure food security in Tunisia like controlling inflation and lowering the food importation as short-term measures and preserving and improving the fertility of land under cereals and adopting climate change as long-term measures.

***Keywords**: Food security, Threat factors, Econometric analysis, Tunisia.*

1. Introduction

Food security is a global issue that encompasses all three spheres of sustainability; environment, social and economic. It is not about scarcity, because there is enough food worldwide, but is about the reliable access to sufficient and nutritious food. There are three pillars of food security; availability, access and utilisation (Figure 1), (Van Eldik, 2012). Interruptions to any of the components will lead to food insecurity affecting food supply and market prices. Stabilisation can be affected by various causes such as climate change, water supply, pest and disease management and the economic environment. Maintaining stability among the three pillars of food security is essential for ensuring continuous food supply (Coates, 2013; Barrett, 2010).

Figure 1 - Three pillars of food security.



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The food security can also be interpreted as a multidimensional and dynamic issue in the short and long term. Solving this problem requires taking into account the specificities of the development model and food strategies in the country. The question of food security was behind the failure of the Tunisian model of development by a social revolution in January 2011. According to the report of the Food and Agriculture Organization (FAO), world food prices reached a record high in January 2011, exceeding the levels reached during the 2007-2008 food crisis. As several analysts have shown, the extreme vulnerability to rising food prices of most countries of North Africa was undoubtedly a precipitating condition for social unrest (Bellemare, 2011; Breisinger *et al.*, 2011; Lagi *et al.*, 2011; World Bank, 2011). Despite the contribution of the Green Revolution and the integration of technology in increasing agricultural production, food security remains a fundamental problem for many countries around the world. The shortage of agricultural products on international markets and the large fluctuations in food prices clearly reflect the tensions between demand and supply, thus causing higher prices and food insecurity in Mediterranean countries (Lacirignola *et al.*, 2015). A recent IFPRI report asserts that "food security has deteriorated in most Arab countries, which is consistent with observed high food prices inflation" and that, particularly in Tunisia. The diminishing capacity of the largest fraction of the population to access staple food and, more generally, the increased inability of the state to hamper the erosion of household incomes has been no doubt an important factor in crystallizing social discontent in North Africa (Breisinger *et al.*, 2011). With this regard, the assertion that the food issue has taken a political dimension should not be understood in a restrictive way, i.e. that increases in food prices are likely to generate food riots and social unrest, but rather that they can lead, as was the case in Tunisia, to the rejection of the entire socio-political system (Gana, 2012). The farmers' protest movement in Tunisia highlights the need for governments to address the social and food security dimension of agricultural development and call for structural reform in land resource allocation, for major transformations in the social and technical models of agricultural production (IAASTD, 2009), as well as for profound changes in the organization of farm input and output markets, at various scales. Finally, the lesson to be learned from the Tunisian case is the profound link between all these factors: social, economic, agricultural and natural resources. The failure of the political system and the development model may worsen the issue of food security in the coming years in Tunisia with the context of climate change, where the Mediterranean regions will be the most affected by this phenomenon and in particular the developing countries.

The initiation of the study or research on the issue of food security must refer mainly to the basic definition of this concept. During the Rome Declaration on World Food Security in 2002, FAO defined food security as when "*all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*" (Belloumi, 2014). This definition explains that food security exists when people, at all times, have access to adequate, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Ojo, 2004). So to address the issue of food security, one must consider the key dimensions in this definition like: availability, stability, access, and utilization (ADB, 2012; Kumar and Sharma, 2013). Several studies and research work have been carried out on the issue of food security and their dimensions in several regions of the world, but in Tunisia, the work remains somewhat limited with a descriptive and qualitative analytical approach. This study will address the issue of food security in a quantitative way by trying to identify the determinants of food security in Tunisia reflecting the key dimensions through an econometric approach adequate to this issue for interesting policy and strategic recommendations.

The study is structured in sections: after the introduction, we present a brief review of the literature on the methodological approach adopted to analyze the issue of food security. Then, a representation of the empirical model used in the study followed by an empirical result of the

estimation techniques and a discussion. At the end, a conclusion summarizes some recommendations for policy makers in terms of food security policy.

2. Literature Reviews

There are several research studies dealing with the problem of food security. Some studies focus on the determinants of the household-level food security model, for others at the national level depending on their intended objectives. The determinants of food security remain the main question of several researches despite the diversity of scales. The national scale remains the most favorable scale for the strategic orientation of policy makers. For example, in Morocco, according to Aker and Lemtouni (1999), there are many factors that affect the Moroccan food security model, namely national food production, rainfall, food prices, Gini coefficient of income distribution, exports, female illiteracy rate and local health environment. Other studies have shown the impact of population growth on food security. Similarly, household size is one of the important determinants of food security at the household level, and empirical results show that household size is significant and negatively related to food security (Mensah *et al.*, 2013). Another study showed that household size for food insecurity at the household level gives a significant and positively related result (Gebre, 2012). On the other hand, the household size was important but had a negative impact on the food insecurity of rural households in Africa (Amaza *et al.*, 2008).

Climate change has also become another important factor to be included in the food security model. Recent research has examined the impact of climate change on major components of food security such as availability, accessibility, affordability, preference, utilization, and nutritional value and food system stability. It is expected that the viability of current world agro-ecosystem and future food availability have long term implication (Edame *et al.*, 2011). Climate change tend to reduce agriculture productivity, production stability and income in some areas that already have high food security.

Tunisia is like other countries in the world, the issue of food security is a priority for agricultural and agri-food policies of countries. The way scientists and researchers and policy makers analyzed this issue was not within the same approach. Scientists focused on specific issues in relation to their skills and expertise specialties while policy makers focused on development policies and regulatory instruments to ensure food security. Food security in Tunisia was often linked to the agriculture sector. This relationship is obvious, since food production was always the output of agricultural activity, but when the agricultural development model ended in deadlock and reached its limits, food security will be the most affected and the repercussions will be great magnitudes on the social and economic life in the country (Lattre-Gasquet *et al.*, 2017).

The issue of food security has been addressed in many ways and on several scales. For some, the national scale is important because food security depends on trade and international exchange and world prices, so the macro-level study is the most appropriate for raising the gaps in food security and country sovereignty in terms of food. Among these works, we can note the paper that addressed the issue of food security at the Maghreb scale through a comparative approach to provide a review of the agricultural policies performance in the jive countries in the Maghreb and examine results of the reforms that have been taking place in these countries to achieve food security (Chebbi and Lachâal, 2004).

Other papers linked the problem of food security to water resources, particularly the concept of virtual water through an analysis of the evolution of food and nutritional security in Tunisia, evaluating its sustainability under conditions of scarcity and free trade areas, with particular emphasis on the meat sector and the impact of climate change on agricultural production (Ouertani *et al.*, 2016). Nutrition is also likely to be affected by climate change through related impacts on food security, dietary diversity, care practices and health. Indeed, climate change is a serious threat to food security if necessary measures are not taken by policy makers (Krishnamurthy *et al.*, 2012).

The majority of these papers on food security are based on a descriptive and qualitative analysis approach on the main dimensions related to the concept of food security in a separate way: availability, access, stability and use in terms of quality and food safety. The search for an integrated, quantitative and explanatory approach remains the most appropriate approach to identify the determinants of food security in Tunisia.

The quantitative approach and in particular the econometric one is an appropriate approach for this type of problems, but the integration of the different dimensions of food security and the influencing factors through the choice of variables remains the most interesting task. This paper will adopt this econometric approach as a methodological tool of analysis to identify the key factors of food security in Tunisia, and the main recommendations that can be drawn to build strategic orientations for agri-food policies on this vital issue.

3. Data and Methodology

3.1. *Data*

The variables of food security used in this study during the period of 1991-2017 are:

- *Food production index* (2004-2006=100) which is proxy of food security. This index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.

- *Inflation*, *consumer prices (annual %)* as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods.

- *Food imports (% of merchandise imports)*; food comprises the commodities in SITC[1] sections 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils and fats) and SITC division 22 (oil seeds, oil nuts, and oil kernels).

- *Land under cereal production (hectares)* refers to harvested area, although some countries report only sown or cultivated area. Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.

- *Population*, *total* is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.

- *Precipitation (mm)* is the average precipitation in depth (mm per year).

- *Temperature (c°)* is the average temperature per year.

All these variables are expressed in long terms. Those data obtained from World Bank and Department of Statistic (DOS) but for the precipitation and temperature from basic data of National Institute of Metrology (INM).

3.2. *Model Specification*

Food security is defined in terms of four components: food availability, access to food, food use, and food stability (FAO, 2006). Food production indicates that food available for the population is produced by a country through national food production, alone or beyond domestic food production or both (Aker and Lemtouni, 1999). National food production is the largest quantitative component of national food security for almost all countries (FAO, 1996). Lack of food will cause hunger and famine in a country. Therefore, the empirical outline will be used for food production as an indicator of food security.

Based on the discussion on the potential determinants of food security, the model can be written as following:

$$FPI = F(INF, LCER, FIMP, POP, PRC, TEMP) \quad (1)$$

[1] Standard International Trade Classification (SITC) is a classification of goods used to classify the exports and imports of a country to enable comparing different countries and years. The classification system is maintained by the United Nations. The SITC classification is currently at revision four, which was promulgated in 2006.

In log terms the equation (1) becomes as follows

$$ln\ FPI = \alpha_0 + \alpha_1 ln\ INF_t + \alpha_2 ln\ LCER_t + \alpha_3 ln\ FIMP_t + \alpha_4 ln\ POP_t + \alpha_5 ln\ PRC_t + \alpha_6 ln\ TEMP_t + \varepsilon_t \quad (2)$$

Where

FPI = Food production index (2004-2006=100)
INF = Inflation, consumer prices (annual %)
LCER = Land under cereal production (hectares)
FIMP = Food imports (% of merchandise imports)
POP = Total population
PRC = Precipitation (mm)
TEMP = Temperature (c°)
α_0, α_1, α_2, α_3, α_4, α_5, = Coefficient for the explanatory variables
ε = error term and *t* = times series period

The food security model analysis is based on tests and econometric techniques. The unit root test, co-integration test, and error correction model (ECM) techniques have been used for analyzing the time series data. The unit root test is called the Augmented Dickey-Fuller (ADF) test. First, the results show that food security and all the explanatory variables are stationary in the first difference value.

Second, the goal is to examine the long run relationship between food security and its determinants through the normalized co-integrating equation showing that all the variables are significant in the long run.

Further, the data were analyzed using the Vector Error Correction Model (VECM) to determine how much the short run deviated from the long run. The coefficient in error correction term (ECT) is the speed of adjustment factor. There exists one error correction term in this analysis. The result shows the value of ECT is negative and significant indicated that there is long run causality between food security and its determinants.

Then, the diagnostic tests were conducted. These tests consist of the normality test (Jarque-Bera). In the Breusch-Godfrey Serial Correlation LM Test, we conclude that there is no evidence of autocorrelation problem in the model. And finally, in the heteroscedasticity test we conclude that there is no evidence of heteroscedasticity problem in the model. To conclude, we can say that the specification of the food security model does not represent statistical anomalies and the representation of this model is acceptable.

3.3. *Unit Root Test*

All the variables used in this food security model are tested for stationarity using unit root test. Testing of the stationarity of the time series ensures that the variables used in the analysis are not subjected to spurious correlation should be done before the estimation of the econometric model. The time series properties of the variables used in this study are the standard Augmented Dickey-Fuller (ADF) test.

The ADF test is given by:

$$Y_t = \alpha_1 + \alpha_2 Y_{t-1} + \mu_t \qquad t = 1,2,3\ \ldots\ldots \quad (3)$$

Where

Y_t = variable y at time t
Y_{t-1} = variable y at legged t

For convenient unit root testing, the equation is subtracted by Yt-1 and we have equation (4):

$$\Delta Y_t = \beta_t + \beta_2 \Delta Y_{t-1} + \varepsilon_t \qquad and\ \ \beta_2 = \rho - 1 \quad (4)$$

The hypothesis for unit root test is as following:

H_0: $\beta_2 = 0$; y_t is non-stationary
H_1: $\beta_2 < 0$; y_t is stationary

3.3.1. *Johansen co-integration test and long run equilibrium*

Johansen test is used to test for co-integration in times series. The purpose of this test is to examine the long run relationship between the dependant variable and explanatory variables in the food security model. This test is carried out when all of the variables appeared to be co-integrated at the same order. In this

study, the focus is to determine the long run relationship between food security and the determinant.

The Johansen tests are likelihood-ratio tests. There are two tests: (1) the maximum eigenvalue test, and (2) the trace test. For both test statistics, the initial Johansen test is a test of the null hypothesis of no co-integration against the alternative of co-integration. The test differs in terms of the alternative. The null hypothesis for the eigenvalue test is r = equals the number of co-integration vectors in the model, while the null hypothesis for trace test is r ≤ the number of co-integration vectors in the model. Similar to the unit root test, the number of co-integration vectors could be constant or include a trend term or both. This approach will later be used to examine the long run impact of the explanatory variables on food security.

3.4. *Vector Error Correction Model (VECM)*

The Vector Error Correction Model (VECM) technique is used when the variables in the Vector Autoregressive Models (VAR) are co-integrated. Granger representation theorem defined that when variables are co-integrated, there must also be an Error Correction Term (ECT) that describes the short run dynamics or adjustments of the co-integrated variables towards their equilibrium values. One period lagged co-integrating equation and the lagged first differences of the endogenous variables ECT consists in ECT. One can estimate ECT by using the Restricted Vector Autoregression (VAR) method. In particular, the Error Correction Model (ECM) can be constructed by expressing changes in the dependant variables as a function of the level of disequilibrium in the co-integrating relationship (captured by the ECT) as well as changes in other explanatory variables. This approach will show the speed of adjustment of the model in short run. Equation (5) shows the error correction model developed:

$$\Delta ln\ FPI = \alpha_0 + \alpha_1 \Delta ln\ INF_t + \alpha_2 \Delta ln\ LCER_t + \alpha_3 \Delta ln\ FIMP_t + \alpha_4 \Delta ln\ POP_t + \alpha_5 \Delta ln\ PRC_t + \alpha_6 \Delta ln\ TEMP_t + \alpha_7 ECT_{t-1}\ \delta_t \quad (5)$$

Where

ECT_{t-1} is the Error Correction term and δ are the random error term.

4. Results and Discussions

The results of ADF unit root test show that at level, t-statistic values for all the variables used in this study such as food production index (*lnFPI*), consumer prices (*lnINF*), land under cereal production (*lnLCER*), food imports *(lnFIMP*), total population (*lnPOP*), precipitation (*lnPRC*) and temperature (*lnTEM*) are not statistically significance. Then, null hypothesis of non-stationary cannot be rejected at any significant level indicates that all variables series are non-stationary at level and the series contain a unit root.

However, at first difference, t-statistic values are significant. So, the null hypothesis of non-stationary can be rejected indicates that all variables are stationary at first different. Therefore, the result means that all the series are integrated of order one, I (1). Since the variables in the model are I (1), the spurious regression problem occurs.

Since the variables in the model are I (1), the spurious regression problems occur. Thus, the following sections discuss the results of co-integration analysis. The discussion starts with the determination of the optimal lag length obtained based on the VAR lag order selection criteria. The results in the Table 2 show that the optimal lag length for co-integration is 1.

The Johansen co-integration test conducted since unit root test showed that all the variables are I (1) and stationary at same order. Johansen test is purposely used to see the long run relationship between two or more variables in the model. There are two co-integration tests conducted such as trace test and max-eigenvalue test and both tests used linear deterministic trend with restriction, the result is presented in Table 3.

The co-integration test results both based on Trace statistic and Max-eigenvalue indicates 2 co-integrating equations at the 5% level. Both results indicate that the variables are co-integrated each other and there is a long run significant relationship at the 1% level between food production index and explanatory variables (Table 4).

Table 1 - Unit root tests of stationarity.

Variable	*Level Intercept*	*Intercept & Trend*	*Level Intercept*	*First Difference Intercept & Trend*	*Results*
lnFPI	-0.607389 [2] (0.8506)	-5.923766 [0] (0.0003)***	-5.923766 [5] (0.0002)***	-5.497041 [5] (0.0016)***	I (1)
lnINF	-2.258717 [1] (0.1924)	-2.398042 [1] (0.3711)	-8.836484 [0] (0.0000)***	-9.022543 [0] (0.0000)***	I (1)
lnLCER	-4.919469 [0] (0.0006)	-4.812466 [0] (0.0038)	-7.230797 [0] (0.0000)***	-3.912758 [5] (0.0323)**	I (1)
lnFIMP	-3.451598 [0] (0.0185)**	-3.538415 [0] (0.0568)	-7.131453 [0] (0.0000)***	-4.762357 [1] (0.0048)***	I (1)
lnPOP	-0.868312 [4] (0.7778)	-4.639239 [5] (0.0076)	-4.737478 [5] (0.0015)***	-4.691917 [5] (0.0074)***	I (1)
lnPRC	-4.919469 [0] (0.0001)***	-5.573624 [0] (0.0007)***	-9.123293 [0] (0.0000)***	-9.009635 [5] (0.0000)***	I (1)
lnTEMP	0.551581 [0] (0.9851)	-0.797104 [0] (0.9525)	-1.818440 [1] (0.3630)	-3.962758 [0] (0.0422)**	I (1)

Notes:

**** Indicates the rejection of hypothesis null of non-stationary at 1 % of significant.*
*** Indicates the rejection of hypothesis null of non-stationary at 5 % of significant.*
** Indicates the rejection of hypothesis null of non-stationary at 10 % of significant.*
[ ] Indicates the lag specification. ( ) Indicates prob. value.

Table 2 - VAR lag order selection criteria.

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	98.81265	NA	1.52e-12	-7.345012	-7.003727	-7.250354
1	250.2652	205.9754*	4.94e-16*	-15.54121*	-12.81093*	-14.78395*

Notes:

** Indicates lag order selected by the criterion at 5% level of significant.*
LR: Sequential modified LR test statistic. - FPE: Final prediction error. - AIC: Akaike information criterion.
SC: Schwarz information criterion. - HQ: Hannan-Quinn information criterion.

Table 3 - Co-integration test results.

Hypothesized No. of CE(s)	*Trace Statistic*	*0.05 Critical Value*	*Max-Eigen Statistic*	*0.05 Critical Value*
None *	225.5030	125.6154	95.51207	46.23142
At most 1 *	129.9909	95.75366	62.51220	40.07757
At most 2	67.47874	69.81889	25.39003	33.87687

Notes:

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level.
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level.
** denotes rejection of the hypothesis at the 0.05 level.*

Table 4 - Results of co-integration equation.

Co-integration equation			*Log likelihood 280.1063*			
Normalized co-integrating coefficients (t-Student in parentheses)						
LFPI	LCPI	LLCER	LPOP	LFIMP	LPRC	LTEMP
1.000000	-3.463718	-3.030863	-14.15710	-13.87866	8.257720	-22.27614
	-4.5723***	-7.7876***	-5.3058***	-15.513***	12.224***	-2.896***

*Note: *** Significant at the 1% level.*

This relationship between these dependent and independent variables supports our hypothesis that food insecurity in Tunisia is a long-term problem and that some factors pose a threat to food security. It is therefore important to take corrective measures or adjustments to maintain and improve food security. Negative signs of some variables in the Table 4 are expected, such as: *INF* (inflation), *POP* (population), and *FIMP* (food import). And several works show these results (Warr, 2014) and (Amjath-Babu *et al.*, 2019).

The negative sign of the climatic variable, such as the temperature variable (TEMP), confirms that climate change will have adverse effects on food security due to the instability and decline in agricultural production of some crops important for food security, such as the cereals. While, the precipitation variable (PER) will have positive effects on agricultural production and productivity. These signs of long-term climatic variables do not differ from the results found in other research on the relationship between food security and climate change (Khee *et al.*, 2011; Alam *et al.*, 2011).

The negative sign of the variable of land under cereal production (*LCER*) is not expected as increasing cereal areas normally contribute to increase agricultural production and food security. But we can find explanations for the negative sign of the variable (*LCER*) in the classical theory of Ricardo land rent (Ricardo, 1815), which decreases because the extension extends to less fertile marginal lands or is already fully cultivated (Bidard, 2014). This variable also explains the negative sign of the population variable (*POP*), indeed, to feed a population it is necessary to extend on land even less fertile marginal lands, and the famous economist Malthus explains this question by the difference between the population with experiential growth and food supplies with arithmetic growth due to this decrease in land rent (Malthus, 1815).

Finally, we can deduce from the co-integration equation that food security is threatened in the long term and that the significant signs of the different variables of the model find these explanations in classical economic theory and the impacts of climate change.

Thus, it would be inappropriate to estimate a VAR model when the variables are co-integrated and expressed in first differences (Baffoe-Bonnie and Gyapong, 2012) because first differencing would lead to the loss of a significant portion of information related to the co-movement in the data. Rather than a VAR model, an error correction model is the appropriate model if the variables are co-integrated in first differences (Engle and Granger, 1987). According to Engle and Granger (1987), the co-integration relationship must have an ECM representation. The ECM essentially estimates the short run dynamics between the variables. The results of short run Error Correction Model for food security is presented in Table 5.

Based on the VECM result in the Table 5, an error correction term exists in this analysis. Since the coefficient value of this error correction term is more than one (ECTt-1> 1), it indicates that the short run deviation goes on rapid paths to equilibrium in the long run. Otherwise, if the coefficient value in this error correction term is less

Table 5 - Results for estimated Vector Error Correction Model (VCEM).

Variables	*Coefficient*	*t-statistic*	*Prob.*
Constant	-0.013713	-0.141989	0.8891
Δ In FPI_{t-1}	0.184697	0.707512	0.4909
Δ In CPI_{t-1}	**-1.841640**	**-2.954334**	**0.0084*****
Δ In $LCER_{t-1}$	**0.534739**	**1.826115**	**0.0492****
Δ In $FIMP_{t-1}$	**-1.751335**	**-2.073653**	**0.0323****
Δ In POP_{t-1}	3.193411	0.410372	0.6877
Δ In PRC_{t-1}	0.164230	0.989621	0.9792
Δ In $TEMP_{t-1}$	-2.070064	-1.075262	0.3004
FPI_{t-1}	**-0.785176**	**-3.497616**	**0.0036*****
R-squared	0.745817		
F-statistic	4.564281		
Prob(F-statistic)	0.005803		

*Notes: *** Significant at the 1% level; ** Significant at the 5% level.*

than one (ECTt-1< 1), it indicates that the error correction term slowly adjust back to equilibrium in the long run. The results presented show that the ECTt-1 coefficient is negative and significant at 1% significant level implying that the series cannot drift too far apart and convergence is achieved at the long run. The estimated coefficient of the error correction term was -0.785176 indicates that the speed of adjustment is around 78% at 1% significant level. It means that the adjustment process of the disequilibrium is a bit slowly; it is about 78% in one year (annually data). Therefore, the representative variables of food security in Tunisia show an overall significance of 74% at a confidence level of 1% in the Table 5 (R-squared =0.745817; Prob (F-statistic) =0.005803).

The results also show the existence of significant short-term relationships between food security through proxy food production and explanatory variables. We note that the variable of land under cereal production (*LCER*) is the only significant positive variable in the short term. This variable positively affects food production in the short term. A 1% increase in $\Delta lnLCER_{t-1}$ will result in $\Delta logFPI_{t-1}$ expansion of 0.534739%. In terms of significant level, $\Delta lnLCER_{t-1}$ is statistically significant at a confidence level of 5%.

This result confirms again the Ricardo hypothesis and also the concept of decreasing marginal productivity of the land. Indeed, it can be deduced that the intensification on land under cereal production (*LCER*) in Tunisia is increasing but the agricultural productivity could be decreasing in the long term. The change of sign of this variable between the short and long term draws the attention for policy makers in agriculture to seek a strategy of preservation of the land under cereal production and improvement of their fertility especially with the context of climate change.

On the other hand, the other variables showed a significantly negative relationship in the short

term. It is noted that the inflation variable (*INF*) has a negative impact on food security. A 1% increase in $\Delta lnINF_{t-1}$ will result in $\Delta lnFPI_{t-1}$ expansion of 0.534739%. In terms of significant level, $\Delta lnLCER_{t-1}$ is statistically significant at a confidence level of 1%. This result asserts that inflation is a factor in the deterioration of purchasing power and consumer basket, and its effects will be passed on to agricultural production since demand is low because of rising food prices and high inflation. The Tunisian citizen is in difficulty to provide his staple food and food security will be threatened. The result also confirms the current situation after revolution, especially the period between 2014 and 2017, when the inflation rate reached 6%. The adverse effects of inflation on food security in the short term require regulatory and price control measures and channel the agri-food chain for some staple crops to food.

The second variable is the food imports variable, which has a significant negative effect in the short term. A 1% increase in $\Delta lnFIMP_{t-1}$ will result in $\Delta logFPI_{t-1}$ expansion of 0.534739%. In terms of significant level, $\Delta lnFIMP_{t-1}$ is statistically significant at a confidence level of 1%. This result shows that food imports are a disincentive for domestic production and also a factor in increasing the cost of production and also in the price of certain food products. Importation is also a source of depreciation of the national currency (Tunisian dinars) and the deterioration of the purchasing power of Tunisians. Therefore, food security requires slowing down the pace of feed imports and encouraging domestic production through incentive and subsidy strategies. Food security requires investment in new technologies to increase agricultural productivity but without compromising the intensive degradation of natural water and soil resources.

In addition to the relevant findings on the determinants of food security, the validation of the applied VCEM model shows the absence of any statistical anomalies for the series of variables chosen according, so the model is statically good and the choice of variable is statistically acceptable and relevant in terms of results and interpretations.

5. Conclusions and Recommendations

Food security in Tunisia is a major issue of great importance for the daily life of Tunisians, especially citizens who have an average income. This problem will worsen with the context of climate change in future years.

The purpose of this study is to determine the influence of certain variables on the food security model of Tunisia. Many variables can play a role for food security in the country. The variables selected for the analysis concerned inflation, population, land under cereals, food imports and the climate variable via precipitation and temperature. These six independent variables have been tested to determine their effect on Tunisia food security model. This study uses time series data from 1991 to 2017.

The result shows that three variables such as inflation, land under cereals and food imports are significant in the short term. Others variables such as climate change and population are neither significant nor important to explain Tunisia's food security in the short term. All variables are significant in the long run at the 1% level. The result also shows that the TCE-1 coefficient is negative and significant at the 1% level, which implies that the series can not deviate too much and convergence is obtained in the long term. The estimated coefficient of the error correction term was 0.78 indicates that the speed of adjustment is about 78% to 1% significant level. This means that the imbalance adjustment process is about 78% in one year.

Based on the results of the study, several recommendations can be made concerning the signs of variables in the equation of long-term and short-term estimates. Indeed, the change in the sign between the short and long term of the variable land under cereals shows that a decline in soil fertility and land rent is decreasing with the context of climate change in accordance with Ricardo's theory. The positive sign of the variable precipitation shows the importance of this variable in food production and also confirms the impact of climate variables on the stability of food security evoked by other research on this issue (Barnett, Adger, 2007; Barrios *et al.*, 2008). Other significant variables having signif-

icant negative effects are short-term and long-term food production such as inflation and food imports. On one hand, other variables such as temperature and population have negative effects in the long term. Thus, it can be deduced from these results that the need to develop long-term conservation measures and strategies for natural resources, especially land cultivated in Tunisia, to improve its fertility. These measures must also be accompanied by policies to adapt to the climate change context in future years. Political measures are necessary in the short term, such as the adoption of a monetary policy to control inflation through the implementation of price control and monitoring instruments throughout the agro-food chain. These measures must also be accompanied by policies to adapt to the climate change context in future years. Political measures are necessary in the short term, such as the adoption of a monetary policy to control inflation through the implementation of price control and monitoring instruments throughout the agro-food chain. A political strategy integrating control instruments for informal trade which helps to control the increase in prices of basic foodstuffs to maintain the balance between supply and demand without shortage of these goods sometimes on the internal market. In terms of opening the Tunisian economy to the outside world, the return to a strategy aimed at reducing food imports to encourage national production by granting specific subsidies to Tunisian farmers in disadvantaged regions for the cultivation of their agricultural land. Encouraging Tunisian agriculture can also be a source of job creation for young specialized graduates to modernize agriculture using the appropriate new technology and contribute to food security in Tunisia in the medium and long term.

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Natural resources revenues, agriculture development and urbanization in African countries

Evidence from a static and dynamic panel data

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Abstract

This paper analyzes the mechanism through which natural resource abundance leads to a poor agricultural performance and a rapid urbanization in African countries. We conducted a static and dynamic panel data analysis for a panel of 39 African countries during the period 2000-2013. Our findings show that natural resources rents have a negative impact on agricultural performance and a positive impact on food import dependency. In addition, the results show a significant positive impact of resource rents on rural-urban migration and on urbanization rate. We argue that these findings can be explained by the government choice to specialize in primary commodities to the detriment of the development of other productive sectors, especially agriculture. Because policy makers tend to invest resources rents in developing infrastructures, mostly in cities, this inevitably creates some pulling factors for rural population in search of a better life. Consequently, we observe a rapid urbanization associated with serious problems (expansion of urban slums, limited access to improved water and sanitations facilities) in many African countries, highly dependent on natural resource rents.

Keywords*: Natural resources curse, Agriculture, Urbanization, Panel data, GMM.*

1. Introduction

The possession of natural resources such as oil, natural gas, diamonds or other mineral deposits does not necessarily lead to economic growth. Many African countries such as Nigeria, Angola, Sudan, Algeria and Congo are classified as resource-rich countries with non-significant economic development, less democracy, a low per capita income and poor living standards. Richard Auty (1986) is apparently the first one who used the term "natural resources curse" to describe this puzzling phenomenon. Empirically, the most popular study by Sachs and Warner (1995) found a strong correlation between natural resources abundance and poor economic growth. Since then, abundant literature has evaluated the effects of natural resources on a wide range of economic, institutional and political performance indicators, and offered a variety of theories and explanations to this complicated

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phenomenon. The purpose of this study is to propose new possible explications for the resource curse in African countries. The study seeks to answer the following questions: first, can oil and mineral resources abundance explain the agricultural poor performance? Second, is there a relationship between natural resources abundance and urbanization trends? Two main hypotheses are tested. The first one suggests that the abundance of oil and mineral resources allows policy makers to specialize in primary commodities and prevents the development of other productive sectors, especially agriculture. This would have a negative consequence on agricultural production, rural employment, food security and would therefore lead to an acceleration of rural-urban migration. The relation between resource revenues (i.e. export oil) and food security was tested in the literature. For instance, Djella *et al.* (2019) test the extent to which, in six countries within the Africa and Middle East areas, gas resources richness (oil-export) contribute to the food dependency in terms of food import and to the food insecurity (undernourishment). Using OLS and quantile regression, the authors shows the sizable and statistically significant impact of oil export on food import and undernourishment. The second hypothesis suggests that oil and mining revenues are mostly spent in cities in order to improve living conditions (housing, water, electricity, health, education, etc.). In general, this could have a positive effect on economic growth. However, the urbanization trend is accelerated by the migration of a rural population looking for jobs and a better life. This may explain the current situation of major African cities with considerable urban problems (slums, pollution, crime, overcrowding, informal sector, etc.). At this point, we note that the available empirical studies show no clear effect of urbanization on growth. The causal relationship between economic growth and urbanization remains unclear, according to the 2010 UN-HABITAT's report.[1]

This study differs from others on three points. First, we use the same framework to present two explanations (or channels) for the natural resources curse in African countries. We link natural resources abundance to the poor agricultural performance and the current urbanization situation. Second, our findings are derived from an empirical analysis based on a panel of 39 African countries. Therefore, the results can provide a global picture of the resource curse for the whole continent. Third, we conduct both static and dynamic panel regression models. The static specification allows the estimation of a country-specific effect while the dynamic specification captures the second round' effects and reduces the effects of unobserved or missing variables. This help us to better capture the complexity of the resource curse paradox.

The rest of the paper is organized as follows. Section 2 presents the literature review related to natural resources curse channels in Africa and the most used proxies for natural resources abundance or dependency measures. The analytical framework is introduced in Section 3. The next section displays a description of the selected variables, data sources and some statistical evidences. We discuss our empirical investigation in Section 5. Finally, we make concluding remarks in Section 6.

2. Review of natural resources curse explanations in Africa

The resource curse is a paradoxical phenomenon observed in countries with abundant natural resources, specifically non-renewable resources like oil and minerals tend not to perform as well economically as those without. The Sub Saharan Africa (SSA) region has become a classic case of the resource curse in the literature. Many countries in the region like the Democratic Republic of Congo (DRC), Chad, Mali, Liberia, Sierra Leone, Sudan and several others, are rich in natural resources, notably oil, minerals and precious metals, but are still classified as low-income economies. Only one country, Botswana has succeeded in becoming an upper middle-income country using its natural resources and has escaped the Resource Curse (Englebert, 2002; Sarraf and Jimanji, 2001; Iimi, 2006).

[1] UN-HABITAT's report, *Urban Trends: Urbanization and Economic Growth* (2010).

How could resources abundance be a curse? What could be the mechanism for this counter-intuitive relationship?

The literature proposes several theories to explain this phenomenon. Several authors (e.g. Frankel, 2010; Van der Ploeg, 2011; Torres *et al.*, 2013; Badeeb *et al.*, 2017) have conducted a very thorough literature review and summarized potential mechanisms for the resource curse. Broadly speaking, there are at least four lines of arguments: *Dutch Disease, volatility in commodity prices, rent seeking/corruption and institutional quality*. The first explanation based on the Dutch Disease suggests that the resource curse might occur when a boom in the resource sector causes a persistent appreciation of the real exchange rate and inflation. This appreciation makes non-resource commodities exports more expensive and imports cheaper and leads to a trade balance deficit in the short term. In the medium and long terms, this situation can create barriers to investments in non-resource tradable sectors and consequently curbs development (Sachs and Warner, 1995; 1997; 2001; Gylfason, 2001a; Papyrakis and Gerlagh, 2004). This negative effect is commonly called the "spending effect". In addition, the natural resources sector attracts capital and labor from other parts of the economy. As a result, the input production costs of other traditional export sectors such as manufacturing and agriculture increase. This resource reallocation is usually denominated "indirect-deindustrialization" (Corden and Neary, 1982; Corden, 1984) or "resource pull effect" (Humphreys *et al.*, 2007). For African countries, both effects are reflected in the decline of the agriculture sector. Other explanations for the resource curse, often cited in the literature as symptoms of the Dutch Disease, are related to the disincentive for entrepreneurship (Sachs and Warner, 2001), the decrease in savings and physical investment (e.g., Gylfason, 2001a; Papyrakis and Gerlagh, 2007) and lower investment in education and human capital (e.g., Gylfason, 2001b; Birdsall *et al.*, 2001; Bravo-Ortega and Gregorio, 2005). This might explain why one out of three young people in SSA region fail to complete primary school and need alternative pathways to acquire basic skills for employment (UNESCO, 2012).[2]

The second explanation suggests that the resource curse may operate because oil and mineral commodity prices are more volatile than the prices of other manufactured products. *Volatility* increases uncertainty in government revenues, and makes it difficult to conduct effective planning and therefore reduces economic growth (Davis and Tilton, 2005). This situation also explains the debt crisis observed in resource-rich countries during the 1980's (Van der Ploeg, 2011). In order to ensure debt repayment and economic restructuring, the IMF and the WB created the so-called Structural Adjustment Policies (SAPs) for a majority of African countries. Poor countries were forced to reduce spending on health, education and infrastructure, while debt repayment and budget balance became the priority.

The third explanation associates the resource curse with rent seeking behaviors and corruption (Auty 2001). According to Collier and Hoeffler (2005), *rent-seeking* occurs when "individuals or firms compete to obtain economic rents that arise when government restrictions are imposed" while *corruption* is defined, according to Kaufmann and Vicente (2011), as the abuse of public or private office, position, or power for private gain in contravention of established rules or norms. These two economic challenges are the principal reasons for underdevelopment in many African regimes (Coolidge and Rose-Ackerman 1999). In addition, Ross (2001) concludes that oil abundance hampers *democracy*. More recently, Arezki and Gylfason (2013) examined the impact of the interaction between resource rents and democracy and corruption for a panel of African economies. They found that large resource rents lead to more corruption, but that the effect is lower for more democratic countries. Finally, the literature shows evidence of

[2] The tenth Education for All Global Monitoring Report, UNESCO (2012).

the negative impact of resources abundance and the *quality of institutions*. For example, Mehlum *et al.* (2006) have demonstrated, using regression analysis that the resource curse is strongly present in countries with weak institutions but is barely present in countries with strong institutions. Other authors like Isham *et al.* (2005), Bulte *et al.* (2005), Robinson *et al.* (2006) and Collier (2010) conclude that natural resources abundance is a cause of poor institutional quality.

2.1. *Resource curse studies using panel data*

In order to test the resource curse for a panel of countries, the literature proposes different methodologies. Some authors use cross-sectional analysis while others use panel data analysis. In cross-sectional analysis, an equation is estimated for a number of countries at a specific point of time. The estimation does not incorporate any temporal dynamics. This method has been used by several authors (see Table 1). In this case, two problems can rise. The first one may stem from a potential endogeneity of resources abundance proxies with growth variables. The second lies in the control of all country-specific effects. In addition, cross-section estimation is more sensitive to omitted variables that may reflect country specific characteristics. Panel data seem to be a solution for these problems. Compared to cross-sectional data, the advantages of panel data lie in using information for both temporal and individual dimensions and it is possible to estimate the country-specific effects. This would reduce the effect of unobserved or omitted variables bias (see Manzano and Rigobon 2001 for comments and justification).

Regarding the results of cross sectional and panel data analysis, a relationship between resources abundance and economic growth might differ. Some authors find evidence of the resource curse while others do not. Based on Torres *et al.* (2013) and Zagozina (2014) surveys and several other studies, Table 1 summarizes recent cross sectional and panel studies on the resource curse and their main findings. The major outcomes presented in the table reflect the importance of choosing relevant resource abundance proxies. In the following section, we discuss different proxies used in the literature to measure this concept.

2.2. *Measures for non-renewable resource abundance*

The literature proposes a number of natural resources abundance or dependency proxies. There are at least four measures for natural resources abundance mostly used by authors (see Table 1): (i) Ratio of natural resources exports to gross domestic product (GDP), (ii) Share of natural resources exports in total exports, (iii) Ratio of mineral production to gross national product (GNP), and (iv) Rents from natural resources over GDP or per capita. Other proxies are used in the literature. For instance, Stijns (2005) measures natural resources abundance by the present value of mineral reserves and finds no correlation between this variable and economic growth. Lederman and Maloney (2008) use the Leamer index (natural resources net exports/labor force) and find no significant impact with respect to GDP per capita growth.

In this study, we use non-renewable resources rents to GDP, which we note "*Rent*", as a measure of natural resources abundance. We use GDP as a denominator to take into account the country size. As we hope to evaluate the impact of resource rent on agricultural performance, we include only minerals, oil and gas rents and exclude forestry and other agricultural resources rents to deal with a possible endogeneity problem. According to the World Bank, the rent for a given commodity is calculated as the difference between the price of this commodity and it average cost of production. The unit rent is multiplied by the physical quantity extracted and expressed as a share of GDP. The choice of this measure is justified by two reasons. First, the use of production or exports of natural resources tend to overestimate the abundance or dependence as no deduction of production cost is made. Second, there are data availability and homogeneity problems for all selected countries.

Table 1 - Summary of selected panel and cross-sectional studies and different Natural Resources (NR) proxies.

Reference	*NR proxy*	*Panel*	*Cross-sectional*	*Main findings*
Sachs and Warner (1995)	NR exports over GDP	No	Yes	Negative relationship between natural resources and growth.
Manzono and Rigobon (2006)	NR exports over GDP	Yes	No	No effect or positive effect once fixed effects are introduced into a model.
Arezki and Van der Ploeg (2011)	NR exports over GDP	No	Yes	Negative relationship between natural resources and income per capita, especially in countries with bad rule of law or bad policies.
Boschini *et al*. (2013)	NR exports over GDP	Yes	Yes	The interaction of ores and metals rents with institutional quality has a negative effect on growth.
Leite and Weidmann (1999)	NR exports over GNP	No	Yes	Natural resources abundance creates opportunities for rent-seeking behaviors and it is an important factor in determining a country's level of corruption.
Davis (1995)	NR exports over total exports	No	Yes	Resource abundance have a positive relationship with economic development.
Dietz *et al.* (2007)	NR exports over total exports	Yes	No	Resource abundance has a negative effect on genuine saving.
Beck (2011)	NR exports over total exports	No	Yes	The paper tested for the existence of a natural resources curse in financial system development. The finance and growth relationship seems as important for resource-based economies as it is for other economies, so that underinvestment in the financial sector will have long-term negative repercussions for economic growth.
Daniele (2011)	NR exports over total exports	Yes	No	Human development is negatively correlated with natural resources dependence, but positively correlated with resource abundance. These effects are particularly significant in countries with comparatively lower institutional quality.
Barajas *et al.* (2013)	NR exports over total exports	Yes	No	The beneficial effect of financial deepening on economic growth is smaller in oil exporting countries.
Papyrakis and Geragh (2003)	NR production over GDP	Yes	No	Natural resources have a negative impact on growth when considered in isolation, but a positive impact on growth when include in the analysis with other variables such as corruption, investments, openness, terms of trade, and schooling, and treating these variables as independent.

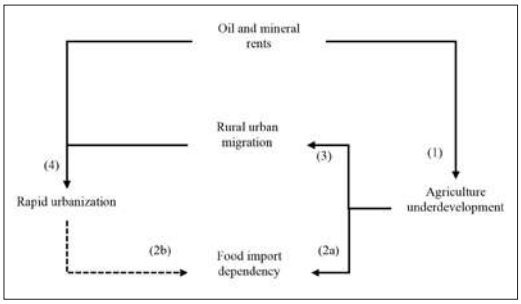
Reference	*NR proxy*	*Panel*	*Cross-sectional*	*Main findings*
Brunnschweiler (2008)	NR production over GDP	No	Yes	A positive relationship between natural resources abundance and economic growth.
Collier and Hoeffler (2009)	NR rents over GDP	Yes	No	Natural resources abundance considerably increases the potential of violent civil conflict.
Ross (2001)	NR rents over GDP	Yes	No	Oil exports are strongly associated with authoritarian rule; that this effect is not limited to the Middle East; and that other types of mineral exports have a similar antidemocratic effect, while other types of commodity exports (agricultural commodities) do not.
Auty (2001)	NR rents over GDP	Yes	No	The presence of abundant natural resources (especially minerals) leads to rent-seeking behavior and corruption, thereby decreasing the quality of governance, which in turn negatively affects economic performance.
Bhattacharyya and Collier (2013)	NR rents over GDP	Yes	No	Resource rents significantly reduce the public capital stock. The adverse effect on public capital is mitigated by good institutions. The depletion of non-renewable (mineral) resources reduces the public capital stock whereas rents from sustainable sources (forestry and agriculture) do not.
Bhattacharyya and Hodler (2010)	NR rents per capita	Yes	No	The relationship between resource rents and corruption depends on the quality of the democratic institutions.

3. Empirical models

3.1. *Identification*

The objective of our empirical study is to evaluate the impact of non-renewable resources abundance on the development of agriculture and urbanization in a sample of African countries. We seek to verify two main hypotheses. The first (H1) suggests that oil and mineral rents can lead to the underdevelopment of the agriculture sector in resource-rich African countries (relation (1) Figure 1). The second (H2) indicates that oil and mineral rents are mostly invested in cities to develop infrastructure and services which, in turn, can attract more people and lead to an acceleration of urbanization (relation (4)). We suppose that the link between the two hypotheses is that poor performance of agriculture exposes the countries to two main problems. First, an increase in rural-urban migration (3) since more than 2/3 of Sub-Saharan African people work in the agricultural sector according to the World Bank estimations. The second problem is the food security. Indeed, faced with the inability of the agricultural sector to satisfy food needs locally, countries cover their deficits

Figure 1 - Oil and mineral rents and its relations with agriculture and urbanization.



through imports (2a). Indirectly, food imports become more attractive for governments in order to feed growing urban populations rather than investing in agriculture[3] (2b).

Empirically, to test these hypotheses, we use a multiplicative interaction regression model. The advantage of a multiplicative interaction model compared to an additive interaction model resides in the fact that the coefficients in an additive model describe the effects of each independent variable on the dependent variable as constant (*Ceteris Paribus*), regardless of the level of the other independent variables; whereas the coefficients in an interactive model assume that the effects of each independent variable on the dependent variable are varying, depending on the level of the other independent variable. In our case, the interactive model enables us to adequately evaluate the impact of agricultural performance on rural-urban migration, food imports dependency and the urbanization rate in African countries conditional to their dependence level on natural resources revenues.

We test these hypotheses, using the following models with interaction effects:

$$Agri_{it} = \beta_0^1 + \beta_1^1 Rent_{it} + \sum_{j=3}^{p} \beta_j^1 Controls_{j,it} + \varepsilon_{it}^1 \quad (1)$$

$$Food\_M\_Dep_{it} = \beta_0^2 + \beta_1^2 Agri_{it} + \beta_2^2 \boldsymbol{Agri_{it} * Rent_{it}} + \sum_{j=3}^{p} \beta_j^2 Controls_{j,it} + \varepsilon_{it}^2 \quad (2a)$$

$$Food\_M\_Dep_{it} = \beta_0^3 + \beta_1^3 Urban_{it} + \beta_2^3 \boldsymbol{Urban_{it} * Rent_{it}} + \sum_{j=3}^{p} \beta_j^3 Controls_{j,it} + \varepsilon_{it}^3 \quad (2b)$$

$$Migration_{it} = \beta_0^4 + \beta_1^4 Agri_{it} + \beta_2^4 \boldsymbol{Agri_{it} * Rent_{it}} + \sum_{j=3}^{p} \beta_j^4 Controls_{j,it} + \varepsilon_{it}^4 \quad (3)$$

$$Urban_{it} = \beta_0^5 + \beta_1^5 \boldsymbol{Rent_{it}} + \beta_2^5 \boldsymbol{Agri_{it} * Rent_{it}} + \sum_{j=3}^{p} \beta_j^5 Controls_{j,it} + \varepsilon_{it}^5 \quad (4)$$

The dependent variables are: $Agri_{it}$ agricultural value added per capita used as a measure of sectorial performance for country i at time t; $Food\_M\_Dept_{it}$ food imports dependency measured by the share of food consumption covered by imports; $Migration_{it}$ rural-urban migration. Ideally, a rural-urban migration estimate can be obtained from a direct survey that gives information on the type of previous residence. This is not the case for Africans countries for which no data are available. Therefore, we opted for an indirect estimation. We assume that the natural population growth (births-deaths) in both urban and rural areas has remained unchanged during the last fifteen years (estimation period) and we assume that the proportion of international migration remain stable. Under these assumptions, we can use simply the ratio of urban population to rural population as a proxy of rural-urban migration. A rise of this ratio would be a result of population movements from rural to urban areas; and $Urban_{it}$ is the ratio of urban population out of the total population.

The explanatory variable of interest is $Rent_{it}$ which is the non-renewable resources abundance measured by the ratio of oil and mineral rents to GDP.

$Controls_{j,it}$ is a set of other explanatory variables that affect the corresponding dependent variable. Theses variables include: $yield_{it}$ which is grain yield as a proxy for agricultural productivity; $land_{it}$ is arable land in percent of total area; $Rural_{it}$ is the percentage of rural population used as a proxy for labor availability. This approximation is justified because African agriculture is characterized by a high percentage of small family farms, where each member of the family has a role to play; $demo_{it}$ is population growth; $Income_{it}$ is the gross domestic product (GDP) per capita measured in constant 2005 US dollars and $Rural\_income_{it}$ is the ratio of agricultural GDP measured in constant 2005 US dollars to rural population and used as a proxy for per capita income in rural area.

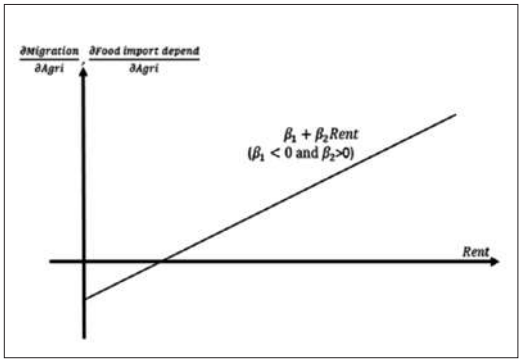
[3] World Bank and IMF structural adjustment programs supported this policy by eliminating government support for agriculture and poor farmers.

3.2. *Expected results*

Equation (1) measures the direct impact of oil and mineral rents on agricultural performance. We test the null hypothesis that resource abundance has no significant effect on agricultural performance (H_0:β_1=0) against the alternative hypothesis that resource abundance negatively affects agricultural performance (H_1:β_1<0). The other explanatory variables are referred to productivity and inputs[4] (land and labor). These variables are: $yield_{it}$, $land_{it}$ and $Rural_{it}$. We expect positive coefficients for these three variables.

