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The Effects of Environmental Risk on Consumption: an Empirical Analysis on the Mediterranean Countries*

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Abstract

This paper empirically estimates a micro-founded model which studies the macroeconomic impact of environmental and financial risks on consumption choices in the Mediterranean Region. The analysis is carried out using time series aggregate data for fourteen Mediterranean countries over the period 1965-2008. Our results indicate that both risks and their interaction significantly influence consumption dynamics. Our estimates of the indexes of relative risk aversion and relative prudence, as well as the relative preference for the quality of environment suggest marked cross-country heterogeneity.

JEL classification: Q50, D81, E21

Key words: consumption, environmental risk, financial risk, prudence, relative risk aversion, relative preference for the quality of environment.

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1 Introduction

As documented by a wide body of literature, uncertainty on environmental conditions and environmental risk are very important factors affecting the dynamics of several key macroeconomic variables.

From a growth theory perspective, Heal (1984) and Keeler et al. (2004) analyze the effects of uncertainty on future productivity changes due to pollution, while Soretz (2007) studies the impacts on output of uncertainty on the quality of environment. Ulph & Ulph (1997) and Pindyck (2000 and 2002) examine the optimal timing for environmental policies in a real option framework. Fan et al. (2010 and 2012) find that uncertainty and risk aversion have significant policy implications in terms of investment incentives. Baiardi & Menegatti (2011) demonstrate that different kinds of environmental uncertainty affect the size of public intervention.

A recent stream of theoretical research investigates how the presence of background risk, namely environmental risk, interacts with financial risk in consumption and saving decisions. In particular, Courbage & Rey (2007), Menegatti (2009a,b) and Denuit et al. (2011) examine consumption dynamics under different assumptions on size and the distribution of environmental and financial risks.

In the empirical literature which studies consumption dynamics, the traditional approach considers financial risk as isolated (See Dynan, 1992; Hahm & Steigerwald, 1999; Guariglia & Kim, 2003 and Menegatti, 2007; 2010). Baiardi et al. (2013) provide the first empirical analysis which combines financial risk with a measure of environmental risk. Their results support the conclusion that the interaction between financial and environmental risks significantly influences consumption.

In this paper we use a micro-founded model to investigate the macroeconomic effects of environmental risk, considered together with financial risk, in consumption and saving in countries in the Mediterranean area. With respect to the previous literature, the novelties of our paper are threefold.

First, the subject of our empirical analysis is countries which share a common and extremely interesting geographical location. In this respect, our paper is new, since it deals with fourteen Mediterranean (MED) countries (Albania, Algeria, Croatia, Cyprus, Greece, Egypt, Israel, Lebanon, Malta, Morocco, Portugal, Slovenia, Tunisia, Turkey) during the period 1965-2008. We deliberately exclude France, Italy and Spain from the group of analyzed countries, since they are likely to be characterized by a degree of environmental awareness significantly different from the other MED countries. Moreover, we believe that focus on the selected countries, especially the less advanced ones, is more interesting and informative, given the process of economic and cultural modernization which many are currently experiencing. Finally, our choice contributes to the innovative nature of this study, since, to the best of our knowledge, few papers in the empirical literature on environmental economics specifically deal with these countries, and none of them tackles the issue of investigating the impacts of environmental risk on consumption for these economies.[1]

Beside their geographical proximity, the MED countries are characterized by a long history of cooperation on environmental conservation initiatives (Kagiannas et al., 2003; Gürlük, 2009). Many international projects involving the MED countries have been approved to foster environmental protection, reduce air and water pollution and facilitate the diffusion of renewable resources. Among them, it is worth noting the 'Initiative Horizon 2020' (EU, 2006), a comprehensive environmental strategy aimed at reducing industrial and urban pollution, implementing environmental laws and developing deeper knowledge about the environment. Other initiatives are the Mediterranean Strategy for Sustainable Development (MSSD, 2005) and the International Augmented Med (IAM, 2012), whose purpose is to reduce the gap between developed and developing countries in the region. Some projects, such as the European Neighborhood Policy (ENP, 2004) and the Mediterranean Action Plan (UNEP/MAP, 2004), are instead related to preservation of the Mediterranean Sea. More important, a new and increasing attention toward the role of environmental risks is acknowledged. This recent attitude is demonstrated by different projects, such as European Mediterranean Sea Acidification (MedSeA, 2011) in a changing climate, which aims to assess the effects of different kinds of uncertainty related to Mediterranean acidification at organismal, ecosystem and economical levels.

Second, our paper provides readers with fresh empirical evidence on the indexes of relative risk aversion and relative prudence, and on the relative preference for the quality of environment for each MED country. Such measures of countries general attitude towards the environment are particularly relevant for the MED economies, since they are strongly heterogeneous in terms of economic development, social and cultural features and environmental conditions. Moreover, a significant number of the major MED countries are currently experiencing profound economic and social instabilities, which will probably renew interest in how different sources of uncertainty impact on economic choices. Therefore, an assessment of the country-specific attitude towards environmental risk, coupled with a quantification of a country's relative preference for the quality of environment, conveys crucial information which should be at the basis of any attempt to understand the differences across countries in the MED region, and any attempt to implement policy and environmental reforms in individual countries.

Third, our approach is radically different from virtually all the studies published so far on environmental and energy economics issues related to the MED region. Our paper for example is innovative compared to more traditional studies which examine the potential of international projects in the MED area (see, among others, Kagiannas et al., 2003; Karakosta et al., 2010; Reiche, 2010; Karakosta & Psarras, 2013), and compared to the literature focusing on more specific topics, such as the implementation of renewable resources (Jacobson & Delucchi, 2010; Komendantova et al., 2012;

[1] See Baiardi et al. (2013) for a similar analysis carried out on a number of OECD countries, including France, Italy and Spain.

Jablonski et al., 2012; Cambini & Fanzi, 2013) or the impact of energy consumption on the environment (Arouri et al., 2012).

