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by

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Institutions and macroeconomic performance: Core vs periphery countries in the Eurozone

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Abstract

We incorporate institutions into the standard neoclassical growth model in an attempt to account for the macroeconomic differences observed in a sample of 12 Eurozone countries since 2001. Our results show that structural parameters, especially those associated with institutional quality, exhibit considerable cross-country differences, so we calibrate and in turn solve the model for each country separately. A general result is that institutions do matter and are fundamental causes of cross-country asymmetries in macroeconomic performance.

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1 Introduction

There have always been distinct differences between Eurozone member-countries and especially between countries in the core and in the periphery of the Eurozone.[1] A common example is the different way in which the 2008 world global financial crisis affected these countries; the economic downturn was deeper and lasted longer in Southern European countries than in the rest (see e.g. European Commission, 2020).

Differences are reflected upon both macroeconomic outcomes and fundamentals that shape these outcomes.[2] An important fundamental is the quality of institutions. Institutions are broadly defined as rules, laws, regulations and policies that affect incentives and thus shape outcomes (see e.g. Acemoglu, 2009, chapter 4). Economic institutions, in particular, are defined as the security of property rights, the enforceability of contracts, entry barriers and tax policy (see e.g. Acemoglu, 2009, chapter 22). But the type of institutions that seems to be more important for economic outcomes is the security of property rights (see e.g. Acemoglu, 2009, chapter 4), which is usually proxied by indices measuring the enforcement of the law, the efficiency of public administration, bureaucracy, violence and political stability, etc (see section 2 below for data). Although the role of institutions has been increasingly emphasized by the growth literature,[3] it has not received much attention from policymakers or from academic papers on the European economy.[4]

In this paper, we incorporate institutions into an otherwise standard neoclassical growth model. This model, and in particular differences in institutional quality as defined above, is used to explain the macroeconomic differences observed in the data of 12 Eurozone countries during the euro period. We believe that our results can contribute to a better understanding of developments in the aftermath of the 2008 global financial crisis and they can also provide useful lessons for the new crisis triggered by the COVID-19 pandemic.

In our model, following most of the related literature, the institutional failure is in the form of incomplete property rights. The latter implies that private and/or public properties become common pools or contestable prizes and this opens the door to a Tullock-type rent-seeking contest, as atomistic individuals compete with each for a fraction of the contestable prize.[5] Here, we assume that it is government transfers that play the role of the contestable prize, in the sense that each individual competes with others for extra fiscal favors.[6] All this distorts individual incentives and eventually hurts the macro-economy. Equivalently, in the terminology of Chari et al. (2007), rent seeking activities manifest themselves as "wedges", primarily as labour wedges.

We calibrate and in turn solve the model separately for 12 Eurozone countries but we also take the averages of core and periphery countries. Our group of core countries consists

[1]See e.g. Micossi (2016) and Papaioannou (2016). Also, see below which countries comprise the core and periphery groups for our analysis.

[2]See e.g. Micossi (2016), Papaioannou (2016), Masuch et al. (2018) and Kollintzas et al. (2018).

[3]See e.g. Hall and Jones (1999), Rodrik et al. (2004), Acemoglu (2009, chapter 4), Besley and Ghatak (2010), etc.

[4]Exceptions include Angelopoulos et al. (2009), Micossi (2016), Papaioannou (2016), Masuch et al. (2018) and Kollintzas et al. (2018).

[5]For a similar modeling, see e.g. Murphy et al. (1991), Drazen (2000), Hillman (2009, chapter 2), Angelopoulos et al. (2009, 2011), Esteban and Ray (2011) and many others.

[6]But, as discussed below, the choice of the prize is not important to our results.

of Austria, Belgium, Germany, Finland, France and the Netherlands, while the periphery countries included are Cyprus, Greece, Ireland, Italy, Portugal and Spain. The calibration of the model to 12 Eurozone countries for the period 2001-2016 leads to considerable differences in structural parameters, especially in those related to institutional quality, between countries and in particular between core and periphery countries. In other words, the calibration process reveals that there is no such a thing as a representative Eurozone country so we need to solve the model country by country.

Our main results are as follows. First, the model can mimic the data relatively well. For instance, both in the data and the model, periphery countries feature lower long-term growth, higher volatility in output and lower volatility in work hours than the core countries; a natural interpretation is that a more stable employment path comes at the cost of more volatile business cycles and/or worse growth prospects. Second, although the model does a relatively good job vis-à-vis the data in general, it does a better job in mimicking the data of the periphery countries in particular. To put it differently, the inclusion of institutional failures helps the model vis-à-vis the data more in the periphery than in the core countries of the Eurozone. Third, the computed wedges are higher in the periphery countries, meaning that institutional failures in the form of insecure property rights, and the resulting adverse effects on productive work, are worse in the periphery. This contributes to the explanation of lower long-term growth in the periphery countries. Fourth, impulse response functions show that shocks to institutional quality or to fiscal transfers (recall that the latter play the role of the constable prize in our model) exert a stronger adverse effect in the periphery countries. Besides, a mix of shocks, which resembles the new current crisis triggered by the COVID-19 pandemic, has more long-lasting adverse effects in the periphery implying a more delayed economy recovery. Fifth, when we distinguish the sub-period before the 2008 global financial crisis and the sub-period after it, we find that the repercussions of the crisis were milder and less protracted in countries which happened to have a better quality of institutions at that time. By contrast, in countries with already poor institutions when the crisis erupted, the crisis led to a further deterioration in institutions that made the economic downturn deeper producing a vicious cycle. Finally, and consistently with the above results, counterfactual scenarios imply that countries with weak institutions could gain a lot if their institutional quality were better, say, like Germany's, other things equal.

Several policy lessons follow naturally from the above results: First, there are significant differences in fundamentals between Eurozone countries, and institutional quality is clearly one of them. Such differences typically question the viability of a currency union to the extent that other variables (prices, wages, factors, cross-country transfers) are not flexible and mobile enough. Second, differences in institutions can contribute to explaining the different impact that the global financial crisis of 2008 had on core and periphery countries. And this lesson is useful for the new crisis triggered by the COVID-19 pandemic. Third, cross-country institutional gaps (as quantified by indices measuring the rule of law, government effectiveness, control of corruption, the justice system, violence and terrorism, etc) should receive more attention from policymakers. Actually, an idea could be to make supranational financial aid to countries in need (monetary aid by the ECB and/or fiscal aid by the ESM and the newly established Recovery Fund) conditional on improvements on national institutional quality, or other fundament drivers of long term growth and equity, rather on temporary macroeconomic outcomes like fiscal surpluses.

The paper is organized as follows. In section 2, we discuss institutional data. In section 3, we present and solve the model. Section 4 discusses data and calibration. Steady state results are in section 5. Transition results and second-moment properties are in section 6. Impulse response functions are in section 7. A comparison of what happened before and after the 2008 crisis is in section 8. Counterfactuals are in section 9. Finally, section 10 closes the paper. An Appendix provides details.

2 Macroeconomic performance and institutions

To motivate our work, in this section, we present data on institutional quality from a selection of 6 Eurozone countries from our sample, representing the core and the periphery of the Eurozone. These countries are Germany, Greece, Spain, France, Italy and Portugal.

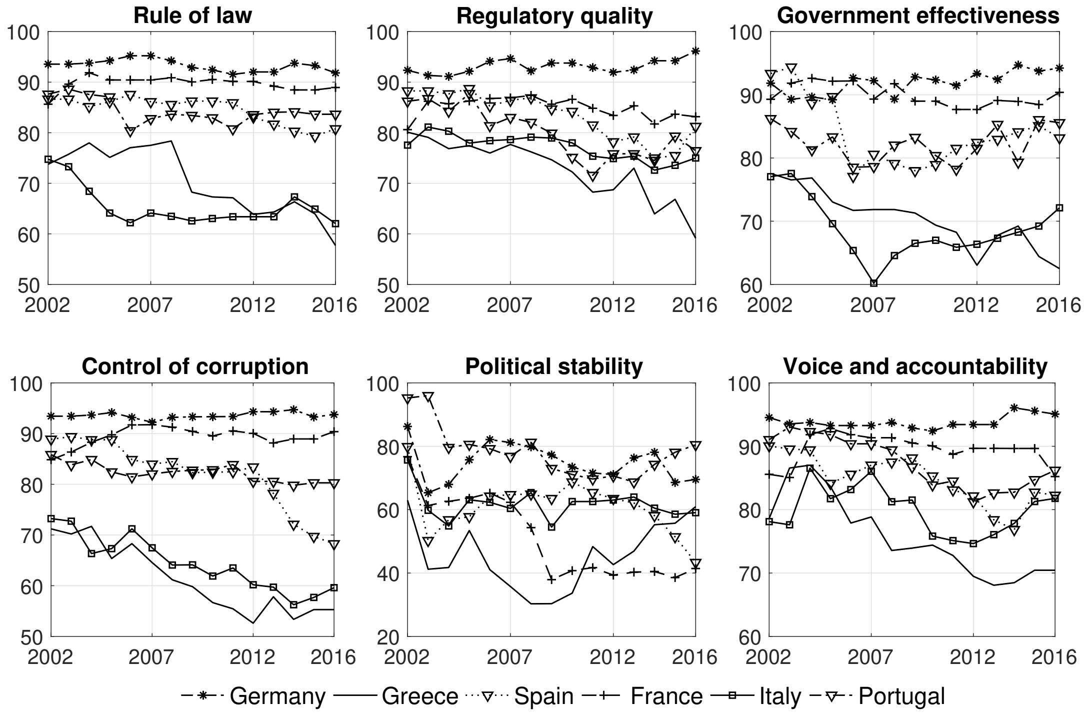

Figure 1: Indices of institutional quality

In Figure 1, we start by presenting some indices that are typically used to construct measures of property rights. These indices are the rule of law, regulatory quality, government effectiveness, control of corruption, political stability and voice and accountability. The data are from the World Governance Indicators of the World Bank. Higher values indicate better institutions. The data reveal that Germany is the country with the best institutional quality overall in our sample. By contrast, Greece scores the worst in almost all indicators.[7]

[7]See also e.g. Micossi (2016), Papaioannou (2016), Masuch et al. (2018) and Kollintzas et al. (2018).

In Figure 2, we present the International Country Risk Guide (ICRG) over 1999-2015 produced by the Political Risk Services (PRS) Group. This consists of 22 measures of risk evaluation. Again higher values indicate better performance. As above, Germany and Greece set the upper and lower bounds respectively. It is interesting to notice that Greece has been featuring the worst score since 1999, with the lowest levels to be in 2010-2012, with the index improving after 2012. Although the period after 2012 seems to differ from Figure 1, recall that the ICRG index is basically a measure of country-risk and this risk was reduced when Greece entered an economic adjustment program designed and monitored by the ECB, the EC and the IMF. This reduced the perceived country-risk and improved the ICRG index, even if most of the core institutional fundamentals, as shown in Figure 1, continued to deteriorate.