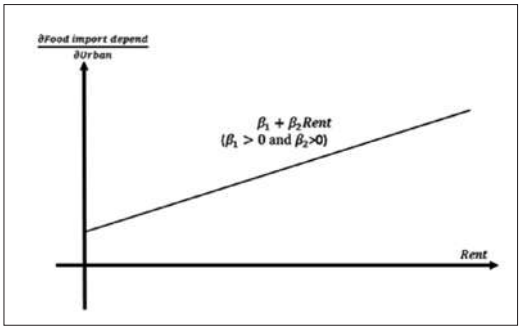
Equation (2a) evaluates the impact of agricultural performance on food import dependency conditional to oil and mineral rents. We expect $\beta_1 < 0$ and $\beta_2 > 0$ (Figure 2).

Figure 2 - Impact of agriculture performance on rural-urban migration and food import dependency depending on oil and mineral rents level.



Equation (2b) evaluates the impact of urbanization dynamics on food imports dependency conditional to oil and mineral rents. Since we suppose that food imports become more attractive for decision makers in resource-rich countries in order to feed growing urban population rather than investing in agriculture, we expect a positive effect of urbanization on food imports dependency. Then, the coefficients β_1 and β_2 in equation (2b) should be positive (Figure 3).

Figure 3 - Impact of urbanization on food import dependency depending on oil and mineral rents level.



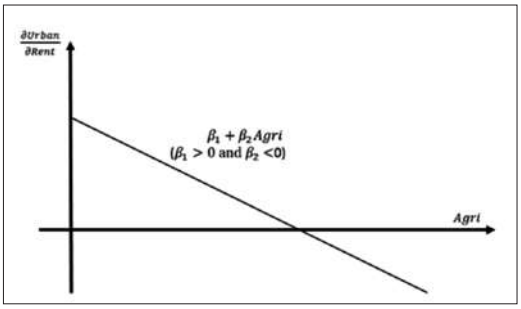
For both equations (2a) and (2b), we use two additional explanatory variables. First, population growth ($demo_{it}$). Intuitively, more population means more food needs. The sign and significance of the coefficient associated with this variable depend on the capacity of agricultural sector to satisfy additional needs. A significant positive coefficient would reflect that the additional food requirements are covered by imports. The second tested variable is $Income_{it}$ which we expect to have a positive coefficient. In Africa, this phenomenon is very visible in cities where urban population – with a higher income level than in rural areas – is heavily dependent on imported wheat and rice (Tchamda *et al.*, 2015).

Equation (3) measures the impact of agricultural performance on rural-urban migration conditional to oil and mineral rents. As illustrated in Figure 2, we expect that a marginal increase of agricultural performance to be associated with a decrease in rural-urban migration when a country is none or lowly dependent on oil and mineral rents (β_1<0). The effect becomes positive when the dependence of oil and mineral rents exceeds a given threshold (β_2<0). Therefore, the marginal increase in agricultural performance will be associated with an increase in migration. We use as control variables: population growth ($demo_{it}$) to capture the structural changes (its effect should be positive), and $Rural\_income_{it}$ which hopefully will have a negative and significant effect.

[4] We explicitly ignore other inputs because Africa's agriculture uses minimal levels of fertilizers, pesticides and infrastructure facilities such as irrigation equipments, machinery, transport and communication.

Finally, equation (4) tests both the direct effect of oil and mineral rents and the effect conditional to agricultural performance on urbanization dynamics. As shown in Figure 4, the coefficient β_1 captures the effect of an increase in oil and mineral rents on the urbanization rate when agricultural performance is absent.

Figure 4: Impact of oil and mineral rents on urbanization depending on agriculture performance.



Since our hypothesis suggests that oil and mineral rents lead to an acceleration of urbanization, we expect to find a positive sign for β_1. For countries with good agricultural performance, we suppose that the urbanization rate grows at a slower rate because of low rural-urban migration. Then, the effect of resources rents on urbanization conditional to agricultural performance should be negative ($\beta_2 < 0$).

3.3. *Estimation strategy*

We first estimate a static panel data model to control for the country-specific effects. Secondly, we estimate a dynamic panel data model to deal with missing variables effects.

3.3.1. *The Static Panel Data Estimations*

We start by estimating a static panel data model spelled as follows (equation 5).

$$y_{it} = \beta' X_{it} + \alpha_1 + c + v_{it,} \quad i = 1,\ldots,N(country); t = 1,\ldots,T(time) \tag{5}$$

where y_{it} is the observed dependent variable for country i at time t, x_{it} are regressors, β the parameter vector to be estimated, c the constant term and v_{it} the residual disturbance term with zero mean, constant variance, and supposed to be uncorrelated across time and individuals. The α_i terms represent the country-specific effects and capture the unobserved heterogeneity in the model.

We first test for the presence of panel heterogeneity using the redundant fixed effect test. The null hypothesis of the redundant fixed effect is that the pooled regression model is more appropriate ($H_0: \alpha_1 = \ldots = \alpha_N = \alpha$), with the alternative hypothesis being that the fixed effect model is preferable. Then, we test both fixed and random effects models. The fixed effects model involves estimating a parameter (α_i) for each country, in our case the 39 selected countries. The random effects model assumes that country-specific terms (α_i) are randomly distributed. In this case, we do not need to estimate a parameter for each country and this can be considerable as an efficiency gain. However, the random effects estimator will be inconsistent due to the presence of correlation between the country-specific effects and one or more independent variables (Baltagi, 1995). We test for random effects estimator consistency in our analysis below by conducting a standard Hausman test. A significant value for the Hausman test statistic would mean that the random effects estimators are inconsistent and that fixed effects estimates are more appropriate. We can easily estimate these models by using standard methods (Least Squares Dummy Variables or LSDV) for fixed effects model and Generalized Least Squares (GLS) for random effects model or Ordinary Least Squares (OLS) for both, if we can assume heteroskedastic disturbances.

3.3.2. *The Dynamic Panel Data Estimations*

In addition to the static approach, we also test for dynamic effects in the models. A dynamic approach may be particularly relevant to evaluate the influence of natural resources rents on agricultural development and urbanization trends. Dynamic panel data models use the lags of the dependent variable as explanatory variables (see equation 6).

$$y_{it} = \gamma y_{it-1} + \beta' X_{it} + \alpha_1 + c + v_{it,} \quad i = 1,\ldots,N; t = 1,\ldots,T \tag{6}$$

It is evident that the model suffers from an endogeneity problem, because y_{ti-1} is correlated with α_i. In this case, the standard estimators (GLS and OLS) would be inappropriate. To solve this problem, we use the Generalized Method of Moments (GMM) approach proposed by Arellano and Bond (1991). We start by transforming the equation into first differences to eliminate the bias arising from individual heterogeneity (equation 7) and then we estimate the transformed equation through the GMM method using lagged values of the endogenous variables as instruments.

$$\Delta y_{it} = \gamma \Delta y_{it-1} + \beta' \Delta X_{it} + \Delta v_{it}, \quad i = 1, \ldots, N; t = 1, \ldots, T \tag{7}$$

The consistency of the GMM estimator depends on the validity of the assumption that the error terms do not exhibit serial correlation and on the validity of the instruments. To address these issues, we use two specification tests suggested by Arellano and Bond (1991) and Sargan (1958). The first one, commonly called "m-test" examines the presence of serial correlation in error terms. As, we run the test on the differenced equation, we only report the test for second-order serial correlation. The second one, commonly called "J-test" of over-identifying restrictions, regresses the residuals from a GMM regression on all instruments and test if all instruments are uncorrelated with the error term. For both tests, we should not reject the null hypothesis to confirm the consistency of the GMM estimators. We note that Arellano and Bond (1991) compared, using simulations, the performance of GMM, OLS, and Within-Group (WG) estimators and they found that GMM estimators exhibit the smallest bias and variance.

4. Data and statistical analysis

4.1. *Data description and sources*

The data are gathered from the World Bank (World Development Indicators), the Food and Agriculture Organization of the United Nations (FAO) and the World Urbanization Prospects and Millennium Development Goals (United Nations). All these sources are characterized by considerable lack of data, forcing us to make an arbitrage concerning the number of countries in the sample, the number of variables to include in the equations and the estimation period. In fact, according to the United Nations, the total number of African countries is 54. Out of this group, 15 countries were excluded due to missing data, both on the dependent and the control variables. We assume that the resulting panel of countries is not endogenous. The estimation is based on annual data span from 2000 to 2013. The selected variables are summarized in Table 2 and the list of selected countries is presented in Table 3.

Table 2 - Data description and sources.

Variable	*Abbreviation*	*Description*	*Source*
Oil and mineral rents dependency indicator	*Rent*	We include the sum of oil rents, natural gas rents, coal rents (hard and soft) and mineral rents. According to the World Bank, the estimates of a resource rents are calculated as the difference between the price of a commodity and its average cost of production. This is done by estimating the world price of units of specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs (including a normal return on capital). These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP).	Estimates based on sources and methods described in *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (World Bank, 2011).

→

Variable	*Abbreviation*	*Description*	*Source*
Agriculture performance	*Agri*	Agriculture value added (VA) divided by total population. Agriculture VA is the net output of agriculture sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.	World Bank national accounts data, and OECD National Accounts data files.
Cereal yield	*yield*	Cereal yield, measured as kilograms per hectare of harvested land, includes wheat, rice, maize, barley, sorghum and others grains.	FAO
Arable land	*land*	Arable land as defined by the FAO measured as a % of total land area.	FAO
Rural population	*Rural*	Rural population refers to people living in rural areas as defined by national statistical offices. It is calculated as % of total population.	World Bank estimates based on United Nations, World Urbanization Prospects.
Food import dependency	*Food_M_Dep*	Share of food imports in total food consumption. Total food consumption is derived from a Demand/Supply equilibrium equation.	World Bank estimates from the Comtrade database, United Nations Statistics Division.
Population growth	*demo*	Annual population growth rate.	World Bank from United Nations Population Division, World Population Prospects.
Prosperity indicator	*Income*	GDP converted to 2005 constant international dollars using Purchasing power parity (PPP) rates divided by total population.	World Bank, WDI
Rural area standard of living indicator	*Rural_income*	Agriculture value Added expressed in constant 2005 US$ and divided by rural population.	World Bank, WDI
Urban population	*Urban*	Share of people living in urban areas as defined by national statistical offices on total population.	United Nations, World Urbanization Prospects.

Table 3 - List of the selected countries.

n°	*Country*	*Rent to GDP*	*n°*	*Country*	*Rent to GDP*	*n°*	*Country*	*Rent to GDP*
1	**Libya**	**54,78**	14	Tunisia	5,87	27	Senegal	0,88
2	**Angola**	**52,31**	15	Ghana	5,60	28	Burundi	0,54
3	**Gabon**	**43,73**	16	South Africa	4,58	29	Liberia	0,49
4	**Algeria**	**37,59**	17	Zimbabwe	4,58	30	Ethiopia	0,40
5	**Mauritania**	**31,14**	18	Mozambique	4,50	31	Swaziland	0,37
6	**Nigeria**	**30,91**	19	Eritrea	4,17	32	Sierra Leone	0,34
7	**Equatorial Guinea**	**29,25**	20	Burkina Faso	3,74	33	Madagascar	0,28
8	**Chad**	**25,65**	21	Botswana	3,45	34	Uganda	0,13
9	**Sudan**	**15,87**	22	Tanzania	2,43	35	Rwanda	0,09
10	**Zambia**	**11,14**	23	Morocco	2,05	36	Kenya	0,07
11	Guinea	9,78	24	Niger	2,03	37	Central African Rep.	0,06
12	Cameroon	8,27	25	Namibia	1,57	38	Benin	0,06
13	Mali	6,63	26	Togo	1,46	39	Malawi	0,03

Table 4 presents descriptive statistics (i.e. mean value, maximum and minimum values, standard deviation and number of observations) for the selected variables. For each variable, we compare computed averages for the whole sample with the average of the top 10 resource-rich Africans countries. It is evident from the data, that natural resources dependency is high for the top 10 group with an average rate close to 33%, compared to the sample average (10.4%). In addition, the top 10 group has a lower agricultural performance in terms of value added per capita, yield and availability of land and labor compared to the whole sample. The Urbanization rate is also higher in the top 10 group (48.6%) compared to the sample average (37.6%).

Table 4 - Descriptive statistics of selected variables (2000-2013).

Variable	*Unit*	*Mean*		*Max*	*Min*	*Std. Dev.*	*Obs.*
		All	*Top 10[a]*				
Rent	%	10,4	33,2	84,7	0,0	17,2	546
Agri	000'$/cap.	35,2	32,9	163,2	1,5	30,8	478
yield	Kg/hect.	1252,4	1107,3	4412,6	130,7	627,9	532
land	%	13,5	6,7	48,7	0,3	12,4	542
Rural	%	62,4	51,4	91,8	13,3	17,4	546
Food_M_Dep	%	28,0	25,7	101,1	0,0	22,4	355
demo	%	0,5	0,3	6,6	-3,0	1,1	546
Income	US$/cap.	1778,9	3661,8	16847,6	132,6	2700,3	546
Rural income	US$/cap.	324,5	529,4	2889,8	20,3	418,2	498
Urban	%	37,6	48,6	86,7	8,2	17,4	546

Note: [(a)] Top 10 highly resource dependent countries (see Table 2).

4.2. *Correlation between oil and minerals rents and agriculture*

Figure 5 shows that on average over the period from 2000 to 2013, agricultural value added per capita is negatively correlated with oil and minerals rents (in percentage of GDP). These two variables have a correlation coefficient of -0.10. In other words, when a country strongly depends on revenues from extractive industries, there is a probability that its agricultural production will be lower and vice versa. However, this chart does not mean that there is a causal link between resources rents and agricultural performance.

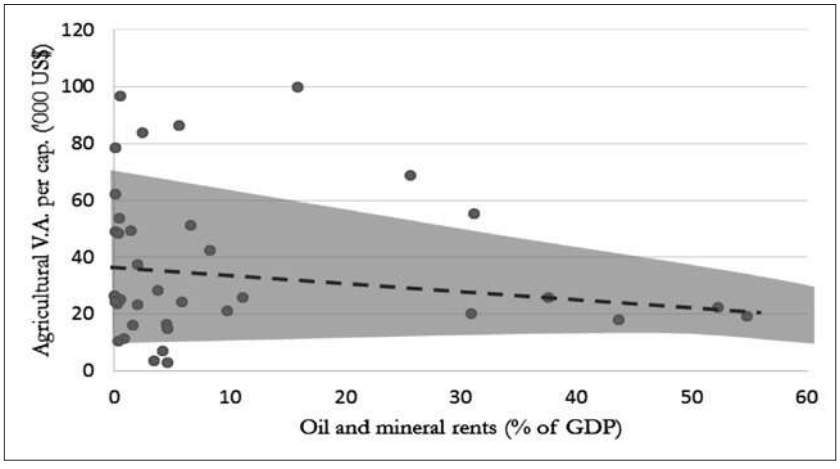


Figure 5 - Natural resources rents and agricultural performance.

4.3. *Correlation between oil and mineral rents and urbanization*

Similarly, Figure 6 shows that on average over the period 2000-2013, the urbanization rate in Africa is positively correlated with oil and minerals rents. These two variables have a correlation coefficient of 0.54. This result suggests that countries highly dependent on natural resources revenues tend to have a higher proportion of urban population. However, this chart does not confirm a causal link between natural resources dependency and urbanization levels.

In addition, the positive correlation between urbanization and natural resources rents does not mean that urban people live in better conditions. Indeed, if we classify the African countries according to the share of resources rents in GDP (Table 5), we can see that the group of countries heavily dependent show higher percentages of urban population living in unhealthy housing (with less access to water and sanitation) compared to the group of countries less dependent.

Figure 6 - Natural resources rents and urbanization.

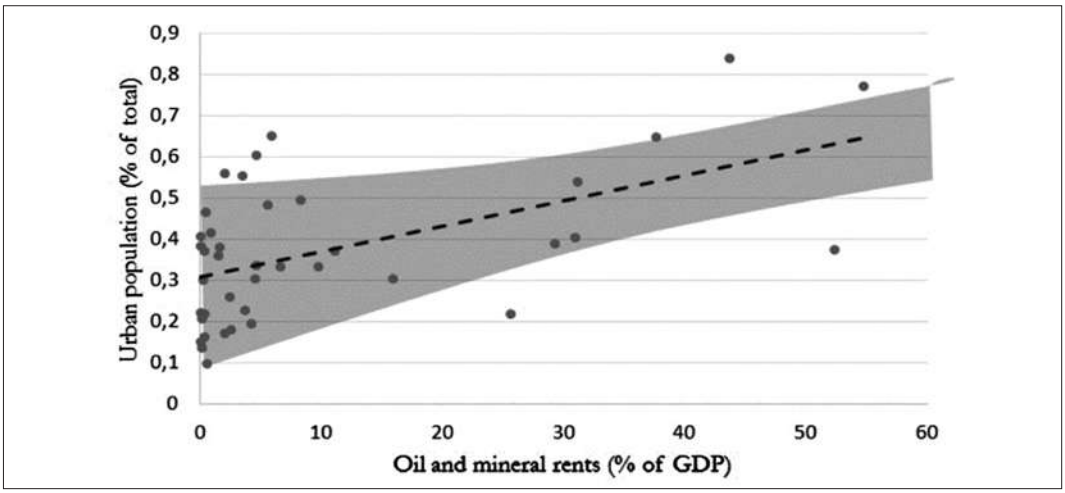


Table 5 - Natural resources rents and urbanization conditions.

	Country groups by Oil and Mineral rents (% of GDP)			
	Group 0	*Group 1*	*Group 2*	*Group 3*
	<5%	*[5-10%]*	*[10-25%]*	*>=25%*
	Less dependent	……	……	*Highly dependent*
Urban population (% of total)	*47,58*	*36,75*	*35,21*	*50,81*
Improved water source, urban (% of urban population with access)	*95,1*	*89,8*	*90,8*	*80,6*
Improved sanitation facilities, urban (% of urban population with access)	*71*	*43,7*	*42,7*	*50,6*
Population living in slums (% of urban population), 2009	*45,3*	*60,7*	*61,7*	*63*

Source: World Bank and United Nation Millennium Development Goals database.

5. Results

5.1. *Econometric validation of static and dynamic panel data estimations*

Table 6 presents the results of the static panel regressions and Table 7 reports the results of the dynamic panel regressions. Each column, in Tables 6 and 7, presents the best specification for the corresponding equation.

In order to validate the model, we run some important specification tests. For static panel regressions, we first conduct the redundant fixed effect test (R-test) for each regression. The result shows that the R-test statistic is significant for all regressions, suggesting a presence of a country specific effect. Moreover, we run the Hausman test to check if this specific effect is fixed or random. The result suggests a fixed effect specification for all regressions as the test is strongly significant (Prob(H-test)<5%). For dynamic panel regressions, we conduct two specification tests (m-test and J-test) to validate our results. As we can see, for all estimated regressions, the m-test is insignificant suggesting the absence of second order serial correlation in residuals, whereas, the J-test of over-identifying restrictions provides support for our choice of instruments.

5.2. *Analysis of the Static Panel Data Estimations*

Column 1 in Table 6 presents the estimated coefficients for equation (1) using panel fixed effects. The results show that oil and minerals rents have a negative and significant effect on agricultural performance. These findings are in line with the first hypothesis (H1), which suggests that oil and minerals rents can lead to the underdevelopment of the agricultural sector in resource-rich African countries. Looking at the control variables, as expected, the two main production factors: arable land (*Land*) and work force (*Rural*) as well as cereal yields (*Yield*) are significant and positive determinants of agricultural performance in African countries. Columns (2) and (3) report the estimated coefficients for equation (2a) and (2b) respectively. The result shows a negative and significant effect of agricultural performance (*Agri*) on food import dependency at 1% level when the conditioning variable (*Rent*) is absent. The coefficient is equal to -0.27. Therefore, a one-percentage point increase in agricultural performance leads to a decrease in food imports dependency of 0.27 percentage points, on average, in the selected panel of African countries. The coefficient of the interaction term between agricultural performance and resource rents (equal to 0.08) is positive and significant at the 10% level. This result can be interpreted as follow: the marginal increase in agricultural performance leads to an increase – i.e. becomes more positive – in food import dependency when a country in highly resource rent dependent (Djella *et al.*, 2019). Urbanization is a significant and positive determinant of food import dependency. The estimated coefficient is equal to 0.655 with interaction of agriculture performance and resource rents as showed in the equation 2a (column 2), and 0.667 with the interaction of urbanization and resource rents in the equation 2b (column 3). The conditional impact of urbanisation to resource rents is positive and significant at the 1% level (0.137) suggesting that urbanization leads to more food import dependency in countries with high resource rents. The estimation results for equation (3) are shown in column (4). Agricultural performance has a negative and significant effect on rural-urban migration, but in terms of magnitude the effect is only 0.05. This would suggest that a one-percentage point increase in agricultural performance leads to a decrease in migration flows by only 0.05%. The interaction between agricultural performance and resources rents is positively significant at the 1% level. This means that agricultural performance plays the opposite role in countries highly dependent on resources rents. Perhaps this is because the agriculture sector, in resource rich-countries, cannot offer more job opportunities and better living standards than in the oil and minerals sector. The control variables used in equation (3) show evidence that population growth affects positively rural-urban migration and is statistically significant at level of 1%; and rural revenue effect is, as expected, negative but not

Table 6 - Static Panel Estimations.

Dependent variable	*Production*	*Food dependency*		*Migration*	*Urbanization*
	Agri	*Food_M_Dep*		*Migration*	*Urban*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Agri		-0,272 ***	-0,266 ***	-0,047 **	0,172 ***
		(0,031)	(0,035)	(0,019)	(0,032)
Agri×Rent		0,080 *		0,223 ***	-0,217 ***
		(0,046)		(0,029)	(0,044)
Urban		0,655 ***	0,667 ***		
		(0,031)	(0,031)		
Urban×Rent			0,137 ***		
			(0,025)		
Rent	-0,354 ***				0,160 ***
	(0,091)				(0,036)
Constant	-0,103 ***	0,086 **	0,064 *	0,042	0,123 ***
	(0,037)	(0,035)	(0,033)	(0,030)	(0,029)
Land	0,545 ***				
	(0,078)				
Rural	0,479 ***				
	(0,143)				
Yield	0,104 **				
	(0,047)				
Rural_income				-0,050	
				(0,040)	
Income					1,076 ***
					(0,048)
Demo				0,561 ***	
				(0,055)	
Adj, R2	0,582	0,415	0,421	0,394	0,612
F-Statistic	17,009	76,209	78,036	78,466	188,862
Prob(F-Stat)	0,000	0,000	0,000	0,000	0,000
Redundant fixed effect test (H_0: Pooled regression model is more appropriate)					
R-Statistic	18,182	34,380	34,206	269,781	442,398
Prob(R)	0,000	0,000	0,000	0,000	0,000
Hausman test (H_0: Random effect test is more appropriate)					
H-Statistic	9,090	18,817	18,091	17,672	20,587
Prob(H)	0,059	0,000	0,000	0,001	0,000
Obs.	461	319	319	478	478
N	37	30	30	38	38

significant. The estimated coefficients for equation 4 are presented in column (5). Our findings support the second hypothesis (H2), which indicates that oil and minerals rents are mostly invested in cities in order to develop infrastructures and services. This can attract more

people and lead to an acceleration of urbanization as the coefficient associated with resource rents is positive and significant at level of 1% (0.16). When we test agricultural performance as a conditioning variable, the effect becomes negative (-0.217). This can imply that the effect on the urbanization rate is positive in countries highly dependent on resources rents but with poor agriculture performance.

5.3. *Analysis of the Dynamic Panel Data Estimations*

Table 7 reports the estimation results of a dynamic panel using the GMM method with instruments taken from lags dated from t-2 to t-5. We observe a positive and statistically significant effect of the lagged dependent variable for all regressions. This means that the omitted variable

Table 7 - Dynamic Panel Estimations.

Dependent variable	*Production*	*Food dependency*		*Migration*	*Urbanization*
	Agri	*Food_M_Dep*		*Migration*	*Urban*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
lag	0,687 ***	0,137 ***	0,170 ***	0,959 ***	1,009 ***
	(0,0889)	(0,0150)	(0,0069)	(0,0001)	(0,0035)
Agri		-0,248 ***	-0,113 ***	-0,017 ***	0,009 ***
		(0,0565)	(0,0396)	(0,0001)	(0,0009)
Agri×Rent		0,195 ***		0,004 ***	0,014 ***
		(0,0431)		(0,0001)	(0,0012)
Urban		1,911 ***	-0,475 ***		
		(0,1734)	(0,0740)		
Urban×Rent			0,133 ***		
			(0,0373)		
Rent	-0,607 ***				0,012 ***
	(0,1720)				(0,0012)
Land	1,617 **				
	(0,7354)				
Rural	6,377 ***				
	(0,9439)				
Yield	0,406 ***				
	(0,0855)				
Rural_income				-0,009 ***	
				(0,0004)	
Income					
Demo					0,012 ***
					(0,0017)
Adj, R2	0,454	0,433	0,449	0,835	0,808
J-Statistic	23,790	21,455	24,123	30,263	28,423
Prob(j)	0,162	0,612	0,512	0,651	0,442
m-Statistic	1,205	-0,564	-0,404	0,877	0,984
Prob(m)	0,228	0,573	0,686	0,381	0,325
Obs.	376	285	285	405	405
N	35	29	29	37	37

*Notes: ***, **, and * indicate significance level at 1%, 5%, and 10%, respectively, against a two sided alternative, figures in parentheses are cluster standard errors and they are robust to arbitrary heteroskedasticity and arbitrary intra-group correlation.*

bias is now reduced. Similar to result obtained from the static panel specification, we find a significant negative impact of resource rents on agricultural performance (column 1). We also find a positive impact of agricultural performance on food imports dependency that is statistically significant at the 1% level (columns 2 and 3). The impact of resources rents on food imports dependency is positive whether it interacts with agricultural performance (column 2) or with urbanization (column 3). As obtained in the static estimation, agricultural performance is a determinant for rural-urban migration. The impact becomes positive and significant with interaction of resources rents (column 4)[5] but the estimated coefficient values is much smaller than the one obtained in a static specification. This may be due to the introduction of a lagged dependent variable. Our estimation indicates a positive and significant effect of resource rents on urbanization at level of 1% (column 5).[6] We do not find the expected sign for the interaction between agriculture and resources rents. The coefficient is positive but too small, as it only equals 0.014.

6. Conclusion

This paper examines the mechanism through which natural resources lead to poor agricultural performance and rapid urbanization in African countries. Using static and dynamic panel models covering the period 2000-2013 and 39 African countries, we show that resources rents affect negatively agricultural value added and positively food imports dependency. This because the resource-rich countries neglect the non-extractive industry, in particular, the agriculture sector. Consequently, this policy orientation tends to expose food security in these countries to international price food fluctuations. Djella *et al.* (2019) which show a significant impact of oil export on the food dependency in terms of food import and the food insecurity (undernourishment) founded the same result.

Our results show a positively significant impact of resources rents on rural-urban migration and therefore the urbanization rate. These findings imply that resource-rich countries indeed have a tendency to neglect agriculture that can be justified by attractive world food commodity prices. However, since 2007-2008, food prices have shown a higher volatility and this situation can present a food security risk for millions of Africans (Kalkuhl *et al.*, 2016).

The positive impact of natural resources rents on the urbanization rate can be interpreted as both a cause and a consequence of policy choices. On the one hand, as policy-makers in resource-rich nations tend to invest in extractive industries to the detriment of other sectors like agriculture, they create a *push factor* for rural migration. On the other hand, as these policy-makers allocate the rents in priority to develop infrastructures in urban area (generally in port cities), they create some *pull factors* to rural population looking for a better life. In fact, this could explain the massive rural-urban migration which contributes to the ongoing debate about the inequality of resource rents distribution in a society.

Generally, urbanization and economic growth are closely linked. The strong positive correlation between these two indicators has been numerously documented.[7] There is no doubt that much of the causation goes from economic growth to increased urbanization. However, as countries grow, they undergo structural changes. Labor forces are reallocated from rural agriculture to urban manufacturing and services sectors (Michaels *et al.*, 2012) and when urbanization occurs without industrialization, serious urban and development problems can arise (Gollin *et al.*, 2013). This is particularly the case for most African countries. The statistical analysis presented in Table 5 shows evidence that the urbanization in rich-resource African countries is associated with huge social problems (expansion of urban slums, limited access to improved water and sanitations facilities).

[5] The variable *Demo* was tested but the results showed an insignificant effect.
[6] The variable *Income* was excluded from equation 4 (column 5) after showed non-significant effect.
[7] See for instance World Bank (2009) and Henderson (2002; 2010).

Further research is needed to focus on this complex causal link between urbanization problems and resource dependence in rich-resources African countries. Future studies should also evaluate the final impact of rapid urbanization in many resource-rich African countries. A time-series analysis of this group of countries, over a longer period, will also allow for more conclusive results.

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Disparités régionales et développement local au Sud Tunisien

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Abstract

Sustainable development is regarded today as a goal which has to be reached by all countries. Therefore cooperation for development is more than ever necessary to face the global challenges such as poverty, human health, food crisis etc. This work aims to study the regional disparity that may exist between provinces in the south of Tunisia. To this end, a data analysis applied to a set of regional development indicators using the principal components analysis method (ACP) was conducted.

Keywords*: Development, Regional disparity, South of Tunisia.*

1. Introduction

Les ressources naturelles, les activités humaines et les niveaux de vie connaissent une distribution géographique inégalitaire au niveau international et au niveau des entités territoriales. Ainsi, la diffusion socioéconomique du développement a été et continue d'être imparfaite. Landes (1998) écrit à ce niveau « la géographie […] elle nous enseigne une vérité désagréable, à savoir que la nature comme la vie est injuste, qu'elle accorde inégalement ses faveurs et qu'il est, de surcroît, difficile de réparer ses injustices ». Les facteurs explicatifs de différenciations spatiales peuvent se présenter autour des concepts de développement économique endogène et exogène. Les facteurs climatiques, pluviométriques, la production et la géographique physique font que en Tunisie se présentent naturellement des disparités interrégionales voire intra-régionales importantes en l'absence d'une politique volontariste de développement régional. La densité de la population, les niveaux de développement socioéconomiques et les opportunités d'emploi diffèrent entre les zones du littoral réputées riches et les zones de l'intérieur du pays réputées pauvres. Ce déséquilibre est accentué depuis toujours par le classique problème de l'exode rural vers les grandes villes. Ces facteurs expliquent le développement des régions du littoral au détriment des autres régions de la Tunisie. Dans ce cadre, la majorité des études réalisées concluent que existe une concentration importante de l'investissement privé et public dans les régions du littoral (Domecq et Régnault, 1990 ; Métral, 2003). D'autres études montrent des phénomènes intéressants comme l'extension des

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zones rurales vers les centres urbains intérieurs les plus proches (Royoux et Signoles, 1980 ; Chebaane, 1990). Le développement régional et par voie de conséquence les effets d'agglomération qui en découlent, subit les impacts de plusieurs facteurs traditionnels comme l'état de l'infrastructure, la localisation géographique, la taille démographique, la densité de la population, le potentiel local, etc. En Tunisie, plusieurs études et travaux de recherche ont été menés dans le cadre d'analyse de la notion des stratégies et indicateurs du développement (Sandron et Sghaier, 2000 ; ONU, 2004 ; Soussi, 2009 ; Belhédi, 1992 ; 1996 ; 1998 ; 2005 ; Elloumi, 2006 ; Bechir *et al.*, 2011 ; Dhehibi et Elloumi, 2012). Aujourd'hui chaque pays a besoin de régions compétitives et dynamiques pour atteindre ses objectifs économiques et sociaux. Le développement régional est un complément indispensable aux politiques macroéconomiques, déclare l'Organisation de coopération et de développement économique pour montrer l'importance d'un développement intégré et global. Dans nos jours, le déséquilibre régional, l'exclusion liée à la ruralité, le partage inégal des richesses ont étés la grande révélation de la révolution tunisienne. En fait, le déséquilibre régional entre les gouvernorats et la disparité territoriale entre les délégations ont été parmi les grandes révélations de la révolution de janvier 2011, où le soulèvement populaire qui a abouti à la chute du régime de Ben Ali est parti des villes tunisiennes défavorisées, d'abord celles du Sud entre 2008 et 2010 (région du bassin minier de Sud-Ouest Gafsa) puis villes frontalières de Sud-Est (Ben Guerdane et Médenine) et plus récemment, celles du Centre-Ouest. Ce papier propose, ainsi, de faire apparaître, en appliquant la méthode d'Analyse en Composantes Principales (ACP), la disparité entre les délégations du Sud Tunisien. Ce travail propose d'agréger un ensemble d'indicateurs régionaux de développement afin de dresser une typologie des délégations du Sud et de discerner les éventuelles défaillances et inégalités freinant leur développement. Ainsi, on va proposer des recommandations et scenarios afin de trouver des solutions aux problèmes qui marquent le Sud Tunisien.

2. Une revue de la littérature du développement des territoires

La théorie de la Nouvelle Economie Géographique (NEG) saisit bien les mécanismes économiques sous-jacents à la persistance, voire à l'exacerbation de déséquilibres socioéconomiques majeurs entre les territoires. Ces déséquilibres régionaux intéressent le chômage, la migration, la pauvreté que ce soit absolue ou relative, la précarité,… et d'autre part l'attractivité, la compétitivité,… Cette théorie remet en cause l'idée assez répandue que le désenclavement constitue un préalable nécessaire au développement des territoires. La réduction des couts de transport, l'amélioration de l'infrastructure, aboutissant à la facilité d'accès aux zones géographique périphériques, offrent de nouveaux débouchés aux entreprises localisées dans les régions centrales. Ceci permet de créer de nouvelles économies d'échelle et par la même renforcer la compétitivité de ces régions centrales. En raison d'une concurrence intense, les entreprises localisées dans le territoire périphérique finissent par délocaliser leur production dans les régions centrales. Ces modèles de la NEG permettent de saisir la composition territoriale façonnée par la libéralisation croissante des marchés et l'exacerbation du phénomène « mondialisation ». La NEG retient un certain nombre de variables explicatives déterminantes pour le choix de l'implantation géographique des entreprises. Il s'agit de l'accès aux débouchés mesurés par la demande pour le secteur d'activités de la firme dans le territoire considéré ; d'autre part des différentes charges auxquelles l'entreprise doit en général supporter (coût du travail, coût du capital, enfin les externalités technologiques mesurées par le degré de concentration des entreprises du même secteur). La théorie de la NEG préconise que les couts agissent comme une force centrifuge à la dispersion de l'activité économique alors que la recherche de débouchés (taille de la demande adressée aux entreprises) agit dans le sens opposé comme une force centripète. L'existence des économies d'échelle permet aux entreprises de s'implanter à proximité des grands bassins d'emplois et de demande. Les rendements d'échelle croissants permettent

une baisse des couts moyens de production. Les zones géographiques les plus peuplées à pouvoir d'achat élevé sont des sites très recherchés. Les entreprises venant s'implanter dans ces zones centrales de productivité permettent de compétitives en réalisant des gains de productivité permettant de réduire les coûts de production. Les grands centres économiques présentent aussi l'avantage d'assurer une forte concentration des biens intermédiaires nécessaires à la production. La concentration géographique des entreprises permet l'attraction d'une main d'œuvre de plus en plus nombreuse assurant une distribution des salaires. L'augmentation de la demande favorise l'attraction de nouvelles entreprises. Ce schéma de causalité circulaire cumulative pourrait entrainer la concentration de toutes les activités économiques dans un seul et même lieu géographique (Myrdal, 1957). Cependant, des forces centripètes pourraient conduire certaines activités économiques à fuir les régions centrales. Le prix du foncier, l'encombrement, l'augmentation de la demande du travail pousse à l'élévation des salaires,… Ceci accroît les coûts de production ; ce qui vient à l'encontre de la concentration géographique de l'activité économique. Ce faisant, certaines activités vont fuir le centre pour se localiser dans les zones géographiques qui offrent un marché potentiel plus limité mais où les entreprises ne subissent pas de concurrence vive. La configuration spatiale des activités résulte d'un équilibre entre forces centrifuges et les forces centripètes. On a cherché à comprendre cette logique qui conduit à la concentration urbaine et ses limites à partir des notions d'économies externes et d'économies d'agglomération. Lorsque les bénéfices retirés par une entreprise augmentent parce que d'autres entreprises viennent s'implanter au même endroit, on dit qu'on est en présence d'économie d'agglomération. Le fondement conceptuel de ces économies d'agglomération peut être exploré dans les travaux de Marshall sur les économies externes et les travaux d'Isard et de Paelinck sur les théories de localisation. Il s'agit des économies d'échelle externes à l'entreprise ou internes à une ville, une région, un territoire. L'on peut distinguer :

- des économies de localisation de type Marshall : celles-ci résultent d'effets externes relatives à une forte spécialisation intra-industrielle, à une meilleure formation d'une main d'œuvre locale, aux facilités de transmission des informations et des innovations ;

- des économies d'urbanisation, qui sont le résultat de la taille optimale de l'agglomération : concentration de la population, présence des infrastructures de base, disponibilités des services aux entreprises.

Les réflexions sur les districts industriels, les systèmes de production localisés, le développement des technopoles ne sont qu'un prolongement et une adaptation des théories anciennes au contexte actuel de l'internationalisation croissante des économies qui s'est traduit par un renforcement poussé de la concurrence et des exigences de la compétitivité. Ainsi en Tunisie on assiste à une confirmation de ces analyses théoriques qui pronostiquent une divergence spatiale de type centre/périphérie. Ce schéma classique dichotomique est renforcé en Tunisie par des inégalités socioéconomiques intra-régionales. L'objet de ce travail est d'identifier ces disparités infrarégionales au Sud Tunisien en appliquant l'Analyse en Composantes Principales (ACP).

3. L'analyse des inégalités intra régionales par l'application de l'Analyse en Composantes Principales (ACP) au Sud Tunisien

Cette étude porte sur les gouvernorats du Sud Tunisien. A cet égard, il est à signaler que le choix de la région du Sud est justifié par son retard de développement et sa diversité au niveau des ressources et des potentialités. Les données de cette étude ont été obtenues à partir des rapports annuels de l'Institut National de la Statistique (INS, 2014) ; *Le sud en chiffre* (2018) ; *Les gouvernorats en chiffres* (2018)… En Tunisie, les inégalités sociales et les disparités régionales ont contribué à la grogne à l'origine de la révolution. La hausse du revenu par habitant avait masqué les inégalités sociales et les disparités régionales persistantes, déformant ainsi la réalité de la situation dans les zones de l'intérieur d'où le déclenchement de la révolution. La concentration des investissements et des services pu-

blics, ainsi que des activités économiques dans les zones côtières a accentué la pauvreté (tant en termes de nombre de pauvres que d'inégalité) et le chômage dans les autres régions, notamment le chômage des jeunes et des femmes. Une réorientation des ressources publiques vers les régions intérieures de Sud du pays, des services publics transparents et décentralisés axés sur les résultats, ainsi qu'une politique de discrimination positive en faveur des jeunes et des agriculteurs pourraient contribuer à rétablir davantage l'équité sociale régionale, et ça on va le montrer à travers l'application de l'ACP où on va identifier les régions le plus défavorisées dans le Sud.

3.1. *Description de l'Analyse en Composantes Principales*

L'Analyse en Composantes Principales (ACP) est une des premières analyses factorielles. Cette méthode qui fut conçue par Karl Pearson en 1901, était vulgarisée par Jean-Paul Benzécri. Elle est sans doute à la base de la compréhension actuelle des analyses factorielles. Les principales variantes de l'ACP viennent des différences de transformations du tableau de données. Ainsi, le nuage de points peut être centré ou non, réduit ou non. Le cas le plus étudié, et que nous présentons ici, est lorsque le nuage de point est centré et réduit ; dans ce cas nous parlons d'ACP normée. D'autres variantes existent telle que l'analyse en composante curviligne pour remédier au fait que les projections sont linéaires, ou encore l'analyse en composantes indépendantes qui conçoit une séparation de sources.

Les données : Les données pour l'ACP sont généralement présentées sous la forme de tableau. Ainsi les données sont constituées d'individus et de variables qui, dans le cas de l'ACP, doivent être quantitatives, continues, elles peuvent être homogènes ou non et sont à priori corrélées entre elles.

Les objectifs : Les objectifs de l'ACP sont ceux d'une analyse factorielle, c'est-à-dire qu'elle cherche à représenter graphiquement les relations entre individus par l'évaluation de leurs ressemblances, ainsi que les relations entre variables par l'évaluation de leurs liaisons. L'étude doit se faire simultanément. Le but final de ces représentations est l'interprétation par une analyse des résultats.

Les domaines d'application : De part de la nature des données que l'ACP peut traiter, les applications son très nombreuses. Il y a en fait deux façons d'utiliser l'ACP :

- soit pour l'étude d'une population donnée en cherchant à déterminer la typologie des individus et des variables. Celle-ci est utilisée dans ce travail ;
- soit pour réduire les dimensions des données sans perte importante d'information, par exemple en traitement du signal et des images, ou l'ACP intervient souvent en prétraitement pour réduire la quantité de données issues de traitement analogiques.

Nous avons dû procéder à plusieurs essais pour aboutir à des résultats satisfaisants en sélectionnant les variables les plus discriminantes. Pour ce faire, on a utilisé le Logiciel XLSTAT. Dans ce travail on s'est contenté de présenter les résultats les plus significatifs.

L'objectif de l'utilisation de l'ACP dans ce papier est de montrer le groupe des délégations les moins développés au Sud Tunisien. Cette méthode d'analyse se base sur une matrice qui regroupe 11 indicateurs pour les régions du Sud de la Tunisie. Cette matrice consiste à une combinaison de variable par délégation, elle est décrite dans le schéma suivant :

$$X = \begin{array}{c} \\ \text{Délégations} \end{array} \begin{array}{c} \text{Variables} \\ \begin{array}{cccc} & 1 & \cdots & p \\ 1 & x_1^1 & \cdots & x_p^1 \\ .. & \cdots & \cdots & \cdots \\ n & x_1^n & \cdots & x_p \end{array} \end{array}$$

3.2. *Découpage administratif en Tunisie*

La Tunisie a connu des découpages administratifs différents, chacun répond à un ordre politique et socioéconomique bien déterminé. Au découpage pré-colonial épousant les données naturelles et historiques et exprimant le compartimentage et la communication difficile entre les

lieux, s'est succédé un découpage colonial qui répond aux impératifs coloniaux d'exploitation et d'encadrement des autochtones, utilisant aux mieux la trame tribale (Bélhedi, 1998). Après l'indépendance, le pays a été doté d'un découpage spatial qui répond aux impératifs de la construction nationale. Avant la période coloniale, le découpage administratif de la Tunisie comporte 70 « caïdats » dont les responsables, « les caïds », avaient une fonction essentiellement fiscale, chaque caïdat est composé de plusieurs « macheikhats » où le responsable, appelé « chikh », assure le lien entre la population et le pouvoir local. À la suite de la colonisation qui a eu lieu en 1881, les autorités françaises ont gardé cette même structure mais en réduisant le nombre de caïdats à 36. Dès l'indépendance en 1956, l'Etat a supprimé l'administration traditionnelle et a mis en place une administration moderne avec un découpage par : gouvernorat – délégation – secteur. Entre 1956 et 2010, le nombre des gouvernorats est passé de 13 à 24, l'augmentation du nombre des gouvernorats en Tunisie a débuté pendant les années 1970 quand trois gouvernorats ont été créés en Tunisie médiane – Siliana, Zaghouan et Sidi Bouzid – et le Centre-Est, à son tour, a été divisé en trois gouvernorats – Sousse, Monastir et Mahdia. Dans les années 1980, après l'affaire de Gafsa, à la suite d'une attaque armée d'un commando infiltré par la frontière algéro-libyenne, ont été créés trois nouveaux gouvernorats dans le Sud – Kébili, Tozeur et Tataouine – qui sont, en fait, des zones frontalières détachées de leurs anciens gouvernorats : respectivement Gabès, Gafsa et Médenine. Après la « Révolte du Pain » en 1984, à la suite d'une augmentation du prix du pain, le gouvernorat de Tunis a été divisé en trois gouvernorats : Tunis, Ariana et Ben Arous. En 2000, le gouvernorat de l'Ariana est scindé en deux avec l'autonomisation de sa partie sud qui constitue le gouvernorat de Manouba. Concernant le nombre des délégations, il est passé de 86 en 1956 à 264 en 2010, subdivisées ainsi en 2073 secteurs. Notons ici que les gouvernements d'après la révolution en Tunisie ont nommé quelques autres régions comme des délégations et cela afin de faciliter les procédures administratives et améliorer les conditions de vie des citoyens.

3.3. *Zone d'étude*

Le Sud Tunisien correspond à une zone limitée à l'ouest par l'Algérie et à l'est par la frontière libyenne et la Méditerranée. Cette zone se caractérise par un climat aride marqué par une pluviométrie faible et irrégulière (50 à 200 mm/an) avec des températures élevées. D'origine nomade et semi-nomade, la population de la région a connu un processus de fixation et de sédentarisation progressive depuis l'intervention coloniale, vers la fin du XIXème siècle. Ce processus s'est traduit au niveau de l'activité sociale et économique par la désagrégation des anciennes structures tribales et communautaires et par la mise en difficulté de l'ancien système de production, basé essentiellement sur l'élevage pastoral et l'agriculture en sec. Au niveau économique, la région est caractérisée par la présence de :

- secteur artisanal et industriel basé sur l'exploitation des ressources pétrolières de l'extrême-sud et sur les unités manufacturières de transformation principalement dans les branches des matériaux de construction, du textile et de l'agro-alimentaire et aussi le pôle d'industries chimiques à Gabès ;
- branche touristique avec la zone touristique de Jerba-Zarzis et Tozeur qui constitue l'un des principaux lieux de concentration entre les établissements touristiques du pays ;
- activité importante du secteur de la pêche à Médenine et Gabès ;
- secteur agricole marqué par l'oléiculture ;
- commerce informel avec la Lybie et l'Algérie ;
- existence de plusieurs oasis ;
- existence de phosphate surtout à Gafsa ;
- existence de pétrole et gaz surtout à Tataouine.

