Competitive and Corporatist Labor Markets: Theory and Evidence from Time Series Data

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Abstract

In a standard macroeconomic model with exogenous productivity and population growth, we study the steady-state labor market equilibrium of a competitive and a corporatist economy; the labor market equilibrium of the latter is described by the efficient bargaining solution. We infer from the theoretical analysis that real wage and labor productivity should be deterministically cointegrated in the competitive setup, while real wage, labor productivity, and employment should be stochastically cointegrated in the corporatist model. A procedure applying multiple time series methodologies is derived to discriminate between the two models statistically. We present results of 18 OECD countries and compare them to the corporatism rankings known from the literature.

Keywords: Labor market models, wage bargaining; vector autoregressive models, cointegration.

JEL classification: E24, J50; C32.

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1 Introduction

It is well known from standard growth theory that labor's share is constant over time in the steady-state equilibrium of a competitive economy. However, standard unit root tests indicate for many OECD countries that the series of labor's share contain a unit root. More precisely, labor's share is best described by a random walk which of course contradicts the implication of a (at least approximatively) constant labor share.

Looking at the labor market structure of many OECD countries, the assumption of a competitive labor market turns out to be hardly realistic. Wages (and employment) are rather determined in negotiations between trade unions and employers' associations. In the remainder of this paper, we shall call for convenience an economy with such a labor market structure a *corporatist economy*. This semantic arrangement may be simplifying in abstracting from a lot of aspects corporatist economies possess; but it should be understood as follows: If we accept the view that the labor market equilibrium is *not* determined by the interaction of a large number of self-interested economic agents, it is rather characterized by large and strong institutions formulating the (aggregate) objective of the whole market side, then we have to search for theoretical models which may capture such a bilateral monopoly structure.

We are going to develop a labor market model capturing the well known stylized facts of labor productivity and population growth in the framework of a cooperative bargaining model. Indeed, by applying the efficient bargaining approach (Nash solution), we shall end up with labor's share varying in a further variable, namely union's bargaining power, in the steady-state equilibrium of the economy.

This variable, however, is not observable but the Nash solution additionally implies that the equilibrium employment is also affected by union's bargaining power. As a matter of fact, there is a stable relation between labor's share and employment (adjusted for population growth) indicating the corporatist labor market equilibrium of the economy.

The linearized version of this relation serves as the cointegrating relation in a vector autoregressive (VAR) model with the three endogenous variables, real wage, labor productivity, and employment. Thus, we are able to estimate a corporatist labor market model by using multivariate time series analysis. Furthermore, since the competitive labor market model implying a constant labor share is nested in the former specification (i.e. real wage and labor productivity are cointegrated), we are also able to construct a statistical test procedure discriminating between the two models.

Thus, the paper proposes a new method of testing whether labor market contracts be efficient. But in contrast to MaCurdy and Pencavel [1986] and Brown and Ashenfelter [1986], we apply here methodologies of the multiple time series analysis.

The difference to the classical papers on corporatism, social consensus, and centralization of wage bargaining (Bruno and Sachs [1985], McCallum [1983, 1986], Calmfors and Driffill [1988]) also containing empirical parts is two-fold: In these papers, the corporatism hypothesis is tested by using cross-country data either through computing the correlation between a constructed index of corporatism and some measure of macroeconomic performance (inflation, unemployment or Okun's misery index which is the sum of both) or running some simple Phillips curve regression including the corporatism index as an additional, explanatory variable. Hence, they have been able to draw conclusions of the sort that corporatist economies perform equal, better or worse than noncorporatist ones.[1]

Conclusions of that style are not intended to be drawn from our investigation. We rather want to propose a macroeconometric specification of the labor market equilibrium which is both theoretically justified and empirical evident. Some countries are better described by the competitive specification, others by the corporatist one. But in contrast to recent work applying time series methods on labor market data (Dolado and Jimeno [1997] and Balmaseda et al. [2000]), we always argue that relations in the levels of the relevant labor market variables can be in fact detected. Hence, we need not to difference all series before analyzing labor market relations by the means of a structural VAR approach or so.