The paper is organized as follows. Section 2 illustrates the theoretical model and its econometric specification. The dataset is described in Section 3. Section 4 discusses the main empirical results. The indexes of relative risk aversion and of relative prudence, together with the relative preference for the quality of environment, are presented for each country in Section 5. Section 6 concludes.

2 The Theoretical Model and the Estimated Equations

We describe consumer's preferences at time t in a multiperiod framework, using a two-argument utility function $U(C_t, E_t)$, where C_t is consumption and E_t is the environment quality level. We assume that the level of E_t is given for the agent (see Smulders & Gradus, 1996 and Ayong Le Kama & Schubert, 2004). We also assume that $U(C_t, E_t)$ is increasing and concave with respect to each of its arguments, that is: $U_c(C_t, E_t) > 0$, $U_e(C_t, E_t) > 0$, $U_{cc}(C_t, E_t) < 0$ and $U_{ee}(C_t, E_t) < 0$, where $U_c(C_t, E_t) \equiv \partial U/\partial c$, $U_e(C_t, E_t) \equiv \partial^2 U/\partial e$, $U_{cc}(C_t, E_t) \equiv \partial^2 U/\partial c^2$ and $U_{ee}(C_t, E_t) \equiv \hat{2}\partial U/\partial e^2$. Similarly, we define the third derivatives of the utility function as: $U_{ccc}(C_t, E_t) \equiv \partial^3 U/\partial c^3$, $U_{cce}(C_t, E_t) \equiv \partial^3 U/\partial c^2 \partial e$ and $U_{cee}(C_t, E_t) \equiv \partial^3 U/\partial c \partial e^2$. Conditions $U_{cc}(C_t, E_t) < 0$ and $U_{ee}(C_t, E_t) < 0$ are particularly important, since they indicate aversion toward risk on consumption and aversion toward risk on the quality of the environment, respectively.

We then extend the univariate framework of Carroll (1992, 1997) by means of the bivariate intertemporal consumption model:

$$\max_{C_t} \mathbb{E} \sum_{t=0}^{T} \beta^t U(C_t, E_t) \tag{1}$$

$$W_{t+1} = (1 + r)(W_t + Y_t - C_t)$$

where Y is income, W is net wealth, r is the constant interest rate, $R = 1 + r$ is the interest factor, δ is the subjective intertemporal discount rate, and $\beta = 1/(1 + \delta)$ is the subjective intertemporal discount factor.

Problem (1) is solved by maximizing the Lagrangian:

$$L = \mathbb{E} \sum_{t=0}^{T} \beta^t [U(C_t, E_t) - \lambda_t (W_{t+1} - R(W_t + Y_t - C_t))].$$

The first-order conditions are:

$$\frac{\partial L}{\partial C_t} = \beta^t \left[U_c(C_t, E_t) - R\lambda_t\right] = 0, \tag{2}$$

$$\frac{\partial L}{\partial W_{t+1}} = -\beta^t \lambda_t + \beta^{t+1} R \mathbb{E}[\lambda_{t+1}] = 0, \tag{3}$$

$$\frac{\partial L}{\partial \lambda_t} = W_{t+1} - R(W_t + Y_t - C_t) = 0. \tag{4}$$

Combining first–order conditions (2) and (3), we obtain Euler's equation:

$$\beta R \mathbb{E}[U_c(C_{t+1}, E_{t+1})] = U_c(C_t, E_t). \tag{5}$$

Following DYNAN (1993), we substitute a second-order Taylor approximation of $U_c(C_t, E_t)$ into the left-hand side of condition (5), obtaining the condition:

$$\frac{\mathbb{E}(C_{t+1} - C_t)}{C_t} = \frac{1 - \beta R}{\beta R} \frac{U_c}{C_t U_{cc}} - \mathbb{E}[(E_{t+1} - E_t)] \frac{U_{ce}}{C_t U_{cc}} - \frac{1}{2} \mathbb{E}[(C_{t+1} - C_t)^2] \frac{U_{ccc}}{C_t U_{cc}}$$
$$- \frac{1}{2} \mathbb{E}[(E_{t+1} - E_t)^2] \frac{U_{cee}}{C_t U_{cc}} - \mathbb{E}[(C_{t+1} - C_t)(E_{t+1} - E_t)] \frac{U_{cce}}{C_t U_{cc}}. \tag{6}$$

The environmental quality level E_t is difficult to measure directly. In the environmental literature, CO_2 emissions are generally considered as an appropriate proxy of environmental quality (see, among others, FRIEDL & GETZNER, 2003; FODHA & ZAGHDOUD, 2010 and WANG, 2012). In this paper, we assume $E_t = P_t^{-1}$, that is the level of environmental quality is a decreasing function of the level of pollution P_t. Along the lines suggested by SMULDERS & GRADUS (1996), AYONG LE KAMA & SCHUBERT (2004) and BAIARDI ET AL. (2013), we consider the two-argument Constant Relative Risk Aversion (CRRA) utility function:

$$U(C_t, P_t) = \frac{C_t^{1-\gamma} P_t^{-\phi(1-\gamma)} - 1}{1 - \gamma} \tag{7}$$

where $\gamma > 0$ and $\phi > 0$ are the parameters of interest. Parameter γ represents the index of relative risk aversion ($-\frac{U_{cc} C_t}{U_c}$), while the index of relative prudence ($-\frac{U_{ccc} C_t}{U_{cc}}$) is equal to $1 + \gamma$. Note that $\gamma > 0$ ensures risk aversion towards uncertainty on consumption (i.e. $U_{cc} < 0$). On the other hand, parameter $\phi = \frac{U_e E_t}{U_c C_t}$ '[...] *represents relative preference for environmental quality* [...]' [see AYONG LE KAMA & SCHUBERT (2004), p. 34].

