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economic performance - the case of Greece

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RENT SEEKING ACTIVITIES AND AGGREGATE ECONOMIC PERFORMANCE- THE CASE OF GREECE

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Abstract

We built upon Angelopoulos et al. (2009) and we employ a dynamic general equilibrium model in order to examine the interrelated role of rent seeking activities, institutions and government policy variables, like tax rates and public spending, on Greece's economic performance during the last forty years. We focus on the period 1979-2001. According to Kehoe and Prescott (2002, 2007) this period can be characterized as a great depression. The model is the standard neoclassical growth model augmented with a government sector and an institutional structure which creates incentives for optimizing agents to engage in rent seeking contests in order to extract rents from the government. This behavior creates a cost to the economy in the form of an unproductive use of resources. Our main findings are as follows: First, in terms of the path of key macroeconomic variables, our model fits the data quite well. Second, by conducting a growth accounting exercise we find that during the period 1979-1995 a non negligible proportion of the decline of total factor productivity (TFP) can be accounted for rent seeking activities. Third, our model produces an index which can be interpreted as a measure of the quality of institutions in the Greek economy. Our model based index exhibits a resemblance with the internal country risk guide (ICRG) index which is widely used in the literature as a proxy for the quality of a country's institutions.

Keywords: Growth Accounting, Rent Seeking, Institutions, Dynamic General Equilibrium.

JEL classification: E62, E32, O17, O40

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1 Introduction

Over the period 1979-2001 the Greek economy experienced a substantial business cycle. More specifically, during the subperiod 1979-1995 (crisis phase) the average annual growth rate of real per capita GDP was -0.07% and during the subperiod 1995-2001 (recovery phase) the respective figure was 3.13%. According to Kehoe and Prescott (2002, 2007) the whole period, i.e., 1979-2001, can be defined as a great depression. The authors characterize a period as a great depression if there is a large, rapid and sustained deviation of real per capita GDP from trend.¹

(Insert Figure 1 about here)

In Gogos et al. (2014a) we asked whether the standard neoclassical growth model can account for Greece's poor economic performance during the period 1979-2001. The answer was affirmative. The observed total factor productivity (TFP) series once fed into the model could generate an equilibrium path for most of the key macroeconomic variables which was very close to the data. Our motivation in choosing the neoclassical growth model as our main theoretical vehicle was based on the statistics that we present in Figure 1. These stem from a standard growth accounting exercise based on a neoclassical production function. In Figure 1 we display in terms of indices the paths of real per capita GDP and of the TFP factor for the period 1973-2013 after removing a linear 2% trend growth rate.² Looking at Figure 1 we observe that in the case of the Greek economy there exists a strong positive correlation between real per capita GDP and the TFP factor. Hence, given our analysis in Gogos et al. (2014a) our main "diagnosis" was as follows: In order to explore in more depth the Greek great depression episode we need to investigate possible factors that lie behind the path of TFP. In the literature the standard candidate factors are government policy and institutions (e.g. see Prescott (1998) and Kehoe (2003)).

In Gogos et al. (2014b) we investigated whether the introduction of a government sector could improve our model's ability to mimic the data. We found that a model with constant distortionary taxes, public consumption, public investment and constant relative risk aversion (CRRA) preferences could move our artificial economy closer to the data relative to the standard neoclassical setting. However, even under that setting, the most important factor in accounting for Greece's economic performance was the TFP factor. Furthermore, we did not model the link between government policy variables and TFP. That is, in Gogos et al. (2014b) we used almost the same exogenous series for TFP as the one we used in Gogos et

¹Kehoe and Prescott (2002, 2007) set three quantitative criteria for a period to be defined as a great depression. The Greek economy for the period 1979-2001 strictly meets these criteria. For quantitative details see Gogos et al. (2014a).

²We define detrended real per capita GDP as follows: $\tilde{y}_t = \frac{y_t}{g_{tr}^{t-T_0} y_{T_0}}$, where g_{tr} is the gross trend growth rate and T_0 is the starting year of the detrending period. For g_{tr} we choose a value equal to 2% which is the average annual growth rate of real per capita GDP of the US economy (industrial leader) during the 20th century. The detrended TFP factor is computed in the same way. Furthermore, for the difference between the definition of the TFP and the TFP factor see subsections 4.6.3 and 4.7.

al. (2014a). The differences in the two studies lied on the inclusion of government policy variables and on a more rich propagation mechanism but not on the TFP series. Thus, the "measure of our ignorance", i.e. the TFP series, in Gogos et al. (2014b) remained the same as that in Gogos et al. (2014a).

In this study we introduce rent seeking activities and institutional factors in the model with the government sector of Gogos et al. (2014b). More specifically, the model, based on the work of Angelopoulos et al. (2009), is the standard neoclassical growth model augmented with a government sector and an institutional structure which creates incentives for optimizing agents to engage in rent seeking contests in order to extract rents from the government (e.g. see Park et al. (2005)). This behaviour creates a cost to the economy in the form of an unproductive use of resources. Our motivation is based on the fact that it is widely recognized in the literature that institutional factors play an important role for a country's aggregate economic performance (e.g. see Prescott (1998), Hall and Jones (1999), Bergoeing et al. (2002) and Angelopoulos et al. (2011)). Furthermore, introducing rent seeking activities which in turn lead to an unproductive use of resources, allows us to endogenize the observed drop in the TFP series during the period 1979-1995 (see Figure 1(c)). In our analysis we follow the same methodological steps as those in Gogos et al. (2014 a and b). First we perform a growth accounting exercise. There we decompose the growth rate of real per capita GDP into three factors. These are, the TFP factor, the capital factor and the labour factor. Then we try to identify and quantify the sources of the movements of the growth accounting components. As sources of variation we use the following exogenous variables: TFP, quality of institutions, population, public consumption and investment and effective tax rates.

Our main findings are as follows: First, in terms of the path of key macroeconomic variables, our model fits the data quite well. Second, by conducting a growth accounting exercise we find that during the period 1979-1995 a non negligible proportion of the decline of total factor productivity (TFP) can be accounted by rent seeking activities. Third, our model produces an index which can be interpreted as a measure of the quality of institutions in the Greek economy. Our model based index exhibits a resemblance with the internal country risk guide (ICRG) index which is widely used in the literature as a proxy for the quality of a country's institutions.

The structure of the paper is as follows: Section 2 presents the model along with the conditions that characterize the decentralized competitive equilibrium. Section 3 presents the data, the calibration of the parameters of our model and the growth accounting exercise. Section 4 presents transition dynamics. Section 5 presents the results. Finally, Section 6 concludes.

2 The model

We build upon Angelopoulos et al. (2009). Our model is a dynamic general equilibrium model with a public sector. The artificial economy consists of a large number of infinitively lived identical households, a large number of identical firms, and a public sector. There is no uncertainty (we assume perfect foresight), all markets clear and all variables are measured in real terms. The representative household chooses paths of consumption, capital, leisure and the allocation of non leisure time between productive work (labour) and rent seeking activities.³ The representative firm produces a homogenous product using private capital, public capital (e.g. public infrastructure), productive work and the available technology. The government levies distortionary taxes and uses the revenues to finance public consumption, public investment, lump-sum transfers and fiscal privileges to rent seekers (privileged transfers, subsidies and tax treatments).⁴ We solve for a symmetric decentralized competitive equilibrium (DCE) where: (i) each individual household and each individual firm maximize their own utility and profits respectively, taking market prices and government policy as given, (ii) the government budget constraint is satisfied and (iii) all markets clear through price flexibility.

2.1 Households

Each period of time t there is a large number of identical households N_t ($h = 1, 2, 3 \dots N_t$). Their population grows at a constant rate equal to $g_N = \frac{N_{t+1}}{N_t}$. The lifetime utility of the representative household h is:

$$\sum_{t=T_o}^{\infty} \beta^{*t} U(C_t^h + \psi \bar{G}_t^c, H_t^h) \quad (1)$$

where $0 < \beta^* < 1$ is the time discount factor, C_t^h is consumption expenditures of the representative household h , \bar{G}_t^c is per household public consumption, H_t^h is the respective hours of leisure and the parameter $\psi \in [0, 1]$ is a measure of the degree of substitutability between private and public consumption in utility. For the instantaneous utility function, we use the following constant relative risk aversion (CRRA) form:

$$U(C_t^h + \psi \bar{G}_t^c, H_t^h) = \frac{\left((C_t^h + \psi \bar{G}_t^c)^\gamma (H_t^h)^{1-\gamma}\right)^{1-\sigma}}{1-\sigma} \quad (2)$$

where $0 < \gamma < 1$ is the consumption share parameter and $\sigma \geq 0$ is the curvature parameter. The representative household h receives a rental rate, r_t , and a wage rate, w_t , for its capital, K_t^h , and productive work services, $n_t^h L_t^h$. Furthermore, it receives a share of profits, Π_t^h , as a shareholder of firms, and per household lump-sum transfers from the government, \bar{G}_t^t .

³As in Angelopoulos et al. (2009), we assume that households consume their available time for rent seeking activities while being at work.

⁴For a list with specific fiscal privileges see Tanzi (1998), Angelopoulos et al. (2009) and Hillman (2009).

Moreover, given a total contestable prize (public privileges) denoted as $\Theta_t R_t$ it receives rents (a share of that prize) generated by the non leisure time in rent-seeking activities. Here we decide the contestable prize to be a proportion of total revenues. Thus, the household's budget constraint is:

$$(1 + \tau_t^c) C_t^h + I_t^h = (1 - \tau_t^l) w_t n_t^h L_t^h + r_t K_t^h - \tau_t^k (r_t - \delta^p) K_t^h + (1 - \tau_t^k) \Pi_t^h + \bar{G}_t + \frac{(1 - n_t^h) L_t^h}{\sum_{h=1}^{N_t} (1 - n_t^h) L_t^h} \Theta_t R_t \quad (3)$$

where $0 < \tau_t^c < 1$, $0 < \tau_t^l < 1$ and $0 < \tau_t^k < 1$ are the effective tax rates on private consumption expenditures, productive work income, net capital income and profits respectively. The terms R_t and Θ_t with $0 < \Theta_t < 1$, denote tax revenues and the economy-wide degree of rent extraction respectively. In what concerns household's h time endowment, for every period t it has at its disposal \bar{h} available hours for leisure and non leisure activities.⁵ It further divides its non leisure time, i.e., work time, L_t^h , between productive work, $n_t^h L_t^h$, and rent seeking activities, $(1 - n_t^h) L_t^h$, thus:

$$\bar{h} = H_t^h + L_t^h \quad (4)$$

$$L_t^h = n_t^h L_t^h + (1 - n_t^h) L_t^h \quad (5)$$

The variable $0 < n_t^h \leq 1$ denotes the fraction of non leisure time that the household devotes to productive work and $0 \leq 1 - n_t^h < 1$ denotes the fraction of non leisure time devoted to rent seeking activities. Finally, household's h capital stock evolves according to the following equation:

$$K_{t+1}^h = (1 - \delta^p) K_t^h + I_t^h \quad (6)$$

where I_t^h is investment expenditures and δ^p is the respective constant depreciation rate parameter. Each household h acts competitively by taking prices, policy and economy-wide variables as given. More specifically, it chooses a vector of quantities $\{K_{t+1}^h, C_t^h, n_t^h, L_t^h\}_{t=T_0}^\infty$ to maximize equations (1) and (2), subject to (3), (4), (5) and (6). The first order necessary conditions are:

$$\frac{U_{H_t^h}(C_t^h + \psi \bar{G}_t^c, H_t^h)}{U_{C_t^h}(C_t^h + \psi \bar{G}_t^c, H_t^h)} = \frac{1}{1 + \tau_t^c} \left((1 - \tau_t^l) w_t n_t^h + \frac{1 - n_t^h}{\sum_{h=1}^{N_t} (1 - n_t^h) L_t^h} \Theta_t R_t \right)$$

⁵Here we make the following assumption: each day the household has 14 hours available for leisure and non leisure activities. Then each year the available hours for leisure and non leisure activities for each household are 14x7x52=5096.

$$\Rightarrow \frac{1-\gamma}{\gamma} \frac{C_t^h + \psi \bar{G}_t^c}{\bar{h} - L_t^h} = \frac{1}{1+\tau_t^c} \left((1-\tau_t^l) w_t n_t^h + \frac{1-n_t^h}{\sum_{h=1}^{N_t} (1-n_t^h) L_t^h} \Theta_t R_t \right) \quad (7)$$

$$(1-\tau_t^l) w_t = \frac{\Theta_t R_t}{\sum_{h=1}^{N_t} (1-n_t^h) L_t^h} \quad (8)$$

$$\begin{aligned} \frac{U_{C_t^h}(C_t^h + \psi \bar{G}_t^c, H_t^h)}{U_{C_{t+1}^h}(C_{t+1}^h + \psi \bar{G}_{t+1}^c, H_{t+1}^h)} &= \beta^* \frac{1+\tau_t^c}{1+\tau_{t+1}^c} (1 + (1-\tau_{t+1}^k)(r_{t+1} - \delta^p)) \\ \Rightarrow \frac{(C_{t+1}^h + \psi \bar{G}_{t+1}^c)^{1-\gamma(1-\sigma)} (\bar{h} - L_{t+1}^h)^{(\gamma-1)(1-\sigma)}}{(C_t^h + \psi \bar{G}_t^c)^{1-\gamma(1-\sigma)} (\bar{h} - L_t^h)^{(\gamma-1)(1-\sigma)}} &= \beta^* \frac{1+\tau_t^c}{1+\tau_{t+1}^c} (1 + (1-\tau_{t+1}^k)(r_{t+1} - \delta^p)) \end{aligned} \quad (9)$$

The optimality conditions are completed with the transversality condition for household's h capital stock:

$$\begin{aligned} \lim_{t \rightarrow \infty} \beta^{*t} U_{C_t^h}(C_t^h + \psi \bar{G}_t^c, H_t^h) K_{t+1}^h &= 0 \\ \Rightarrow \lim_{t \rightarrow \infty} \beta^{*t} (C_t^h + \psi \bar{G}_t^c)^{\gamma(1-\sigma)-1} (\bar{h} - L_t^h)^{(1-\gamma)(1-\sigma)} K_{t+1}^h &= 0 \end{aligned} \quad (10)$$

2.2 Firms

Each period of time t there is a large number of identical firms M_t ($f = 1, 2, 3 \dots M_t$). The representative firm f produces a homogeneous product, Y_t^f , using the following production function:

$$Y_t^f = A_t \left(K_t^f \right)^{\alpha_p} \left(\bar{K}_t^g \right)^{\alpha_g} \left(Q_t^f \right)^{1-\alpha_p-\alpha_g} \quad (11)$$

where $0 < \alpha_p < 1$, $0 < \alpha_g < 1$, and $0 < 1 - \alpha_p - \alpha_g < 1$, are the output elasticities of private capital, K_t^f , public capital (per firm), \bar{K}_t^g , and productive work, Q_t^f , respectively. Following Lansing (1998) we make the assumption that the production function exhibits constant returns to scale to all three inputs and as a result the firm f earns an economic profit equal to the difference between the value of output and the payments made to its private inputs. The variable A_t is total factor productivity (TFP) which grows at an exogenously given rate, $g_A = \frac{A_{t+1}}{A_t}$. The representative firm f acts competitively by taking prices, policy and economy-wide variables as given, and chooses, in each period t , the quantity of productive work, Q_t^f , and private capital, K_t^f , in order to maximize profits, Π_t^f :

$$\max_{Q_t^f, K_t^f} \Pi_t^f = Y_t^f - w_t Q_t^f - r_t K_t^f \quad (12)$$

subject to equation (11). Taking the first order necessary conditions with respect to Q_t^f and K_t^f we get the following two optimality conditions:

$$w_t = (1 - \alpha_p - \alpha_g) A_t \left(K_t^f\right)^{\alpha_p} \left(\bar{K}_t^g\right)^{\alpha_g} \left(Q_t^f\right)^{-\alpha_p - \alpha_g} \quad (13)$$

$$r_t = \alpha_p A_t \left(K_t^f\right)^{\alpha_p - 1} \left(\bar{K}_t^g\right)^{\alpha_g} \left(Q_t^f\right)^{1 - \alpha_p - \alpha_g} \quad (14)$$

2.3 Government

The government collects tax revenues, R_t , by taxing private consumption expenditures, income from productive work, net capital income and profits. Rent seekers extract $\Theta_t R_t$, with $0 < \Theta_t < 1$. Then, the government uses the remaining tax revenues $(1 - \Theta_t) R_t$ in order to finance public consumption, G_t^c (or \bar{G}_t^c in per household terms), public investment, G_t^i (or \bar{G}_t^i in per firm terms), and lump-sum transfers, G_t^t (or \bar{G}_t^t in per household terms). Thus, the government budget constraint is:

$$\sum_{h=1}^{N_t} \bar{G}_t^c + \sum_{f=1}^{M_t} \bar{G}_t^i + \sum_{h=1}^{N_t} \bar{G}_t^t = (1 - \Theta_t) R_t \quad (15)$$

where

$$R_t = \tau_t^l w_t \sum_{h=1}^{N_t} n_t^h L_t^h + \tau_t^k (r_t - \delta^p) \sum_{h=1}^{N_t} K_t^h + \tau_t^k \sum_{h=1}^{N_t} \Pi_t^h + \tau_t^c \sum_{h=1}^{N_t} C_t^h \quad (16)$$

Furthermore, public investment, G_t^i , is used to augment the public capital stock, K_t^g , whose law of motion has as follows:

$$K_{t+1}^g = (1 - \delta^g) K_t^g + G_t^i \quad (17)$$

Thus, we have six policy instruments (G_t^c , G_t^i , G_t^t , τ_t^c , τ_t^l and τ_t^k) out of which one will be residually determined to satisfy the government budget constraint. Unless otherwise stated, we choose this variable to be lump-sum transfers, G_t^t .