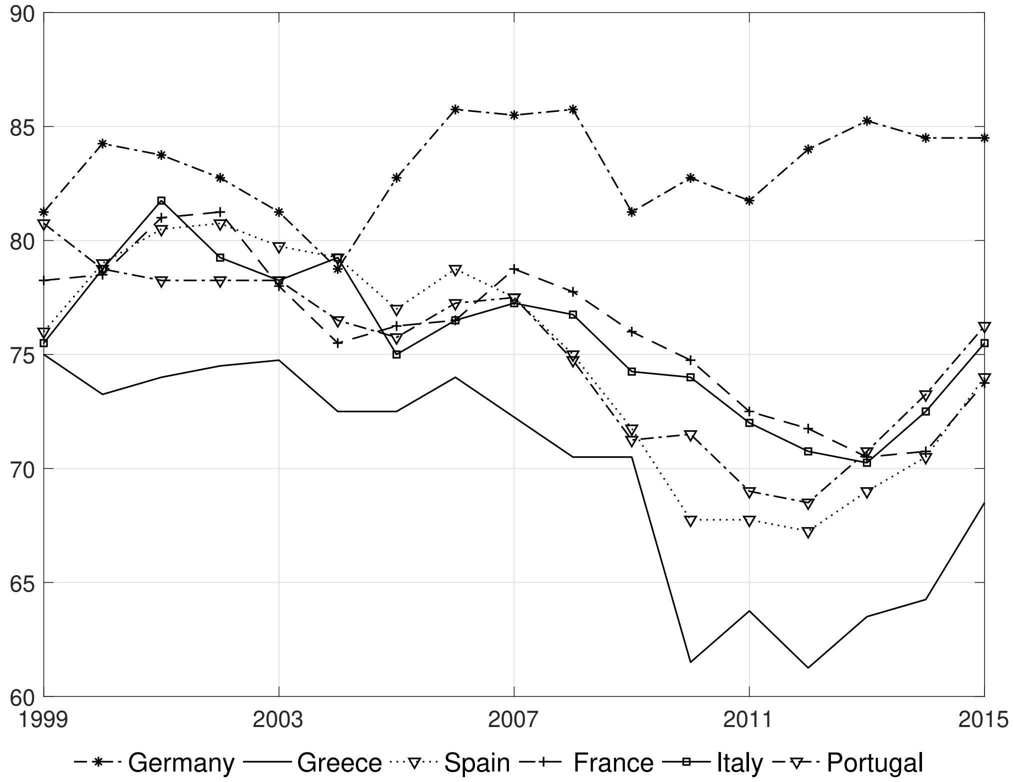

Figure 2: The ICRG index

3 Model

We augment the neoclassical growth model with an institutional failure in the form of insecure property rights.[8] As said above, this failure allows the creation of a common pool or a contestable prize which in turn can incentivize self-interested individuals to be engaged

[8]Our model is close to that in Angelopoulos et al. (2009, 2011).

in rent seeking competition for a share of this prize in the spirit of Tullock (1980).[9] Here we will assume that it is government transfers that play the role of the contestable prize although our results do not depend on this.[10]

The economy is closed and populated by households, firms and the government. In each period, there are N_t identical households and an equal number of identical firms. The population size evolves over time as $N_{t+1} = \gamma_n N_t$, where $\gamma_n \geq 1$ and $N_0 > 0$ are parameters. Households, indexed by $h = 1, 2, \ldots, N_t$, own capital and labour which they supply to firms and choose, in addition to consumption, leisure and savings in the form of capital and bonds, how to allocate their effort or non-leisure time between productive work and rent seeking activities. Firms, indexed by $f = 1, 2, ..., N_t$, produce an homogeneous product using capital and labour. The government imposes distorting taxes and issues bonds to finance government consumption and government transfers. In what follows, we will first define the rent seeking mechanism and then present the otherwise standard neoclassical growth model.

3.1 Institutional failure and rent seeking technology

Each household has one unit of time in each period and this is allocated to leisure, L_t^h, and effort or non-leisure time, H_t^h. Thus, as usually, the time constraint is:

$$L_t^h + H_t^h = 1 \tag{1}$$

The household further divides its effort or non-leisure time, H_t^h, between productive work, $\eta_t^h H_t^h$, and rent-extracting or seeking activities, $(1 - \eta_t^h)H_t^h$, where $0 < \eta_t^h \leq 1$ and $0 \leq (1-\eta_t^h) < 1$ denote respectively the fractions of non-leisure time allocated to productive work and rent seeking. Thus, in each period, we have:

$$H_t^h = \eta_t^h H_t^h + (1 - \eta_t^h)H_t^h \tag{2}$$

We assume that a fraction $0 \leq \theta_t < 1$ of total government spending earmarked for general transfers, G_t^t, is a common pool so that atomistic agents compete for a share of this pool in a Tullock-type redistributive contest. Specifically, as is standard in this literature, the share of the common pool extracted by each agent is proportional to the effort time allocated to rent seeking by this agent relative to the total, economy-wide time allocated to rent seeking by all agents. In other words, each household's budget constraint contains the following additional term:

$$\frac{(1 - \eta_t^h)H_t^h}{\sum_{h=1}^{N_t}(1 - \eta_t^h)H_t^h}\theta_t G_t^t \tag{3}$$

In other words, $0 \leq \theta_t < 1$ is a measure of institutional quality with a lower value indicating better institutions; if $\theta_t = 0$, there is no common pool so that property rights are fully secured.

[9] Hillman (2009, chapter 2) provides a good review of this literature.

[10] We report that we have examined several alternative contestable prizes, including total tax revenues and the economy-wide output. The results are very similar and are available upon request. This is not surprising since, in equilibrium, all these prizes are a fraction of output produced.

3.2 Household's problem

The expected discounted lifetime utility of household h is given by:

$$E_0 \sum_{t=0}^{\infty} \beta^{*^t} U(C_t^h + \psi \bar{G}_t^c, L_t^h) \tag{4}$$

where E_0 denotes rational expectations conditional on the information set available at time zero, the time discount factor is $\beta^* \in (0,1)$, C_t^h is household h's consumption at t, $\bar{G}_t^c$ is per capita utility-enhancing goods and services provided by the government at t, L_t^h is household h's leisure time at t and ψ is a parameter that measures the degree of substitutability between private and government consumption in utility.

Without loss of generality, in our numerical solutions, we will use the instantaneous utility function:

$$U(C_t^h + \psi \bar{G}_t^c, L_t^h) = \frac{\left((C_t^h + \psi \bar{G}_t^c)^{\mu} (L_t^h)^{1-\mu} \right)^{1-\sigma}}{1-\sigma} \tag{5}$$

where $0 < \mu < 1$ and $\sigma \geq 0$ are preference parameters.

The household receives income from work, $w_t Z_t \eta_t^h H_t^h$, where w_t is the wage rate, $\eta_t^h H_t^h$, is the effective time allocated to productive work as defined above and Z_t is a labour augmenting technology variable evolving according to $Z_{t+1} = \gamma_z Z_t$, $\gamma_z \geq 1$ and $Z_0 > 0$ are constant parameters; income from savings in the form of capital and government bonds, $r_t^k K_t^h$ and $r_t^b B_t^h$, where r_t^k and r_t^b are the gross returns to capital and bonds; income from dividends, Π_t^h, received from the ownership of firms; a lump-sum transfer from the government, $\bar{G}_t^{t,E}$, which is common across agents and independent of rent seeking activities; and finally, as specified above, an extra government transfer that depends on the relative effort time allocated to rent seeking. Thus, the budget constraint is:

$$\begin{aligned} &(1+\tau_t^c) C_t^h + I_t^h + D_t^h = \\ &\qquad (1-\tau_t^y)(r_t^k K_t^h + w_t Z_t \eta_t^h H_t^h + \Pi_t^h) + r_t^b B_t^h + \bar{G}_t^{t,E} + \frac{(1-\eta_t^h) H_t^h}{\sum_{h=1}^{N_t} (1-\eta_t^h) H_t^h} \theta_t G_t^t \end{aligned} \tag{6}$$

where I_t^h and D_t^h denote new investment in capital and bonds respectively while $0 \leq \tau_t^c < 1$ and $0 \leq \tau_t^y < 1$ are tax rates on consumption and income.

The laws of motion of capital and bonds for each household are:

$$K_{t+1}^h = (1-\delta) K_t^h + I_t^h \tag{7}$$

$$B_{t+1}^h = B_t^h + D_t^h \tag{8}$$

where the parameter $0 < \delta < 1$ is the depreciation rate and K_0^h and B_0^h are initial conditions.

Each household h acts competitively choosing $\{C_t^h, H_t^h, \eta_t^h, K_{t+1}^h, B_{t+1}^h\}_{t=0}^{\infty}$ to maximize lifetime utility Eq. (4) given the definition of instantaneous utility Eq. (5), subject to the budget constraint Eq. (6), the time constraints Eqs. (1)-(2), and the laws of motion in Eqs. (7)-(8) by taking K_0^h, B_0^h given.[11] [12]

3.3 Firms

Each firm f uses capital and labour inputs, K_t^f and Q_t^f, to produce a homogeneous product Y_t^f, according to the production function:

$$Y_t^f = A_t(K_t^f)^\alpha(Q_t^f)^{1-\alpha} \tag{9}$$

where $A_t > 0$ is TFP (defined in subsection 3.5 below) and $0 < \alpha < 1$ is a standard technology parameter.

Each firm f acts competitively by choosing K_t^f and Q_t^f in order to maximize profits subject to the production function, Eq. (9):[13]

$$\Pi_t^f = Y_t^f - r_t^k K_t^f - w_t Q_t^f \tag{10}$$

3.4 Government

The government imposes consumption and income taxes and uses the collected tax revenue, denoted as R_t,[14] as well as the revenue from the issuance of new bonds, B_{t+1}, to finance government consumption, G_t^c, government transfers, G_t^t, and interest payments on its inherited debt, $(1 + r_t^b)B_t$. As said above, a fraction of government transfers is extracted by rent seekers, $G_t^{t,RS} = \theta_t G_t^t$, whereas the remaining, $G_t^{t,E} = (1 - \theta_t)G_t^t$ is equally distributed in a lump-sum fashion to all households. Thus, $G_t^t = G_t^{t,RS} + G_t^{t,E} = \theta_t G_t^t + (1 - \theta_t)G_t^t$.

Therefore, the government budget constraint is:

$$G_t^c + G_t^t + (1 + r_t^b)B_t = B_{t+1} + \tau_t^c C_t + \tau_t^y Y_t \tag{11}$$

3.5 Exogenous stochastic variables

The exogenous stochastic variables are total factor productivity, A_t, the economy-wide measure of institutional quality, θ_t, the GDP shares of government consumption and government transfers ($s_t^c = \frac{G_t^c}{Y_t}$ and $s_t^t = \frac{G_t^t}{Y_t}$ respectively) as well as the two tax rates, τ_t^c and τ_t^y. In our numerical solutions below, we will assume that the tax rates are constant over time as in the data averages, while A_t, θ_t, s_t^c and s_t^t follow univariate stochastic AR(1) processes:

$$lnA_{t+1} = (1 - \rho_\alpha)lnA + \rho_\alpha lnA_t + \epsilon_{t+1}^\alpha \tag{12}$$

$$ln\theta_{t+1} = (1 - \rho_\theta)ln\theta + \rho_\theta ln\theta_t + \epsilon_{t+1}^\theta \tag{13}$$

$$lns_{t+1}^t = (1 - \rho_t)lns^t + \rho_t lns_t^t + \epsilon_{t+1}^t \tag{14}$$

[11] See Appendix A for the household's first-order conditions.

[12] Each h takes economy-wide variables (G_t^t, $\sum_{h=1}^{N_t}(1 - \eta_t^h)H_t^h$ and θ_t) as given.

[13] See Appendix A for the firm's first-order conditions.