Blanchard [1997] also analyzes the evolution of the income shares of several OECD countries. He shows that capital's share is highly persistent for the continental European countries whereas it is more or less constant in the case of Canada, the United Kingdom, and the United States.[2] To reason the long-lasting shifts in the income distribution of the continental countries, he suggests three potential explanations: long lags in the adjustment process of factor proportions to factor prices, changes in the distribution of rents between workers and firms, and technical change biased against labor. Taken Blanchard's research agenda for granted, our paper can be understood as a contribution to the theoretical and empirical underpinning of the second argument.

The remainder of the paper is organized as follows: We start the theoretical analysis in reporting briefly the steady-state equilibrium of a competitive economy with exogenous labor productivity and population growth well known from the Solow [1956] growth model. In section 2.2, we derive the steady-state labor market equilibrium of a corporatist economy in the present context. The theoretical part ends with a brief comparison of both models. Then, the econometric investigation follows: First, we establish a cointegrated VAR model with a deterministic time trend and three en-

[1] See Flanagan [1999], p.1156-1162 for a more detailed survey including a critique of the empirical testing of the corporatism hypothesis and the bargaining structure of economies.

[2] See Blanchard [1997], figure 1, p.90.

dogenous variables, real wage, labor productivity, and employment, as the appropriate framework of an empirical labor market model. Then, we formulate the statistical hypotheses to be tested. We use the test procedure on quarterly time series data of 18 OECD countries. The results are reported and interpreted by the means of contrasting them to corporatism rankings known from the literature. Section 4 finally concludes.

2 The theoretical model

In the theoretical part, we are going to specify the equilibrium dynamics of the central variables of an aggregate labor market, the (average) real wage and employment. We use the concept of a steady-state equilibrium to abstract from effects caused by sluggish adjustment of capital. Although important in reality, these effects block the focus on economic essentials in a long-run analysis.

Because of the stylized fact that real wage, labor productivity, and employment are trending over time, the model allows for labor-augmenting technical progress and population growth. In order to keep the analysis as simple as possible, both sources of economic growth are assumed to be exogenous. Furthermore, they are completely separable from the decision processes within some period. This means in essence that the whole model can be solved period by period in discounting first all trending variables with the respective growth factor and then establishing the equilibrium in a static setup. Thus, all behavioral functions (like the union members' utility function and the agents' labor supply) can be defined as time-independent functions relating discounted economic variables to each other.

Population is assumed to grow at the constant rate n and productivity at the constant rate θ. For convenience, we define the factor Θ_t as the following product

$$\Theta_t \equiv e^{\theta t}. \tag{2.1}$$

Notice that Θ_t is interpreted as the "effectiveness of labor" (Romer [1996], p.7) later on because it forces labor productivity to grow. Moreover, Θ_t also serves as the discount factor for all economic variables which are affected by the labor-augmenting technical progress, that is real wage besides labor productivity.

As a matter of fact, the competitive solution of our model is simply the well known Solow growth model.[3] We shall shortly report that solution as a benchmark in the subsequent section because of two reasons: First, its implications help to construct an empirical test which makes the discrimination between a competitive and a corporatist labor market possible;

[3]This model was first developed in Solow [1956]. Recent textbook versions of this model are found in Barro and Sala-i-Martin [1995], chapter 1, or Romer [1996], chapter 1.

and second, the competitive labor market equilibrium serves as the bargaining parties' threat points, the situation when wage negotiations have been breaking down.

In the corporatist model, however, real wage and employment are assumed to be bargained in an efficient bargaining process. The efficient bargaining solution is of course only one among different candidates. We choose it because of two reasons: First, it has a quite simple analytical structure and appealing axiomatic properties; but second and more important, time series data of many countries will be shown to fit the results of the efficient bargaining solution quite well.

It should be stressed that this concept does not exclude conflicting negotiations and strikes; it rather means that the labor market equilibrium is (besides the economic fundamentals) dependent on a further variable, the power structure of bargaining parties.