2.4 Economy-wide rent extraction

To complete our model we must specify the economy-wide degree of rent extraction, i.e., $0 < \Theta_t < 1$. Again we build upon Angelopoulos et al. (2009) and assume that Θ_t increases with per capita rent seeking activities. Using a linear specification, we assume:

$$\Theta_t = \xi_t \frac{\sum_{h=1}^{N_t} (1 - n_t^h) L_t^h}{N_t} \quad (18)$$

where $\xi_t \geq 0$ is a technology variable that translates rent seeking effort into rent extraction. Higher values of ξ_t indicate a more "efficient" rent seeking technology, through permissive

legal systems and permissible corruption, etc. Thus, ξ_t can be considered as a proxy for the level of institutional quality, with higher values indicating worse institutions.⁶

2.5 The decentralized competitive equilibrium

We solve for a symmetric decentralized competitive equilibrium (DCE). More specifically, the DCE consists of a vector of quantities for the representative household, $\{Y_t^h, C_t^h, I_t^h, \Pi_t^h, K_{t+1}^h, n_t^h, L_t^h, H_t^h\}_{t=T_0}^\infty$, a vector of quantities for the representative firm $\{Y_t^f, K_t^f, Q_t^f, \Pi_t^f\}_{t=T_0}^\infty$ and a vector of prices $\{w_t, r_t\}_{t=T_0}^\infty$, such that, given sequences for the exogenous variables $\{A_t, N_t, \xi_t\}_{t=T_0}^\infty$, the policy instruments variables $\{\bar{G}_t^c, \bar{G}_t^i, \bar{G}_t^t, \tau_t^c, \tau_t^l, \tau_t^k\}_{t=T_0}^\infty$, the initial private capital stock $K_{T_0}^h$ and the initial public capital stock $\bar{K}_{T_0}^g$: (i) Given prices $\{w_t, r_t\}_{t=T_0}^\infty$, the vector of quantities for the household, $\{Y_t^h, C_t^h, I_t^h, \Pi_t^h, K_{t+1}^h, n_t^h, L_t^h, H_t^h\}_{t=T_0}^\infty$ solves the household's maximization problem, (ii) Given prices $\{w_t, r_t\}_{t=T_0}^\infty$, the vector of quantities for the firm $\{Y_t^f, K_t^f, Q_t^f, \Pi_t^f\}_{t=T_0}^\infty$ solves the firm's maximization problem, (iii) Given prices $\{w_t, r_t\}_{t=T_0}^\infty$, the vector of quantities for the household, $\{C_t^h, K_{t+1}^h, n_t^h, L_t^h, \Pi_t^h\}_{t=T_0}^\infty$ satisfies the government budget constraint, (iv) Given the vectors of quantities for households and firms, $\{Y_t^h, C_t^h, I_t^h, \Pi_t^h, K_{t+1}^h, n_t^h, L_t^h, H_t^h\}_{t=T_0}^\infty$, $\{Y_t^f, K_t^f, Q_t^f, \Pi_t^f\}_{t=T_0}^\infty$, the vector of prices $\{w_t, r_t\}_{t=T_0}^\infty$ is such that all markets clear. Thus, in each period t , the market clearing conditions for the goods market, the labour market, the private capital stock market and profits, are respectively:

$$\sum_{f=1}^{M_t} Y_t^f = \sum_{h=1}^{N_t} Y_t^h \quad (19)$$

$$\sum_{f=1}^{M_t} Q_t^f = \sum_{h=1}^{N_t} n_t^h L_t^h \quad (20)$$

$$\sum_{f=1}^{M_t} K_t^f = \sum_{h=1}^{N_t} K_t^h \quad (21)$$

$$\sum_{f=1}^{M_t} \Pi_t^f = \sum_{h=1}^{N_t} \Pi_t^h \quad (22)$$

Hence, the DCE is summarized by equations (3), (4), (6) to (9) and (11) to (22). This is a system of eighteen equations in seventeen endogenous variables, that is $Y_t^h, C_t^h, I_t^h, \Pi_t^h, K_{t+1}^h, \bar{K}_{t+1}^g, n_t^h, L_t^h, H_t^h, Y_t^f, K_t^f, Q_t^f, \Pi_t^f, R_t, \Theta_t, w_t, r_t$, and one policy instrument variable which is endogenously-residually determined, \bar{G}_t^t , in each period t .

⁶We treat the quality of institutions, ξ_t , as exogenous. See Angelopoulos et al. (2009) for a more general case where the quality of institutions is treated as an endogenous variable depending on the share of output that the government earmarks for the financing of courts, inspectors, police, prisons, etc. We leave such an extension for future research.

2.6 The aggregate economy

In terms of aggregate quantities, the DCE can be reduced to a system in fourteen equations and fourteen unknowns. These are:

$$w_t = (1 - \alpha_p - \alpha_g) A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g} (n_t L_t)^{-\alpha_p - \alpha_g} \quad (23)$$

$$r_t = \alpha_p A_t K_t^{\alpha_p - 1} (K_t^g)^{\alpha_g} (n_t L_t)^{1 - \alpha_p - \alpha_g} \quad (24)$$

$$Y_t = A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g} (n_t L_t)^{1 - \alpha_p - \alpha_g} \quad (25)$$

$$\Pi_t = Y_t - w_t n_t L_t - r_t K_t \quad (26)$$

$$(1 + \tau_t^c) C_t + I_t = (1 - \tau_t^l) w_t n_t L_t + r_t K_t - \tau_t^k (r_t - \delta^p) K_t + (1 - \tau_t^k) \Pi_t + G_t^t + \Theta_t R_t \quad (27)$$

$$N_t \bar{h} = H_t + L_t \quad (28)$$

$$K_{t+1} = (1 - \delta^p) K_t + I_t \quad (29)$$

$$K_{t+1}^g = (1 - \delta^g) K_t^g + G_t^i \quad (30)$$

$$\frac{1 - \gamma}{\gamma} \frac{C_t + \psi G_t^c}{N_t \bar{h} - L_t} = \frac{1}{1 + \tau_t^c} \left((1 - \tau_t^l) w_t n_t + \frac{\Theta_t R_t}{L_t} \right) \quad (31)$$

$$\begin{aligned} & \frac{(C_{t+1} + \psi G_{t+1}^c)^{1 - \gamma(1 - \sigma)} (N_{t+1} \bar{h} - L_{t+1})^{(\gamma - 1)(1 - \sigma)}}{(C_t + \psi G_t^c)^{1 - \gamma(1 - \sigma)} (N_t \bar{h} - L_t)^{(\gamma - 1)(1 - \sigma)}} \\ &= \beta \frac{1 + \tau_t^c}{1 + \tau_{t+1}^c} (1 + (1 - \tau_{t+1}^k)(r_{t+1} - \delta^p)) \end{aligned} \quad (32)$$

$$(1 - \tau_t^l) w_t = \frac{\Theta_t R_t}{(1 - n_t) L_t} \quad (33)$$

$$G_t^c + G_t^i + G_t^t = (1 - \Theta_t) R_t \quad (34)$$

$$R_t = \tau_t^l w_t n_t L_t + \tau_t^k (r_t - \delta^p) K_t + \tau_t^k \Pi_t + \tau_t^c C_t \quad (35)$$

$$\Theta_t = \xi_t \frac{(1 - n_t) L_t}{N_t} \quad (36)$$

where $\beta = \beta^* g_N^\sigma$. Hence, the DCE in aggregate terms is summarized by equations (23) to (36). This is a system of fourteen equations in thirteen endogenous variables, that is, Y_t , C_t , I_t , Π_t , K_{t+1} , K_{t+1}^g , n_t , L_t , H_t , R_t , Θ_t , w_t , r_t and one policy instrument variable which is endogenously-residually determined, G_t^t , in each period t .

3 Data

In order to perform the growth accounting exercise and then simulate our model economy, we must calibrate our model's parameters, δ^p , δ^g , α_p , α_g , ψ , σ , β , γ , g_N and g_A assign values to the exogenous variables, A_t , N_t , ξ_t , G_t^c , G_t^i , τ_t^c , τ_t^l and τ_t^k , and produce series for the private and public capital stock, K_t and K_t^g (details for the data are provided in

Appendix A). To do so we work as follows: First, we match up our model's variables and data. Second, we compute series for the private and public capital stock, K_t , K_t^g , along with values for the respective depreciation rate parameters, i.e. δ^p and δ^g . Third, we produce estimates for the output elasticities of private capital, α_p , public capital, α_g , and productive work, $1 - \alpha_p - \alpha_g$. Fourth, we produce series for the effective tax rates, τ_t^c , τ_t^l , τ_t^k . Fifth, we calibrate the parameters ψ , σ , β , γ , g_N and g_A . Finally, we compute series for the technology variable that transforms rent seeking effort to rent extraction, ξ_t , for the fraction of productive work time, n_t , and for TFP, A_t .

3.1 Match up model's variables and data

All data have been extracted from OECD and Groningen Growth Development Center (GGDC) databases. Our model economy is a closed one with a public sector. Hence, the income identity takes the following form:

$$Y_t = C_t + I_t + G_t^c + G_t^i \quad (37)$$

We define output, Y_t , as real gross domestic product (at factor prices), private investment, I_t , as real private gross fixed capital formation, public consumption, G_t^c , as real general government final consumption and public investment, G_t^i , as real government fixed capital formation.⁷ Using the income identity we obtain private consumption, C_t , residually. That is:

$$C_t = Y_t - I_t - G_t^c - G_t^i \quad (38)$$

In Figure 2 we present the evolution of public consumption and public investment as shares of GDP during the period 1960-2013. Clearly, the former variable followed an upward trend path. More specifically, from the early 1970s to the late 2000s it increased by approximately 10 percentage points (from 10.20% in 1973 to 20.54% in 2009). The latter variable fluctuated around a band of 1.72% (minimum value in 2011) to 4.68% (maximum value in 1961) with an average value equal to 3.16%.

Finally, except from public consumption and public investment, the other exogenous variable which we take directly from the official databases (the other five, that is, A_t , ξ_t , τ_t^c , τ_t^l and τ_t^k , are constructed) is population (number of households), N_t . In order to be consistent with the structure of our artificial economy where all people are capable of working, we match up this variable with data series for working age population.

(Insert Figure 2 about here)

⁷Since all series share a common price (one good economy), consistency requires to transform all variables from nominal to real terms with the same deflator, that is, the GDP deflator. Furthermore, we convert real gross domestic product from market prices to factor prices by subtracting from it net indirect taxes, that is, taxes less subsidies on production and imports.

3.2 Private and public capital stock

To compute the private and public capital stock series we apply the perpetual inventory method. To do so, we employ the two rules of motion for private and public capital stock (eq. 29 and 30) along with the series for private and public investment, i.e., I_t and G_t^i . In order to obtain values for the private and public capital stock depreciation rate parameters, δ^p and δ^g , and for the respective initial values, K_{T_0} and $K_{T_0}^g$, we follow Conesa et al. (2007) and we impose two restrictions. These are as follows: First, for the period 1970-2013, the ratio of consumption of fixed capital over GDP must be equal with that in the data. For the private and the public sector it holds:

$$\frac{1}{44} \sum_{t=1970}^{2013} \frac{\delta^p K_t}{Y_t} = 10.34\% \quad (39)$$

$$\frac{1}{44} \sum_{t=1970}^{2013} \frac{\delta^g K_t^g}{Y_t} = 1.32\% \quad (40)$$

Second, the capital-output ratio in the initial period (in our case 1960) must be equal to the average capital-output ratio over the period 1961-1970. Thus:

$$\frac{K_{1960}}{Y_{1960}} = \frac{1}{10} \sum_{t=1961}^{1970} \frac{K_t}{Y_t} \quad (41)$$

$$\frac{K_{1960}^g}{Y_{1960}} = \frac{1}{10} \sum_{t=1961}^{1970} \frac{K_t^g}{Y_t} \quad (42)$$

Equations (29), (30), and (39) to (42) constitute two systems of 55 equations in 55 unknowns ($K_0, K_1, \dots, K_{2013}, \delta^p$ and $K_0^g, K_1^g, \dots, K_{2013}^g, \delta^g$). The solution of these two systems, along with the private and public capital stock series, imply $\delta^p = 3.96\%$, $\frac{K_{1960}}{Y_{1960}} = 1.3576$ and $\delta^g = 2.59\%$, $\frac{K_{1960}^g}{Y_{1960}} = 0.3621$.

As Figure 3 depicts, both the private and the public capital-output ratio followed an upward trend path (capital deepening) during the last 53 years. More specifically, in the early 1960s the growth rate of the public capital stock was higher than the respective figure of the private sector, while for the period 1965 to 1983, the average annual growth rate of the private capital stock was higher by approximately 2.76 percentage points (8.60% vs 5.84%) compared to that in the public sector. As a result, the ratio of the public over the private capital stock decreased by 9.83 percentage points, that is, from 26.67% to 16.84%. During the next thirty years, i.e., 1983 to 2013, given an average annual growth rate of the private capital stock, 2.22%, and of the public capital stock, 2.91%, the same ratio increased by 3.88 percentage points, that is, from 16.84% to 20.72%. Finally, given the path of the Greek output from 1979 to 2013, the private capital-output ratio increased by 80.86% (from 2.0704 to 3.7444) and the public capital-output ratio by 96.47% (from 0.3949 to 0.7759).

(Insert Figure 3 about here)

3.3 Output elasticities

In order to get values for the output elasticities, α_p , α_g and $1 - \alpha_p - \alpha_g$, we work as follows: The perfect competitive labour market structure dictates that the wage rate is equal to the marginal product of labour. As a result, the output elasticity with respect to labour is equal to the respective income share. To compute the labour income share we take into account the fact that in the Greek economy the self-employed are a considerable fraction of total employment⁸. Hence, to avoid an underestimation of the labour share parameter we produce an estimate for total compensation of the self-employed (e.g. see Gollin (2002)). We do that by dividing total compensation of employees (net of employer's social security contributions) with total dependent employment and then multiplying this with total self-employment. The result is a constructed annual rate for total compensation of the self-employed. Finally, we add the latter figure to total compensation of employees and then we divide this number with real GDP at factor prices. Hence:

$$\text{Labour share}_t = \frac{CE_t^{DE} + CE_t^{SE}}{Y_t - NIT_t} \quad (43)$$

where CE^{DE} is total compensation of employees that belong to dependent employment, CE^{SE} is the imputed total compensation of the self-employed and NIT is net indirect taxes, i.e, indirect taxes less subsidies on production and imports. Taking the average of equation (43) over the period 1970-2011, we compute a value for the labour share parameter equal to 56.60%.⁹

In what concerns the output elasticities of private and public capital stock, we follow Baxter and King (1993) and we set α_g equal to the average value of the ratio of public investment over GDP, $\frac{G_t^i}{Y_t}$. In the Greek economy, during the period 1970-2013, this ratio was equal to 3.01%. Finally, given the computed values of the output elasticities of labour and public capital, we compute the elasticity of private capital (or private capital income share) residually, that is, $\alpha_p = 1 - 56.60\% - 3.01\% = 40.39\%$.

3.4 Effective tax rates

To compute series for the effective tax rates τ_t^c , τ_t^l , and τ_t^k , we follow Papageorgiou (2012) and we adopt a variation from the methodology of Mendoza et al. (1994).¹⁰ Looking at Figures 2(a) and 4(b) we observe that during the period 1970 to 2013 the effective tax rate on labour income followed a somewhat similar pattern like the one that public consumption as a share of GDP did (a correlation coefficient equal to 0.88). More specifically, we note

⁸From 1970 to 2013 the average ratio of the self-employed over total employment was 38.67%. However, during that period this ratio followed a downward trend path. In fact it decreased by 20.41 percentage points, that is, from 49.98% in 1970 to 29.57% in 2013.

⁹Our choice to take the average over the period 1970-2011 is due to data availability. More specifically, time series for net indirect taxes are available from 1970 to 2013 and for employer's social security contributions from 1965 to 2011.

¹⁰For details see Appendix B.

two subperiods of a steep increase, that is, from 15.77% in 1975 to 25.08% in 1986 and from 22.98% in 1992 to 31.94% in 1998. In terms of the path of the effective tax rate on net capital income, we observe a big jump from 1993 to 2000 (10.69% to 30.84%) and a big fall from 2000 to 2010 (30.84% to 19.64%). During the 1990s, the signing of Maastricht treaty and the strategic goal of entering the European Monetary Union (EMU) led the Greek government to reduce its public deficit and in order to meet that goal it tried to increase its revenue by increasing the tax rates on labour and capital income (e.g. see Kollintzas (2000)). Finally, in what concerns the path of the effective tax rate on private consumption expenditures, it increased remarkably between 1980 to 1987 (8.74% to 19.08%), and then it fluctuated around a band of 14.47% (minimum value in 1989) to 19.08% (maximum value in 1987) with an average value equal to 17.23%.

(Insert Figure 4 about here)

3.5 Calibration for parameters ψ , σ , β , γ , g_N and g_A

For the parameter of substitutability between private and public consumption in utility, ψ , we examine three different cases. Therefore, we run three experiments. In case 1 we set its value equal to 0, in case 2 equal to 0.5 and in case 3 equal to 1. Obviously, the two polar cases are 1 and 3. In the former we treat public consumption as a waste of resources (e.g see Angelopoulos et al. (2009) and Papageorgiou (2012)), while in the latter we treat private and public consumption as perfect substitutes.¹¹ Note that the value of parameter ψ affects the magnitude of the wealth effect triggered by changes in public consumption. The higher the value of ψ , i.e. higher degree of substitutability between public and private consumption, the lower the wealth effect. Also, as we explain below, the value of the parameter affects the fraction of the productive time and the constructed time series for the rent seeking technology. For the utility curvature parameter, σ , we choose the usual value used in the literature, i.e., 2. In what concerns the consumption share parameter, γ , we set its value equal to 0.2749, 0.3038 and 0.3303. These values correspond to experiments 1, 2 and 3 respectively. Our choice is consistent with an average value (1970-2013) for the fraction of productive time, n_t , equal to 75%. This figure is close to the respective long run solution (for the case of Greece) in Angelopoulos et al. (2009). The time discount factor, β , is calibrated using the Euler equation (eq. 32). This is written in the following way:

$$\beta = \frac{\left(\frac{C_{t+1} + \psi G_{t+1}^c}{C_t + \psi G_t^c}\right)^{1-\gamma(1-\sigma)} \left(\frac{N_{t+1}\bar{h} - L_{t+1}}{N_t\bar{h} - L_t}\right)^{(\gamma-1)(1-\sigma)}}{\frac{1+\tau_t^c}{1+\tau_{t+1}^c} \left(1 + (1 - \tau_{t+1}^k)(\alpha_p \frac{Y_{t+1}}{K_{t+1}} - \delta^p)\right)} \quad (44)$$

¹¹Of course, public and private consumption goods can also be complements (see e.g. Fiorito and Kollintzas (2004)). We follow most of the relevant literature by treating public consumption as either a waste of resources or substitute to private consumption.

Given time series for C_t , G_t^c , N_t , L_t , τ_t^c , Y_t , K_t and values for the parameters ψ , γ , σ , \bar{h} , α_p and δ^p , we take the average of equation (44) over the period 1970-2010 and we compute a value for the time discount factor equal to 0.9496, 0.9510 and 0.9523. As was the case with the parameter γ these values correspond to the three experiment of our model. Finally, we set g_A and g_N equal to 1.0113 and 1.0052 respectively. The former corresponds to a value of 1.02 for $g_A^{\frac{1}{1-\alpha_p-\alpha_g}}$ while the latter is the average (1970-2013) value of the working age population in Greece. Our model's calibrated parameter values are summarized in Table 1:

(Insert Table 1 about here)

3.6 Construction of variables ξ_t , n_t and A_t

3.6.1 Rent seeking technology and fraction of productive time

To construct series for the exogenous variables, ξ_t and A_t , we follow the real business cycles (RBC) methodology tradition and use our model's equations. Given the specific aggregate production function, i.e., $Y_t = A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g} (n_t L_t)^{1-\alpha_p-\alpha_g}$, to produce series for TFP, A_t , we need to have at our disposal series for Y_t , K_t , K_t^g , n_t , L_t and values for α_p and α_g . Having, data for Y_t and L_t (from OECD database), constructed series for K_t and K_t^g , and calibrated values for α_p and α_g , the only missing variable is the households' fraction of productive time, n_t . To construct series for n_t , along with series for the technology variable that transforms rent seeking effort to rent extraction, that is, ξ_t , we use equations (23) (31), (33) and (36). More specifically, the variable n_t is computed using the following equation:

$$n_t = \frac{(1 - \tau_t^l)(1 - \alpha_p - \alpha_g) \frac{Y_t}{L_t}}{\xi_t \frac{R_t}{N_t}} \quad (45)$$

The economic rationale that lies behind equation (45) has as follows: *ceteris paribus*, an increase in the effective tax rate on labour income induces households to decrease their fraction of productive time for two reasons. First, it decreases the compensation of productive work and second, it increases the contestable prize (through an increase in tax revenues) which is available for rent extraction. On the other hand, an increase in the level of rent seeking technology, ξ_t , makes the extraction of public rents less costly and therefore creates incentives for households to decrease their fraction of productive time.¹²

In Figure 5 we present the paths, from 1973 to 2013, for the technology variable that transforms rent seeking effort to rent extraction and for households' fraction of productive time. Given the equations that we use to construct series for the rent seeking technology variable, ξ_t (eq. 23, 31, 33 and 36), its value depends, among other variables and parameters, on the value of the substitutability parameter (sp), ψ . Since we examine three different specifications for this parameter we also have to produce three different series for ξ_t , n_t and

¹²The series for the variable of tax revenues, R_t , is constructed using equation (57), series for Y_t , C_t , K_t , τ_t^c , τ_t^l , τ_t^k and calibrated values for α^p , α^g and δ^p .

consequently for A_t . As Figure 5 depicts the variables ξ_t and n_t follow the same general path under the three specifications.