[14] $R_t = \tau_t^c C_t + \tau_t^y Y_t$ or $R_t = \tau_t^c \sum_{h=1}^{N_t^h} C_t^h + \tau_t^y \sum_{h=1}^{N_t^h}(w_t^h Z_t \eta_t^h H_t^h + r_t^k K_t^h + \Pi_t^h)$

$$lns^c_{t+1} = (1-\rho_c)lns^c + \rho_c lns^c_t + \epsilon^c_{t+1} \quad (15)$$

where A, θ, s^t and s^c are means of the stochastic process; $\rho_\alpha, \rho_\theta, \rho_t$ and ρ_c are first-order autocorrelation coefficients and $\epsilon^\alpha_{t+1}, \epsilon^\theta_{t+1}, \epsilon^t_{t+1}$ and ϵ^c_{t+1} are i.i.d. shocks.[15]

3.6 Decentralized Competitive Equilibrium (DCE)

We solve for a DCE in which households maximize welfare, firms maximize profits, all markets clear and all constraints are satisfied.[16] Given that our economy convergences to a balanced growth path along which consumption, output, capital, investment, bonds and levels of public spending can grow at a positive rate $\gamma_n\gamma_z$, we transform the DCE in terms of stationary variables expressed in per capita and efficient labour units (or in per capita units in the case of labour).[17] We thus end up with a dynamic system of eight equations in eight variables which are $y_t, c_t, h_t, \eta_t, i_t, r^b_t, b_{t+1}$ and k_{t+1}. This is given the paths of A_t, θ_t, and the four independently set fiscal policy instruments $s^c_t, s^t_t, \tau^c_t, \tau^y_t$.[18]

4 Taking the model to the data and calibration

4.1 Matching the model with the data

To match the model to the data, we follow usual practice (see e.g. Kehoe and Prescott (2002, 2007) and Conesa et al. (2007)) by defining output and investment in the model as the real gross domestic product and total investment (gross fixed capital formation) in the data respectively. Consequently consumption in the model should be compared to the difference between GDP and investment in the data.

There are no data on the fraction of effort or non-leisure time allocated to productive work, η_t, and thus on the hours allocated to productive work, $\eta_t h_t$, relative to rent seeking. To address this issue, we assume that rent seeking takes place while agents are at work (see also e.g. Angelopoulos et al. (2009, 2011)). That is, we assume that hours at work, which are available in the data, include both productive hours at work, $\eta_t h_t$, and hours allocated to rent-seeking activities, $(1-\eta_t)h_t$.

[15]Here we take institutions as given. This is as in most of the literature. We are aware of course that institutions are endogenous (see e.g. Rodrik et al., 2004, Besley and Persson, 2009, Acemoglu, 2009, Besley and Ghatak, 2010). For example, here, we could assume that θ_t is endogenous and increases with per capita rent-seeking activities, $\theta_t = \phi_t \frac{\sum_{h=1}^{N_t}(1-\eta^h_t)H^h_t}{N_t}$, and, in addition, depends on the fraction of output that the government allocates to protecting property rights, s^p_t, (i.e. expenditures on police, courts, etc.), in which case $\theta_t = \phi_t (s^p_t)^{-\xi_2}\left(\frac{\sum_{h=1}^{N_t}(1-\eta^h_t)H^h_t}{N_t}\right)^{\xi_1}$, where ϕ_t, ξ_1 and ξ_2 are parameters.

[16]The market clearing conditions are $\sum_{f=1}^{N_t} Y^f_t = \sum_{h=1}^{N_t} Y^h_t$ in the product market, $\sum_{f=1}^{N_t} Q^f_t = Z_t \sum_{h=1}^{N_t} \eta^h_t H^h_t$ in the labour market, $\sum_{f=1}^{N_t} K^f_t = \sum_{h=1}^{N_t} K^h_t$ in the capital market and $\sum_{f=1}^{N_t} \Pi^f_t = \sum_{h=1}^{N_t} \Pi^h_t = 0$ in the dividend market.

[17]That is, we express quantities in per capita and efficient unit terms so as to make them stationary, so that for any economy-wide variable, X_t, $X_t \equiv (Y_t, C_t, K_t, B_t, G^c_t, G^t_t)$, we define $x_t = \frac{X_t}{N_t Z_t}$. We also define $h_t = \frac{H_t}{N_t}$ which is per capita non-leisure time.

[18]The DCE system is presented in Appendix A.

Similarly, the data on government transfers do not distinguish between transfers given as a result of rent seeking pressure and flat transfers given independently of rent seeking. Hence, the sum of G_t^{RS} and G_t^E in our model (i.e. government transfers extracted by rent seekers, $G_t^{RS} = \theta_t G_t^t$, and government transfers given to households independently of rent seeking activities, $G_t^{t,E} = (1-\theta_t)G_t^t$) is set equal to total government transfers in the data, $G_t^t = G_t^{t,RS} + G_t^{t,E} = \theta_t G_t^t + (1-\theta_t)G_t^t$. The measure of institutional quality, θ_t, will be calibrated separately for each country.

4.2 Data and Calibration

The model will be calibrated and solved for 12 Eurozone countries. Since there is no such thing as a representative Eurozone country, we will calibrate and solve it country by country. But we will also divide the 12 countries into two groups, the core and the periphery countries. As already mentioned in the Introduction, the core consists of Austria (AT), Belgium (BG), Germany (DE), France (FR), Finland (FI) and the Netherlands (NL), while the periphery countries are Cyprus (CY), Greece (GR), Ireland (IR), Italy (IT), Portugal (PT) and Spain (ES).

Data are of annual frequency and cover the euro period since 2001. Our data sources are Eurostat, Total Economy Database, St. Louis FED and AMECO.[19] Furthermore, we construct the effective tax rates on consumption, τ_t^c, and income, τ_t^y, by following Mendoza et al. (1994).[20] Data averages over 2001-2016 for macroeconomic variables, as well as for fiscal policy instruments used in the calibration, are presented in Tables 1 and 2 respectively.

Table 1: Macroeconomic variables (data averages)

	Countries											
Variable	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
h	0.31	0.27	0.36	0.41	0.34	0.30	0.35	0.36	0.28	0.33	0.37	0.33
c/y	0.54	0.61	0.60	0.60	0.56	0.54	0.61	0.63	0.55	0.57	0.59	0.55
i/y	0.22	0.20	0.24	0.19	0.25	0.22	0.20	0.20	0.20	0.23	0.20	0.22
k/y	2.65	2.95	2.49	3.78	3.33	2.96	3.12	2.40	2.80	3.45	2.95	2.91
r^b	0.02	0.02	0.03	0.07	0.02	0.02	0.02	0.04	0.02	0.01	0.03	0.01

Note h: hours at work, c/y: consumption to output ratio, i/y: investment to output ratio
k/y: capital to output ratio, r^b: return to government bonds (annually)

Following usual practice, we set the curvature parameter in the utility function, σ, equal to 2 and the degree of substitutability between private and government consumption in the utility function, ψ, equal to zero. We set the population growth, γ_n, equal to the average growth rate of population in each country and the growth rate of the exogenous labour-augmenting technology to 1.024 which is the value in the USA. Also, the effective tax rates on consumption, τ_t^c, and income, τ_t^y, as well as the GDP shares of public consumption and transfers, s_t^c and s_t^t, are set at their averages in the data. We follow King and Rebelo (1999)

[19]See Appendix B for details.
[20]See Appendix B for details.

Table 2: Fiscal policy instruments (data averages)

Policy instrument	Countries BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
τ^c	0.21	0.19	0.24	0.18	0.16	0.21	0.17	0.21	0.23	0.22	0.20	0.27
τ^y	0.45	0.37	0.23	0.28	0.32	0.42	0.43	0.24	0.34	0.39	0.27	0.42
s^t	0.23	0.24	0.13	0.19	0.16	0.24	0.21	0.12	0.20	0.22	0.17	0.19
s^c	0.23	0.19	0.16	0.20	0.19	0.23	0.19	0.17	0.24	0.20	0.20	0.23

Note: τ^c: effective tax rate on consumption, τ^y: effective tax rate on total income
s^t: share of government transfers to GDP, s^c: share of government consumption to GDP

and normalize the initial level of technical progress, Z_0, to 1 and set the level of long-run aggregate productivity, A, of each country to its average value in the data by using the Total Factor Productivity series of the St. Louis FED.[21] Using data on capital series from AMECO, we calibrate the annual rate of depreciation rate, δ, separately for each country. To calibrate the time preference rate, β, we use data on real interest rates, again for each country, and plug them into the Euler equation for government bonds. We calibrate the capital share in production, α, from the Euler equation for capital using data on investment to output ratio for each country. Furthermore, we set the persistence parameters ρ_θ to 0.99, ρ_t and ρ_c to 0.95, and the standard deviation of the shocks, σ_t, σ_c, σ_θ, to 0.01, whereas we choose ρ_α and σ_α so as to match the volatility and persistence of the output series generated by the model with the volatility and persistence of the GDP series in the data and this is for each country separately. Parameter values are listed in Table 3.

Table 3: Parameterization and calibration

Parameters	Countries BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
α	0.41	0.32	0.31	0.40	0.37	0.38	0.35	0.26	0.31	0.39	0.29	0.38
A	0.98	0.94	1.18	0.63	0.86	1.03	0.84	0.77	1.05	0.87	0.68	0.84
ρ_α	0.74	0.43	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.73	0.99	0.78
σ_α	0.01	0.01	0.06	0.05	0.03	0.01	0.02	0.03	0.02	0.01	0.02	0.02
γ_n	1.01	1.00	1.02	1.00	1.02	1.01	1.01	1.02	1.00	1.01	1.00	1.00
β	0.97	0.98	0.96	0.94	0.96	0.97	0.97	0.96	0.97	0.97	0.97	0.97
δ	0.07	0.06	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.05	0.06	0.06

Note: $\sigma = 2$, $\gamma_z = 1.024$, $\psi = 0$, $Z_0 = 1$ $\rho_\theta = 0.99$, $\rho_t = \rho_c = 0.95$, $\sigma_t, \sigma_c, \sigma_\theta = 0.01$ for all countries.
α: capital share (Calibrated), A: long-run aggregate productivity (Set)
σ: curvature parameter in the utility function (Set), β: discount factor (Calibrated)
ρ_α: autocorrelation coefficient and σ_α: standard deviation of TFP shock (Calibrated)
γ_n: population growth rate (Set), γ_z: labour-augmenting technology growth rate (Set)
ψ: substitutability between private and government consumption (Set)
Z_0: initial level of technical progress (Set), δ: capital depreciation rate (Calibrated)

[21] The series used for Total Factor Productivity from St. Louis FED is an index where the USA take the value of 1.

To calibrate the long-run value of economy-wide institutional quality, θ, we need, in addition to the great ratios from the data (see Table 1), the calibrated parameter of α, the average values of τ_t^y and s_t^t, as well as a value for η (recall that η is the fraction of non-leisure time allocated to productive work). The latter is not in the data. To overcome this problem and get a value for η, we follow a practice similar to that used for the construction of several Composite Risk Rating sub-indices (ICRG).[22] These values are presented in Table 4 in the main text. We then calibrate θ for each country separately using the first-order condition with respect to the effort level, η_t.[23] Given the calibrated value of θ, we calibrate the value of μ using the respective first-order condition for non-leisure time, h_t. The calibrated values of θ and μ are listed in Table 4, where, as perhaps expected, periphery countries (Greece, Portugal, Spain, Cyprus, Ireland and Italy) exhibit higher values for θ (i.e. worse institutional quality) and lower values for η (i.e. the fraction on non-leisure time devoted to productive work relative to rent seeking) than core countries.