In usual wage bargaining setups, the capital stock is assumed to be at a fixed value.[4] Since we aim at analyzing the steady-state equilibrium of the economy, we have to determine firms' investment behavior given labor-augmenting technical change and population growth. We suppose that firms are obliged to decide on investment before the bargaining process is starting. Hence, at the stage of the negotiations on wages and employment, the capital stock is fixed, and we are still on familiar grounds in deriving the bargaining solution.

On the other hand, if the economy were perfectly competitive, there would be no reason for a preceding investment decision. As usual price-takers, firms would maximize profits with respect to labor and capital given factor and output prices.

2.1 The competitive economy

A perfectly competitive economy is characterized by the fact that all markets clear. Firms and workers behave as price-takers both in the commodity and the labor market.

We consider a representative firm producing a single output good with a technology characterized by constant returns to scale in its two inputs, capital K_t and effective labor $(\Theta_t L_t)$:

$$Y_t = Q(K_t, \Theta_t L_t) = \Theta_t L_t q(\kappa_t) \tag{2.2}$$

where $\kappa_t \equiv K_t/(\Theta_t L_t)$ is the capital intensity.

The production function is assumed to satisfy the so-called Inada conditions: The marginal product of capital is always positive but decreasing as capital (per unit of effective labor) rises, i.e. $q' > 0$, $q'' < 0$; and no output can be produced without capital, i.e. $q(0) = 0$. Moreover, $\lim_{\kappa_t \to 0} q'(\kappa_t) = \infty$ and

[4] See Booth [1995], chapter 5, for a recent summary of different bargaining approaches.

$\lim_{\kappa_t \to \infty} q'(\kappa_t) = 0.$
Households (or population) are assumed to supply labor dependent on the offered real wage. Moreover, population grows at the exogenous rate n. Thus, labor supply in period t may be described by the following function

$$L_t^s = L_0 (W_t/\Theta_t)^{\eta} e^{nt} \tag{2.3}$$

where $\eta > 0$ the wage-elasticity of labor supply and L_0 labor force in the initial period.
To keep the analysis as simple as possible, we suppose an exogenous savings rate s which is not varying over time. Since we are only interested in labor market implications, this simplification is justified. Furthermore, we can directly follow the analysis of Solow [1956].
We finally suppose that the initial values of all variables take strictly positive values.
We define the steady-state equilibrium of the competitive economy:

Definition 1 (Competitive equilibrium) Given the supply of labor as in equation (2.3) and the exogenous savings rate s, the allocation $\{K_t^*, L_t^*\}$ and the (factor) price system $\{R_t^*, W_t^*\}$ constitute the steady-state equilibrium of a competitive economy in period t if the following conditions are satisfied:

i. firms' profit maximization: $\max_{K_t, L_t} \Pi_t$ given factor prices $\{R_t, W_t\}$;

ii. market clearing on the labor market: $L_t^* = L_0 (W_t^*/\Theta_t)^{\eta} e^{nt}$;

iii. market clearing on the capital market: $sY_t^* = d\,K_t^*/d\,t$;

iv. steady-state condition: $d\,\kappa_t^*/d\,t = 0$

with the production technology $Y_t^* = Q(K_t^*, \Theta_t L_t^*)$.

Firms' profit maximization behavior provides the first two equilibrium conditions given the factor prices $\{R_t, W_t\}$:

$$R_t = q'(\kappa_t), \tag{2.4}$$
$$W_t = \Theta_t[q(\kappa_t) - \kappa_t q'(\kappa_t)] \tag{2.5}$$

where $\kappa_t \equiv K_t/(\Theta_t L_t)$ as well as K_t and L_t are functions in factor prices.[5]
Note that equations (2.4) and (2.5) together with the two market-clearing conditions ii. and iii. determine the equilibrium values of the endogenous variables $\{R_t, W_t; K_t, L_t\}$. From condition iii., it is clear that we abstract from depreciation of the capital stock here.
We solve the model as follows: First, we state the labor market equilibrium $\{W_t^*, L_t^*\}$ as a function of the capital stock K_t. Then, we use the equilibrium

[5] The sufficient conditions for a maximum are checked in the appendix A.1.