In terms of the path of the rent seeking technology variable (see Figure 5(a)) we observe that during the period 1973-2000 there was a decline in its index value (base year 1973=100) from 100 to 46.13 ($\psi = 0$), 49.31 ($\psi = 0.5$) and 52.94 ($\psi = 1$). This path was a result of a steep decrease during three subperiods, that is, mid-1970s, mid-1980s and mid-1990s. Exceptions to that general declining path were the subperiods 1979-1981 and 1987-1989. During the former there was an increase by 4.23 index units ($\psi = 0$), 4.64 ($\psi = 0.5$) and 5.30 ($\psi = 1$), while during the latter the increase was 9.32 ($\psi = 0$), 8.64 ($\psi = 0.5$) and 8.27 ($\psi = 1$). Finally, from 2000 to 2013, with an exception of the period 2005-2007 (a drop by 5.37 index units ($\psi = 0$), 4.62 ($\psi = 0.5$) and 4.11 ($\psi = 1$)), we observe an increase by 12.85 index units ($\psi = 0$), 10.69 ($\psi = 0.5$) and 9.16 ($\psi = 1$).

(Insert Figure 5 about here)

In what concerns the path of households' fraction of productive time, after reaching a value of almost 90% in the late 1970s (peak in 1978, 88.82% ($\psi = 0$), 89.32% ($\psi = 0.5$) and 89.63% ($\psi = 1$)) it abruptly decreased during the subperiod 1979-1982 (in 1982, 76.49% ($\psi = 0$), 76.83% ($\psi = 0.5$) and 77.03% ($\psi = 1$)). Then, until 1991, it oscillated around a mean of approximately 79% and afterwards it experienced its second steep decrease from 81.55% ($\psi = 0$), 82.23% ($\psi = 0.5$) and 82.70% ($\psi = 1$) in 1991 to 71.24% ($\psi = 0$), 71.57% ($\psi = 0.5$) and 71.77% ($\psi = 1$) in 1995. Hence, according to our model's equations and the data, during the crisis phase (1979-1995) of the Greek great depression episode there was a cumulative drop in households' fraction of productive time by approximately 18 percentage points, i.e. in 1979 for every 60 minutes of recorded non leisure hours, 6.60 minutes were consumed for non productive uses (quest of privileges from the government, $\Theta_t R_t$) while in 1995 the same figure was almost tripled to 17.40 minutes. Since that period was marked by a major drop in Greek economy's TFP (see Figure 1(c)) the above analysis can serve as a candidate factor in explaining that change (see the next subsection with the growth accounting exercise).

During the next 18 years (1995-2013) households' fraction of productive time fluctuated around a mean of 68% with not negligible variations. Looking at the southeast side of Figure 5(b) we observe two subperiods of a major decline and two subperiods of a sharp increase. More specifically, from 73.66% ($\psi = 0$), 73.77% ($\psi = 0.5$) and 73.80% ($\psi = 1$) in 1997 households' fraction of productive time fell to 63.60% ($\psi = 0$), 62.13% ($\psi = 0.5$) and 61.00% ($\psi = 1$) in 2005. Then, after increasing to 71.29% ($\psi = 0$), 68.26% ($\psi = 0.5$) and 66.05% ($\psi = 1$) in 2007 it once again decreased to levels close to 60% in 2011 (61.89% ($\psi = 0$), 61.67% ($\psi = 0.5$) and 61.45% ($\psi = 1$)). Finally, in 2013 it jumped to 67.63% ($\psi = 0$), 67.98% ($\psi = 0.5$) and 68.20% ($\psi = 1$).

(Insert Table 2 about here)

Although our research interest focuses on the comparison between the equilibrium paths of the endogenous variables of our model with those in the data, in Table 2 we present the long-run solutions (three experiments) of our model with respect to the following three endogenous variables: households' fraction of productive time, n_t , economy-wide degree of rent extraction, Θ_t , and extracted public rents as a percentage of GDP, $\frac{\Theta_t R_t}{Y_t}$. Our calibrated to the Greek economy model suggests that households devote 70.29% ($\psi = 0$), 73.24% ($\psi = 0.5$) and 78.86% ($\psi = 1$) of their non leisure time to productive uses and the economy-wide degree of rent extraction takes the values of 41.85% ($\psi = 0$), 36.38% ($\psi = 0.5$) and 26.80% ($\psi = 1$). The numbers of the latter variable translate to favoured public spending and tax privileges equal to 15.62% ($\psi = 0$), 13.50% ($\psi = 0.5$) and 9.91% ($\psi = 1$) as a percentage of GDP. Finally, it is worth pointing out that according to our model's long-run solutions there exists an inverse relationship between the value of the substitutability parameter, i.e., ψ , and rent seeking activity. The higher the former, that is, the degree of substitutability between private and public consumption goods increases, the lower the latter, that is, households increase their fraction of productive time and the economy-wide degree of rent extraction decreases.

3.6.2 Official vs model based indices: the case for the exogenous variable ξ_t

As mentioned in the former subsection, when we simulate our artificial economy, the series for the exogenous variable, ξ_t , that we feed into our model, is constructed using our model's equations and the data. The rent seeking technology variable shows how "easily" rent seeking per capita effort, i.e., $\frac{\sum_{h=1}^{N_t} (1-n_t^h) L_t^h}{N_t}$ translates into rent extraction, i.e. Θ_t . Hence, the exogenous variable, ξ_t , can be considered as a proxy for the quality of institutions of the economy. Given rent seeking per capita effort, a higher value for ξ_t (lower institutional quality) indicates higher rent extraction. Before using the constructed series of ξ_t to simulate our model economy, it would be fruitful for our analysis to ask whether the aforementioned series, presented in Figure 5(a) and reproduced in Figure 6, display any resemblance with available indices that can be considered as proxies for the quality of institutions of the Greek economy. An affirmative answer to that question would give support, partially at least, to our choice to use the specific series for the exogenous variable ξ_t . In order to address this issue we present two widely used indices. These are: the *International Country Risk Guide* (ICRG) index constructed by a private firm named Political Risk Services (PRS) Group Inc., and the *Corruption Perceptions Index* (CPI) produced by Transparency International a non-governmental organization that monitors corruption for a big sample of countries (e.g. 177 countries for the 2013 edition).¹³ For the former index the data are available for the period 1984-2005 while for the latter they are available for the period 1995-2013.

(Insert Figure 6 about here)

¹³Useful information about these two indices (methodology etc.) can be found at the following two internet sites: for the ICRG index, www.prsgroup.com, and for the CPI index, www.transparency.org.

The ICRG dataset includes 22 variables in three subcategories. These are: the political, the financial and the economic risk subcategory. As Angelopoulos et al. (2011) point out many economists have used the political risk subcategory as a measure of the quality of a country's institutions. This subcategory takes values between 0 (highest political risk) and 100 (lowest political risk) and includes 12 variables. These are: government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability and bureaucracy quality. The first 5 variables take values between 0 (min) to 12 (max), the following 6 between 0 (min) and 6 (max) and the last one between 0 (min) and 4 (max). The sum of the values of these variables leads to the formation of the political risk subcategory index. Given that a higher value of this index can be interpreted as an improvement in the quality of a country's institutions while for our model's rent seeking technology variable ξ_t a higher value indicates the opposite (a lower quality of institutions), to compare the two series we take the reciprocal of the political risk index. Furthermore, we do not sum up all the twelve subcomponents but instead we choose the following 5: government stability, investment profile, corruption, democratic accountability and bureaucracy quality. We construct two indices, one from the ICRG dataset and one from the constructed series of the variable ξ_t , with 1984 as the base year. The two indices are presented in Figure 6(a). We observe that the ICRG index follows a path very similar to the one that our model's rent seeking technology index follows during the period 1984-2005. It displays both the downward path of the 1990s and the reverse of that trend in the 2000s. Furthermore, the correlation coefficient is equal to 0.90 (if instead of 5 we sum up all the 12 variables of the political risk index then the correlation coefficient drops to 0.82).

The other official index which can be considered as a proxy for the quality of a country's institutions is the CPI. According to Transparency International the CPI "ranks countries and territories based on how corrupt their public sector is perceived to be. A country or territory's score indicates the perceived level of public sector corruption on a scale of 0 (highly corrupt) to 100 (very clean)".¹⁴ Furthermore, the CPI generally defines corruption as "the misuse of public power for private benefit". As was the case with the ICRG index we must take the reciprocal of the CPI so as to make it comparable with the rent seeking technology variable of our model. In Figure 6(b) we display the two series from 1995 to 2013 (base year 1995). Although the correlation coefficient between the two indices is very weak (but positive), i.e. 0.15, there are some subperiods where the CPI follows a similar path like the one that the variable ξ_t follows (e.g. 1995-1997, 2000-2002, 2004-2007 and 2008-2009). On the contrary, during the subperiods 1997-2000, 2002-2004 and 2011-2013 the two indices follow paths with entirely opposite directions.

Generally speaking the above analysis reveals a similarity between the variability of the rent seeking technology variable ξ_t and that of a two official indices that can be considered as

¹⁴For example, in 2013, Greece's CPI score was 40 (rank: 80th out of a sample of 177 countries).

proxies for the quality of a country's institutions. Most important of all, these two indices, i.e. ICRG and CPI, are entirely exogenous to our model. This fact gives support to our choice of choosing our model based series for the exogenous variable ξ_t .

3.6.3 Total factor productivity

Having time series for Y_t , K_t , K_t^g , n_t , L_t and values for α_p and α_g , we compute the TFP series using the aggregate production function. As in Conesa et al. (2007), the exogenous TFP series which we feed into our model is obtained using as a series for output, real GDP at factor prices. We do that because we want our TFP exogenous series to be net of net indirect taxes. These taxes are modeled explicitly with the use of the effective tax rate on private consumption expenditures, τ_t^c . As a result:

$$A_t = \frac{Y_t}{K_t^{\alpha_p} (K_t^g)^{\alpha_g} (n_t L_t)^{1-\alpha_p-\alpha_g}} \quad (46)$$

In the growth accounting exercise, when we report the contribution of TFP to growth we calculate TFP as conventionally measured, that is using real GDP at market prices, thus:

$$\hat{Y}_t = (1 + \tau_{\bar{T}}^c)C_t + I_t + G_t^c + G_t^i \quad (47)$$

The resulting TFP series is as follows:

$$\hat{A}_t = \frac{\hat{Y}_t}{K_t^{\alpha_p} (K_t^g)^{\alpha_g} (n_t L_t)^{1-\alpha_p-\alpha_g}} \quad (48)$$

where \bar{T} is the base year (for Greece this is 2005).

3.7 Growth accounting

In order to perform the growth accounting exercise we modify the aggregate production (e.g. see Kehoe and Prescott (2002, 2007)) in the following way:

$$\frac{Y_t}{N_t} = A_t^{\frac{1}{1-\alpha_p-\alpha_g}} \left(\frac{K_t}{Y_t} \right)^{\frac{\alpha_p}{1-\alpha_p-\alpha_g}} \left(\frac{K_t^g}{Y_t} \right)^{\frac{\alpha_g}{1-\alpha_p-\alpha_g}} \frac{n_t L_t}{N_t} \quad (49)$$

or in natural logarithms

$$\ln \frac{Y_t}{N_t} = \frac{1}{1-\alpha_p-\alpha_g} \ln A_t + \frac{\alpha_p}{1-\alpha_p-\alpha_g} \ln \frac{K_t}{Y_t} + \frac{\alpha_g}{1-\alpha_p-\alpha_g} \ln \frac{K_t^g}{Y_t} + \ln \frac{n_t L_t}{N_t} \quad (50)$$

with

$$\ln \frac{n_t L_t}{N_t} = \ln n_t + \ln \frac{L_t}{N_t} \quad (51)$$

where $A_t^{\frac{1}{1-\alpha_p-\alpha_g}}$ is the TFP factor, $\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha_p}{1-\alpha_p-\alpha_g}}$ is the private capital factor, $\left(\frac{K_t^g}{Y_t}\right)^{\frac{\alpha_g}{1-\alpha_p-\alpha_g}}$ is the public capital factor and $\frac{n_t L_t}{N_t}$ is the labour factor. The latter factor (per capita hours of productive work) can be divided into two terms, the fraction of productive time, n_t , and per capita non leisure time, $\frac{L_t}{N_t}$. In the absence of shocks our model economy converges to a balanced growth path. Along that path the private capital factor, the public capital factor and the labour factor remain constant (the fraction of productive time and per capita non leisure time remain constant). As a result, the growth rate of real per capital GDP is driven exclusively by the growth rate of the TFP factor, that is, $g_A^{\frac{1}{1-\alpha_p-\alpha_g}}$.

In Table 3 we present the growth accounting exercise. We divide the period 1973-2013 into 5 subperiods, these are: 1973-1979 (before depression), 1979-1995 (crisis), 1995-2001 (recovery), 2001-2007 (post depression) and 2007-2013 (new crisis). Taking annual differences of equation (50) we compute the growth rate of real per capita GDP as the sum of the growth rate of the TFP factor (net of the fraction of productive time n_t), the private capital factor, the public capital factor and the labour factor. Furthermore, using equation (51), we compute the growth rate of the labour factor as the sum of the growth rate of the fraction of productive time and per capita non leisure time.

Since we examine three different cases with respect to the substitutability parameter ψ (our choice for ψ affects the variable n_t and as a result it also affects $n_t L_t$ and A_t , e.g. see eq. (46)) we present three, partially different, growth accounting exercises. There the average annual growth rate of real per capita GDP, the private capital factor, the public capital factor and per capita non leisure time is the same in all three cases (we use the symbol -// - to denote that the value of a variable remains the same across the columns of Table 3). On the other hand, the average annual growth rate of the TFP factor (net), the labour factor and the fraction of productive time takes different values in all three specifications.

The term TFP Factor (gross, i.e., including the fraction of productive time) refers to the respective growth accounting exercise when the production function does not includes the variable n_t , i.e., $Y_t = A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g} L_t^{1-\alpha_p-\alpha_g}$. That was the case in Gogos et al. (2014b). Under that setting the growth rate of per capita non leisure time coincided with that of the labour factor, i.e. all hours of work (non leisure time) were considered as productive. Hence, any variations in the fraction of productive time showed up as variations in the TFP factor (gross). The growth accounting setting that we adopt in this study (based on the model of Angelopoulos et al. (2009)) helps us to move our research one step further since it allows us to identify and quantify a proportion of the sources of the variability in the TFP factor (gross) observed in Gogos et al. (2014b), i.e. the "measure of our ignorance" unfolds.

Looking at Table 3 we observe that during the whole period 1973-2013 the average annual growth rate of real per capita GDP was less than half of the 2% trend, i.e. 0.75%. This poor growth performance was a result of a negative growth rate -1.10% ($\psi = 0$), -1.14% ($\psi = 0.5$) and -1.23% ($\psi = 1$) of the labour factor and of a very weak but positive contribution 0.17% ($\psi = 0$), 0.21% ($\psi = 0.5$) and 0.29% ($\psi = 1$) of the TFP factor (net). It is worth noting

that the decline of the labour factor was produced by a negative average annual growth rate of the fraction of productive time (-0.54% ($\psi = 0$), -0.58% ($\psi = 0.5$) and -0.67% ($\psi = 1$)) and of the per capita non leisure time (-0.56%). The main engine of growth was the private capital factor with an average annual growth rate of 1.58%. The contribution of the public capital factor was of the same magnitude as that of the TFP factor (net), i.e., 0.11%.

The subperiod 1973-1979 (before depression) was marked by a growth performance (2.13%) close to the 2% trend. The contribution of the private capital factor, the public capital factor and the labour factor was 3.50%, 0.11% and 0.27% ($\psi = 0$), 0.01% ($\psi = 0.5$) and -0.51% ($\psi = 1$), respectively. On the other hand the average annual growth rate of the TFP factor (net) was -1.75% ($\psi = 0$), -1.49% ($\psi = 0.5$) and -0.97% ($\psi = 1$). Hence, the positive growth rate of the private capital factor fully offsetted the negative growth rate of the TFP factor and that led to an increase of real per capita GDP.

(Insert Figure 7 about here)

During the crisis phase (1979-1995) of the Greek great depression episode the average annual growth rate of real per capita GDP was -0.07%. The contribution of the labour factor was negative with an average annual growth rate of -1.90% ($\psi = 0$), -1.91% ($\psi = 0.5$) and -1.93% ($\psi = 1$). This was a result of a decrease of the fraction of productive time by -1.35% ($\psi = 0$), -1.36% ($\psi = 0.5$) and -1.39% ($\psi = 1$) and of a decline of the per capita non leisure time by -0.54%. The contribution of the private and the public capital factor was positive with an average annual growth rate of 1.68% and 0.12% respectively. Furthermore, the average annual growth rate of the TFP factor (net) was close to zero, i.e., 0.03% ($\psi = 0$), 0.04% ($\psi = 0.5$) and 0.06% ($\psi = 1$). In the respective growth accounting exercise in Gogos et al (2014b), the contribution of the TFP factor (gross) was -1.33% (see the row TFP Factor (gross) on the northeast side of Table 3). Hence, according to our new growth accounting exercise, on average, during the period 1979-1995, 40.84% ($\psi = 0$), 41.14% ($\psi = 0.5$) and 41.74% ($\psi = 1$) of the gap between the growth rate of the TFP factor (gross) and the 2% trend can be attributed to rent seeking activities (see Figure 7(c)).

The subperiod 1995-2001, i.e. the recovery phase, was marked by an aggregate economic performance well above the 2% trend growth rate. More specifically the average annual growth rate of real per capita GDP was 3.13%. The main engine of growth was the TFP factor (net) with an average annual growth rate of 3.43% ($\psi = 0$), 4.15% ($\psi = 0.5$) and 4.70% ($\psi = 1$). Under the specifications $\psi = 0$ and $\psi = 0.5$ the contribution of the labour factor was positive (0.93% and 0.20%) whereas under the specification $\psi = 1$ it was negative (-0.34%). These differences, given the average increase of the per capita non leisure time (0.75%), stem from the path of households' fraction of productive time. Under the first specification it experienced an average annual growth rate of 0.18%, while the respective figures under the other two specifications were -0.55% and -1.09%. Finally, the contribution of the private and the public capital factor turned negative with an average annual growth rate of -1.20% and -0.03% respectively. For this particular subperiod rent seeking activities

can not explain the gap of 1.52 percentage points between the growth rate of the TFP factor (gross) and the 2% trend (see Figure 7(d)). On the contrary, according to our new growth accounting exercise that gap now becomes wider (with an exception of the specification $\psi = 0$), i.e., 1.43% ($\psi = 0$), 2.15% ($\psi = 0.5$) and 2.70% ($\psi = 1$).

The superperiod 2001-2007 is close to be characterized as one of a balanced growth path. The average annual growth rate of real per capita GDP was 3.83% and the workhorse for this economic performance was the TFP factor (net) with a contribution of 3.99% ($\psi = 0$), 4.06% ($\psi = 0.5$) and 4.11% ($\psi = 1$). The private and the public capital factor continued their declining path with an average annual growth rate of -0.60% (half of the respective figure in the 1995-2001 subperiod) and -0.02% respectively. On the other hand the contribution of the labour factor was positive with an average annual growth rate of 0.47% ($\psi = 0$), 0.40% ($\psi = 0.5$) and 0.35% ($\psi = 1$). This was a result of a positive average annual growth rate of the per capita non leisure time of 0.64%. The respective figure for the fraction of productive time was -0.17% ($\psi = 0$), -0.24% ($\psi = 0.5$) and -0.29% ($\psi = 1$).