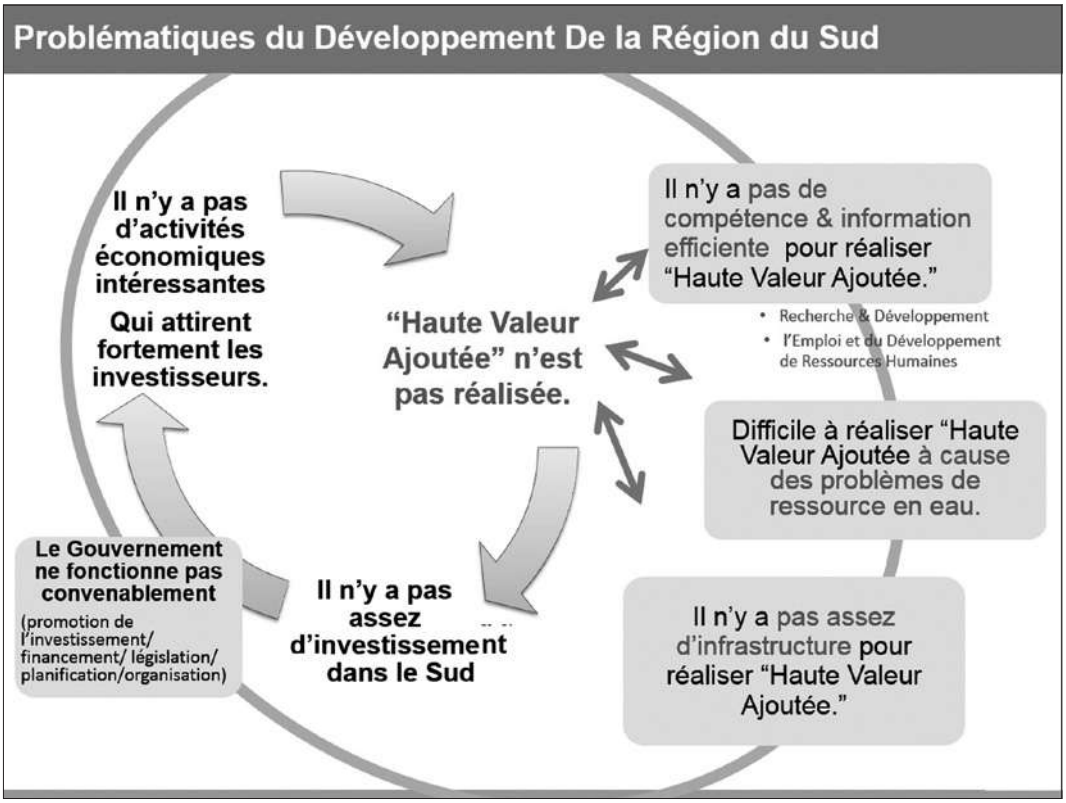
Les principales cultures agricoles sont celles de l'arboriculture, comprenant les dattes à Tozeur et Kébili et les olives à Médenine et, en moindre quantité, à Gabès et Tataouine. Les cultures hors-saison particulièrement celles utilisant l'eau de source chaude ont commencé. L'élevage du bétail, comprenant les chèvres et les moutons pour la production de viande est prépondérante avec de vastes zones de pâ-

turages, tandis que la production de la volaille et du lait est en pleine croissance. La pêche est également un secteur important. Comme les ressources halieutiques naturelles sont en baisse, l'aquaculture a été élaborée. Le secteur minier est représenté par l'extraction de minerai de phosphate à Gafsa. Un grand volume de minerai de phosphate a été trouvé à Tozeur, où l'extraction n'a pas encore commencé. Une réserve assez importante de gros volumes de diverses ressources minérales, tels que le gypse, la pierre à chaux, le marbre, l'argile, le sel et le sable, nommées comme des substances appelées utiles, se trouvent sur la région, et dont certaines sont extraites et traitées. Pour la fabrication, il y a également une concentration relative d'entreprises à Gabès, Médenine et Gafsa pour ce qui est du Sud. Le secteur de la transformation alimentaire, concentré à Gabès, Médenine, et Tozeur, constitue une part substantielle des secteurs de fabrication. Par ailleurs, le secteur chimique est concentré à Gabès et l'industrie textile est concentrée à Gabès et Gafsa. Certains agglomérats d'entreprises du secteur métallique et mécanique se sont aussi développés à Gabès et Gafsa. En ce qui concerne le tourisme, le tourisme balnéaire de masse a été développé de manière significative à Djerba et Zarzis. Le tourisme du Sahara et d'oasis est en cours d'élaboration à Tozeur et Douz. Du fait d'une attraction touristique variable dans la région, le secteur du tourisme a souffert de saisonnalité grave. Il y a de bonnes perspectives d'investissement dans les domaines suivants : i) l'agriculture ayant recours aux ressources géothermiques, la production biologique d'huile d'olive, de dattes, de fruits, et de lait de vache ; ii) la culture et la commercialisation de produits à forte valeur ajoutée tels que les légumes hors-saison, les plantes médicinales et aromatiques, et les algues marines ; iii) l'élevage ; iv) l'aquaculture ; v) la valorisation des substances utiles telles que le gypse, le marbre, l'argile, etc. ; vi) les industries de la plastique et du carton ; vii) les technologies de l'information et de la communication (TIC) ; viii) le tourisme à des fins variées tel que le tourisme d'affaires, médical, culturel et sportif ; ix) autres services. Dans le Code d'incitations aux investissements, la plus grande partie du Sud de la Tunisie est classée en tant que zone prioritaire. Sur la période 2010-2012, l'ensemble des investissements dans les six gouvernorats du Sud a connu différentes tendances d'un gouvernorat à un autre. L'investissement direct de l'étranger (IDE) dans le Sud est encore très limité en termes de nombre de compagnies comme en termes de nombre d'emplois créés. Les produits exportables principaux sont ceux dérivés de l'agriculture commerciale, comprenant les dattes et l'huile d'olive, et ceux des riches ressources naturelles, tels que les produits de phosphate ainsi que le gypse, le marbre, et les dérivés du sel. Les produits du textile, de l'habillement et de l'industrie électriques et électroniques sont exportés en petite quantité. Le Sud de la Tunisie, avec une position géographique et relative proximité avec la Lybie pour les échanges commerciaux et également avec les pays européens, est considéré comme ayant des atouts commerciaux particuliers avec la Libye. Il y a une forte attente de l'augmentation des Projet de Planification pour le Développement Régional du Sud de la Tunisie, en particulier concernant les matériaux de construction tels que le gypse et la brique. En effet, une demande plus importante devrait se manifester alors que la reconstruction s'accélère actuellement en Libye. Les défis les plus cruciaux auxquels doivent faire face les entreprises d'exportation dans différents secteurs sont :

- les capacités limitées de transformation pour l'exportation de produits à valeur ajoutée ;
- le sous-développement relatif des transports et de la logistique d'exportation, des facteurs qui mènent à des expéditions restreintes et des coûts de transport plus élevés.

La population dans le Sud a atteint le chiffre de 1594000 habitants, soit quasiment le double par rapport à celle de l'année 1975. Le taux de croissance démographique a considérablement diminué pendant la même période. La pyramide de la population dans le Sud de la Tunisie s'est maintenue aux alentours de 15%. La pyramide démographique a évolué d'une pyramide à base large en 1985 à une pyramide à base rétrécie en 2011 (indiquant un faible taux de naissance et de décès). La distribution géographique de la population est caractérisée par une double concentra-

Figure 1 - Problématiques du développement au Sud Tunisien.

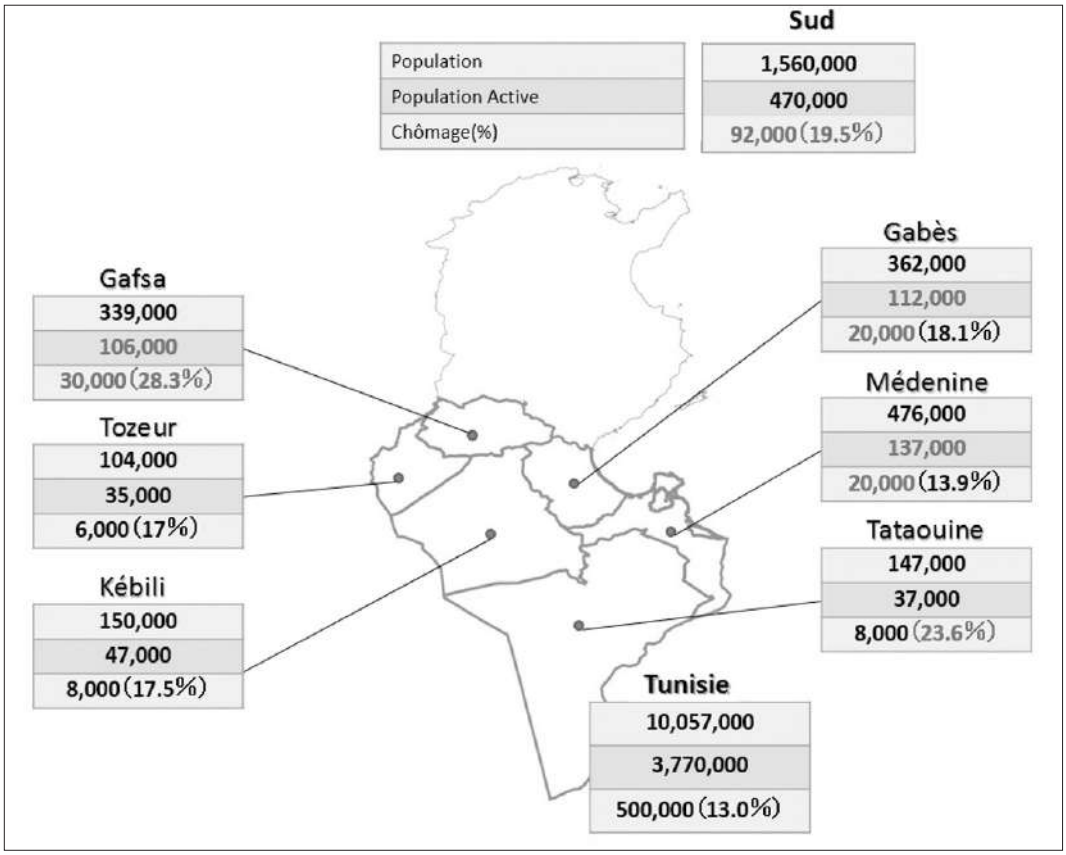


tion dans les zones littorales, avec 52,7% de la population vivant dans les gouvernorats côtiers de Médenine et de Gabès, alors que les deux gouvernorats représentent ensemble seulement 18% de la superficie du Sud. L'urbanisation élevée est également l'une des caractéristiques démographiques du Sud, avec 70,8% de la population habitant en zone urbaine (communale), tandis que le taux dans l'ensemble de la Tunisie est de 66,4%. Des dix zones socio-agro-écologiques en Tunisie, les hautes steppes (1%), la chaîne de l'Atlas (8%), le Chott (lac salé) (23%), le Grand Erg Oriental (mer de sable) (33%), Dahar et Matmata (plateaux) (22%), et Jeffara-Oura (plaines) (13%) s'étendent dans le Sud de la Tunisie. Le potentiel de ressources en eau comprend 212 millions m^3/an d'eau de surface (19%), 124 millions m^3/an de nappes phréatiques (11%), et 784 millions m^3/an d'aquifères fossiles (70%). L'exploitation dangereusement excessive peut être observée dans les zones à l'est de Médenine et dans les alentours d'El Hamma, l'exploitation excessive dans les plaines à l'est de Ben Guerdane, les zones dans les environs de Mareth et Beni Khedache, les oasis dans le gouvernorat de Tozeur, les zones dans le gouvernorat de Gafsa, tandis que les perspectives excèdent l'exploitation dans une plaine à l'est de Tataouine, les zones dans l'ouest de Tataouine, une plaine dans les alentours de Zarzis et le nord-ouest de Médenine et ouest de Ben Guerdane, les zones au nord et à l'ouest du gouvernorat de Gabès, du gouvernorat de Kébili. Le potentiel et l'usage de l'eau sont équilibrés sur l'île de Djerba et les zones dans les alentours de Dhiba.

4. Résultats

La méthode de l'ACP est utilisée dans les analyses de plusieurs variables quantitatives observées sur individus (gouvernorats et délégations). Elle permet de regrouper les observations

Figure 2 - Données démographiques et sociales des gouvernorats de Sud Tunisien.

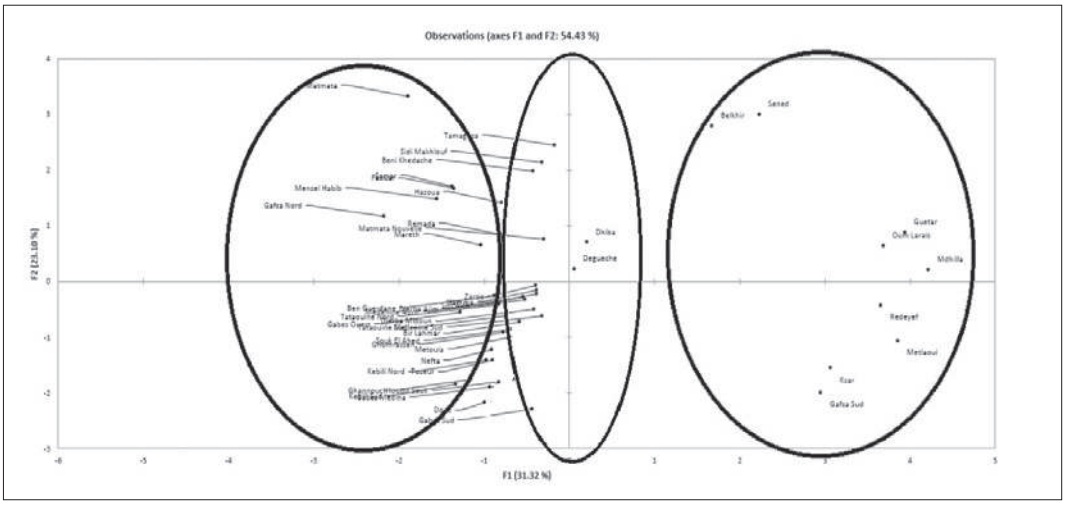


semblables (par unité d'observation), d'isoler les individus marginaux et d'étudier les relations reliant les variables. La corrélation de chaque point sur un axe exprime la qualité se représentation du point sur l'axe. Elle prend des valeurs entre 0 (pas corrélé du tout) et 1 (fortement corrélé). Si cette valeur et proche de 1, alors le point est bien représenté par le plan factoriel. Leur interprétation ne peut donc être effectuée avec confiance. Notre analyse est basée sur 11 indicateurs de toutes les délégations de Sud Tunisien pour l'année 2014 quand l'Institut National de la Statistique a réalisé le dernier recensement[1]. L'interprétation des observations des axes F1 et F2 où se récupèrent 54.43% de l'information initiale, montre que l'axe horizontal du graphique oppose les gouvernorats équipés en infrastructure de base à ceux les moins équipés.

On peut, ainsi, identifier trois groupes de délégations qui se diffèrent de niveau de développement : les Régions à faible niveau de développement socioéconomique, les Régions à développement socioéconomique moyen et les Régions équipées en infrastructure et à haut

[1] V1: Ration Nombre des bénéficiaires d'électrification / Population (INS, 2014) ; V2: Ration Nombre des bénéficiaires en milieu non communal / Population (INS, 2014) ; V3: Ration Nombre des bénéficiaires de l'eau potable / Population (SONEDE, 2014) ; V4: Ratio Nombre des bénéficiaires de l'eau potable en milieu non communal / Population (SONEDE, 2014) ; V5: Taux de branchement à l'ONAS en milieu communal (ONAS, 2014) ; V6: Taux de branchement aux réseaux téléphoniques (INS, 2014) ; V7: Nombre d'abonnés à l'ADSL (INS, 2014) ; V8: Taux des accouchements assistés (Direction Régionale de la Santé Publique, 2014) ; V9: Taux de chômeurs (INS, 2014) ; V10: Taux de chômeurs d'enseignement supérieurs (INS, 2014) ; V11: Taux d'analphabétisme (INS, 2014).

Figure 3 - Résultats de l'ACP.



niveau de développement. Le graphique ci-dessus confirme bien les analyses déduites des résultats précédents. Une opposition franche entre les délégations des zones Sud.

4.1. *Régions à faible niveau de développement socioéconomique*

En Tunisie, il est bien remarqué que depuis l'indépendance de la Tunisie, les dépenses publiques avaient favorisé les régions côtières au détriment des régions du Sud. Les indicateurs de développement régional mettent en évidence donc le déséquilibre régional manifesté qui existe toujours entre l'Est et l'Ouest du pays. L'intérieur du pays est non seulement moins industrialisé mais il possède proportionnellement moins d'activités capables de servir à un processus de développement régional. Ainsi, les activités de services sont fortement implantées dans quelques régions côtières. Les activités du commerce et de l'enseignement, santé et administration sont aussi moyennement représentées sur l'ensemble du territoire et surtout dans le Sud du pays. Cette disparité existe même entre les délégations du Sud. La croissance économique qu'a connue le Sud depuis plusieurs années a abouti à un déséquilibre spatial entre le littoral et l'intérieur de cette zone. En effet, les délégations « défavorisées » constitués essentiellement par plusieurs délégations de Gafsa (Sned Belk-

Figure 4 - Disparités entre les délégations de Sud Tunisien (selon l'ACP).

hir, Gtar, Oum Larayes, Mdhilla, Redeyef, Métlaoui, Ksar, Gafsa Sud). Ces résultats expliquent pourquoi dans la région de Gafsa il y a toujours des mouvements de protestation, grèves, sit-ins, blocage de routes, affrontements avec les forces de l'ordre avec une tension sociale véhiculée par la colère de nos concitoyens contre la léthargie du gouvernement sur l'urgence sociale qui touche plusieurs régions du pays, notamment la précarité, le chômage, et la dégradation du pouvoir d'achat. Cet embrasement social n'est qu'un rappel à la société tunisienne que la précarité qui affecte la plupart des régions de Gafsa et du Sud ne s'est pas améliorée après la révolution. Ces disparités peuvent être également expliquées par le déficit de connectivité au réseau routier et ferroviaire du pays, qui forme un obstacle pour l'accès aux marchés, c'est le cas notamment pour tout le Sud de la Tunisie. C'est une des causes principales du fait que ces régions pâtissent d'une faible économie d'agglomération. Le déséquilibre régional est bien évidemment le fruit des politiques de développement non intégrées basée sur la concentration des investissements dans les régions côtières, c'est alors que les zones industrielles sont réparties sur une superficie de 5000 hectares dont, seulement 20% dans les zones intérieures sur 1000 hectares, et 4000 hectares dans les zones du littoral. Cette répartition géographique inégalitaire du nombre d'entreprises a donné lieu à un déséquilibre régional beaucoup plus important au niveau de l'emploi, de la production, de la valeur ajoutée et de l'investissement public mais surtout privé. L'activité minière dans la région de Gafsa porte sur l'extraction des phosphates, qui est assurée depuis plus d'un siècle par la Compagnie de Phosphate de Gafsa. L'activité est localisée dans les 4 délégations de Métlaoui, Redeyef, Moularès et Mdhilla, c'est-à-dire au sud-ouest du gouvernorat. La plus grande partie (environ 90%) de la production de phosphate est destinée à la production de plusieurs dérivés par le Groupe Chimique de Gafsa, situé à Mdhilla et par d'autres unités situées à Sfax, Gabès et Shkira… Le reste est exporté. L'importance des ressources naturelles à Gafsa n'a pas résulté à un développement des infrastructures ou même des conditions de vie des citoyens dans ces délégations défavorisées. L'analyse des indicateurs régionaux de développement montre qu'un effort devrait être apporté, surtout pour l'accès des ménages aux services de base, dans ces délégations défavorisées qui sont des régions qui souffrent de l'absence d'une bonne gouvernance et d'une politique cohérente de développement à long terme d'une part, et de leur faible intégration dans le tissu régional et national d'autre part.

4.2. *Régions à développement socioéconomique moyen*

Ce groupe est formé des délégations : Ajim, Degache, Dhiba, Tamaghza, Sidi Makhlouf, Beni Khedache, Matmata Nouvelle, Benguardane, Hamma, Sidi Aïche, Médenine Sud, Bir Lahmar, Souk Lahad, Métouiya, Gabès Sud, Remada. Elles ont connu, depuis les années 70, un développement économique renforcé par quelques actions du secteur privé avec l'apparition des zones industrielles. Cet effort d'investissement a permis de créer plusieurs postes d'emploi mais le taux de chômage dans la région reste élevé. En effet, aujourd'hui, l'activité industrielle est encore limitée en raison de l'absence d'un environnement industriel important, du manque des fonds d'investissement locaux, et des coûts additionnels de transport pour l'écoulement de la production. Notons ici que la plus part de ces délégations de cette région est connue pour sa longue tradition en matière d'émigration surtout vers la France, l'Algérie et vers la Libye. Ainsi, la population locale de cette zone a profité de la proximité géographique de la frontière libyenne pour créer une dynamique économique basée sur le commerce informel. Ce commerce, malgré ses inconvénients qui touchent l'économie nationale, a permis l'amélioration du niveau de vie et la fixation de la population dans la zone du Sud.

4.3. *Régions équipées en infrastructure et à haut niveau de développement*

Ce groupe est formé des délégations où l'agriculture (oasis) et le tourisme se présentent comme les secteurs économiques principaux. Le développement du tourisme saharien et aussi à l'île de Djerba est stratégique. L'Etat tunisien a été l'acteur

initial par ses investissements et ses avantages fiscaux et financiers consentis aux établissements touristiques. Ainsi, la présence de l'aéroport international « Djerba-Zarzis », de l'aéroport de Tozeur, et d'infrastructures routières contribue à en faire un centre touristique important et un générateur de croissance économique pour la région. Ce secteur touristique a créé des emplois directs et indirects, le nombre d'emplois directs lié à l'hôtellerie. L'emploi indirect est lié surtout à la construction des complexes hôteliers, aux services, à l'artisanat, au transport, etc., mais ceci reste toujours lié à la stabilité du secteur touristique.

Concernant les délégations de Gabès et de Gafsa, elles abritent une activité économique diversifiée, notamment un secteur industriel important spécialisé dans l'industrie chimique notamment le traitement des phosphates tunisiens. Le port de la ville de Gabès est le quatrième port de commerce du pays en termes de chiffre d'affaires. Gabès abrite aussi une infrastructure d'exploitation pétrolière off-shore et pétrochimique. L'infrastructure de base de la ville de Gabès est en pleine mutation, progressant vers une situation très favorable et attractive. Aussi, les délégations de cette région sont connues par sa palmeraie qui s'étend sur un ensemble d'une dizaine d'oasis. L'importante récolte des grenades dans ces oasis côtiers a permis d'améliorer la situation socioéconomique des agriculteurs. Par rapport à ce produit agricole, des études des produits « d'appartenance d'origine contrôlées » ont commencé pour identifier les grenades de Gabès.

4.4. *Discussion et solutions proposées*

La disparité régionale et territoriale nourrit un sentiment d'injustice engendrant plusieurs problèmes politiques, économiques et sociaux. Ainsi, le Sud Tunisien est marqué par la présence de territoires souffrant d'une crise multiforme. Celle-ci peut prendre la forme d'une crise de gestion des ressources naturelles dont la mobilisation a servi de palliatifs à des politiques de développement basées sur les ressources humaines et sur la maîtrise de la technologie. Le taux de chômage au niveau de ces régions ainsi que le taux de pauvreté demeurent relativement élevés par rapport à la moyenne nationale (Abaab et Elloumi, 2009). La réduction des disparités territoriales nécessite, à cet effet, d'améliorer l'infrastructure de base avec une redéfinition du rôle des espaces économiques et un redécoupage régional (Bélhedi, 2005) aussi bien dans le milieu rural, où la transformation des structures et la réduction des écarts entre secteur moderne et traditionnel doivent s'accompagner par des sessions de formation des agriculteurs et par la mobilisation des personnes ressources qualifiées, que dans le milieu urbain où l'état de concentration du réseau doit évoluer vers des formes d'organisation décentralisées, intégrées au plan régional et utilisatrices de main-d'œuvre (El Ansar, 2009). Depuis les années 80, la politique libérale adoptée par le programme d'ajustement structurel visait à insérer la Tunisie dans le processus de mondialisation suite à divers accords de libre-échange (OMC, UE, etc.). Cette politique a conduit à la suppression des réductions des subventions et des investissements publics, (réduction des transferts vers les zones rurales, etc.), la stagnation des prix à la production et des prix des intrants. Par conséquent, cette situation a eu un impact sur les régions intérieurs et a réduit l'utilisation de certains intrants provoquant une stagnation et/ou une baisse des rendements de certaines cultures dans une production minimale (Dhehibi et Elloumi, 2012). Aujourd'hui, le développement régional au Sud souffre de plusieurs handicaps, tels que :

- manque de l'information statistique actualisée périodiquement lié surtout au problème de la pauvreté au niveau local (par délégation), ce qui entrave l'élaboration des plans locaux de développement ;
- manque des études stratégiques régionales et locales ;
- les retards dans l'exécution de plusieurs projets de développement dans les régions du Sud ;
- la centralisation des décisions concernant l'octroi des crédits et des primes d'investissement au profit des entrepreneurs, ainsi que la complexité et la lourdeur des procédures administratives ;
- l'insuffisance de l'infrastructure de base ce qui représente un frein à l'attraction des investisseurs.

Ainsi, il est à remarquer que la participation aux concertations sur les politiques en Tunisie,

était jusqu'en 2011, et même parfois après 2011, réservée aux partenaires du dialogue social. Depuis, toutes les prises de position dans l'arène politique nationale sont examinées de près par un vaste ensemble d'organisations de la société civile et de groupes d'intérêts spécifiques, qui ne cessent de gagner en maturité.

Si la société civile est aujourd'hui un acteur clé des réformes nationales qui dispose depuis 2011 d'une marge de manœuvre beaucoup plus large qui lui permet de s'intéresser aux questions politiques, au niveau régional, la situation est toute autre. La société civile locale peine en effet à se professionnaliser et se frayer un chemin clair pour atteindre la maturité requise lui permettant la participation effective dans la mise en œuvre de politiques de développement. Des efforts doivent être apportés pour :

- renforcer la société civile locale et l'habiliter à devenir un acteur clé de toute stratégie territoriale ;
- tenir compte de la participation de la société civile dans les décisions politiques de développement ;
- concevoir un « modèle » qui catalyse les dynamiques locales en habilitant la société civile régionale à formuler des stratégies de développement régional et qui tire parti des capacités de toutes les forces mobilisables (hommes, femmes et jeunes) ;
- mandater les administrations régionales à envisager des solutions de développement régional en collaboration avec une société civile locale mieux organisée et plus efficace ;
- opérationnaliser les principes de la décentralisation et de la bonne gouvernance dans les domaines de développement des régions.

4.5. *Scenarios de développement*

Le développement régional devrait se concentrer dans les zones prioritaires dans l'arrière-pays confrontées à des débouchés d'emploi plus faibles, un taux de chômage élevé et/ou l'exode de la population : Tozeur, Gafsa, Kébili et Tataouine. Pour cela on va proposer trois scenarios qui ont des différents impacts sur la région du Sud.

	Scénario 1 : Initiative Privée de Développement de Cluster (Les clusters de développement seront créés partout dans la région du Sud. La région sera également améliorée même sur les plans social et économique)	**Scénario 2 : Initiative Privée de Développement Concentré** (C'est une approche de développement de passage qui introduit la tendance du développement centralisé tout d'abord par initiative privée qui devrait, à long terme, entraîner un appui au développement intérieur. Tout d'abord la zone côtière sera développée avec l'approche concentrée, puis les zones intérieures seront développées par la suite)	**Scénario 3 : Initiative Publique de Développement de Cluster** (Cette approche est pour créer un cluster de secteurs productifs ou basé sur le produit dans le cadre des initiatives publiques, prenant en compte les secteurs et/ou produits qui devraient avoir une synergie efficace dans le développement, et pour promouvoir les domaines potentiels avec plus d'options dans le développement qui serait exécuté par le secteur privé dans le cluster)
Efficience du développement d'infrastructure	Nécessité d'un développement plus large d'infrastructure, pour cela **Efficience Relativement Faible**	Développement concentré d'infrastructure, pour cela **Efficience Relativement Forte**	Développement planifié & raisonnable de l'infrastructure, pour cela **Efficience Relativement Forte**

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Aspect de l'Effet Economique et ses Changements	Développer lentement au début, les clusters seront créés au long terme.	Un effet économique devrait être remarqué au début.	Développer lentement au début, les activités à haute valeur ajoutée doivent s'accélérer après la création de cluster.
	Une modeste mais stable croissance économique peut être remarquée après 2035 et en une période plus longue.	Certains domaines peuvent ralentir leur croissance économique après 2035.	Davantage de croissance économique sera remarquée après 2035.
Risques Economiques	Une suprématie de marché peut apparaitre.	Le risque de développement est faible en raison du plan de développement concentré.	Un niveau prometteur d'effet et de croissance économiques peut être remarqué.
	Une augmentation de profit peut être possible dans des secteurs de production ou des entreprises limités, puisque chacun sera principalement développé à part.	Il pourrait y avoir une réduction en profit suivant la réduction en production après 2035 à cause de la consommation excessive de ressources.	Il y aurait une possibilité de retard de développement à cause de la mauvaise conduite du développement par le gouvernement.
Création d'Emploi et Exode de Population	Possibilité de création d'emploi dans les zones intérieures et côtières, mais la création d'emploi et la formation des ressources humaines devrait prendre plus de temps.	Il a un potentiel de création très rapide d'emploi, mais qui doit entrainer une forte tendance de concentration de l'emploi dans la zone côtière en une courte période.	Une création d'emploi en un niveau plus élevé dans les zones intérieures et côtières peut être réalisée dans le cadre du développement basé sur le cluster.
	Le flux de la population peut être efficacement contrôlé, les communautés seront stables.	Cela peut entrainer un flux de la population dans les communautés de la zone intérieure en une courte période.	Cela contribue à stabiliser la population et le peuplement, les communautés de même seront stables.
Zone du Gouvernement Action et Impact	Il est plus difficile de développer l'infrastructure pour soutenir et activer également les développements répartis dans la région dans le cadre de l'initiative privée.	Il est plus difficile par la suite d'accomplir des actions politiques pour apporter un avantage économique aux zones intérieures basé sur le développement avec le principe d'économie de marché.	Cela nécessite un niveau très élevé de capacité d'organisation chez les agences gouvernementales pour exécuter la planification, le fonctionnement et la gestion du développement.
Conservation et Gestion de Ressources en Eau	Il est nécessaire de gérer une distribution équilibrée de ressources en eau entre les zones, les régions et les entrepreneurs surtout dans les zones intérieures.	Il n'y a pas de grands enjeux de ressources en eau dans les zones intérieures comme la production principale s'effectue dans la zone côtière, malgré qu'une grande station de dessalement sera nécessaire dans le développement concentré.	La distribution et la gestion des ressources en eau peuvent être efficacement réalisées dans le cadre de développement coopératif basé sur les secteurs et/ou les régions.

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Mesures de Contrôle de Pollution	Un traitement individuel et attentif est nécessaire pour les problèmes de pollution existants dans la région.	Le traitement et la gestion de pollution peuvent être facilement réalisés puisque le développement concentré entraine aussi une concentration de pollution dans la zone côtière.	Un traitement individuel et attentif est nécessaire pour les problèmes de pollution existants dans la région.

5. Conclusion

Cette analyse montre que des disparités intra-régionales sont mises en exergue dans le Sud Tunisien. Certains facteurs peuvent expliquer l'inégal développement socioéconomique de cette région qui est composée de six gouvernorats et de 48 délégations. Les résultats obtenus suite à une Analyse en Composantes Principales (ACP) montrent que la région de Sud Ouest est peu développée et cela est attesté par plusieurs variables déterminants qui sont principalement des variables sociales tels que le taux de chômage, le taux de scolarisation, le solde migratoire, la pauvreté et l'exclusion sociale. Les résultats montrent la nécessité d'adaptation des politiques afin d'appliquer l'article 12 de la constitution tunisienne de 2014 en relation avec la discrimination positive. Aussi aujourd'hui il y a une nécessité de limiter la dégradation des revenus des ménages en milieu rural, en particulier pour les petits agriculteurs, et prévenir le risque d'exode massif vers les régions urbaines, il faut ici diversifier l'économie des régions intérieures, où l'agriculture continue d'être, dans une large mesure, le secteur d'activité prédominant (Dhehibi et Elloumi, 2012). Ces variables doivent être repensées dans la réorientation des nouvelles politiques de développement. Les disparités intra-régionales dans le Sud Tunisien sont le produit de plusieurs facteurs explicatifs :

- accumulation différenciée des capitaux sous toutes ses formes : capital physique, capital humain, dotation différenciée de l'infrastructure de base ;
- présence de chômage, de l'analphabétisme, d'un solde migratoire négatif, de l'inanité de création d'emploi…

Au terme de l'Analyse en Composantes Principales, force est de constater qu'au clivage classique entre les régions de l'intérieur et du littoral en Tunisie vient se greffer des inégalités à l'intérieur même des gouvernorats. La théorie de la Nouvelle Economie Géographique (NEG) se trouve confirmer, la région du Sud-Est connait un renforcement de son attractivité. Cette dynamique économique prend sa source dans l'expansion du tourisme balnéaire qui constitue un facteur déterminant de littoralisation au niveau national mais aussi, l'analyse le confirme, au niveau régional. D'importantes infrastructures d'accompagnement ont été octroyées à la région du Sud (aéroport, routes, adduction d'eau, électrification, téléphone…). La région du Sud-Est, notamment l'axe Jerba-Zarzis, en est la plus bénéficiée en raison de l'accumulation primitive des capitaux et de ses dotations initiales. Le clivage intra-régional est fondé sur deux modèles difficiles à distinguer : un modèle capitaliste avec des fonctions des villes de type moderne et diversifié concernant la région Sud-Est et un modèle étatique basé sur l'emploi public administratif greffé sur un modèle traditionnel. L'Analyse en Composantes Principales a identifié un clivage dans le Sud Tunisien entre la zone côtière du Sud-Est doté d'une infrastructure de base et l'intérieur peu développé. La réduction des disparités intra-régionales nécessite de repenser les politiques de développement de type « top down ». La concentration des activités économiques sur la bande côtière du Sud-Est par rapport aux régions de l'intérieur du Sud trouve ses fondements dans la faiblesse des structures productives de ces zones intérieures. Il importe d'engager un processus de développement local endogène et inclusif basé sur les spécificités culturelles, historiques et sociales des populations de l'intérieur du Sud Tunisien. L'approche participative (botton up) fondée sur l'amélioration des structures productive informelles et le

développement des relations informelles entre les divers acteurs en présence, appuyé par un nouveau modèle de développement, permettent de créer des effets de synergies dans la région du Sud Tunisien dans son ensemble. Les analyses traditionnelles de développement socioéconomique à la Perroux (pole de croissance) des régions foyers (Perrin) du développement polarisé (Friedman) sont reprises et modélisés par Krugman, Thisse, Fujita… Cette école est nommée communément la Nouvelle Economie Géographique. Fujita et Thisse écrivent « Toute configuration spatiale d'activités économique peut être vue comme le résultat d'un processus impliquant deux types de forces opposées, à savoir les forces d'agglomération (ou forces centripètes) et les forces de dispersion (ou forces centrifuges). La Nouvelle Economie Géographique postule que les disparités régionales proviennent de l'inégale dotation géographique des économies d'agglomération ».

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Optimisation des réseaux de distribution des produits agroalimentaires : Modélisation et application

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Abstract

A certain number of factors can affect the functioning of the distribution chains of large agrifood companies and impact their efficiency. Among them, poor adaptation to fluctuations in demand, imperfect control of production and transport costs and poor location of distribution centers. These dysfunctions can have negative consequences with high product prices, supply disruptions and customer dissatisfaction. The company is therefore required to review regularly the distribution plan for its products in order to optimize it: addition, deletion, relocation, reassignment of warehouses, delivery centers, etc. We propose, through a case study of the agro-food group Cevital (Algeria), a solution to the problem of restructuring supply and distribution networks, at a stage of development of this company. Using an operational research tool (mixed-integer linear programming), the study assesses four scenarios for structuring the company's distribution network and suggests, for decision-making purposes, strategic solutions for managers.

***Keywords**: Agri-food industry, Supply-chain, Management, Modeling, Location, Distribution centers, Transport cost, Cevital group, Mediterranean region.*

1. Introduction

L'alimentation fut longtemps un fait essentiellement agricole. Elle est assurée aujourd'hui à travers un processus multisectoriel de production, transformation et de distribution faisant appel à un grand nombre d'activités différentes et d'agents économiques de plus en plus nombreux. Ces agents interagissent dans le cadre de ce qui est communément appelé supply chain. Leur diversité et le développement des activités en amont et en aval de l'agriculture conduisent à des réseaux complexes avec de nouvelles préoccupations en termes de circulation des produits alimentaires depuis leur production jusqu'à leur consommation (Padilla et Bencharif, 2001). La croissance de la demande en produits agroalimentaires, du fait notamment de l'augmentation de la population, accentue les défis d'organisation des supply chains.

L'offre alimentaire est de plus en plus assurée à travers un réseau complexe regroupant un ensemble d'activités en interaction, incluant la

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production/transformation, la collecte, le stockage, le conditionnement, la commercialisation (marchés de gros ou de détail, centres de distribution). Les questions liées à la distribution, à l'entreposage, au transport de marchandises, la satisfaction juste à temps et sans rupture de la clientèle, sont une préoccupation constante, en particulier pour les grandes entreprises du secteur, que ces activités soient d'ailleurs intégrées ou assurées par des partenaires extérieurs. En effet, un certain nombre de facteurs peut affecter le fonctionnement d'une chaîne d'approvisionnement et de distribution, réduisant la valeur créée en son sein, notamment les aléas de la demande, la non maitrise des coûts de production et des coûts de transport, des localisations inadéquates des entrepôts, des centres de distribution, etc. L'entreprise doit subir de telles inefficacités des fonctions logistiques quand celles-ci sont externalisées. Elles ont une plus grande flexibilité stratégique pour en améliorer le fonctionnement quand ces fonctions sont intégrées en leur sein de l'entreprise. Les entreprises qui disposent de leur propre réseau logistique doivent alors anticiper au mieux les fluctuations de marché pour décider de façon optimale les caractéristiques de leur réseau. Ils doivent, le cas échéant, ajuster quand cela est nécessaire leur infrastructure à des stades postérieurs de leur développement (ajout, suppression, relocalisation et/ou réaffectation d'entrepôts, de centres de livraison…).

Il est fréquent en effet qu'à un stade de son développement, l'entreprise soit contrainte de redéfinir le dimensionnement de son réseau et/ou de décider de son extension en tenant compte à la fois de son expérience passée et des nouvelles données du marché. Devant la difficulté de prédire précisément l'évolution des marchés, certains choix de localisation et des plans de distribution, qui pouvaient apparaître efficaces à une étape du développement de l'entreprise, peuvent s'avérer inappropriés à une autre. Les ajustements passent alors le plus souvent par la remise en cause des choix antérieurs, souvent les plus lourds en termes d'investissement.

L'objectif de cet article est justement de proposer, à travers un modèle de localisation et de relocalisation des infrastructures logistiques, des solutions pour rationaliser les décisions du groupe agro-alimentaire algérien Cevital. Nous allons montrer tout d'abord à travers cette étude de cas, comment cet outil de recherche opérationnelle, au-delà des aspects mathématiques nécessaires à la résolution de la question posée par l'entreprise, peut s'avérer particulièrement utile à éclairer la décision privée. L'analyse et la résolution du problème d'optimisation conclut à une nécessité de redimensionnement du réseau de l'entreprise (localisation, ajout ou suppression de certaines infrastructures), afin d'améliorer au mieux les performances de cette dernière. Le modèle, construit à partir des questions concrètes que se pose une entreprise a toutefois une valeur de généralité. Il peut être adapté aux spécificités d'autres entreprises en prenant en compte leurs contraintes et environnement propres.

2. Etat de lieu et littérature économique

Historiquement, les fondements de la théorie économique de la localisation appliquée à l'agriculture ont été posés par Von Thünen (1826) dans son ouvrage intitulé *Isolated State with Respect to Agriculture and National Economy*. L'idée est d'expliquer la localisation des activités agricoles, l'utilisation des sols et la formation de la rente en mettant en évidence le rôle de la distance entre les bassins de production et les places de marché (et in fine les coûts de transports qui y sont associés). Plus tard, s'est développé un certain nombre de théories économiques de la localisation, qui diffèrent essentiellement par la nature des questions spécifiques étudiées et le corpus d'hypothèses pris en compte : environnement des acteurs (typologies des marchés, structure des systèmes de production et de la demande, des coûts de transport…), comportement des acteurs (faiseurs ou preneurs de prix, nature des variables de décision, typologie des jeux d'interaction sur les marchés…). Reprenant une classification proposée par Ponsard et Beguin (1988), on peut citer entre autres, les travaux de Weber (1909) avec sa théorie de la localisation industrielle et la détermination du coût minimum de transport, le modèle d'Hotelling (1929) analysant, dans le cadre de la nouvelle économie industrielle, les liens entre la localisation des entreprises et la concurrence sur le marché (prix

et parts de marché). La théorie, communément appelée « nouvelle économie géographique » (Krugman, 1998), se pose comme objectif d'expliquer les mécanismes qui déterminent la localisation des systèmes de production et des activités agro-industrielles (forces d'agglomération et de dispersion (Fujita et Thisse, 1997).

Une branche récente de la littérature sur la question de la localisation se concentre sur la réalité des échanges et des flux commerciaux au sein des chaînes d'approvisionnement et des filières. Il s'agit d'analyser, par exemple, les effets de la localisation des marchés de gros (Etemadnia *et al.*, 2015 ; Zheng *et al.*, 2019 ; Biuki *et al.*, 2020) ou des bassins de production (Sarkar *et al.*, 1997 ; Rhim *et al.*, 2003) sur le fonctionnement des marchés et la formation des prix. Parallèlement à cette littérature d'essence économique, une autre approche, fondée sur les outils de recherche opérationnelle, sans formalisation des questions de comportement et de marché, s'est développée autour de préoccupations plus concrètes : la recherche de solutions techniques pour améliorer la gestion et le management des opérations le long des chaînes d'approvisionnement et de distribution (ReVelle et Eiselt, 2005 ; Baumol et Wolfe, 1976). Un large panel de questions concrètes s'est dès lors imposé : Quels délais d'acheminement des produits ? Quels coûts et pour quels prix ? Quel nombre, quelle taille et quelle localisation des centres de production et de distribution ? Quelle technologie utiliser dans la production/transformation ? Quelle serait la modalité optimale de transport, de stockage ? Quels sont les produits à fabriquer et à stocker dans chaque entrepôt ?

A partir de modèles mathématiques, les travaux, plutôt théoriques, proposent des solutions techniques pour optimiser le fonctionnement des réseaux logistiques en déterminant les caractéristiques souhaitables (taille des centres de distribution ; des entrepôts, leurs localisations…). Ces travaux portent sur différentes typologies de réseaux, intégrant différentes contraintes de l'environnement de la chaîne : zones géographiques éligibles, localisation, comportements des acteurs, nature des flux de produits, structure de la demande, fonction objectif du décideur[1]. Au niveau méthodologique, il est utile de préciser ce qui distingue les modèles de localisation et les modèles de distribution (optimisation des chaines de distribution). Un modèle de distribution est une extension d'un modèle de localisation discret auquel sont ajoutées certaines variables et contraintes, notamment de flux de marchandises et de coûts de transport. Le modèle de localisation analyse la localisation des entrepôts en fonction de celles des usines et des clients (Balinski, 1965 ; Klose et Drexl, 2005 ; Melo *et al.*, 2009). Il permet, comme décrit dans Francis *et al.* (1983), de localiser des établissements tenant compte de certains coûts, comme ceux de transport et de construction. Le modèle de Geoffrion et Graves (1974) a été le premier modèle de distribution à intégrer la localisation des centres de distribution et l'affectation des produits et des clients à ces derniers afin de minimiser le coût total du système. Dans la lignée de cette littérature, Ahmadi-Javid et Hoseinpour (2015) proposent un programme non linéaire à variables mixtes, pour déterminer les localisations optimales des centres de distribution à approvisionner. Le modèle prend en compte la variation de la demande en fonction des prix et des contraintes de capacités de stockage. Le modèle, à la différence de Cortinhal *et al.* (2015), ne traite cependant pas la question de redimensionnement d'un réseau logistique. Dans le prolongement de cette approche, Tang *et al.* (2016) considèrent un réseau collaboratif (entre un cluster de fournisseurs et plusieurs milliers de clients) et Ma *et al.* (2016) un modèle de localisation (formellement, une programmation bi-niveaux) pour la gestion de la chaîne d'approvisionnement.

Le modèle de localisation-allocation que nous proposons est dans la lignée de cette littérature et se pose comme objectif l'optimisation et le

[1] Parmi les questions traitées : nombre et localisation des installations pour minimiser les coûts de transport et/ou satisfaire la demande, schéma de circulation des flux pour garantir la qualité des produits et la traçabilité, nombre et emplacement des hubs alimentaires, allocation de zones géographiques aux clients…

redimensionnement du réseau de distribution de Cevital. Nous analysons différents scénarios associés à la structure du réseau de cette entreprise. Sur un plan technique, il renvoie à un programme linéaire mixte (MILP)[2].

3. Position du problème et modélisation

En Algérie, le secteur des industries agroalimentaires a connu une progression vigoureuse au cours de ces 20 dernières années. Les perspectives de croissance à venir sont a priori prometteuses au regard de l'importance de la demande et des possibilités d'exportation dans certains secteurs (Bennacer, 2018). Le secteur privé à plus de 80 % occupe une place de choix dans l'approvisionnement du marché national en produits qui constituent la base du système alimentaire et nutritionnel algérien (farine, semoule, pâtes alimentaires, lait et produits dérivés, huiles alimentaires, tomate industrielle, sucre, etc.) (Bessaoud *et al.*, 2019).

Le groupe industriel Cevital représente l'une des figures clé de ce paysage. Le Groupe est un conglomérat algérien de l'industrie agroalimentaire, la grande distribution, l'industrie et les services. Créé en 1998 sur des fonds privés (Société Par Actions), le groupe est parmi les entreprises algériennes qui ont vu le jour dès l'entrée de l'Algérie en économie de marché, pour constituer aujourd'hui un acteur incontournable dans l'économie nationale, en raison de sa taille, sa diversification et son déploiement à l'échelle nationale. Le groupe occupe également les premières places en matière de création d'emploi et de distribution de la richesse et, par conséquent, apporte une forte contribution au budget de l'Etat. Il compte, par ailleurs, parmi ses clients de grands noms du domaine de l'agro-business, citons : Coca-Cola, Kraft Food, Danone, etc. (ANPCE, 2019).

Composé de plusieurs unités de production (les raffineries de sucre et des huiles, la margarinerie, le conditionnement d'eau minérale ainsi que la fabrication et le conditionnement de boissons rafraichissantes et conserverie), le secteur agro-alimentaire représente la pierre angulaire du groupe Cevital (80 % de ses activités[3]) et lui procure une très bonne position sur le marché national (parmi un certain nombre de producteurs nationaux et importateurs) et en Afrique. L'implantation de l'usine de production des huiles, de sucre et de margarine au sein du port de Béjaia a permis à Cevital de disposer de silos portuaires et de l'accès direct à un quai du port pour le déchargement des matières premières et l'exportation de ses produits. Grace à ses filières, le groupe Cevital devient le plus grand groupe privé en Algérie et le deuxième exportateur après l'entreprise pétrolière SONATRACH. Une grande partie de sa production est exportée dans plusieurs pays européens (France, Espagne, Italie, Allemagne) et d'autres pays de l'Europe orientale, d'Afrique, du Moyen Orient et du Maghreb.

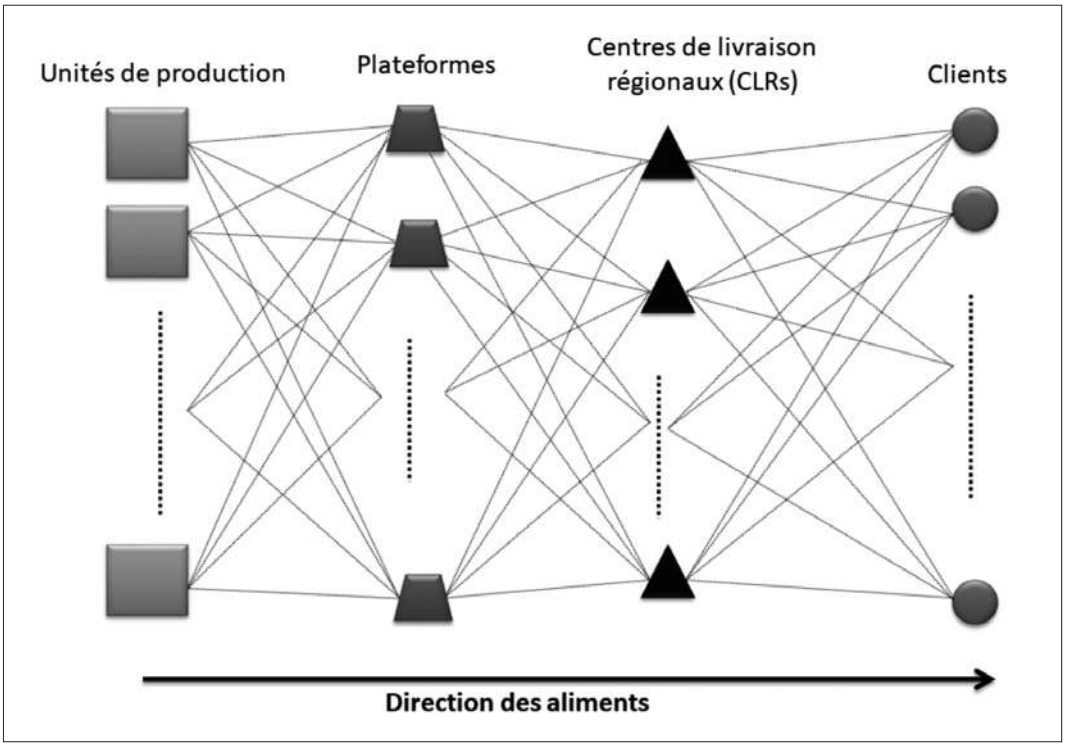
Pour assurer une bonne couverture de ses produits en les rapprochant le mieux possible des clients dans les délais les plus courts et au meilleur prix, le groupe Cevital a développé son propre réseau de distribution avec la création de ses filiales Numilog (2012) et Numidis (2007). Ainsi, le transport journalier de la marchandise depuis les trois unités de production jusqu'aux trois plateformes et des plateformes aux CLRs est assuré par le groupe Cevital. Les coûts de transport des produits depuis les CLRs ou depuis les unités de production aux clients sont à la charge des clients.

Le développement continu du groupe Cevital et l'évolution de son environnement socio-économique imposent à son réseau de distribution une mise à niveau régulière de ses moyens logistiques et de transport et une actualisation de ses plans de distribution pour maintenir sa performance.

Pour répondre à ces questions, nous construisons dans une première étape un modèle général d'optimisation d'un réseau de distribution de produits pour une entreprise agroalimentaire avant de l'appliquer, dans la section

[2] La résolution du modèle s'effectue en utilisant la version CPLEX Community 12.6.3 comme solveur du MILP.
[3] https://www.cevital.dz/agro-industrie-et-distribution/.