Table 4: Calibration of θ and μ

	Countries											
Parameter	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
η	0.95	0.95	0.95	0.80	0.85	0.90	0.90	0.90	0.95	0.95	0.85	0.95
θ	0.07	0.09	0.22	0.57	0.46	0.17	0.20	0.52	0.12	0.09	0.53	0.10
μ	0.46	0.38	0.42	0.47	0.40	0.41	0.48	0.41	0.36	0.47	0.41	0.47

Note η: fraction of effort time allocated to work (Set), θ: extraction parameter (Calibrated)
μ: Consumption weight in utility (Calibrated)

5 Steady state results

In this section, we present the steady state solution for each country as well as the averages of core and periphery countries. Steady state solutions are particularly useful for thinking about the process of long-term growth. This solution follows if we use the policy instruments in Table 2, along with the parameter values in Tables 3 and 4, into the 8-equation DCE system when stationary variables do not change. At steady state, we set the annual public debt-to-output ratio as in the data and instead allow the public consumption-to-output ratio, s^c, to follow residually and close the government budget constraint. We start with some key macroeconomic variables and then present the so-called wedges.

5.1 Macroeconomic variables and rent seeking

The steady state solution for each country is presented in Table 5. The calibrated model gives a steady state solution for the great ratios which is close to the data averages in each country. Besides, the solution implies significant differences between countries, also present

[22]See Appendix B for details.

[23]Alternatively, we could set θ by using data on the World Governance Indicators by the World Bank and so construct a series for η_t. We report that this gives very similar results.

in the data averages. In particular, as shown in Table 5, output is higher in core countries (0.48) as compared to periphery countries (0.40). The consumption to output ratio is higher in periphery countries (0.55) than in core countries (0.50). The investment to output ratio takes its lowest value in Greece (0.19), whereas the highest value is observed for Spain (0.25). The capital to output ratio is smaller in periphery countries (2.43) as compared to core countries (2.48). The model predicts that non-leisure time is higher is periphery countries (0.38) than in core countries (0.33). On the other hand, the effort level, η, is, on average, higher in the core countries (0.94) than in the periphery countries (0.88). Actually, Greece has the lowest value (0.80) which is consistent to previous studies (see e.g. Angelopoulos et al. (2009)). In other words, agents in periphery countries allocate a higher fraction of their non-leisure time to rent seeking activities as compared to core countries. Moreover, the share of government consumption in periphery countries is 0.23 whereas in core countries it is 0.29. Finally, the real interest rate on government bonds is higher in periphery countries (0.04) than in core countries (0.03).

Table 5: Steady state solutions

	Countries													
Variable	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI	Core	Periphery
c/y	0.46	0.57	0.53	0.63	0.51	0.50	0.50	0.56	0.53	0.49	0.58	0.44	0.50	0.55
i/y	0.22	0.20	0.24	0.19	0.25	0.22	0.20	0.20	0.20	0.23	0.20	0.22	0.22	0.21
k/y	2.25	2.39	2.31	2.62	2.76	2.48	2.36	2.21	2.36	2.92	2.35	2.46	2.48	2.43
y	0.55	0.39	0.67	0.27	0.44	0.52	0.44	0.33	0.43	0.54	0.26	0.48	0.48	0.40
h	0.34	0.29	0.38	0.39	0.36	0.32	0.40	0.39	0.29	0.37	0.37	0.38	0.33	0.38
η	0.95	0.95	0.95	0.80	0.85	0.90	0.90	0.90	0.95	0.95	0.85	0.95	0.94	0.88
ηh	0.32	0.28	0.36	0.32	0.31	0.29	0.36	0.35	0.27	0.35	0.32	0.36	0.31	0.34
r^b	0.03	0.03	0.05	0.06	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.04
s^c	0.31	0.24	0.23	0.17	0.24	0.28	0.31	0.24	0.26	0.28	0.21	0.34	0.29	0.23

Note y: output, c/y: consumption to output ratio, i/y: investment to output ratio
h: hours at work, η: fraction of non-leisure time allocated to productive work
k/y: capital to output ratio, s^c: government consumption to output ratio
r^b: return to government bonds (annually)

5.2 Wedges

Here, using the above steady state solutions, we quantify the distortions caused by rent seeking activities in each country other things equal. In the terminology of Chari et al. (2007), frictions (such as distortionary taxation, market power, sticky prices/wages) manifest themselves as wedges that distort the labour, investment, etc, decisions and in turn shape macroeconomic outcomes. The idea is that such frictions alter first-order conditions, and possibly resource constraints, relative to the baseline neoclassical growth model which is without distorting policy and without institutional failures.

In our model, ill-defined property rights, and the associated rent seeking activities, result in what we label a labour wedge and a rent seeking wedge. The labour wedge, which captures the difference in the first-order condition for non-leisure time between our model and the baseline neoclassical growth model, is defined as:

$$\mathcal{W}_h^{RS} = \frac{1-\tau_t^y}{1+\tau_t^c} + \frac{\theta_t s_t^t}{(1+\tau_t^c)(1-\alpha)} \tag{16}$$

where, the higher its value, the stronger the distortive effect on effort time from weak institutions.

At the same time, here we have an additional choice variable, η_t , which is the fraction of effort time devoted to anti-social rent seeking activities. This rent seeking wedge is defined as:

$$\mathcal{W}_\eta^{RS} = \frac{\theta_t s_t^t \eta_t}{(1-\tau_t^y)(1-\alpha)} \tag{17}$$

where, again, the higher its value, the stronger the distortion from weak institutions.

Table 6: Wedges

	Countries													
Wedge	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI	Core	Periphery
Labour	0.48	0.55	0.65	0.76	0.69	0.53	0.54	0.70	0.56	0.53	0.72	0.48	0.52	0.68
Rent seeking	0.05	0.05	0.05	0.20	0.15	0.10	0.10	0.10	0.05	0.05	0.15	0.05	0.06	0.13

Results for the labour and the rent seeking wedge for all countries as well as the averages of core and periphery countries are reported in Table 6. As can be seen in Table 6, there are differences in the labour wedge among countries. Furthermore, the labour wedge is higher in periphery (0.68) than in core (0.52) countries. The picture is similar for the rent seeking wedge. Namely, Table 6 implies that there are country differences, while, on average, the rent seeking wedge is larger in periphery (0.13) than in core countries (0.06). Consequently, institutional failures, and their damaging effects on productive work, play a bigger role in the periphery.

6 Transition results and second moment properties

Here we linearize the model around its steady state solution. The linearized DCE can be written in the form $E_t[A_1\widehat{x}_{t+1} + A_0\widehat{x}_t + B_1\widehat{z}_{t+1} + B_0\widehat{z}_t] = 0$, where we define $\widehat{x}_t = (lnx_t - lnx)$, $\widehat{x}_t \equiv [\widehat{y}_t, \widehat{c}_t, \widehat{i}_t, \widehat{\eta}_t, \widehat{h}_t, \widehat{r}_t^b, \widehat{k}_t, \widehat{b}_t]$, $\widehat{z}_t \equiv [\widehat{A}_t, \widehat{\theta}_t, \widehat{s}_t^t, \widehat{s}_t^c]$, and A_1, A_0, B_1, B_0 are constant matrices of dimension 8x8, 8x8, 8x4 and 8x4 respectively. The elements of $\widehat{z}_t$ follow the AR(1) processes in Eqs. (12)-(15) while the tax rates are assumed to remain constant. We thus end up with a linear stochastic difference equation system in eight variables out of which two are predetermined $(\widehat{k}_t, \widehat{b}_t)$ and the remaining six are forward-looking $(\widehat{y}_t, \widehat{c}_t, \widehat{i}_t, \widehat{\eta}_t, \widehat{h}_t, \widehat{r}_t^b)$. Given the calibrated parameter values, the system is characterized by saddle-path stability meaning local determinacy.

We will typically focus on volatility, serial correlation or persistence, and co-movements with output. In particular, we work as follows. We solve and simulate the model so as to generate series for each of the eight endogenous variables. We choose ρ_α and σ_α so as to match the volatility and persistence of the output series generated by the model with the volatility and persistence of the GDP series in the data. We calculate the trend by using the HP filter with a smoothing parameter of 100 and then obtain the cyclical component. We finally compare the second moment properties (relative volatility with respect to output, persistence and co-movement with output) of the series generated by the model to those in the data.

6.1 What the data tell us

We first study volatility, persistence and co-movement in the data. To save on space, here we report results for core and periphery countries only.[24] The data are reported in Tables 7, 8 and 9 respectively.

Table 7: Relative volatility, $x \equiv s_x/s_y$

		c	i	h	k	η	s^y
Data	Core	0.93	2.66	0.42	0.34	Na	0.0161
	Periphery	0.78	3.48	0.27	0.40	Na	0.0343
Model	Core	0.49	2.27	0.42	0.32	0.05	0.0162
	Periphery	0.74	1.71	0.19	0.27	0.06	0.0343

Regarding volatility, a key feature in the data is that output in periphery countries is on average much more volatile than in core countries.[25] When it comes to the relative volatility of consumption to output, this is less volatile than output and, on average, consumption in periphery (0.78) is less volatile than in core (0.93). Investment is more volatile than output in all countries, yet this is more acute in periphery (3.48) as compared to core (2.66). Also, for all countries, hours at work are less volatile than output, although this volatility is lower in periphery (0.27) compared to core (0.42). In all countries, capital is less volatile than output; the ranking among core and periphery countries is more mixed but still on average relative volatility of capital is slightly higher in periphery countries.

Table 8: Persistence, $\rho(x_t, x_{t-1})$

		y	c	i	h	k	η
Data	Core	0.42	0.45	0.44	0.22	0.77	Na
	Periphery	0.68	0.45	0.66	0.47	0.84	Na
Model	Core	0.40	0.49	0.38	0.39	0.80	0.47
	Periphery	0.48	0.50	0.46	0.46	0.84	0.47

Regarding persistence as recorded in the data, output is more persistent in periphery countries than in core countries. More specifically, the average persistence of output in periphery countries is 0.68, whereas it is 0.42 in core countries. The picture is the same for

[24] In Appendix C we also present results for each country.

[25] For instance, in Cyprus, Greece, Ireland and Spain, output is more than twice as volatile compared to the country where output is least volatile, i.e. Belgium.

investment and capital, meaning that periphery countries are characterized by higher persistence. This becomes most evident in the case of investment where the average persistence of investment in periphery is almost double to that in core.[26] Hours at work are considerably more persistent in periphery compared to core countries with the respective average values being 0.47 and 0.22 respectively.

Table 9: Contemporaneous co-movement with output, $\rho(y_t, x_t)$

		x				
		c	i	h	k	η
Data	Core	0.67	0.85	0.47	0.39	Na
	Periphery	0.59	0.91	0.39	0.30	Na
Model	Core	0.83	0.98	0.89	-0.08	0.01
	Periphery	0.98	0.99	0.89	-0.03	0.02

Finally, regarding cross-correlations of key macro variables with output, in general, most countries share similar qualitative and quantitative characteristics and there no notable distinctions among core and periphery countries. Specifically, consumption, investment and hours at work are contemporaneously pro-cyclical and capital is lagging pro-cyclically. The remaining correlations (i.e. with respect to a lead or a lag) are also qualitatively similar. Pro-cyclicality with output for all variables is a feature shared by most countries as well; however, this pro-cyclicality may either have a leading or a lagging feature.[27]

Summing up, the data reveal differences (both qualitative and quantitative) among Eurozone countries, when the criteria are volatility relatively to output, persistence over time and co-movement with output. That is, a general message is that business cycles are not symmetric across the Eurozone.

6.2 What the model generates

We now look at volatility, persistence and co-movement as generated by our model. Simulated results for core and periphery countries are included in Tables 7, 8 and 9.