employment L_t^* to describe the firms' investment. Together with the savings function, we receive the capital stock K_t^* clearing the capital market. R_t^* follows from equation (2.4) then. The commodity market clears because of Walras' law.
For some $K_t > 0$, there is a unique combination $\{W_t^*, L_t^*\}$ solving the labor market clearing condition[6]

$$L_t^* = L_0 (W_t^*/\Theta_t)^\eta e^{nt}. \tag{2.6}$$

Differentiating equation (2.6) with respect to time, we get

$$\frac{d\,L_t^*/d\,t}{L_t^*} = n + \eta \left(\frac{d\,W_t^*/d\,t}{W_t^*} - \theta \right) \tag{2.7}$$

We also differentiate $K_t = \Theta_t L_t^* \kappa_t$ with respect to time:

$$\frac{d\,K_t}{d\,t} = \Theta_t L_t^* \left(\frac{d\,\kappa_t}{d\,t} \right) + \Theta_t L_t^* \kappa_t \left(\theta + \frac{d\,L_t^*/d\,t}{L_t^*} \right). \tag{2.8}$$

Plugging equation (2.7) in this equation, we obtain an expression for investment per unit of effective labor:

$$\frac{d\,K_t/d\,t}{\Theta_t L_t^*} = \frac{d\,\kappa_t}{d\,t} + \kappa_t \left[(1-\eta)\,\theta + n + \eta \left(\frac{d\,W_t^*/d\,t}{W_t^*} \right) \right]. \tag{2.9}$$

Equilibrium wage growth can be obtained from equation (2.5):

$$\frac{d\,W_t^*/d\,t}{W_t^*} = \theta - \frac{\kappa_t q''(\kappa_t)}{q(\kappa_t) - \kappa_t q'(\kappa_t)} \frac{d\,\kappa_t}{d\,t}. \tag{2.10}$$

We substitute this in equation (2.9) and use the market-clearing condition of the capital market so that we end up with in the following differential equation in the equilibrium capital intensity κ_t^*:

$$\frac{d\,\kappa_t^*}{d\,t} = C_t \left[s\,q(\kappa_t^*) - \kappa_t^* (\theta + n) \right] \tag{2.11}$$

with

$$C_t \equiv \frac{q(\kappa_t^*) - \kappa_t^* q'(\kappa_t^*)}{[q(\kappa_t^*) - \kappa_t^* q'(\kappa_t^*)] - \eta\, \kappa_t^{*\,2}\, q''(\kappa_t^*)} > 0 \tag{2.12}$$

because $q(\kappa_t^*) - \kappa_t^* q'(\kappa_t^*) > 0$ and $q''(\kappa_t^*) < 0$.
The equilibrium capital intensity κ_t^* determines the capital market equilibrium $\{R_t^*, K_t^*\}$ with $R_t^* = q'(\kappa_t^*)$ and $K_t^* = \Theta_t L_t^* \kappa_t^*$.
Given the assumptions on $q(\cdot)$, equation (2.11) implies that there is a unique steady state κ^* solving

$$s\,q(\kappa^*) = \kappa^* (\theta + n). \tag{2.13}$$

[6]See appendix A.1 for more details.

to which the economy will always converge.[7]
Hence, we are able to simplify the subsequent analysis in looking just at the equilibrium outcomes of all endogenous variables on the balanced growth path; i.e. condition iv. is imposed to the model from now on.
The steady-state condition directly implies that the real user costs of capital are constant because with equation (2.4) we have

$$R^* = q'(\kappa^*). \tag{2.14}$$

The competitive labor market equilibrium in the steady state of the economy is given by the following two equations:

$$W_t^* = A_t^* \left[1 - \frac{R^* \kappa^*}{q(\kappa^*)}\right] \tag{2.15}$$

$$L_t^* = L_0^* e^{nt} \tag{2.16}$$

where $A_t^* = \Theta_t q(\kappa^*) = Y_t^*/L_t^*$ is the steady-state labor productivity and $L_0^* \equiv L_0[q(\kappa^*) - \kappa^* q'(\kappa^*)]^\eta$.
Dividing equation (2.15) by A_t^*, we infer that labor's share is constant over time in the steady-state equilibrium of a competitive economy because

$$S^* = 1 - \frac{R^* \kappa^*}{q(\kappa^*)} \quad \forall t. \tag{2.17}$$

The following proposition summarizes the interesting features of the steady-state labor market equilibrium in a perfectly competitive economy:

Proposition 1 In the steady-state equilibrium of a perfectly competitive economy with exogenous labor-augmenting technical change and population growth, real wage grows at the rate of labor productivity, while employment is determined by population growth. Labor's share is constant over time.