Figure 1 - Système type d'une chaine logistique de distribution de produits pour les entreprises agroalimentaires.



Source: réalisée par les auteurs.

suivante, aux données factuelles attachées à une problématique spécifique posée par Cevital.

Un système typique d'une chaine logistique de distribution de produits pour les entreprises agroalimentaires est illustré dans la Figure 1, où les nœuds représentent des unités de production, des plateformes (ou des entrepôts) et des centres de livraison régionaux (CLRs). Les arêtes de liaison représentent les flux de marchandises entre les nœuds.

Pour redimensionner d'une manière optimale et mettre à jour cette infrastructure existante, nous sommes amenés à répondre aux questions suivantes :

- Que se passera-t-il si nous ajoutons des plateformes et/ou des CLRs ? Où les localiser ? A quelles tailles et à quel nombre ?
- Que se passera-t-il si nous fermons des plateformes et/ou des CLRs ? Lesquels ?
- Quelles réaffectations (optimales) entre les unités de production, les plateformes, les CLR et les clients ?

Les réponses à ces questions vont constituer des décisions critiques, permettant de minimiser le coût total du réseau de distribution, qui inclut :

- le coût total de transport de l'entreprise ;
- le coût total de transport des clients ;
- le coût total de maintien des plateformes et des CLRs ;
- le coût total de fermeture des plateformes et des CLRs ;
- le coût total d'installation de nouvelles plateformes et CLRs.

En notant par :

- x: le vecteur des décisions à prendre, dont les composantes désigneront : les quantités de produit à transporter d'une destination à une autre du réseau, les plateformes en activité à fermer et les nouvelles à construire, les CLR à ouvrir et ceux à fermer ;
- X: l'ensemble des solutions réalisables vérifiant les contraintes relatives au réseau de distribution (capacités, satisfaction de la demande…) ;

- φ la fonction du coût total du réseau de distribution agrégeant les coûts de transport de l'entreprise et ceux des clients ; le coût de maintien des plateformes et des CLRs en activités, les coûts de fermeture des plateformes et des CLRs en activité et les coûts de construction (fixe et variable) de nouvelles plateformes et de nouveaux CLRs.

Le problème d'optimisation d'un réseau de distribution d'une entreprise agroalimentaire se ramène à la résolution du programme linéaire mixte: (voir annexe 2 pour la description plus détaillée du modèle) :

$$\min_{x \in X} \varphi(x) \qquad (1)$$

4. Étude de cas: optimisation du réseau de distribution du groupe Cevital

Face au développement du groupe Cevital, de nouveaux besoins se sont fait sentir pour améliorer les performances de son réseau de distribution. Les fréquentes ruptures de stocks constatées au sein de certains CLRs du centre du pays en raison de la progression de la demande dans cette région et pour se rapprocher des clients du Sud, qui s'approvisionnaient depuis les trois unités de production du Nord, le groupe Cevital a pris la décision stratégique de localiser deux nouvelles plateformes sur deux régions : l'une à Alger, au Nord du pays, et l'autre à Biskra, au Sud. Il projette aussi de délocaliser certains de ses CLRs qui ne sont pas rentables, car ils génèrent des coûts de stockage avec de faibles taux d'occupation. Dans le but d'acheminer les produits des unités de production aux clients à moindre coût, les gestionnaires de Cevital nous ont soumis la problématique suivante : Quelles seraient les tailles optimales des plateformes d'Alger et de Biskra, si ces dernières venaient éventuellement à être installées ? Quelles seront les affectations optimales des CLRs à la plateforme d'Alger ? Quelles seront les affectations optimales des clients à la plateforme de Biskra ? Et enfin, quels seront les CLRs à supprimer ?

Nous développons une application du modèle (1) pour l'optimisation et le redimensionnement du réseau de distribution de Cevital, qui répond à cette problématique.

Le réseau initial de distribution du groupe Cevital se compose de[4] :

a) 3 unités de production spécialisées localisées comme suit :
   - Bejaia usine, située au port de Béjaia : unité de production et de conditionnement de sucre, de margarine et de différentes catégories d'huile ;
   - Cojek usine, située à El Kseur (Wilaya de Béjaia) : unité de production des boissons fruitées et des conserves ;
   - LLK usine, située à Tizi-Ouzou : unité de production et de conditionnement des eaux minérales (plates, gazeuses et sodas).

b) 3 plateformes de stockage externes qui sont propres à l'entreprise : Bouira au Centre, Oran (Hassi-Ameur) à l'Ouest et Constantine (El-Khroub) à l'Est.

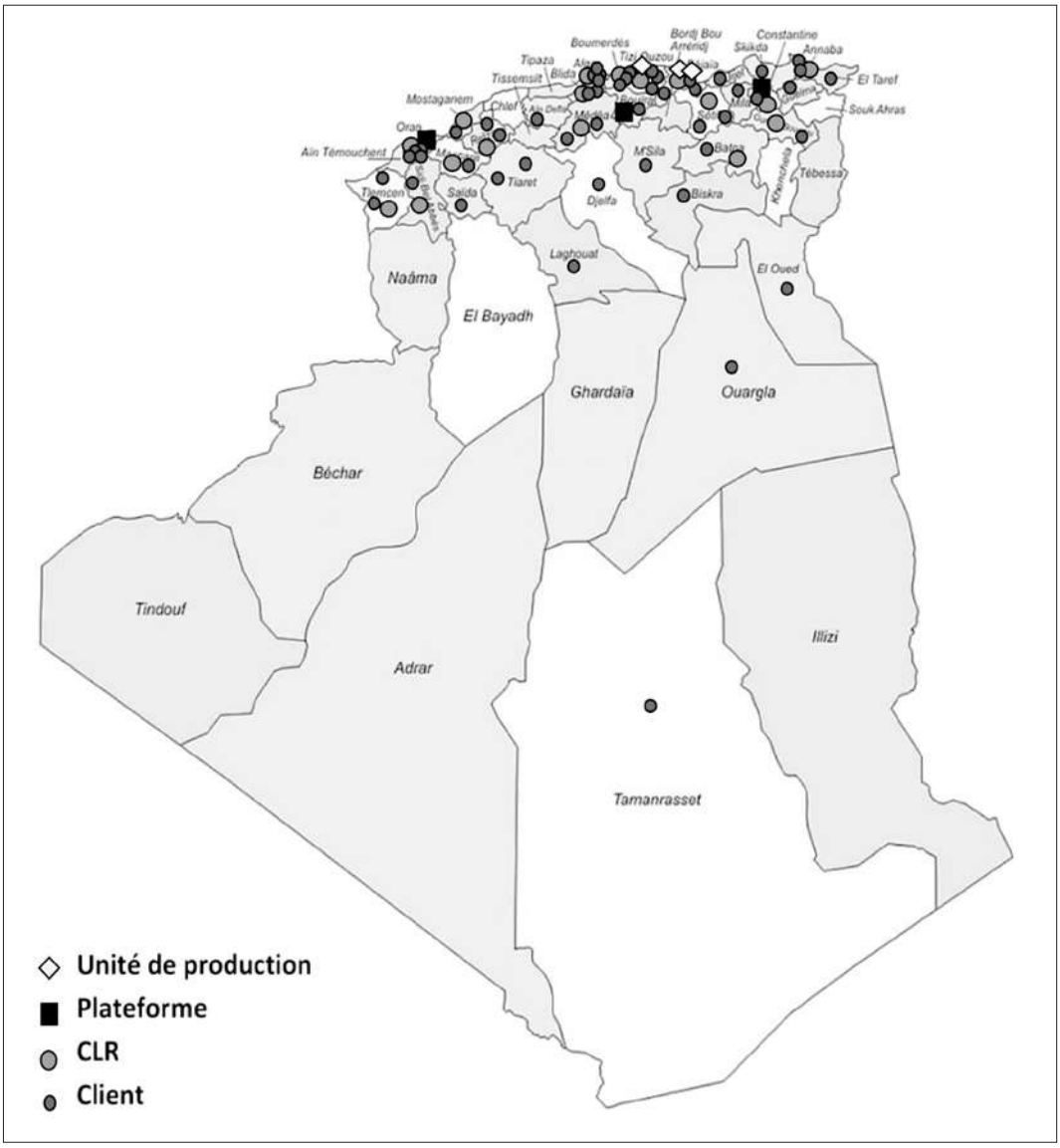
c) 18 Centres de Livraison Régionaux (CLRs)[5] répartis comme suit :
   - 7 CLRs reliés à la plateforme d'Oran, qui sont : Sidi-Bel-Abbas (22), Oran (31), Relizane (48), Mostaganem (27), Tlemcen (13), Tiaret (14) et Mascara (29) ;
   - 6 CLRs reliés à la plateforme de Bouira, qui sont : Alger (16), Blida (09), Boumerdès (35), Tizi-Ouzou (15), Bejaia (06) et Médéa (26) ;
   - 5 CLRs reliés à la plateforme de Constantine, qui sont : Batna (05), Constantine (25), Sétif (19), Oum El Bouaghi (04) et Annaba (23).

d) de grands clients, dont les grossistes, les représentants, les industriels, qui sont dispersés sur tout le territoire national. Il s'agit de :

[4] Les plateformes, les CLRs et les clients prennent le nom et le code administratif de leur wilaya.

[5] Etablissement créé par l'entreprise en 2014 pour réduire la pression sur le complexe et rapprocher la marchandise du client. Il est doté d'un centre d'appels pour gérer les demandes et possède une base de données de tous les clients.

Figure 2 - Le réseau de production-distribution de l'entreprise Cevital sur le territoire national.



Source: réalisée par les auteurs à partir de la carte géographique de l'Algérie.

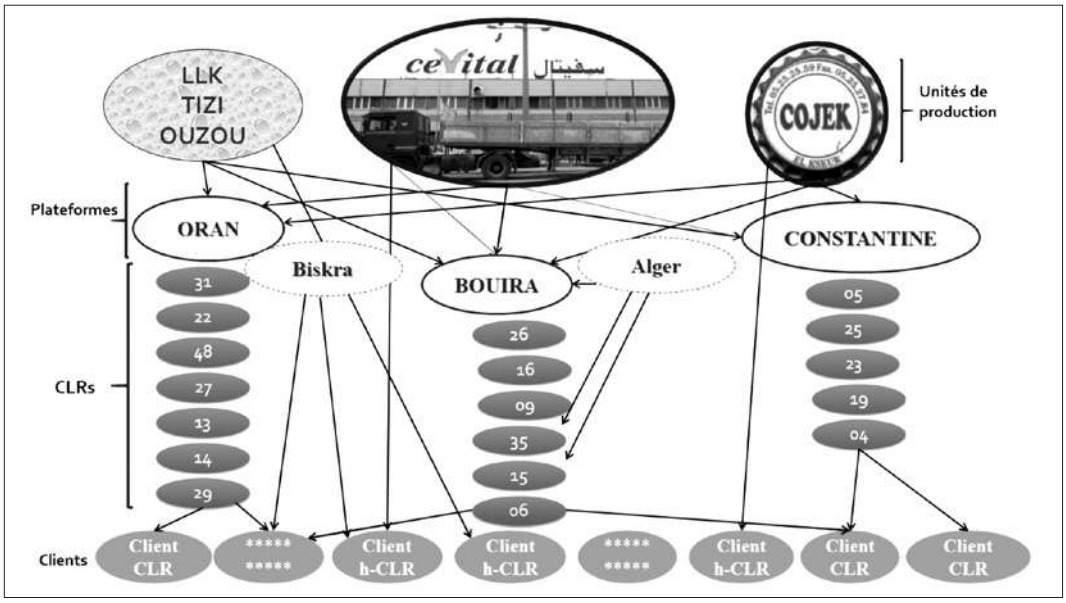
- 26 clients qui s'approvisionnent uniquement des CLRs (clients-CLR) ;
- 26 clients qui s'approvisionnent uniquement des unités de production (clients hors-CLRs).

Par ailleurs, nous illustrons sur la carte géographique de l'Algérie (Figure 2), le réseau de production-distribution de l'entreprise Cevital sur le territoire national.

Le plan de transport de marchandise adopté par Cevital est comme suit :

- le transport de la marchandise depuis les 3 unités de production jusqu'aux 3 plateformes et des plateformes aux CLRs est assuré par Cevital ;
- le coût de transport des produits depuis les CLRs ou les unités de production jusqu'aux clients est à la charge des clients eux-mêmes,

Figure 3 - Le nouveau réseau envisagé par l'entreprise Cevital.



sachant que les clients-CLR s'approvisionnent des CLRs et les clients hors-CLR s'approvisionnent des 3 unités de production.

La problématique de Cevital consiste alors, d'une part, à déterminer les tailles des plateformes d'Alger et/ou de Biskra et, d'autre part, à identifier les CLRs qui s'approvisionneront à partir de la plateforme d'Alger, à déterminer les clients qui s'approvisionneront de la plateforme de Biskra et à décider des éventuels CLRs à supprimer. Enfin, notre travail consistera à définir la configuration optimale du réseau global de distribution de Cevital.

Sur la Figure 3, nous schématisons le nouveau réseau envisagé par l'entreprise.

4.1. *Collecte de données*

La collecte de données de l'année 2018 a été effectuée au niveau des différents services de l'entreprise Cevital. Au niveau du service production, nous avons collecté des données sur la capacité de production et fait un inventaire de sa gamme de produits (Cf. Tableau 1).

Dans le Tableau 2, nous représentons la liste des plateformes de l'entreprise Cevital avec leurs capacités de stockage, que nous avons recueillie au niveau du service commercial.

Tableau 1 - Capacité de production journalière de chaque produit.

N° du produit	*Produit*	*Capacité de production (palette/jour)*
1	Huile	14203
2	Sucre	9024
3	Margarine	3426
4	Eau minérale	6495
5	Boissons fruitées et conserves	1299

Source : Réalisé par les auteurs, à partir des données collectées au niveau du groupe Cevital.

Tableau 2 - Les capacités des plateformes.

Localisation	*Plateformes*	*Capacité (palettes)*
Centre	Bouira	20000
Est	Constantine (El Khroub)	3000
Ouest	Oran (Hassi-Ameur)	12000

Source : Réalisé par les auteurs, à partir des données collectées au niveau du groupe Cevital.

Tableau 3 - Coût de stockage d'une palette dans les CLRs.

CLR	*Coût (DA) (palette/ jour)*	*CLR*	*Coût (DA) (palette/ jour)*
Oum El Bouaghi (04)	798	Sidi Bel Abbas (22)	1440
Batna (05)	739	Annaba (23)	570
Bejaia (06)	1856	Constantine (25)	1348
Blida (09)	1014	Médéa (26)	1148
Tlemcen (13)	713	Mostaganem (27)	939
Tiaret (14)	723	Mascara (29)	713
Tizi-Ouzou (15)	595	Oran (31)	482
Alger (16)	775	Boumerdès (35)	879
Sétif (19)	714	Relizane (48)	718

Source : Réalisé par les auteurs, à partir des données collectées au niveau de Cevital.

Au niveau du service logistique, nous avons collecté les données suivantes :

- le coût de transport : 89 DA/km ;
- le coût moyen de stockage journalier (DA/ palette) dans chaque CLR (représentant la somme des coûts de stockage, d'allocation et de manutention) est présenté dans le Tableau 3.

Les données concernant les demandes[6] des clients CLRs pour l'année 2018 sont représentées dans le Tableau 4 (voir annexe 1). Pour ne pas surcharger le papier, nous avons omis de présenter les demandes des clients hors-CLR.

Par ailleurs, nous avons utilisé l'application Web « Google Map » pour calculer certaines des distances inter-wilayas que nous avons utilisées dans le modèle.

4.2. *Application du modèle et étude de scénarios*

L'application du modèle mathématique (1) à la problématique spécifique de Cevital nous conduit à l'étude de quatre scénarios :

- *Scénario 1* : modélise le réseau actuel de l'entreprise (sans la mise en activité des plateformes d'Alger[7] et de Biskra) ;
- *Scénario 2* : modélise le réseau avec la mise en activité de la plateforme d'Alger ;
- *Scénario 3* : modélise le réseau avec la mise en activité de la plateforme de Biskra ;
- *Scénario 4* : modélise le réseau envisagé par Cevital (avec la mise en activité des deux plateformes d'Alger et de Biskra).

Pour chacun des quatre scénarios, l'entreprise cherche, d'une part, à délocaliser d'une manière optimale les CLRs en surplus afin de réduire les coûts et, d'autre part, à déterminer les réaffectations optimales des clients associés. Pour optimiser sa politique de distribution, l'entreprise se pose comme objectif la minimisation à la fois de son coût total de transport et du coût total de transport des clients[8].

[6] Demandes moyennes journalières de l'année 2018.

[7] Dans le modèle, une plateforme alimente uniquement des CLRs. Dans cette étude de cas, la plateforme d'Alger pourra par contre alimenter la plateforme de Bouira et certains de ses CLRs dans l'objectif de gérer les pénuries. Pour ce scénario, nous rajoutons la contrainte permettant ces affectations.

[8] Pour le cas spécifique du réseau de Cevital, les termes que nous considérons dans la fonction objectif (d'après les objectifs du groupe) sont : le coût de transport de l'entreprise et des clients et le coût de stockage dans les CLRs.

4.3. *Analyse et discussion des solutions obtenues*

Après la résolution des modèles associés aux quatre scénarios, nous obtenons les coûts optimaux, que nous résumons dans le Tableau 5.

Tableau 5 - Coûts optimaux de transport (DA/Jour) pour les quatre scénarios.

Coûts totaux	*Coûts associés à l'entreprise (DA)*	*Coûts associés aux clients (DA)*
Scénario 1	857142	5213531
Scénario 2	896302	5000768
Scénario 3	954508	4078603
Scénario 4	993668	3865840

Scénario 1

Le coût de transport optimal de l'entreprise (depuis les unités de production jusqu'aux CLRs) est égal à 857142 DA. La somme des coûts de transport des clients (depuis les CLRs jusqu'à leurs sites) est égale à 5213531 DA. Ces deux valeurs représentent les coûts optimaux de transport du réseau actuel de Cevital. Elles nous serviront comme coûts de référence pour comparer avec les résultats des autres scénarios.

Scénario 2

Le scénario 2 correspond au cas de l'ajout d'une plateforme à Alger qui aura à alimenter la plateforme de Bouira et certains de ses CLRs.

Par ailleurs, les affectations optimales sont comme suit : quelques CLRs seront alimentés à partir de la plateforme d'Alger et d'autres à partir de la plateforme de Bouira. Ces affectations sont résumées dans le Tableau 6.

Tableau 6 - Réaffectation des CLRs pour le cas d'ajout de la plateforme d'Alger.

Plateforme	Plateforme d'Alger	Plateforme de Bouira
CLR	Blida (09), Alger (16), Boumerdès (35)	Tizi-ouzou (15), Médéa (26)

Comparativement au scénario 1, nous constatons qu'avec l'ajout de la plateforme d'Alger, le coût de transport de l'entreprise augmente (de 39160 DA), alors que celui des clients baisse (de 212763 DA). En effet, ajouter la plateforme d'Alger permettrait d'alimenter certains des CLRs de la plateforme de Bouira et de réduire leurs pénuries de stock. Ainsi, chaque client pourrait s'alimenter auprès d'un seul CLR au lieu de plusieurs, évitant des coûts de transport supplémentaires.

Scénario 3

Dans le cas où l'on ajoute une plateforme à Biskra, les réaffectations optimales des clients sont présentées dans le Tableau 7.

Tableau 7 - Réaffectation optimale des clients hors-CLRs à la plateforme de Biskra.

Clients	Biskra (07)	Boussaâda (28)	EL-Oued (39)	Ouargla (30)
	Djelfa (17)	Saida (20)	Laghouat (03)	Tamanrasset (11)

En comparaison avec le scénario 1 de référence, l'ajout de la plateforme de Biskra, située au sud de l'Algérie, permet de tirer les enseignements suivants :

- d'une part, le coût de transport de l'entreprise augmente, car elle serait amenée à acheminer la marchandise des unités de production du Nord jusqu'à la plateforme de Biskra ;
- d'autre part, le coût total de transport des clients diminue. Ce résultat est expliqué par le fait que les huit clients du Sud réaffectés à la plate-forme de Biskra (Cf. Tableau 7) ne seront plus contraints d'aller jusqu'au Nord pour s'alimenter.

Scénario 4

Dans ce dernier scénario, il s'agit d'étudier le développement du réseau de distribution tel qu'il est planifié par Cevital, consistant en l'ajout d'une plateforme à Alger et une autre à Biskra. Les réaffectations optimales des CLRs et des clients sur les deux nouvelles plateformes sont représentées dans les Tableaux 6 et 7.

La lecture des résultats nous permet de conclure que l'ajout de la plateforme d'Alger et de la plateforme de Biskra permet à la fois :

i) une augmentation considérable du coût de transport de l'entreprise par rapport aux scénarios 2 et 3, expliquée par le fait que les deux plateformes ajoutées doivent être approvisionnées par l'entreprise elle-même à partir des unités de production ;
ii) une réduction considérable du coût de transport des clients. Ce résultat s'explique en grande partie, d'une part par le rôle joué par la plateforme d'Alger dans la couverture d'une agglomération ayant une forte demande et, d'autre part, par le fait d'éviter aux clients du Sud d'effectuer de très longues distances pour s'approvisionner auprès des unités de production du Nord (et donc de leur permettre une économie conséquente).

Délocalisation des CLRs (scénarios 1, 2, 3 et 4)

A l'issue de notre analyse des quatre scénarios, les résultats suggèrent de supprimer 3 CLRs et recommandent les réaffectations des clients comme suit :

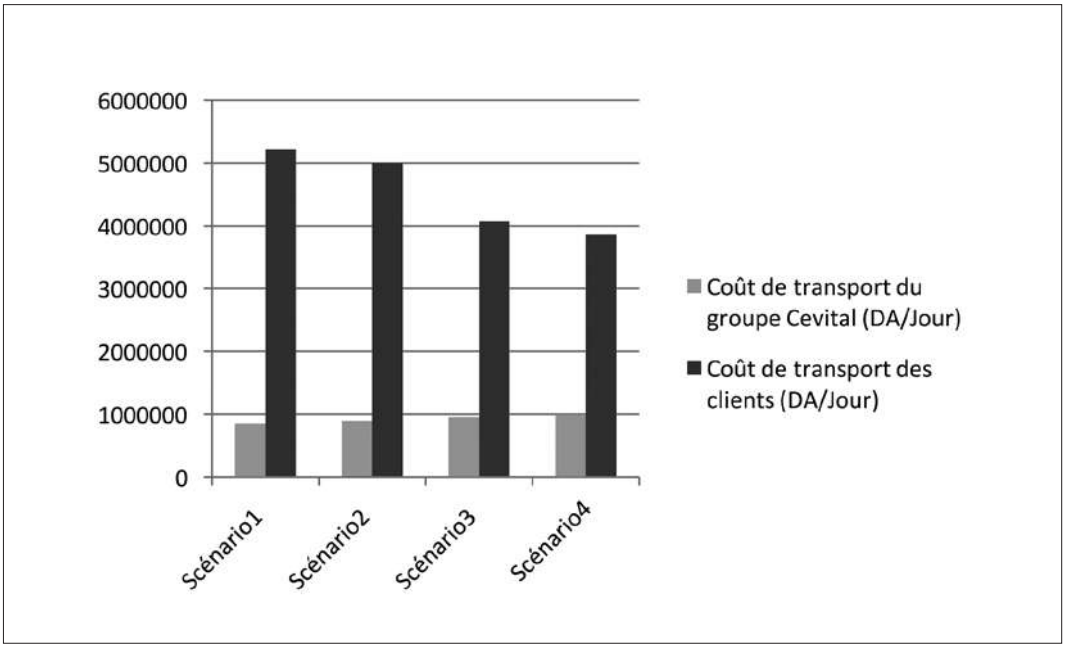
- supprimer le CLR de Bejaia et réaffecter ses clients aux 3 unités de production ;
- supprimer le CLR de Constantine et réaffecter ses clients au CLR de Oum-El-Bouaghi ;
- supprimer le CLR de Tlemcen et réaffecter ses clients au CLR de Mascara.

Afin de synthétiser et comparer les solutions associées aux quatre scénarios, nous schématisons les résultats du Tableau 5 dans la Figure 4.

A partir de la comparaison des solutions des quatre scénarios, nous pouvons tirer les conclusions principales suivantes :

- l'ajout de la plateforme d'Alger (scénario 2) et de la plateforme de Biskra (scénario 3) engendre pour l'entreprise des coûts de transport supplémentaires, mais permet de réduire les coûts de transport des clients ;
- l'ajout en même temps de la plateforme d'Alger et de la plateforme de Biskra (scénario 4) engendre certes pour l'entreprise des coûts de transport beaucoup plus importants que ceux des scénarios 2 et 3 mais, en contrepartie, permet de réduire énormément les coûts de transport des clients.

Figure 4 - Coûts de transport de l'entreprise Cevital et de ses clients.



Ainsi, Cevital pourra choisir le plan de distribution qui lui conviendra le plus, tenant compte de son coût de transport, de ses objectifs financiers, des objectifs de rapprochement des produits aux clients et de leur satisfaction.

5. Conclusion

Le développement du commerce agricole et agroalimentaire méditerranéen est de plus en plus conditionné par les capacités des pays à se doter d'infrastructures modernes pour faciliter la circulation des marchandises, maximiser la valeur créée par les filières et garantir la qualité des produits offerts (Meziani *et al.*, 2016 ; Driouech *et al.*, 2014). La position géographique stratégique de la région méditerranéenne, reliant trois continents par des routes commerciales et présentant des marchés en croissance potentielle, en fait l'une des zones économiques les plus importantes pour le commerce dans le monde. Cependant, et malgré ce potentiel, la région éprouve des difficultés à jouer ce rôle clé sur le marché mondial. Les faiblesses de la région se concentrent principalement au niveau des pays du Sud et de l'Est de la Méditerranée (PSEM). Parmi les facteurs qui pèsent lourdement sur la performance commerciale des PSEM, les insuffisances logistiques (infrastructures de transport, de conditionnement, de stockage…) apparaissent comme prégnants et constituent l'une des préoccupations majeures des décideurs[9]. Deux études de la Banque mondiale, menées en 2012 et en 2014, pointent clairement du doigt ces insuffisances, notamment pour les PSEM. S'appuyant sur un indice de performance logistique, l'étude de 2014 montre qu'aucun des pays méditerranéens ne figure dans les dix premières positions du classement établi et la majorité ont vu leur position dégradée par rapport au précédent classement de 2012 (voir Banque mondiale, 2014).

Malgré ces insuffisances logistiques, on peut déplorer que les recherches dans ce domaine soient au final peu nombreuses au regard des enjeux associés. Par ailleurs, les études existantes se concentrent le plus souvent, sur le rôle des infrastructures de type publique : infrastructures de stockage (silos, entrepôts frigorifiques en zones de fret…), de transport (routes, transport ferroviaire, aérien…). Il n'existe pas, à notre connaissance, d'analyses portant sur le rôle des réseaux logistiques de type privé (stockage, entreposage, centre de distribution…). Les insuffisances d'organisation des secteurs de la collecte, de l'entreposage, de distribution et de transport des produits agro-alimentaires (absence de services publics, d'entreprises spécialisées, prédominance de l'informel) poussent certains groupes industriels des pays du Sud de la méditerranéen à internaliser les opérations de distribution de leurs produits ou à créer leurs propres filiales de logistique, de distribution ou de transport[10]. Les modèles d'optimisation des réseaux, à l'exemple du modèle que nous proposons, permettent de répondre à un niveau microéconomique, au besoin de ces entreprises en matière de dimensionnement de leur réseau et d'optimisation de son fonctionnement. En s'appuyant sur les données réelles de l'entreprise et sur la structure de son réseau, l'étude a contribué à proposer des solutions opérationnelles, après avoir construit un modèle adapté à la réalité de l'entreprise. De ce point de vue, notre étude comble un manque flagrant de la théorie de la localisation en études de cas, les travaux étant généralement articulés autour de scénarios théoriques donnant lieu à des modélisations originales et des techniques de résolution innovantes (voir ReVelle et Eiselt, 2005)[11].

[9] A titre d'exemple, Carruthers (2012) montre qu'une augmentation de 10 % des frais de transport peut réduire de 20 % le volume des échanges et générer une inflation aux effets négatifs sur la compétitivité des économies.

[10] En Algérie par exemple avec le groupe Cevital et sa filiale Numilog, au Maroc avec le groupe Unimer SA et sa filiale de logistique et de distribution VCR Logistics et en Tunisie avec le groupe Poulina, où chacune de ses filiales intègre son propre réseau de distribution.

[11] Comme exceptions, on peut citer par exemple Yıldız et al. (2019) qui s'intéressent aux localisations de magasins d'alimentation en Turquie, Wang et al. (2017), pour la localisation de centres de distribution réfrigérés pour une grande chaîne de supermarchés d'une compagnie chinoise.

Si cette approche opérationnelle est nécessaire pour aider les entreprises à concevoir et gérer de façon optimale leurs réseaux propres, l'analyse des performances qui en découlent sur le développement des pays de la région méditerranéenne est, comme souligné précédemment, une question de recherche ouverte. Quel rôle joue de tels réseaux dans les performances économiques de ces pays ? Quelles en sont les externalités sur les circuits de commercialisation, les prix, les capacités de production et de distribution du pays ? On peut raisonnablement penser qu'au-delà des retombées directes sur les revenus des entreprises en question, une bonne gestion de ces réseaux peut générer des effets positifs et des effets d'entraînement sur les différents maillons et activités du secteur agro-alimentaire d'un pays. Ces effets pourraient être d'autant plus intéressants à évaluer qu'un certain nombre d'infrastructures privées ont été justement conçues pour pallier les insuffisances et les défaillances des infrastructures publiques. L'évaluation de tels effets constitue de notre point de vue, un enjeu important et un axe de recherche qui mérite d'être davantage développé.

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Annexe 1

Tableau 4 - Les demandes des clients-CLRs.

Clients-CLR	*Demandes (palettes/jour)*				
	Huile	*Sucre*	*Margarine*	*LLK*	*Cojek*
Oum El Bouaghi (04)	60	50	35	40	15
Batna (05)	90	60	30	25	15
Bejaia (06)	15	10	5	5	5
Blida (09)	70	60	30	25	15
Tlemcen (13)	40	35	25	15	10
Tlemcen (13)	35	30	5	10	5
Tiaret (14)	50	50	20	15	10
Tizi-Ouzou (15)	70	30	40	10	12
Tizi-Ouzou (15)	40	70	30	20	18
Alger (16)	70	100	30	10	5
Alger (16)	70	40	80	5	0
Alger (16)	110	60	40	15	15
Setif (19)	50	35	25	10	12
Setif (19)	20	35	45	10	8
Sidi Bel Abbès(22)	35	30	15	10	10
Annaba (23)	65	50	35	20	10
Constantine (25)	25	20	15	5	5
Médéa (26)	40	35	15	10	10
Mostaganem (27)	60	50	35	20	10
Mascara (29)	45	30	20	15	15
Oran (31)	120	110	30	5	5
Oran (31)	20	80	10	5	15
Oran (31)	60	70	10	0	5
Boumerdès (35)	40	30	45	20	5
Boumerdès (35)	20	40	25	10	15
Relizane (48)	60	55	45	30	20

Annexe 2

Description du Modèle (1)

Les données du problème

Pour définir les entités de la chaine de distribution agroalimentaire, nous disposons de :
- I: un ensemble d'unités de production ;
- P_e (resp. L_e: un ensemble de plateformes (resp. de centres de livraison régionaux (CLRs)) en activités ;
- P_n (resp. L_n) : un ensemble de sites candidats pour la localisation de nouvelles plateformes (resp. de nouveaux CLRs) ;
- J : un ensemble de clients ;
- $P = P_e \cup P_n$: l'ensemble des plateformes ;
- $L = L_e \cup L_n$: l'ensemble des CLRs ;
- M : l'ensemble des produits impliqués dans la chaine de distribution.

Par ailleurs, nous notons les données de la chaine utilisées dans le modèle comme suit :
- c^1 : le coût unitaire de transport des produits assumé par l'entreprise ;
- c^2 : le coût unitaire de transport des produits assumé par les clients ;
- c_p^3 : le coût de stockage dans la plateforme en activité, p, $p \in P_e$;
- c_l^4 : le coût de stockage dans le CLR en activité, l, $l \in l_e$;
- c_p^5 : le coût de fermeture de la plateforme en activité p, $p \in P_e$;
- c_l^6 : le coût de fermeture du CLR en activité l, $l \in l_e$;
- c^7 (resp. c^8) : le coût unitaire de construction d'une nouvelle plateforme (resp. d'un nouveau CLR) ;
- c^9 (resp. c^{10}) : le coût fixe de construction d'une nouvelle plateforme (resp. d'un nouveau CLR) ;
- O_i^m : quantité produite du produit par l'unité de production, i, $i \in I$, $m \in M$;
- D_j^m : quantité demandée du clientpour le produit m, $j \in J$, $m \in M$;
- S_p^1 (resp. R_p^1) : capacité maximale (resp. minimale) de la plateforme p, $p \in P$;
- S_l^2 (resp. R_l^2) : capacité maximale (resp. minimale) du CLR l, $l \in L$;
- d_{ip}^1 : distance entre l'unité de production i et la plateforme p, $i \in I$, $p \in P$;
- d_{pl}^2 : distance entre la plateforme p et le CLR l, $p \in P$, $l \in L$;
- d_{lj}^3 : distance entre le CLR l et le client j, $l \in L$, $j \in J$.

Les variables de décision

Les variables de décision du modèle sont :
- x_{ip}^m : quantité du produit m à transporter de l'unité de production i à la plateforme p, $i \in I$, $p \in P$, $m \in M$;
- y_{pl}^m : quantité du produit m à transporter de la plateforme p au CLR l, $p \in P$, $l \in L$, $m \in M$;
- z_{lj}^m : quantité du produit m à transporter du CLR l au client j, $m \in M$, $l \in L$, $j \in J$;
- u_p^e : variable booléenne égale à 1 si une plateforme en activité p est à fermer, $p \in P_e$;
- v_l^e : variable booléenne égale à 1 si un CLR en activité l est à fermer, $l \in L_e$;
- u_p^n : variable booléenne égale à 1 si la nouvelle plateforme p est retenue pour être construite, $p \in P_n$;
- v_l^n : variable booléenne égale à 1 si un nouveau CLR l est retenu pour être construit, $l \in L_n$;
- $x = ((x_{ip}^m, p \in P, l \in L, m \in M), (y_{pl}^m, p \in P, l \in L, m \in M), (z_{lj}^m, m \in M, l \in L, j \in J), (u_p^e, p \in P_e)$ $(v_l^e, l \in L_e), (u_p^n, p \in P_n), (v_l^n, l \in L_n))$ - le vecteur des décisions.

La fonction économique (objectif)

$$\varphi(x) = \boldsymbol{c^1}\left(\sum_{i\in I}\sum_{p\in P}\boldsymbol{d_{ip}^1}\sum_{m\in M}\boldsymbol{x_{ip}^m} + \sum_{p\in P}\sum_{l\in L}\boldsymbol{d_{pl}^2}\sum_{m\in M}\boldsymbol{y_{pl}^m}\right) + \boldsymbol{c^2}\left(\sum_{l\in L}\sum_{j\in J}\boldsymbol{d_{lj}^3}\sum_{m\in M}\boldsymbol{z_{lj}^m}\right)$$
$$+ \sum_{p\in P_e}\boldsymbol{c_p^3}(\mathbf{1}-\boldsymbol{u_p^e}) + \sum_{l\in L_e}\boldsymbol{c_l^4}(\mathbf{1}-\boldsymbol{v_l^e}) + \sum_{p\in P_e}\boldsymbol{c_p^5}\boldsymbol{u_p^e} + \sum_{l\in L_e}\boldsymbol{c_l^6}\boldsymbol{v_l^e}$$
$$+ \sum_{p\in P_n}\left(\boldsymbol{c^7}\boldsymbol{u_p^n} + \boldsymbol{c^9}\sum_{i\in I}\sum_{m\in M}\boldsymbol{x_{ip}^m}\right) + \sum_{l\in L_n}\left(\boldsymbol{c^8}v_l^n + \boldsymbol{c^{10}}\sum_{p\in P_e}\sum_{m\in M}\boldsymbol{y_{pl}^m}\right) \qquad (A2.1)$$

Contraintes

$$\sum_{p\in P}\boldsymbol{x_{ip}^m} \le O_i^m, \qquad \forall i \in I, \quad \forall m \in M; \qquad (A2.2)$$

$$\sum_{l\in L}\boldsymbol{z_{lj}^m} = \mathrm{D_j^m}, \qquad \forall j \in J, \quad \forall m \in M; \qquad (A2.3)$$

$$\sum_{i\in I}\boldsymbol{x_{ip}^m} = \sum_{l\in L}\boldsymbol{y_{pl}^m}, \quad \forall p \in P, \quad \forall m \in M; \qquad (A2.4)$$

$$\sum_{p\in P}\boldsymbol{y_{pl}^m} = \sum_{j\in J}\boldsymbol{z_{lj}^m}, \quad \forall l \in L, \quad \forall m \in M; \qquad (A2.5)$$

$$\sum_{i\in I}\sum_{m\in M}\boldsymbol{x_{ip}^m} \le (\mathbf{1}-\boldsymbol{u_p^e})\boldsymbol{S_p^1}, \qquad \forall p \in P^e; \qquad (A2.6)$$

$$\sum_{i\in I}\sum_{m\in M}\boldsymbol{x_{ip}^m} \le \boldsymbol{n_p^n}\boldsymbol{S_p^1}, \qquad \forall p \in P^n; \qquad (A2.7)$$

$$\sum_{i\in I}\sum_{m\in M}\boldsymbol{x_{ip}^m} \ge (\mathbf{1}-\boldsymbol{u_p^e})\boldsymbol{R_p^1}, \qquad \forall p \in P^e; \qquad (A2.8)$$

$$\sum_{i\in I}\sum_{m\in M}\boldsymbol{x_{ip}^m} \ge \boldsymbol{n_p^n}\boldsymbol{R_p^1}, \qquad \forall p \in P^n; \qquad (A2.9)$$

$$\sum_{p\in P}\sum_{m\in M}\boldsymbol{y_{pl}^m} \le (\mathbf{1}-\boldsymbol{v_p^e})\boldsymbol{S_l^2} \qquad \forall l \in L^e; \qquad (A2.10)$$

$$\sum_{p\in P}\sum_{m\in M}\boldsymbol{y_{pl}^m} \le \boldsymbol{v_p^n}\,\boldsymbol{S_l^2}, \qquad \forall l \in L^n; \qquad (A2.11)$$

$$\sum_{p\in P}\sum_{m\in M}\boldsymbol{y_{pl}^m} \ge (\mathbf{1}-\boldsymbol{v_p^e})\boldsymbol{R_l^2}, \qquad \forall l \in L^e; \qquad (A2.12)$$

$$\sum_{p\in P}\sum_{m\in M}\boldsymbol{y_{pl}^m} \ge \boldsymbol{v_p^n}\boldsymbol{R_l^2}, \qquad \forall l \in L^n; \qquad (A2.13)$$

$$\boldsymbol{x_{ip}^m} \ge \mathbf{0}, \quad \forall i \in I, \quad \forall p \in P, \quad \forall m \in M; \qquad (A2.14)$$

$$\boldsymbol{y_{pl}^m} \ge \mathbf{0}, \quad \forall p \in P, \quad \forall l \in L, \quad \forall m \in M; \qquad (A2.15)$$

$$\boldsymbol{z_{lj}^m} \ge \mathbf{0}, \quad \forall l \in L, \quad \forall j \in J, \quad \forall m \in M; \qquad (A2.16)$$

$$\boldsymbol{u_p^e}, \boldsymbol{u_p^n} \in \{0,1\}, \qquad \forall p \in P; \qquad (A2.17)$$

$$\boldsymbol{v_l^e}, \boldsymbol{v_l^n} \in \{0,1\}, \qquad \forall l \in L. \qquad (A2.18)$$

L'ensemble X des solutions réalisables du modèle est constitué des vecteurs de décisions vérifiant les contraintes (A2.1)-(A2.18).

Le modèle mathématique obtenu est un programme linéaire mixte[12] (MILP). La fonction objective du modèle, donnée dans (A2.1), référence le coût total du réseau. Les coûts logistiques (transport de marchandise) sont donnés dans les trois premiers termes : le coût de transport entre les unités de production et les plateformes dans le premier terme ; le coût de transport entre les plateformes et les CLRs dans le deuxième terme ; et celui entre les CLRs et les clients dans le troisième. Les coûts stratégiques (installation et fermeture des centres) sont donnés dans les termes restants : le coût de maintien des plateformes (resp. des CLRs) en activité dans le quatrième (resp. le cinquième) terme ; le coût de fermeture des plateformes (resp. des CLRs) en activité dans le sixième (resp. le septième) terme ; le coût de construction (fixe et variable) de nouvelles plateformes (resp. de nouveaux CLRs) dans le huitième (resp. le neuvième) terme.

Les contraintes (A2.2) assurent que chaque unité de production ne peut délivrer plus qu'elle en possède pour chaque produit. Les contraintes (A2.3) garantissent que la demande de chaque client pour chaque produit soit satisfaite. Les contraintes (A2.4) assurent que la marchandise reçue par chaque plateforme en provenance de toutes les unités de production devrait être transférée aux CLRs. Les équations (A2.5) assurent que la marchandise reçue par chaque CLR en provenance des plateformes devrait être transférée aux clients. Les contraintes (A2.6) (resp. (A2.7)) représentent la limitation en capacité des plateformes en activité (resp. à localiser). Les contraintes (A2.8) (resp. (A2.9)) fixent les capacités minimales que doivent avoir les plateformes en activité (resp. à localiser). Les contraintes (A2.10) (resp. (A2.11)) représentent la limitation en capacité des CLRs en activité (resp. à localiser). Les contraintes (A2.12) (resp. (A2.13)) fixent les capacités minimales que doivent avoir les CLRs en activité (resp. à localiser). Les contraintes (A2.14) – (A2.16) (resp. (A2.17) – (A2.18)) sont les contraintes de non négativité (resp. d'intégralité).

[12] Le terme mixte est relatif au fait que certaines variables de décision sont réelles et d'autres sont entières binaires.

Information and communication technologies as development tools for second-tier cooperatives

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Abstract

The Spanish olive oil sector is the world leader in terms of olive oil production. This sector primarily comprises companies in the social economy, especially cooperatives, which account for more than 75% of production. The emergence of second-tier cooperatives has enabled the implementation of one of the recurring recommendations by scholars, namely enhancing the commercialization of olive oil through greater concentration and integration of supply. This improved commercialization is made possible in part by the greater capacity of these companies to invest in information and communication technologies (ICTs) and human capital specialized in managing these ICTs. The use of the Internet gives these companies access to a market of unparalleled dimensions. In light of this situation, this study examines the factors that explain a higher level of online sales activity by these firms. To do so, fuzzy-set qualitative comparative analysis (fsQCA) is used. The results show that age, size, the management's ICT training, social network activity, and outsourced ICT management are associated with greater online sales of olive oil by second-tier cooperatives.

Keywords*: Olive oil, Second-tier cooperatives, Information and communication technologies (ICTs), fsQCA.*

1. Introduction

The olive grove is a true native crop of the Mediterranean basin. The principal produce of olive groves consists of olive oil and table olives, which are staples of the Mediterranean diet. Global olive oil production is experiencing continued growth, linked not only to a steady increase in olive grove surface area but also to an increase in the area of irrigated land and to the introduction of improvements in technology (Parras *et al*., 2013). On the demand side, although the benefits and attributes of olive oil are driving consumption of this product, olive oil represents only 4% of total consumption of oils and fats worldwide (Vilar and Cárdenas, 2016). This sector is nonetheless strategic because of its major role in the agricultural sector of the main olive-oil-producing countries. However, there is

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still much to improve to increase the profitability of this sector, which faces serious commercial problems on account of its lack of orientation to the end market. The predominant sales format among producers is bulk sales, which has prevented them from capturing a large amount of the additional value created by the commercialization of bottled oil.

The tools that have emerged under the umbrella concept of the Internet, together with these technologies' growing penetration in society, have changed the rules of the market. The sheer scope of the Internet today and the changes that the Internet has driven in consumer habits are phenomena that have not gone unnoticed by organizations (Martín *et al*., 2019). Information and communication technologies (ICTs) provide organizations with numerous advantages, including streamlining business activities, allowing better coordination of an organization's human resources, and encouraging communication and learning (Vázquez *et al*., 2019). However, commerce is where the effects of ICTs have been most noticeable and where ICTs can help organizational development the most (Kaplan and Haenlein, 2010; Mozas *et al*., 2016). Indeed, the costs of information, negotiation, and guarantees have been slashed by the use of ICTs, enabling firms to provide consumers with a more economical, personalized, and streamlined service (Karoui *et al*., 2015; Stephen and Toubia, 2010).

The Spanish olive oil sector primarily comprises companies from the social economy, particularly cooperatives, which make up 75% of production. Despite this leading role, the main problem for virgin olive oil producers has been for years their distance from the end market. However, the rapid and profound changes that are occurring around this sector, including the disappearance of intervention mechanisms as a result of reforms to the Common Agricultural Policy, increasing foreign competition, and the dominance of the major distributors, mean that it is becoming increasingly necessary to leave this passive attitude behind. The literature shows the importance of following a path that is oriented toward the end market to make this activity profitable. The emergence of second-tier cooperatives enables the implementation of one of the recommendations by scholars of this area, namely improving the commercialization of this product through concentration and integration (i.e., by strengthening the business side of this sector).

Given this background, this study aims to identify the factors that explain higher online sales by oil producers. Fuzzy-set qualitative comparative analysis (fsQCA) is used to do so. This paper has the following structure. Following this introduction, the contextual framework is established, and the propositions of the study are presented. Next, the technical characteristics of the study are described in the method section. Following this, the results are presented. Finally, the conclusions of the study are discussed.

2. Theoretical framework

2.1. *State of play in the olive sector*

Throughout this section we will analyze the olive sector and the main problems it faces. In addition, we will study the cooperative sector as the main producer of olive oil in Spain and how ICTs have helped to reduce organizational and commercial problems, as well as to improve this sector's competitiveness.

Undoubtedly, one of the biggest events that have occurred in the olive oil sector worldwide is the increase in production (Parras *et al.*, 2013). In this sense and according to data from the International Olive Oil Council (IOC, 2019c; 2019d), if we compare the 1990/91 campaign where 1,453,000 tons were produced with the 2018/19 campaign where 3,131,000 tons have been produced worldwide, we will conclude that production has doubled and that the forecasts for the future show a constant increase. If we focus on the analysis of the countries responsible for this increase, we can say that traditionally, olive cultivation for oil production was located in the countries of the Mediterranean basin, but there are more and more territories that, without having an olive growing tradition, are acquiring greater importance (Mozas *et al.*, 2015).

According to Vilar and Cárdenas (2016), the number of hectares destined to the cultivation of oils and fats in the world amounts to

231,000,000, which is 26% of the total arable land in the world, of which 11,316,000 hectares are used exclusively for the cultivation of 1,500 million olive trees (72% are mountain and hill), located mainly in the Mediterranean basin (79%). Annually, there is an increase in the surface area of olive groves that represents 1% per year (between 34 and 45 million seedlings, which means 154,000 new hectares) (Vilar and Cárdenas, 2016).

On the other hand, and focusing on consumption, according to information provided by the IOC (2019a; 2019b) the growth trend stands out, in parallel with the evolution described for production. Secondly, the data show that it is, above all, the greater demand for this product in traditionally non-consuming countries that justifies this trend. In this sense it should be noted that if production was located basically in the Mediterranean basin, in consumption countries are diversifying. The most important, after Spain and Italy, is the United States with consumption of more than 10.6% of production in the 2018/19 season. The first four countries account for 50.8% of world consumption and the first 10 countries for 70.7%. Some of these countries have shown very significant annual increases, such as Brazil, Japan, China, Australia and Canada, making them strategic markets.

Exports are not only necessary but also essential, especially for Spain (the leading producer) where an average of around 500,000 tons has been consumed in recent years but 1,500,000 tons are produced. ICTs have positioned themselves as tools that help companies in the export process (Bernal *et al.*, 2019). These tools enable companies to compete in a wider market, at a lower cost and with greater commercial possibilities, being one of the most important options to increase the profitability of productive resources and, therefore, improve their economic results (Medina *et al.*, 2016).

On the other hand, it should be noted that in three of the main European producing countries (Spain, Italy and Greece), consumption has been reduced by 425,000 tons from the 2000/01 to the 2018/19 season (IOC, 2019b). In fact, in the 2000/01 marketing year, consumption in these three countries as a whole reached 1,579,800 tons, with consumption per country being 580,800 tons for Spain; 729,000 tons for Italy; and 277,000 tons for Greece. However, in the 2018/19 season consumption in these three countries fell to 1,155,000 tons. Consumption in the 2018/19 marketing year has been distributed as follows: Spain with 525,000 tons, Italy with 500,000 tons and Greece with 130,000 tons.