The model can match rather well the main characteristics observed in the data when it comes to relative volatility. As in the data, the model produces for all countries consumption, hours at work and capital series that are less volatile than output, whereas the investment series produced are more volatile than output. Notice that the average relative volatility of consumption is closely matched for periphery countries (0.74 in the model and 0.78 in the data). The model also catches rather well the relative volatility of investment to output in core countries (2.27 in the model and 2.66 in the data). For non-leisure time, the average value of all countries is 0.31 as compared to 0.35 in the data (this applies to all 12 countries).

[26]When it comes to consumption series, we observe that in Greece, Italy and Spain consumption is up to 3 times more persistent relative to, say, Belgium where consumption is the least persistent.

[27]As can be seen in Appendix C, the only notable exceptions are the counter-cyclical behaviour of consumption for Cyprus and Portugal and the counter-cyclical behaviour of labour in France and Spain. For this reason, we exclude these countries from the respective calculations in what concerns the actual data for the core and periphery averages in Table 9.

Finally, the relative volatility of capital is closely matched for the core countries (0.32 in the model and 0.34 in the data).

Regarding persistence, this is also matched by the model. For consumption, the model generates series that are on average 0.49 persistent, whereas in the data the respective value is 0.45 (this applies to all 12 countries). Persistence of investment series is higher in periphery (0.46 in the model and 0.66 in the data) relative to core (0.38 in the model and 0.44 in the data). The picture is similar when we look at hours at work, where there is higher persistence in periphery. Notably, the average persistence of the series in the model is 0.46, which is what we also find in the data. Finally, capital persistence generated by the model is closely matched with what we find in the data.

Regarding co-movements, the model predicts qualitatively and quantitatively similar results for all countries and in most cases these results are close to the data. More specifically, the model implies that, in all countries, consumption, investment, hours at work and effort are contemporaneously pro-cyclical, while capital lags pro-cyclically. No clear distinction among core and periphery countries arises. In what concerns η_t, this is rather weakly pro-cyclical for all countries but also clearly bigger in the periphery compared to the core countries.

Summing up, the statistical properties of the series generated by the model are relatively close to those in the actual data. Actually, the model does a better job in mimicking the data of the periphery countries. In other words, the inclusion of institutional failures helps the model vis-à-vis the data more in the periphery than in the core countries of the Eurozone.

7 Impulse response functions

In this section, we compute the responses of the key endogenous variables (measured as percentage deviations from their model-consistent steady state value) to a unit shock to total factor productivity, A_t, government consumption, s_t^c, institutional quality, θ_t, and government transfers, s_t^t. We will report results for each country, as well as for the averages of core and periphery countries. In Tables 10-14, we report the responses on impact while in Tables 15-16, we report the half-lives (i.e. the number of periods needed in order for the response of a variable to reach the half of its initial response).[28]

Table 10: Positive shock to A_t: Response on impact

	Countries											
Variables	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
y	1.34	1.55	1.13	1.11	1.12	1.12	1.10	1.14	1.16	1.37	1.14	1.34
c	0.47	0.40	0.83	0.81	0.82	0.84	0.84	0.83	0.83	0.42	0.83	0.46
i	3.14	4.81	1.81	2.12	1.73	1.74	1.77	2.03	2.01	3.41	2.01	3.07
h	0.57	0.81	0.19	0.18	0.19	0.19	0.16	0.19	0.23	0.60	0.19	0.55
η	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ηh	0.57	0.81	0.19	0.18	0.19	0.19	0.16	0.19	0.23	0.60	0.19	0.55

[28] The half-lives are very sensitive to the persistence parameters of the AR(1) processes. What we are interested here is the qualitative properties of these responses, which do not change with the values of ρ_α etc.

The IRFs of positive shocks to A_t and s_t^c, illustrated in Tables 10 and 11, are standard and are as in the real business cycle (RBC) literature. The IRFs of a positive shock to θ_t shown in Table 12 (recall that a higher θ_t means deterioration in institutional quality) are like an adverse shock to A_t (see also Angelopoulos et al. (2011)). A shock to s_t^t shown in Table 13 exerts a negative effect on η_t meaning that, as the contestable prize increases, agents devote a bigger fraction of their effort time to rent seeking activities and this in turn hurts economic activity.

Table 11: Positive shock to s_t^c: Response on impact

	Countries											
Variables	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
y	0.20	0.16	0.14	0.08	0.14	0.19	0.18	0.15	0.20	0.16	0.13	0.22
c	-0.32	-0.18	-0.20	-0.14	-0.21	-0.25	-0.29	-0.19	-0.21	-0.25	-0.16	-0.35
i	-0.12	-0.05	-0.06	-0.08	-0.11	-0.11	-0.20	-0.08	-0.03	-0.18	-0.07	-0.20
h	0.34	0.24	0.20	0.14	0.23	0.30	0.28	0.21	0.29	0.25	0.18	0.35
η	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ηh	0.34	0.24	0.21	0.14	0.23	0.30	0.28	0.21	0.29	0.25	0.18	0.35

Focusing on differences between core and periphery countries, as summarized by Table 14, the effect on impact of a positive shock to TFP, A_t, is stronger in core than in periphery countries, with the exception of consumption where the opposite holds. Similarly, the responses on impact of a government consumption shock, s_t^c, are bigger in core than in periphery countries with the exception of investment where the picture is more mixed. Albeit quantitatively small, the effects on impact of a shock to institutional quality, θ_t, are stronger in periphery than in core countries. A notable example of the latter is when we compare two polar countries, Greece and Germany: η drops by almost four times in Greece as compared to Germany. A similar picture arises in the case of shocks to transfers, s_t^t. That is, a further deterioration of institutions and/or an increase in the size of the contestable prize, in a country with already poor institutions, make incentives and outcomes much worse.

Table 12: Positive shock to θ_t: Response on impact

	Countries											
Variables	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
y	-0.01	-0.01	-0.02	-0.05	-0.04	-0.02	-0.03	-0.03	-0.01	-0.01	-0.05	-0.01
c	-0.01	-0.01	-0.01	-0.04	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.03	-0.01
i	-0.02	-0.02	-0.03	-0.11	-0.07	-0.04	-0.05	-0.06	-0.02	-0.02	-0.09	-0.02
h	0.03	0.03	0.03	0.11	0.09	0.06	0.06	0.05	0.03	0.03	0.09	0.03
η	-0.05	-0.05	-0.05	-0.20	-0.15	-0.10	-0.10	-0.10	-0.05	-0.05	-0.15	-0.05
ηh	-0.02	-0.02	-0.02	-0.09	-0.06	-0.04	-0.04	-0.05	-0.02	-0.02	-0.06	-0.02

Furthermore, looking at Table 15, we observe that, after a shock to, say, A_t, the responses of the endogenous variables is more persistent in the periphery countries than in the core countries. Indicatively, after a shock to A_t, it takes 108 periods for output to reach the half-life of its response in periphery countries, whereas, in core countries, this is only 40 periods. This implies that, in the presence of a negative total factor productivity shock, the effects will be more long-lasting in periphery countries.

Table 13: Positive shock to s_t^t: Response on impact

	Countries											
Variables	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
y	-0.01	-0.01	-0.02	-0.06	-0.05	-0.03	-0.03	-0.04	-0.01	-0.01	-0.05	-0.02
c	-0.01	-0.01	-0.01	-0.03	-0.02	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02	-0.01
i	-0.03	-0.04	-0.04	-0.16	-0.10	-0.06	-0.08	-0.10	-0.04	-0.03	-0.13	-0.03
h	0.03	0.03	0.02	0.10	0.08	0.06	0.05	0.05	0.03	0.03	0.08	0.03
η	-0.05	-0.05	-0.05	-0.20	-0.15	-0.10	-0.10	-0.10	-0.05	-0.05	-0.15	-0.05
ηh	-0.02	-0.02	-0.03	-0.10	-0.07	-0.04	-0.05	-0.05	-0.02	-0.02	-0.07	-0.02

Table 14: Positive shocks: Response on impact in core and periphery

	A_t		θ_t		s_t^c		s_t^t	
Variables	Core	Periphery	Core	Periphery	Core	Periphery	Core	Periphery
y	1.31	1.12	-0.01	-0.04	0.19	0.14	-0.02	-0.04
c	0.57	0.83	-0.01	-0.02	-0.26	-0.20	-0.01	-0.02
i	3.03	1.91	-0.02	-0.07	-0.12	-0.10	-0.04	-0.10
h	0.49	0.18	0.04	0.07	0.30	0.21	0.03	0.06
η	0.00	0.00	-0.06	-0.13	0.00	0.00	-0.06	-0.13
ηh	0.49	0.18	-0.02	-0.05	0.30	0.21	-0.03	-0.06

Table 15: Positive shock to A_t: Periods until half-life of the shock

	Countries													
	BG	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI	Core	Periphery
y	5	2	103	120	115	119	115	94	101	5	98	5	40	108
c	16	7	133	152	145	146	141	125	133	16	128	16	56	137
k	30	16	299	331	329	333	333	294	306	34	301	33	125	315
i	4	7	59	55	75	77	71	40	49	4	44	3	24	57
h	3	2	8	9	10	10	11	7	8	3	7	3	5	9

Finally, motivated by the ongoing shock to the global economy triggered by the current COVID-19 pandemic, we examine the joint response caused by a negative shock to A_t and a positive shock to s_t^c. The former captures the adverse supply side effects of the COVID-19 shock, while the latter captures the need for higher government spending as a counter-cyclical reaction to the health and economic crisis. The results in Table 16, which focus on two polar countries in terms of institutional quality, Germany and Greece, reveal that the response of output to this joint shock is much more persistent in Greece than in Germany, indicating a more delayed economy recovery similar to that that happened after the 2008 crisis.

Table 16: Joint negative shock to A_t, and positive shock in s_t^c: Periods until half-life of shock (Germany vs Greece)

	y	c	h	i	k
Germany	2	8	2	2	17
Greece	127	135	4	51	328

8 What changed in the aftermath of the 2008 global financial crisis

In Tables 17 and 18, we present the averages of the main fiscal policy variables before, and after, the global financial crisis of 2008, i.e. the sub-period 2001-2008 and the sub-period 2009-2016. As can be seen, there are significant changes in fiscal policy instruments in the years following the crisis. Motivated by this fact, we investigate whether these changes in fiscal policy have played a role in macroeconomic developments as well as in rent seeking activities. In other words, other things equal, we use the averages of (s^t, τ^c, τ^y) before and after the crisis and re-compute the model for the two different sub-periods. Steady state solutions for two key variables, output, y, and the fraction of non-leisure time allocated to work, η, are in turn presented in Table 19.

Table 17: Policy instruments average: 2001-2008

	Countries											
Policy instrument	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
τ^c	0.22	0.19	0.26	0.18	0.17	0.21	0.17	0.22	0.23	0.23	0.21	0.28
τ^y	0.44	0.37	0.24	0.27	0.33	0.40	0.41	0.23	0.34	0.38	0.26	0.41
s^t	0.22	0.25	0.11	0.16	0.14	0.23	0.19	0.10	0.18	0.22	0.15	0.17
s^c	0.22	0.18	0.16	0.20	0.17	0.23	0.19	0.17	0.23	0.19	0.20	0.21

Note: τ^c: effective tax rate on consumption, τ^y: effective tax rate on total income
s^t: share of government transfers to GDP, s^c: share of government consumption to GDP

The solutions in Table 19 show that in all countries, except Germany, η and (of course y) have worsened after 2008. Periphery countries, like Greece, Spain, Italy, Portugal and Cyprus, have suffered the sharpest decrease in the fraction devoted to productive work. This suggests that, in countries with an already relatively poor quality of institutions as measured by θ, the crisis was accompanied by political and social tensions which made the economic crisis even deeper (see also e.g. Economides et al. (2020) for a study of the Greek economy).

