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Economy of Greece: An Evaluation of Real Sector

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The paper presents an evaluation of recent changes for real sector of Greek economy by an original vintage capital model with putty-clay technology. At a given capital intensity and a given depreciation rate they can evaluate age structure of production capacities by past real investments. External parameters can be determined by comparison of pairs of time series for each macroeconomic index: first calculated by the model and second took from data of its statistical analog. The identified parameters are used for calculation the production capacity dynamics of the immediate past and can be used for forecasts of the immediate future.

INTRODUCTION

Any critical situation in an economy is always reflected on real sector of the economy. Here it is considered the real sector of Greek economy impacted by the situation with external debt which is reflected in the distribution of its production capacities by age. The paper presents an evaluation for real sector of recent Greek economy by an original vintage capital model with putty-clay technology. In fact the model uses an age structure of production capacities instead of vintage capital. So the model can be called as a "vintage capacity model".

Production capacity is determined as a maximum of possible output in a year. Gross domestic product (GDP) of Greek economy at constant 2005 prices measured in US dollars is used here as the output. At a given capital intensity and a given depreciation rate they can evaluate age structure of production capacities by the past real investments. This two unknown parameters (the capital intensity, the depreciation rate) along with unknown parameters of a production function can be determined in an indirect way by comparison of pairs of time series for each macroeconomic index calculated by the model and taken from statistics.

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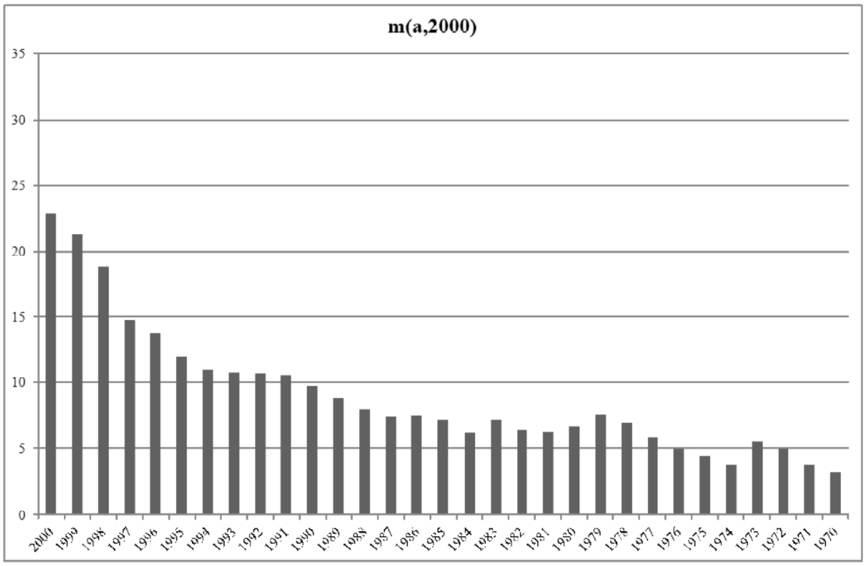

Figure 1: Distribution of production capacity in 2000 by age (vintage capacity) in constant prices of 2005, USD billions

Source: My own estimations for the model by data of National Accounts Main Aggregates Database

External parameters of the model obtained in the process of model identification are used here for calculation the production capacity dynamics for the immediate past of 1970-2014 and can be used for forecasts of the immediate future of 2016-2020. These evaluations can be used also to estimate required and feasible structural transformations of the Greek economy.

Methods of evaluation are based on a description of economic model for investment policy of firms in a market economy, presented in the works Olenev *et al*. (1986), Olenev and Pospelov (1986), Olenev and Pospelov (1989).

MODEL OF INVESTMENT POLICY OF FIRMS

The model of investment policy of firms in a market economy (Olenev *et al.*, 1986, Olenev and Pospelov, 1986, Olenev and Pospelov, 1989) was constructed in the end of 1980-s and it can be used here to analyze the structural changes in Greece.