Given Specification (7) and since $E_t = P_t^{-1}$, risk aversion towards the environmental quality requires:

$$U_{ee} = \phi[\phi(1 - \gamma) - 1] C_t^{1-\gamma} E_t^{-\phi(1-\gamma)-2} = \phi[\phi(1 - \gamma) - 1] C_t^{1-\gamma} P_t^{-\phi(1-\gamma)+2} < 0. \tag{8}$$

Using Specification (7), Equation (6) can be re-written as:

$$\Delta log(C_{t+1}) = \alpha_0 + \alpha_1 \Delta log(P_{t+1}) + \alpha_2 Var_t[\Delta log(C_{t+1})] +$$

$$+ \alpha_3 Var_t[\Delta log(P_{t+1})] + \alpha_4 Cov_t[\Delta log(C_{t+1}), \Delta log(P_{t+1})] + u_{t+1}. \quad (9)$$

where

$$\alpha_0 = \frac{r-\delta}{(1+r)\gamma}, \quad (10)$$

$$\alpha_1 = -\frac{\phi(1-\gamma)}{\gamma}, \quad (11)$$

$$\alpha_2 = \frac{(1+\gamma)}{2}, \quad (12)$$

$$\alpha_3 = \frac{\phi(1-\gamma)[\phi(1-\gamma)+1]}{2\gamma}, \quad (13)$$

$$\alpha_4 = \phi(1-\gamma) \quad (14)$$

From Conditions (11) and (12), we obtain that:

$$\gamma = 2\alpha_2 - 1 \quad (15)$$

and

$$\phi = \frac{-\alpha_1\gamma}{(1-\gamma)}. \quad (16)$$

Moreover, combining Equation (14) with Equation (15), Condition (11) can be re-written as:

$$\alpha_1 = \frac{-\alpha_4}{2\alpha_2 - 1} \quad (17)$$

and, similarly, from Equations (11), (13) and (14), we obtain that:

$$\alpha_3 = -\frac{1}{2}\alpha_1[\alpha_4 + 1]. \quad (18)$$

It is worth noting that Coefficient α_1 introduces the direct effect of pollution on consumption choices, while Coefficient α_2 indicates the effect on consumption of financial risk. Coefficient α_3 shows the influence on consumption of uncertainty about environmental conditions, while the covariance between the two risks, related to Coefficient α_4, describes the interaction between environmental risk and financial risk. Note that our assumptions have implications for the signs of these parameters. In particular, the assumption $\gamma > 0$ ensures $\alpha_2 > 0$, while condition (8) implies that $\alpha_4 < 1$.

On the other hand, our theoretical model does not impose any priori assumptions about the sign of the Coefficients α_1 and α_3. In order to have some theoretical indications about the sign of the Coefficient α_3, it is necessary to introduce an additional condition which is specifically related to the utility function specified by Equation (7). In this respect, our model assumes aversion towards uncertainty on environmental quality ($U_{ee} < 0$), while Equation (7) introduces an indirect measure of the environmental quality E_t

based on pollution P_t. Since the relationship between E_t and P_t is decreasing, although not linear, by assumption, $U_{ee} < 0$ does not guarantee that $U_{pp} < 0$. Therefore, an additional condition, which indicates aversion toward uncertainty on the level of pollution, is required:

$$U_{pp} = \phi[\phi(1-\gamma)+1]C_t^{1-\gamma}P_t^{-\phi(1-\gamma)-2} < 0. \tag{19}$$

Condition (19) implies $\alpha_3 > 0$. In other words, by introducing the assumption of aversion toward uncertainty on the level of pollution, we obtain a sign restriction on α_3, which must be positive.

3 The Data

Two different kinds of uncertainty are considered in Equation (9): an environmental risk, measured by the variance of the pollution rate of growth ($VARP_t$), and a financial risk, similarly computed as the variance of consumption growth ($VARC_t$). Following Dynan (1993) and Guariglia & Kim (2003), $VARC_t$ and $VARP_t$ are computed, at each year t, on the basis of observations on the previous five years. We use growth rate of CO_2 emissions as a proxy of environmental pollution, as is usual in environmental economics literature. (See, among others Friedl & Getzner, 2003; Fodha & Zaghdoud, 2010; Wang, 2012).

Our empirical analysis is focused on the MED countries. In particular, we consider the following fourteen countries: Albania, Algeria, Croatia, Cyprus, Egypt, Greece, Israel, Lebanon, Malta, Morocco, Portugal, Slovenia, Tunisia and Turkey, organized in three distinct groups according to their geographical position along the MED Sea (Gürkük, 2009): Euro–MED (Albania, Croatia, Greece, Malta, Portugal and Slovenia), Euro–Asian–MED (Cyprus, Israel, Lebanon and Turkey), African–MED (Algeria, Egypt, Morocco and Tunisia).

The variables considered in our analysis are annual aggregate per capita CO_2 emissions (metrics tons) and annual aggregate per capita consumption (i.e. aggregate household final consumption expenditure, measured in constant 2000 USD). Data are collected from the World Bank Development Indicators (2013).

Table 1 shows the periods of data availability (in general, from 1960 to 2008) for each country. Table 1 also presents the World Bank classification of each country based on per capita Gross National Income (GNI). According to this classification, Egypt and Morocco are the only Lower Middle Income (LMI) countries in our sample, while Albania, Algeria, Lebanon and Turkey are Upper Middle Income (UMI) countries. Finally, Croatia, Cyprus, Greece, Israel, Malta, Portugal and Slovenia are classified as High Income (HI) countries.[2]

[2]According to the World Bank classification, Lower Middle Income (LMI) countries have a per capita GNI between 1,036USD and 4,085USD, Upper Middle Income (UMI) have a per capita GNI between 4,086USD to 12,615USD, and High Income (HI) countries have a per capita GNI equal or greater than

In the empirical analysis, c_t, p_t and y_t are the logarithmic transformation of consumption, CO_2 emissions and GDP, respectively. C_t, P_t and Y_t indicate the first differences of c_t, p_t and y_t, that is the growth rates of consumption, CO_2 emissions and GDP, respectively. The variance of C_t and the variance of P_t are labeled as $VARC_t$ and $VARP_t$, while $COVCP_t$ is the covariance between C_t and P_t. Finally, $COVYP_t$ and $VARY_t$ are the covariance between P_t and Y_t and the variance of Y_t. The variance of Y_t is computed following the same procedure used for calculating $VARC_t$ and $VARP_t$.