(Insert Table 3 about here)

The subperiod 2007-2013 was marked by an abrupt fall of real per capita GDP. The average annual growth rate was -3.88%. This steep contraction in aggregate economic activity was a result of two factors. First, the TFP factor (net) experienced a decline of -4.64% ($\psi = 0$), -5.45% ($\psi = 0.5$) and -6.05% ($\psi = 1$) and second, the labour factor decreased by -3.96% ($\psi = 0$), -3.15% ($\psi = 0.5$) and -2.55% ($\psi = 1$). The decline of the labour factor was mostly produced by the decrease of the per capita non leisure time (-3.08%). The average annual growth rate of the fraction of productive time was -0.88% ($\psi = 0$), -0.07% ($\psi = 0.5$) and 0.53% ($\psi = 1$). Finally, the private and the public capital factor had a positive contribution to real per capita GDP growth of 4.37% and 0.34% respectively.

The main question that we address in this study is whether the observed exogenous series of TFP, A_t , the rent seeking technology variable (a proxy for the quality of institutions) ξ_t , the effective tax rates, τ_t^c , τ_t^l , τ_t^k , the public sector GDP components, G_t^c , G_t^i and population, N_t , can account for the aforementioned growth accounting characteristics presented in Table 3. The answer is affirmative. Our model performs well vis-a-vis the data. Furthermore, a non negligible proportion of the decline of the TFP factor (gross) observed in Gogos et al. (2014b), is endogenized and is attributed to rent seeking activities

4 Solving for the DCE path

After doing some algebra we end up with the following six equations in six unknowns, i.e., Y_t , C_t , L_t , K_{t+1} , K_{t+1}^g and R_t (in aggregate terms), in each period t :

$$Y_t = (A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g})^{\frac{1}{\alpha_p + \alpha_g}} \left(\frac{(1 - \tau_t^l)(1 - \alpha_p - \alpha_g)}{\xi_t \frac{R_t}{N_t}} \right)^{\frac{1 - \alpha_p - \alpha_g}{\alpha_p + \alpha_g}} \quad (52)$$

$$Y_t = C_t + K_{t+1} - (1 - \delta^p) K_t + G_t^c + G_t^i \quad (53)$$

$$\frac{1 - \gamma}{\gamma} \frac{C_t + \psi G_t^c}{N_t \bar{h} - L_t} = \frac{1}{1 + \tau_t^c} \xi_t \frac{R_t}{N_t} \quad (54)$$

$$\begin{aligned} & \frac{(C_{t+1} + \psi G_{t+1}^c)^{1-\gamma(1-\sigma)} (N_{t+1} \bar{h} - L_{t+1})^{(\gamma-1)(1-\sigma)}}{(C_t + \psi G_t^c)^{1-\gamma(1-\sigma)} (N_t \bar{h} - L_t)^{(\gamma-1)(1-\sigma)}} \\ &= \beta \frac{1 + \tau_t^c}{1 + \tau_{t+1}^c} \left(1 + (1 - \tau_{t+1}^k) (\alpha_p \frac{Y_{t+1}}{K_{t+1}} - \delta^p) \right) \end{aligned} \quad (55)$$

$$K_{t+1}^g = (1 - \delta^g) K_t^g + G_t^i \quad (56)$$

$$R_t = (\tau_t^l (1 - \alpha_p - \alpha_g) + \tau_t^k (\alpha_p + \alpha_g)) Y_t + \tau_t^c C_t - \tau_t^k \delta^p K_t \quad (57)$$

Solving for the DCE equilibrium path involves choosing sequences of Y_t , C_t , L_t , K_{t+1} , K_{t+1}^g and R_t , such that the system of equations (52) to (57) has a unique solution, given sequences of $\{A_t, \xi_t, N_t, G_t^c, G_t^i, \tau_t^c, \tau_t^l, \tau_t^k\}_{t=T_0}^\infty$, the initial private and public capital stock K_{T_0} , $K_{T_0}^g$, and the corresponding transversality condition. We follow Gogos et al. (2014 a and b) and we convert the above system of infinite equations with infinite unknowns into a tractable dynamic system by assuming that our economy converges to a balanced growth path at some finite date T_1 . Our system is thus reduced to:

For $t = T_0, T_0 + 1, \dots, T_1$

$$Y_t = (A_t K_t^{\alpha_p} (K_t^g)^{\alpha_g})^{\frac{1}{\alpha_p + \alpha_g}} \left(\frac{(1 - \tau_t^l)(1 - \alpha_p - \alpha_g)}{\xi_t \frac{R_t}{N_t}} \right)^{\frac{1 - \alpha_p - \alpha_g}{\alpha_p + \alpha_g}} \quad (58)$$

$$Y_t = C_t + K_{t+1} - (1 - \delta^p) K_t + G_t^c + G_t^i \quad (59)$$

$$\frac{1 - \gamma}{\gamma} \frac{C_t + \psi G_t^c}{N_t \bar{h} - L_t} = \frac{1}{1 + \tau_t^c} \xi_t \frac{R_t}{N_t} \quad (60)$$

$$K_{t+1}^g = (1 - \delta^g) K_t^g + G_t^i \quad (61)$$

$$R_t = (\tau_t^l (1 - \alpha_p - \alpha_g) + \tau_t^k (\alpha_p + \alpha_g)) Y_t + \tau_t^c C_t - \tau_t^k \delta^p K_t \quad (62)$$

For $t = T_0, T_0 + 1, \dots, T_1 - 1$

$$\begin{aligned} & \frac{(C_{t+1} + \psi G_{t+1}^c)^{1-\gamma(1-\sigma)} (N_{t+1} \bar{h} - L_{t+1})^{(\gamma-1)(1-\sigma)}}{(C_t + \psi G_t^c)^{1-\gamma(1-\sigma)} (N_t \bar{h} - L_t)^{(\gamma-1)(1-\sigma)}} \\ &= \beta \frac{1 + \tau_t^c}{1 + \tau_{t+1}^c} \left(1 + (1 - \tau_{t+1}^k) (\alpha_p \frac{Y_{t+1}}{K_{t+1}} - \delta^p) \right) \end{aligned} \quad (63)$$

$$K_{T_1+1} = g_A^{\frac{1}{1-\alpha_p-\alpha_g}} g_N K_{T_1} \quad (64)$$

This is a system of $6(T_1 - T_0 + 1)$ equations, in $6(T_1 - T_0 + 1)$ unknowns, i.e. the respective output, private consumption, private capital, public capital, non leisure time and public

revenues sequences. We set $T_0 = 1970$ and $T_1 = 2269$. Thus, we solve the system for 300 periods.

Since data, for TFP, population and public consumption and investment are available until 2013, and for the effective tax rates until 2011, we make the following assumptions regarding the path that they follow for the period after 2013 and 2011 respectively. For TFP we assume that for 2014 and 2015 follows a proportionally similar path to the respective OECD projections for real per capita GDP and after 2015 increases smoothly until 2020 when it reaches its trend growth rate g_A . In what concerns population we assume that after 2013 it grows at its annual average growth rate over the period 1970-2013, that is g_N . For the rent seeking technology variable we assume that after 2013 it follows a smooth path trajectory (with a constant annual proportional rate of change) and in 2020 it reaches the same value that it had in 2001. After 2020 we assume that its value remains constant. As Figures 5 and 6 display, the value of the rent seeking technology variable in 2013 was higher relative to 2001. As a result for the period 2013-2020 we assume that there is a continuous improvement in the quality of Greece's institutions. Our assumption is consistent with one of the main goals of the relatively recently signed two Greek economic adjustment programmes (2010 and 2012) which is the modernizing of the state and of the public administration.

In what concerns public consumption and investment we make the same assumption as Conesa et al. (2007) do. We assume that after 2013 they grow at a constant growth rate equal to $g_A^{\frac{1}{1-\alpha_p-\alpha_g}} g_N$. This assumption is necessary for our equilibrium to converge to a balanced growth path. Finally, as regards the tax rates we assume that they retain the same values as those in 2011, that is $\tau_t^c = 17.99\%$, $\tau_t^l = 34.69\%$, and $\tau_t^k = 23.19\%$.

5 Numerical experiments

In this Section we compare the growth accounting from the data with that from our artificial economy. Furthermore, we present our model's performance (in figures) relative to the time paths of real per capita private capital stock, real per capita private investment and real per capita private consumption. Our results are presented in Tables 4 (average annual changes, %) and 5 (levels) as well as in Figures 8 to 14. More specifically, Table 5 depicts the index values corresponding to the growth accounting exercise. It shows the index values of detrended real per capita GDP, detrended TFP factor, private capital factor, public capital factor, labour factor, fraction of productive time and per capita non leisure time relative to their respective values in the beginning of the whole period 1973-2013 and in the beginning of each of the five subperiods, i.e. 1973-1979, 1979-1995, 1995-2001, 2001-2007 and 2007-2013.

(Insert Table 4 about here)

As noted in the former subsections we run three numerical experiments. Experiments 1, 2 and 3 (e.g. see Tables 4 and 5) correspond to the cases where $\psi = 0$, $\psi = 0.5$ and $\psi = 1$

respectively. In experiment 1 we treat public consumption as a waste of resources and in experiment 3 as a perfect substitute of private consumption. In what concerns Figures 8 to 14, we present the equilibrium paths (only for experiment 1), along with the data, for the following seven variables: detrended real per capita GDP, private capital factor, fraction of productive time, per capita non leisure time, detrended real per capita private capital stock, detrended real per capita private investment and detrended real per capita private consumption.

(Insert Table 5 about here)

5.1 Data vs model

5.1.1 Last fourty years: 1973-2013

For the 1973-2013 period as a whole all the experiments of our model underestimate the increase of real per capita GDP (0.75% in terms of growth rates).¹⁵ Experiments 1, 2 and 3 predict an average annual growth rate of 0.39%, 0.43% and 0.47% respectively (see Table 4). In terms of detrended index values (see Table 6) experiments 1, 2 and 3 produce a cumulative decline of real per capita GDP equal to -47.09%, -46.31% and -45.37% respectively (-38.82% in the data). As we mentioned in the subsection with the growth accounting exercise, the workhorse of the aforementioned growth performance was the private capital factor (1.58%). On the contrary, the contribution of the labour factor was negative (-1.10% ($\psi = 0$), -1.14% ($\psi = 0.5$) and -1.23% ($\psi = 1$)). Our model reproduces well these growth accounting characteristics. More specifically, in terms of the path of the private capital factor, experiments 1, 2 and 3 predict an average annual increase of 1.48%, 1.51% and 1.55% respectively, and in terms of the path of the labour factor the respective figures are -1.34%, -1.37% and -1.46%.¹⁶ Moreover, our artificial economy performs well in terms of predicting the breakdown of the average annual growth of the labour factor. It underestimates the decrease of the fraction of productive time (-0.54%, -0.58% and -0.67% in the data vs -0.49%, -0.39% and -0.47% in the model) and it overestimates the decrease of the per capita non leisure time (-0.56% in the data vs -0.85%, -0.98% and -0.99% in the model).

(Insert Table 6 about here)

¹⁵Unless otherwise stated, our results are presented in terms of average annual growth rates.

¹⁶It is worth pointing out that all three experiments of our model predict the same equilibrium path for the public capital stock (in all the experiments we have used the same equation, i.e., (61), for the law of motion of public capital stock, the same calibrated value for the constant depreciation rate parameter, the same exogenous series for public investment and the same initial value for the public capital stock). As a result, in Tables 4 to 7 any differences in the solutions of the three experiments with respect to the predicted path of the public capital factor reflect the respective differences in terms of the predicted path of real per capita GDP.

5.1.2 Before crisis: 1973-1979

For the subperiod 1973-1979 our model succeeds in reproducing the path of real per capita GDP. More specifically, experiments 1, 2 and 3 predict an average annual growth rate of 1.84%, 1.76% and 1.77% respectively (2.13% in the data). In what concerns the path of the private capital factor all the experiments overestimate its increase (3.50% in the data vs 4.14%, 3.99% and 3.96% in the model, and 23.36% in the data vs 28.17%, 27.07% and 26.86% in the model in terms of levels). On the other hand, in terms of the path of the labour factor our results are mixed. Experiments 1 and 2 diverge both qualitatively and quantitatively from the data (0.27% and 0.01% in the data vs -0.66% and -0.81% in the model) while experiment 3 diverges only in quantitative terms (-0.51% in the data vs -1.24% in the model). Finally, although our model accounts for - in qualitative terms - the breakdown of the average annual growth rate of the labour factor, it misses its path in quantitative terms. All the experiments predict a big jump of the fraction of productive time (0.89%, 0.62% and 0.11% in the data vs 3.21%, 3.00% and 2.00% in the model) and a steep decline of the per capita non leisure time (-0.62% in the data vs -3.87%, -3.81% and -3.24% in the model).

(Insert Table 7 about here)

The increase in the equilibrium series of the fraction of productive time is attributed to the decrease of the rent seeking technology exogenous variable, ξ_t (see Figure 5(a)). The improvement in the "quality of institutions" (rent seeking becomes more costly) induces households to decrease (increase) the fraction of their non leisure time that devote to rent seeking activities, $1 - n_t$ (productive work). Furthermore, the decrease of the TFP factor (see Figure 7(b)), the increase of the effective tax rate on labour income (from 15.31% in 1973 to 20.04% in 1979) and the increase of public consumption (from 10.20% in 1973 to 14.41% in 1979 as a share of GDP) create a substitution and a negative wealth effect.¹⁷ On the one hand the former creates incentives to households to decrease their non leisure time to productive work, $n_t L_t$, (labour factor). On the other hand the latter creates incentives to households to increase their non leisure time, L_t . According to our results the substitution effect dominates the wealth effect and households decrease their non leisure time to productive work.¹⁸ Finally, since the fraction of productive time, n_t , has increased and the non leisure time to productive work, $n_t L_t$, has decreased, the non leisure time, L_t , has to decrease so as to overshoot the increase of the fraction of productive time (-3.87% vs 3.21%, -3.81% vs 3.00 and -3.24% vs 2.00%).

¹⁷The negative wealth effect becomes smaller as we go from the specification $\psi = 0$, i.e. public consumption is treated as a waste of resources, to $\psi = 1$, i.e. public and private consumption are treated as perfect substitutes.

¹⁸The decrease of the TFP factor and the increase of the effective tax rate on labour income also affect households fraction of productive time (see equation (45)). The former has both a negative and a positive effect since it decreases the compensation of productive work and the contestable prize (through public revenues). The latter has a negative effect since it decreases the net compensation of productive work and increases the contestable prize.

(Insert Figure 8 about here)

5.1.3 Crisis: 1979-1995

For the crisis phase of the Greek great depression episode our model fits the data quite well. In terms of the path of real per capita GDP all the experiments overestimate its decrease. Experiments 1, 2 and 3 predict an average annual growth rate of -0.36%, -0.37% and -0.38% respectively (-0.07% in the data). These growth rates translate to a cumulative decline of detrended real per capita GDP equal to -31.21%, -31.32% and -31.42% respectively (-27.99% in the data). In what concerns the main contributing factor for that poor growth performance, i.e. the labour factor, our model performs well vis-a-vis the data. More specifically, all the experiments underestimate the decrease that we observe in the data (-1.90%, -1.91% and -1.93% in the data vs -1.63%, -1.67% and -1.72% in the model and -26.20%, -26.33% and -26.61% in the data vs -23.01%, -23.44% and -24.09% in the model in terms of levels). Furthermore, in terms of the breakdown of the labour factor all the experiments underestimate the decrease of the fraction of productive time (-1.35%, -1.36% and -1.39% in the data vs -1.23%, -0.97% and -0.82% in the model), experiments 2 and 3 overestimate the decline of the per capita non leisure time (-0.54% in the data vs -0.70% and -0.90% in the model) while experiment 1 underestimates it (-0.54% in the data vs -0.41% in the model).

(Insert Figure 9 about here)

The subperiod 1979-1995 was marked by big increases in the effective tax rates on private consumption expenditures, labour (productive work) income and net capital income (see Figure 4). Furthermore there was an increase of public consumption as a share of GDP (see Figure 2). As was the case with the analysis of the 1973-1979 subperiod, these changes create a substitution and a negative wealth effect. According to our model's results the former effect dominates the latter and our experiments produce an equilibrium series for the labour factor with a negative average annual growth rate. In what concerns the economic rationale that lies behind the decline of the fraction of productive time we observe two opposite effects. On the one hand the aforementioned increases in the effective tax rates create incentives to households to reduce their fraction of productive time (see equation (45)). On the other hand, the subperiod 1979-1995 was also characterized by a decrease in the rent seeking technology variable. This change increases the relative cost of rent seeking activities and consequently creates incentives to households to increase their fraction of productive time. According to our model's response, the former effect dominates the latter and the fraction of productive time decreases, i.e. the effect from the improvement in the quality of institutions does not manage to counterbalance the effect from the increase of the effective tax rates.

(Insert Figure 10 about here)

5.1.4 Recovery: 1995-2001

For the recovery phase, i.e. 1995-2001, our model produces an equilibrium path for real per capita GDP which accounts for the 2/3 of the respective increase in the data. According to our results, experiments 1, 2 and 3 produce an average annual growth rate of 2.07%, 2.04% and 2.01% respectively, lower relative to the data by nearly 1 percentage point (3.13%). In terms of the path of the private capital factor all the experiments of our model underestimate its decrease (-1.20% in the data vs -0.88%, -0.96% and -1.04% in the model) and in terms of the path of the labour factor experiments 1 and 2 underestimate its increase (0.93% and 0.20% in the data vs 0.67% and 0.05% in the model) while experiment 3 slightly overestimates its decrease (-0.34% in the data vs -0.38% in the model). In what concerns the breakdown of the labour factor the results of our model are mixed. Here experiment 3 dominates. It produces an equilibrium path for the fraction of productive time (-1.09% in the data vs -1.16% in the model) and for the per capita non leisure time (0.75% in the data vs 0.78% in the model) which is very close to the data. On the other hand experiments 1 and 2 diverge qualitatively from the data in terms of the per capita non leisure time. The former predicts an average annual growth rate of -0.97% and the respective figure for the latter is -0.56% (0.75% in the data). Finally, experiment 1 overestimates the increase of the fraction of productive time (0.18% in the data vs 1.64% in the model) and experiment 2 underestimates it increase (-0.55% in the data vs -0.06% in the model).

(Insert Figure 11 about here)

The subperiod 1995-2001 was characterized by a boost in the TFP factor, an increase in the effective tax rate on labour income, a steep increase of the effective tax rate on net capital income and a decline in the rent seeking technology variable.¹⁹ In experiment 1 the increase of the fraction of productive time is attributed to the increase of the TFP factor and the decrease of the rent seeking technology variable. These changes counterbalance the effect from the increase of the effective tax rates. This result does not hold for experiments 2 and 3. There the increase of the TFP factor is higher and the decrease of the rent seeking technology variable is lower relative to the respective figures in experiment 1. More specifically, in experiment 2 the effect from these changes is slightly counterbalanced from the effect of the increase of the effective tax rates, i.e. the fraction of productive time decreases with an average annual growth rate of -0.06%. In experiment 3 the drop of the fraction of productive time is even higher.

(Insert Figure 12 about here)

¹⁹As stated in Gogos et al. (2014a), the increase in TFP coincides with the beginning and gradual implementation of structural reforms aimed at the financial liberalization, as well as the deregulation in goods and services markets.

5.1.5 Post depression: 2001-2007

For the post depression subperiod our model performs very well vis-a-vis the data. In terms of the path of real per capita GDP, experiments 1, 2 and 3 predict an average annual growth rate of 3.73%, 3.94% and 4.15% respectively (3.83% in the data). In what concerns the private capital factor, experiment 1 overestimates its decrease (-0.60% in the data vs -0.74% in the model) and experiments 2 and 3 underestimate it (-0.56% and -0.37%). Finally, in terms of the path of the labour factor all the experiments are very close to the data. More specifically, experiment 1, 2 and 3 predict an average annual growth rate of 0.43%, 0.44% and 0.45% respectively (0.47%, 0.40% and 0.35% in the data).