Recall the basic definitions and hypotheses. Production capacity is defined as a maximum possible output in a given period of time. In the vintage capacity model each "firm" is determined by time of

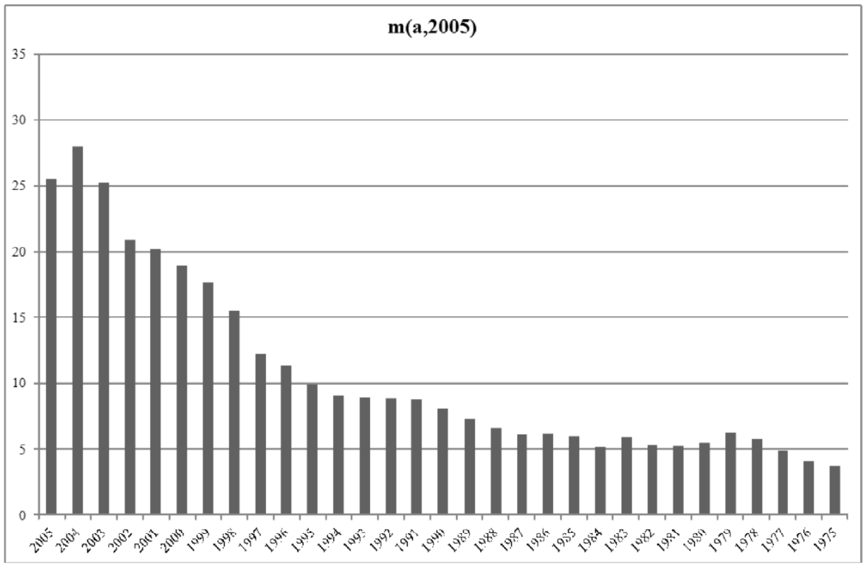

Figure 2: Vintage production capacity in 2005 in constant prices of 2005, USD billions

Source: My own estimations for the model by data of National Accounts Main Aggregates Database

creation and has a production capacity with unique value and productivity (putty-clay technology).

Production capacity $m(t, t)$ created in year t in this year t is determined by gross fixed capital formation $\Phi(t)$ divided on a coefficient $b(t)$ of capital intensity.

$$m(t,t) = \frac{\Phi(t)}{b(t)}. \quad (1)$$

The value of the capital intensity $b(t)$ depends in general of a present technological level and in particular of a country's corruption level. For simplicity it is supposed here that capital intensity is diminished with a constant rate: $b(t) = b(0) \exp(-\beta t)$. As a rule, rate $\beta > 0$.

The model of investment policy of firms used a hypothesis of fixed number of workplaces $r(\tau, t)$ on every capacity through its all life period from the moment of its creation τ until its dismantling. It is supposed also that production capacity of the firm created in a year τ decreases with increasing of its age $t - \tau$ by a specified rate $\mu > 0$.

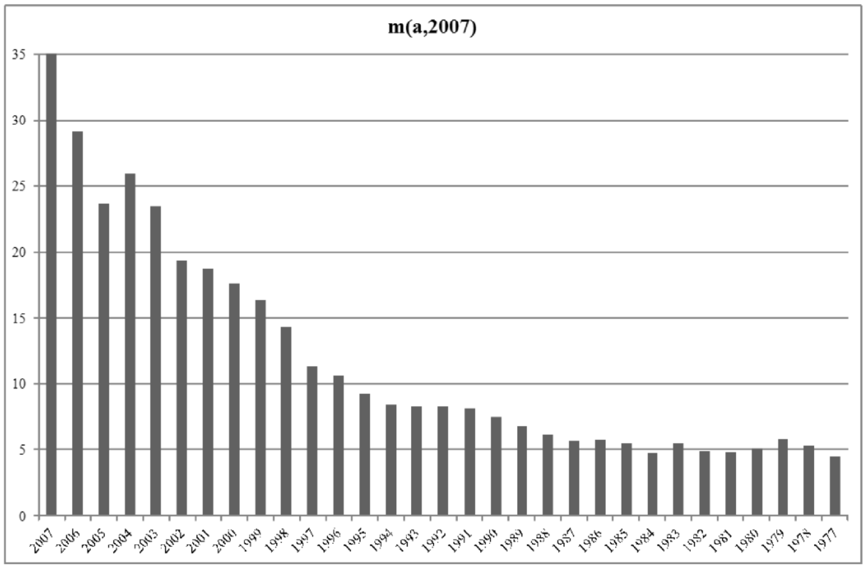

Figure 3: Vintage production capacity in 2007 in constant prices of 2005, USD billions