Table 1 about here

The data descriptive statistic are summarized in Table 1. Albania is the only country with an average negative consumption rate of growth (-0.44 per cent). Algeria and Lebanon show the lowest consumption growth rates (0.32 per cent and 0.26 per cent respectively). On the other hand, C_t is on average particularly high in HI countries, especially Cyprus (2.18 per cent), Malta (1.85 per cent) and Slovenia (1.80 per cent). Similarly, Malta, Croatia and Slovenia are the countries with the highest GDP growth rate (1.92 per cent, 1.86 per cent and 1.77 per cent respectively), while Algeria, Albania and Morocco exhibit the lowest level of GDP rate of growth (0.48 per cent, 0.82 per cent and 0.89 per cent respectively). With regard to variable P_t, Israel is the only country with a sizable, negative pollution growth rate (-2.14 per cent) in the period spanned by our data. The growth rate of pollution is also particularly low in Lebanon and Albania (0.25 per cent and 0.60 per cent). The highest increment in pollution are recorded in Greece and in all the African–MED countries.

The correlation coefficients among the eight variables analyzed for each country show the existence of a positive correlation between C_t and $VARC_t$, with the exception of Albania, Croatia and Greece for the Euro–MED countries, Israel for the Euro–Asian–MED countries, and Algeria and Morocco among the African–MED countries. Similarly, the correlation between C_t and $VARP_t$ is positive, with the exception of Malta and Portugal among the European–MED countries and Egypt, Morocco and Tunisia among the African–MED countries. Finally, the KPSS unit-root test statistic (Kwiatkowski et al. 1992) indicates the presence of a unit-root (i.e. non-stationary behavior) for consumption, pollution and GDP in all countries, with the exception of p_t and y_t in Albania and of c_t in Lebanon.[3]

4 Empirical Results

The estimated version of Equation (9) is:

$$C_t = \alpha_0 + \alpha_1 P_t + \alpha_2 VARC_t + \alpha_3 VARP_t + \alpha_4 COVCP_t + u_t \tag{20}$$

12,616USD.

[3]In order to save space, the correlation matrices and the KPSS unit-root test statistics are available from the authors on request.

where the non-linear relations (17) and (18) are imposed on the parameters α_1, α_2, α_3 and α_4. In order to take into account problems related to endogeneity, possible biases due to omitted variables and measurement errors which potentially affect CO_2 emission and consumption data (as noted by Carroll, 1997), Equation (20) is estimated with the Generalized Method of Moments (GMM). In this last respect, since $VARC_t$ is a potentially endogenous variable (see Carroll 1992, Hahm & Steigerwald 1999 and Menegatti, 2007, 2010; Baiardi et al., 2013), lagged values of Y_t, $VARC_t$ and $VARY_t$ are used as instruments. The potential endogeneity of $VARP_t$, P_t and $COVCP_t$ is treated by instrumenting the first two variables with their lagged values, while $COVCP_t$ is instrumented with its own lagged values and the lagged values of $COVYP_t$. Coefficient estimates are obtained using Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors.

Tables 2, 3 and 4 about here

Tables 2, 3 and 4 show the results for each group of countries. The J-statistic in Tables 2, 3 and 4 indicates that the null hypothesis of valid over-identifying restrictions is not rejected in all countries, while residual autocorrelation and heteroskedasticity do not in general affect the estimated equations.[4] The null hypothesis of residual normal distribution is not rejected by the Jarque–Bera test in most of the countries, with Malta, Portugal and Cyprus as the only exceptions among Euro–MED and Euro–Asian MED countries, and Egypt and Morocco among African–MED countries.

Coefficient α_2 analyzes the effects of financial risk on consumption and saving choices. In line with economic theory, we find that this coefficient is always positive and highly statistically significant (at 1 or 5 per cent significance level) in all the three groups of countries, with the sole exception of Morocco. This result validates the hypothesis that financial risk raises precautionary saving in a context where environmental risk is also considered.[5]

Coefficient α_3 captures the direct effect of environmental risk on consumption and saving. This parameter is positive, as expected, and statistically significant in half the Euro–MED countries (Croatia, Portugal and Slovenia) and Euro–Asian–MED countries

[4]There are specific cases of serial correlation and heteroskedasticity in the residuals in Algeria, Cyprus, Greece, Malta and Portugal. Albania and Egypt show some serial correlation problems in the error term, while heterosckedasticity affects estimation results for Egypt, Morocco and Tunisia. Carroll (1992) states that the presence of serial correlation supports the buffer stock saving hypothesis.

[5]Traditional literature does not consider environmental risk explicitly, whereas the precautionary saving hypothesis is only indirectly identified with the introduction of the saving rate as the dependent variable in the estimated equations, instead of the consumption rate of growth (see for example Hahm & Steigerwald, 1999 and Menegatti, 2007, 2010). Different reasons, such as alternative assumptions about the utility function, which may not be a CRRA, consumer impatience (Carroll, 1992) and gradual adjustment of saving or changes in the degree of income uncertainty, have been put forward to justify the traditional approach.

(Cyprus and Israel). Conversely, α_3 is not significant in three out of four of the African–MED countries, and actually negative in the case of Tunisia. These results indicate that a direct effect of environmental risk on consumption appears in our data, although the effect clearly emerges only in a subgroup of Euro-MED and Euro–Asian–MED countries, and is not as clear in the African-MED countries.