It is worth mentioning that equation (2.15) provides the basis for an empirical specification of the labor market equilibrium of a competitive economy because the real wage W_t^* and the labor productivity A_t^* are both observable variables.

2.2 The corporatist economy

The theoretical analysis of a corporatist economy is much more complicated. For a first impression, we present a quite informal definition of the labor market equilibrium at this stage. In effect, section 2.2.1 is devoted to a precise description of all ingredients necessary for an analytical handling of the corporatist scenario in the setup used here.

[7] See appendix A.1 for the proof of the existence of a steady state.

Definition 2 (Corporatist equilibrium) The labor market equilibrium of a corporatist economy is described by an efficient solution of a centralized or coordinated bargain on real wage and employment between a trade union and an employers' association, both economy-widely organized.

After the preparation in section 2.2.1, we are going to derive analytically the labor market equilibrium of a corporatist economy in section 2.2.2. Since the resulting equilibrium is nonlinear in general, we are going to linearize it in section 2.2.3.

2.2.1 The bargaining participants' objective functions

We are going to model the labor market equilibrium of a corporatist economy as the solution of a bilateral monopoly. This raises several questions to be answered at the beginning: Which are the bargaining participants? Which concept should be used to solve the bilateral monopoly? Which are the appropriate objective functions of the bargaining participants? And which is the pair of threat points, namely the participants' payoffs when they decide not to cooperate any more?

Most corporatist economies are characterized by centralized or at least coordinated wage negotiations. Hence, the bargaining parties are an employers' association and a trade union, both economy-widely organized. As mentioned before, we choose the concept of efficient bargains to describe the labor market equilibrium.

Given these prerequisites, we turn to the last two questions which need some analytical effort to be answered because the bargaining setup should be founded on the same framework where the competitive labor market equilibrium has been derived. Most generally, the employers' association as well as the trade union strives to maximize the objective function of the representative firm and union member, respectively.

The employers' association. Since all firms are identical, the objective function of the employers' association is fairly simple: The representative firm maximizes its profit. Since firms are assumed to have already decided on capital before wage negotiations start, the profit function of the representative firm is given by

$$\Pi_t = Y_t - W_t L_t - R_t^o K_t^o \tag{2.18}$$

where W_t is the bargained real wage and R_t^o the real user costs of capital.[8] K_t^o is the predetermined capital stock, the solution of the firms' unilateral decision on investment which will be considered later on.

[8] From capital owners' view, R_t^o may be called the guaranteed or minimum return on capital because it is assumed in the remainder that possible profits typically generated in an efficient wage bargain are distributed exclusively amongst capital owners.

The trade union. The objective function of the trade union, however, is not so straightforward to derive: As usual in comparable bargaining setups, the trade union is assumed to maximize the expected utility of the representative union member

$$V_t = \frac{L_t}{M_t}\, v\left(\frac{W_t}{\Theta_t}\right) + \left[1 - \frac{L_t}{M_t}\right] v\left(\frac{W_t^o}{\Theta_t}\right) \tag{2.19}$$

where M_t is the number of union members and W_t^o is the wage at which the representative agent is indifferent between working and consuming leisure ("leisure-equivalent" wage, henceforth). $v(W_t^o/\Theta_t)$ is therefore the utility from being unemployed, i.e. when "being allowed to" consume leisure.

$v(\cdot)$ is a Bernoulli utility function with $v' > 0$ and $v'' < 0$, that is union members are risk-averse. We know that real wage grows at the same rate as labor productivity in a competitive steady-state equilibrium. Since we want to define a time-independent utility function, we have to discount W_t by the factor Θ_t to get a non-trending argument.[9] The function V_t is of the von Neumann/Morgenstern expected utility form because $L_t/M_t \in [0;1]$ can be interpreted as the probability of some union member to be employed in period t. It should be noted that $L_t < M_t \;\forall\, t$ in the present framework.