Increasing domestic consumption, especially in the main producing countries, is a strategy that must be carried out by producing and marketing companies. In this sense, ICTs play a fundamental role. We refer to the communication of the health benefits of olive oil consumption throughout life. The literature shows that ICTs are very powerful communication tools that are capable of transmitting information to the point of becoming viral (Medina *et al.*, 2016). This turns these platforms into particularly attractive sales channels for sectors such as the agro-food or the ecological sector, which have traditionally faced important commercial deficiencies related mainly to the scarcity of information and points of sale in the market (Fernández *et al.*, 2020).

Quality oils are preferred in international markets, since three quarters of what is exported are virgin olive oils and organic oils, products that fetch higher prices in foreign markets. In this respect, it should be noted that Spain is the main producer and exporter of organic olive oils in the world (Willer and Lernoud, 2019). In these products the use of ICTs is particularly relevant. This is because they are "experiential" agricultural products, in which the presence of elements that facilitate an intensive exchange of information, with respect to tangible and especially intangible aspects (symbols, tradition, culture, tourism or gastronomy, among others) can significantly enhance the perceived value of the product by the consumer (Stricker *et al.*, 2007). In the organic olive sector, which faces significant commercial problems related to the shortage of points of sale or consumer misinformation (Tsakiridou *et al.*, 2008), these shortcomings can be resolved by the use of ICTs (Fernández *et al.*, 2020).

On the other hand, production and consumption at a global level have a growing trend, so we can say that there is a certain link between production and consumption at an international

level. The data analyzed allows us to state that we are facing a thriving sector at the global level, with great potential for growth, backed by a quality product and beneficial to health, with the support of institutions and governments (Mozas *et al.*, 2015).

However, if the focus is on Spain, the situation is quite different (Mozas *et al.*, 2015). In the national market supply far exceeds demand, resulting in significant surpluses, which cause many problems at the national and international level (Mozas, 1999):

- The first of these is the fierce competition presented by the internal market. In fact, the existence of a large number of producers (more than 1,800 competing all in the same market), and few distributors, means that the bargaining power is in the distribution, so that the distributors impose the prices.
- The lack of integration in the producing companies, mainly cooperatives, causes the distribution sector to acquire the bargaining power.
- There are many private labels in distribution. In Spain, almost 70% of olive oil is sold under private labels (Alimarket, 2019), which means that the producer companies' own brands do not have a great impact, except in a few exceptions.
- There is no product differentiation. In spite of being a quality product, there are no great differences depending on the producer.
- The pressure exerted by the distribution and use of olive oil as a claim product (hook products, being a product of daily use) means that prices are low. In fact, in order to exercise greater control some distribution companies have been integrated backwards, so that they have their own production, their own oil mills and bottling plants.
- Finally, the prices generated in Spain have an international impact, with price falls that lead to a lack of profitability in the producing sector.

However, the main problem of the olive grove is the lack of profitability. Greater economic efficiency or greater differentiation in the performance of activities in the value chain is what Porter (1985; 1990) indicated as competitiveness. Specifically, he indicated that "competitive advantage derives from the way in which firms organize and carry out discrete activities In order to gain competitive advantage over its rivals, a firm must offer comparable value to the buyer, but carry out the activities more efficiently than its buyers (lower cost) or carry out the activities in a particular way that creates greater value for the buyer and leads to a premium (differentiation)."

In olive oils there is no differentiation from one producer to another and this is used by the large distributors to increase their bargaining power vis-à-vis the producers. The prices offered by the distribution to the producers are minimal, in many cases not even covering the production costs.

Miller and Jones (2010) indicated that a chain is only as strong as its weakest link and, therefore, the stronger the links, the safer the flow of products and services within the chain. In this sense, referring to the agricultural value chain of olive oils in Spain, the literature shows that the producing sector is the weakest link. There are several reasons that help us to justify this statement, although the main reason is the lack of concentration of the producing sector (about 1,800 producers only in Spain) that face the 7 main distributors in the Spanish market (Mercadona, Carrefour, Lidl, Día, Eroski, Auchan-Alcampo and El Corte Inglés) that according to the Alimarket report (2019) sell almost 70% of the oil in Spain under their own brands, highlighting, among them, Mercadona where 1 out of every 3 litres of oil bought by Spanish consumers is sold.

The producers, mainly cooperatives, began processes of business integration, giving rise to second grade cooperatives, as a means of trying to reduce the structural problems they had due to their small size. According to Mozas and Guzmán (2017), integration in the olive grove sector has led to a total degree of corporate integration in the Spanish olive grove sector of 27.47%, which means that there are still 1,305 marketing companies, compared to 7 companies that practically dominate distribution, so

that the total production volume managed in an integrated manner reached only 30% in 2017.

Despite the fact that the degree of concentration is 30%, this has been generated mainly by cooperative societies, creating second degree cooperatives that have incorporated professionalization and innovation in the agricultural, processing and marketing activity.

For years, many researchers have been committed to vertical integration and concentration as a way of strengthening these organizations and ensuring their survival (Vargas, 1995; Carrasco and Garrido, 1991; Martínez, 1990; Juliá, 1993; Bel Durán, 1996; Mozas, 1999; Torres *et al.*, 2000; Parras *et al.*, 2013). The existing second degree cooperatives in the sector have shown that integration makes possible:

- a higher degree of professionalization due to the differentiation of activities and the need for more specialized training among their staff;
- possibilities for further innovation through joint investments in the incorporation of new technologies;
- increased access to international markets;
- the achievement of economies of scale and scope;
- the reduction of risks as a result of business cooperation.

These companies have learned what nations have always known: "in a complex and uncertain world full of dangerous opponents, it is better not to go it alone" (Ohmae, 1989). Agricultural producers must respond to the challenge of meeting demands for higher quality products at competitive prices and obtaining greater competition in volatile markets. In order to be more competitive, agricultural products need to develop their value-added potential, whether through improving the quality of primary agricultural production or through processing and manufacturing before export (Islam and Xayavong, 2010). The use of tools that provide them with competitive advantages such as ICTs should not be forgotten. The theory of transaction costs explains the potential of ICTs in enterprises, providing multiple benefits in organizational performance and in the reduction of the different types of costs that arise in the development of a transaction (Fernández *et al.*, 2016).

2.2. *Propositions*

Some characteristics of top managers have been frequently cited as determinants of business success (Medina *et al*., 2016). Multiple studies have reported the top manager's training as a determinant of an organization's economic efficiency (Levie and Autio, 2011) because it can encourage a commitment to innovation and the implementation of more efficient organizational practices (Mozas *et al*., 2016). Similarly, specific ICT training of the top manager is important for organizations to embrace these tools and improve their business performance (Nguyen and Barrett, 2006; Mozas *et al*., 2018). This relationship owes to the fact that managers with ICT training are more aware of the importance of ICTs and dedicate more efforts to the proper use of these technologies and a commitment to innovation, all of which contributes to improving the firm's economic efficiency (Kim and Jee, 2007). Based on these arguments, the following proposition may be formulated:

Proposition 1. The top manager's ICT training boosts the organization's online sales

The theories of economies of scale and economies of scope highlight the importance of organizational size when performing operational functions as efficiently as possible (Schneider, 2004). Numerous authors have defended the existence of positive relationships between efficiency and business size and between innovation and business size (Voulgaris and Lemonakis, 2013). In addition, studies in agricultural sectors have shown that organizational size is an explanatory factor of greater profitability (Castillo and García, 2013). The predominant organizational structure in the olive oil sector is that of the cooperative, and size plays a particularly prominent role in the grasping of opportunities in the environment based on criteria of profitability, innovation adoption, and efficiency (Gorgues *et al*., 2019; Moyano and Fidalgo, 2001). Based on these arguments, the following proposition may be formulated:

Proposition 2. Organizational size in terms of the number of members affects the percentage of online sales

In the literature, there is a certain degree of controversy regarding the relationship between the age of an organization and its degree of innovation (Rowley *et al*., 2016). One stream suggests that the age of the organization can be considered a trigger of its innovative activity (Díaz Díaz *et al*., 2006). According to this view, when an organization adopts a certain technology, this starts a process of learning that leads to more effective exploitation of this technology (Fagerberg *et al*., 2005). In the olive oil sector, previous research would suggest that there is a positive relationship between age and efficient use of technology (Mozas *et al*. 2016). This relationship owes to the experience that has been acquired: older firms have developed skills and competencies that improve their organizational performance (Bierly and Daly, 2007). Based on these arguments, the following proposition may be formulated:

Proposition 3. Older firms have a higher percentage of online sales

ICTs have the capacity to reduce transaction costs, improving the efficiency of a business's actions throughout the value chain (Evans and Wurster, 1997). Numerous studies concur that the degree of innovation, as well as a commitment to ICTs, improves productivity and organizational performance (Mozas *et al*., 2016). Thus, the use of online social networks as a communication channel and relational marketing strategy improves organizational competitiveness and therefore increases the renown and performance of the firm (Wei *et al*., 2013). These results occur, particularly when there is a strong focus on these online networks (Bernal *et al*., 2019). Thus, firms with a commitment to these virtual platforms should achieve better commercial performance and increase their competitiveness (Jorge-Vázquez *et al*., 2019). Based on these arguments, the following proposition may be formulated:

Proposition 4. The use of social networks boosts an organization's online sales

The internal management of innovation is considered an important factor for organizational development and for achieving competitive advantages (Gray, 2006). The presence of staff who are well trained and highly qualified at managing different applications offered by the Internet enables the efficient use and exploitation of these applications (Peansupap and Walker, 2006). Olive oil organizations, however, tend to lack internal staff who are trained and qualified ad hoc to manage these technologies (Fernández *et al*., 2016). In such cases, scholars such as He *et al*. (2017) have suggested that outsourcing these functions is the best way of achieving better performance. Based on these arguments, the following proposition may be formulated:

Proposition 5. External management of ICTs increases the percentage of online sales

3. Population and method

Spain has approximately 40 organizations that are either second-tier cooperatives or business groups that market olive oil from the group of oil mills they represent. These are the largest vendors of olive oil and account for approximately one third of national olive oil production. Second-tier cooperatives make up the population of the study. A structured telephone survey was conducted, targeting the managers of each of these 35 entities (total population). Of these 35 entities, 27 responded, giving a response rate of 77.1%. The organizations represent 444 entities. These entities have more than 165,000 individual members, a combined turnover of more than 2 billion Euros, and more than 2,500 employees. Details of the fieldwork appear in Table 1.

Qualitative Comparative Analysis (QCA) was employed as the data analysis method in this study. Specifically, fuzzy-set Qualitative Comparative Analysis (fsQCA) was used to establish the technology-related and organizational conditions that, when combined, are associated with greater efficiency. QCA methodology, which is based on Boolean algebra, combines verbal, conceptual, and mathematical language, making it both qualitative and quantitative and lending it some of the advantages of both of these methodologi-

Table 1 - Details of the fieldwork.

Fieldwork characteristic	*Details*
Universe	Second-tier cooperatives that make and market olive oil
Geographical scope	Spain
Data collection period	July to December 2018
Size of universe	35 organizations
Participant organizations	27 organizations
Response rate	77.1%

Source: Compiled by the authors.

cal streams (Ragin, 1987). By applying QCA, it is possible to systematically analyze a data set to identify the causal patterns, in the form of relationships of necessity and sufficiency, between a set of conditions and an outcome of interest (Schneider and Wagemann, 2010). One of the advantages of this method versus regression analysis is that it can be used to establish links between subsets of conditions to explain relationships. FsQCA is one of the most widely used variants of QCA because it overcomes one of the main drawbacks and criticisms of the earliest form of QCA (crisp-set qualitative comparative analysis), namely its strictly dichotomous approach (Sehring *et al*., 2013).

FsQCA provides one or more *antecedent combinations* that are sufficient for a given outcome to occur. For example, X_1*~X_2*X_3 may be sufficient to produce the outcome Y. Adopting the standard notation for this technique, this result would be expressed as (X_1*~X_2*X_3→Y, where X_1, X_2, and X_3 are antecedents; Y is the outcome of interest; * denotes the union of two or more conditions; and ~ denotes the absence or negation of a condition, in this case equal to the opposite value of X_2 (i.e., $1 - X_2$).

The fsQCA technique was originally developed for small samples or populations (Ragin, 1987). Therefore, the fact that the sample universe for this study was small was not a drawback. To correctly apply this technique, the stages recommended in the literature should be followed. The first is the calibration of variables. The second is the analysis of necessity. The third is the analysis of sufficiency.

We first calibrated the variables. Next, we performed analysis of necessary conditions based on the consistency values for each condition. The aim was to verify that none of these values exceeded the recommended threshold of 0.9, established by Ragin (2006). This situation was corroborated by the results.

The outcome (analogous to the dependent variable in regression analysis) in this study was the percentage of online sales. The conditions (analogous to independent variables) were age of the firm, the management's ICT training, organizational size (measured as the number of members of the organization), the presence and use of online social networks, and the need for outsourced professional ICT management or support. Table 2 displays this information. Table 2 also shows the type of variable (continuous, categorical, or dichotomous) and the way in which each categorical variable was calibrated.

Table 2 - Variables used in the fsQCA.

Outcome	*Description*	
Percentage of online sales	Online sales as a percentage of total sales	Continuous variable*
Condition	*Description*	
osn	Use of online social networks	Dichotomous variable[1]
age	Age of organization	Continuous variable*
size	Number of members of the organization	Continuous variable*
ict.training	Top manager's ICT training	Categorical variable[2]
ict.outsourcing	Outsourcing of ICT management	Dichotomous variable[3]

Source: Compiled by the authors.

**Continuous variables were calibrated using fsQCA 2.0 software.*

[1] Dichotomous variable (1: use of online social networks; 0: no use of online social networks).

[2] Categorical variable with four levels (0.01: no knowledge; 0.33: user level; 0.67: intermediate level; 0.99: advanced level). Calibrated as per Rihoux and Ragin (2009).

[3] Dichotomous variable (1: outsourced ICT management; 0: no outsourced ICT management).

4. Results and discussion

By way of preliminary analysis in this study, Table 3 presents the descriptive statistics (means) for the variables considered in the analysis.

Table 3 - Descriptive statistics for the variables used in this study.

Variable	*Mean*
Online sales as a percentage of total sales	1.30%
Percentage of organizations that use social networks	62.96%
Age of the organization	27 years
Number of individual members of the organization	6,135 members
Top manager's ICT training	18.51% high 74.07% moderate 7.40% low
Percentage of organizations with outsourced ICT management	33.33% internal management 48.15% internal management with outsourced support 18.52% outsourced management

Source: Compiled by the authors.

The population comprises firms with a low percentage of online sales, despite their extensive presence on online social networks. E-commerce opens the door to a huge market, which organizations should consider in their commitment to competitiveness, especially cooperative societies (Jorge-Vázquez *et al*., 2019). For their online business activities, these organizations primarily rely on internal management with support from external specialists. The top managers have ICT training that they themselves class as moderate. These firms have considerable experience and, on average, have more than 6,000 members. The integration and size of cooperatives have been considered clear development factors in the literature (Gorgues *et al*., 2019).

The analysis presented below aims at identifying which of the previously discussed factors are positively related to the percentage of online sales of these companies. The results of the fsQCA appear in Table 4, which presents the intermediate solution, showing the causal configurations ordered by their raw coverage.

The results indicate that the first configuration has a raw coverage of 37%. The results also indicate that the age of the organization, the top management's ICT training, the use of online social networks, and external ICT management or support are conditions that, when combined, explain a high percentage of online sales. The top organizational manager is a key figure in the commitment to innovation (Mozas *et al*., 2016). The outsourcing of ICT to professionals and the use of virtual social networks, as a means of loyalty, explain higher online sales (Bernal *et al*., 2019). Similarly, the second causal configuration consists of the use of online social networks, the top management's ICT training, the external management of ICT tools, and organizational size. Literature shows that there are positive relationships between innovation and

Table 4 - Results of the fsQCA.

Causal configuration	*Raw coverage*	*Unique coverage*	*Consistency*
age* ict.training*osn*ict.outsourcing	0.375967	0.062463	1.000000
size* ict.training*osn*ict.outsourcing	0.359310	0.045806	0.964856
~age*~ ict.training*~osn*~ict.outsourcing	0.198691	0.198691	0.869792
~size*~age*ict.training*~osn*ict.outsourcing	0.032124	0.032124	0.900000
Model coverage	0.652588		
Model consistency	0.933617		

Source: Compiled by the authors.

company size (Voulgaris and Lemonakis, 2013). This combination of conditions explains a high percentage of online sales, with a raw coverage of 35.9%. This model has a total coverage of 65.26%, which denotes the percentage of organizations explained by the conditions used in the analysis. The total consistency is 93.36% of the cases. This value comfortably exceeds the minimum recommended consistency of 0.74, which supports the validity of the model (Ragin, 2008; Woodside, 2013).

These results provide empirical evidence that enables acceptance of the five propositions formulated earlier. Thus, the conditions of age, size, the management's ICT training, participation in online social networks, and outsourced ICT management positively influence firms' tendency to participate actively in e-commerce through online sales. In view of the results obtained, this study should serve as encouragement to olive oil agri-food cooperatives, and the olive oil agri-food industry in general. It has become increasingly clear that the incorporation of these technologies into the olive oil sector is a decisive competitive factor in ensuring the survival and profitability of companies and in tackling the challenges posed by this new digital era (Bernal *et al.*, 2019). In short, agri-food companies have an obligation to adapt to the technological revolution in order to compete successfully in the market (Gaiani, 2008).

5. Conclusions

The greater competitiveness generated by the increase in olive oil production at world level and the structural deficiencies of the Spanish olive sector (lack of integration in the olive grove, small organizational structures, lack of professionalization, low profitability and low bargaining power vis-à-vis distribution) have led a large group of cooperative societies to create second-degree cooperative societies from which carry out, jointly, the marketing of their products in order to achieve greater profitability.

Based on the proposed objective, consisting of analysing Spanish second-degree olive-growing entities in terms of their participation in e-commerce, the results obtained through the fsQCA analysis have made possible to identify a series of structural and organizational variables that explain a greater participation in e-commerce through online sales. In this way, the hypotheses put forward in the theoretical framework are accepted, which indicates that the ICT training of management, the age of the company, the presence and use of virtual social networks and the size of the organisation (measured by the number of members of the organisation and external ICT management) are factors which together have a relevant explanatory capacity for the level of online sales in organisations.

The results have been obtained from the total population of second degree olive cooperatives, and not from a sample, so they are representative of the reality under study. According to the literature analysed, integration favours the professionalisation of companies. On the other hand, in the study carried out it has been shown that the training in ICT of the company head favours the online sales of the organization. All this suggests the need to achieve greater integration in the sector that favours investment in ICT training, both for their managers and for the rest of their employees. The increase in e-commerce is a reality in all countries and companies need to have human capital capable of using ICTs, especially in the commercial field. However, this study shows that the external management of ICTs increases the percentage of online sales. This can be explained by the shortage of ICT professionals in the commercial field specialising in specific sectors, such as the olive grove, and the lack of this type of professional in the small organisational structures, which leads them inexorably to outsourcing. However, we believe that in the future the internal management of ICTs should be adopted as a priority and even more so if the increase in business size allows greater investment in specialised human capital. This investment in ICT training will be essential in an increasingly digitalised future.

Achieving greater integration must also be a future business strategy. It has been shown that the size of the organisation affects the percentage of its sales that are made online. Creating synergies between second grade cooperatives, either by creating third grade structures or by

generating agreements with other companies, cooperatives or non-cooperatives in the olive sector, would improve marketing and further level out the negotiating power in the sector now in the hands of distribution.

The capacity of ICTs to reduce transaction costs and improve efficiency in companies along the value chain is a reality. If we refer to the commercial area, it is known that the use of virtual social networks as a communication channel and a relationship marketing strategy improve competitiveness. This study shows that its use improves online sales, so the achievement of greater popularity and presence in the networks should be established as goals to be achieved.

This research opens up a huge field of work for future research. Within it we can highlight the following: to deepen the study of which structural and organizational variables favor market orientation through virtual social networks or other ICT applications and to determine whether this explanatory model coincides with other agri-food subsectors.

The objective of this research was to analyze Spanish second-tier olive oil producers in terms of their participation in e-commerce. The results of the study, which were obtained using fsQCA, enables identification of a series of structural and organizational conditions that explain a higher level of participation in e-commerce through online sales. Accordingly, the propositions formulated in the theoretical framework are accepted. These propositions posit that the management's ICT training, the age of the firm, the presence and use of online social networks, the size of the organization (in terms of number of members), and external ICT management are factors that, when combined, have considerable explanatory capacity for organizations with a higher percentage of online sales.

The results of this study were obtained by analyzing data on the total population of second-tier olive oil cooperatives. They therefore offer meaningful insight. Accordingly, these results should encourage these firms to invest in ICT training for both managers and other employees and in establishing a stronger social network presence. These are key factors in the design and implementation of expansion or diversification strategies with regard to online business. At the same time, the positive relationship between size and the percentage of online sales provides another argument to support greater integration of the olive oil sector in an attempt to tackle the commercial problems that have plagued this sector for decades.

This study opens a vast field of research that may be exploited by future studies. Potential opportunities include furthering the study of the structural and organizational variables that encourage a market orientation through online social networks and other ICT applications and studying whether this explanatory model might be applicable in other agri-food sectors.

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Technical efficiency of arable farms in Serbia: do subsidies matter?

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Abstract

This paper analyses the technical efficiency of arable farms in Serbia and its determinants using a two-stage double bootstrap Data Envelopment Analysis (DEA) approach on the Farm Accountancy Data Network (FADN) data from 2014 and 2015 with special emphasis on the impact of agricultural subsidies on the technical efficiency of arable farms in Serbia. Bias-corrected DEA efficiency scores were first calculated and then regressed on a set of explanatory variables using the double-truncated regression approach. The estimates suggest that the share of rented land, land to labour ratio and financial stress variables are the main determinants of arable farm efficiency in Serbia. For the subsidies we found that area payments and input subsidies have some impacts on the technical efficiency of arable farms. In contrast, investment and other subsidies were found to have an insignificant impact on farm technical efficiency. These results suggest that the future potential shift of the Serbian agricultural support towards the Common Agricultural Policy (CAP)-like area based payments is expected to have a minimal but likely positive impact on farms technical efficiency in Serbia.

Keywords*: Technical efficiency, Arable farms, Agricultural subsidies, Serbia, Data Envelopment Analysis, Double bootstrapping.*

1. Introduction

Understanding how agricultural subsidies impact farm efficiency is one of a major research topic studied in agricultural production economics motivated by its implications for policy making. There are two opposing policy relevant arguments regarding the impact of agricultural subsidies on farm efficiency. On the one hand, within the context of the World Trade Organization (WTO) trade liberalisation agenda, the discussion centres on the distortionary impact of subsidies on agricultural markets (including farm efficiency). On the other hand, many developing and transition countries call for maintaining agricultural support to stimulate productivity growth and improvement of farm efficiency in order to address concerns related to food security and rural poverty (Gorton and Davidova, 2004; FAO, 2011; Minviel and Latruffe, 2017).

Theoretical studies are inconclusive in providing an exact explanation of the impact of agricultural subsidies on farm efficiency. Subsidies may have either a positive impact or a negative impact on farm efficiency depending on channels through which they impact efficiency. The negative impact of subsidies on efficiency may, among others, be caused by allocative and tech-

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nical efficiency losses induced by distortions in production choices and factor use and soft budget constraints. The positive impact of subsidies may be due to investment-induced productivity gains caused by interactions of credit and risk attitudes with subsidies (e.g. subsidy-induced credit access, lower cost of borrowing, reduction in risk aversion) (Rajan and Zingales, 1996; Hennessy, 1998; Blancard *et al.*, 2006; Ciaian and Swinnen, 2009; Rizov *et al.*, 2013). Empirical literature finds mixed effects of subsidies on farm efficiency depending on contextual factors, type of subsidies, data and applied methodology (Minviel and Latruffe, 2017). For example, a negative impact of agricultural subsidies on technical efficiency was found by Zbranek (2014) and Zhu and Oude Lansink (2010), who showed that in some European Union (EU) countries the share of total subsidies in total farm revenue has a negative impact on technical efficiency. Similarly, Latruffe and Fogarasi (2009) and Bojnec and Latruffe (2013) argued that less subsidized farms were more technically efficient, while Lakner (2009) shows that the agri-environmental payments and investment support have negative effects on the technical efficiency of organic dairy farms in Germany. Subsidies may affect negatively farm performance also because they are often conditional on meeting certain environmental requirements which might adversely impact the economic efficiency of resource allocation (e.g. land) on farms. For example, Cimino *et al.* (2015) show that greening requirements linked to direct payments have a negative effect on gross margin of arable farms in Italy and that the green payments usually do not compensate the reduction of farm gross margin for the affected farms. On the other hand, there is evidence supporting the positive influence of subsidies on farm technical efficiency. Galanopoulos *et al.* (2011) found that subsidies have a significant impact on the technical efficiency of the small-sized farms in EU, while Pechrová (2015) emphasised that subsidies for Less Favourable Areas positively affect farm efficiency. Sauer and Park (2009) find a positive influence of organic subsidies on total factor productivity change (technical efficiency change and technological change) for organic dairy farms in Denmark. Latruffe *et al.* (2017), in addition to positive association between subsidies and technical efficiency on dairy farms in some European countries, also found a negative or no significant relationship in some EU countries.

The existing empirical studies usually employ a two-stage approach to analyse the impact of subsidies on farm efficiency whereby efficiency measures are estimated in the first stage and then these efficiency measures are regressed on subsidies and other explanatory variables in the second stage (e.g. Lansink and Reinhard, 2004; Johansson and Öhlmér, 2007; Lakner, 2009; Sauer and Park, 2009; Zhu and Lansink, 2010; Lenglet *et al.*, 2014; Poudel *et al.*, 2015). The most often used methods to estimate farm efficiency are the non-parametric approach with Data Envelopment Analysis (DEA) and the parametric Stochastic Frontier Analysis (SFA) (Coelli *et al.*, 2005). However, when it comes to the second stage, a Tobit regression model (Tobin, 1958) is often used to investigate explanatory variables that affect technical efficiency. In this regard, Simar and Wilson (2007) have criticised the use of the Tobit regression model where DEA efficiencies are used as the dependent variable in the second stage − due to the fact that the statistical inference for the calculated coefficients is biased due to the serial correlation of DEA efficiency estimators. Therefore, they proposed an alternative estimation and statistical inference procedure based on a double-bootstrap approach (Algorithm 2). This approach has been applied relatively widely to analyse the technical efficiency in the agricultural sector (Balcombe *et al.*, 2008; Latruffe *et al.*, 2008a; Monchuk *et al.*, 2010), but it has not yet been applied to investigate the technical efficiency of farming sector in Serbia.

This paper contributes to the literature by analysing the impact of agricultural subsidies on technical efficiency of arable farms in Serbia. We have applied a two-stage double bootstrap DEA approach using the Farm Accountancy Data Network (FADN) data from 2014 and 2015. Serbia represents particularly interesting case study as it is a transitional country facing economic development challenges and changing agricultural policy environment. Serbia is under the EU accession negation process which requires reforming its agricultural policy to make it compatible

with the Common Agricultural Policy (CAP). Most empirical studies analysing the impact of subsidies on farm efficiency focus on developed countries. There is significantly less work done on developing and transition countries particularly from the Western Balkans. A better understanding of the relationship between subsidies and farm efficiency could provide a relevant input to support the evidence based policy making and the potential future reforms in Serbia. This is particularly relevant given that agricultural policy in Serbia is under a constant adjustment driven by the EU accession process and internal political economy factors (Bogdanov and Rodić, 2014; Bogdanov *et al.*, 2017).

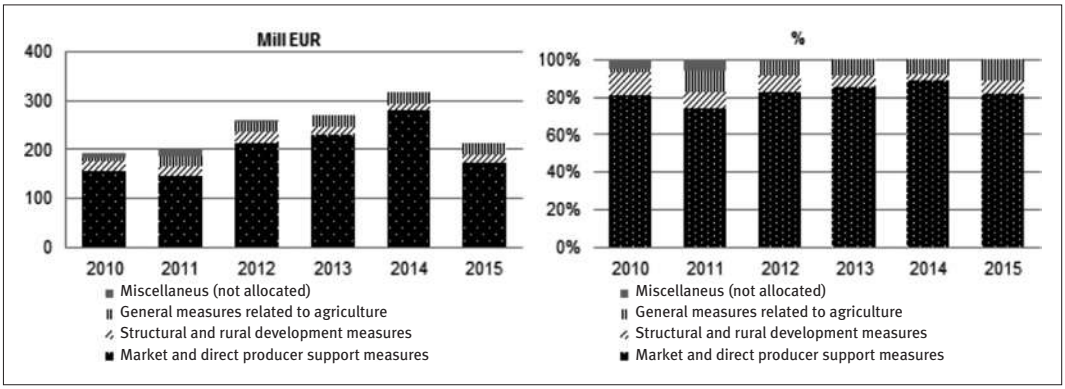
The rest of paper is structured as follows. The next section describes agricultural subsidies in Serbia. The third section outlines the methodology and data employed in the paper. The fourth section presents the estimated results. The final fifth section summarises and concludes the paper.

2. Agricultural subsidies in Serbia

During the past decade the agricultural policy in Serbia was marked by frequent changes in the policy framework, the implementation mechanism and the magnitude of the support. These policy changes were mostly driven by internal political factors as well as by the EU accession process aiming to gradually approximate Serbian agricultural policy with the EU CAP (Bogdanov and Rodić, 2014; Bogdanov *et al.*, 2017). The Serbian agricultural subsidies can be structured in three groups: (i) market and direct producer support measures; (ii) structural and rural development measures; and (iii) general measures related to agriculture. Figure 1 shows the development of agricultural subsidies in Serbia for the period 2010-2015. Over this period, the level of subsidies varied from EUR 191.1 million in 2010 to EUR 315.4 million in 2014. The market and direct producer support represented the largest share of the total subsidies (more than 70%) followed by rural development payments (between 4% and 12%). The total subsidies increased continually until 2014. In 2015, a significant budgetary cut was implemented causing total agricultural subsidies to fall by 33% compared to 2014, with direct producer support experiencing the largest decline (38%). On the other hand, the support allocated to rural development increased (by 24%), as well as their proportion in the total agricultural subsidies (from 4.0% in 2014 to 7.4% in 2015). The general support remained at the same level in absolute terms (EUR 24 million) in the period 2010-2015, while their proportion of the total agricultural subsidies increased from 7.6% in 2014 to 11.3% in 2015 (Bogdanov *et al.*, 2017).

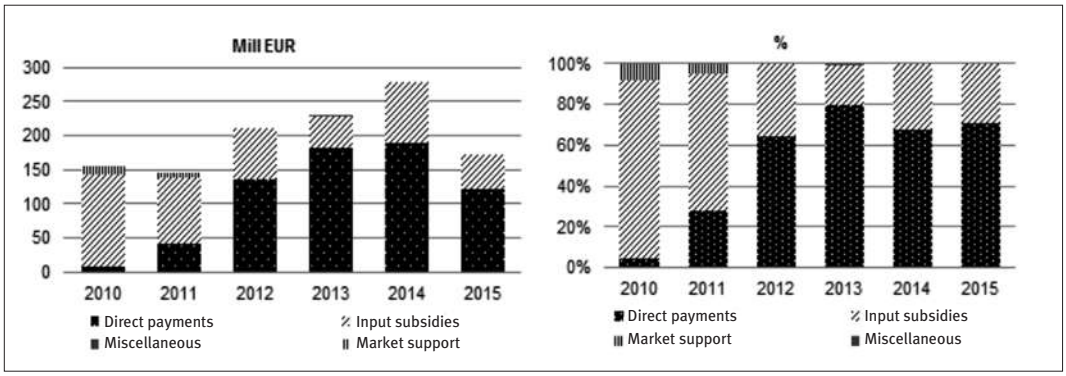
The market and direct producer support in Serbia have been undergoing constant adaptation and change over time. A key reform was implemented at the beginning of the 2000s, which introduced direct payments coupled to production levels, cultivated area or animal numbers. The aim of the

Figure 1 - Development of agricultural subsidies in Serbia, 2010-2015.



Source: Bogdanov et al., 2017.

Figure 2 - Development of market and direct producer support in Serbia, 2010-2015.



Source: Bogdanov et al., 2017.

direct payments was to compensate farmers for cuts in market support. Figure 2 shows the development of the market and direct producer support in Serbia for the period 2010-2015. The total value of the market and direct producer support increased from EUR 154.7 million in 2010 to EUR 278.8 million in 2014 and then decreased to EUR 172.5 million in 2015. There was a significant shift in the structure of the market and direct producer support over the period 2010-2015. Direct payments increased from less than 15% in 2010 to around 70% of the total direct producer support in 2015. Input subsidies, which are the second most important, accounted for around 30% of the total market and producer support in 2015, decreasing for more than 85% in 2010 (Bogdanov *et al.*, 2017).

The area and animal direct payments varied considerably in the 2010-2015 period in terms of the payment amount (total and per hectare/head), product coverage and eligibility criteria. In 2012, area payments were intended only for areas under arable crops; however, since 2013, this support has been extended (in the form of a flat rate area payment) to permanent crops. In parallel, area payments replaced some previously used input subsidies for fertilisers and fuel in 2013. In the relatively short period since the introduction of area payments, there has been a constant decrease in their per hectare value: from EUR 56.8 per ha in 2012 to EUR 49.3 per ha in 2015. In addition, the maximum area eligible for area payments was reduced significantly in 2015 from 100 ha to 20 ha. This relatively low eligibility threshold made area payments (mainly for larger farms) similar to a lump sum payment scheme. Essentially, the reduction of the total agricultural subsidies and, particularly, the sharp decline in direct payments in 2015 relative to 2014 is in most part a result of the reduction in the maximum eligible area for area payments (Bogdanov *et al.*, 2017).

Direct payments granted per animal head were introduced in 2007 in Serbia. In comparison with area payments, they are more diversified in terms of the number of measures and supported animal types. In 2010 and 2011, animal payments were implemented for breeding animals (cows, sheep and goats and pigs) and, since 2012, they have been extended to fattening cattle and pigs. Since 2013, animal payments have also included support for fattened lambs, beehives, various types of parental poultry and, since 2015, for suckler cows (Bogdanov *et al.*, 2017).

Input subsidies were granted mainly for diesel fuel and mineral fertilisers in the period 2010-2015. However, their value decreased continually over this period. A particular drop in input subsidies was observed in 2015 (from EUR 84.3 million in 2014 to EUR 48.6 million in 2015) caused by the reduction of the maximum area eligible for fuel and fertiliser subsidies (from 100 ha to 20 ha). In addition to fuel and fertilisers subsidies, insurance subsidies were implemented in Serbia in the period 2010-2015. However, their proportion in the total value of input subsidy was relatively small (less than 3.7%) (Bogdanov *et al.*, 2017).

The rural development support includes various set of measures such as on-farm investment support, subsidies for sustainable rural development and subsidies for improvement and development of rural economy (e.g. rural infrastructure). Investment support represents the main bulk (on average 84% in the period 2010-2015) of the rural development support in Serbia. The primary aim of this support is to promote the improvement of farm competitiveness and product quality standards. The investment support gained in importance over time. The total value of investment support was EUR 10.0 million in 2014 increasing to EUR 13.8 million in 2015 (Bogdanov and Rodić, 2014; Bogdanov *et al.*, 2017).

In summary, agricultural subsidies were substantially changed in Serbia over the 2010-2015 period, particularly in 2015. The changes introduced in 2015, among others, led to the reduction of the overall support to the farming sector and the redistribution of subsidies among farms (particularly caused by changes in eligibility criteria for direct payments and input subsidies) to the detriment of large arable farms. This paper aims to shed light on the potential impacts of subsidies and their changes on technical efficiency of arable farms in Serbia. In further analysis we consider the following agricultural types of the subsidies implemented in Serbia which are relevant for arable farms: (i) area payments, (ii) input subsidies, (iii) investment subsidies, and (iv) other subsidies.

3. Methodology and data

3.1. *Methodology*

In line with previous literature, we have applied double bootstrap DEA analysis proposed by Simar and Wilson (2007) to assess the technical efficiency of arable farms and the impact of agricultural subsidies on technical efficiency scores. The DEA method involves the liner programming method to construct a non-parametric envelopment frontier over the data points, so that all observed points lie on or below the production frontier (Farrell, 1957; Charnes *et al.*, 1978; Coelli, 1996). A farm is considered efficient when there is no other farm producing the same level of outputs with a lower level of inputs. The literature on farm efficiency measurement often focuses on two efficiency concepts: (i) the technical efficiency, i.e. the ability to produce maximal output from a given amount of inputs and (ii) the price efficiency or allocative efficiency, i.e. the ability to choose an optimal set of inputs such that their marginal revenues are equal to their marginal costs (Farrell, 1957; Färe *et al.*, 1990; Jha *et al.*, 2000; Henderson and Kingwell, 2002). The technical efficiency is the main indicator used in the literature to measure farm efficiency.

Technical efficiency can be measured with DEA by two approaches: (i) input-oriented model which measure how much inputs could be reduced while maintaining the existing level of output, or (ii) output-oriented model which measure how much output could be increased while using the given amount of inputs. Coelli *et al.* (2005) argues that "one should select the orientation according to which quantities (inputs or outputs) the managers have most control over". Given that farmers have usually more control over inputs than over outputs, we have opted for the input-orientated DEA model.

DEA models can differ with respect to the assumed returns to scale technology: (i) CCR (Charnes Cooper Rhodes) model which assumes the constant return-to-scale (CRS) and is appropriate when the farm operates at an optimal scale (Coelli *et al.*, 1998) and (ii) BCC (Banker Charnes Cooper) model which assumes variable returns-to-scale (VRS). We have applied the second model anticipating that some factors (e.g. imperfect competition, financial constraints) may not allow a farm to operate optimally (Banker *et al.*, 1984).

The input-oriented BCC model evaluates the efficiency of farms by solving the following minimisation problem:

(1) $min\ \theta$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{i0}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0$$

where x and y are inputs and outputs, respectively; i is the number of inputs (i = 1, 2, ..., m); r is the number of outputs (r = 1, 2, ..., s); j represents j^{th} farm (j = 1, 2, ..., n); λ_j is the weights used to construct the efficient frontier which determines the point on the frontier of efficient farms: and θ is the technical efficiency (TE).

As mentioned before, the DEA method involves the liner programming method and thus has no statistical properties or accounts for measurement error. In order to account for both the bias and serial correlations of efficiency scores, we have used the double bootstrap procedure (Algorithm 2) suggested by Simar and Wilson (2007) which allows for valid inference. By using a specific bootstrap procedure in the first stage, the DEA efficiency estimator is corrected for the bias. A parametric bootstrap procedure has also been applied, in the second stage analysis, to the truncated regression of DEA bias-corrected efficiency scores on explanatory variables. These variables are viewed as possibly affecting the production process, but are not under the control of managers. Determining the effect of these variables on efficiency is essential for determining performance improvement strategies.

The truncated regression model used in the second stage in our study is specified as follows:

$$\delta_j = \beta Z_j + \varepsilon_j \quad (2)$$

where δ_j is the dependent variable ($\delta_j = \frac{1}{TE_j}$ is the reciprocal of technical efficiency scores of arable farms in Serbia estimated in (1)), β is a vector of parameters to be estimated, Z_j is a vector of individual farm characteristics assumed to affect the choice and use of inputs and output, and ε_i is the statistical noise.

Since the reciprocal of technical efficiency scores of arable farms in Serbia (input-oriented BCC DEA model) is chosen as the dependent variable, there is a positive relationship between an arable farm specific variable and technical efficiency if the sign of the coefficient is negative, whereas a relationship is negative if the coefficient is positive.

3.2. *Data and variable selection*

Data used in this paper were derived from the Serbian FADN database for the 2014-2015 period. The FADN database is harmonised with the EU FADN database. The FADN is a European system of sample surveys that take place each year and collect structural and accountancy data on farms. In total, there is information about 150 variables on farm structure and yield, output, inputs, costs, subsidies and taxes, income, balance sheet, and financial indicators. The Serbian FADN sample covers approximately 1,000 agricultural farms annually. For the period 2014-2015 they represented almost 32% of farms, covering approximately 90% of the total utilised agricultural area and accounting for more than 90% of the total agricultural production in Serbia. Farm-level data are confidential and, for the purposes of this paper, they were accessed under a special agreement.

Farms are selected to take part in the survey on the basis of sampling plans established at the level of each region in Serbia. The FADN survey does not, however, cover all farms in Serbia, but only those which are of a size allowing them to rank as commercial holdings. According to the data of the agricultural census carried out by Statistical Office of the Republic of Serbia, there were 631,552 agricultural holdings in Serbia in 2012 (SORS, 2013). Around 203,665 holdings exceed the threshold of the economic size of EUR 4,000 and these holdings form the base for field survey of the Serbian FADN.

In this paper we have used a subsample of arable farms specialized in cereals (other than rice), oilseeds and protein crops (COP), which are the most significant contributors to the output of the agricultural sector in Serbia. The crop sector represented 65% of the total gross agricultural output (GAO), while arable farms represented 36% of GAO in 2015 (SORS, 2016). Arable farms represented 20% of the total number of farms and used 46% of the total Utilised Agricultural Area (UAA).

Methodologically, the assumption of a common frontier across different farm types is a sensitive issue in DEA. In general, management practices and the technology differ between farm types, especially if the farms under investigation have different production specialisation.

Estimating a common production function may lead to biased estimates of the efficiency scores. This is a second reason for using specialised subsample of arable farms.

Overall, the dataset used in this paper includes 143 (179) COP farms out of the total 930 (1,130) farms available in the FADN database for 2014 (2015). Thus, the final sample consists of 322 COP farms out of total 2,060 farms participating in the FADN survey during the 2014-2015 period.[1]

Input and output variables used in previous studies to explain the efficiency varied depending on the research objectives and availability of data. The most commonly used output variable is the total agricultural production (expressed in monetary values). Several studies also consider non-agricultural output (e.g. revenue from non-agricultural activities such as rural tourism, rural service, forestry and other outputs) expressed in monetary terms (Bojnec and Latruffe, 2008; 2013; Latruffe *et al.*, 2008a; Latruffe and Fogarasi, 2009; Mamardashvili and Schmid, 2013). Most frequently used inputs in the literature are land, labour and intermediate costs (either aggregated intermediate inputs or disaggregated by type, e.g. fertiliser, seed, pesticides, energy, etc.) (Atici and Podinovski, 2015; Gunes and Guldal, 2019).

For technical efficiency analysis, we have retrieved as much information as possible from the Serbian FADN database available for this paper. It should be noted that although the Serbian FADN database attempts to be fully harmonised with the EU FADN database, it is still under the process of full harmonisation of all quality standards applied by the EU FADN database. Considering the information available in the FADN database, we have considered one output variable which measures total production value of farms and associated crop-specific costs such as seeds, fertilisers and crop protection costs and three factor inputs (capital, labour and land). Non-agricultural outputs (e.g. obtained from rural tourism, rural service, forestry), as suggested by other studies (e.g. Bojnec and Latruffe, 2008; 2013; Latruffe *et al.*, 2008a; Latruffe and Fogarasi, 2009; Mamardashvili and Schmid, 2013), were not considered as they are not available in the Serbian FADN data given that most arable farms in Serbia are not involved in the non-agricultural activities. Regarding input variables, we have included ten categories: total labour input (AWU), UAA, seeds and plant costs, fertilisers, crop protection costs, farming overheads, depreciation, external costs, total assets and total liabilities (Table 1). These input and output variables have been chosen as they are expected to represent characteristics of the arable farms in Serbia, human capital and technology employed.

Following the literature (Davidova and Latruffe, 2003; Latruffe *et al.*, 2008a; 2008b; Bakucs *et al.*, 2010), we have considered the following variables as determinants of technical efficiency used in the second-stage in the regression model defined in equation (2): age of holder, farm size measured as total farm area expressed in hectares, the share of rented land in total farmland, the share of hired labour in total farm labour, capital to labour ratio, land to labour ratio, debt to asset ratio which is the percentage of total assets that were paid for with borrowed money, current ratio as financial ratio that shows the proportion of current assets to current liabilities (i.e. the indicator of a farm ability to meet short-term financial obligations), financial stress as ratio that reflects the interest and rent payments to the value of the farm output, agricultural subsidies implemented in Serbia which are relevant for arable farms (area payments, input subsidies, investment subsidies, and other subsidies), dummy variable for 2015 (it equals 1 if the year is 2015; zero otherwise) and interaction between subsidies and time dummy variable to account for possible effects of the change in policy implementation between 2014 and 2015.[2]

[1] Note that the final sample of 322 farms also takes into account observations excluded during the data cleaning in case errors were detected in the data.

[2] Note that running the estimation with the full sample by including time dummies and the interaction variables or splitting the sample by year are equivalent approaches. We have opted for the first approach as it allows us to test for the statistical significance of the change in the subsidy implementation between the two years (i.e. for the interaction variables) as well as it increases the number of observations, which causes estimates to be more precisely estimated.

It should be noted that the FADN database available for this paper has not included certain variables due to the confidentiality of individual farm data used in this paper. Hence, it was not possible for some explanatory variables (e.g. legal status of farms and education of a farm manager) used in previous empirical studies to be considered in the second-stage estimations.

In addition, it should be noted that the output variable in our paper does not include subsidies. Although some consider subsidies as an additional output to the traditional farm outputs used in the efficiency calculations (Silva *et al.*, 2004; Hadley, 2006; Rasmussen, 2010; Silva and Marote, 2013), in general subsidies are used in most studies as an explanatory variable of farm efficiency (e.g. Zhu and Lansink, 2010; Bojnec and Latruffe, 2013; Kumbhakar *et al.*, 2014; Sipiläinen *et al.*, 2014). One of the reasons is that if subsidies are included both as dependent and independent variables in the model (defined in equation 2), it will generate an endogeneity problem leading to biased regression coefficient estimates. The second reason for excluding subsidies from output variable is that the efficiency score of farms receiving subsidies might be biased in certain situations. For example, consider a hypothetical situation where two farms have the same output and input levels, but only the first farm receives decoupled payments (e.g. because only the first farm fulfils the eligibility criteria). The first farm will show higher efficiency than the second one if subsidies are included in the output measure although both farms are equally efficient. In this case, we would observe a positive relationship between subsidies and efficiency solely induced by the construction of the policy support (i.e. eligibility criteria). Indeed, this might be the case of Serbia where eligibility criteria for receiving subsidies changed substantially between 2014 and 2015 (e.g. the maximum area eligible for area payments reduced from 100 ha in 2014 to 20 ha in 2015). If accounting subsidies in the output variables it might generate biased estimated results. Table 1 shows descriptive statistics of output and inputs variables used in the DEA model and explanatory variables used in regression analysis.

4. Results

The DEA estimation results are reported in Table 2. The average technical efficiency of arable farms in both observed years was similar: 0.76 in 2014 versus 0.74 in 2015. The efficiency scores lower than one imply for the possibility of arable farms to improve their efficiency by reducing the input use (by 24% in 2014 and 26% in 2015) while producing the same quantity of output. These results suggest that arable farms faced greater challenges in 2015 in minimising the combination of inputs for the produced output level. In this regard, efficient farms (TE = 1) could sustain their efficiency unless there were major changes in the inputs/outputs. In addition, the efficiency of marginal inefficient farms ($0.9 < TE < 1$) could easily be increased to 1 while inefficient farms ($TE < 0.9$) could not easily be transformed into efficient ones in a short period and would remain inefficient unless there were major changes in inputs/outputs.

Table 3 compares the subsidies received by efficient and marginal inefficient farms on the one hand and inefficient farms on the other hand in 2014 and 2015. It can be seen that in both years efficient and marginal inefficient farms received higher subsidies than inefficient farms: 114.5 EUR/ha versus 90.1 EUR/ha in 2014 and 66.3 EUR/ha versus 44.8 EUR/ha in 2015. Regarding the subsidy type, efficient and marginal inefficient farms had higher area payments, input subsidies, and investment subsidies than inefficient farms in both years. For other subsidies inefficient farms received slightly higher values in 2014, while the reverse was valid in 2015.

When comparing changes in subsidies between years, we have identified a significant decrease in the total subsidies in 2015 compared to 2014. Furthermore, inefficient farms experienced a greater drop in subsidies than efficient and marginal inefficient farms: by 50.3% versus 42.1%, respectively. As explained above, the subsidy cut is driven by a decrease of area payments and input subsides. This holds for both efficient and marginal inefficient and inefficient farms. Area payments (input subsidies) decreased by 53.8% (42.5%) for efficient and marginal inefficient farms and 49.8% (50.1%) for inefficient farms

Table 1 - Descriptive statistics of arable farms.