Looking at the middle panel of Table 5 we observe that our model does not succeeds to reproduce the breakdown of the labour factor into its two components. Although it fits the data in qualitative terms it fails to reproduce the data series in quantitative terms. Experiments 1, 2 and 3 predict an average annual change for the fraction of productive time equal to -2.19%, -2.28% and -2.43% respectively (-0.17%, -0.24% and -0.29% in the data) and the respective figures for the per capita non leisure time are 2.62%, 2.71% and 2.88% (0.64% in the model).

(Insert Figure 13 about here)

5.1.6 New crisis: 2007-2013

For the new crisis subperiod our model predicts the steep drop of real per capita GDP observed in the data. Experiments 1, 2 and 3 predict an average annual growth rate of -4.08%, -3.93% and -3.81% respectively (-3.88% in the data). In terms of detrended index values the respective figures are (see the lower panel of Table 7) -30.51%, -29.84% and -29.35% (-29.67% in the data). Except from the TFP factor, the other contributing factor that led to that sharp drop of real per capita GDP was the labour factor. All the experiments of our model reproduce this growth accounting fact, although they overestimate its decrease since they predict an average annual growth rate of -5.04%, -4.37% and -3.95% respectively (-3.96%, -3.15% and -2.55% in the data). In what concerns the decomposition of the labour factor our model succeeds to reproduce the data series in quantitative terms. More specifically, experiments 1, 2 and 3 predict an average annual growth rate for the fraction of productive time equal to -2.66%, -0.70% and 0.63% respectively (-0.88%, -0.07% and 0.53% in the data). The respective figures for the per capita non leisure time are -2.37%, -3.67% and -4.58% (-3.08% in the data). Finally our model fits the data well in terms of the path of the private capital factor (4.37% in the data vs 4.27%, 4.48% and 4.66% in the model).

(Insert Figure 14 about here)

6 Concluding remarks

In this study we investigated whether a dynamic general equilibrium model with a government sector, rent seeking activities and institutional factors can account for Greece's poor economic performance over the period 1979-2001. Our main findings are as follows: First, in terms of the path of key macroeconomic variables, our model fits the data quite well. Second, by conducting a growth accounting exercise we find that during the period 1979-1995 a non negligible proportion of the decline of total factor productivity (TFP) can be accounted by rent seeking activities. Third, our model produces an index which can be interpreted as a measure of the quality of institutions in the Greek economy. Our model based index exhibits a resemblance with the internal country risk guide (ICRG) index which is widely used in the literature as a proxy for the quality of a country's institutions.

References

- [1] Abramovitz M., (1956), "Resource and Output Trends in the United States Since 1870", *American Economic Review*, Vol. 46, pp. 5-23.
- [2] Angelopoulos K., Philippopoulos A., and Vassilatos V., (2009), "The Social Cost of Rent Seeking in Europe", *European Journal of Political Economy*, Vol. 25, pp. 280-299.
- [3] Angelopoulos K., Economides G and Vassilatos V., (2011), "Do Institutions Matter for Economic Fluctuations? Weak Property Rights in a Business Cycle Model for Mexico", *Review of Economic Dynamics*, Vol. 14, pp. 511-531.
- [4] Baxter M. and King R. G., (1993), "Fiscal Policy in General Equilibrium", *American Economic Review*, Vol. 83, No. 3, pp. 315-334.
- [5] Bergoeing R., Kehoe P. J., Kehoe T. J., and Soto R., (2002), "A Decade Lost and Found: Mexico and Chile in the 1980s", *Review of Economic Dynamics*, Vol. 5, pp. 166-205.
- [6] Cole H., Ohanian L., (Winter 1999), "The Great Depression in the United States From a Neoclassical Perspective", *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 23, no. 1, pp. 2-24.
- [7] Conesa J., Kehoe T., and Ruhl K., (November 2007), "Modeling Great Depressions: The Depression in Finland in the 1990s", *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 31, no. 1, pp. 16-44.
- [8] Conesa J. and Kehoe T., (2005), "Productivity, Taxes, and Hours Worked in Spain, 1970-2005", *Manuscript*, University of Minnesota.
- [9] Fiorito R. and Kollintzas T., (2004), "Public Goods, Merit Goods, and the Relation Between Private and Government Consumption", *European Economic Review*, Vol. 48, Issue 6, pp. 1367-1398.
- [10] Gogos, S.G., Mylonidis, N., Papageorgiou, D., Vassilatos, V., (2014a), "1979–2001: A Greek Great Depression Through the Lens of Neoclassical Growth Theory", *Economic Modelling*, No. 36, pp. 316-331.
- [11] Gogos, S.G., Papageorgiou, D., Vassilatos, V., (2014b), "Tax Rates, Government Spending and TFP - A Quantitative Assessment of their Role in the Greek Depression: 1979-2001", *Athens University of Economics and Business, Department of Economics, Working Paper Series*, No. 3, pp. 1-19.
- [12] Gollin D., (2002), "Getting Income Shares Right", *Journal of Political Economy*, Vol. 110, pp. 458-474.

- [13] Hillman, A. L., (2009), "Public Finance and Public Policy: Responsibilities and Limitations of Government", 2nd Edition, Cambridge University Press, New York.
- [14] Kehoe T., (2003), "What Can We Learn from the 1998-2002 Depression in Argentina", *Scottish Journal of Political Economy*, Vol. 50, pp. 609-633.
- [15] Kehoe. T and Prescott E., (2002), "Great Depressions of the 20th Century", *Review of Economic Dynamics*, Vol. 5, pp. 1-18.
- [16] Kehoe. T and Prescott E., (2007), "Great Depressions of the Twentieth Century", Minneapolis, Federal Reserve Bank of Minneapolis.
- [17] Kollintzas T., (2000), "The Inertia of the Status Quo and Other Pathogenic Causes of the Greek Economy" (in Greek), Kritiki Publishing.
- [18] Mendoza E. G, Razin A and Tesar L. L, (1994), "Effective Tax Rates in Macroeconomics, Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption", *Journal of Monetary Economics*, Vol. 34, pp. 297-323.
- [19] Papageorgiou D., (2012), "Fiscal Policy Reforms in General Equilibrium: The case of Greece", *Journal of Macroeconomics*, Vol 34, pp. 504-522.
- [20] Park H., Philippopoulos A. and Vassilatos V., (2005), "Choosing the Size of the Public Sector Under Rent Seeking from State Coffers", *European Journal of Political Economy*, Vol. 21, pp. 830–850.
- [21] Prescott E., (1998), "Needed: A Theory of Total Factor Productivity", *International Economic Review*, Vol. 39, Issue. 3, pp. 525-551.
- [22] Tanzi V.,(1998), "Corruption Around the World: Causes, Consequences, Scope and Cures", *IMF Staff Papers* 45, 559–594, in: Abed, G.T., Gupta, S. (Eds.), *Governance, Corruption and Economic Performance*, International Monetary Fund, Washington, D.C., pp. 19–58.

Appendix A. data

Details on the sources of the data and the construction of the variables, parameters, figures and tables are provided below. First, we present all the variables (along with their sources) that we use in our analysis for the Greek economy. Second, we provide technical details for the construction of some key variables and parameters. Third, we present the specifications for the construction of all tables and figures. All data have been extracted from two data sources, OECD and Groningen Growth Development Center (GGDC) databases. Furthermore, we have used data (only for presentation purposes) from Transparency International a non-governmental organization that monitors corruption for a big sample of countries and from Political Risk Services (PRS) Group Inc.

- (a) OECD (2014), "Aggregate National Accounts: Gross domestic product", OECD National Accounts Statistics (database).
- (b) OECD (2014), "Aggregate National Accounts: Disposable income and net lending/borrowing", OECD National Accounts Statistics (database).
- (c) OECD (2013), "Aggregate National Accounts: Population and employment by main activity", OECD National Accounts Statistics (database).
- (d) OECD (2013), "Detailed National Accounts: Non-Financial Accounts by Sectors", OECD National Accounts Statistics (database).
- (e) OECD (2013), "Revenue Statistics: Greece", OECD Tax Statistics (database).
- (f) OECD (2014), "Labour Force Statistics: Population and labour force", OECD Employment and Labour Market Statistics (database).
- (g) OECD (2014), "OECD Economic Outlook No. 95", OECD Economic Outlook: Statistics and Projections (database).
- (h) OECD (2013), "OECD Economic Outlook No. 93", OECD Economic Outlook: Statistics and Projections (database).
- (i) OECD (2010), "OECD Economic Outlook No. 88", OECD Economic Outlook: Statistics and Projections (database).
- (j) European Commission, Ameco - The annual macro-economic database.

(k) The Conference Board Total Economy Database (January 2014), "Output, Labour, and Labour Productivity, Country Details 1950-2013".

(l) The Conference Board Total Economy Database (January 2014), "Growth Accounting and Total Factor Productivity, Country Details 1950-2013".

(m) Political Risk Services (PRS) Group Inc. - International Country Risk Guide (ICRG) index.

(n) Transparency International - Corruption Perceptions Index (CPI).

Variables for the Greek economy (last update: 26/4/2014)

GR.1: Gross Domestic Product, unit: millions of euros, time period: 1960-2013, source: (a).

GR.2: Gross Domestic Product, unit: millions of 2005 euros, time period: 1960-2015, source: (a) and (g).

GR.3: Final Consumption Expenditure: General Government, unit: millions of euros, time period: 1960-2013, source: (a).

GR.4: Final Consumption Expenditure: Households, unit: millions of euros, time period: 1960-2013, source: (a).

GR.5: Final Consumption Expenditure: Non Profit Institutions Serving Households, unit: millions of euros, time period: 1960-2013, source: (a).

GR.6: Gross Capital Formation, unit: millions of euros, time period: 1960-2013, source: (a).

GR.7: Gross Capital Formation, unit: millions of 2005 euros, time period: 1960-2013, source: (a).

GR.8: Gross Fixed Capital Formation, unit: millions of euros, time period: 1960-2013, source: (a).

GR.9: Gross Fixed Capital Formation, unit: millions of 2005 euros, time period: 1960-2013, source: (a).

GR.10: Gross Government Fixed Capital Formation, unit: millions of euros, time period: 1960-2013, source: (g) and (i).

GR.11: Consumption of Fixed Capital, unit: millions of euros, time period: 1960-2013, source: (b).

GR.12: Government Consumption of Fixed Capital, unit: millions of euros, time period: 1960-2013, source: (g) and (i).

GR.13: Households Consumption of Fixed Capital, unit: millions of euros, time period: 1960-2013, source: (g) and (i).

GR.14: Taxes less Subsidies on Production and Imports, unit: millions of euros, time period: 1970-2013, source: (a).

GR.15: Taxes on Income, Profits, and Capital Gains: Individuals (1100), time period: 1965-2011, source: (e).

GR.16: Taxes on Income, Profits, and Capital Gains: Corporations (1200), time period: 1965-2011, source: (e).

GR.17: Social Security Contributions (2000), time period: 1965-2011, source: (e).

GR.18: Social Security Contributions: Employees (2100), time period: 1965-2011, source: (e).

GR.19: Social Security Contributions: Employer's (2200), time period: 1965-2011, source: (e).

GR.20: Social Security Contributions: Self-Employed or Non Employed (2300), time period: 1965-2011, source: (e).

GR.21: Taxes on Payroll and Workforce (3000), time period: 1965-2011, source: (e).

GR.22: Recurrent Taxes on Immovable Property (4100), time period: 1965-2011, source: (e).

GR.23: Taxes on Financial and Capital Transactions (4400), time period: 1965-2011,

source: (e).

GR.24: General Taxes (5110), time period: 1965-2011, source: (e).

GR.25: Excises (5121), time period: 1965-2011, source: (e).

GR.26: Compensation of Employees, unit: millions of euros, time period: 1970-2013, source: (g) and (i).

GR.27: Households Gross Operating Surplus and Mixed Income, unit: millions of euros, time period: 1970-2013, source: (g) and (i).

GR.28: Total Employment, unit: thousands of persons, time period: 1961-2013, source: (g) and (i).

GR.29: Total Dependent Employment, unit: thousands of persons, time period: 1961-2013, source: (g) and (i).

GR.30: Hours Worked per Employee, unit: hours, time period: 1960-2013, source: (c) and (h).

GR.31: Total Annual Hours Worked, unit: thousands of hours, time period: 1960-2013, source: (k).

GR.32: Labour Compensation Share, unit: percentage, time period: 1990-2011, source: (l).

GR.33: Working Age Population, unit: thousands of persons, time period: 1960-2013, source: (f), (i) and (j).

GR.34: International Country Risk Guide (ICRG) index, time period: 1984-2005, source: (m).

GR.35: Corruption Perceptions Index (CPI), time period: 1995-2013, source: (n).

Construction of variables and parameters

GRC.1 = I_t : For real private investment we construct the following series, $I_t = (GR.8 - GR.10) * \frac{GR.2}{GR.1}$.

GRC.2 = G_t^i : For real public investment we construct the following series, $G_t^i = GR.10 * \frac{GR.2}{GR.1}$.

GRC.3 = C_t : For real private consumption we construct the following series, $C_t = GR.2 - GR.14 * \frac{GR.2}{GR.1} - GRC.1 - GR.3 * \frac{GR.2}{GR.1}$.

GRC.4 = L_t : For labour hours we construct the following series, $L_t = GR.28 * GR.30$.

GRC.5 = K_t : For the construction of real private capital stock K_t we use $\frac{\delta^p K_t}{Y_t} = \frac{GR.11 - GR.12}{GR.1}$ as consumption of private fixed capital over GDP, $GRC.1 = I_t$ and equations (29) and (41).

GRC.6 = K_t^g : For the construction of real public capital stock K_t^g we use $\frac{\delta^g K_t^g}{Y_t} = \frac{GR.12}{GR.1}$ as consumption of public fixed capital over GDP, $GRC.2 = G_t^i$ and equations (30) and (42).

GRC.7 = $1 - \alpha_p - \alpha_g$: To compute the labour share parameter we use $TCE^{DE} = GR.26$, $TCE^{SE} = \frac{GR.26 - GR.19}{GR.29} * (GR.28 - GR.29)$, $Y_t = GR.1$, $NIT = GR.14$ and we take the average (1970-2011) of equation (43).

GRC.8 = ξ_t : As noted in the main text of this study, to construct series for the rent seeking technology variable we use equations (23), (31), (33) and (36). Thus we get

$$\xi_t = \frac{1-\gamma}{\gamma} \frac{GRC.3 + \psi * GR.3 * \frac{GR.2}{GR.1}}{GR.33 * h - GRC.4} * \frac{(1 + GRC.11) * GR.33}{(GRC.11 * GRC.7 + GRC.13 * (\alpha_p + \alpha_g)) * (GR.2 - GR.14 * \frac{GR.2}{GR.1}) - GRC.13 * (GR.11 - GR.12) \frac{GR.2}{GR.1} + GRC.11 * GRC.3}.$$

GRC.9 = n_t : To construct series for the fraction of productive time we use equation (45).

$$\text{Thus we get } n_t = \frac{(1 - GRC.12) * GRC.7 * \frac{GR.2 - GR.14 * \frac{GR.2}{GR.1}}{GRC.4}}{\frac{GRC.8}{GR.33}} * \frac{1}{(GRC.11 * GRC.7 + GRC.13 * (\alpha_p + \alpha_g)) * (GR.2 - GR.14 * \frac{GR.2}{GR.1}) - GRC.13 * (GR.11 - GR.12) \frac{GR.2}{GR.1} + GRC.11 * GRC.3}.$$

GRC.10 = A_t : For the construction of TFP series we plug $K_t = GRC.5$, $K_t^g = GRC.6$, $n_t = GRC.9$, $L_t = GRC.4$, $GRC.7$, α_g is the average of $\frac{GR.10}{GR.1}$ over the period 1970-2013, $1 - \alpha_g - GRC.7 = \alpha_p$, and $Y_t = GR.2 - GR.14 * \frac{GR.2}{GR.1}$ in equation (46).

GRC.11 = τ_t^c : For the construction of the effective tax rate on private consumption expenditures see Appendix B.

GRC.12 = τ_t^l : For the construction of the effective tax rate on labour income see Appendix B.

GRC.13 = τ_t^k : For the construction of the effective tax rate on net capital income see

Specifications for the construction of tables

Table 1: For β we take the average of

$$\beta = \frac{\left(\frac{GRC.3_t + \psi GRC.3_t * \frac{GR.2_t}{GR.1_t}}{GRC.3_{t+1} + \psi GRC.3_{t+1} * \frac{GR.2_{t+1}}{GR.1_{t+1}}} \right)^{\gamma(1-\sigma)-1} \left(\frac{GR.33_t * \bar{h} - GRC.4_t}{GR.33_{t+1} * \bar{h} - GRC.4_{t+1}} \right)^{(1-\gamma)(1-\sigma)}}{\frac{1+GRC.11_t}{1+GRC.11_{t+1}} * \left(1 + (1-GRC.13_{t+1}) * ((1-\alpha_g - GRC.7) * \frac{GR.2_{t+1} - GR.14_{t+1} * \frac{GR.2_{t+1}}{GR.1_{t+1}} - \delta^p}{GRC.5_{t+1}}) \right)}$$

over the period 1970-2010. For details on the computation of γ see subsection 3.6

Table 2: These are the long-run solutions (experiments 1, 2 and 3) of the following variables n_t , Θ_t and $\frac{\Theta_t R_t}{Y_t}$.

Table 3: Average annual differences of the natural logarithm of real per capita GDP (at market prices), $\frac{Y_t}{N_t} = \frac{GR.2}{GR.33}$, TFP factor, $A_t^{\frac{1}{1-\alpha_p-\alpha_g}} = GRC.10^{\frac{1}{GRC.7}}$, private capital factor, $\left(\frac{K_t}{Y_t} \right)^{\frac{\alpha_p}{1-\alpha_p-\alpha_g}} = \left(\frac{GRC.5}{GR.2} \right)^{\frac{1-\alpha_g-GRC.7}{GRC.7}}$, public capital factor, $\left(\frac{K_t^g}{Y_t} \right)^{\frac{\alpha_g}{1-\alpha_p-\alpha_g}} = \left(\frac{GRC.6}{GR.2} \right)^{\frac{1-\alpha_p-GRC.7}{GRC.7}}$, labour factor, $\frac{n_t L_t}{N_t} = \frac{GRC.9 * GRC.4}{GR.33}$, fraction of productive time, n_t , and per capita non-leisure time, $\frac{L_t}{N_t}$.

Table 4 and 5: The columns that present the data are the same as these in Table 3. The other three columns are derived from model's solutions.

Table 6 and 7: The variables are the same as these in Tables 4 and 5. For detrended, 2%, index values we use the formula presented in footnote 2. For index values we use the same formula without the trend parameter.

Specifications for the construction of figures

Figure 1(a) to 1(f): Detrended, 2%, index values of the variables $\frac{Y_t}{N_t} = \frac{GR.2}{GR.33}$ and $A_t^{\frac{1}{1-\alpha_p-\alpha_g}}$ (we use the TFP factor series from Gogos et al. (2014b)).

Figure 2: (a) values of the variable $\frac{GR.3}{GR.1} = \frac{G_t^c * \frac{GR.1}{GR.2}}{Y_t * \frac{GR.1}{GR.2} + GR.14}$ and (b) values of the variable $\frac{GR.10}{GR.1} = \frac{G_t^c * \frac{GR.1}{GR.2}}{Y_t * \frac{GR.1}{GR.2} + GR.14}$.

Figure 3: (a) index values of the variables $\frac{K_t}{Y_t} = \frac{GRC.5}{GR.2}$ and $\frac{K_t^g}{Y_t} = \frac{GRC.6}{GR.2}$, (b) annual percentage changes of the variables $K_t = GRC.5$ and $K_t^g = GRC.6$ and (c) values of the variable $\frac{K_t^g}{K_t} = \frac{GRC.6}{GRC.5}$.