Coefficient α_4 is related to the covariance between environmental and financial risks. It is highly significant and less than 1 in almost all the countries analyzed, as required by the theoretical constraint of our model.[6] This result shows that the interaction between financial and environmental risks is relevant in determining consumption growth. This conclusion, together with previous findings on coefficient α_3, suggests that the influence of environmental risk on consumption is more indirect, i.e. through its interaction with financial risk, than direct.

Our model does not predetermine the sign of coefficient α_1. In general, the results indicate that pollution influences consumption choices. Specifically, environmental degradation tends either to reinforce consumption (α_1 positive and statistically significant) in the case of the Euro–MED countries (Albania and Malta are the exceptions), or to counteract consumption (α_1 negative and statistically significant) in the case of the Euro–Asian MED countries (Turkey is the only exception). A less clear conclusion can be drawn for the African countries, where coefficient α_1 is not significant in three cases out of four, with the only exception of Tunisia.

To conclude, we find that all the coefficients have the expected sign in Croatia, Portugal and Slovenia among the Euro–MED countries, and in Cyprus and Israel among the Euro–Asian MED countries. Promising results are also obtained in the case of Greece, Turkey and Tunisia. The African–MED countries are generally characterized by less clear–cut evidence: the variables which proxy financial risk and the interaction between environmental and financial risks (whose coefficients are $\alpha_2 > 0$ and $\alpha_4 < 1$, respectively) exhibit the expected marginal effects on consumption (with the only exception of Morocco), while the evidence of the influence of environmental risk on consumption (measured by coefficient α_3) is less robust.

5 Estimates of Risk Aversion and Prudence

The results shown in Tables 2, 3 and 4 allow us to derive estimates for the parameters γ and ϕ in the utility function (7). Table 5 reports the estimated parameters γ and ϕ, together with the indexes of partial relative risk aversion and partial relative prudence for the three groups of countries. The two indexes directly depend on the magnitude of the parameter γ, since they equal to $-\frac{U_{cc}C_t}{U_c} = \gamma$ and $-\frac{U_{ccc}C_t}{U_{cc}} = 1 + \gamma$, respectively. According to Gollier (2003), if the utility function is a CRRA, plausible values of the relative risk aversion index (and, consequently, of γ) vary from 1 to 4.

[6] Wald test statistics confirm that the estimated values of α_4 satisfy the condition $\alpha_4 < 1$.

Table 5 about here

In general, we find that the presence of two sources of uncertainty provides reasonable estimates for the parameter γ. Our results confirm the conclusions reached by BAIARDI ET AL. (2013), who interpret the omission of relevant sources of uncertainty, such as environmental risk, as the main cause of the implausible estimates of the relative risk aversion index based on financial risk only (DYNAN, 1993).

More specifically, we find that the parameter γ varies from 0.94 to 2.31 among the Euro–MED countries. The most risk averse countries in this group are Croatia (2.31) and Greece (2.28), while the less risk averse are Portugal and Malta, where the parameter is fairly low, but not significantly different from 1 (0.94 and 0.98 respectively).[7]

The Euro–Asian MED countries show the highest variability in this parameter, which assumes values ranging from 0.78 to 2.85. In this group Lebanon and Turkey are the most risk-averse countries (2.85 and 2.11 respectively), while Cyprus is the least risk averse country (0.78). The estimated parameter obtained for Israel is too high, at least according to the literature.

Focusing on the African–MED countries, we note that Egypt is the only country with plausible value of the parameter γ, which is equal to 3.03. For Algeria and Tunisia, γ is positive as expected, but shows values which are too low, and inconsistent with the theoretical indications provided by GOLLIER (2003). In the case of Morocco, this parameter is actually negative. These results may be due to certain characteristics of these countries. In particular, the literature shows the significant role which may be played in these countries by additional kinds of uncertainty, such as political risk (See, among the others, AL KHATTAB ET AL., 2008; KOMENDANTOVA ET AL., 2012). Furthermore, our results may be influenced by personal remittances, which are a significant source of funds in North Africa (World Bank Development Indicators, 2013).[8] When personal remittances are high, consumption choices may be affected by the variability of income in foreign countries, and not only by the variance of domestic income.

Considering all the MED countries together, our estimates imply that Egypt is the most risk-averse country (3.03), followed by Lebanon (2.85), Croatia (2.31) and Greece (2.28). The least risk averse countries are Cyprus, Portugal and Malta (0.78, 0.94 and 0.98, respectively). Excluding the implausible estimates obtained for Israel among the Euro–Asian MED group and for African–MED countries (as already noted, Egypt is the only exception), we find that Euro–MED countries are less risk averse (relative risk aversion is

[7]The value 1 is within the 95 per cent confidence interval.

[8]According to the World Bank classification, personal remittances are computed by considering personal transfers and compensation of employees. The first element consist of all current transfers (in cash or in other nature) between resident and nonresident individuals, while the second element refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities. Remittances account for 6.97 per cent of total GDP in Morocco (the only country in our sample where the parameter γ is negative), 5.96 per cent in Egypt and 4.04 per cent in Tunisia.

on average equal to 1.60) than Euro–Asian MED countries (γ, on average, is equal to 1.91). Moreover, given that the relative prudence index is equal to $\gamma + 1$, the estimates for this index are between 1.78 and 4.03. These results suggest a stronger precautionary saving motive in Egypt, Lebanon, Greece, Croatia and Turkey, an intermediate motivation level for Albania and Slovenia, and the weakest motivation in Cyprus, Portugal and Malta.