	Unit	2014		2015	
		Mean	Std. deviation	Mean	Std. deviation
Output variable in DEA					
Total output	EUR	56,572.0	51,588.2	58,100.0	46,480.0
Input variables in DEA					
Total labour input	AWU	1.6	1.0	1.6	0.9
Utilised agricultural area	ha	60.9	52.8	63.9	51.2
Seeds and plant costs	EUR	5,109.7	4,961.8	5,572.8	5,502.2
Fertilisers	EUR	7,786.9	7,745.2	7,273.3	6,821.9
Crop protection	EUR	2,863.6	3,300.7	3,206.9	3.334,6
Farming overheads	EUR	10,569.4	9,755.4	10,522.3	9,927.1
Depreciation	EUR	2,527.7	5,539.4	4,536.1	9,279.1
External costs	EUR	8,916.2	9,534.3	8,976.9	9,802.8
Total assets	EUR	260,122.6	241,590.6	300,075.5	270,780.4
Total liabilities	EUR	7,720.5	27,007.8	7,222.8	24,760.4
Explanatory variables					
Age of holder	years	47.1	11.1	47.5	11.0
Farm size	ha	60.9	52.8	63.9	51.2
Share of rented land in total farmland	%[(a)]	0.5	0.3	0.5	0.3
Share of hired labour in total farm labour	%[(a)]	0.2	0.2	0.1	0.2
Capital to labour ratio	EUR/AWU	2,048.1	4,283.3	3,306.3	6,136.1
Land to labour ratio	ha/AWU	42.8	34.6	47.0	39.3
Debt to asset ratio	ratio	0.02	0.06	0.02	0.07
Current ratio	ratio	0.7	4.6	0.4	2.1
Financial stress	ratio	0.1	0.1	0.1	0.1
Area payments	EUR/ha	42.2	24.1	21.1	19.0
Input subsidies	EUR/ha	47.2	18.3	24.1	19.2
Investment subsidies	EUR/ha	1.9	18.1	1.9	20.9
Other subsidies	EUR/ha	0.7	3.4	0.2	1.1

Note: [(a)] Percentages are expressed as decimals.

Table 2 - Technical efficiency scores of arable farms in Serbia (input-oriented BCC DEA model).

Efficiency scores	*%*	*Mean*	*95% confidence interval lower*	*95% confidence interval upper*
2014				
All farms	100	0.76	0.69	0.85
Efficient and marginal inefficient farms	8.39	0.92	0.87	1.00
Inefficient farms	91.61	0.74	0.68	0.84
2015				
All farms	100	0.74	0.68	0.81
Efficient and marginal inefficient farms	11.73	0.93	0.87	1.00
Inefficient farms	88.27	0.71	0.66	0.78

Note: Efficient farms are those with TE = 1, marginal inefficient farms are those with 0.9 < TE < 1 and inefficient farms are those with TE < 0.9.

Table 3 - Subsidies received by efficient and inefficient arable farms in 2014 and 2015.

Indicators	*Type of farm*	*2014*		*2015*	
		Mean	*Std. deviation*	*Mean*	*Std. deviation*
Area payments (EUR/ha)	Efficient and marginal inefficient farms	46.8	31.8	21.6	21.1
	Inefficient farms	41.8	23.8	21.0	18.8
Input subsidies (EUR/ha)	Efficient and marginal inefficient farms	50.3	28.3	28.9	25.1
	Inefficient farms	46.9	17.2	23.4	18.3
Investment subsidies (EUR/ha)	Efficient and marginal inefficient farms	17.0	59.1	15.0	60.5
	Inefficient farms	0.5	6.4	0.1	1.8
Other subsidies (EUR/ha)	Efficient and marginal inefficient farms	0.4	1.3	0.7	2.3
	Inefficient farms	0.7	3.5	0.2	0.8
Total subsidies (EUR/ha)	Efficient and marginal inefficient farms	114.5	115.5	66.3	85.0
	Inefficient farms	90.1	40.	44.8	35.0

in 2015 compared to 2014. For other subsidy types, we have observed a mixed development. Investment subsidies decreased for efficient and marginal inefficient farms by 11.8%, while they decreased by 80.0% for inefficient farms in 2015 compared to 2014. Finally, for other subsidies efficient and marginal inefficient farms experienced an increase (75.0%), while inefficient farms experienced a decrease (71.4%) in their per hectare value over the same period (Table 3).

The second stage estimated results are reported in Table 4. We have estimated several models

Table 4 - Determinants of technical efficiency of arable farms in Serbia[(a)]: double bootstrap estimation.

Variable names	*Model 1 (M1)*	*Model 2 (M2)*	*Model 3 (M3)*	*Model 4 (M4)*
Costs	**1.39E+00****	**1.35E+00****	**1.54E+00****	**1.57E+00****
	(6.09E-01; 2.08E+00)	(6.35E-01; 2.01E+00)	(7.86E-01; 2.26E+00)	(7.53E-01; 2.39E+00)
Age of holder (years)	-6.30E-03	-5.29E-03	-6.24E-03	-7.06E-03
	(-1.73E-02; 4.86E-03)	(-1.53E-02; 4.84E-03)	(-1.66E-02; 3.71E-03)	(-1.76E-02; 2.92E-03)
Farm size_Total Utilised Agricultural Area (ha)	7.81E-03	**7.91E-03****	**7.46E-03****	7.32E-03
	(-3.42E-05; 1.70E-02)	(2.57E-04; 1.69E-02)	(2.14E-05; 1.60E-02)	(-5.14E-04; 1.63E-02)
Farm size_Total Utilised Agricultural Area Square (ha)	-2.57E-05	-2.65E-05	-2.43E-05	-2.38E-05
	(-7.45E-05; 8.77E-06)	(-7.40E-05; 7.97E-06)	(-6.91E-05; 8.82E-06)	(-6.95E-05; 1.01E-05)
Share of rented land (%)[(b)]	**-6.40E-01****	**-5.38E-01****	**-6.45E-01****	**-6.80E-01****
	(-1.23E+00; -7.71E-02)	(-1.10E+00; -4.41E-02)	(-1.19E+00; -1.41E-01)	(-1.24E+00; -1.76E-01)
Share of hired labour (%)[(b)]	2.95E-01	3.03E-01	2.76E-01	2.46E-01
	(-2.69E-01; 8.49E-01)	(-2.56E-01; 8.36E-01)	(-2.68E-01; 7.95E-01)	(-2.95E-01; 7.51E-01)

→

Variable names	*Model 1 (M1)*	*Model 2 (M2)*	*Model 3 (M3)*	*Model 4 (M4)*
Capital to labour ratio (EUR/AWU)	1.30E-05	9.16E-06	1.19E-05	1.16E-05
	(-2.04E-05; 4.02E-05)	(-2.33E-05; 3.56E-05)	(-1.90E-05; 3.72E-05)	(-2.00E-05; 3.74E-05)
Land to labour ratio (ha/AWU)	**-2.43E-02****	**-2.37E-02****	**-2.38E-02****	**-2.36E-02****
	(-3.39E-02; -1.67E-02)	(-3.25E-02; -1.67E-02)	(-3.34E-02; -1.64E-02)	(-3.25E-02; -1.63E-02)
Debt to asset ratio	-3.49E-01	-1.61E-01	-3.17E-01	-2.85E-01
	(-2.49E+00; 1.36E+00)	(-2.07E+00; 1.39E+00)	(-2.21E+00; 1.25E+00)	(-2.23E+00; 1.32E+00)
Current ratio	-4.20E-03	-5.47E-03	-4.54E-03	-4.00E-03
	(-7.02E-02; 3.36E-02)	(-6.77E-02; 3.05E-02)	(-6.54E-02; 3.22E-02)	(-7.27E-02; 3.32E-02)
Financial stress	**5.87E+00****	**5.30E+00****	**5.67E+00****	**5.71E+00****
	(4.30E+00; 7.54E+00)	(3.91E+00; 6.90E+00)	(4.28E+00; 7.27E+00)	(4.27E+00; 7.40E+00)
Area payments per ha (EUR)	-4.36E-03	**-3.96E-02****	-4.09E-03	-7.35E-03
	(-1.19E-02; 3.18E-03)	(-6.67E-02; -1.55E-02)	(-1.13E-02; 3.62E-03)	(-1.71E-02; 2.40E-03)
Input subsidies per ha (EUR)	-1.81E-03	**3.21E-02****	-3.08E-03	-1.08E-04
	(-1.10E-02; 6.44E-03)	(7.87E-03; 6.02E-02)	(-1.28E-02; 5.77E-03)	(-1.60E-02; 1.50E-02)
Investment subsidies per ha (EUR)	-1.90E-03	1.84E-02	-1.59E-03	-2.45E-04
	(-1.54E-02; 4.65E-03)	(-1.26E-02; 5.37E-02)	(-1.40E-02; 4.88E-03)	(-2.38E-02; 1.06E-02)
Other subsidies per ha (EUR)	-5.71E-03	-4.94E-03	-8.21E-03	-5.50E-03
	(-8.32E-02; 4.25E-02)	(-1.49E-01; 1.27E-01)	(-7.94E-02; 3.72E-02)	(-9.41E-02; 4.49E-02)
Area payments per ha Square (EUR)		**7.79E-04****		
		(2.97E-04; 1.37E-03)		
Input subsidies per ha Square (EUR)		**-7.37E-04****		
		(-1.34E-03; -2.64E-04)		
Investment subsidies per ha Square (EUR)		-1.62E-04		
		(-5.73E-04; 3.14E-05)		
Other subsidies per ha Square (EUR)		-3.88E-05		
		(-9.36E-03; 6.64E-03)		
Dummy variable "2015"=1			-6.63E-02	-5.77E-02
			(-3.15E-01; 1.81E-01)	(-6.65E-01; 4.71E-01)
Dummy variable "2015"=1 * Area payments per ha (EUR)				8.80E-03
				(-6.48E-03; 2.54E-02)

→

Variable names	*Model 1 (M1)*	*Model 2 (M2)*	*Model 3 (M3)*	*Model 4 (M4)*
Dummy variable "2015"=1 * Input subsidies per ha (EUR)				-7.28E-03
				(-2.73E-02; 1.24E-02)
Dummy variable "2015"=1 * Investment subsidies per ha (EUR)				-3.36E-03
				(-4.31E-02; 2.44E-02)
Dummy variable "2015"=1 * Other subsidies per ha (EUR)				-7.59E-03
				(-2.30E-01; 1.62E-01)

*Notes: *** significant at the 0.001 level, ** significant at the 0.05 level and * significant at the 0.10 level. Figures in parentheses indicate lower and upper bounds for 5 percent confidence interval.*
[(a)] Reciprocal of technical efficiency scores of arable farms in Serbia (input-oriented BCC DEA model) is chosen as the dependent variable. Therefore, the parameters with negative signs indicate sources of efficiency and vice versa.
[(b)] Percentages are expressed as decimals.

to account for possible effects of subsidies on farm efficiency. In the first specification (M1) we included all variables related to different types of subsidies. The second specification (M2) considered square terms for subsidies to account for possible nonlinearities. The third specification (M3) includes all subsidies (without square terms) and time dummy variable for 2015. The forth model (M4) was the same as the third model except that we added interaction between subsidies and time dummy variable to account for possible effects of the change in policy implementation between 2014 and 2015.

The double bootstrap estimation results show that three explanatory variables had a significant influence on technical efficiency of arable farms in all model specifications: share of rented land, land to labour ratio, and financial stress (Table 4).

The share of rented land and land to labour ratio positively influenced technical efficiency of arable farms in Serbia. These results imply that farms with more rented land and farms with less labour intensive production system could attain higher efficiency. Our estimates are consistent with Latruffe *et al.* (2004) who have also found that the share of rented land positively affects the technical efficiency of crop farms in Poland. Latruffe *et al.* (2004) argues that this effect could be due to the positive size-efficiency relationship. An alternative explanation could be that farms with a greater share of rented land achieve higher efficiency because they might be less credit-constrained and thus be able to invest in technology and new farm practices. This is because expanding farmland through renting is less financially demanding than expanding farm through land acquisition. Similarly to our finding, Latruffe *et al.* (2008a) have found that the land to labour ratio has a positive influence on technical efficiency. In addition, Bakucs *et al.* (2010) report positive relationship between the land to labour ratio and farm efficiency in Hungary. Latruffe *et al.* (2008a) argue that this could be caused by the fact that in some European countries agriculture has served as a shelter from industrial unemployment (or hidden unemployment) during the process of transition and/or economic crises leading to over-employment in the farming sector and thus lower efficiency of some farms.

The financial stress has a negative impact on the technical efficiency of arable farms in Serbia. The estimates of Latruffe *et al.* (2008a) also confirm that farms with high financial stress have lower technical efficiency which could be because of the obligation concerning the repayment of rentals and interest payment leaving less to pay for on-investments or variable inputs.

For subsidies, we found that area payments and input subsidies had a statistically significant impact on the technical efficiency of arable farms in Serbia, although the findings have not been consistently confirmed across all estimated models. Area payments had a positive impact on technical efficiency, while input subsidies were found to have a negative effect. The estimates also provided some evidence that there might be nonlinear relationship between area payment and technical efficiency on one side and between input subsidies and technical efficiency on the other. This indicate that farm efficiency gains increase as farms get higher area payment per hectare, but the gain decreases and even becomes negative if area payments per hectare increase significantly. On the other hand, farm efficiency gains decrease as farms get higher input subsidies per hectare, but the gain increases and even becomes positive if input subsidies per hectare increase significantly (Table 4).

The possible explanation for the positive relationship between subsidies and farms efficiency could be found in the literature on credit constraints and risk behaviour in agriculture (e.g. Blancard *et al.*, 2006; Ciaian and Swinnen, 2009; Kumbhakar and Bokusheva, 2009; Hüttel *et al.*, 2010). If farms are credit-constrained, then subsidies may provide an additional source of finance either directly by increasing farms' financial resources or indirectly through the improved access to formal credit. In other words, for credit-constrained farms, subsidies may serve as a substitute for credit (Rizov *et al.*, 2013).

Regarding the investment subsidies, Minviel and Latruffe (2017) have found, on the basis of extensive literature review, that there are examples of both positive and negative impacts of investment subsidies on farm efficiency, but there is also the example of a neutral effect. Similar results were found by Pechrová (2015), who has demonstrated that the effect of investment subsidies on technical efficiency of organic and conventional farms in the Liberecký region (Czech Republic) is negligible. However, the impact of investment subsidies on improved farm efficiency should be reflected in long-term rather than short-term analysis as captured in our analysis. This might explain why the investment subsidies were found to have statistically insignificant impact on the technical efficiency in our estimations. That is, because our paper considers rather a short period (only 2 years), the coefficients associated with investment subsidies and their square value are statistically insignificant because their effect might not have materialised within the period covered in the paper in terms of improving farm efficiency.

Finally, other subsidies and the interaction term between subsidies and time dummy variable for 2015 are statistically insignificant. Other subsidies might have insignificant impact on technical efficiency because this variable encompasses different subsidy types, the impact of each might offset each other in impacting the technical efficiency. The insignificant coefficient for the interaction variable seems to suggest that the change in the subsidy implementation between 2014 and 2015 did not affect the technical efficiency of farms in Serbia.

5. Conclusions

The agricultural policy reform in Serbia, similar to other transition countries, is undergoing a series of distinct adjustment phases, largely reflecting the orientation of government political agenda towards their harmonisation with the EU CAP, at the same time taking in consideration the internal political constraints. However, this reform process needs to be supported by evidence-based assessments of the impact of alternative policy options in order to support the policy decision making. This also applies to analysis of the effects of agricultural policy reforms on farm performance where empirical evidence-based micro data is missing. The empirical literature is inconclusive on how agricultural subsidies affect technical efficiency of farms, while there is no empirical evidence available for Serbia. Only some limited and highly fragmented insights have been provided for different sub-sectors using simple methods and farm samples of varying quality.

The objective of this paper was to fill the gap in this area by analysing the technical efficiency of arable farms in Serbia. We have applied a two-stage double bootstrap DEA on a sample of

322 arable farms derived from FADN database from the 2014-2015 period to examine whether and how the agricultural subsidies implemented in Serbia impacted their technical efficiency.

The results show that the average technical efficiency of arable farms in Serbia was similar in 2014 and 2015 (0.76 and 0.74 respectively). The average technical efficiency score indicates that inefficient arable farms could have reduced the use of inputs by 24% in 2014 and 26% in 2015 without suffering output loss. In other words, the results suggest that arable farms faced challenges in using efficient combination of inputs in the production process. These results further imply that there is scope for extension service providers to address the need for strengthening farmers' knowledge and managerial skills particularly in the area of input use and their allocation.

The variables comprising the share of rented land, land to labour ratio, and financial stress were found to be main determinants of arable farm efficiency in Serbia in the period 2014-2015. The share of rented land and land to labour ratio positively influenced the technical efficiency of farms, while the financial stress had a negative impact on the efficiency. These results suggest that, access to credit might be a factor at play and thus policy action might be oriented in this area to boost technical efficiency of farms in Serbia.

Regarding the subsidies, we found that area payments and input subsidies had a statistically significant impact on the technical efficiency of arable farms in Serbia, although the findings were not consistently confirmed across all estimated models. Area payments had a positive impact on technical efficiency, while input subsidies were found to have a negative effect. In contrast, investment and other subsidies were found to have an insignificant impact on farm technical efficiency. Our results also suggest that the change in the subsidy implementation between 2014 and 2015 did not affect the technical efficiency of farms in Serbia. It is important to emphasize that evidence presented here on the influence of subsidies on farm technical efficiency must be understood in the given context. Namely, in this paper we have estimated the effects of area payments, input subsidies, investment support and other subsidies allocated from the national budget. However, other types of measures, like investment support from local and regional authorities and international donors are not included as data were not available to account for them in the analyses.

The results presented here provide evidence that there might be nonlinear relationship between area payment and technical efficiency on one side and between input subsidies and technical efficiency on the other. These results suggest that the future potential reform of the Serbian agricultural policy towards the CAP-like payments (i.e. area based payments) could have insignificant impact or rather small positive impact on farm technical efficiency depending on the magnitude of the support change. This could be partially explained by the fact that both area subsidies and input subsidies were found to affect technical efficiency to some extent but their impact is reverse when their size increases (i.e. the coefficient associated with square term is positive for area payments and negative for input subsidies). As a result, the potential future reform of coupled subsidies (particularly input subsidies) may lead to a (small) increase in farm technical efficiency in Serbia; for example, this would be the case if the past trend of subsides shift from the input support to the area and animal payments will continue in future. Note that the estimated impact of area payments and input subsidies on farm technical efficiency was not robust across all estimated model and thus this result needs to be taken in consideration when interpreting the estimates of this paper.

During 2010s Serbian agricultural policy has been reformed in order to bring it closer to the CAP principles. The main policy instruments of the Serbian agricultural policy are the area payments and input subsides, whereas one of the key policy objectives is the promotion of on-farm investments in modern technologies in order to stimulate productivity growth of the agricultural sector. Although modern inputs and technologies can help farmers to improve farm performances and increase the productivity and profitability, if they are not efficiently

applied, they may generate small or insignificant productivity gains. This paper has confirmed concerns that the significant increase in certain types of farm subsidies may not give the right incentives to arable farmers in Serbia to make their decisions on input and output so as to increase farm efficiency. Therefore, given the limited understanding of effects of different policy instruments on farmers' performance particularly related to the Serbian agricultural policy, the results of this paper can contribute to better understanding factors affecting technical efficiency of the largest sub-sector of the Serbian agricultural sector.

Despite the comprehensiveness of the analyses, the findings of this paper have to be considered with some caution on account of the data limitations. First, although the Serbian FADN database attempts to be fully harmonised with the EU FADN database, it is still under the process of full harmonisation of all quality standards applied by the EU FADN database. Second, although the objective of the FADN sampling is to achieve a high degree of representativeness of the Serbian farming sector, some farm types are under-represented in the FADN database. These include small non-commercial farms, which are excluded from FADN by construction of sampling plans, and large farms which are often reluctant to participate in the FADN survey. Third, the FADN database available for this paper did not include some variables due to the confidentiality issue. Hence, it was not possible for some explanatory variables (e.g. legal status of farms and education of a farm manager) used in previous empirical studies to be considered in the second stage estimations. Third, we were not able to capture long-term effects of subsidies (in particular investment subsidies) on farm efficiency due to the availability of data for a short period (i.e. for 2014 and 2015). Despite these limitations, the paper shows the potential implications of the effects of agricultural subsidies on efficiency on arable farm in Serbia, which provides valuable ideas that can guide further research, can provide insights into agricultural policy making and can raise awareness about the need for evidence based policy making in the study region.

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Innovation ecosystems for youth agrifood entrepreneurship in the Mediterranean region

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Abstract

This paper is the outcome of a reflection on the MIP report 2020, a collection of information and data used to describe the scenario on youth innovation and entrepreneurship in agrifood sector in Mediterranean countries. In particular, it highlights the need to study innovation in Mediterranean regions under the lens of social and institutional innovation. It is argued that social and institutional innovation are key drivers of the development of Innovation Ecosystems. The paper discusses the main findings – and relevant case studies – of the MIP report, with a specific attention to the role of the Innovation Support Organizations. It is noted that while in the field of institutional innovation there are signs of official activity, in the field of social innovation there is no or very limited attempt to embody social innovation into national policy frameworks. However, the article identifies interesting bottom-up initiatives that may constitute the basis for new policy initiatives.

***Keywords**: Innovation, Agrifood sector, Youth entrepreneurship, MENA region.*

1. Background and objectives

The Agenda 2030 has indicated a clear direction for development efforts of MENA region.[1] Hardly Sustainable Development Goals (SDG) will be achieved with "business as usual" policies: they will require radical innovation at all levels. Unfortunately, the Innovation goal (Goal 9) is one of the worst performing in the MENA region (SDG report, United Nations, 2019).

The agrifood sector in all the Mediterranean region can be the significant strategic lever for local socio-economic development through innovative and sustainable businesses capable of increasing the number of people in employment, especially young people and women (Seyfettinoglu, 2016). Identifying and designing "innovation ecosystems" can support the processes of business creation in the agrifood sector and enhance growth opportunities and youth entrepreneurship development.

In the last 10 years, CIHEAM Bari has actively provided significant assistance to support the Mediterranean Innovation Ecosystem, enhancing different tools for agrifood entrepreneurship.

[1] In this paper the analysis is focused on Mediterranean countries of MENA (Middle East and North Africa) region. In particular on Algeria, Morocco, Tunisia, Egypt, Jordan, Lebanon, Palestine, Albania.

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It has developed the "MEDAB model" (Mediterranean Incubator for Business creation and change in the agrifood sector) to assist young entrepreneurs in the agrifood sector. It is expanding by sharing this experience with other Mediterranean countries through establishing an international network, namely, the *Mediterranean Innovation Partnership (MIP) for youth entrepreneurship and technology transfer in the agrifood sector*, which was established in February 2016 among public authorities (Ministries and research organizations) from 9 different countries. CIHEAM Bari is the promoter and coordinator of the MIP initiative (mip.iamb.it).

The MIP network's main objective is to develop activities related to capacity building, knowledge sharing and cooperation to promote an entrepreneurship culture, entrepreneurship creation, and innovation among young people "*to build up the Mediterranean Innovation Ecosystem*". One of the priorities of the MIP Action Plan 2018-2020, is to encourage new innovation stakeholders (both public and private) to join the MIP Network.

The more we strengthen the networking at local and international levels, the more effective is our action in supporting young people in the creation of business and in finding job opportunities. The MIP thus intends to extend the existing partnership to new countries and organizations from the Euro-Mediterranean region, including the Innovation Support Organizations (ISOs)[2] and Small and Medium Enterprises (SMEs) Clusters.

Within the framework of MIP objectives there is the engagement of all members to contribute to a regular survey on Mediterranean Innovation Ecosystem in order to describe the scenario on youth innovation and entrepreneurship in agrifood sector in MENA countries, to update and evaluate the situation of ISOs in the different MENA countries, together with the degree of their specialisation, partnership, governance, target and year of establishment, the innovation-oriented policies, youth entrepreneurship, the access to funding and the services they offer.

1.1. *State of art*

The MIP report moves from the principles that innovation is not just based on technology. On the contrary, often institutional innovation and social innovation are the necessary conditions for an effective diffusion of technological innovation (Woodhill, 2010) and, in any way, the success of technological innovation depends on the capacity to promote social and institutional innovation.

In fact, technological innovation can provide important opportunities but, depending on the context to which technology is applied, the outcomes could be very different, and far from those expected (Bartoli *et al.*, 2015; Schot and Steinmueller, 2016). An approach that focuses exclusively on technological innovation may contribute to create new inequalities, bringing countries far from social goals, or may create environmental spillovers, retarding the achievement of environmental goals. An appropriate innovation policy coherent with SDG should then be able to start from the problems and identify the areas of innovation that can contribute to solve them (UN independent group, 2019). Innovation, in this approach, is a driver for systemic change (Schot and Steinmuller, 2016).

In this paper we focus on institutional and social innovation as conditions for systemic change and necessary complement to technological innovation.

Institutional innovation is necessary to adapt administration to a goal-based policy: "*without robust capacity – strong institutions, systems, and local expertise – developing countries cannot fully own and manage their development processes*" (OECD, 2018 quoted by Woodhill, 2010). The recent SDG report, Mediterranean Countries Edition (2020), identifies three pillars of this adaptation: 1) high-level public state-

[2] Innovations Support Organizations (ISOs) are structures (namely, clusters, technology parks, business incubators, technology transfer offices, seed accelerators, business angels and early-stage investors, etc.) where young aspiring entrepreneurs, innovators, public institutions, private investors, research and training centers, meet to share knowledge, experiences and best practices aimed at building up an "enterprise culture".

ments by governments in support of sustainable development, such as a Voluntary National Reviews and public speeches in support of the SDGs; 2) strategic use of public practices and procedures for the goals, such as dedicated Centres of Governments, budgeting practices for financing SDG activities, national monitoring mechanisms, stakeholder engagement mechanisms; and 3) alignment of content of government strategies and policy actions with SDG goals. A specific aspect of institutional innovation is related to policy innovations. As it is now clear that innovation is rarely the outcome of individual firms' activities, but it occurs when firms interact intensively with their environment, the issue is to develop innovation ecosystems (Adner and Kapoor, 2010) the finality of which are consistent with SDGs.

Social innovation regards how people and enterprises change their behaviours to address societal goals: it affects both the way activities are organized and their outcomes (Cajaiba-Santana, 2014; Pol and Ville, 2009). Achieving SDG implies understanding of the nexus between biophysical and social spheres into daily practices, to make systemic links visible, to identify the barriers and bottlenecks to change. Barriers and bottlenecks are often embodied into daily practices and affect even those who are already convinced of the need to change (Anderson and Ronteau, 2017).

This paper aims at identifying good institutional and social innovation practices in the agricultural and food sector, and at proposing a policy framework to boost innovation in MENA region.

2. Methodology

The research was carried out through desk and field analyses at country and Mediterranean levels based on the MIP report 2017 data and best practices with respect to the critical issues that emerged in the collection of information from stakeholders.

The research was co-designed and carried out by CIHEAM Bari in 2018-2019 in collaboration with the MIP Network country focal points (Albania, Algeria, Egypt, Jordan, Lebanon, Morocco, Palestine Authority and Tunisia).

The desk analysis consisted in the collection of information and data from international sources and in the single countries mainly to collect the main descriptive indicators of the situation at country level and of the policies to support the sector and to compare and evaluate the positioning of the MENA countries in the global scenario. The field analysis consisted in the definition of a questionnaire, administered to about 300 ISOs of the eight MENA target countries. It is important to underline that there are no official sources to be adopted as reference regarding the ISOs.

The questionnaire was articulated in 3 main sessions: a) ISO information mainly on specialization, services offered, governance model, collaborations with regional and international networks (networking); b) the national policies regarding innovation and youth entrepreneurship, and c) social innovation.

In addition, case studies were collected for each target country, identified by MIP focal points, which enabled the analysis to be integrated in relation to the country scenario and the role of the ISO.

The case studies are mainly successful initiatives at national level, supporting innovation and entrepreneurship.

In this paper, some of them will be listed.

In the end, an analysis of all the data collected by MIP focal points was elaborated by the MIP coordination unit of CIHEAM Bari to have a regional overview of data, policies, positive signs, and future prospects in addition to the country's scenario.

3. Results

3.1. *Role of the institutions in fostering innovation ecosystem*

Innovation ecosystem is the term used to describe the large number and diverse nature of participants and resources that are necessary for innovation. The capacity to achieve and sustain any development outcome depends on the ability and joint work of multiple and interconnected actors: governments, civil society, private sector, universities, individual entrepreneurs and others.

The *key innovation stakeholders* in the Mediterranean are:

- *entrepreneurs*, innovation managers of small businesses or major groups, researchers working on innovative projects, all of whom are interested in finding the adequate interface, partners and anchor institutions;
- *ISOs* that promote innovation in the Mediterranean (technology parks, incubators, business centres, entrepreneur networks), interested in exchanging on good practices and joint initiatives;
- *governmental organizations* (Ministries, innovation agencies) and non-governmental organizations offering support in the area of technology transfer and innovative entrepreneurship, interested in improving synergy with existing programmes;
- *financial institutions* from the public sector (funding bodies) and the private sector (investment funds, banks, venture capitalists) (Dagault *et al.*, 2012).

For this purpose, the MIP Network aims to create the Mediterranean Innovation Ecosystem, putting together the key innovation stakeholders, to support the youth entrepreneurship in the agrifood sector following 3 main axes of action:

- knowledge sharing and transfer of (model and system);
- capacity building (the new role of innovation actors);
- cooperation and enhancement of collaboration among public institutions and ISO's and other actors of the innovation chain/ecosystem.

To achieve this goal and to give concrete responses to youth in particular, support and implementation of interventions that affect some components, such as incentives for startups or incubators, are not sufficient. It is needed to have an overall vision and supporting plans that affect the entire ecosystem by strengthening single components and mainly the relationships among them. This is a priority objective for the MIP.

Entrepreneurs improve economy and people's lives by creating jobs, developing new solutions to problems, creating technology and non-technology innovation that improve efficiency and exchanging ideas globally, taking into consideration social aspects (social innovation). Many of the conditions that help entrepreneurs also help the economy as a whole, providing even broader gains from supporting entrepreneurship through policies, strategies, access to funds and networking.

3.1.1. *Analysis of Innovation and entrepreneurship in MENA region*

A socio-economic background description of MENA region

In the dynamics of total population, it is interesting to note that, in the decade 2008-2017, in MENA Region the growth rate is quite 2% (FAO, World Bank) with an average life expectancy of 73 years (World Bank, 2018) and a percentage of undernourished people of 4% and 8% for MENA (World Bank, 2018). The last two indicators are worst if just compared with EU Mediterranean countries; in the rural areas the rural population increased in the last decade of about 1%. As regards wealth production (FAOSTAT, 2017), the *pro capita* GDP is around 3,000 US$ but the increasing rate, in the 2008-2017 decade, showed a positive trend for African countries, due to the Morocco performances, and negative for Middle East, due to the Syrian war situation. The situation of unemployment is worse specially if gender and age are taken in consideration (World Bank, 2018). Moreover, in MENA region the contribution of agricultural sector in defining the GDP is very relevant and predominant (World Bank, 2017) and, although the employment level is under the 50% of the labour force (World Bank, 2018), agricultural sector takes quite 1/3 of workers. Unfortunately, agricultural sector does not succeed to reduce the import amount of food: for example, the cereal import dependence is of 40% for North Africa and 80% for Middle East (FAOSTAT, 2017). In this context, the role of innovation becomes particularly strategic, both in terms of the introduction of technological know-how and of cultural construction of new forms of enterprise. Above all, it is necessary to create an environment suitable for autonomously generating innovation starting from research and training.

Analysis of the principal indicators regarding entrepreneurship and innovation

To describe and analyse the situation of entrepreneurship and innovation in MENA region, two indicators were taken into consideration: Global Entrepreneurship Index (GEI 2019) and Global Innovation Index (GII 2019).

With reference to the Global Entrepreneurship Index (GEI 2019),[3] MENA region has a strength in Product Innovation and Risk Capital. The region is bringing new products to market and integrating new technology, while also providing the capital to help businesses grow. The region's lowest average scores are in the areas of Competition and Risk Acceptance, as large firms dominate many economies in the region and businesses face higher risks in many MENA countries than in other areas. While Europe shows stable high scores in Technology Absorption and Internationalization, and the region's average score on Startup Skills has recently climbed into the same league.

In GEI 2019, USA is in pole position among the 137 countries scored, with Chad at the last position (137); the first ten classified countries are the same in 2017, 2018 and 2019 with a small declassification except for the Netherlands that leaves its place to France then comes back in 2019. France ranks 14th in 2019 at world level and it ranks 1st among the Mediterranean countries, while Turkey ranks 1st among MENA countries but 44th at world level (Table 1).

Another indicator is the Global Innovation Index (GII)[4] that ranks the world's countries and economies through innovative measures, environments, and outputs. The MED countries rank between 70th and 129th in terms of innovation performance and they are also losing their positions despite the introduction of proactive policies and infrastructures in the majority of countries (Table 2).

Table 1 - The Global Entrepreneurship Index ranking of MED countries (GEI 2019).

	Rank		
Country	*2017*	*2018*	*2019*
Albania	80	83	87
Algeria	73	80	88
Egypt	81	76	81
France	13	10	14
Greece	49	48	50
Italy	46	42	36
Jordan	56	49	63
Lebanon	63	59	66
Morocco	70	65	68
Palestine	ND	ND	ND
Portugal	29	31	32
Spain	33	34	31
Tunisia	42	40	53
Turkey	36	37	44

Table 2 - Performance of MED countries in the area of innovation over the years (GII 2019).

	Rank			
Country	*2011*	*2017*	*2018*	*2019*
Morocco	80	72	76	74
Tunisia	37	74	66	70
Lebanon	115	81	90	88
Jordan	77	83	79	86
Egypt	103	105	95	92
Algeria	132	108	110	113
Albania	-	93	83	83
Palestine	-	> 127	> 126	>129
Italy	-	29	31	30

Youth entrepreneurship and innovation policies in MENA region

Besides the GEI and GII indexes, a possible indicator on how policies affect the creation of youth entrepreneurship is the number of students who create startups. Students represent the en-

[3] The GEI is an annual index that measures the health of the entrepreneurship ecosystems in each of 137 countries. It then ranks the performance of these against each other. This provides a picture of how each country performs in both the domestic and international context.

[4] The GII is a source of insight into the multidimensional facets of innovation-driven growth. Providing 80 detailed metrics for 129 economies in 2019, the GII has become one of the leading references for measuring the economy's innovation performance.

trepreneurs of tomorrow; their entrepreneurial plans and activities will shape tomorrow's societies and the overall economic well-being. Recent data from the international survey research project GUESSS (Global University Entrepreneurial Spirit Students' Survey) shows that less than 5% of all students worldwide aim to start up their own business directly after studies. Most prefer paid employment directly after studies: more than two-thirds intend to start as an employee in a large firm, public service or academia – many fewer choose an SME as their first intended workplace. However, five years after completion of studies, more than 20% think of founding their own business (OECD, 2012). In the Mediterranean region, new types of highly innovative small businesses and startups created by managers with international training are spreading (Dagault *et al.*, 2012). They include industrial companies with a new generation of managers at the helm, spin-offs of major public groups and startups. These businesses essentially need assistance on issues including market access, mentoring and sponsorship, international team building and seed funding.

Young people, especially young women, lack knowledge about business startups, they lack support in the form of information and advisory services, they lack collateral assets making access to finance difficult, and there is a lack of supported premises where they can launch and nurture their new business startups (European Union, 2018). Though, for example, entrepreneurs in Morocco have relatively easy access to bank finance compared to other countries in the region; over one fifth of working capital and investment is financed through the banks (EBRD, 2016).

Nevertheless, numerous measures and initiatives have been introduced to overcome these difficulties and gaps in support. Most of these measures have been put in place by central governments, civil society or the private sector with some international donor assistance, although relatively few measures have been adopted and implemented by Local and Regional Authorities (European Union, 2018).

Young entrepreneurs lack access to loan finance due to the lack of collaterals and unwillingness of the banking system to lend funds to young people without a track record of experience. Governments have therefore introduced measures to provide subsidised financial support to young entrepreneurs in Egypt, Lebanon, and Morocco. Private sector venture capital funds also actively invest in business startups by young entrepreneurs in the region with examples found in Egypt, Jordan, and Lebanon (OECD, 2018).

The private sector has also stepped in to provide incubator capacity in Egypt, Jordan and Lebanon. International donors have supported the development of business incubators in Lebanon (OECD, 2018).

Since the mid-1990s, many governments have promoted an entrepreneurial culture as one means to create awareness for entrepreneurship as professional career option, including specific programmes to foster graduate entrepreneurship (European Union, 2018).

Programmes for entrepreneurial learning are adopted in formal education systems in Egypt, Jordan and Lebanon. Initiatives for informal entrepreneurial learning are developed in Egypt, Jordan, and Lebanon. Informal training is provided by NGOs. One of these, called Injaz (which in Arabic means "achievement"), is an international NGO, which operates in Egypt, Jordan and Lebanon (Zgheib, 2017).

MIP Survey: evaluation of ISOs' state-of-art in the different MENA countries

The MIP overview on ISOs is the result of a survey carried out by CIHEAM Bari in 2018-2019 in collaboration with the MIP Network country focal points. However, it does not represent the official statistics of each country. In this survey, a 45% increase is evident in the number of registered ISOs, going from 207 in 2017 (MIP report 2017) to 295 in 2019 (Table 3). It is important to underline that the survey didn't include in 2019 Turkey and Balkan countries as in 2017. Actually, Albania, Lebanon, Tunisia and Palestine registered in 2019 the highest number of ISOs identified, with Lebanon and Tunisia in pole position.

Tunisia was leading the classification in 2017 and still in 2019, with an increase of 20% in the number of ISOs versus 2017. However, Pales-

tine has registered the highest increase of 86% compared to 2017.

This could be explained by a greater involvement of the MIP members in the survey based on the created network of contacts but also by the observed evolution in the country due to a greater political attention and a cultural change of stakeholders. There is a higher entrepreneurship demand by youth who are trying to improve their social status. Thus, entrepreneurial activities have been lately an active field, through the establishment of several ISOs supporting creative entrepreneurs by facilitating the realization of their dream.

Table 3 - Number of ISOs identified per country (MIP survey 2017; 2019).

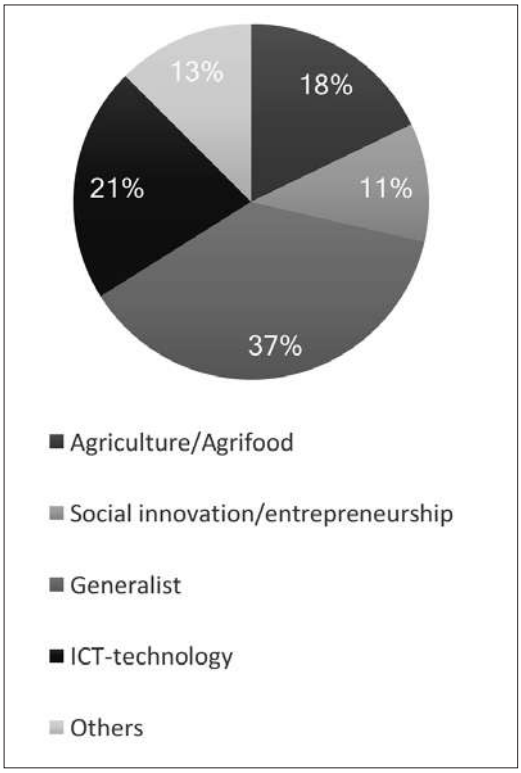
Country	*No. ISO/country 2017*	*No. ISO/country 2019*
Albania	13	40
Algeria	11	20
Egypt	19	38
Jordan	12	17
Lebanon	14	54
Morocco	23	23
Palestine	6	44
Tunisia	43	54
Turkey	32	-
Balkan countries[5]	34	-
TOTAL	207	295

More than 40% of the ISOs in the MENA region have been established in the last decade. 5% existed from before the period 1990-1999. It is a quite fresh environment and it varies between countries. For example, in Albania the first accelerator was established in 1993 and hosted by an institute. It is specialized in agriculture and targets farmers; the most recent one – the Metropolitan incubator – was established in 2018; it is a private entity not specialized in a single sector. In Jordan, the most recent ISOs date back to 2015, in Lebanon to 2016.

Out of the total number of ISOs, 37% cover the general category; it means they can cover different sectors without being specialized in a defined one while 21% of ISOs are specialized in ICT and 18% in the agrifood sector.

Out of the 295 ISOs, 10% are specialized in social entrepreneurship and 14% were grouped under the category entitled "other" that includes industry, economy and finance, health, metallurgy) (Figure 1).

Figure 1 - Specialization of the ISO (MIP survey 2018-2019).



However, within the general category, some ISOs cover the agrifood sector without being specialized only in agrifood. It is a kind of protective way to ensure continuity to the ISO without taking the risk of being mono sectorial.

In addition to the fact that youth is attracted by technology and to fast results, these data could be due to the incentives and funds more easily oriented towards the ICT sectors and the expec-

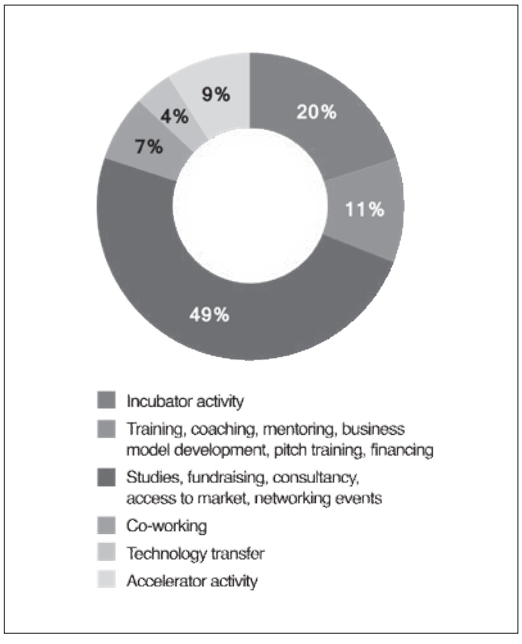
[5] Balkan Countries included in 2017 Bosnia and Herzegovina, Croatia, Macedonia, Montenegro and Serbia.

tations of more immediate success results. The survey registered 2 cases of agrifood incubators that closed after few years in business due to the difficulty in going on with the activities.

The percentage of ISOs specialized in the agrifood sector varies form 4% in Egypt to 22% in Tunisia. The highest presence of agrifood ISOs was noted in Tunisia with 22% of the total Tunisian ISOs and 21% of the total agrifood ISOs. This could be explained by the support given by the government and the funding agencies to encourage the graduated students to take initiatives and innovate in the frame of newly established incubators in the research institutions. The lowest percentage, 4%, was noted in Egypt, although the country is very well classified in the business creation mainly in the ICT sector and agriculture is of high importance.

Another important feature of ISOs is the type of services they offer (Figure 2): studies, fundraising, consultancy, access to market, networking events (49%), followed by incubator activity (20%), training, coaching, mentoring, business model development, pitch training, financing (11%), technology transfer (4%), co-working (7%) and accelerator activity (9%).

Figure 2 - Type of services offered by ISOs (MIP survey 2018-2019).



However, these data represent the sample of 295 ISOs registered during this survey and they may be subject to changes. They cover a wide range of ISOs and continuous updates may modify or confirm the abovesaid percentages.

Governance and funding of ISOs

The governance model varies from country to country. If we consider the total number of ISOs, we notice that public percentage is as high as 40%, followed closely by the private sector with 36%, and NGOs with 25%. Looking at each country, in Algeria, Palestine and Jordan most providers are public, in Lebanon and Tunisia there is a large presence of NGOs and private organizations, and a presence of private and public sector in Morocco.

It seems that in Algeria, the government continues to be the main actor that provides support through the National Upgrading Programme managed by the SME agency ANDPME. In Egypt, the governmental bodies remain the main actors, as the new Micro Small Medium Enterprises Agency (MMSMEA). In Tunisia, the main player is the Agency for the Promotion of Industry and Innovation (APIA). The Lebanese Investment & Development Authority (IDAL) established a Business Support Unit (BSU) in its premises to provide startups with information, advice and licensing support in early 2018. In Jordan, entrepreneurs receive support through the Jordan Enterprise Development Company (JEDCO).

In Algeria, the market is mainly dominated by public institutions, including two credit guarantee funds – the credit guarantee fund for SMES /FGAR and the fund for credit investment – and the Wilaya Investment Fund.

An interesting point is that, in many cases, ISOs were previously working according to a defined agenda on training courses, workshops and business plan support by using limited fund projects. Once these funds were consumed, the project stopped, and the ISOs closed. In other words, there is great concern about the number of active ISOs for the time being at the national level, as the sustainability of their activities is not ensured permanently.

Networking

The survey also focuses on the degree of openness of these organizations, gathering information on their involvement in international networks. The identified ISOs answered the simple question whether they have stable collaborations with regional and international networks and with which ones.

We noticed a lack of networking at country level. It means that within the same country there is no interaction among the different innovation stakeholders, universities, incubators, research institutions, technology transfer offices (national network). Equally, there is a low percentage of international networking that leads to the loss of effectiveness and knowledge. This entails reduced visibility of ISOs and interactions with other entities for the exchange of knowledge and experiences, and less opportunities for collaboration and new initiatives. A preliminary and not exhaustive analysis revealed that out of the 295 registered ISOs, 32% are members of an international network but this percentage varies from one country to another.

In Palestine we noticed the highest number of ISOs connected to international networks (38%). This may be explained by the necessity of PA to be connected abroad to overcome the internal obstacles, so indeed there is very little to choose. Albania showed to have the lowest level of networking (15% of ISOs are linked to networks).

More than 10 international networks and some national networks are active in the MENA region, such as *Entrepreneurs and Startups Networking in Palestine*. The networks registered in the last survey of 2017 are reported in the MIP report 2017. The new networks registered in 2018 are given below:

- *SPICE group* (Science Park and Innovation Centre Experts);
- *ARTECNET*, the Arab Technology incubators and Techno parks Network established in November 2013, with the support of the International Telecommunication Unit (ITU) as the main sponsor, aiming at providing a structured platform for cooperation between Techno parks and technology incubators to its members and to the region;
- *EFE,* a network for training and connecting youth to the world of work and it operates in Egypt, Jordan, Morocco, Palestine, Saudi Arabia, Tunisia, Yemen, and the United Arab Emirates (UAE);
- *The Anna Lindh Foundation*, an international organization working from the Mediterranean to promote intercultural and civil society dialogue in the face of growing mistrust and polarization;
- *DARPE*, *DAI*, *Slowfood*, *Vi Campesina* and *JA Worldwide*, which is one of the world's largest youth-serving NGOs that prepares young people for employment and entrepreneurship;
- *EBN* and *ANIMA*, the most involved networks in MENA region;
- Euro Lavalle Mayenne Technopole and Euraxess in Albania.

3.1.2. *Good practices*

Hereby are listed some of the good practices identified in the survey.

AIDA (Albanian Investment Development Agency)

AIDA is a government body with the main objective of attracting foreign investment, increasing the competitiveness of the Albanian economy through the support for SMEs, as well as through innovation. It has different funds for young companies like: Innovation Fund and startup Fund. They collaborated with different organizations (Startup Live, Startup Albania, Giz IDEA project, Risi Albania) to allocate these funds, but companies can apply directly to AIDA to request grants.

Tathmine programme (Algeria)

As part of the enhancement of the results of research and the promotion of entrepreneurship, a programme called "Tathmine" literally "valorization" in Arabic language, was launched in March 2017 by the Ministry of Higher Education and Scientific Research (MESRS). It is implemented by the National Agency in charge of the Valorization of Scientific Research and Technological Development (ANVREDET). "Tathmine" is a national programme of assistance and

support for the creation of innovative companies that allows project owners to benefit from three types of services: co-incubation, co-accompaniment, co-financing.

Qoot, Lebanese agrifood innovation cluster

Qoot is the first Lebanese agrifood consortium that brings together Lebanese enterprises, rising SMEs, multinational companies, knowledge providers, support institutions, and investment entities to collaboratively catalyze and innovate the agrifood sector in Lebanon.

Initiated by Berytech and the Kingdom of the Netherlands with the active guidance of FoodValley, Netherland's leading agrifood cluster, Qoot was born out to equip Lebanon with the resources and processes that have made the Netherlands one of the leading agricultural innovators and food exporters worldwide.

The vision is to lead the agrifood innovation scene in the region and put Lebanon back on the global agrifood innovation map. Launched in February 2019, the cluster has already brought on board 26 innovative Lebanese agrifood companies of all sizes, all committed in joining forces and accelerating the sustainable growth of Lebanon's agricultural sector.