Source: My own estimations for the model by data of National Accounts Main Aggregates Database

$$m(\tau,t) = m(\tau,\tau)\exp(-\mu(t-\tau)). \quad (2)$$

If norm of labour input of firm created in year τ at time *t* denote as $\lambda(\tau,t)$ than the number of workplaces $r(\tau,t) = \lambda(\tau,t)m(\tau,t)$ is fixed and therefore the norm of labour input increases (labor productivity decreases)

$$\lambda(\tau,t) = \lambda(\tau,\tau)\exp(\mu(t-\tau)). \quad (3)$$

Olenev *et al.*, (1986) show that if they come from the variables (τ,t) to the variables (λ,t) in a description of capacity dynamics for a density of distribution $m(\lambda,t)$ the capacity dynamics satisfies a partial differential equation of the first order:

$$\frac{\partial m(\lambda,t)}{\partial t} = j(\lambda,t) - 2\mu m(\lambda,t) - \mu\lambda \frac{\partial m(\lambda,t)}{\partial \lambda}, \quad (4)$$

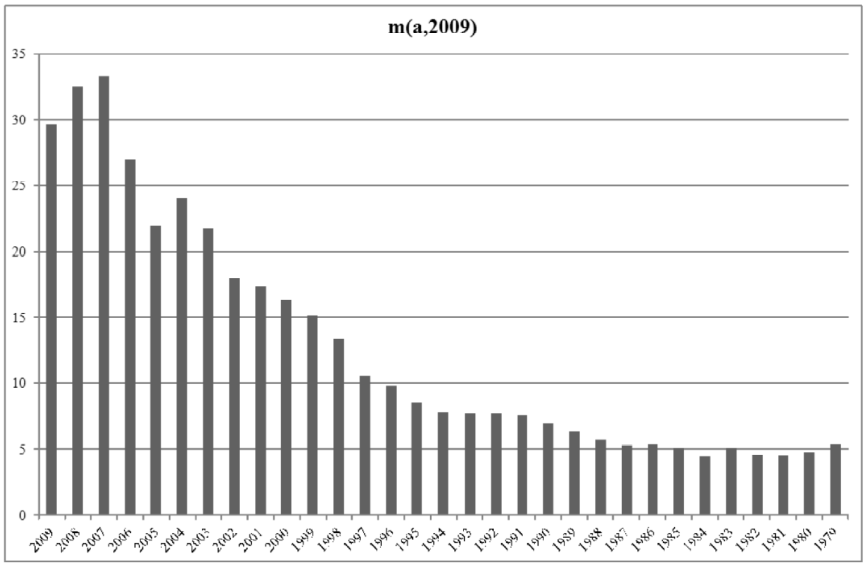

Figure 4: Vintage production capacity in 2009 in constant prices of 2005, USD billions

Source: My own estimations for the model by data of National Accounts Main Aggregates Database

where $j(\lambda,t)$ is an investment in technology with labour intensity λ.

Equation (4) completely determines the density of production capacity $m(\lambda,t)$ if an initial condition $m(\lambda,0)=m_0(\lambda)$ is specified. If as it is supposed in equation (1) all investments $J(t)=\Phi(t)/b(t)$ come in a new technology with a norm of labour input $\nu(t)$ then $j(\lambda,t)=J(t)\delta_+(t-\nu(t))$, where $\delta_+(x)$ is Dirac delta plus function. Now we can find by integrating (4) by norm of labour input from $\nu(t)$ to ∞ an equation for a total capacity

$$M(t)=\int_{\nu(t)}^{\infty} m(\lambda,t)d\lambda \tag{5}$$

of an industry or an economy. The equation obtained here from the microeconomic description is usually used in macroeconomic models:

$$\frac{dM(t)}{dt}=J(t)-\mu M(t). \tag{6}$$

Note (Olenev *et al.*, 1986), if we have a limit on upper value of the integral (5) we will have a more general equation then (6).

If share of investments in total capacity of an economy $\sigma = J(t)/M(t)$ is constant than this microeconomic description allows you to build an analytical expression for production function of the economy, that is, the dependence of the output $Y(t)$ from the production factors: total capacity $M(t)$ and the total labour $L(t)$:

$$Y(t) = M(t)\, f(t, x), \tag{7}$$

where $x = L(t)/M(t)$. It only needs to define function of scientific and technical progress which in this model is reflected in a dynamics of the best and the lowest norm of labour input $\nu(t)$.

$$\frac{1}{\nu(t)} \frac{d\nu(t)}{dt} = -\varepsilon\sigma, \tag{8}$$

where parameter $\varepsilon > 0$ is a rate of scientific and technical progress (see for details Olenev *et al.*, 1986). So, we can find (Olenev *et al.*, 1986) an analytical form of a new kind of production functions:

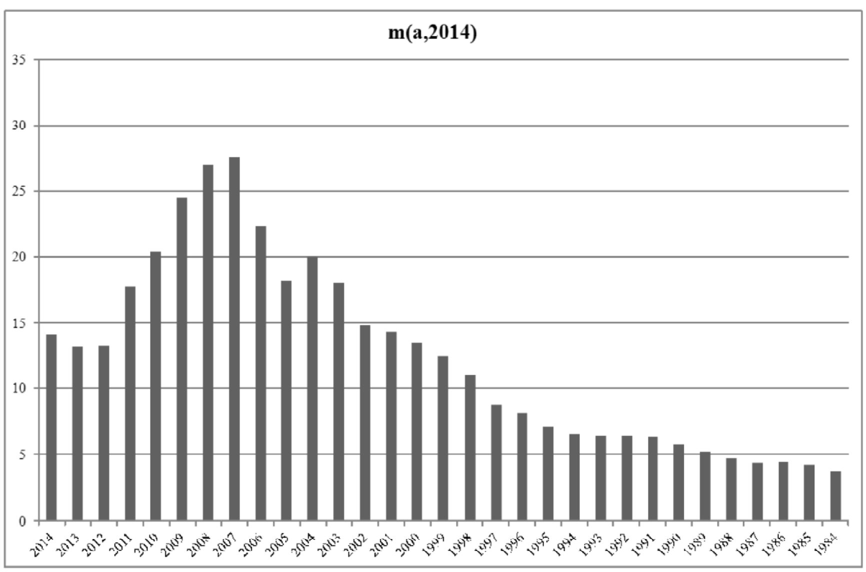

Figure 5: Vintage production capacity in 2014 in constant prices of 2005, USD billions

Source: My own estimations for the model by data of National Accounts Main Aggregates Database

$$f(t,x)=1-\left[1-\left(1-\varepsilon-\frac{\mu}{\sigma}\right)\frac{x}{\nu(t)}\right]^{\frac{1}{1-\varepsilon-\mu/\sigma}}. \tag{9}$$

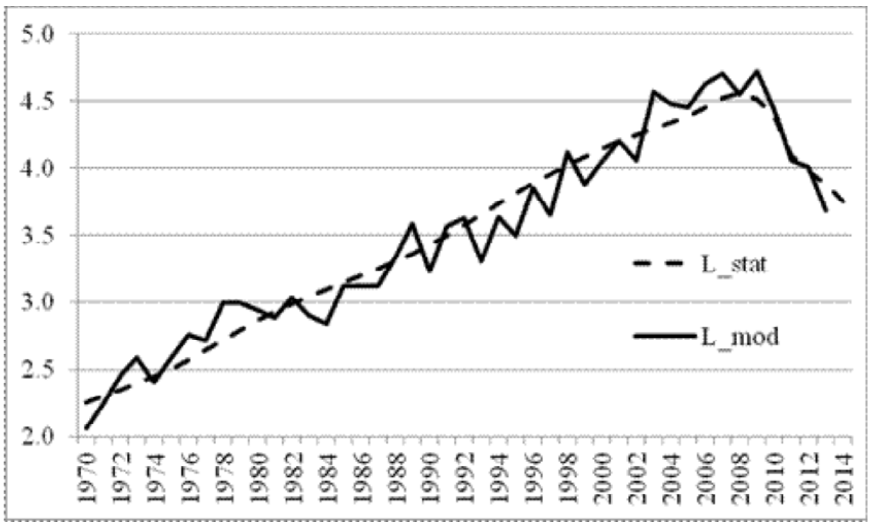

Figure 6: Identification for the model of Greek economy by the employment fitting. Time series for employment: L_mod – estimation by vintage capacity model, L_stat – statistical data, millions people

Source: My own estimations for the model by data of National Accounts Main Aggregates Database and data of the Statistical Institute

In general case when the share of new capacities in the total capacity $\sigma(t)$ is not constant the analytical form is not available but it is possible to construct a production function numerically using relations (1)-(3), (8).

So let begin numerical estimations by the model for Greek economy.