Table 18: Policy instruments average: 2009-2016

Policy instrument	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
	Countries											
τ^c	0.21	0.20	0.22	0.19	0.15	0.21	0.17	0.20	0.23	0.22	0.19	0.26
τ^y	0.46	0.37	0.23	0.30	0.32	0.44	0.45	0.25	0.35	0.39	0.28	0.42
s^t	0.25	0.24	0.15	0.22	0.18	0.25	0.22	0.13	0.22	0.23	0.19	0.21
s^c	0.24	0.19	0.17	0.21	0.20	0.24	0.20	0.17	0.26	0.20	0.19	0.24

Note τ^c: effective tax rate on consumption, τ^y: effective tax rate on total income
s^t: share of government transfers to GDP, s^c: share of government consumption to GDP

Table 19: Policy changes, institutions and macroeconomic performance

Variable	BE	DE	IE	GR	ES	FR	IT	CY	NL	AT	PT	FI
	Countries											
Policy instruments set to their pre-crisis period 2001-2008 average												
y	0.57	0.39	0.69	0.29	0.45	0.55	0.46	0.34	0.44	0.55	0.27	0.49
η	0.95	0.95	0.96	0.83	0.87	0.91	0.91	0.91	0.95	0.95	0.87	0.96
Policy instruments set to their post-crisis period 2009-2016 average												
y	0.53	0.39	0.66	0.26	0.43	0.50	0.42	0.32	0.42	0.53	0.25	0.46
η	0.95	0.95	0.94	0.77	0.83	0.89	0.89	0.89	0.95	0.95	0.83	0.94
% change in output and effort level												
y	-7.11	-0.07	-3.81	-10.68	-4.68	-8.27	-9.13	-4.87	-5.08	-2.65	-6.86	-5.84
η	-0.86	0.09	-1.50	-6.78	-3.73	-1.74	-2.27	-2.70	-0.94	-0.34	-3.84	-1.05

Note y: output, η: effort level

9 Counterfactuals

In this section, to get a better picture of the role of institutions, we study a counter-factual scenario according to which a periphery country with particularly poor institutions as reflected in its value of θ suddenly enjoys the good institutional quality of a core country (see e.g. Prescott (2002) for similar experiments although not in terms of institutions). In particular, we ask what would happen if θ in Greece were like in Germany's and vice versa. That is, we assume that the two countries change places regarding institutional quality other things equal. Steady state results are reported in Table 20, where we present the solutions for output, y, and the fraction of non-leisure time devoted to work, η, in the two countries. As can be seen, an improvement in institutional quality, i.e. a decrease in θ, would allow Greece to enjoy an increase in output and the time allocated to productive uses. The opposite holds for Germany. In other words, periphery countries can benefit a lot from an improvement in their quality of institutions.

Table 20: Counterfactual: Changes in institutional quality, (Greece vs Germany)

	Greece		Germany	
Parameter	Actual	Fictitious	Actual	Fictitious
θ	0.57	0.09	0.09	0.57
Variable	Actual	Fictitious	Actual	Fictitious
y	0.27	0.29	0.39	0.36
η	0.80	0.96	0.95	0.75

Note y: output, η: effort level
θ: extraction parameter (Calibrated)

10 Conclusions, caveats and possible extensions

In this paper, we incorporated institutions into the standard neoclassical growth model in an attempt to account for the differences observed in the data of 12 Eurozone countries. We saw that structural parameters, especially those associated with institutional quality, exhibit considerable cross-country differences, so we calibrated and in turn solved the model for each country separately. A general result is that institutions matter and are fundamental causes of cross-country asymmetries both in trends and cycles.

Since the main results and policy implications have already been written in the introductory section, we close with some caveats and possible extensions. First, here we have taken institutional quality as given. It is recognized, however, as already mentioned above, that institutions are endogenous and persist over time. It would therefore be interesting to endogenize institutions in each country and search for their determinants. Second, here we developed a single model which was then calibrated and solved separately for each country. It would be interesting to develop a two-region currency union model, where the two regions are the core and the periphery of the Eurozone, and study the cross-country external effects of institutional quality in one region upon the other region. We leave these extensions for future work.

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Appendix to

Institutions and macroeconomic performance: Core vs periphery countries in the Eurozone

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Appendix A: Model

Households' optimality conditions

$$\frac{\partial u_t(.)}{\partial L_t^h} = \frac{1}{1+\tau_t^c}\frac{\partial u_t(.)}{\partial C_t^h}\left[(1-\tau_t^y)w_t Z_t \eta_t^h + \frac{(1-\eta_t^h)}{\sum_{h=1}^{N_t}(1-\eta_t^h)H_t^h}\theta_t G_t^t\right] \tag{1}$$

$$(1-\tau_t^y)w_t Z_t H_t^h = \frac{H_t^h}{\sum_{h=1}^{N_t}(1-\eta_t^h)H_t^h}\theta_t G_t^t \tag{2}$$

$$\frac{1}{1+\tau_t^c}\frac{\partial u_t(.)}{\partial C_t^h} = \beta^* E_t\left[\frac{1}{1+\tau_{t+1}^c}\frac{\partial u_{t+1}(.)}{\partial C_{t+1}^h}\Big((1-\tau_{t+1}^y)r_{t+1}^k + 1 - \delta\Big)\right] \tag{3}$$

$$\frac{1}{1+\tau_t^c}\frac{\partial u_t(.)}{\partial C_t^h} = \beta^* E_t\left[\frac{1}{1+\tau_{t+1}^c}\frac{\partial u_{t+1}(.)}{\partial C_{t+1}^h}(1+r_{t+1}^b)\right] \tag{4}$$

Firms' optimality conditions

$$r_t = \frac{\alpha Y_t^f}{K_t^f} \tag{5}$$

$$w_t = \frac{(1-\alpha)Y_t^f}{Q_t^f} \tag{6}$$

Decentralized Competitive Equilibrium (DCE)

The stationary DCE is summarized by Eqs. (7)-(14):

$$\eta_t = 1 - \theta_t \frac{s_t^t}{(1-\tau_t^y)(1-\alpha)\frac{y_t}{\eta_t h_t}}\frac{y_t}{h_t} \tag{7}$$

$$\left(\frac{1-\mu}{\mu}\right)\left(\frac{c_t + \psi s_t^c y_t}{1-h_t}\right) = \left[\frac{1-\tau_t^y}{1+\tau_t^c} + \frac{\theta_t s_t^t}{(1+\tau_t^c)(1-\alpha)}\right](1-\alpha)\frac{y_t}{h_t} \tag{8}$$

$$\left(\frac{c_{t+1} + \psi s_{t+1}^c y_{t+1}}{c_t + \psi s_t^c y_t}\right)^{1-\mu(1-\sigma)}\left(\frac{1-h_t}{1-h_{t+1}}\right)^{(1-\mu)(1-\sigma)} = \beta\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left[\alpha(1-\tau_{t+1}^y)\frac{y_{t+1}}{k_{t+1}} + 1 - \delta\right] \tag{9}$$

$$(s_t^c + s_t^t)y_t + (1+r_t^b)b_t = \gamma_n\gamma_z b_{t+1} + \tau_t^c c_t + \tau_t^y y_t \tag{10}$$

$$(1-s_t^c)y_t = c_t + i_t \tag{11}$$

$$\left(\frac{c_{t+1} + \psi s_{t+1}^c y_{t+1}}{c_t + \psi s_t^c y_t}\right)^{1-\mu(1-\sigma)}\left(\frac{1-h_t}{1-h_{t+1}}\right)^{(1-\mu)(1-\sigma)} = \beta\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)(1+r_{t+1}^b) \tag{12}$$

$$\gamma_n \gamma_z k_{t+1} = (1-\delta)k_t + i_t \tag{13}$$

$$y_t = A_t k_t^{\alpha} (\eta_t h_t)^{1-\alpha} \tag{14}$$

where $\beta \equiv \beta^* \gamma_z^{\mu(1-\sigma)-1}$.

Appendix B: Data, effective tax rates and η

Data

We consider the following two two sets of countries: a) Core countries, consisting of Austria (AT), Belgium (BG), Germany (DE), France (FR), Finland (FI), Netherlands (NL) and b) Periphery countries, consisting of Cyprus (CY), Greece (GR), Ireland (IR), Italy (IT), Portugal (PT) and Spain (ES). Data are of annual frequency and cover the period 2001-2016. Our main data source for macroeconomic variables is Eurostat. We also use data from the Total Economy Database, the St. Louis FED and AMECO, the International Country Risk Guide from the PRS Group and the World Governance Indicators from the World Bank.

To find the share of hours at work in available time, h_t, we use the ratio of the 'annual hours worked per worker' series to the 'total available time per worker' from the Total Economy Database.[1] We use the 'Net Capital stock' series from AMECO for real capital in our model. For the calibration of the depreciation rate, δ we use series on real capital and real gross fixed capital formation from AMECO and the law of motion of capital , $K_{t+1} = (1-\delta)K_t + I_t$.[2]

To match the model to the data, we follow usual practice (see e.g. Kehoe and Prescott (2002, 2007) and Conesa et al. (2007)) by defining output and investment in the model as the real gross domestic product and total investment (gross fixed capital formation) in the data respectively. Consequently consumption in the model should be compared to the difference between GDP and investment in the data.

Effective tax rates

We construct the effective tax rates of consumption, τ_t^c, and of total income, τ_t^y, following Mendoza et al. (1994) and Papageorgiou et al. (No. 235, BoG, 2017).[3]

Tax rate on personal income

$$\tau_t^h = \frac{HY}{(WSSE - SSCH - SSCER) + (GOSMIH - CFCH) + (IYRH - IYPH)} \tag{15}$$

[1]Total available time per worker is calculated as 52 weeks x 14 hours x 7 days.

[2]We use the GDP deflator to transform nominal variables to real variables.

[3]The effective tax rate of total income is a weighted average of the effective tax rates on employed labor income and the effective tax rate on capital income.

Effective tax rate on employed labor income

$$\tau_t^l = \frac{\tau^h(WSSE - SSCH - SSCER) + SSCH + SSCER}{WSSE} \tag{16}$$

Effective tax rate on capital income

$$\tau_t^k = \frac{\tau^h(GOSMIH - CFCH + IYRH - IYPH) + CAPT}{GOSMIT - CFCT} \tag{17}$$

where $CAPT = TFCT + CAT + TLG + (OTP - TLBS - TWP) + STAMP + CTC + OTPN + CORY$ are capital income tax revenue.

Effective tax rate on consumption

$$\tau_t^c = \frac{CT}{HC + GIC - CT} \tag{18}$$

where $CT = TP - STAMP - TLG - OTP$ are total tax revenue from indirect taxation.

where HY : taxes on individual or household income including holding gains, WSSE: compensation of employees, $SSCH$: households' actual social security contributions, $SSCER$: employers' actual social security contributions, $GOSMIH$: gross operating surplus and mixed income of households, $CFCH$: consumption of fixed capital of households, $IYRH$: interest income received by households, $IYPH$: interest income paid by households, HC : household and NPISH final consumption expenditure, GIC : government intermediate consumption.