The exogenous variables M_t and W_t^o are inter-related through a voluntary labor supply decision of agents which turns here to the question whether or not an agent becomes union member. In order to derive this relation, define the discounted "leisure-equivalent" wage of the representative union member by $W^o \equiv W_t^o/\Theta_t$. Decompose the union membership $M_t \equiv Me^{nt}$ where M is taken as exogenous for the moment. Define further the inverse labor supply by $W(L)$ with $W' > 0$ where L is the component of an analogous factorization of L_t. Then, the discounted "leisure-equivalent" wage of the representative of M union members has to satisfy the following condition:

$$v(W^o(M)) = \int_0^M v(W(L))\, dL. \tag{2.20}$$

Equation (2.20) implies that W^o is increasing in M,[10] that is the higher the membership the higher the representative agent's "leisure-equivalent" wage.

The participants' threat points. BINMORE et al. [1986] suggest defining the pair of threat points $\{\Pi_t^o, V_t^o\}$ by the payoffs in the event when the

[9]In other words, we specify the utility function such that the utility of the representative agent is constant over time in a competitive labor market equilibrium.

[10]By total differentiation of equation (2.20), we obtain

$$\frac{dW^o}{dM} = \frac{v(W^o(M))}{v'(W^o(M))} > 0$$

because $v' > 0$.

bargaining process have been breaking down. As a matter of fact, the firms' capital stock K_t^o must be such high that capital owners and workers receive at least the payoffs they would obtain if there were perfect competition in the labor market.
This means on the one hand that capital owners would accept that firms bargain on real wage and employment with the union (instead of letting the market mechanism play) if the return on capital R_t^o were at least as high as the real user costs of capital R_t^* in the competitive equilibrium. On the other hand, workers would not join the trade union and accept wage negotiations if they did not profit from it on average even in the worst situation when cooperation is breaking down. This implies that the representative union member must receive a real wage being at least as high as its "leisure-equivalent" wage W_t^o.
Both conditions lead to the result that the firms' capital decision replicates that of the perfect competition economy, because if the capital stock is K_t^* and cooperation is breaking down, firms will voluntarily employ L_t^* workers to produce efficiently. Thus, the resulting factor prices $\{R_t^*, W_t^*\}$ will satisfy the aforementioned conditions just with equality ($R_t^o = R_t^*$, $W_t^o = W_t^*$).
All these considerations finally enable us to determine the pair $\{\Pi_t^o, V_t^o\}$: From the analysis of the perfect competition economy, we know that firms earn zero profits in equilibrium; so, $\Pi_t^o = 0$. We obtain the expected utility of the representative union member in that event by substituting $L_t = L_t^*$ and $W_t^o = W_t^*$ in equation (2.19). This leads to $V_t^o = v(W_t^o/\Theta_t)$.

2.2.2 Efficient bargains

It has become standard in most applications to specify an efficient solution of a bilateral bargaining setup by the so-called (generalized) Nash solution.[11]
Cooperation generates an additional aggregate payoff which is distributed among the bargaining participants according to their relative power.
Analytically, we are maximizing the (generalized) Nash product Ω_t defined by the weighted product of the bargaining participants' net payoffs:

$$\Omega_t \equiv \left\{V_t - V_t^o\right\}^{\Xi_t} \left\{\Pi_t - \Pi_t^o\right\}^{1-\Xi_t} \tag{2.21}$$

where $\Xi_t \in [0; 1]$ is interpreted as union's bargaining power.
Equations (2.18) and (2.19) as well as the pair of threat points (Π_t^o, V_t^o) lead

[11] Due to NASH [1953]. LEONTIEF [1946] originally discussed an efficient solution in a bilateral monopoly (like wage negotiations between unions and employers' associations). MCDONALD and SOLOW [1981] introduce that idea in the modern framework of optimization behavior and pareto-efficiency. The formal approach, which is used here, is strongly related to the standard textbook versions, see BOOTH [1995], chapter 5, for a recent example.