3.2. *The social dimension of innovation ecosystem*

3.2.1. *The concept of social innovation*

Development means change, and innovation can activate change. Innovation studies have developed within economic studies and, to a great extent, in the past, they focused on economic actors in market contexts. As a consequence, innovation studies have mainly been based on approaches focused on enterprises competing with each other in markets and having the profit as their goal. These approaches tended not to consider that economic actors are embedded into social relations and that their choices depend on the values and on the social constraints provided by the context where they operate (Jack and Anderson, 2002). Moreover, economic policies have not gone much beyond purely economic outcomes (productivity, employment, incomes) when considering innovation.

The SDG framework encourages all to develop a different approach that, being centred on people, addresses all determinants of people's lives in an integrated way (Nilsson *et al.*, 2016). It looks at economic processes as the necessary means to achieve social and environmental goals, and at the reciprocal influences between economic, social, ecological spheres. In other words, it requires an in-depth revision of economic paradigms and policy frameworks.

When considering SDG 2 (No hunger), for example, the question is: how to develop food systems that provide sufficient, nutritionally appropriate, and culturally acceptable food to all without depleting natural resources and without generating social inequalities and gender unbalances? How to do it when market forces pull in different directions?

The concept of social innovation meets the abovesaid requirement. It departs from the assumption that economic and social processes are not separated from each other, and that change can be measured in terms of the capacity of socio-technical and socio-ecological systems to increase the production of social value, i.e. a value beneficial to society as a whole. It is not impossible to do so: there is increasing evidence of successful enterprises that make profits and grow at the same time contributing to the improvement of health, environment, work conditions, gender relations, community welfare. Approaches in the past, conceived of enterprises' activity as a 'race to the bottom', forced to reduce production costs by growing competitive pressure and the demand for standardized products. On the other hand, the current emergence of 'concerned consumers' who are willing to pay for the public goods embodied in the commodities they buy has created a 'win-win' space for the conciliation of public and private objectives (Porter and Kramer, 2019).

Moreover, the concept of social innovation stresses another essential point. Whereas innovation studies have focused for a long time on technology, social innovation looks at social resources as an alternative – or additional – driver for innovation, especially in contexts where economic conditions don't allow to afford investments in technology (Moulaert, 2016). Social in-

novation can thus create new social resources or mobilize existing social resources into new economic activities. Social innovation occurs, for example, when new routines are established, as in the case of new consumption patterns or new organization of family life. For example, when a family develops the capacity to nourish itself better with the same amount of money, or when it can reduce the environmental impact of consumption by reducing waste and improving the capacity to recycle it (Jaeger-Erben *et al*., 2015).

Social innovation also occurs when new social capital is created. Social capital is a relational pattern that improves mutual understanding, trust, and capacity to collaborate (Portes, 1998). When, in a group, communication is easy and trust is high, it is possible to mobilize the group for tasks outside the original scope. It is proved that communities with high levels of social capital are more resilient to external shocks and stresses, such as wildfires or drought (Woolcock and Narayan, 2000). Social capital consists of:

- bonding relations (relations between peers, characterized by frequent interaction);
- linking relations (with peers belonging to different networks, which expose the community to information about different solutions to similar problems or about the same solutions to different problems);
- bridging relations (giving local communities access to sources of power, such as when a high-level government officer maintains the links with his/her community of origin) (Woolcock, 2001).

Without social innovation, these practices are being eroded because traditional approaches have often considered social practices as obstacles rather than resources to development or because they don't evolve fast enough to catch up with the evolution of the social organization.

Sustainability also implies that the production of goods and services with high social value can cover the costs of production and remunerate labour adequately (Schandl, Walker, 2017). It is related to two main factors: a) the capacity of the enterprise to attract consumers' attention to the social value embodied in goods and services. When this is the case, consumers are willing to pay higher prices or, for equal prices, they prefer the product with higher social value; b) the capacity of social resources to reduce the costs of production. For example, voluntary work is not remunerated by the market, and it produces benefits for business competitiveness.

Enterprises that adopt the principle of social innovation can be of three types:

- conventional enterprises that invest in social innovation because they find it potentially profitable;
- enterprises that adopt social responsibility as part of their long-term strategy, and in this regard, they develop systems of internal auditing and reporting that demonstrate the progress in the creation of social value;
- 'For-benefit' enterprises, the social purposes of which are stated in the enterprise statute. More than in long-term strategies, social values constitute the foundational identity of an enterprise;
- social enterprises, which predominantly pursue social goals, and see the creation of private value as the necessary condition to achieve these goals (Hiller, 2013).

In the agrifood sector, for a long time, policies have privileged some social goals (availability of food) and have overlooked others, first of all, biodiversity, quality of soils, conservation of natural resources (McIntyre *et al.*, 2009). The achievement of SDG imposes a transition of production and distribution systems towards a new regime centered upon environmental, nutrition, and ethical goals. Social innovation is key to this transition.

The 2018-2019 MIP survey tried to investigate the concept of social innovation in each country.

In Albania, social innovation and innovators are hard to be understood and considered as part of the culture yet. In most cases, the perception is that they relate only to research and not to broad productivity in general. Mentality and political culture are some of the biggest challenges, as well. Social innovation requires a change in how policies should be formulated, proposed, tested and implemented and emphasizing the role of citizens, stakeholders, users and target groups.

Social innovation in Palestine can be summarized as an action that can help toward more sustainable development and better local economy and social life. Major challenges are freedom of movement between regions; unemployment; lack of water resources; lack of health and education services and infrastructures; corruption; marketing; bureaucracy and democracy; lack of enforcement of laws and regulations.

In Lebanon social innovation is defined as new strategies, concepts, ideas and organizations that aim to meet social needs resulting from working conditions, education, community development, and health.

The definition reported by the country reports emphasized that, even if there are common elements inside the proposed definitions, no unique and clear definition exists of social innovation and, like in any other part of the world, it is adapted to the context and the experience of a specific country.

3.2.2. *Conditions for social innovation*

Interventions addressed to rural social innovation should first of all be characterized by some identity elements that contribute to creating social value, social resources and new organizations in local communities. These identity elements of the social innovation processes disregard the type of organization and initiatives implemented on the territory. Be it a public or a private organization, an initiative established within the firm or the development cooperative, some elements cannot be missing.

Innovation can achieve social results strictly related to the achievement of the output (for instance, the supply of local health services) that, on one hand, meets needs and, on the other hand, generates wellbeing for the community (direct creation of social value) but also results that are inherent in the process, in the new relationships, in the new governance arrangements, in the triggered social capital (indirect creation of social value). The indirect creation of social value also consists of the increased capacity for action of society (empowerment), thanks to a collective learning process, peer-to-peer learning, and activation. The two dimensions of the created value contribute to the outcome of innovation, namely, what is defined as a social improvement.

Identity elements contributing to the creation of social value, deriving from a previous research conducted by the authors in the framework of Rural Hub project (Petruzzella et al., 2017) are reported in Table 4.

Table 4 - Identity elements contributing to the creation of social value.

Better environment	Improvement of health
Use of resources	Prevention
Biodiversity	Access to health care
Waste reduction	Better nutrition
Pollution reduction	Food safety
Climate change mitigation	Improvement of animal welfare
Social conditions improvement	Social responsibility of enterprises
Equity and social justice	Strategies for sustainability
Work conditions	Availability of information
Social integration	Transparency in decision-making
Gender equality	
Children's rights	
Access to education	

Source: authors' elaboration.

Concerning *social resources*, it is possible to create and identify large toolboxes based on experience. We believe that all tools are based on three principles: selective openness, diversity and participation.

Openness is the capacity to connect to elements of the external environment. Connection to external entities is a key element of social capital improvement ('linking' and 'bridging'). The connection allows access to ideas, know-how, and resources. However, openness should be selective, as it should be related to local needs and expectations. In the recent past, innovation has been considered a good in itself: now it is more apparent that innovation can be disruptive and can generate unintended consequences. A sound appraisal of the needs, expectations, and potential impact of main drivers can help identify the hierarchy of problems, reveal the sensitiveness of local people to drivers of change, and identify criteria for selection of external forces to which it is desirable to connect. Foresight exercises encourage communities to anticipate future adversities and to reflect on present vulnerabilities.

Diversity is the source of innovation, as it creates synergies between resources. The capacity to recognize diversity is the key to understand what can be useful for development and what may be disruptive or harmful. Diversity is also a way to generate an identity in a sea of differences, and identity can help select external connections based on affinity or complementarity.

Participation is the third pillar of social innovation. It is the condition for diversity (of knowledge, of needs, of interests) to be appraised. Participation is based on procedures that encourage inclusion and collaboration. Through participatory methods, cooperation bodies can stimulate reflection and knowledge creation and generate social capital. The outcome of participatory appraisal is a shared representation of the context and the problems, and the emergence of collaborative networks that can be involved in further initiatives.

The same research identified a repertoire of initiatives and support schemes that can encourage the creation of social resources (Table 5). It ranges from support to integration of non-conventional labour force (voluntary work, people with disabilities) into economic activities, sharing of instrumental goods or information, creation of study groups, crowdfunding, microcredit based on collective responsibility for the loans.

Table 5 - Initiatives aimed at creating social resources.

Integration of volunteering in economic activities	Activation or strengthening of participatory processes
Sharing of instrumental resources	Stakeholders' involvement
Sharing of information	Multi-actor projects
Crowdfunding	Extension and training activities
Learning groups among enterprises	Mobility and cultural exchange
Collaboration among enterprises for common interest initiatives	Foresight and scenario building
Public-private-civil Partnership	Active policies for gender equality
Citizens' science	Involvement of schools
Open access to information and scientific results	

Source: authors' elaboration.

A third identity element is the capacity of the initiatives to generate new, economically sustainable organizations with a long-lasting approach. The new organizations can widely vary in their composition: startups created by young people or women, community cooperatives (among citizens), structured collaborations between public and private entities, or between enterprises of the same economic sector or belonging to different sectors.

These new organizations are generated from the relations among the stakeholders involved in the social innovation processes, and they take shape through the co-design and development of the innovative solutions proposed to meet social needs.

Whether these new organizations have to be necessarily formalized is open to discussion.

Table 6 - A list of possible social innovation-oriented organizations.

Enterprises	Hybrid organizations
Startups	Public-private consortium (former LAGs)
Innovative enterprises	No-profit associations
Social enterprises	NGOs
Farmers' and consumers' cooperatives	Foundations
Community cooperatives	Informal organizations

Source: authors' elaboration.

In all MIP countries, regulatory frameworks for social innovation are non-existent. Social enterprises often start operations informally, exposing them to the same regulatory requirements as commercial enterprises or NGOs, without any privileges. No specific funds are allocated to these initiatives, and often they start thanks to international cooperation projects or donors to NGOs or national organizations.

3.2.3. *Good practices*

Research activity implemented in MENA region emphasized some organizational models and initiatives adopting innovative approaches that try to give an answer to social problems in rural areas, even if they are not recognized as social innovation initiatives and are not familiar with the concepts on which social entrepre-

neurship is based. We are convinced that many of them present exciting elements that can be adopted in other contexts or, in any case, be a positive example for all the Mediterranean communities. In many Mediterranean countries even the creation of ISO specialized in supporting social innovation initiatives is more and more widespread. The experience of some of them, together with a selection of innovative entrepreneurial ideas put in place in different countries can be of inspiration for all future social entrepreneurs and for policy decision makers.

CISE (Moroccan Centre for social innovation entrepreneurship) experience (Morocco)

The Moroccan Centre for Innovation and Social Entrepreneurship is a not-for-profit organization dedicated to finding entrepreneurial and innovative solutions to every social challenge in Morocco. It was founded in 2012 by a group of 17 people enthusiastic about social change in Morocco, being convinced that supporting social entrepreneurs with system-changing ideas can provide benefits for Morocco and the wider global community.

Their vision is: a world where innovative ideas and opportunities are at the service of the common good. Their mission is to find innovative and entrepreneurial solutions for every social challenge in Morocco. Their approach of theory of change is based on a three-level integrated approach: inspire, learn and develop.

Training and knowledge transfer activities are crucial for this organization, like the Tamkeen initiative. It is an awareness programme launched in 2013, with the objective of promoting social entrepreneurship and social innovation in public schools (high schools). The initiative involved more than 500 people among students, teachers and local authorities in 36 schools of the country. An assessment in 2015 concluded that the programme effectively achieves its goals of increasing skills and awareness for students and the community.

"Acacias for all": when a small project succeeds in fighting desertification, improving women's conditions, and alleviating poverty (Tunisia)

"Acacias for all" is the social enterprise founded in 2012 by Sarah Toumi, a young Tunisian entrepreneur born and grown up in France who never stopped her relationship with her family village in Tunisia. This social enterprise is changing the agricultural sector in the Arab Maghreb sub-region by introducing a new holistic farming approach to fight desertification. It shifts its focus towards alternative, natural, plant-based irrigation complemented by crops that fit the local context; in addition, it creates a change movement through which farmers adopt new and sustainable farming techniques and organize themselves into cooperatives, in order to manage the entire new farming cycle.

Initially, Sarah' idea was to plant acacia trees in desert areas in order to create a green belt to protect rural lands from sand and wind. The acacia tree is characterized by very long roots that extend up to 100 meters underground, providing the soil with nitrogen and bringing fresh water to the surface. Thus, the roots keep the soil salt free while also re-fertilizing it. Additionally, acacias are adaptable to desert conditions and when planted around a farm they create a green belt, preventing the invasion of sand and wind, allowing the growth of fruits and vegetables inside the farm. Moreover, after 3 years, acacia trees produce Arabic gum and moringa oil, which have an economic value.

In 2011 Sarah began also working with female rural farmers in the village of Bir-Salah in Tunisia, recognizing that women represent a strong entry point into the agricultural sector, as they are more receptive to change. Additionally, most women own small pieces of land and have no adequate access to education or markets. She supported them in establishing a cooperative and providing them with training on entrepreneurship and business skills.

Long-term plans include spreading the initiative to Morocco and Algeria, as both countries are facing the same environmental problems. Recently, Sarah Toumi has been selected by Forbes among the best 30 young social entrepreneurs in the world.

Beyond Research & Development (Lebanon)

It is a private firm having the mission to promote social entrepreneurship mindset and tools through formal and informal education and in

partnership with universities, schools and development agencies; thus, the activities oriented to enhance the social entrepreneurship in Lebanon are focusing on:

- building the capacity of actors within the ecosystems such as incubators, accelerators, business development support structures, and financing institutions;
- conducting specific research and studies to assist networks in advocating for enabling policy and regulatory environment. Social Enterprise (SE) formal and informal programme design, entrepreneurial and experiential teaching training (training of university instructors, SE practitioners, mentors, coaches, etc.), research and mapping of SE context (skills, stakeholders…), capacity development for SE actors (Organizational Development Journeys Design and Development of SE Strategies, Approaches and Indicatives Technical Support for SE Programmes Implementation), network building within SE Ecosystem.

Green Ideas: the competition supporting small-scale green economic development ideas (Albania)

Partners Albania aims to serve as an incubator for small-scale green economic development ideas in Albania, utilizing local resources and revitalizing traditions of production and community-based markets in an environmentally friendly way. The novelty lies in the cooperation and creation of a joint seed fund from national companies and international donor institutions with the institutional support of Rockefeller Brothers Fund. Since 2012, it has been organizing an annual competition that, through clear criteria and a transparent and fair competition process, supports individuals, social enterprises, non-for-profit organizations and small business ventures to improve and contribute to a better life for society in Albania. The shortlisted finalists present their proposal during the two days of competition, before an Evaluation Panel consisting of experts in the field of education, environment, economy and finance. At the end of the competition, three winners are selected and awarded a financial support up to around 8,000 Euros.

4. Concluding remarks

This article has emphasized the importance of addressing institutional and social innovation as drivers of broader innovation for development.

The wind of change is blowing in MENA countries, as it appears from the previously described scenario. A greater attention from policy makers is paid to youth employment and specifically to: i) youth entrepreneurship and innovation in businesses; ii) a private sector that is taking the initiatives in the creation of incubators and business accelerators; iii) a greater investment of the universities in entrepreneurial culture; iv) and a greater attention to networking and collaboration at local and international levels. Positive signals were perceived from each of the surveyed countries. They highlight a system that is continuously evolving but still needs more attention and support at both local and international levels.

While in the field of institutional innovation there are signs of official activity in MED countries, in the field of social innovation there are interesting bottom-up initiatives, but no or very limited attempts to embody social innovation into national policy frameworks. Further research should be able to highlight the potential of the connection between the establishment of innovation ecosystems and their capacity to generate new entrepreneurship models that align private objectives with sustainable development goals. On this regard, the social innovation practices identified in this article should be further analysed to look at the support measures and the bottlenecks that may facilitate or limit the transformative capacity of these initiatives.

The main critical points that have emerged from this survey and analysis are:

Firstly, the need for policies and funds dedicated to youth entrepreneurship. The region needs to encourage education programmes, to train new entrepreneurs and to promote the spread of an entrepreneurial culture among students. It is also important to introduce new teaching methods on the entrepreneurial culture, as for example open innovation and design thinking approaches to help students advance towards entrepreneurship and their needs for innovation.

As a result, young people do not have the skills needed to start a business or to innovate or to grow their own business.

Secondly, youth entrepreneurship should be mainly supported by a public authority capable of providing information and services in a swift and effective manner. There is a need to invest more in the creation of technology transfer centres that enhance and valorize the results of research, and in incubators and business accelerators that support the youth specifically in fragile territories.

Thirdly, the difficulty to access to credit remains highly problematic given that young entrepreneurs often do not have the opportunity to finance their own entrepreneurial projects. For this reason, it is important for the public authorities to implement financial support mechanisms and/or guarantees for access to credit. Moreover, it is necessary to increase the private investments in enterprise innovation and creation.

The fourth issue is the need to foster the cooperation for innovation at all levels: between researchers and enterprises (innovation supply chain), between ISOs at the local level, by fostering contamination processes and multi-sectorial partnerships (cross-innovation), between ISOs at international level, by promoting the development of an environment that can improve the performance of ISOs and increase the number of startups on the market by reducing their failure (Mediterranean ecosystem).

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A research on the opinions and suggestions of the youth who study agriculture in Turkey on the Young Farmer Grant Project

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Abstract

The agricultural population in Turkey declines year by year due to rural-urban migration and, consequently, the number of young farmers is on the decrease in Turkey, like in some developed countries. The Young Farmer Grant Project was launched for encouraging young people in rural areas in 2016. This study was conducted to determine the tendency of the youth who study agriculture to invest in agriculture and their opinions and suggestions on the Young Farmer Grant Project. Data was collected by the survey from 480 students who studied agriculture at Ege University and Kocaeli University. Five-point Likert scale was used to determine the opinions, tendencies and expectations of the students. At this stage, chi-square tests and analysis of variance were also applied. Logistical regression was performed for determining of factors affecting the probability of students benefiting from the Young Farmer Grant Project. According to results of logistical regression, age, the situation of being a farmer in the family and having a family-owned farmland positively affect the probability of students benefiting from the Young Farmer Grant Project.

Keywords*: Young farmer grant project support, Agricultural production, Rural development, Youth employment, Students, Turkey.*

1. Introduction

The Food and Agriculture Organization of the United Nations (FAO) expects the world's population to reach 9 billion in the next 30 years and, in parallel with the population growth, food demand is predicted to increase. However, global warming and decrease in agricultural production, along with the world's increasing population, give the signs of a possible food shortage in the future. In this respect, governments have to produce and develop policies aimed at taking necessary measures to ensure adequate food production.

The young population engaged in agriculture throughout the world is declining every year. For this reason, many countries have started to create various supporting models that can bring young people into agriculture in order to ensure economic sustainability in agricultural production (Yalçın *et al.*, 2020). In most European countries, the number of farmers under the age of 40 is also declining. There is concern that this demographic

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trend could have a negative impact on the agricultural industry (Leonard *et al.*, 2017).

Agriculture is of distinct importance to developing countries such as Turkey. Because of the supply of raw materials to the industry, exports, qualified labor, employment opportunities, food needs and national income because of its contribution to take on an important task. According to the Turkish Statistical Institute (TurkStat), while the share of agricultural sector in Turkey's Gross Domestic Product (GDP) was 9% in 2004, it was 6% in 2018 with $ 789 billion (TurkStat, 2018). For this reason, agriculture needs to be further supported by the state.

The rural population engaged in agricultural production activities is seen to have decreased considerably in Turkey. According to Address-Based Population Registration System data, the proportion of population living in towns and villages was 25% in 2008, but decreased to 7.7% in 2018 (TurkStat, 2019). People migrate from rural to urban areas because the income earned by farmers from agriculture is inadequate for their expenditures, and employment opportunities are available mainly in cities. Additionally, agriculture is not seen as an attractive employment area by young people and the employment potential of non-agricultural sectors in rural areas is low (Kan *et al*., 2019). As a result, the young population in rural areas wants to live and work in the city and, for this reason, most of the young people in rural areas are not engaged in agriculture. The decline in the number of young farmers, the farmer's reluctance to pass the farm on to new generations, educational, financial and motivational reasons are effective (Corsi, 2009; Mishra *et al.*, 2010; Mishra and El-Osta, 2016; May *et al.*, 2019). The youth's disengagement from, or decreasing interest in, agriculture may result in the loss of productive workforce in a dynamic rural economy model, posing a problem in terms of sustainability (Mosaee and Ommani, 2011). Besides, today's rapid disengagement from agriculture may cause serious problems in food production in the future (Doğan *et al*., 2015). In rural areas, the young population, which decreases in number, must be directed towards agriculture for economic revival and employment.

The rural population in Turkey is getting older. Young people in rural areas do not see agriculture as an area of work that can improve living conditions (Engindeniz and Can, 2020). The youth migrate from rural to urban areas with the belief that they have no future in the agricultural sector and will have a better social life in the city. Sustainability in agricultural production will only be possible by keeping the young population in agriculture (Doganay and Alim, 2010). However, sustainable rural development and continuity of agricultural production can be achieved only through the youth who have received agricultural education and become specialized in their field (Unakitan and Başaran, 2018).

The Young Farmer Grant Project was introduced to the 18-40-year-old people planning to carry out agricultural activities within the framework of Rural Development Supports to ensure sustainability in agriculture. As part of the project, 14,678 young farmers were granted 450 million Turkish Liras in 2016, and 16,067 young farmers were granted 483 million Turkish Liras in 2017 (TOB, 2013). The increase in the number of applicants indicates that it is possible to increase agricultural employment by supporting young people.

Therefore, it is of great importance for the future that studies are conducted to enhance the opportunities for agricultural employment and rural youth development in agricultural policies both in Turkey and all over the world. In this respect, the young people who have received agricultural education should be guided for economic and social development as well as agricultural sustainability. Thanks to the increase in the incentives and supports provided to the youth who tend to engage in agriculture, directing the youth to agricultural investments has become even more important.

There are many studies on the incentives and supports that have been offered to the youth up to the present in Turkey and all over the world (Aggelopoulos and Arabatzis, 2010; Sottomayor *et al.*, 2011; Harakal'ova, 2013; Harakal'ova, 2014; Derderi *et al.*, 2015; Đurić and Njegovan, 2015; Bournaris *et al.*, 2016; Leonard *et al.*, 2017; Ayele *et al.*, 2017; McKillop *et al.*, 2018; Šimpach, 2017; Walters *et al.*, 2018; Šim-

pachová Pechrová and Šimpach, 2018; May *et al.*, 2019; Sav and Sayin, 2018; Dogan *et al.*, 2018; Unakitan and Başaran, 2018; Filloux *et al.*, 2019; Salvago *et al.*, 2019; Touzeau, 2019; Brodzinski, 2019; Đurić *et al.*, 2019; Kan *et al.*, 2019; Phiboon *et al.*, 2019; Eistrup *et al.*, 2019; Badan *et al.*, 2019; Cristea *et al.*, 2019; Castillo-Quero and Guerrero-Baena, 2019; May *et al.*, 2019). Nevertheless, there is a need for studies that analyze the tendencies of the youth in Turkey and offer solutions on agricultural incentives and supports.

Agricultural education is a practical education, so it is preferred by students who are more interested. This research was preferred because young people who are interested in agricultural education at the university will have more potential to be interested in agriculture after graduation. Upon graduation, senior students studying agriculture are likely to invest in agricultural production thanks to agricultural supports given to young people. It concerns not only rural youth, but also young people who have studied agriculture, especially in urban areas for keeping and increasing of the young population in agriculture of Turkey. On the other hand, some of the university students are of rural origin and they should be asked whether they want to return to rural areas and deal with agriculture. The opinions and expectations of young people on agricultural supports provided in Turkey is important to prepare the effective and appropriate policies.

This research was conducted to determine the tendency of the youth who study agriculture to invest in agriculture and their opinions and suggestions on the Young Farmer Grant Project. In the scope of the research, a face-to-face survey was conducted on a total of 480 students who studied agriculture at Ege University (EU) and Kocaeli University (KOU).

2. Materials and Methods

The primary data obtained from the survey conducted on the seniors who studied agriculture at EU's Faculty of Agriculture and KOU's Arslanbey Agriculture and Food Vocational Schools in the academic year of 2015-2016 constituted the main material of the research. In the survey, the students (seniors) in the last year were interviewed. Seniors were preferred in the research with the idea that seniors have wider knowledge on account of the education they have received and more elaborated forward-looking thoughts because of their upcoming graduation. It was preferred to interview all students without sampling. The data obtained from a total of 480 students (176 undergraduate degree students from EU and 304 associate degree students from KOU) was evaluated. The survey was conducted in April and May of 2016. The questionnaires were filled by the students between the courses at the universities.

The survey form used in the research is composed of two main sections. The first section contains questions about the students' demographic characteristics, while the second section is made up of questions to express their tendency to invest in agriculture and opinions and suggestions on the Young Farmer Grant Project.

The data collected through the survey was encoded and interpreted on the SPSS 22.0. Frequency and % distributions, chi-square test and analysis of variance were employed to analyze the data. 5-point Likert scale was used for presenting the students' opinions, tendencies and expectations on the Young Farmer Grant Project.

In this study, logistical regression (logit model) was performed for determining of factors affecting the probability of students benefiting from the Young Farmer Grant Project. When the dependent variable is a 0-1 binary variable, the logit or probit model estimation methods can be used. The logit model has the following functional form (Greene, 1993; Gujarati, 1995; Ramanathan, 1995):

$$P_i = E(Y = 1 / X_1) = \frac{1}{1 + e^{-(z_i)}} = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \quad (1)$$

In the equation:

P = the probability of choosing
E = cumulative probability function
$z = \alpha + \beta X_i$
α = constant coefficient
β = parameter to be estimated for each descriptive (independent) variable
X = independent variable

In the logit model, the dependent variable (Y) is student's willingness to benefit from the Young Farmer Grant Project. If students want to benefit from the Young Farmer Grant Project, the dependent variable takes the value 1, and 0 otherwise. i is a vector of explanatory variables related to student's benefit from the Young Farmer Grant Project and β is the vector of estimated coefficients. Positive coefficients increase the probability that a student benefit from the Young Farmer Grant Project. For the logit model, the most suitable estimation technique is maximum likelihood, where the maximum likelihood coefficient is consistent and symptotically normally distributed (Bierens, 2004).

3. Results

3.1. *Students' demographic and socio-economic characteristics*

In this section, research findings were evaluated statistically. The students who took part in the survey were analyzed first in terms of their demographic characteristics. As is seen from Table 1, 51.66% of the students were female, and 48.34% were male. At EU, 37.50% were female, and 62.50% were male. At KOU, however, 59.86% were female, and 40.14% were male. Of all the students, 93.95% were single, while 6.05% were married. The number of married students was higher at Kocaeli Uni-

Table 1 - Students' demographic characteristics.

Characteristics	*Ege University*		*Kocaeli University*		*Total*	
Sex	Number	%	Number	%	Number	%
Female	66	37.50	182	59.86	248	51.66
Male	110	62.50	122	40.14	232	48.34
Total	176	100.00	304	100.0	480	100.00
Age Group						
19-21	10	5.68	204	67.11	214	44.58
22-24	129	73.30	67	22.04	196	40.84
25 years old and older	37	21.02	33	10.85	70	14.58
Total	176	100.00	304	100.00	480	100.00
Marital Status						
Married	4	2.27	25	8.22	29	6.05
Single	172	97.73	279	91.78	451	93.95
Total	176	100.00	304	100.00	480	100.00
Monthly Family Income						
1000 TRY and below	18	10.23	43	14.15	19	3.95
1001-1500 TRY	29	16.47	79	25.98	108	22.50
1500-2000 TRY	18	10.23	35	11.52	53	11.04
2000-2500 TRY	24	13.64	56	18.42	80	16.67
2501-3000 TRY	18	10.23	26	8.55	44	9.17
3000 TRY and above	69	39.20	65	21.38	134	27.91
Total	176	100.00	304	100.00	480	100.00
Place of Birth						
Province center	100	56.82	121	39.80	221	46.04
District center	58	32.96	122	40.13	180	37.50
Town	3	1.70	33	10.86	36	7.50
Village	15	8.52	28	9.21	43	8.96
Total	176	100.00	304	100.00	480	100.00

versity, with a share of 8.22%. In terms of their monthly family income, the students who had a monthly family income of 3000 TRY and above had the highest proportion (27.91%) both at EU and at KOU.

45% of the students stated that they had been working, while 55% stated they had not. Of all students who had been working, those between the ages of 19 and 21 had the highest proportion (43.52%). The students of both EU and KOU were asked to define their economic condition, and 173 said "I can only afford the basic needs" (36.04%), 115 said "I can buy most of what I want" (23.96%), and 105 said "I live in prosperity" (21.87%), respectively. 37 students said "I cannot afford the basic needs", with the lowest share of 7.71%. In general, the majority of students had a level of income to afford the basic needs and buy most of what they wanted.

3.2. *Students' opinion on investing in agriculture*

The agricultural students were asked to sort their expectations from investing in agriculture by level of importance. Table 2 shows the findings obtained. For evaluation purposes, attitude sentences were scored as 1- Not at all important, 2- Slightly important, 3- Neutral, 4- Important, 5- Extremely important and weighted averages were calculated. The greatest expectation of the students from investing in agriculture was "enhancing employment opportunities", with an average score of 4.40, followed by "adjusting production to natural conditions" with an average score of 4.37 and "implementing agricultural innovations" with an average score of 4.35. These findings suggest that the students are more willing to invest in the agricultural fields that provide employment

Table 2 - Students' expectations from investing in agriculture.

Expectations	*1* *N* *%*	*2* *N* *%*	*3* *N* *%*	*4* *N* *%*	*5* *N* *%*	*T N* *%*	*Avg.*	*SS*
Earning money	9 1.9	30 6.3	35 7.3	207 43.1	199 41.4	480 100.0	2.79	1.61
Motivation and working	8 1.7	15 3.1	44 9.2	228 47.5	185 38.5	480 100.0	2.97	1.61
Self-fulfillment	10 2.1	23 4.8	47 9.1	200 41.7	200 41.7	480 100.0	2.72	1.59
Making use of the knowledge of agriculture	6 1.3	14 2.9	31 6.4	246 51.3	183 38.1	480 100.0	3.62	1.26
Contributing to national agriculture	2 0.4	25 5.3	31 6.4	213 44.4	209 43.5	480 100.0	3.52	1.02
Offering natural food to consumers	4 0.8	22 4.6	36 7.6	197 41.0	221 46.0	480 100.0	3.18	1.54
Making the best of agricultural production factors	6 1.3	9 1.9	41 8.5	198 41.2	226 47.1	480 100.0	3.25	1.48
Enhancing employment opportunities	10 2.1	21 4.4	50 10.4	204 42.5	195 40.6	480 100.0	4.40	0.84
Implementing agricultural innovations	2 0.4	9 1.9	23 4.8	211 43.9	235 49.0	480 100.0	4.35	0.73
Adjusting production to natural conditions	11 2.3	20 4.2	25 5.2	191 39.8	233 48.5	480 100.0	4.37	0.76

Note: Scale values 1 - Not at all important; 2 - Slightly important; 3 - Neutral; 4 - Important; 5 - Extremely important.

opportunities and enable them to employ high-tech tools in agriculture in line with the education they have undergone.

The students were asked how to convert this money into investment if you own 30,000 TRY. The most popular response was "I would start my own business", given by 207 students. This response was followed by "I would deposit it in a bank" (91 students) and "I would play on the stock market" (87 students), respectively. The analysis of variance conducted proves that there is a significant difference between the students' opinion on turning 30,000 TRY into an investment and their sex ($p=0.020<0.05$), while no significant difference between their opinion and age ($p=0.468>0.05$).

3.3. *Students' opinions and expectations on the young farmer grant project*

For the purpose of determining the agricultural students' opinions on, and expectations from, the Young Farmer Grant Project, they were first asked from which source they had heard about the Project. The top response was "TV-Radio", given by 235 students. The next two responses were "Internet" (199 students) and "friends" (185 students), respectively. The fact that the most popular response given by the students of both EU and KOU was "TV-Radio" suggests the students actively listen to the radio and use the Internet and social media from their mobile phones.

A chi-square analysis was conducted to determine the relationship between the students' sex and their level of awareness of the Young Farmer Grant Project, and the difference between the variables was found significant ($p=0.026<0.05$), as is seen from Table 3. In the case of female students, those who were "slightly aware" (67 female students) had the highest proportion (27.13%). On the other hand, the highest proportion (31.33%) in the case of male students belonged to those who were "moderately aware" (73 male students). It is thought that, compared to female students, male students are more aware of, and more interested in, the Young Farmer Grant Project. Dogan *et al.* carried out a study in 2018 in the TR 71 Region of Turkey (provinces of Aksaray, Kirikkale, Kirsehir, Nevsehir, and Nigde) and found that 63.3% of the people who benefited from the Young Farmer Grant Project were male. Their finding supports the thought mentioned above.

The likelihood of the students to make use of the Young Farmer Grant Project was analyzed

Table 3 - Relationship between the students' sex and their level of awareness of the young farmer grant project.

Level of Awareness		*Sex*		*Total*	*Chi-Square Test Result*		
		Female	*Male*		χ^2	*sd*	P^*
Not at all aware	n	30	23	53	11.068	4	0.026
	%	12.14	9.87	11.04			
Slightly aware	n	67	38	105			
	%	27.13	16.31	21.88			
Somewhat aware	n	44	42	86			
	%	17.81	18.03	17.91			
Moderately aware	n	61	73	134			
	%	24.70	31.33	27.92			
Extremely aware	n	45	57	102			
	%	18.22	24.46	21.25			
Total	n	247	233	480			
	%	100.00	100.00	100.00			

*Note: *It is significant at the 0.05 level.*

by age groups. As is seen from Table 4, of all 348 students "likely" and "extremely likely" to make use of the support, 157 were 22-24 years old, with the highest share. As a result of the chi-square analysis, the relationship between the students' age group and their likelihood to make use of the Young Farmer Grant Project was found to be significant (p=0.003<0.05).

Of all EU and KOU students taking part in the research, 205 had a family-owned farmland, while 275 did not. Besides, 26.5% of the students had at least one family member engaged in farming. This proportion was 29.5% for KOU students, and 21% for EU students. As is seen from Table 5, 355 students (73.96%) stated they did not plan to live in the rural area to

Table 4 - Relationship between the students' age group and their likelihood to make use of the young farmer grant.

Likelihood		*Age Group*			*Total*	*Chi-Square Test Result*		
		19-21 Years Old	*22-24 Years Old*	*25 Years Old and Older*		χ^2	*sd*	*P**
Extremely unlikely	n	3	3	0	6	22.910	8	0.003
	%	1.40	1.54	0.00	1.25			
Unlikely	n	24	12	1	37			
	%	11.16	6.16	1.43	7.71			
Neutral	n	53	23	13	89			
	%	24.65	11.79	18.57	18.54			
Likely	n	79	90	31	200			
	%	36.74	46.15	44.29	41.67			
Extremely likely	n	56	67	25	148			
	%	26.05	34.36	35.71	30.83			
Total	n	215	195	70	480			
	%	100.00	100.00	100.00	100.00			

*Note: *It is significant at the 0.05 level.*

Table 5 - Students' plan on living in the rural area to make use of the young farmer grant project by having a family-owned farmland.

Plan on living in the rural area	*Ege University*				*Kocaeli University*				*Total*	
	Has a family-owned farmland		*Does not have a family-owned farmland*		*Has a family-owned farmland*		*Does not have a family-owned farmland*			
	Number	%	Number	%	Number	%	Number	%	Number	%
Plans to live in the rural area	8	21.62	20	14.39	62	45.59	35	20.83	125	26.04
Does not plan to live in the rural area	29	78.38	119	85.61	74	54.41	133	79.17	355	73.96
Grand Total	37	100.00	139	100.00	136	100.00	168	100.00	480	100.00

make use of the Young Farmer Grant Project, suggesting that having a family-owned farmland does not have that much effect on such a plan.

A chi-square analysis was performed to assess the relationship between the students' family income and finding themselves qualified for investing in agriculture, and the relationship was found significant (p=0.001<0.05), as is seen from Table 6. Of the students "extremely likely" to invest in agriculture, those with a family income of 3000 TRY and above had the highest proportion (46.51%). On the other hand, of the students having a family income of 1000 TRY and below, those "extremely unlikely" to invest in agriculture had the highest proportion, with a share of 39.22%. These findings indicate that the students who have a lower level of income are less courageous in making investments, while those having a higher level of income are more courageous because they are economically better off.

The students were asked their opinion on the changes that the Young Farmer Grant Project, which was launched in Turkey in 2016, could lead to in the future. The change expected most was "The number of young people engaged in agriculture will increase" (254 students), followed by "Engaging in agriculture will become an important profession" (225 students) and "Rural-urban migration will decrease" (222 students), respectively (Table 7). So, for the students, the Young Farmer Grant Project will contribute to the development of agriculture in the future.

Students' opinion was examined on the likelihood of the 18-41-year-old people's taking advantage of the young farmer grant project. 48.54% of the students (233 students) said 18-41-year-old people were "extremely likely" to take advantage of the Young Farmer Grant Project, and 29.79% expressed it was "likely". The analysis of variance demonstrated that there was a significant difference between the students' opinion on the likelihood of the 18-41-year-old people's taking advantage of the Project and their sex (p=0.043<0.0059) and age (p=0.037<0.05). 48.5% of the female students and 51.5% of the male students said 18-41-year-

Table 6 - Relationship between the students' family income and finding themselves qualified for investing in agriculture.

Family Income	*Likelihood of Investing in Agriculture*										*Total*		*Chi-Square Test Result*		
	Extremely Unlikely		*Unlikely*		*Neutral*		*Likely*		*Extremely Likely*						
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*K2*	d_f	*P**
1000 TRY and below	80	39.22	21	32.81	16	20.25	18	20.00	10	23.26	145	30.21	53.391	24	0.001
1001-1500 TRY	23	11.27	13	20.31	17	21.52	22	24.44	5	11.63	80	16.67			
1501-2000 TRY	8	3.92	9	14.06	12	15.19	8	8.89	3	6.98	40	8.33			
2001-2500 TRY	29	14.22	6	9.38	14	17.72	13	14.44	3	6.98	65	13.54			
2501-3000 TRY	7	3.43	4	6.25	1	1.27	6	6.67	2	4.65	20	4.17			
3000 TRY and above	57	27.94	11	17.19	19	24.05	23	25.56	20	46.51	130	27.08			
Total	204	100.00	64	100.00	79	100.00	90	100.00	43	100.00	480	100.00			

*Note: *It is significant at the 0.05 level.*

Table 7 - Students' predictions of the future effects of the young farmer grant project by sex.

Prediction	*Sex*	*Ege University*		*Kocaeli University*		*Total*	
		Number	*%*	*Number*	*%*	*Number*	*%*
Rural-urban migration will decrease	Female	32	34.04	77	60.16	109	49.10
	Male	62	65.96	51	39.84	113	50.90
Total		94	100.00	128	100.00	222	100.00
Farmlands will increase in value	Female	24	33.33	78	55.71	102	48.11
	Male	48	66.67	62	44.29	110	51.89
Total		72	100.00	140	100.00	212	100.00
The number of young people engaged in agriculture will increase	Female	25	33.78	108	60.00	133	52.36
	Male	49	66.22	72	40.00	121	47.64
Total		74	100.00	180	100.00	254	100.00
Engaging in agriculture will become an important profession	Female	34	41.46	81	56.64	115	51.11
	Male	48	58.54	62	43.36	110	48.89
Total		82	100.00	143	100.00	225	100.00
National agricultural production will grow	Female	26	33.77	82	54.67	108	47.58
	Male	51	66.23	68	45.33	119	52.42
Total		77	100.00	150	100.00	227	100.00
Other	Female	3	33.33	4	23.53	7	26.92
	Male	6	66.67	13	76.47	19	73.08
Total		9	100.00	17	100.00	26	100.00

old people were "extremely likely" to take advantage of the Young Farmer Grant Project. The students indicated that the Young Farmer Grant Project could be an opportunity especially for young entrepreneurs.

The relationship between the students' family income and finding 30,000 TRY given as the Young Farmer Grant adequate was assessed. The amount of grant in question was found inadequate by 346 students and adequate by 134 students. Of the students who found the amount adequate, those with a family income of 1000 TRY and below had the highest proportion (25.37%). Likewise, of the students who found the amount inadequate, those with a family income of 1000 TRY and below again had the highest proportion (32.08%). As a result of the chi-square analysis, the relationship between the students' family income and finding 30,000 TRY given as the Young Farmer Grant adequate was found to be insignificant ($p=0.176>0.05$).

The students were asked their opinion on the level of importance of the project subjects supported within the scope of the Young Farmer Grant Project for Turkey's rural development (Table 8). For evaluation purposes, attitude sentences were scored as 1 - Not at all important, 2 - Slightly important, 3 - Neutral, 4 - Important, 5 - Extremely important, and weighted averages were calculated. As is seen from Table 8, the project subject to which the students attributed the highest importance for Turkey's rural development was "plant and animal production with organic and good agriculture practices" with an average score of 4.28, followed by "producing, processing and packaging food with geographical indication" with an average score of 4.11

Table 8 - Distribution of the young farmer grant project subjects by level of importance for Turkey's rural development.

Project Subjects	*1* *N* *%*	*2* *N* *%*	*3* *N* *%*	*4* *N* *%*	*5* *N* *%*	*T N* *%*	*Avg.*	*SS*
Cattle breeding	180 37.4	41 8.5	49 10.2	107 22.2	103 21.4	480 100.0	2.81	1.62
Sheep and goat breeding	76 15.8	98 20.4	72 15.0	110 22.9	124 25.8	480 100.0	3.22	1.43
Beekeeping	72 15.0	67 13.9	89 18.5	127 26.4	125 26.0	480 100.0	3.34	1.38
Poultry farming	11 2.3	44 9.1	127 26.4	177 36.8	121 25.2	480 100.0	3.73	1.01
Silkworm breeding	17 3.5	53 11.0	121 25.2	161 33.5	128 26.6	480 100.0	3.68	1.09
Orcharding	19 4.0	40 8.3	75 15.6	182 37.8	164 34.1	480 100.0	3.90	1.08
Viticulture	21 4.4	21 4.4	71 14.8	193 40.1	174 36.2	480 100.0	3.99	1.03
Orcharding for strawberry and other berry fruits	24 5.0	29 6.0	87 18.1	194 40.3	146 30.4	480 100.0	3.85	1.07
Mushroom cultivation	27 5.6	40 8.3	125 26.0	141 39.3	147 30.6	480 100.0	3.71	1.15
Producing, processing and packaging medicinal and aromatic plants	17 3.5	35 7.3	87 18.1	140 29.1	201 41.8	480 100.0	3.98	1.10
Plant and animal production with organic and good agriculture practices	16 3.3	19 4.0	42 8.7	137 28.5	266 55.3	480 100.0	4.28	1.00
Producing, processing and packaging food with geographical indication	14 2.9	23 4.8	72 15.0	164 34.1	207 43.0	480 100.0	4.11	1.05

Note: Scale values 1 - Not at all important; 2 - Slightly important; 3 - Neutral; 4 - Important; 5 - Extremely important.

and "viticulture" with an average score of 3.99, respectively. Similar results were obtained from both EU and KOU students. The fact that people attach greater importance to healthy nutrition nowadays has led to an increase in the areas of investment in organic agriculture. This is probably why the students attributed a higher level of importance to this project subject.

The students who want to benefit from the Young Farmer Grant Project are required to invest in agriculture and also live in the rural area. In other words, students will continue their lives in agriculture and rural areas. Students who have no family land will be able to rent. In this study, logistical regression (logit model) was performed for determining the factors that affect the possibility of students to benefit from the Young Farmer Grant Project. In the logit model, the dependent variable is student's willingness to benefit from the Young Farmer Grant Project. The model's independents variables are age, sex, place of birth, place of residence, monthly family income, the situation of being a farmer in the family, having a family-owned farmland and regular job status. As is seen from Table 9, definitions of dependent and independent variables.

Before testing whether the explanatory variables are important in the model, it should be tested whether the model is statistically significant. At this stage, the following hypotheses are created:

Table 9 - Variables used for logit models.

Dependent variables	*Variable categories*
The student's willingness to benefit from the Young Farmer Grant Project	1: Yes 0: No
Independent variables	
Age (year)	1: ≤ 21 2: 22-24 3: ≥ 25
Sex	1: Female 2: Male
Place of birth	1: Province center 2: District center 3: Town 4: Village
Place of residence	1: Province center 2: District center 3: Town 4: Village
Monthly family income	1: ≤ 1500 TRY 2: 1501-2500 TRY 3: ≥ 2501 TRY
The situation of being a farmer in the family	1: Yes 0: No
Having a family-owned farmland	1: Yes 0: No
Regular job status	1: Yes 0: No

H_0: Some variables have no effect on the possibility of benefiting from the project.

H_1: At least one variable has an impact on the possibility of benefiting from the project.

According to the results obtained, the model was found to be significant at $p < 0.01$ level and H0 hypothesis was rejected.

The aim of the model is to identify factors that affect the likelihood of students benefiting from young farmer grant support. The confirmatory classification rate (CCR) for this model was 78.1%. The use of logit model showed that there is a statistically significant between the dependent and the independent variables ($p=0.000$, $R^2=0.253$). The results of the logit model estimation are shown in Table 10. Accordingly, males are less likely to benefit from young farmer grant support than females. But this information is not a statistically significant ($p=0.754>0.05$). For the variables "Age (≤21 and ≥25)", "The situation of being a farmer in the family", "Having a family-owned farmland" and "Regular job status", the relevant Beta coefficients were found to be statistically significant ($p<0.01$). And "The place of birth (village)" was a statistically significant ($p<0.05$). Age, the situation of being a farmer in the family and having a family-owned farmland positively affect the possibility of benefiting from the project.

4. Discussion and Conclusion

The agricultural sector is promoted through various policies in all countries of the world. Given the fact that a major part of the population is employed in the agricultural sector in developing countries like Turkey, government support is essential to make the agricultural sector have a steady structure (Dogan *et al.*, 2018). The recent supports given to, and policies developed for, the agricultural sector in Turkey show the importance attached to agricultural production. The share of dynamic youth population in total population is 16.4%. The development of rural youth, then, plays a vital role in preventing agricultural depopulation in the future. However, this is possible only when social and economic opportunities are enhanced in rural areas and rural areas are made desirable for the young people who live in rural areas or live in the city but have the potential of migrating to rural areas.

The European Union has similar problems to Turkey (aging agricultural population, the youth's disengagement from agriculture, etc.). Current evidence has revealed that the number

Table 10 - Results of logit model.

Dependent variables *The student's willingness to benefit from the Young Farmer Grant Project 1: Yes 0: No*						
Independent variables		*Beta*	*Std. Error*	*Wald*	*p*	*Exp. (ß)*
Sex		0.078	0.249	0.098	0.754	1.081
Age						
	≤ 21	1.478	0.204	12.881	0.002**	1.613
	22-24	-0.158	0.450	0.123	0.726	0.854
	≥ 25	1.668	0.472	12.505	0.000**	5.301
Place of birth						
	Province center	0.431	1.525	0.080	0.778	1.539
	District center	0.103	0.422	0.059	0.808	1.108
	Town	-0.105	0.427	0.061	0.806	0.900
	Village	-1.639	0.769	4.547	0.033*	0.194
Place of residence						
	Province center	0.342	0.687	0.103	0.884	1.105
	District center	-0.358	0.515	0.484	0.486	0.699
	Town	-0.262	0.583	0.202	0.653	0.770
	Village	-0.194	0.615	0.099	0.753	0.824
Monthly family income						
	≤ 1500 TRY	-0.197	0.294	0.358	0.479	0.726
	1501-2500 TRY	-0.175	0.304	0.332	0.565	0.840
	≥ 2501 TRY	-0.096	0.262	0.133	0.715	0.909
The situation of being a farmer in the family		0.929	0.290	10.245	0.001**	2.532
Having a family-owned farmland		1.026	0.258	15.832	0.000**	2.791
Regular job status		-0.948	0.374	6.419	0.011**	0.387
Constant		-1.223	0.551	4.926	0.026*	0.294
Log likelihood-LL:=459.740 Cox & Snell R^2=0.172 Nagelkerke R^2=0.253						

*Notes: *It is significant at the 0.05 level*; *** It is significant at the 0.01 level.*

of young farmers in several developed countries such as the United States and European countries has decreased over the last decades as a consequence of technological, social, and economic changes (Mills-Novoa, 2011; Chen et al., 2014; Mihi-Ramirez and Kumpikaite, 2014; Bednaříková et al., 2016; Leonard et al., 2017; Duesberg et al., 2017; Mishra et al., 2010). The latest European Union Farm Structure Survey indicated that, by 2013, 55.8% of European farmers were over 55 years of age (Eistrup et al., 2019) and only 8.7% of farmers in the European Union were younger than 35 years of age (Castillo-Quero and Guerrero-Baena, 2019). The disengagement of the youth from agriculture poses a threat to its long-term sustainability. The youth in Europe disengage from agriculture due to lack of rural infrastructure and many other socio-economic problems. In the European Union, the youth are encouraged to own farm establishments by means of incentives and supports through the Common Agricultural Policy (Unakitan and Başaran, 2018).