The fraction of non-leisure time allocated to productive work, η

Since there is no data for η, in order to obtain a long-run value for η needed for the calibration process, we follow a practice similar to that used for the construction of several Composite Risk Rating sub-indices (ICRG).[4] In particular, we first split the ICRG index (that takes value in the (0-100) interval) into ten clusters of equal magnitude. For each cluster, we assign a value of η following the rule: $\eta = 1$ for the cluster (90-100), $\eta = 0.95$ for the cluster 80-90, etc. We then rank and assign each country to the corresponding cluster according to the country's value of the ICRG index. This automatically implies the corresponding value for η for this country. These values are presented in Table 4 in the main text.

[4]See International Country Risk Guide (ICRG) index, 2015, "International Country Risk Guide Methodology" https://www.prsgroup.com/wp-content/uploads/2012/11/icrgmethodology.pdf .

Appendix C: Second moment properties

Table A. 1: Relative volatility $x \equiv \frac{s_x}{s_y}$, All countries

	Belgium			Germany			Ireland	
x	Data	Model	x	Data	Model	x	Data	Model
c	1.0662	0.4391	c	0.8775	0.2809	c	0.9510	0.7339
i	3.3621	2.3463	i	2.7486	3.1736	i	2.9088	1.6097
h	0.4463	0.5125	h	0.4576	0.5642	h	0.2382	0.1736
k	0.4376	0.3783	k	0.3496	0.3415	k	0.1888	0.2958
η	Na	0.0548	η	Na	0.0416	η	Na	0.0098
s^y	0.0117	0.0118	s^y	0.0156	0.0156	s^y	0.0662	0.0659

	Greece			Spain			France	
x	Data	Model	x	Data	Model	x	Data	Model
c	0.6508	0.7272	c	0.6662	0.7371	c	0.7594	0.7687
i	2.7938	1.9286	i	3.6178	1.5539	i	2.6467	1.5520
h	0.1958	0.1760	h	0.2155	0.1976	h	0.7080	0.2904
k	0.3236	0.2581	k	0.3784	0.2544	k	0.2566	0.2526
η	Na	0.0567	η	Na	0.0770	η	Na	0.1052
s^y	0.0460	0.0459	s^y	0.0251	0.0253	s^y	0.0120	0.0123

	Italy			Cyprus			Netherlands	
x	Data	Model	x	Data	Model	x	Data	Model
c	0.8397	0.7703	c	0.9486	0.7275	c	1.0981	0.7237
i	2.3631	1.6113	i	5.3665	1.7922	i	2.9898	1.7382
h	0.3861	0.2106	h	0.3418	0.1862	h	0.2659	0.2483
k	0.3973	0.2467	k	0.6201	0.2888	k	0.3301	0.2745
η	Na	0.0722	η	Na	0.0433	η	Na	0.0333
s^y	0.0178	0.0179	s^y	0.0299	0.0299	s^y	0.0194	0.0194

	Austria			Portugal			Finland	
x	Data	Model	x	Data	Model	x	Data	Model
c	0.9328	0.3552	c	0.5983	0.7348	c	0.8695	0.3754
i	1.9755	2.5094	i	3.8339	1.7780	i	2.2224	2.3135
h	0.5192	0.4846	h	0.2387	0.1979	h	0.1366	0.4386
k	0.4243	0.3175	k	0.4953	0.2819	k	0.2599	0.3475
η	Na	0.0483	η	Na	0.0935	η	Na	0.0261
s^y	0.0133	0.0134	s^y	0.0205	0.0208	s^y	0.0244	0.0248

Table A. 2: Relative volatility $x \equiv \frac{s_x}{s_y}$, All countries (Ranking)

Data: Ranking of volatility of output and relative volatility

	s_y	Ratio		c	Ratio		i	Ratio		h	Ratio		k	Ratio
BG	0.0117	1.0	PR	0.5983	1.0	AT	1.9755	1.0	FI	0.1366	1.0	IE	0.1888	1.0
FR	0.012	1.0	GR	0.6508	1.1	FI	2.2224	1.1	GR	0.1958	1.4	FR	0.2566	1.4
AT	0.0133	1.1	ES	0.6662	1.1	IT	2.3631	1.2	ES	0.2155	1.6	FI	0.2599	1.4
DE	0.0156	1.3	FR	0.7594	1.3	FR	2.6467	1.3	IE	0.2382	1.7	GR	0.3236	1.7
IT	0.0178	1.5	IT	0.8397	1.4	DE	2.7486	1.4	PR	0.2387	1.7	NL	0.3301	1.7
NL	0.0194	1.7	FI	0.8695	1.5	GR	2.7938	1.4	NL	0.2659	1.9	DE	0.3496	1.9
PR	0.0205	1.8	DE	0.8775	1.5	IE	2.9088	1.5	CY	0.3418	2.5	ES	0.3784	2.0
FI	0.0244	2.1	AT	0.9328	1.6	NL	2.9898	1.5	IT	0.3861	2.8	IT	0.3973	2.1
ES	0.0251	2.1	CY	0.9486	1.6	BG	3.3621	1.7	BG	0.4463	3.3	AT	0.4243	2.2
CY	0.0299	2.6	IE	0.951	1.6	ES	3.6178	1.8	DE	0.4576	3.3	BG	0.4376	2.3
GR	0.046	3.9	BG	1.0662	1.8	PR	3.8339	1.9	AT	0.5192	3.8	PR	0.4953	2.6
IE	0.0662	5.7	NL	1.0981	1.8	CY	5.3665	2.7	FR	0.708	5.2	CY	0.6201	3.3

Averages	s_y	c	i	h	k
Core	0.0161	0.9339	2.6575	0.4223	0.3430
Periphery	0.0343	0.7758	3.4807	0.2694	0.4006
All	0.0252	0.8548	3.0691	0.3458	0.3718

Model: Ranking of volatility of output and relative volatility

	s_y	Ratio		c	Ratio		i	Ratio		h	Ratio		k	Ratio		η	Ratio
BG	0.0118	1.0	DE	0.2809	1.0	FR	1.5520	1.0	IE	0.1736	1.0	IT	0.2467	1.0	IE	0.0098	1.0
FR	0.0123	1.0	AT	0.3552	1.3	ES	1.5539	1.0	GR	0.1760	1.0	FR	0.2526	1.0	FI	0.0261	2.7
AT	0.0134	1.1	FI	0.3754	1.3	IE	1.6097	1.0	CY	0.1862	1.1	ES	0.2544	1.0	NL	0.0333	3.4
DE	0.0156	1.3	BG	0.4391	1.6	IT	1.6113	1.0	ES	0.1976	1.1	GR	0.2581	1.0	DE	0.0416	4.2
IT	0.0179	1.5	NL	0.7237	2.6	NL	1.7382	1.1	PR	0.1979	1.1	NL	0.2745	1.1	CY	0.0433	4.4
NL	0.0194	1.6	GR	0.7272	2.6	PR	1.7780	1.1	IT	0.2106	1.2	PR	0.2819	1.1	AT	0.0483	4.9
PR	0.0208	1.8	CY	0.7275	2.6	CY	1.7922	1.2	NL	0.2483	1.4	CY	0.2888	1.2	BG	0.0548	5.6
FI	0.0248	2.1	IE	0.7339	2.6	GR	1.9286	1.2	FR	0.2904	1.7	IE	0.2958	1.2	GR	0.0567	5.8
ES	0.0253	2.1	PR	0.7348	2.6	FI	2.3135	1.5	FI	0.4386	2.5	AT	0.3175	1.3	IT	0.0722	7.4
CY	0.0299	2.5	ES	0.7371	2.6	BG	2.3463	1.5	AT	0.4846	2.8	DE	0.3415	1.4	ES	0.0770	7.8
GR	0.0459	3.9	FR	0.7687	2.7	AT	2.5094	1.6	BG	0.5125	3.0	FI	0.3475	1.4	PR	0.0935	9.5
IE	0.0659	5.6	IT	0.7703	2.7	DE	3.1736	2.0	DE	0.5642	3.2	BG	0.3783	1.5	FR	0.1052	10.7

Averages						
Core	0.0162	0.4905	2.2722	0.4231	0.3186	0.0516
Periphery	0.0343	0.7385	1.7123	0.1903	0.2709	0.0588
All	0.0253	0.6145	1.9922	0.3067	0.2948	0.0552

Table A. 3: Persistence $\rho(x_t, x_{t-1})$, All countries

Belgium			Germany			Ireland		
x	Data	Model	x	Data	Model	x	Data	Model
y	0.4127	0.4137	y	0.1953	0.1986	y	0.7097	0.4774
c	0.2013	0.5183	c	0.3192	0.4038	c	0.2042	0.4999
i	0.4812	0.3913	i	0.4528	0.1773	i	0.7204	0.4604
h	0.2728	0.4051	h	0.1985	0.1935	h	0.5320	0.4481
k	0.7625	0.8013	k	0.7703	0.6878	k	0.7000	0.8411
η	Na	0.4647	η	Na	0.4680	η	Na	0.4636

Greece			Spain			France		
x	Data	Model	x	Data	Model	x	Data	Model
y	0.8112	0.4802	y	0.7294	0.4815	y	0.5003	0.4781
c	0.5683	0.4993	c	0.7511	0.4973	c	0.7271	0.4911
i	0.6694	0.4641	i	0.7537	0.4699	i	0.4225	0.4664
h	0.3536	0.4574	h	0.6591	0.4603	h	0.5392	0.4647
k	0.8736	0.8456	k	0.8639	0.8461	k	0.7495	0.8461
η	Na	0.4696	η	Na	0.4647	η	Na	0.4685

Italy			Cyprus			Netherlands		
x	Data	Model	x	Data	Model	x	Data	Model
y	0.4980	0.4766	y	0.6947	0.4776	y	0.5971	0.4774
c	0.5686	0.4894	c	0.3066	0.4993	c	0.5481	0.4974
i	0.5436	0.4661	i	0.6051	0.4598	i	0.6016	0.4614
h	0.4585	0.4600	h	0.6241	0.4527	h	0.0828	0.4564
k	0.8865	0.8451	k	0.8609	0.8407	k	0.7922	0.8427
η	Na	0.4656	η	Na	0.4657	η	Na	0.4662

Austria			Portugal			Finland		
x	Data	Model	x	Data	Model	x	Data	Model
y	0.3954	0.3981	y	0.6289	0.4800	y	0.4285	0.4257
c	0.4308	0.5046	c	0.3062	0.5000	c	0.4732	0.5280
i	0.2138	0.3825	i	0.6665	0.4631	i	0.4646	0.4085
h	0.0924	0.3898	h	0.1837	0.4567	h	0.1505	0.4075
k	0.7673	0.7999	k	0.8807	0.8419	k	0.7568	0.8119
η	Na	0.4659	η	Na	0.4664	η	Na	0.4681

Table A. 4: Persistence $\rho(x_t, x_{t-1})$, All countries (Ranking)