ESTIMATION OF PRODUCTION CAPACITIES FOR GREEK ECONOMY

Here, an annual gross domestic product (GDP) at constant 2005 prices in US dollars is used as the output $Y(t)$ of Greek economy. Consider the distribution of production capacity on age (see Figures 1-5 for the distribution of production capacity over the years established in 2000, 2005, 2007, 2009 and 2014, respectively, where capacities are measured in billion USD of 2005).

Let us evaluate the external parameters b_0, β, μ, ν_0, ε, $m_0(\lambda)$ of the Greek economy 1970-2013 by the model described above from some natural conditions. One of the condition is that the production capacities are utilized an average on 70% approximately, implying an existence of a normal reserve of capacities on the level of approximately 30% (Olenev, 1995).

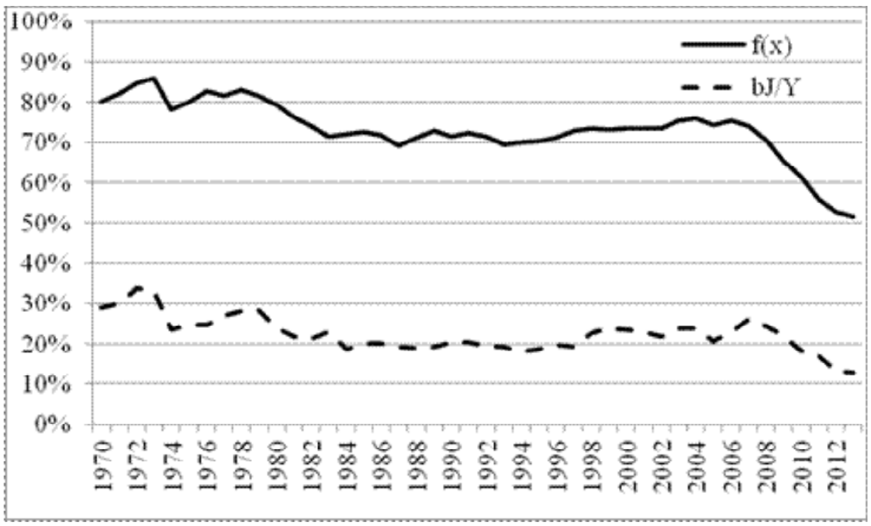

Figure 7: Time series for macroeconomic indices: f(x) – capacity utilization, *bJ/Y* – ratio of investment product to GDP

Source: My own estimations for the model by data of National Accounts Main Aggregates Database and data of the Statistical Institute

Let use for estimation fitting of time series for labour $L(t)$ and output $Y(t)$. Namely, we iterate through all valid sets of parameters using high-performance computing on supercomputer MVS-1000M of Joint supercomputer centre of Russian academy of sciences and select a combination of the parameters in which the match of statistics and calculations is complete for GDP $Y(t)$ and the best one for labour $L(t)$.

Figures 1-5 show a history of changing the form for distribution of production capacities by dates of creation. Up to 2007 Greek economy developed rapidly with a slight decline in 2005, which resulted in an investment level and in a correspondent fluctuation of the capacity distribution.

It is interesting to note that at the same time the human development index calculated entirely on other indicators (human life expectancy (longevity), education level, living standards in purchasing power parity), allowed the Greek economy attributed to the group of developed countries. However, Figures 1-3 show that Greek economy in 2000-2007 maintained a fairly long "tail" of production capacity with a large age and therefore with a relatively low labour productivity (or which is the same with a high norm of labour input).

And when the flow of foreign lending has fell as a result of the world crisis the problems have arisen because the internal resources of real sector were not enough to support development of production and payments on the accumulated foreign debt.

Figures 3-5 show how the decline in investment affects the distribution of production capacity after 2007 and up to 2014. A naked eye from these drawing can see that the average age of production capacity increases and average labor productivity reduces, accordingly, reducing the competitiveness of Greek economy and, therefore, under a fixed exchange rate of national currency increasing unemployment to curb the growth of average norm of labour input.

To increase the average productivity in the conditions of the fixed rate of national currency it would have been better during the growth of new production capacity to dismantle the old capacities and grow by creating more productive capacities, but that did not happen.

With no possibility to devalue the national currency and thereby making the old production capacities profitable it remains to hope only for the possibility of debt relief since the policy of clamping one region in the common economic space looks strange and for the possibility of a new development program including the construction of new capacities and destruction of old ones, which lenders and borrowers can offer jointly.