Figure 4: (a) values of the variable $GRC.11 = \tau_t^c$, (b) values of the variable $GRC.12 = \tau_t^l$

and (c) values of the variable $GRC.13 = \tau_t^k$.

Figure 5: (a) index values of the variable $\xi_t = GRC.8$ and (b) values of the variable $n_t = GRC.9$.

Figure 6: (a) index values of the variable $GR.34$ and $\xi_t = GRC.8$, and (b) index values of the variable $GR.35$ and $\xi_t = GRC.8$.

Figure 7(a) to 7(f): Detrended, 2%, index values of the variables $A_t^{\frac{1}{1-\alpha_p-\alpha_g}} = GRC.10^{\frac{1}{GRC.7}}$ and $A_t^{\frac{1}{1-\alpha_p-\alpha_g}}$ (we use the TFP factor series from Gogos et al. (2014b)).

Figure 8(a) to 8(f): The solid line is the detrended, 2%, index value of $\frac{Y_t}{N_t} = \frac{GR.2}{GR.33}$, the dashed line is the respective series from model's solution (experiment 1).

Figure 9(a) to 9(f): The solid line is the index value of $\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha_p}{1-\alpha_p-\alpha_g}} = \left(\frac{GRC.5}{GR.2}\right)^{\frac{1-\alpha_g-GRC.7}{GRC.7}}$, the dashed line is the respective series from model's solution (experiment 1).

Figure 10(a) to 10(f): The solid line is the index value of $n_t = GRC.9$, the dashed line is the respective series from model's solution (experiment 1).

Figure 11(a) to 11(f): The solid line is the index value of $\frac{L_t}{N_t} = \frac{GRC.4}{GR.33}$, the dashed line is the respective series from model's solution (experiment 1).

Figure 12(a) to 12(f): The solid line is the detrended, 2%, index value of $\frac{K_t}{N_t} = \frac{GRC.5}{GR.33}$, the dashed line is the respective series from model's solution (experiment 1).

Figure 13(a) to 13(f): The solid line is the detrended, 2%, index value of $\frac{I_t}{N_t} = \frac{GRC.1}{GR.33}$, the dashed line is the respective series from model's solution (experiment 1).

Figure 14(a) to 14(f): The solid line is the detrended, 2%, index value of $\frac{C_t}{N_t} = \frac{GRC.3}{GR.33}$, the dashed line is the respective series from model's solution (experiment 1).

Appendix B. effective tax rates, $\tau_t^c, \tau_t^l, \tau_t^k$

To compute series for the effective tax rates τ_t^c , τ_t^l , and τ_t^k , we follow Papageorgiou (2012) and we adopt a variation from the methodology of Mendoza et al. (1994). First, when we compute the tax base on labour income we take into account the labour income earned from the self-employed. Doing this, makes the specific tax rate series consistent with our labour share parameter estimate. Second, since in our theoretical framework decisions, from households and firms, are taken at the margin we set the income tax rates, τ_t^l and τ_t^k , equal to their effective marginal rates. In order to convert the effective average taxes rates to marginal, we follow Prescott (2002) and we simply multiply the first by a factor of 1.6. Given data on tax bases (consumption, income, and investment) and tax revenues, the marginal effective tax rates are computed as follows:

Effective consumption tax rate (τ_t^c)

We define the tax base as the sum of households (H) and nonprofit institutions serving households (NPISH'S) final consumption expenditures (FCE). The tax revenues are general taxes (GT 2100) and excises (EXC 5121).²⁰

$$\tau_t^c = \frac{GT(5110) + EXC(5121)}{H\ FCE + NPISH'S\ FCE - GT(5110) - EXC(5121)} \quad (65)$$

Effective income tax rate (τ_t^h)

To compute series for labour and capital income tax rates, we begin by computing the aggregate marginal tax rate on household income. We define the tax base as the sum of compensation of employees (net of employer's (2200) and employees (2100) contributions to social security (SSC)), imputed compensation of the self-employed (net of self-employed or non-employed contributions to social security (SSC 2300)), and households' non labour income. The last component is taken residually by subtracting from households' net operating surplus and mixed income (HGOSMI - HCFC) compensation of the self-employed. The tax revenues are taxes on income, profits, and capital gains of individuals (TIPCGI 1100).

$$\tau_t^h = \mu \frac{TIPCGI(1100)}{TCE^{DE} - SSC(2200) - SSC(2100) + TCE^{SE} - SSC(2300) + HGOSMI - HCFC - TCE^{SE}}$$

²⁰The numbers in the parentheses are the codes of the specific tax revenues in the OECD tax statistics database.

$$\Rightarrow \tau_t^h = \mu \frac{TIPCGI(1100)}{TCE^{DE} - SSC(2200) - SSC(2100) - SSC(2300) + HGOSMI - HCFC} \quad (66)$$

where HCFC is households' consumption of fixed capital. The progressivity of the income tax system implies that marginal tax rates tend to be larger than the average tax rates we are computing. The term μ is an adjustment factor that transforms average tax rates to marginal tax rates. We follow Prescott (2002) and we set $\mu = 1.6$.

Effective labour tax rate (τ_t^l)

The tax revenues are computed as follows: We add to tax revenues from households' labour income, social security contributions (SSC 2000) and taxes on payroll and workforce (TPW 3000). The tax base is simply the total labour income.

$$\tau_t^l = \frac{\tau_t^h (TCE^{DE} - SSC(2200) - SSC(2100) + TCE^{SE} - SSC(2300)) + SSC(2000) + TPW(3000)}{TCE^{DE} + TCE^{SE}} \quad (67)$$

Effective capital tax rate (τ_t^k)

The tax revenues are computed as follows: We add to tax revenues from households' capital income, taxes on income, profits, and capital gains of corporations (TIPCGC 1200), recurrent taxes on immovable property (RTIP 4100), and taxes on financial and capital transactions (TFCT 4400). The tax base is simply the total net capital income.

$$\tau_t^k = \frac{\tau_t^h (HGOSMI - HCFC - TCE^{SE}) + TIPCGC(1200) + RTIP(4100) + TFCT(4400)}{GDP - NIT - CFC - TCE^{DE} - TCE^{SE}} \quad (68)$$

where CFC is consumption of fixed capital.