Data: Ranking of persistence

	y	Ratio		c	Ratio		i	Ratio		h	Ratio		k	Ratio
DE	0.1953	1.0	BG	0.2013	1.0	AT	0.2138	1.0	NL	0.0828	1.0	IE	0.7000	1.0
AT	0.3954	2.0	IE	0.2042	1.0	FR	0.4225	2.0	AT	0.0924	1.1	FR	0.7495	1.1
BG	0.4127	2.1	PT	0.3062	1.5	DE	0.4528	2.1	FI	0.1505	1.8	FI	0.7568	1.1
FI	0.4285	2.2	CY	0.3066	1.5	FI	0.4646	2.2	PT	0.1837	2.2	BG	0.7625	1.1
IT	0.4980	2.5	DE	0.3192	1.6	BG	0.4812	2.3	DE	0.1985	2.4	AT	0.7673	1.1
FR	0.5003	2.6	AT	0.4308	2.1	IT	0.5436	2.5	BG	0.2728	3.3	DE	0.7703	1.1
NL	0.5971	3.1	FI	0.4732	2.4	NL	0.6016	2.8	GR	0.3536	4.3	NL	0.7922	1.1
PT	0.6289	3.2	NL	0.5481	2.7	CY	0.6051	2.8	IT	0.4585	5.5	CY	0.8609	1.2
CY	0.6947	3.6	GR	0.5683	2.8	PT	0.6665	3.1	IE	0.5320	6.4	ES	0.8639	1.2
IE	0.7097	3.6	IT	0.5686	2.8	GR	0.6694	3.1	FR	0.5392	6.5	GR	0.8736	1.2
ES	0.7294	3.7	FR	0.7271	3.6	IE	0.7204	3.4	CY	0.6241	7.5	PT	0.8807	1.3
GR	0.8112	4.2	ES	0.7511	3.7	ES	0.7537	3.5	ES	0.6591	8.0	IT	0.8865	1.3
Averages														
Core	0.4216			0.4500			0.4394			0.2227			0.7664	
Periphery	0.6786			0.4508			0.6598			0.4685			0.8443	
All	0.5501			0.4504			0.5496			0.3456			0.8054	

Model: Ranking of persistence

	y	Ratio		c	Ratio		i	Ratio		h	Ratio		k	Ratio		η	Ratio
DE	0.1986	1.0	DE	0.4038	1.0	DE	0.1773	1.0	DE	0.1935	1.0	DE	0.6878	1.0	IE	0.4636	1.0
AT	0.3981	2.0	IT	0.4894	1.2	AT	0.3825	2.2	AT	0.3898	2.0	AT	0.7999	1.2	ES	0.4647	1.0
BG	0.4137	2.1	FR	0.4911	1.2	BG	0.3913	2.2	BG	0.4051	2.1	BG	0.8013	1.2	BG	0.4647	1.0
FI	0.4257	2.1	ES	0.4973	1.2	FI	0.4085	2.3	FI	0.4075	2.1	FI	0.8119	1.2	IT	0.4656	1.0
IT	0.4766	2.4	NL	0.4974	1.2	CY	0.4598	2.6	IE	0.4481	2.3	CY	0.8407	1.2	CY	0.4657	1.0
NL	0.4774	2.4	CY	0.4993	1.2	IE	0.4604	2.6	CY	0.4527	2.3	IE	0.8411	1.2	AT	0.4659	1.0
IE	0.4774	2.4	GR	0.4993	1.2	NL	0.4614	2.6	NL	0.4564	2.4	PR	0.8419	1.2	NL	0.4662	1.0
CY	0.4776	2.4	IE	0.4999	1.2	PR	0.4631	2.6	PR	0.4567	2.4	NL	0.8427	1.2	PR	0.4664	1.0
FR	0.4781	2.4	PR	0.5000	1.2	GR	0.4641	2.6	GR	0.4574	2.4	IT	0.8451	1.2	DE	0.4680	1.0
PR	0.4800	2.4	AT	0.5046	1.2	IT	0.4661	2.6	IT	0.4600	2.4	GR	0.8456	1.2	FI	0.4681	1.0
GR	0.4802	2.4	BG	0.5183	1.3	FR	0.4664	2.6	ES	0.4603	2.4	ES	0.8461	1.2	FR	0.4685	1.0
ES	0.4815	2.4	FI	0.5280	1.3	ES	0.4699	2.6	FR	0.4647	2.4	FR	0.8461	1.2	GR	0.4696	1.0
Averages																	
Core	0.3986			0.4906			0.3813			0.3862			0.7983			0.4669	
Periphery	0.4789			0.4975			0.4639			0.4559			0.8434			0.4659	
All	0.4387			0.4940			0.4226			0.4210			0.8208			0.4664	

Table A. 5: Co-movement $\rho(y_t, x_{t+1})$, All countries

Belgium

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.4253	0.3216	0.0485	0.1792	0.6732	0.4362
i	0.2597	0.8065	0.5077	0.4390	0.9736	0.3373
h	0.0258	0.5271	0.3018	0.4305	0.9055	0.2858
k	0.2218	0.6270	0.7644	-0.3480	-0.0488	0.5427
η	Na	Na	Na	0.0068	0.0117	-0.0010

Germany

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	-0.1400	0.5622	0.1890	-0.0070	0.7949	0.3927
i	0.3419	0.8795	0.2015	0.2321	0.9892	0.1307
h	0.1566	0.5903	-0.2734	0.2515	0.9752	0.1105
k	0.0781	0.4135	0.4016	-0.4098	-0.2003	0.5663
η	Na	Na	Na	0.0036	0.0091	0.0032

Ireland

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.4819	0.6685	0.1997	0.4468	0.9943	0.5222
i	0.6347	0.8610	0.8051	0.5039	0.9954	0.4263
h	0.2398	0.3779	0.3638	0.5308	0.9598	0.3341
k	-0.2452	-0.0366	0.4592	-0.3163	-0.0115	0.5254
η	Na	Na	Na	0.0032	0.0068	0.0048

Greece

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.5836	0.7700	0.7465	0.4500	0.9947	0.5218
i	0.7015	0.9087	0.7111	0.5117	0.9938	0.4222
h	0.6084	0.3132	0.1341	0.5240	0.9483	0.3451
k	0.0792	0.4140	0.7341	-0.3396	-0.0398	0.4932
η	Na	Na	Na	0.0129	0.0206	0.0088

Spain

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.0541	0.1748	0.0725	0.4504	0.9850	0.5123
i	0.7613	0.9418	0.6431	0.5024	0.9943	0.4416
h	-0.0173	0.0366	0.0821	0.4806	0.8806	0.3328
k	-0.0126	0.3354	0.7126	-0.3439	-0.0449	0.4868
η	Na	Na	Na	0.0141	0.0274	0.0151

France

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.5518	0.7141	0.4933	0.4210	0.9228	0.4744
i	0.1794	0.8526	0.5696	0.4916	0.9787	0.4311
h	-0.0863	-0.0555	-0.3696	0.3593	0.6765	0.2635
k	-0.5018	0.0906	0.4393	-0.3366	-0.0445	0.4791
η	Na	Na	Na	0.0162	0.0281	0.0137

Italy

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.4406	0.7592	0.3413	0.4377	0.9575	0.4876
i	0.3628	0.9207	0.5959	0.4937	0.9846	0.4326
h	0.2674	0.5850	0.1638	0.3969	0.7466	0.2874
k	-0.1332	0.2792	0.6079	-0.3493	-0.0554	0.4741
η	Na	Na	Na	0.0119	0.0216	0.0101

Cyprus

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.2347	-0.0153	-0.2906	0.4434	0.9880	0.5193
i	0.5301	0.8580	0.7088	0.5070	0.9926	0.4193
h	-0.1717	0.1409	0.2704	0.5075	0.9200	0.3262
k	0.1404	0.4545	0.7461	-0.3266	-0.0222	0.5162
η	Na	Na	Na	0.0024	0.0110	0.0061

Netherlands

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.4989	0.7379	0.2521	0.4349	0.9695	0.5088
i	0.5568	0.9127	0.5998	0.5032	0.9899	0.4226
h	0.4691	0.3217	-0.2667	0.4667	0.8558	0.3129
k	-0.0332	0.5158	0.7948	-0.3316	-0.0305	0.5037
η	Na	Na	Na	0.0003	0.0055	0.0020

Austria

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.2035	0.8027	0.4131	0.1905	0.7671	0.4718
i	0.0802	0.7483	0.4492	0.4235	0.9831	0.3383
h	0.0967	0.3904	-0.1818	0.4323	0.9520	0.3013
k	0.0545	0.4016	0.5298	-0.3910	-0.1020	0.5041
η	Na	Na	Na	0.0072	0.0148	0.0087

Portugal

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	-0.3630	-0.1622	-0.0527	0.4454	0.9841	0.5171
i	0.6421	0.9579	0.6158	0.5085	0.9919	0.4232
h	0.6903	0.5240	0.0625	0.4789	0.8676	0.3129
k	-0.0637	0.3413	0.7253	-0.3299	-0.0260	0.5103
η	Na	Na	Na	0.0178	0.0333	0.0140

Finland

	Data			Model		
	t-1	t	t+1	t-1	t	t+1
c	0.4108	0.8712	0.4073	0.2574	0.8542	0.5327
i	0.3452	0.8987	0.5022	0.4543	0.9886	0.3657
h	0.3903	0.5419	-0.2048	0.4652	0.9604	0.3192
k	-0.2430	0.2984	0.6768	-0.3653	-0.0652	0.5220
η	Na	Na	Na	0.0009	0.0048	-0.0011

Table A. 6: Contemporaneous co-movement $\rho(y_t, x_t)$, All countries (Ranking)

Data: Ranking of contemporaneous co-movement with output

	c		i		h		k
PT	-0.1622	AT	0.7483	FR	-0.0555	IE	-0.0366
CY	-0.0153	BG	0.8065	ES	0.0366	FR	0.0906
ES	0.1748	FR	0.8526	CY	0.1409	IT	0.2792
BG	0.3216	CY	0.8580	GR	0.3132	FI	0.2984
DE	0.5622	IE	0.8610	NL	0.3217	ES	0.3354
IE	0.6685	DE	0.8795	IE	0.3779	PT	0.3413
FR	0.7141	FI	0.8987	AT	0.3904	AT	0.4016
NL	0.7379	GR	0.9087	PT	0.5240	DE	0.4135
IT	0.7592	NL	0.9127	BG	0.5271	GR	0.4140
GR	0.7700	IT	0.9207	FI	0.5419	CY	0.4545
AT	0.8027	ES	0.9418	IT	0.5850	NL	0.5158
FI	0.8712	PT	0.9549	DE	0.5903	BG	0.6270
Averages							
Core	0.6683		0.8497		0.4743		0.3912
Periphery	0.5931		0.9075		0.3882		0.2980
All	0.8874		0.8786		0.4313		0.3446

Model: Ranking of contemporaneous co-movement with output

	c		i		h		k		η
BG	0.6732	BG	0.9736	FR	0.6765	DE	-0.2003	FI	0.0048
AT	0.7471	FR	0.9787	IT	0.7466	AT	-0.1020	NL	0.0055
DE	0.7949	AT	0.9831	NL	0.8558	FI	-0.0652	IE	0.0068
FI	0.8542	IT	0.9846	PT	0.8676	IT	-0.0554	DE	0.0091
FR	0.9228	FI	0.9886	ES	0.8806	BG	-0.0488	CY	0.0110
IT	0.9575	DE	0.9892	BG	0.9055	ES	-0.0449	BG	0.0117
NL	0.9695	NL	0.9899	CY	0.9200	FR	-0.0445	AT	0.0148
PT	0.9841	PT	0.9919	GR	0.9483	GR	-0.0398	GR	0.0206
ES	0.9850	CY	0.9926	AT	0.9520	NL	-0.0305	IT	0.0216
CY	0.9880	GR	0.9938	IE	0.9598	PT	-0.0260	ES	0.0274
IE	0.9943	ES	0.9943	FI	0.9604	CY	-0.0222	FR	0.0284
GR	0.9947	IE	0.9954	DE	0.9752	IE	-0.0115	PT	0.0333
Averages									
Core	0.8270		0.9839		0.8876		-0.0819		0.0124
Periphery	0.9839		0.9921		0.8872		-0.0333		0.0201
All	0.9054		0.9880		0.8874		-0.0576		0.0163