In a study conducted in Greece was evaluated the aid programmes for young farmers and, more specifically, the first measure of the third axis of the operational programme "Rural De-

velopment - Regeneration of the Countryside 2000-2006", based on improvements to the level of viability. The categorical regression was used in this study. The results show that the orientation of the farms, after the implementation of the financing programme, is towards exploiting the comparative advantages of the various regions by making use of suitable crops (Aggelopoulos and Arabatzis, 2010).

Zagata and Sutherland (2015) argued in their study, that there is insufficient evidence to adequately inform debates about the role of young people in European agriculture, proposing a research agenda which includes more consistent conceptualization of the 'young farmer problem', targeted research on the role of young people in agricultural innovations, assessment of regional differences within countries, and identification of farm succession processes in new EU Member States.

As part of the Young Farmer Grant Project, which was put into effect in 2016 in Turkey, 30,745 18-40-year-old people were granted 933 million Turkish Liras between the years 2016-2017. These figures demonstrate that the youth are willing to invest in agriculture if they are supported and guided. Filloux et al., carried out a study in 2019, on Thai agriculture students of Thailand and found that good results will be obtained from graduate students with agricultural support to be given to young people. Their results support the situation in Turkey.

According to results of this study, most of the agricultural students think themselves knowledgeable about investing in agriculture. Their greatest expectation from the Young Farmer Grant Project is an increase in the number of young people engaged in agriculture in the future, indicating that the youth lean towards investing in agriculture, provided they receive, in addition to agricultural education, government incentives and supports as well as family support.

In Turkey, not only gradual rural depopulation but also the higher average age of people engaged in agriculture pose a threat to the future of agricultural production. The only factor to reverse this trend is the youth. To this end, rural areas must be rendered appealing to the youth by enhancing social and economic opportunities in villages such as education, employment, health care, housing and infrastructure. If income and living conditions are improved in rural areas, the youth will not intend to migrate to the city and agriculture will become attractive for them, which will also play a fundamental role in rural development.

The increased importance of agriculture and nutrition suggests the necessity of raising the awareness of, and guiding, the youth in respect of agricultural production. There is a need for an organization to communicate with the students of agricultural faculties and vocational schools. Those students must be guided by means of detailed information about agricultural investment education, incentives and supports as well as case studies.

The greatest expectations of the students from investing in agriculture are to create employment and implement agricultural innovations, respectively. So, the youth look with favor on investing in agriculture because it provides them with employment opportunities and the chance of managing their own business. Besides, today's youth keep up with the cutting-edge technology and are more interested in the investments that allow them to employ high-tech tools in agriculture. The investment cost of the technologies used in agriculture is quite high. For this reason, increasing the amount of supports and simplifying application requirements will encourage both agricultural students and other investors more.

In this study, the agricultural students were asked the likelihood of making use of the Young Farmer Grant Project support, and 72.5% of them responded with "likely" and "extremely likely", proving their willingness to invest in agriculture. Thus, agricultural entrepreneurship courses may be offered to students during their period of study for enabling them to design and realize the investing activities they have in mind.

The Young Farmer Grant Project intended for agricultural students and other young people in respect of agricultural investment is a considerable step for Turkey. Today, the con-

tinuity of agricultural production is critically important. So, social security status, marketing opportunities and higher amounts of support are crucial for encouraging the youth to take advantage of such supports.

Therefore, it is essential to pursue necessary policies to support and guide agricultural students, who hold the future of agriculture.

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Consumer preferences and purchasing rationales for wine: A multivariate data analysis

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Abstract

The wine market is very heterogeneous and complex, being the knowledge of the behaviour and attitudes of consumers a key tool to design efficient marketing plans, namely in countries that are traditionally wine producers and consumers, such as Portugal. In this country, Port wine is an economic and cultural icon, but, in the last decade, total sales have been decreasing. Despite this trend the domestic consumption has been gaining relevance and therefore a focus to reverse the negative cycle of total sales. The main goal of this paper is to analyse the profile and behaviour of domestic Port wine consumers, identifying homogeneous market segments. For this purpose, an online survey was applied and random sample of 678 Portuguese Port wine consumers was collected. Using multivariate statistical techniques, three profiles of purchasers/consumers emerged: experienced, less experienced and inexperienced consumers. This segmentation shows that Port wine consumers can be grouped according to their involvement with the product, consumption occasion and price they are willing to pay. In addition to the academic contribution of wine market segmentation, the paper provides useful insights to be used in designing marketing plans, both by institutional stakeholders and wineries.

Keywords*: Multivariate statistical techniques, Market segmentation, Wine consumers, Wine economics.*

1. Introduction

Over the last five decades, wine market has witnessed an increasing competition. The wine industry was forced to develop competitive strategies able to face new challenges, both on supply and demand side. The wine industry has become a typical case of monopolistic competition structure characterized by a large number of wineries with different strategies and several wine denominations, styles and brands. In this

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setting, the process underlying the wine choice is a complex task and, therefore, consumers tend to adopt risk reduction strategies, in order to reduce the chance of a bad choice, namely: information research, brand loyalty, price and past consumption experience (Bruwer and Rawbone-Viljoen, 2012). Additionally, challenges regarding the patterns of wine consumption arise from the presence of new consumers with specific cultural background, and different purchasing habits, behaviour, and preferences.

Given the diversity of wine consumers, it is expected that different motivations and constraints underpin the wine choice process. Thus, wine market segmentation has been broadly applied to achieve homogeneous consumers' groups with similar needs and wishes, according to several variables, such as socio-demographic, psychographic or behavioural (Johnson *et al.*, 2017). Particularly, the related literature reports different consumer profiles for still wines. However, due to the highly differentiated nature of wine, the results are product-specific and hard to generalize. There is no evidence if these findings can be transferred and generalized to another typology of wines, such as fortified wines.

Port wine is a fortified wine with a long history in the market and with specific characteristics related to the *terroir* for which standards, habits and motivations of consumption are expected to be also very specific. It is produced in Portugal, a traditional wine producing-consuming country, more specifically in the Douro Demarcated Region (DDR). The soil and climatic physiognomies of this region influence the sensorial and chemical features of Port wine, which explains the production of several categories with distinctive market positioning. In spite of a long history of production and internationalization, Port wine faces a negative trend of consumption that could be a signal of it having become a non-fashionable drink when compared with other alcoholic beverages. In total, from 2006 to 2016, Port wine sales decreased 16%, in volume, and 5% in value, while domestic consumption decreased 3.3% in volume, but grew in value at an average annual rate of 1%. In 2016, the Portuguese market accounted for 17%, in volume, and 19%, in value, of total sales, ranking second, after the French market. In this way, the inversion of the decreasing trend in total Port wine sales, demands for a better knowledge of the Portuguese market and its consumer's segmentation.

Although consumer segments for still wines have been identified in the literature, there is a lack of research regarding to the consumption patterns of fortified wine, in particular, of Port wine in Portugal. The main objective of the present article is to fill in the gap identified in the literature to look for distinct consumption and behavioural patterns of Port wine consumers. The paper contributes to deepen the scientific knowledge about Port wine consumers' preferences and attitudes, and provides guidelines that are also useful for supporting the development of marketing strategies, both at institutional and managerial level. It constitutes a starting point for tailoring marketing strategies aimed at specific market segments, with a particular emphasis for companies working or intending to act in Port wine market.

The present paper is organized as follows: Section 2 comprises a brief literature review, including segmentation methods and variables; Section 3 describes the survey design and presents the data; methods and results are presented in Section 4; and, finally, the main conclusions and recommendations for future research are discussed in Section 5.

2. Literature review

Wine is an experience good whose main attributes can only be evaluated at the moment of consumption, and therefore the consumer's ability to gauge quality prior to consumption is very low. Additionally, wine is a multifaceted product with a wide range of intrinsic and extrinsic quality cues. The characteristics that are desirable to consumers when they choose a wine are not homogeneous and must be identified. Based on this information, producers may develop products for differing segments of consumers.

Still wine consumers have been typically segmented with clustering techniques according to behavioural segmentation criteria (e.g., Spawton, 1991; Hall, 1999; Aurifeille *et al.*, 2002; Thomas and Pickering, 2003; Kalazić *et al*., 2010; Duarte *et al*., 2010; Liu *et al.*, 2014; Thach and Olsen, 2015) or sociodemographic factors (e.g., Barber

et al., 2008; Wolf *et al.*, 2018). Some studies have applied multivariate statistical techniques, such as, for example, those by Di Vita *et al.* (2014) and Kelley *et al.* (2015). In same line, Callieris *et al.* (2016) applied a cluster analysis to identify organic consumers in Tunisia.

Based on expectations and risk-reduction strategies, Spawton (1991) found four different groups in the Australian still wine market, namely the *connoisseurs*, *aspirational* drinkers, *beverage wine* consumers, and *new wine* drinkers. Later, using covariates on choice and consumption behaviour, Hall (1999) confirmed the evidence of Spawton (1991), but suggested changing the *new wine drinkers* segment to an *enjoyment-oriented* segment that is characterized by young wine drinkers who drink out of the home to have a good time. Using still wine involvement factors, Aurifeille *et al.* (2002) showed that some groups were analogous between Australian and French still wine consumers. Thomas and Pickering (2003) segmented the New Zealand still wine market into *heavy*, *medium,* and *light* wine purchasers. Kalazić *et al.* (2010) segmented the Croatian still wine market based on purchasing power and brand sensitivity variables. Six consumer groups were identified: *prestigious consumers*, *experts*, *traditional* consumers, *hedonists*, *savers*, and *modest* consumers. Liu *et al.* (2014) clustered Chinese still wine customers into *intrinsic-attribute-seeking*, *extrinsic-attribute-seeking*, and *alcohol-level-attribute-seeking*.

A multivariate statistical analysis was applied by Di Vita *et al.* (2014) to segment the Italian still wine market into *high-quality-demanding purchasers*, *occasional consumers*, and *basic consumers*. Kelley *et al.* (2015) segmented the US still wine market based on consumption frequency and found *super core drink*, *core drink*, and *marginal drink* consumer segments that are distinct in terms of generation and gender. Thach and Olsen (2015) also examined the US still wine market based on wine consumption frequency by price segment and found three homogeneous groups: *high*, *moderate*, and *low* spenders.

Duarte *et al.* (2010) clustered the Portuguese still wine market based on purchasing and consumption behaviour. Three consumers' segments were found: *enthusiast*, *infrequent*, and *convivial* wine drinkers. This research showed that younger generations of Portuguese people are convivial and less frequent wine consumers, and they usually perceive higher prices to be synonymous with quality.

With respect to sociodemographic factors, Cardillo *et al.* (2017) highlight the influence of these factors on consumer behaviour. In general, young people demonstrate less emotional brand linkage. For instance, with regard to the younger generations, Barber *et al.* (2009) recommended that wine branding should focus on social aspects of wine rather than on the specific product attributes. The literature has shown that the attributes sought by the still wine consumer seem to differ by generation.[1] For example, millennials seem to seek out lower priced wines, while Generation X privilege superior quality wines and prestigious brands (Wolf *et al.*, 2018). According to Wolf *et al.* (2018), baby boomers are driven by product quality and health benefits. In general, millennial consumers are more attracted by innovative packaging, low prices, and high alcohol content. Further, baby boomers see wine as being relaxing, natural, and healthy, whereas millennial consumers consider wine to be sensual, cool, relaxing, and sophisticated (Barber *et al.*, 2008; Olsen *et al.*, 2007; Thach and Olsen, 2015).

Regarding gender segments, in general men tend to rely on heuristics to simplify the decision process, especially in the case of wine. On the other hand, women tend to analyse decisions more than men, perceive the risk associated with choosing a particular wine over another, and consequently search for more information because they are more sensitive to details (Atkin *et al.*, 2007; Bruwer *et al.*, 2011; Barber *et al*., 2006; Bruwer and McCutcheon, 2017; Forbes, 2012; Thach, 2012). Mora *et al*. (2018) also found significant differences in emotional response by gender and age. For all the still wines tested, men and

[1] According to the Pew Research Center (2014), these are the baby boomer generation (born 1946-1964), Generation X (born 1965-1980), and millennials, born after 1981.

older adults reported higher scores on significant emotions than their counterparts.

Although the previous results show a diversity of still wine market segments, the literature related show that there is not a market segmentation study for fortified wine, particularly for the Port wine. Therefore, the present study looks at distinct market segments of a special wine, fortified wine, taking Port wine as a reference.

Distinctly from still wines, the consumption of fortified wine is usually linked to a specific occasion, and therefore high frequency and large quantity consumed are scarce. Yormirzoev (2016) investigated the factors influencing fortified wine consumption in Russia and found that men have a higher propensity to consume fortified wine than women, due to its high alcohol content. Based on a focus group analysis, Silva and Rebelo (2019) highlighted promotion, product adaptation to the market and focus in innovation, as the three main areas to boost Port wine sales.

3. Survey Design and Descriptive Statistics

A questionnaire was defined to collect information about socio-demographics, drinking habits, purchasing behaviour, and self-assessed knowledge about Port wine, as shown in Table 1.

Table 1 - Variables used in the questionnaire, shortened terms, and categories.

Original Variables	*Shortened Term*	*Categories*
Do you have Port wine at home?	Home	Yes No
Place of purchase	Purchase	Retail stores Speciality stores No type of outlet in particular
Factors influencing purchasing decision	Price Quality Design Prestige	Price Quality Design (label/bottle) Prestige
Mode of consumption	Mode	Alone With partner and/or family Friends and/or colleagues No occasion in particular
Consumption occasion	Occasion	Between meals During meals No time in particular
Frequency of consumption	Consumption	Occasional consumption: once a year Infrequent consumption: at least twice a year Frequent consumption: at least once per month Very frequent consumption: several times a month
Price willing to pay per bottle	WTP	Less than €10 €10–€20 €20–€50 €50–€100 More than 100€
Oenological knowledge	Knowledge	No knowledge Poor Moderate Considerable Very considerable
Type of Port wine typically consumed	Category	Standard Special No type in particular

The survey was digitally applied between January and September 2016 to obtain a random sample and to reach as many consumers as possible with different socio-economic characteristics such as age, gender, socio-professional field and living place. Specifically the questionnaire has been put online within the framework of a website whose address was subsequently disseminated within different networks (both institutional and private), using a snowball effect perspective. Thus, a random sample was gathered, with 678 Portuguese respondents aged 18-86, with a mean age of 47 (61% men), who came from every Portuguese regions, North (62%), Centre (26%), South (2,5%), and Madeira or the Azores (9%). The majority (83.4%) of the respondents are employed, 8.5% are retired, 3.4% are unemployed, and 4.8% are students.[2]

Concerning purchasing and consumption habits, almost all respondents (97%) said that they have Port wine at home. The purchase place was not specified by 50%, whereas 33% prefer to shop in retail stores and 17% in specialty stores. The main choice criterion is the perceived quality of Port wine (70%), followed by price (40%). The vast majority (78%) is willing to pay between €10 and €50 for a bottle of wine and nearly 50% could be designated as infrequent consumers. In general, Port wine is consumed at dinnertime (89%) with friends and relatives (63%). The majority (80% of respondents) consume any type of Port wine, and only 4.4% stated that they consumed special categories.

4. Methods and Results

4.1. *Bivariate Statistical Analysis*

As mentioned in the literature review, the gender and age of consumers are commonly used for clustering in the wine market. Subsequently, a chi-square test of independence was applied to evaluate whether the behaviour of purchasing and consumption of Port wine is associated with gender or age. Results are summarized in Table 2.

Table 2. Chi-square test of independence.

Variables (shortened term)	*Independent Variables*	
	Gender p values	*Age p values*
Purchase	0.821	<0.001***
Design	0.407	<0.005**
WTP	0.748	<0.001***
Mode	0.007**	n.s.
Consumption	<0.001***	0.459
Knowledge	<0.001***	<0.001***
Category	0.239	0.006**

*Notes: * significant relationships p≤0.05; ** significant relationships p≤0.01; *** significant relationships p≤0.001.*

Results indicate significant associations between age and the following covariates: place of purchase, design of label/bottle, price willing to pay per bottle, oenological knowledge, and type of Port typically consumed. With regard to gender, significant associations were found for occasion of consumption, frequency of consumption, and oenological knowledge.

In line with other studies (Bruwer *et al*., 2002; Cohen *et al.*, 2009; Duarte *et al.*, 2010; Nunes *et al*., 2016; Silva *et al.*, 2014), age showed itself to be a determining factor of consumer motivation and attitudes. In the present study, it may provide a useful variable for clustering the Port wine market.

4.2. *Segmenting the Port wine market*

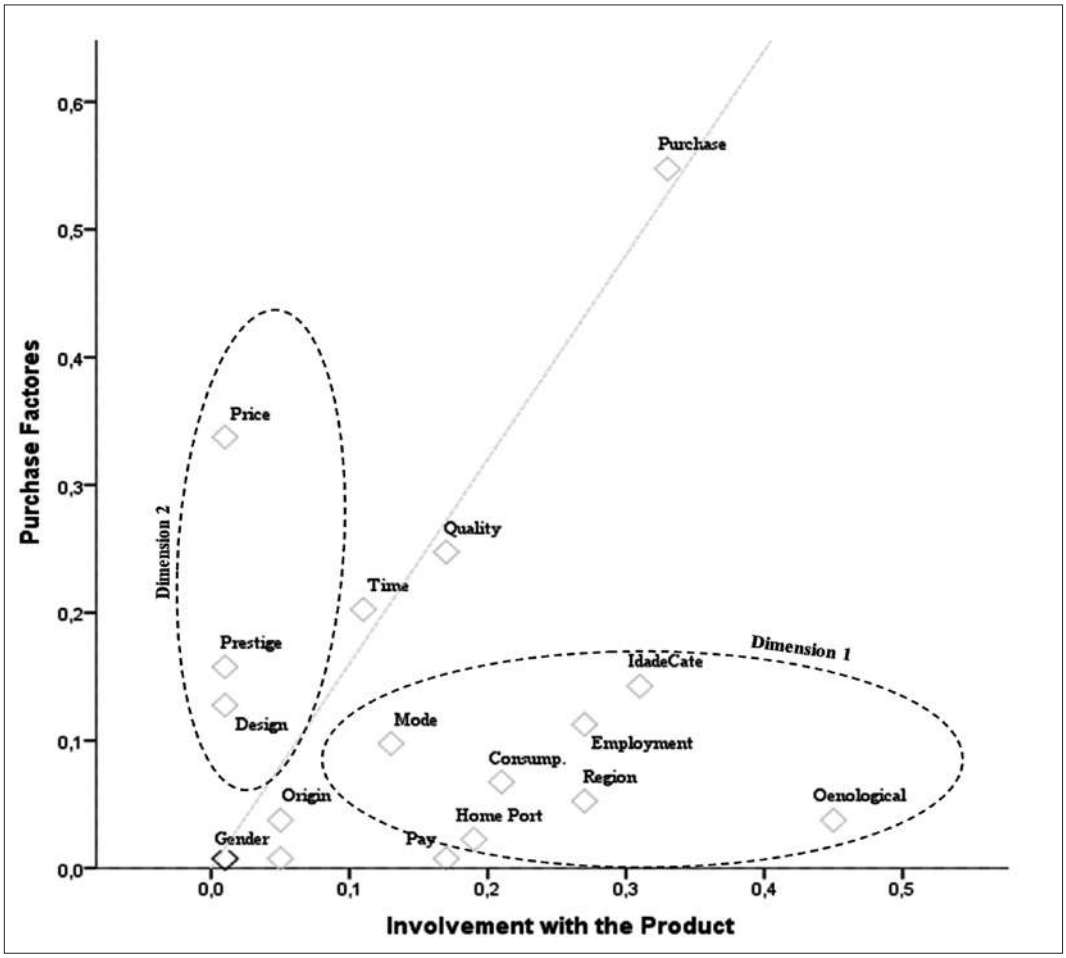
Multivariate techniques, such as multiple correspondence analysis and cluster analysis, were used to identify consumer segments based on consumers' behaviour towards Port wine. These techniques take into account the existence of

[2] Comparing our sample with the national population demographics, there is only a slight difference between the proportion of men (61%, against 47%) and a slight over-representation of residents in the North (62%, against 35%). Given that men are the largest consumers of wine (in quantitative terms) and that Port wine is produced in the North, it may have led to these groups being more willing to complete the survey. The age structure of our sample (according to the ranges presented in Table 4) is similar to that of the Portuguese population aged from 18-86.

multiple factors that are relevant for the analysis of behaviour and the qualitative nature of the majority of the independent variables gathered in the survey (Carvalho, 2008: 25).

A multiple correspondence analysis (MCA)[3] was applied to detect the relationships between socio-demographics and behavioural covariates (i.e., to identify the space of the consumer's social position). Seventeen dimensions were initially specified, but the Cronbach alpha results and associated eigenvalues suggested two dimensions (explaining 30% of the total variance) should be retained.[4] Using only the variables that distinguish these two dimensions most clearly, Figure 1 depicts these dimensions along two axes.

Figure 1 - Discrimination traits for the space of purchase and consumption.



[3] As a data reduction technique, MCA transforms the number of original variables into a smaller set of variables, the uncorrelated dimensions, which retain as much as possible of the information from the original variables. Simultaneously, the MCA transforms the categories of variables into numerical values through optimal scaling levels, maintaining the order and/or the distance of the original variables (Carvalho, 2008: 30). The dimensions have metric properties of quantitative variables that enable the use of a cluster analysis, forming homogeneous segments or groups that share common characteristics.

[4] The values of the Cronbach alphas for two dimensions are 0.708 and 0.585, respectively, indicating a satisfactory consistency in the two dimensions (Marôco, 2014: 459).

The first dimension represents the association between the following categories: age, region, type of Port wine consumed, the presence of Port wine at home, oenological knowledge, and the price the consumer is willing to pay per bottle. The second dimension summarizes the association between the categories that explains the motives/attitudes underpinning the purchase of Port wine (price, design, and prestige). One can thus designate Dimension 1 as 'involvement with the product' and Dimension 2 as 'purchase-related factors'.

Based on the scores (individual) in the two dimensions identified via MCA, a cluster analysis (k-means method) was performed, the results of which are presented in Table 3.

Cluster 1, which includes 41% of the respondents, presents positive values and a small difference between the two dimensions. Cluster 2, with 48% of the respondents, displays negative values and a higher value for purchase-related factors. Cluster 3, with 12% of the respondents, presents higher values for involvement with the product.

Table 3 - Cluster centre identification.

Dimension	*Cluster 1*	*Cluster 2*	*Cluster 3*
Involvement with the product	0.63	-0.03	-1.99
Purchase-related factors	0.68	-0.84	0.91
% of respondents	40.7	47.5	11.8

A bivariate analysis, including cross-tabulation with chi-square statistics, was used to characterize each cluster in terms of its corresponding sociodemographic characteristics and consumer behaviour (Table 4).

Cluster 1 is overwhelmingly constituted of men (78%) over 45 years of age (62%), employed (92%), and resident in the north of Portugal (76%). All individuals of Cluster 1 affirmed that they habitually had Port wine at home and

Table 4 - Cluster profiling: sociodemographic characterization and purchase/consumption behaviour.

Relative Frequency	*Total Sample N=678*	*Cluster 1*	*Cluster 2*	*Cluster 3*	*p values*
Gender					
Female	39%	22%	52%	48%	<0.001***
Male	61%	78%	48%	52%	
Age					
18-24	7%	1%	1%	51%	<0.001***
25-34	14%	18%	8%	31%	
35-44	16%	19%	14%	8%	
≥ 45	63%	62%	77%	10%	
Region of residence					
North	62%	76%	61%	18%	<0.001***
Centre	26%	17%	25%	65%	
South	3%	2%	2%	5%	
Madeira or the Azores	9%	5%	12%	13%	
Employment situation					
Employed	83%	92%	86%	41%	<0.001***
Students	5%	0%	0%	39%	
Retired	9%	6%	13%	0%	
Unemployed	3%	2%	1%	20%	
Presence of Port wine at home					
Yes	97%	100%	99%	76%	<0.001***
No	3%	0%	1%	24%	
Purchase-influencing factors[1]					
Design (label/bottle)	3%	12%	2%	24%	<0.001***

→

Relative Frequency	*Total Sample N=678*	*Cluster 1*	*Cluster 2*	*Cluster 3*	*p values*
Price	16%	49%	26%	64%	<0.001***
Quality	24%	83%	63%	56%	<0.001***
Prestige	57%	45%	20%	45%	<0.001***
Place of purchase					
Retail stores	46%	21%	38%	54%	<0.001***
Specialty stores	25%	25%	15%	1%	
No outlet in particular	29%	44%	26%	31%	
No answer		9%	21%	14%	
Price willing to pay per bottle					
Less than €10	14%	6%	16%	23%	<0.001***
€10-€20	45%	35%	56%	53%	
€20-€50	31%	45%	24%	21%	
€50-€100	8%	8%	4%	3%	
More than €100	2%	6%	1%	1%	
Frequency of consumption					
Occasional consumption	10%	2%	26%	20%	<0.001***
Infrequent consumption	31%	29%	62%	55%	
Frequent consumption	53%	54%	10%	20%	
Very frequent consumption	6%	16%	3%	5%	
Occasion of consumption					
Alone	20%	38%	7%	14%	<0.001***
With partner and/or family	64%	56%	71%	58%	
Friends and/or colleagues	15%	6%	20%	28%	
No occasion in particular	1%	0%	2%	0%	
Type of Port wine					
Standard	8%	2%	20%	45%	<0.001***
Special	47%	9%	2%	0%	
No type in particular	45%	89%	78%	55%	
Oenological knowledge					
No knowledge	6%	1%	8%	18%	<0.001***
Poor	30%	29%	34%	66%	
Moderate	45%	58%	57%	15%	
Considerable	13%	48%	1%	3%	
Very considerable	6%	21%	0%	0%	
CLUSTER ATTRIBUTION		**Experienced**	**Less experienced**	**Inexperienced**	

Notes:
[1] Refers to all answers of each cluster.
** significant relationships p≤0.05; ** significant relationships p≤0.01; *** significant relationships p≤0.001.*

considered quality as the factor that most influences their purchasing decisions. Concerning the buying and consumption habits of those in Cluster 1, it was confirmed that 44% were indifferent to where they purchased, while 25% preferred specialist stores. Members of the cluster were willing to pay €20-€50 per bottle and evaluated their consumption of Port wine as 'frequent'. The majority consumes with their partner and/or family, but there are still individuals who prefer to drink alone (38%). More than half of the individuals in Cluster 1 are not attached to the consumption of a specific type, but their knowledge of wine is good. Moreover, those preferring

special categories of Port wine are to be found almost entirely in Cluster 1. The same is true for the level of oenological knowledge, where Cluster 1 encompasses most of the consumers with high knowledge and who are willing to pay more for a bottle of Port wine.

Cluster 2 is mainly constituted (52%) of women above 45 years old. They live mostly in the north of Portugal and, as a rule, are employed. Similar to Cluster 1, consumers in Cluster 2 also stated that they habitually had Port wine available at home and that the quality factor determined purchasing choices. However, in contrast, purchasers in Cluster 2 opted to buy wine at retail stores, and were infrequent consumers willing to pay €10-€20 per bottle. Members of Cluster 2 clearly prefer to drink Port wine with their partner and/or friends, are largely indifferent to the type of Port wine they consume, and have a poor to moderate knowledge of wine. Comparing consumers from Clusters 1 and 2, the latter are willing to pay a lower price, and have a lower frequency of consumption and lower oenological knowledge.

Finally, Cluster 3 comprises mainly young people between 18 and 34 years of age, who work or study. As distinct from the other clusters, the consumers in Cluster 3 do not habitually have Port wine at home, and price rather than quality is the main factor in their buying decisions. They prefer to purchase in retail stores with a price per bottle of €10-€20 (i.e., the price they are willing to pay is lower). Their Port wine consumption is predominantly classified as infrequent and occurs essentially with their partner and/or family and/or friends. Regarding the type of wine consumed, the individuals in Cluster 3 opt for standard categories, in contrast with the other two clusters. The last cluster is characterized by individuals who have no or only poor oenological knowledge.

In summary, and comparing the clusters according to buying and consumption behaviour regarding Port wine, Cluster 1 is mainly made up of males with higher consumption of Port wine, who are willing to pay over €20 for a bottle of Port wine, and for whom quality is the determining factor when choosing a wine to purchase. These respondents possess a high level of oenological knowledge and prefer consuming alone, especially if the wine is from a special category. Cluster 2 is very similar to Cluster 1, but males do not predominate, and purchases in retail stores are preferred at a price of up to €10. These individuals have weak oenological knowledge. Contrariwise, Cluster 3 is constituted by occasional or less-frequent consumers who choose to consume the standard category among friends and family. This segment is characterized by individuals with a low level of oenological knowledge, with weak involvement with the product, and for whom price acts as the determining factor in the purchase decision. In recognition of these distinct consumption patterns, the three clusters were named as follows: Cluster 1 – experienced consumers; Cluster 2 – less experienced consumers; and Cluster 3 – inexperienced consumers. These results are in line with Silva and Rebelo (2019), based on a focus group approach. Young consumers and our group of inexperienced consumers have a similar behaviour of purchasing and consuming Port wine.

Comparing our results with the main findings of other research on still wine market segmentation (Table 5) some common features arise (e.g. Thomas and Pickering, 2003; Duarte *et al.*, 2010; Di Vita *et al.*, 2014, Kelley *et al.*, 2015). All of these studies identified a group who drinks wine regularly and is driven by wine knowledge. A group of individuals designated as inexperienced drinkers was also found in the above-mentioned studies; this segment of consumers is characterized by younger individuals under 34 years old, who associate higher prices to higher quality. Finally, there is a group of less experienced consumers, mostly of women, who drink wine occasionally, with low wine knowledge.

5. Conclusion

The wine industry presents a typical market structure of monopolistic competition. From the demand side it is characterized by a huge diversity of consumers with specific cultural backgrounds, and different purchasing habits, behaviour, and preferences. Consequently, an efficient marketing strategy requires a proper market segmentation. Typically, the research carried out has been focused on still wine and not on other wine's typology, such as fortified wines, in which Port wine has a dominant position (Gouveia and Macedo,

Table 5 - Port wine segmentation and evidences on still wine.

Main common features	*Previous still wine market segmentation*				*Port wine market segmentation*
	Thomas and Pickering (2003, New Zealand)	*Duarte et al. (2010, Portugal)*	*Di Vita et al. (2014, Italy)*	*Kelley et al. (2015, US)*	*present study*
• Highly knowledgeable • Regular consumers • Willing to pay more per a wine bottle • Mostly men • Consumers older	Heavy wine purchase	Enthusiast wine drinkers	High quality demanding purchases	Super core drink	Experienced consumers
• Moderate knowledgeable • Infrequent consumers • Consumers concerned with the social aspects of wine drinking • Mainly women	Medium wine purchase	Infrequent wine drinkers	Occasional consumers	Core drink	Less experienced consumers
• Poor or no knowledgeable • Occasional consumers • Consume at social occasions • The choice is dependent price • Young consumers	Light wine purchase	Convivial wine drinkers	Basic consumers	Marginal drink	Inexperienced consumers

2018). Moreover, the literature review shows that the market segmentation is heterogeneous, according to the variables considered in the survey and the profile of the respondents.

This paper contributes to a better knowledge of wine consumers' behaviour, taking as target the Port wine Portuguese consumers. To achieve this goal and supported in the literature review, a random sample online survey was implemented and focused on issues related to socio-economic profile, oenological knowledge, purchasing and consumption taking decision. Applying multivariate statistical techniques, three distinct profiles of Portuguese Port consumers were identified: (1) Experienced Consumers, (2) Less Experienced Consumers, and (3) the Inexperienced Consumers. The market segmentation reveals that Port consumers are grouped according to their involvement with the product, the occasion when consumption takes place and the price that they are willing to pay. Age and gender are the most distinctive socio-economic covariates. The Experienced Group consumes Port wine very frequently and comprises mostly men with a high degree of involvement with the product. By contrast, the Inexperienced Group consists largely of young, price-driven consumers who drink standard categories of Port with friends. The Less Experienced Group includes mostly women, occasional consumers with little or no knowledge of wine, who drink Port on special occasions, accompanied by their partner and/or family members.

From an academic perspective, this paper contributes to improve knowledge on segmenting wine market. Distinctly from the majority of wine segmentation studies research, which

applied clustering techniques according to behavioural and sociodemographic variables, we applied multivariate statistical techniques, matching multiple correspondence analysis with a cluster analysis. As managerial implications, it also provides useful results for the design and development of strategic plans in the wine industry, both at the collective, institutional, and business level. Specifically, for Port wine, the results point out to the development of a market viewpoint that would be able to identify detailed information on the profile, habits and attitudes of consumers. Through the dissemination of this information by wineries, they may adapt their marketing mix elements on specific market segments, including: i) the product; ii) the collective promotion or advertising (under the Port wine umbrella) and individual (firm brands); iii) and the distribution channels. For example, the results show that if the aim is to sell higher priced wines, firms should focus on the most knowledgeable and older consumers, while if the aim is to sell more, the target segment should be the young people, offering them a fashionable drink when compared with other alcoholic beverages, such as whisky, gin or vodka.

Additionally, the market for Port wine has an opportunity to grow, by promoting the product involvement of the Less Experienced Consumers, though, for example, actions that enhance their interest and oenological knowledge, which in turn would increase both the frequency of Port wine consumption and their willingness to pay higher prices per bottle. Given the growing number of female oenologists, wine critics, and vineyard entrepreneurs, it would be valuable to conduct research into Portuguese women's perceptions with a view to developing marketing strategies to counteract what appears to be their relative indifference to the distinctive 'identities' of different wines.

As usual, this work has also limitations, namely linked to the sample selection and data collection. The sample is random, but only covers the Portuguese consumers. So, in order to solve this drawback, the survey should be extended and applied to other markets and to non-Port wine-consumers, both national and foreign, driving a better understanding of the present and potential market. Thus, future research should overcome these drawbacks and should be interesting to apply approaches, such as focus-group, discrete choice experiments or even preferences revealed in a real context.

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Notes

Exploring the nexus between pandemics and natural capital: COVID-19 and other zoonoses

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The COVID-19 pandemic has had a wide impact on our lives (Hakovirta and Denuwara, 2020) and is going to have further direct and indirect impacts on our 'common home'. Besides justified renewed attention to human health and to reinforce the sanitary systems, reasonable worries are developing around the impact of the pandemic on food systems[1] and on possible solutions to be enacted for counteracting the effect of present and future emergencies and ensuring access to food to human population worldwide. After 2007-08 and 2010-11 economic crises, our globalized economic system has been once again set on the edge of a deep crisis. In this context, a debate is arising on the main factors at the base of the spread of pandemics and misleading concepts/interpretations are more and more at the centre of media attention. Such misleading information could drive current mainstream opinion in a direction that can further impair the natural capital, increasing risk for new pandemic outbreaks and further ingenerating unbalance in food access.

Natural Capital and COVID-19

In the frame of the COVID-19 pandemic scenario, a wide and hot debate is going on, trying to explain and to find out where the pandemic came from and what are the causes of its occurrence. The discussion develops around two main points: a) whether the pandemic spread and spillover started because of habitat destruction (WWF, 2020; Lugassy *et al.*, 2019) or b) because of a too intensive and unregulated proximity between wildlife and humans in urban centres (Mariutti, 2020).

As matter of fact, zoonoses and spillover (Thompson, 2013) are not new phenomena and are more likely to occur when the contacts between humans and wildlife/animals are more frequent. Most of the epidemics affecting humans (e.g. Ebola, AIDS, SARS, avian influenza, swine flu) come from animals and so far we know from researchers that the current pandemic most probably originated from bats sold live and slaughtered in Chinese markets (Benvenuto *et al.*, 2020).

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[1] IPES-Food, 2020. *COVID-19 and the crisis in food systems: Symptoms, causes, and potential solutions*. Communiqué by IPES-Food, April 2020. Available at: http://www.ipes-food.org/_img/upload/files/COVID-19_CommuniqueEN.pdf.

The hypothesis are: a) the zoonosis comes as a direct consequence of the high density of wild animal species with no sanitary control in highly anthropised contexts (e.g. cities, urban centres, markets), where traditional dietary models persist in urban contexts characterized by high human density; b) the zoonosis comes from more frequent contacts between wild animals and human population resulting as a direct consequence of the loss of natural habitats and of the disruption of living environments or niches where wild animals live.

In the first case sustainable hunting and supply chain tracking and strict sanitary control can be the best way to decrease the risk; while in the second case urgent actions should be devoted to conserve natural capital and entail the restoration of the ecological niches and habitats. Both the hypothesis appear correct and possible, then the real question is: "Which of these actions requires priority and immediate attention because is at the real core of the recovery?"

There are some elements that require further attention: Food crisis and difficult or no access to food increases the consumption of bushmeat in many countries, and also to an increase of often illegal cross border trade due to low prices of such meat and the mixing of species typical of markets increases the probability of emergence of new viruses able to infect new species, including humans, starting from urban markets where authorities in charge for control are not able to monitor the health safety status of people and wild animals. On the other hand, the continued loss of habitats and their disruption, lead different species of wild animals to live closer to each other, in non-healthy conditions and increases the possibility for spillover (Kilpatrick and Randolph, 2012; Lambin *et al.*, 2010; Morse *et al.*, 2012).

For more, when it comes to pandemics another element to be considered is the speed of spreading of the disease, i.e. the factor at the base of the transition from epidemic to pandemic. People density, goods and people movement around the globe facilitated the quick spreading of the disease avoiding or contrasting the possibility of the virus of adapting to its new host – the human. The speed of diffusion is important because in nature a balance exists between the virus and the host species aimed to maximize its survival and its ability to multiply; as matter of fact the death of the host for a virus means the death of the virus itself, then an adaptation mechanism between viruses and hosts allow both to survive; but the emergence of such adaptation mechanism after the spillover requires some time. The high level of contacts between people coming from all over the world was a weak point that greatly facilitated the spread of the disease before the adaptation could occur; emergency measures essentially aimed to decrease the intensity of contacts between people slowing down the spreading.

The fallouts of distance measures included a prompt response from natural capital. After the lockdown, the quality of air and the quality of marine water, in some measure, improved; some neighbouring animal species ranged out invading 'our' urban centres. Nature is trying to regain space, but beside the wonder, in front of such manifestations, there is a growing feeling of fear because the zoonosis originated from contacts between wild animals and humans, and people are starting to overestimate the risk of a closer contact with animals and nature; people are perceiving the presence of wild animals as a concrete risk, directly connecting the idea of pandemic risk with nature.

Beside, this pandemic will negatively affect our natural capital also in other ways; the increase of attention and efforts devoted to face challenges (present and future) that may

derive from pandemics, can dilute the efforts in protecting and conserving natural capital. For instance, a renewed attention will be paid to reinforcing health systems worldwide but no or little consideration is devoted to the impact that this might have on environment as widely justified by the emergency and responsible of a high level of CO_2 equivalents (Eckelman *et al.*, 2018). The lockdown led to a decrease of GHG emissions worldwide but all activities are re-starting to the business-as-usual level.

The recovery beyond the emergency

In facing the emergency, the lockdown and social distancing measures are necessary in order to slow down the transmission of a virus until a new balance is achieved and human fatality rate decreases.

To face zoonoses, the health sector needs to be reinforced either to face the emergencies or to enact correct surveillance; monitoring systems need to be enhanced to avoid impact of present or future diseases and to avoid enforcement of new lockdown measures and their devastating economic impact.

Short term solutions to decrease the risk of pandemics should actually include both possibilities: safety control of market, contrast to illegal trade of wild bushmeat and also agriculture that is fundamental to feed the growing global population as well as to support development all over the world. Plants are the foundation of life on earth, they are the first trophic level, are a primary source of matter and provide food for our planet, this poses agriculture at the "human-animal-ecosystem interface" and, as such, it is increasingly impacted by the evolution and emergence of pathogens, not only those affecting humans, representing global risks.

The world, even before the COVID-19 pandemic, has been facing a number of challenges that threaten food security and the society's wellbeing; climate change [increase of 2°C global average temperature by 2060 – (IPCC[2])], biodiversity loss (loss of 10-15% by 2050) and depletion of natural resources [exceeded double by 2050 in respect to 'planetary boundaries' – International Resource Panel[3]], put pressure on the food availability and increase the risk of outbreaks of new pests and pathogens as a consequence of both global changes and the way food is produced, handled and consumed. Human population displacements – due to economic, political and humanitarian crises – represent another set of potential drivers for emerging issues (Richardson *et al.*, 2016).

Solutions are needed that could match in the meantime the facing of the emergency and the caring for natural capital. Emergency measures to contrast epidemics are necessary but should be applied in a transitory way, while long-term solutions aiming to reinforce the health system, to change the food system model and to protect natural capital and ecosystems are to be acted urgently.

[2] IPCC, 2018. Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Geneva, Switzerland: World Meteorological Organization.

[3] International Resource Panel, 2019. *Global Resources Outlook 2019: Natural Resources for the Future We Want*. A Report of the International Resource Panel, United Nations Environment Programme (UNEP), Nairobi (Kenya). https://www.resourcepanel.org/file/1172/download?token=muaePxOQ.

In this context, the One Health approach[4] started some years ago by the World Health Organization (WHO) and encompassing, *inter alia*, food safety, control of zoonoses, combatting antibiotic resistance, could help enacting preventive measures on the base of a robust long-term outlook; to be really effective it should be strengthened and reinforced by including the whole agriculture sector and informing the whole food sector.

Agricultural systems of the future will cultivate with limited natural resources, face new pests and diseases derived from climate change effects and unbalanced environment, while, at the same time, struggling to reduce GHG emissions and increase crops productivity with no access to additional agricultural land.

There is a need to focus on the relationship between agriculture, food system and nature to ensure adequate access to food, a challenge that was clearly evident during the pandemic emergency. This calls for a new approach able to match productivity with the possibility to produce in more sustainable way by relying on the support provided by ecosystems through pest and disease regulation, and by other ecosystem services[5] – such as carbon sequestration, climate regulation, flood and erosion control, water purification – that enable production to be achieved with reduced inputs and environmental impact.

Ecosystem services are goods or services provided by ecosystems that could be either directly or indirectly enjoyed, consumed, or used by humans. Natural capital, ecosystems are in charge of delivering all the ecosystem services and, among others, the ability to regulate pest and diseases. Pest and diseases occur quite often even when balance and proper functioning of natural systems are in place, but the very quick spreading of this epidemic and its transition to a pandemic indicate that the mechanism of pest and diseases regulation exerted by natural capital and ecosystems is not working anymore and this is one of the key messages we should learn from this pandemic. The solution is not in investigating or taking positions by choosing to blame the disruptive effect of human action or by fighting against nature, the solution can only be in an adaptive process to be enacted quickly and that operates on development models, which should ensure the provision of the whole set of ecosystem services but most of all could guarantee the self-supporting ability of ecosystems and natural capital to perpetuate themselves.

To achieve proper insight transdisciplinary research is required to use concepts and methods deriving from various disciplines as basic tools to look for answers and solutions. This will help to overcome limitations deriving from compartmentalization of disciplines and will contribute to respond to questions arising from pressure exerted by global drivers of change. The transdisciplinary paradigm will be adequate to articulate different disciplines by constructing a solid support to expanded 'one health' approach, including a state of complex physical, chemical and biological processes between the nature-human-soil-plant-water and climate systems over time and space.

Key functions of the natural capital, self-support enabling ecosystems should be recovered and this is even more urgent in countries already facing though challenges coming

[4] WHO, 2017. *One Health*. https://www.who.int/news-room/q-a-detail/one-health; WHO, 2020. Food safety. https://www.who.int/health-topics/food-safety.

[5] CICES, 2020. *CICES - Towards a common classification of ecosystem services*. https://cices.eu; Haines-Young R., Potschin M.B., 2018. *Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure*. Available at: https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf.

from climate change. In this context, food system and ecosystem need to reconciled and a strong change of mind is needed to steer to transition and to do that in time so as to restore at least a bit the unbalance between nature asset/natural capital and anthropic activities.

The European Union's growth strategy named the European Green Deal[6] goes in the direction of a green and inclusive transition to help improving people's well-being and securing a healthy planet for the generations to come. This could be the opportunity to really start a change in our model of development, hoping that 'graduality' would not hamper reaching the final aim. In line with the European Green Deal, on the 20th of May 2020, the European Union issued the Biodiversity Strategy for 2030,[7] which focuses on natural capital, and, the same day, the EU Farm to Fork Strategy,[8] which focuses on the food system. All the three documents (viz. European Green Deal, Biodiversity Strategy for 2030, Farm to Fork Strategy) present a strong perspective of change in relation to Natural capital, Food System and, finally, the Development Model. They also conceptually integrate well with the One Health approach, which is a premise for cross-fertilization and transdisciplinary approach (Eggermont *et al.*, 2015) as well as nature-based solutions.[9]

Conclusions

Among the many questions arose in the pandemic era, the most pressing is about "how to prevent future zoonoses and to make our systems more resilient to pandemics without jeopardizing natural capital and ecosystems."

We need to raise awareness of the basic mechanisms that co-acted in determining the quick spreading of COVID-19 in order to adopt measures of containment, but also to enact long-term biodiversity-based solutions, because zoonoses as well as other diseases have higher probability to occur, develop and spread when our development model and natural capital conflict.

The clear, manifested intention to pursue the general aim of saving our 'common home' and our common future, is widely shared, at least apparently at EU level. At wider level though, things can go in a different way. Actually richer entities and countries may not be so available or feeling ambitious in reducing human impact and in protecting or restoring ecosystem and the provision of ecosystem services. Poorer countries are struggling on different fronts, that in the time of the COVID-19 pandemic resulted even more pressing, urging them to act in various directions that can be very different from the expectations

[6] European Commission, 2019. *What is the European Green Deal?* Available at: https://ec.europa.eu/commission/presscorner/api/files/attachment/859152/What_is_the_European_Green_Deal_en.pdf.pdf (accessed 13/06/2020); European Commission, 2020. *A European Green Deal - Striving to be the first climate-neutral continent*. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en; European Commission, 2020a. *Europe's moment: Repair and prepare for the next generation*. Available at: https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_20_940/IP_20_940_EN.pdf.

[7] European Commission, 2020b. *EU Biodiversity Strategy for 2030*. https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm.

[8] European Commission, 2020c. *Farm to Fork Strategy – for a fair, healthy and environmentally-friendly food system*. https://ec.europa.eu/food/farm2fork_en. The Farm to Fork Strategy is at the heart of healthy and environmentally friendly. The Farm to Fork Strategy aims to accelerate our transition, neutral or positive environmental impact.

[9] IUCN, 2020. *A Global Standard for Nature-based Solutions*. International Union for Conservation of Nature (IUCN). https://www.iucn.org/theme/ecosystem-management/our-work/a-global-standard-nature-based-solutions.

in terms of climate change mitigation/adaptation or ecosystem restoration. Without an integrated approach to mitigating the consequences of the disease emergence relating to environmental change, countries' abilities to achieve the Sustainable Development Goals (SDGs) and the Global Health Security Agenda (GHSA) targets will be compromised. This can lead, in turn, to a setback of the actions devoted to reduce the anthropic impact on natural resources thus increasing pressure on ecosystem that would further hamper the achievement or restoration of a balance between what we get from our 'common home' and what we leave to allow its perpetuation.

Furthermore, even at EU level, signals of a growing feeling of uneasiness in respect to wildlife and to nature are showing. Everybody knows that nature is to be preserved, but discussion on land sharing and land sparing is starting to buzz and risks hampering the implementation of long-term actions and measures across Europe or can be exploited by parts of European societies that do not really pursue a reduction of environmental impact right after the economic impact of restriction measures. However, the commitment of governments will be strongly supported, with multiple mechanisms, by the European Green Deal. This will further put pressure on global economies and extra-EU countries that will require support to overcome further economic barriers and market distortions. In this respect, there is a need for a 'system thinking' approach to translate solutions into socio-economic and policy frameworks in order to build a new resilience that is more widely distributed in this world, which goes with different speeds toward the future.

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