Finally, Table 5 proposes the estimates of parameter ϕ, which, according to AYONG LE KAMA & SCHUBERT (2004), measures the relative preference of agents for environmental quality. As expected, this parameter shows positive values. Israel, Lebanon and Tunisia are the only exceptions, since this parameter is negative, although very close to zero. If we exclude countries with a negative value of ϕ, the Euro–MED and the Euro–Asian MED groups prove to be environmentally aware (with preference towards the environment, on average, equal to 2.21 and 2.26, respectively). The opposite holds for African–MED countries, where ϕ is near to zero. This confirms the low level of attention given to the environmental conservation in the African–MED region identified by other papers (M'HENNI, 2005; GÜRLÜK, 2009; FODHA & ZAGHDOUD, 2010; AROURI ET AL., 2012).[9] This conclusion may also explain the low effect of environmental risk on consumption measured by the parameter α_3, as discussed in the previous section.

6 Conclusions

This paper investigated the effects of environmental and financial risks on consumption dynamics in the MED area. In particular, we analyzed fourteen countries (Albania, Algeria, Croatia, Cyprus, Egypt, Greece, Israel, Lebanon, Malta, Morocco, Portugal, Slovenia, Tunisia and Turkey) over the period 1965-2008.

Our results show a positive and statistically significant influence of financial risk on the growth rate of consumption in all countries, with Morocco as the only exception. Our estimates confirm the key role of the interaction between environmental and financial risks on consumption. We also find evidence of a direct influence of environmental risk on consumption choices, although the results are less clear–cut when considering the less developed MED economies.

We estimated some indexes of agent's attitude toward risks, such as the relative risk aversion and the relative prudence indexes, and an index measuring the relative preference towards the quality of environment. The results indicate that Euro–MED are the least risk averse countries, while the most risk averse are Euro–Asian MED countries. Moreover, both groups of countries show a great attention to the level of environmental quality.

On the other hand, very low values are obtained in the African-MED subregion for both the relative risk aversion and the relative prudence indexes, as well as for the relative preference toward environmental quality. We argue that a possible explanation for these

[9]As noted by REICHE (2010), consistent strategies to improve environmental awareness have not yet been implemented in the area.

findings may be related to the presence of additional important sources of uncertainty in the North-African MED area, and to the role of remittances. The introduction of these effects into our theoretical model is on our future research agenda.

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Table 1: Descriptive statistics: MED Countries

		Mean	Max	Min	Std. Dev.	Jarque–Bera
Euro-MED Countries						
Albania (UMI)	C_t	-0.44	4.64	-10.09	2.92	4.50 (0.10)
1990-2008	P_t	-0.60	23.32	-27.57	9.68	6.36 (0.04)
Croatia (HI nonOECD)	C_t	1.64	4.12	-2.01	1.53	1.52 (0.47)
1995-2008	P_t	1.11	3.84	-1.92	1.83	0.90 (0.63)
Greece (HI OECD)	C_t	1.51	4.27	-0.86	1.26	0.75 (0.68)
1960-2008	P_t	1.85	10.77	-3.59	2.76	0.72 (0.69)
Malta (HI nonOECD)	C_t	1.85	8.47	-1.07	1.88	0.96 (0.62)
1970-2008	P_t	1.19	13.59	-18.19	6.07	12.93 (0.00)
Portugal (HI OECD)	C_t	1.46	10.48	-2.06	2.11	0.22 (0.89)
1960-2008	P_t	1.58	9.70	-4.48	2.66	0.99 (0.61)
Slovenia (HI OECD)	C_t	1.80	5.82	0.21	1.37	1.55 (0.45)
1992-2008	P_t	0.73	11.02	-6.59	3.53	11.39 (0.00)
Euro-Asian MED countries						
Cyprus (HI nonOECD)	C_t	2.18	8.69	-3.11	2.29	0.80 (0.67)
1997-2008	P_t	1.26	8.98	-3.15	2.43	0.25 (0.88)
Israel (HI OECD)	C_t	0.81	2.57	-0.85	0.94	0.07 (0.96)
1995-2008	P_t	-2.14	5.57	-25.98	7.59	58.25 (0.00)
	C_t	0.26	3.87	-3.33	1.81	0.02 (0.98)
Lebanon (UMI)	P_t	0.25	4.79	-7.19	3.46	1.40 (0.50)
1994-2008	Y_t	0.85	3.52	-1.71	1.41	75.72 (0.00)
Turkey (UMI)	C_t	1.06	4.60	-3.59	2.19	1.68 (0.43)
1987-2008	P_t	0.95	3.63	-5.20	2.36	3.64 (0.17)
African-MED countries						
Algeria (UMI)	C_t	0.32	24.01	-12.77	5.39	17.92 (0.00)
1960-2008	P_t	1.57	16.83	-17.04	7.22	0.35 (0.84)
Egypt (LMI)	C_t	1.18	5.31	-1.10	1.36	0.70 (0.70)
1973-2008	P_t	1.78	8.85	-5.96	3.02	0.66 (0.72)
Morocco (LMI)	C_t	0.75	4.33	-3.65	2.00	0.80 (0.67)
1960-2008	P_t	1.43	9.74	-10.03	3.34	0.82 (0.66)
Tunisia (UMI)	C_t	1.33	5.48	-3.48	1.84	0.43 (0.80)
1962-2008	P_t	1.63	14.20	-5.83	3.21	0.25 (0.88)

Notes: C_t and P_t are the first differences of the logarithm of the level of consumption and CO_2 emissions, respectively; Jarque-Bera tests the null hypothesis of normal distribution (p-values in parentheses); According to the World Bank classification of the world's economies based on estimates of per capita Gross National Income (GNI), Lower Middle Income (LMI) countries have a per capita GNI between 1,036USD and 4,085USD, Upper Middle Income (UMI) countries have a per capita GNI 4,086USD to 12,615USD, High Income (HI) countries have a per capita GNI equal to or greater than 12,616USD.