Figure 1: Detrended Real per Capita GDP and TFP Factor, 1973-2013

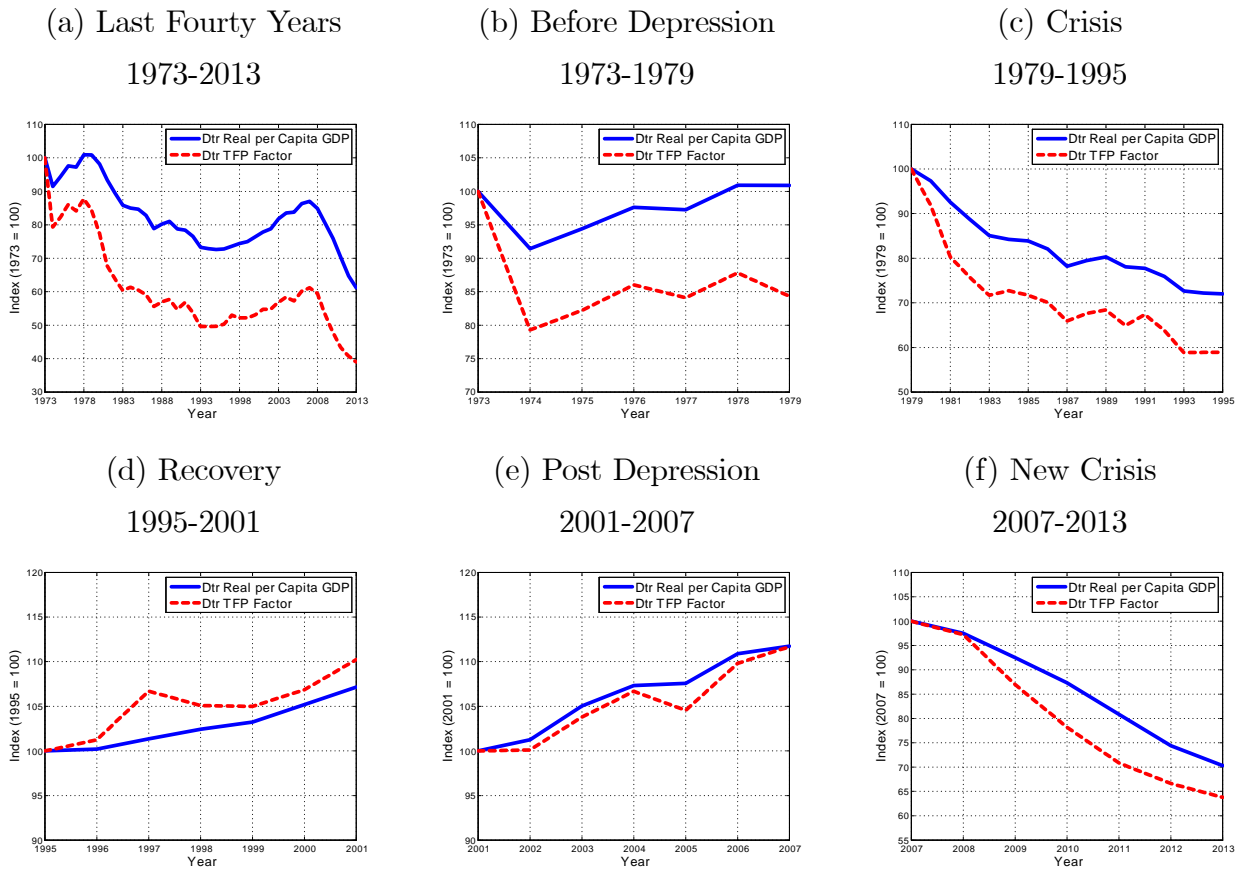


Figure 2: Public Consumption and Investment as Shares of GDP, 1960-2013

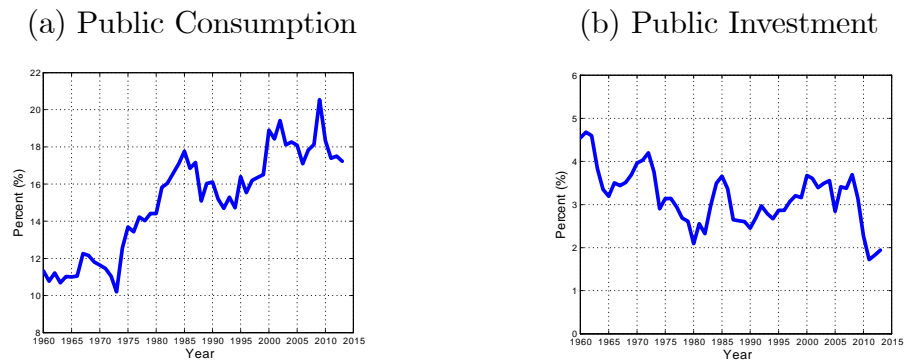


Figure 3: Capital Stock (Private and Public), 1960-2013

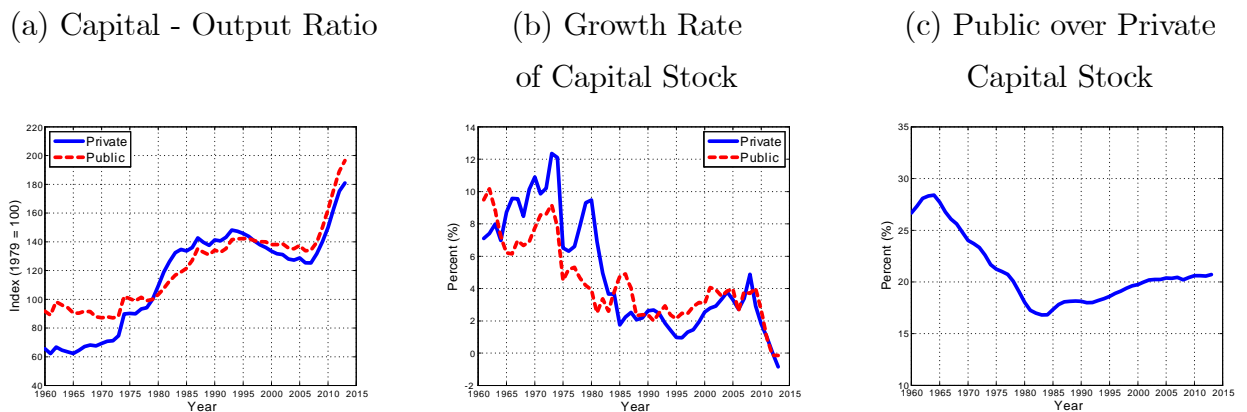


Figure 4: Effective Tax Rates, 1970-2011

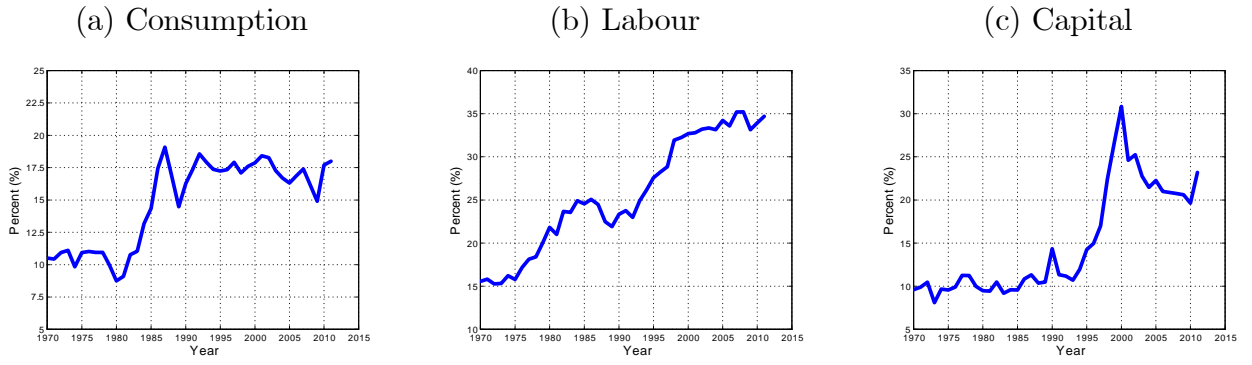


Figure 5: Rent Seeking Technology and Fraction of Productive Time, 1973-2013

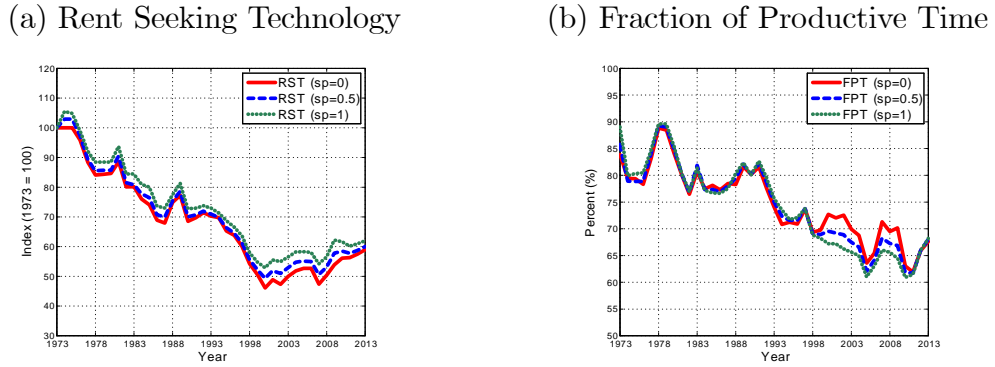


Figure 6: Rent Seeking Technology, Official and Model Based Indices, 1984-2013

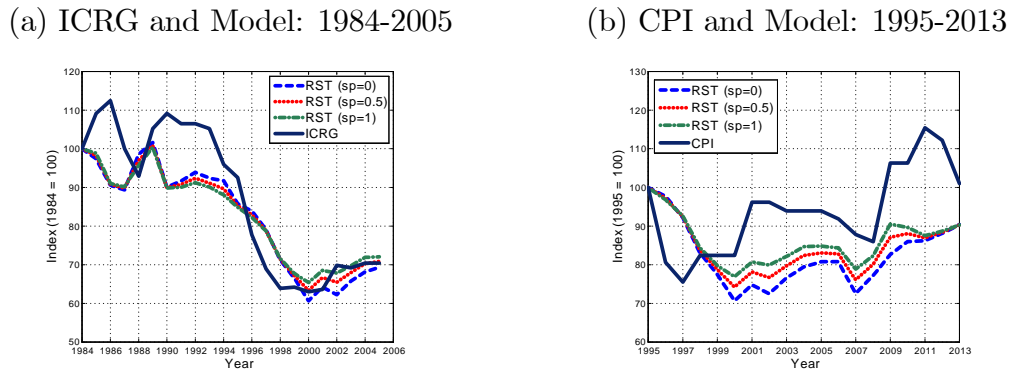


Figure: 7 Detrended TFP Factor

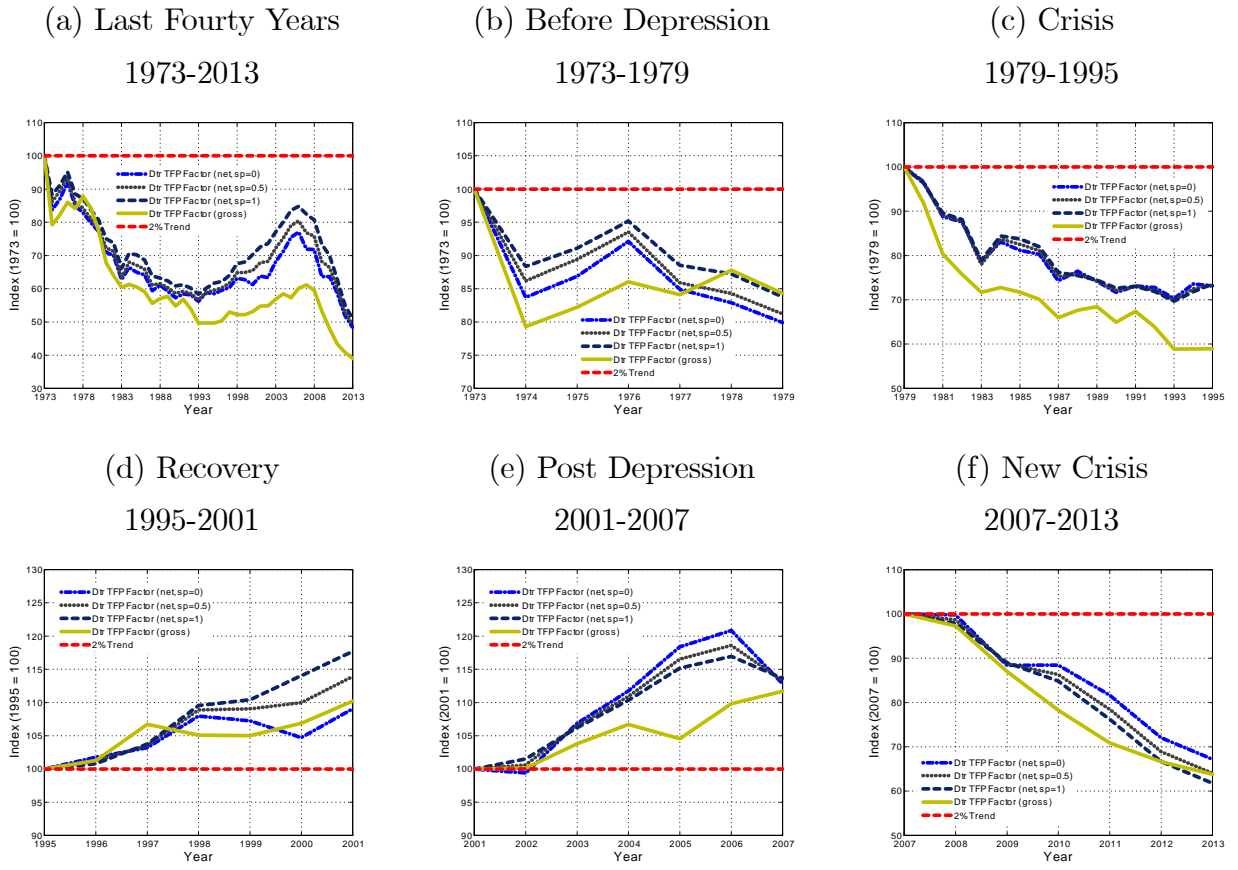


Figure 8: Data vs Model: Detrended Real per Capita GDP

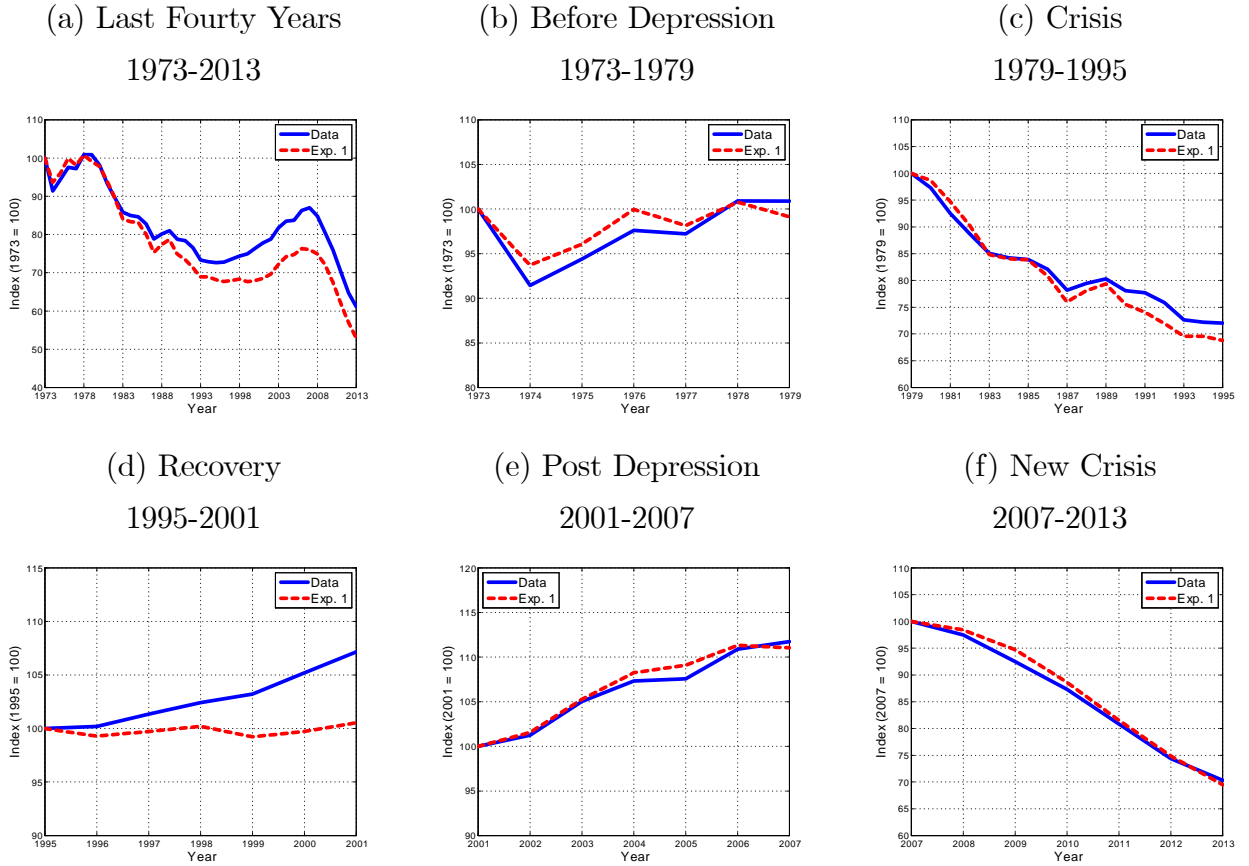


Figure 9: Data vs Model: Capital Factor (Private)

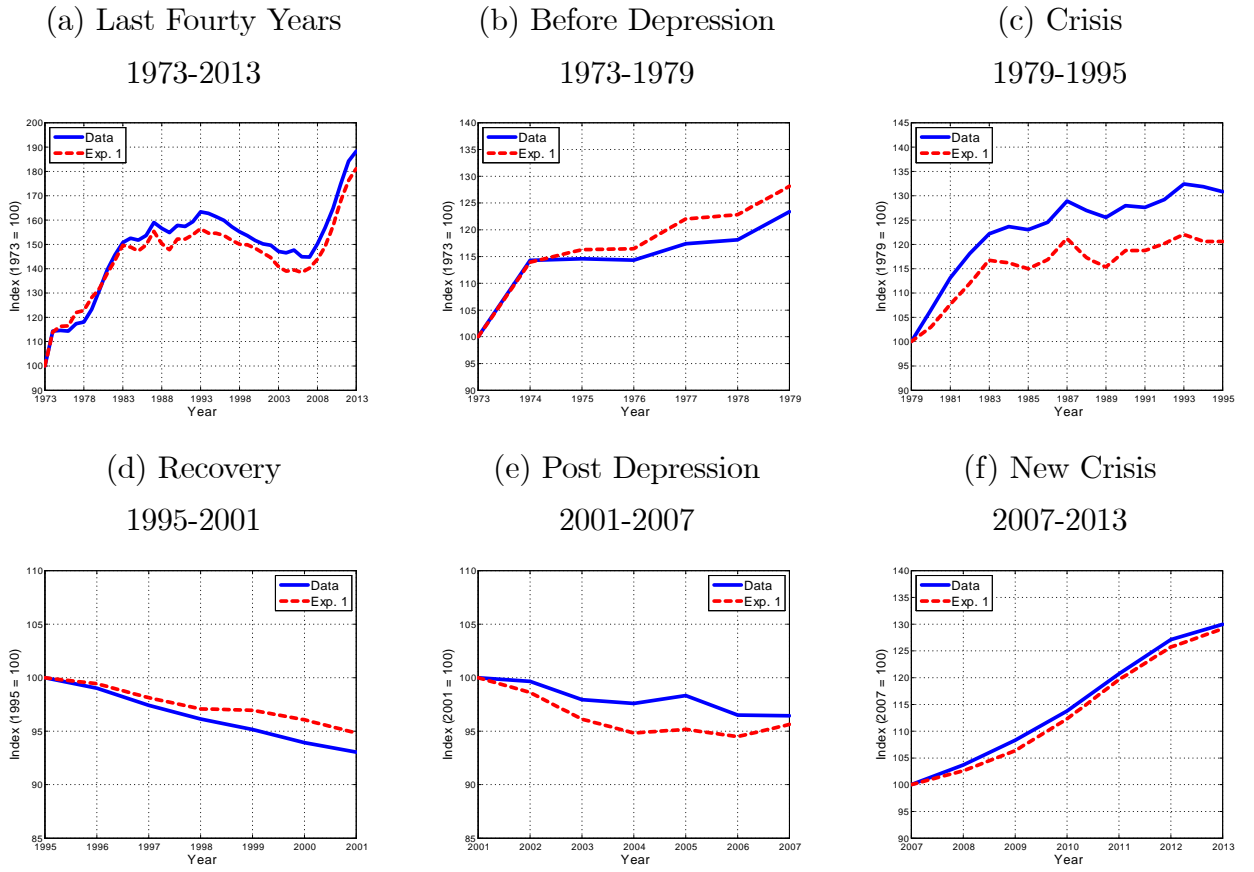


Figure 10: Data vs Model: Fraction of Productive Time

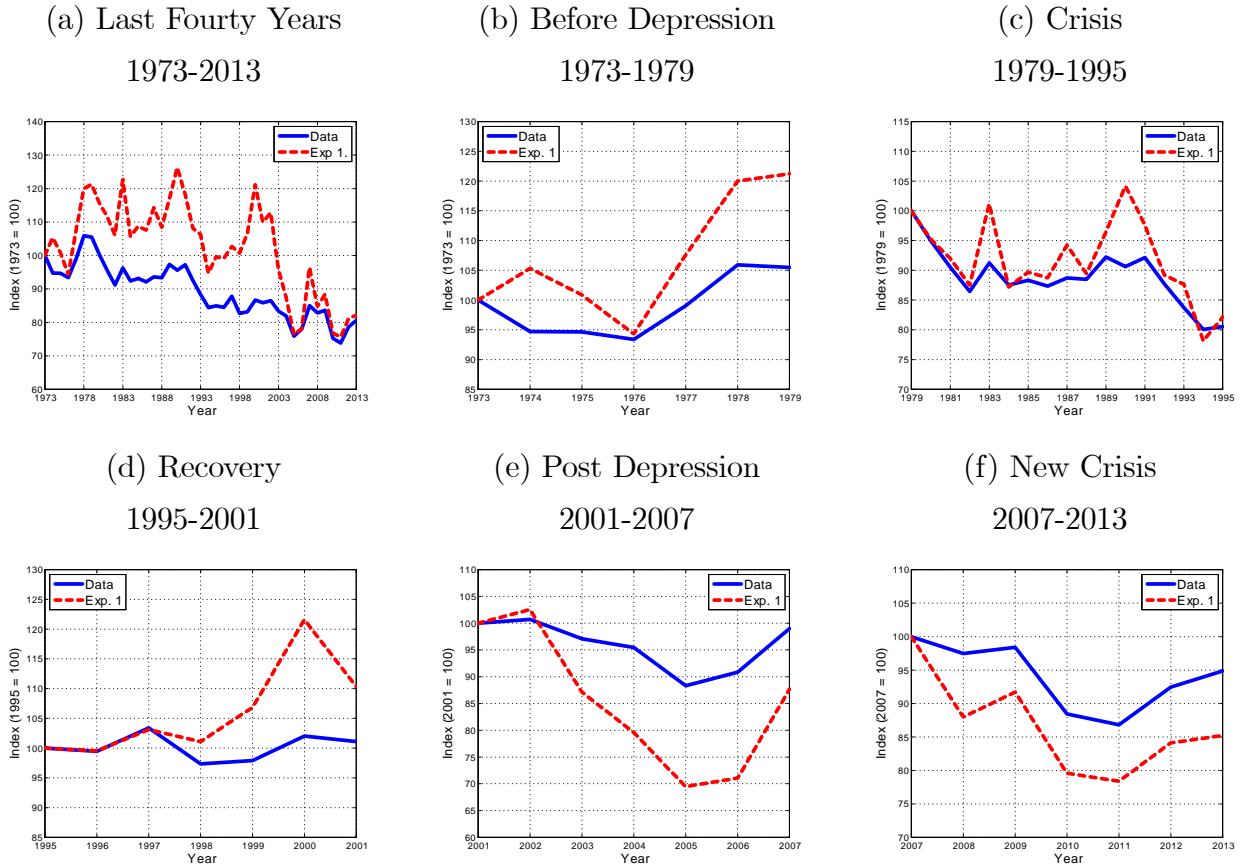


Figure 11: Data vs Model: Per Capita Non Leisure Time

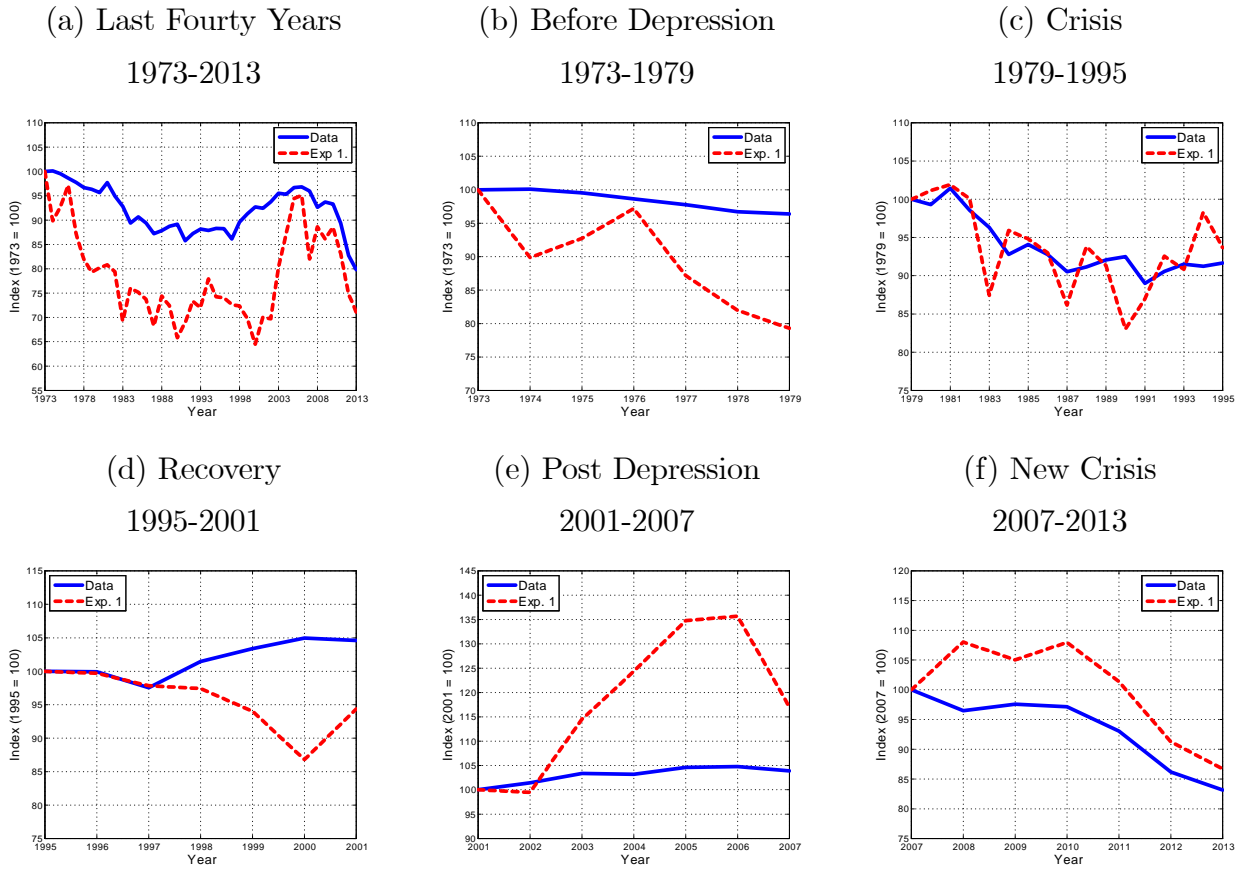


Figure 12: Data vs Model: Detrended Real per Capita Capital Stock (Private)

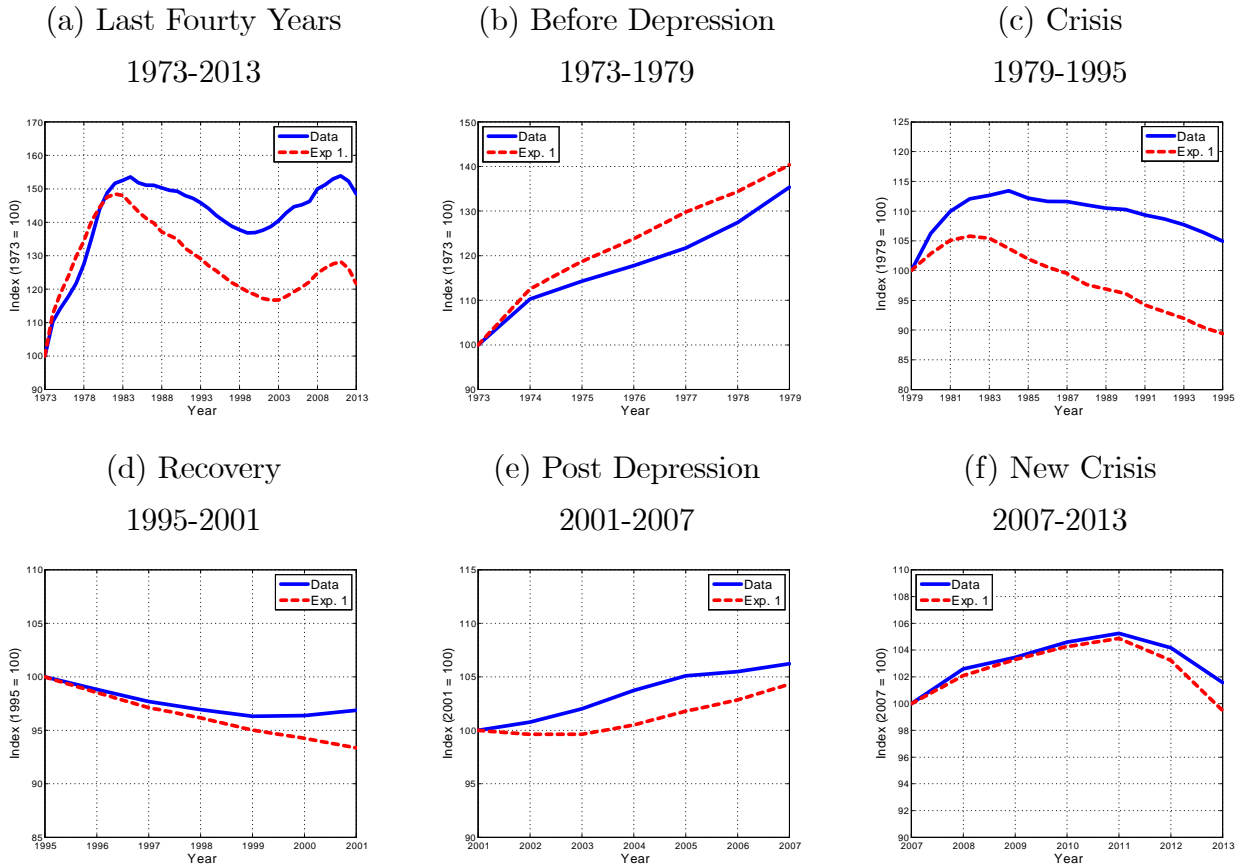


Figure 13: Data vs Model: Detrended Real per Capita Consumption (Private)