As a result of research we have the next estimations for Greek economy of 1970-2013: capital intensity in 1970 $b_0 = 2.755$, rate of its decline $\beta = 0.009$, the best norm of labour input in 1970 $\nu_0 = 0.01576$, the rate of scientific and technical progress $\varepsilon = 0.051$, the rate of capacity depreciation $\mu = 0.0375$. Value of $b(t)$ differs in different countries, the value characterizes the level of technology in new capacities and the level of corruption. A value of rate μ characterizes an average level of capacities depreciation as a result of technical ageing in the given country (it depends on the production culture and the climatic conditions). The inverse value 1/μ gives an evaluation of the maximum possible lifetime (age) of capacities by technical performance. Taking into account the moral depreciation the lifetime drops below 1/μ increasing the competitiveness of the economy.

Figure 6 indicates a quality of fitness of the model and statistics by these parameters.

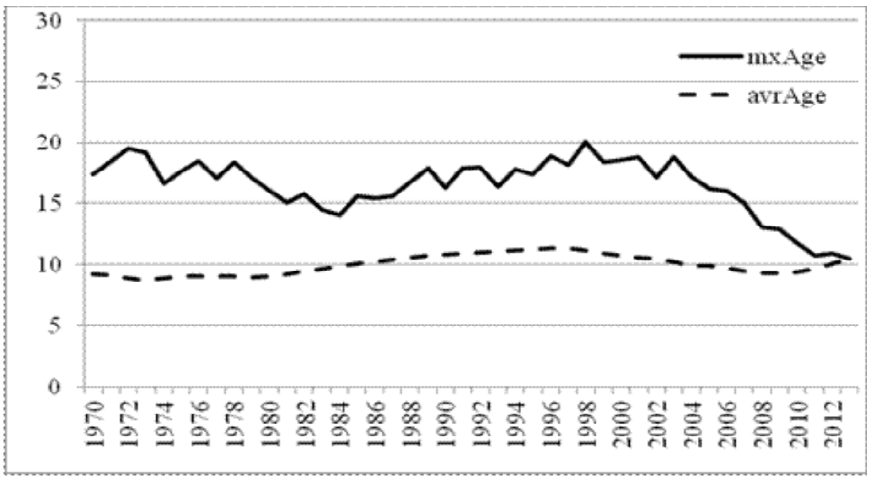

Figure 8: Time series for macroeconomic indices: *mxAge* – maximal age of capacities which are used in production of output, *avrAge* – average age of production capacities

Source: My own estimations for the model by data of National Accounts Main Aggregates Database and data of the Statistical Institute

Figure 7 shows the dynamics of production capacity utilization by labor employed in Greek economy. It is seen that after 2007 the capacity utilization has fallen sharply below the economically reasonable level of 70%. The figure 7 shows also a ratio of investment product to GDP. It also falls down after 2008.

Figure 8 shows that in 2013 maximal age of capacities used in production is fell down below the average age.

Figure 9 shows that in 2013 the share of investments in total capacity is fell down below the rate of depreciation. So, total capacity (maximal total output) of Greek economy fall down.

COMPARATIVE ANALYSIS

The model allows conducting a comparative analysis of Greek economy with other countries. For example, Italian economy gives the next

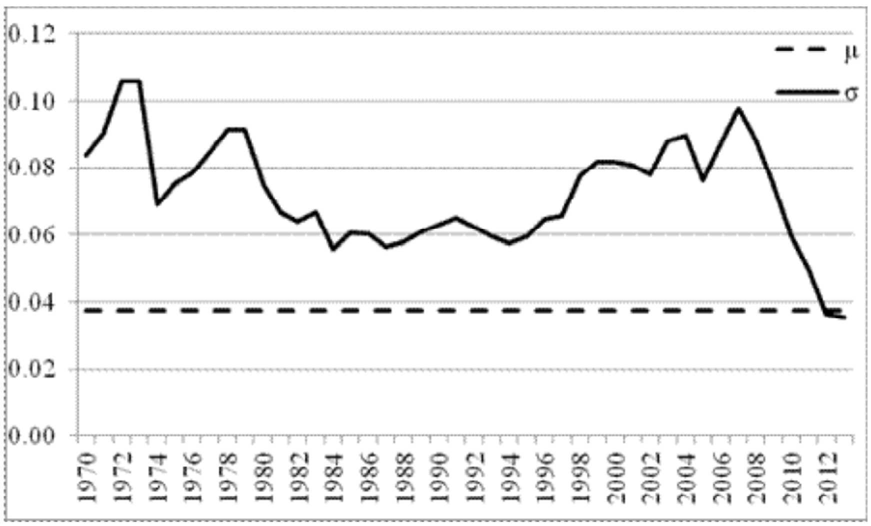

Figure 9: Time series for macroeconomic indices: σ(*t*) – share of investments in total capacity, μ – rate of depreciation