Table 2: Euro–MED Countries: GMM estimation of the regression model (20) with restrictions (17) and (18)

	Albania	**Croatia**	**Greece**	**Malta**	**Portugal**	**Slovenia**
α_0	-13.92	-20.51	-0.41	0.03	-1.60	0.16
	(22.12)	(1.67)***	(0.12)***	(0.10)	(0.16)***	(0.09)
α_2	1.32	1.65	1.64	0.99	0.97	1.22
	(0.46)**	(0.02)***	(0.10)***	(0.06)***	(0.03)***	(0.04)***
α_4	-0.18	-6.45	-0.94	0.01	0.24	-1.34
	(0.25)	(0.23)***	(0.06)***	(0.00)**	(0.01)***	(0.01)***
Indirect estimation						
α_1	0.11	2.80	0.41	-0.01	-0.26	0.93
	(0.26)	(0.08)***	(0.03)***	(0.00)	(0.01)***	(0.04)***
α_3	-0.05	7.62	-0.01	0.00	0.16	0.16
	(0.07)	(0.53)***	(0.01)	(0.00)	(0.00)***	(0.00)***
S.E. of regression	2.55	4.51	1.58	2.51	4.08	1.51
Durbin Watson stat	0.66	0.80	1.16	0.68	1.04	1.32
Sum squared resid	5846.95	81.49	87.70	169.96	632.18	16.01
Diagnostics						
J-statistic	3.21	2.76	11.46	8.58	8.94	4.28
Degrees of freedom	5	3	29	23	15	5
p-value	0.67	0.43	0.99	0.99	0.88	0.51
Residual serial correlation						
Q-statistic	29.99	0.39	44.16	54.02	8.82	0.78
p-value	0.08	0.53	0.04	0.02	0.00	0.37
White test for heteroskedasticity						
Obs*R-squared	11.27	9.00	27.46	29.33	24.26	9.98
p-value	0.19	0.34	0.00	0.00	0.00	0.26
Normality test						
Jarque-Bera	0.70	0.68	0.00	23.98	8.43	0.06
p-value	0.70	0.67	0.99	0.00	0.00	0.96

Notes: All variables are expressed in log-differences; asymptotic standard errors are reported in brackets; A *(**)[***] indicates significance at 10(5)[1] per cent level; a Wald test supports the conclusion that the coefficient α_4 is smaller than one, as imposed by the theoretical restriction of the model; the J-statistic tests the validity of the over-identifying restrictions when the number of instruments is larger than the number of estimated parameters; the Q-Statistic at lag k tests the null hypothesis of no residual serial correlation up to order k, $k = 1, ..., 10$; to save space, the Q-statistic and the corresponding p-value reported in the table are for $k = 1$; the White statistic is a test of the null hypothesis of no heteroskedasticity against heteroskedasticity of some unknown general form; the Jarque-Bera statistic tests the null hypothesis that the standardized residuals are normally distributed; the estimated coefficient covariance matrix is weighted with Kernel Bartlett Bandwidth Fixed without prewhitening for Albania and Croatia and with Kernel Bartlett Bandwidth Fixed with prewhitening for Portugal; Kernel Quadratic Bandwidth Andrews (with prewhitening) and Kernel Bartlett Bandwidth Andrews (without prewhitening) are used for Greece and Slovenia respectively; Instruments (I) for each country are: Albania I=[constant, C_{t-1}, $COVCP_{t-1}$, P_{t-1}, $VARC_{t-1}$, $VARP_{t-1}$, Y_{t-1}]; Croatia I=[constant, $COVCP_{t-1}$, $COVPY_{t-1}$, $VARC_{t-1}$, $VARY_{t-1}$, Y_{t-1}]; Greece I=[constant, C_{t-1}, $COVCP_{t-i}$, $COVPY_{t-i}$, P_{t-i}, $VARC_{t-i}$, $VARP_{t-i}$, Y_{t-i}, for $i = 1, ..., 5$]; Malta I=[constant, C_{t-1}, $COVCP_{t-i}$, $COVPY_{t-i}$, P_{t-i}, $VARC_{t-j}$, $VARP_{t-i}$, Y_{t-k}, for $i = 1, ..., 3$, $j = 1, ..., 4$, $k = 1, ..., 5$]; Portugal I=[constant, C_{t-i}, $COVCP_{t-i}$, $COVPY_{t-i}$, P_{t-i}, $VARC_{t-i}$, $VARP_{t-i}$, $VARY_{t-i}$, Y_{t-i}, for $i = 1, 2$]; Slovenia I=[constant, $COVCP_{t-1}$, $COVPY_{t-1}$, P_{t-1}, $VARC_{t-1}$, $VARP_{t-1}$, $VARY_{t-1}$, Y_{t-1}].

Table 3: Euro–Asian MED countries: GMM estimation of the regression model (20) with restrictions (17) and (18)

	Cyprus	**Israel**	**Lebanon**	**Turkey**
α_0	-2.16	-4.02	-4.27	-4.12
	(0.55)***	(0.00)***	(1.02)***	(0.33)***
α_2	0.89	4.33	1.93	1.55
	(0.01)***	(0.00)***	(0.23)***	(0.10)***
α_4	0.72	0.41	0.15	-1.35
	(0.08)***	(0.00)***	(0.14)	(0.19)***
Indirect estimation				
α_1	-0.92	-0.05	-0.05	0.64
	(0.13)***	(0.00)***	(0.04)	(0.04)***
α_3	0.79	0.04	0.03	0.11
	(0.15)***	(0.00)***	(0.03)	(0.07)
S.E. of regression	5.05	1.53	3.05	2.34
Durbin Watson stat	0.78	1.01	0.79	0.95
Sum squared resid	612.94	2.35	46.54	49.30
Diagnostics				
J-statistic	3.97	2.99	5.72	4.09
Degrees of freedom	5	35	5	27
p-value	0.55	1.00	0.33	0.99
Residual serial correlation				
Q-statistic	54.68	0.06	0.02	13.46
p-value	0.02	0.80	0.88	0.25
White test for heteroskedasticity				
Obs*R-squared	7.01	9.00	7.69	11.65
p-value	0.00	0.34	0.46	0.17
Normality test				
Jarque-Bera	5.93	0.96	1.00	0.76
p-value	0.05	0.62	0.60	0.68