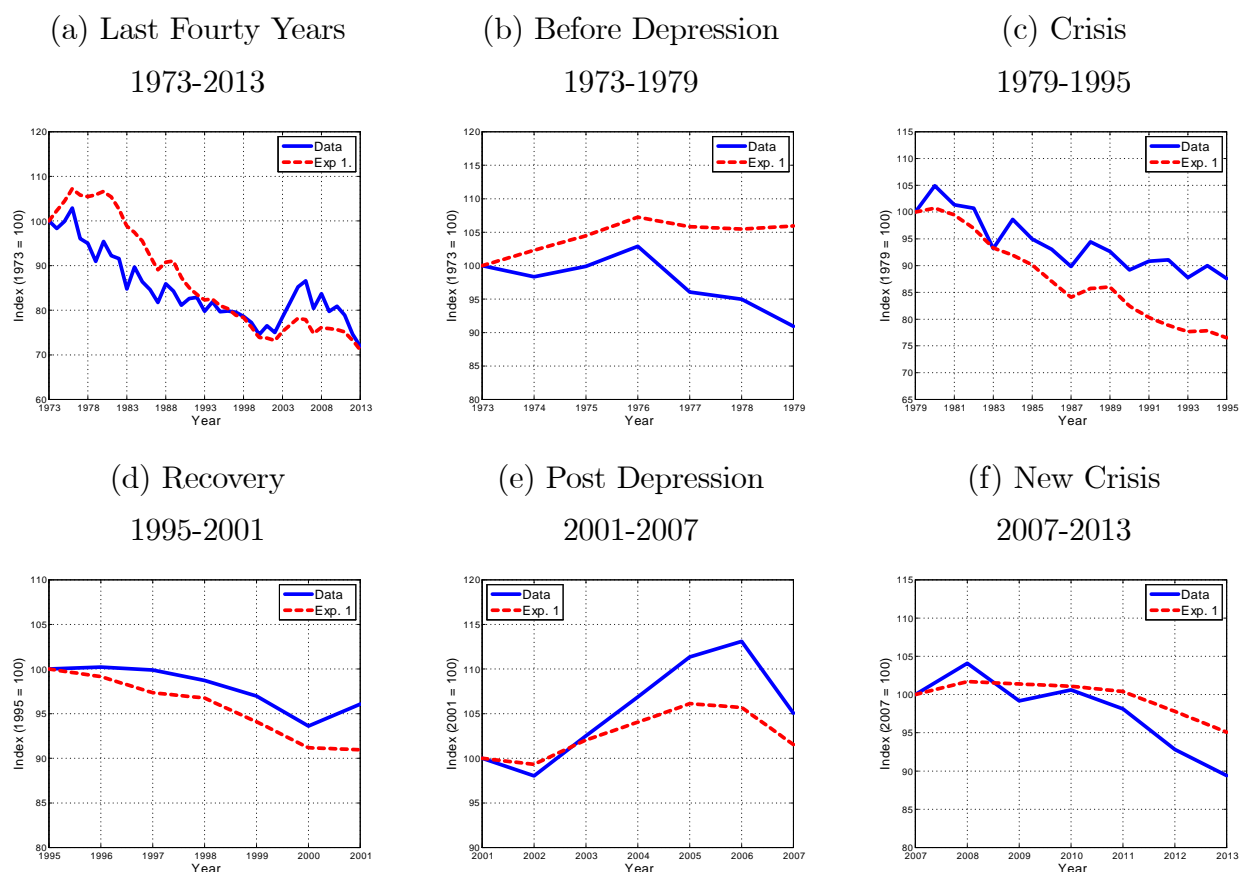


Figure 14: Data vs Model: Detrended Real per Capita Investment (Private)

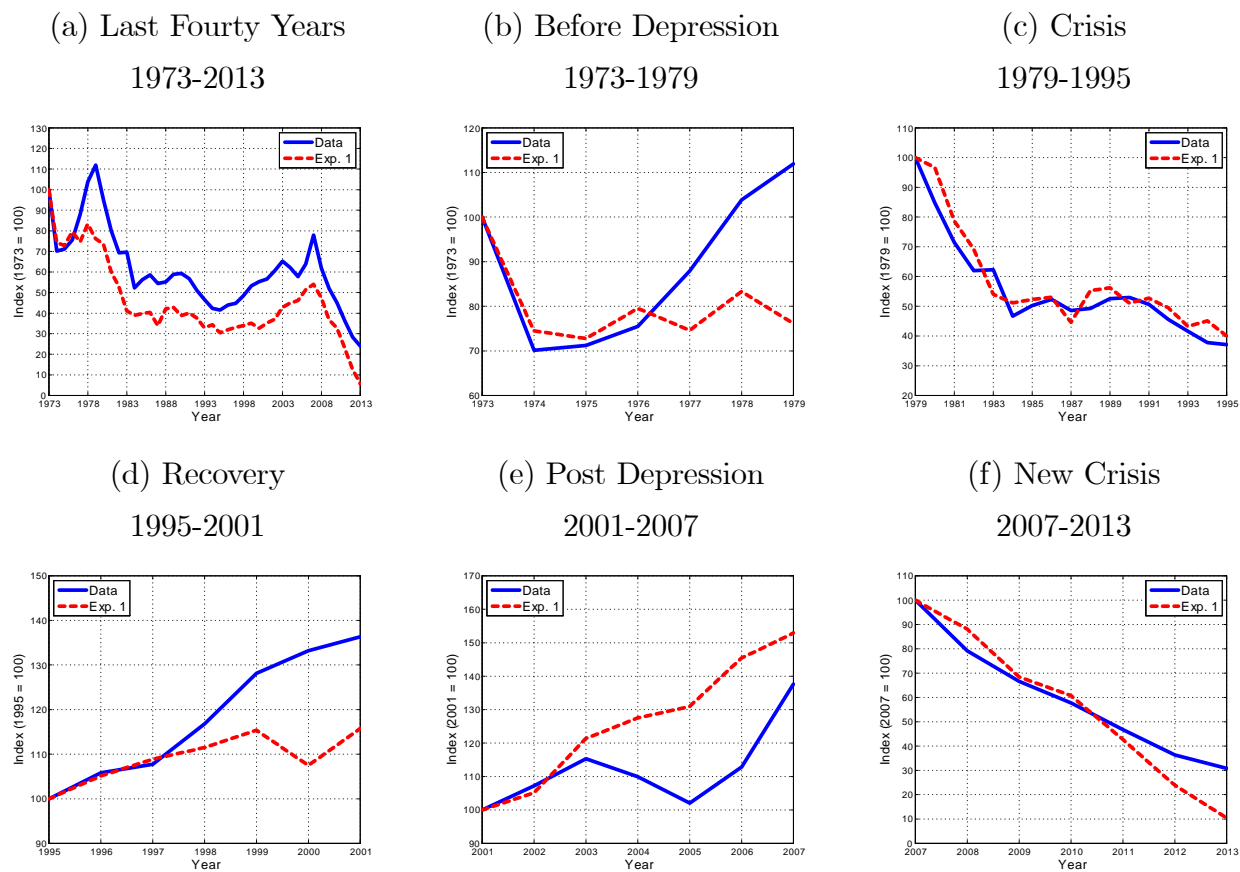


Table 1: Calibration

Experiments	1	2	3				
Substitutability Parameter	$\psi = 0$	$\psi = 0.5$	$\psi = 1$				
Parameters							
γ	0.2749	0.3038	0.3303				
β	0.9496	0.9510	0.9523				
Parameters with common values to all 3 experiments							
δ^p	δ^g	α_p	α_g	g_A	g_N	\bar{h}	σ
3.96%	2.59%	43.40%	3.01%	1.0113	1.0052	5096	2

Table 2: Long-Run Solutions for Rent Seeking Activity

Variable	Description	Long-Run Solution
Substitutability Parameter		
n_t	Fraction of Productive Time	
$\psi = 0$ (Experiment 1)		70.29%
$\psi = 0.5$ (Experiment 2)		73.24%
$\psi = 1$ (Experiment 3)		78.86%
Θ_t	Rent Seeking Extraction	
$\psi = 0$ (Experiment 1)		41.85%
$\psi = 0.5$ (Experiment 2)		36.38%
$\psi = 1$ (Experiment 3)		26.80%
$\frac{\Theta_t R_t}{Y_t}$	Extracted Rents as % of GDP	
$\psi = 0$ (Experiment 1)		15.62%
$\psi = 0.5$ (Experiment 2)		13.50%
$\psi = 1$ (Experiment 3)		9.91%

Table 3: Accounting for Growth - Average Annual Changes, %

Growth Accounting Components	Before Depression			Crisis		
	1973-1979			1979-1995		
	$\psi = 0$	$\psi = 0.5$	$\psi = 1$	$\psi = 0$	$\psi = 0.5$	$\psi = 1$
Real per Capita GDP	2.13	-//-	-//-	-0.07	-//-	-//-
TFP Factor (net)	-1.75	-1.49	-0.97	0.03	0.04	0.06
<i>TFP Factor (gross)</i>	<i>-0.66</i>	<i>-//-</i>	<i>-//-</i>	<i>-1.33</i>	<i>-//-</i>	<i>-//-</i>
Private Capital Factor	3.50	-//-	-//-	1.68	-//-	-//-
Public Capital Factor	0.11	-//-	-//-	0.12	-//-	-//-
Labour Factor	0.27	0.01	-0.51	-1.90	-1.91	-1.93
Fraction of Productive Time	0.89	0.62	0.11	-1.35	-1.36	-1.39
<i>Per Capita Non Leisure Time</i>	<i>-0.62</i>	<i>-//-</i>	<i>-//-</i>	<i>-0.54</i>	<i>-//-</i>	<i>-//-</i>
*				40.84	41.14	41.74
	Recovery			Post Depression		
	1995-2001			2001-2007		
	$\psi = 0$	$\psi = 0.5$	$\psi = 1$	$\psi = 0$	$\psi = 0.5$	$\psi = 1$
Real per Capita GDP	3.13	-//-	-//-	3.83	-//-	-//-
TFP Factor (net)	3.43	4.15	4.70	3.99	4.06	4.11
<i>TFP Factor (gross)</i>	<i>3.52</i>	<i>-//-</i>	<i>-//-</i>	<i>3.80</i>	<i>-//-</i>	<i>-//-</i>
Private Capital Factor	-1.20	-//-	-//-	-0.60	-//-	-//-
Public Capital Factor	-0.03	-//-	-//-	-0.02	-//-	-//-
Labour Factor	0.93	0.20	-0.34	0.47	0.40	0.35
Fraction of Productive Time	0.18	-0.55	-1.09	-0.17	-0.24	-0.29
<i>Per Capita Non Leisure Time</i>	<i>0.75</i>	<i>-//-</i>	<i>-//-</i>	<i>0.64</i>	<i>-//-</i>	<i>-//-</i>
	New Crisis			Last Fourty Years		
	2007-2013			1973-2013		
	$\psi = 0$	$\psi = 0.5$	$\psi = 1$	$\psi = 0$	$\psi = 0.5$	$\psi = 1$
Real per Capita GDP	-3.88	-//-	-//-	0.75	-//-	-//-
TFP Factor (net)	-4.64	-5.45	-6.05	0.17	0.21	0.29
<i>TFP Factor (gross)</i>	<i>-5.52</i>	<i>-//-</i>	<i>-//-</i>	<i>-0.36</i>	<i>-//-</i>	<i>-//-</i>
Private Capital Factor	4.37	-//-	-//-	1.58	-//-	-//-
Public Capital Factor	0.34	-//-	-//-	0.11	-//-	-//-
Labour Factor	-3.96	-3.15	-2.55	-1.10	-1.14	-1.23
Fraction of Productive Time	-0.88	-0.07	0.53	-0.54	-0.58	-0.67
<i>Per Capita Non Leisure Time</i>	<i>-3.08</i>	<i>-//-</i>	<i>-//-</i>	<i>-0.56</i>	<i>-//-</i>	<i>-//-</i>

* During the period 1979-1995 the average annual growth rate of the TFP factor (gross) was -1.33%. Hence, on average, there was a gap of 3.33 percentage points between that rate and the 2% trend. Based on our new growth accounting exercise this gap now becomes 1.97 for $\psi = 0$. As a result, rent seeking activities can account for the 40.84% ($\frac{3.33-1.97}{1.97}$) of the gap between the average annual growth rate of the TFP factor (gross) and the 2% trend.

Table 4: Average Annual Changes in Real per Capita GDP, %

Growth Accounting Components	Experiments					
	$\psi = 0$		$\psi = 0.5$		$\psi = 1$	
	1		2		3	
	Data	Model	Data	Model	Data	Model
1973-2013						
Real per Capita GDP	0.75	0.39	-//-	0.43	-//-	0.47
TFP Factor	0.17	0.12	0.21	0.16	0.29	0.25
Capital Factor (Private)	1.58	1.48	-//-	1.51	-//-	1.55
Capital Factor (Public)	0.11	0.13	-//-	0.12	-//-	0.12
Labour Factor	-1.10	-1.34	-1.14	-1.37	-1.23	-1.46
<i>Fraction of Productive Time</i>	-0.54	-0.49	-0.58	-0.39	-0.67	-0.47
<i>Per Capita Non Leisure Time</i>	-0.56	-0.85	-//-	-0.98	-//-	-0.99
1973-1979						
Real per Capita GDP	2.13	1.84	-//-	1.76	-//-	1.77
TFP Factor	-1.75	-1.77	-1.49	-1.56	-0.97	-1.08
Capital Factor (Private)	3.50	4.14	-//-	3.99	-//-	3.96
Capital Factor (Public)	0.11	0.13	-//-	0.13	-//-	0.13
Labour Factor	0.27	-0.66	0.01	-0.81	-0.51	-1.24
<i>Fraction of Productive Time</i>	0.89	3.21	0.62	3.00	0.11	2.00
<i>Per Capita Non Leisure Time</i>	-0.62	-3.87	-//-	-3.81	-//-	-3.24
1979-1995						
Real per Capita GDP	-0.07	-0.36	-//-	-0.37	-//-	-0.38
TFP Factor	0.03	-0.03	0.04	0.00	0.06	0.04
Capital Factor (Private)	1.68	1.17	-//-	1.17	-//-	1.18
Capital Factor (Public)	0.12	0.13	-//-	0.13	-//-	0.13
Labour Factor	-1.90	-1.63	-1.91	-1.67	-1.93	-1.72
<i>Fraction of Productive Time</i>	-1.35	-1.23	-1.36	-0.97	-1.39	-0.82
<i>Per Capita Non Leisure Time</i>	-0.54	-0.41	-//-	-0.70	-//-	-0.90

Table 5: Average Annual Changes in Real per Capita GDP, %

Growth Accounting Components	Experiments					
	$\psi = 0$		$\psi = 0.5$		$\psi = 1$	
	1		2		3	
	Data	Model	Data	Model	Data	Model
1995-2001						
Real per Capita GDP	3.13	2.07	-//-	2.04	-//-	2.01
TFP Factor	3.43	2.25	4.15	2.92	4.70	3.40
Capital Factor (Private)	-1.20	-0.88	-//-	-0.96	-//-	-1.04
Capital Factor (Public)	-0.03	0.03	-//-	0.03	-//-	0.03
Labour Factor	0.93	0.67	0.20	0.05	-0.34	-0.38
<i>Fraction of Productive Time</i>	0.18	1.64	-0.55	-0.06	-1.09	-1.16
<i>Per Capita Non Leisure Time</i>	0.75	-0.97	-//-	-0.56	-//-	0.78
2001-2007						
Real per Capita GDP	3.83	3.73	-//-	3.94	-//-	4.15
TFP Factor	3.99	4.05	4.06	4.09	4.11	4.12
Capital Factor (Private)	-0.60	-0.74	-//-	-0.56	-//-	-0.37
Capital Factor (Public)	-0.02	-0.02	-//-	-0.03	-//-	-0.04
Labour Factor	0.47	0.43	0.40	0.44	0.35	0.45
<i>Fraction of Productive Time</i>	-0.17	-2.19	-0.24	-2.28	-0.29	-2.43
<i>Per Capita Non Leisure Time</i>	0.64	2.62	-//-	2.71	-//-	2.88
2007-2013						
Real per Capita GDP	-3.88	-4.08	-//-	-3.93	-//-	-3.81
TFP Factor	-4.64	-3.66	-5.45	-4.37	-6.05	-4.86
Capital Factor (Private)	4.37	4.27	-//-	4.48	-//-	4.66
Capital Factor (Public)	0.34	0.35	-//-	0.34	-//-	0.33
Labour Factor	-3.96	-5.04	-3.15	-4.37	-2.55	-3.95
<i>Fraction of Productive Time</i>	-0.88	-2.66	-0.07	-0.70	0.53	0.63
<i>Per Capita Non Leisure Time</i>	-3.08	-2.37	-//-	-3.67	-//-	-4.58

Table 6: Levels, Indices

Growth Accounting Components	Experiments					
	$\psi = 0$		$\psi = 0.5$		$\psi = 1$	
	1		2		3	
	Data	Model	Data	Model	Data	Model
<hr/> 1973-2013 (1973=100)						
Dtr Real per Capita GDP	61.18	52.91	-/-	53.69	-/-	54.63
Dtr TFP Factor	48.39	47.53	49.23	48.30	50.95	50.06
Capital Factor (Private)	188.28	181.11	-/-	183.11	-/-	186.15
Capital Factor (Public)	104.34	105.15	-/-	105.07	-/-	104.97
Labour Factor	64.36	58.46	63.26	57.78	61.13	55.85
<i>Fraction of Productive Time</i>	80.64	82.19	79.26	85.44	76.58	82.85
<i>Per Capita Non Leisure Time</i>	79.82	71.13	-/-	67.62	-/-	67.41
<hr/> 1973-1979 (1973=100)						
Dtr Real per Capita GDP	100.88	99.14	-/-	98.68	-/-	98.76
Dtr TFP Factor	79.92	79.86	81.21	80.88	83.76	83.22
Capital Factor (Private)	123.36	128.17	-/-	127.07	-/-	126.86
Capital Factor (Public)	100.66	100.76	-/-	100.78	-/-	100.78
Labour Factor	101.64	96.13	100.03	95.28	96.98	92.84
<i>Fraction of Productive Time</i>	105.48	121.26	103.81	119.71	100.65	112.78
<i>Per Capita Non Leisure Time</i>	96.36	79.28	-/-	79.59	-/-	82.32
<hr/> 1979-1995 (1979=100)						
Dtr Real per Capita GDP	72.01	68.79	-/-	68.68	-/-	68.58
Dtr TFP Factor	73.18	72.55	73.31	72.81	73.59	73.26
Capital Factor (Private)	130.85	120.59	-/-	120.63	-/-	120.73
Capital Factor (Public)	101.89	102.14	-/-	102.15	-/-	102.15
Labour Factor	73.80	76.99	73.67	76.56	73.39	75.91
<i>Fraction of Productive Time</i>	80.52	82.17	80.38	85.60	80.07	87.73
<i>Per Capita Non Leisure Time</i>	91.65	93.69	-/-	89.43	-/-	86.52

Table 7: Levels, Indices

Growth Accounting Components	Experiments					
	$\psi = 0$		$\psi = 0.5$		$\psi = 1$	
	1		2		3	
	Data	Model	Data	Model	Data	Model
<hr/> 1995-2001 <hr/>						
Real per Capita GDP	107.15	100.55	-//-	100.38	-//-	100.20
TFP Factor	109.06	101.63	113.94	105.79	117.72	108.89
Capital Factor (Private)	93.05	94.85	-//-	94.41	-//-	93.97
Capital Factor (Public)	99.84	100.18	-//-	100.19	-//-	100.20
Labour Factor	105.76	104.12	101.23	100.30	97.98	97.73
<i>Fraction of Productive Time</i>	101.09	110.34	96.75	99.67	93.65	93.26
<i>Per Capita Non Leisure Time</i>	104.63	94.36	-//-	100.64	-//-	104.80
 2001-2007 <hr/>						
Real per Capita GDP	111.76	111.04	-//-	112.49	-//-	113.93
TFP Factor	112.83	113.25	113.31	113.51	113.65	113.68
Capital Factor (Private)	96.44	95.64	-//-	96.71	-//-	97.78
Capital Factor (Public)	99.85	99.88	-//-	99.82	-//-	99.75
Labour Factor	102.86	102.63	102.43	102.67	102.12	102.75
<i>Fraction of Productive Time</i>	98.99	87.71	98.57	87.23	98.27	86.46
<i>Per Capita Non Leisure Time</i>	103.91	117.01	-//-	117.69	-//-	118.65
 2007-2013 <hr/>						
Real per Capita GDP	70.33	69.49	-//-	70.16	-//-	70.65
TFP Factor	67.23	71.28	64.05	68.30	61.78	66.33
Capital Factor (Private)	129.98	129.17	-//-	130.83	-//-	132.29
Capital Factor (Public)	102.05	102.11	-//-	102.06	-//-	102.02
Labour Factor	78.87	73.92	82.79	76.92	85.84	78.92
<i>Fraction of Productive Time</i>	94.87	85.23	99.59	95.90	103.25	103.86
<i>Per Capita Non Leisure Time</i>	83.13	86.73	-//-	80.21	-//-	75.99

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