Source: My own estimations for the model by data of National Accounts Main Aggregates Database and data of the Statistical Institute

estimations for the model: capital intensity in 1970 $b_0 = 3.3$, rate of its decline $\beta = 0.019$, the best norm of labour input in 1970 $\nu_0 = 0.012$, the rate of scientific and technical progress $\varepsilon = 0.08$, the rate of capacity depreciation $\mu = 0.017$.

Figure 10 illustrates the dynamics of capital intensity for Greece and for Italy. So that $b(2014) = 1.85$ for Greece, and $b(2014) = 1.42$ for Italy. This means particularly that the nowadays level of corruption in Greece is on 30% more greater than in Italy.

The total capacity of each compared country was calculated by a condition that average loading of capacities is approximately equaled 70 percent. The condition gives a value for age of a marginal capacity which included in total capacity of the country. It was determined that for Greek economy the age is 30 years old, and for Italy it is 28 years old. So that the smaller is the tail of the capacity distribution, the greater is the rate of growth in this economy. Note that as it was shown in Olenev and Pospelov (1989) the longer is the tail of the distribution of capacities by age, the less stable growth of the economy is in the future.

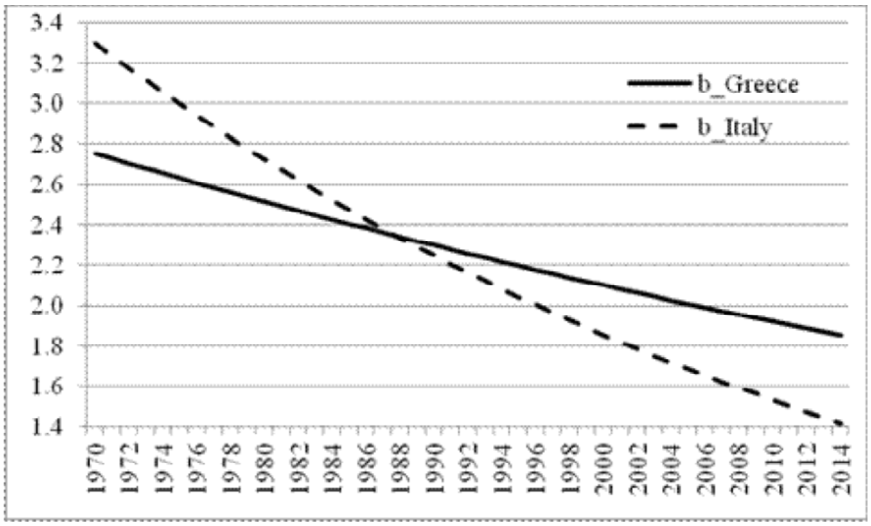

Figure 10: Time series for capital intensity $b(t)$ for economy of Greece (solid curve) and for economy of Italy (dashed curve)

Source: My own estimations for the model by data of National Accounts Main Aggregates Database and data of the Statistical Institute

CONCLUSIONS

The paper presents my estimation of a recent situation in real sector of Greek economy obtained by the model identification on the base of official statistical data. The volume of investment and the value of productivity have dramatically diminished in Greece during the last six years of crisis.

The model of economy, techniques of its identification and especially its application for Greek economy require further research, some areas of which are given in Kamenev and Olenev (2015), Matveenko *et al.* (2015), Olenev (2015).

Sometimes unscrupulous analysts say politicians that they have only two or three possible scenarios of behavior. In fact the number of ways is limited only by an imagination. As ancient Chinese people said: "It is known that in any situations there are 36 possible ways out." (Shi Naian, 2010). You need only to choose an optimal way in terms of acceptance criteria for a given situation.

In order to ensure sustained growth of the Greek economy in the future and to be able to repay the debts have to recommend reducing of the age limit of capacities that can be used in production. For example, this can be done by increased taxation on old capacities, which may differ by production sectors.

Acknowledgements

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Statistical Institute: *http://www.statistics.gr/*