Notes: See Table 2; the estimated coefficient covariance matrix is weighted with Kernel Quadratic Bandwidth Andrews (with prewhitening) for Lebanon and Israel and with Kernel Bartlett Bandwidth Andrews (without prewhitening) for Cyprus; Kernel Bartlett Bandwidt Variable Newey-West (1) with Prewhitening is used for Turkey; Instruments (I) for each country are: Cyprus I=[constant, COVCP_{t-1}, COVCY_{t-1}, P_{t-1}, VARC_{t-1}, VARP_{t-1}, Y_{t-1}]; Israel I=[constant, COVCP_{t-i}, COVPY_{t-i}, P_{t-i}, VARC_{t-i}, VARP_{t-i}, VARY_{t-i}, Y_{t-j}, for $i = 1, ..., 4$, $j = 1, ..., 5$]; Lebanon I=[constant, COVCP_{t-1}, COVPY_{t-1}, P_{t-1}, VARC_{t-1}, VARP_{t-1}, VARY_{t-1}, Y_{t-1}]; Turkey I=[constant, COVCP_{t-i}, COVPY_{t-i}, P_{t-i}, VARC_{t-i}, VARP_{t-i}, VARY_{t-i}, Y_{t-j}, for $i = 1, ..., 4$, $j = 1, ..., 5$].

Table 4: African–MED countries: GMM estimation of the regression model (20) with restrictions (17) and (18)

	Algeria	**Egypt**	**Morocco**	**Tunisia**
α_0	-0.16	0.85	2.27	1.53
	(0.40)	(0.28)***	(0.38)***	(0.01)***
α_2	0.60	2.02	-0.48	0.57
	(0.11)***	(0.60)***	(0.10)***	(0.00)***
α_4	0.00	-0.08	0.15	-0.03
	(0.00)	(0.04)*	(0.04)***	(0.00)***
Indirect estimation				
α_1	-0.00	0.03	0.08	0.18
	(0.00)	(0.02)	(0.02)	(0.00)***
α_3	0.00	-0.01	-0.04	-0.09
	(0.00)	(0.00)	(0.01)	(0.00)***
S.E. of regression	5.15	1.50	2.71	1.75
Durbin Watson stat	0.32	0.27	1.67	1.28
Sum squared resid	530.93	42.78	265.57	117.99
Diagnostics				
J-statistic	5.89	8.40	9.91	8.56
Degrees of freedom	14	10	10	22
p-value	0.97	0.59	0.45	0.99
Residual serial correlation				
Q-statistic	12.77	91.56	0.11	0.09
p-value	0.00	0.00	0.74	0.76
White test for heteroskedasticity				
Obs*R-squared	1.63	16.01	16.38	21.71
p-value	0.04	0.04	0.03	0.00
Normality test				
Jarque-Bera	2.65	15.71	21.85	2.22
p-value	0.26	0.05	0.00	0.92

Notes: See Table 2; the estimated coefficient covariance matrix is weighted with Kernel Bartlett Bandwidth Fixed without prewhitening for Algeria; Kernel Quadratic Bandwidth Andrews (with prewhitening) and Kernel Bartlett Bandwidth Andrews (without prewhitening) are used for Morocco and Egypt respectively; Kernel Bartlett Bandwidt Variable Newey-West (1) without Prewhitening is used for Tunisia; Instruments (I) for each country are: Algeria I=[constant, C_{t-i}, $COVCP_{t-i}$, $VARC_{t-i}$, Y_{t-j}, for $i = 1, ..., 4$]; Egypt I=[constant, $VARC_{t-i}$, Y_{t-i} for $i = 1, , 6$]; Morocco I=[constant, $COVPY_{t-i}$, $VARY_{t-i}$, Y_{t-i}, for $i = 1, ..., 4$]; Tunisia I=[constant, $COVCP_{t-i}$, $COVPY_{t-i}$, P_{t-i}, $VARC_{t-i}$, $VARP_{t-i}$, $VARY_{t-i}$, Y_{t-i}, for $i = 1, ..., 4$].

Table 5: Estimation of relative risk aversion, relative prudence and relative preference of environmental quality

	γ	ϕ	Relative risk aversion	Relative prudence
Euro-MED Countries				
Albania	1.64	0.28	1.64	2.64
	(0.93)	(0.78)		
Croatia	2.31	4.94	2.31	3.31
	(0.03)	(0.13)		
Greece	2.28	0.73	2.28	3.28
	(0.19)	(0.09)		
Malta	0.98	0.38	0.98	1.98
	(0.12)	(2.34)		
Portugal	0.94	3.91	0.94	1.94
	(0.06)	(4.31)		
Slovenia	1.44	3.05	1.44	2.44
	(0.08)	(0.52)		
Euro-Asian MED countries				
Cyprus	0.78	3.30	0.78	1.78
	(0.03)	(0.07)		
Israel	7.66	-0.06	7.66	8.66
	(0.00)	(0.00)		
Lebanon	2.85	-0.08	2.85	3.85
	(0.45)	(0.06)		
Turkey	2.11	1.23	2.11	3.11
	(0.28)	(0.08)		
African-MED countries				
Algeria	0.21	0.00	0.21	1.21
	(0.22)	(0.00)		
Egypt	3.03	0.04	3.03	4.03
	(1.21)	(0.04)		
Morocco	-1.96	0.05	-1.96	-0.96
	(0.20)	(0.01)		
Tunisia	0.14	-0.03	0.14	1.14
	(0.01)	(0.00)		

Notes: Asymptotic standard errors are reported in brackets; The relative risk aversion index is equal to $-\frac{U_{cc}C_t}{U_c} = \gamma$; The relative prudence index is equal to $-\frac{U_{ccc}C_t}{U_{cc}} = 1 + \gamma$.