to the following expression

$$\Omega_t = \left\{ \frac{L_t}{M_t} \left[v\left(\frac{W_t}{\Theta_t}\right) - v\left(\frac{W_t^o}{\Theta_t}\right) \right] \right\}^{\Xi_t} \left\{ \Theta_t L_t q(\kappa_t) - W_t L_t - R_t^o K_t^o \right\}^{1-\Xi_t} \tag{2.22}$$

which has to be maximized with respect to the two instruments, the real wage W_t and the employment L_t.
To save space, we denote the union's net payoff by $\tilde{V}_t$ in the following.
The necessary conditions for a maximum are obtained by calculating the first-order conditions of the optimization problem:

$$\begin{aligned} \frac{\partial \Omega_t}{\partial L_t} &= \Xi_t \left\{ \tilde{V}_t \right\}^{\Xi_t - 1} \left(\frac{1}{M_t} \right) \left[v\left(\frac{\bar{W}_t}{\Theta_t}\right) - v\left(\frac{W_t^o}{\Theta_t}\right) \right] \left\{ \Pi_t \right\}^{1-\Xi_t} + \\ &\quad + (1-\Xi_t) \left\{ \tilde{V}_t \right\}^{\Xi_t} \left\{ \Pi_t \right\}^{-\Xi_t} \left[\Theta_t [q(\bar{\kappa}_t) - \bar{\kappa}_t q'(\bar{\kappa}_t)] - \bar{W}_t \right] = 0, \end{aligned} \tag{2.23}$$

$$\begin{aligned} \frac{\partial \Omega_t}{\partial W_t} &= \Xi_t \left\{ \tilde{V}_t \right\}^{\Xi_t - 1} \left(\frac{\bar{L}_t}{M_t} \right) \left(\frac{1}{\Theta_t} \right) v'\left(\frac{\bar{W}_t}{\Theta_t} \right) \left\{ \Pi_t \right\}^{1-\Xi_t} - \\ &\quad - (1-\Xi_t) \left\{ \tilde{V}_t \right\}^{\Xi_t} \left\{ \Pi_t \right\}^{-\Xi_t} \bar{L}_t = 0. \end{aligned} \tag{2.24}$$

where $\bar{\kappa}_t \equiv K_t^o / (\Theta_t \bar{L}_t)$.
Dividing (2.23) by (2.24) gives the contract curve, i.e. the loci of all pareto-efficient solutions $(\bar{W}_t, \bar{L}_t)$:

$$\frac{v(\bar{W}_t/\Theta_t) - v(W_t^o/\Theta_t)}{v'(\bar{W}_t/\Theta_t)} = \frac{\bar{W}_t}{\Theta_t} - \left[q(\bar{\kappa}_t) - \bar{\kappa}_t q'(\bar{\kappa}_t) \right]. \tag{2.25}$$

The first-order condition (2.24) can be rewritten in the following form:

$$\frac{\Xi_t}{1-\Xi_t} \cdot \frac{\Theta_t \bar{L}_t q(\bar{\kappa}_t) - \bar{W}_t \bar{L}_t - R_t^o K_t^o}{\bar{L}_t} = \frac{v(\bar{W}_t/\Theta_t) - v(W_t^o/\Theta_t)}{(1/\Theta_t)\, v'(\bar{W}_t/\Theta_t)}. \tag{2.26}$$

After some calculus, we end up with the so-called rent division curve:

$$\bar{W}_t = \Theta_t \left[q(\bar{\kappa}_t) - \bar{\kappa}_t [\Xi_t R_t^o + (1-\Xi_t) q'(\bar{\kappa}_t)] \right]. \tag{2.27}$$

It is worth noting at this stage that the efficient bargaining solution for the case $\Xi_t = 0$ replicates the competitive solution $\{W_t^*, L_t^*\}$.
Dividing equation (2.27) by actual labor productivity $\bar{A}_t = \bar{Y}_t / \bar{L}_t = \Theta_t q(\bar{\kappa}_t)$, we obtain the equilibrium expression of labor's share in a corporatist economy follows:

$$\bar{S}_t = 1 - \frac{\bar{\kappa}_t}{q(\bar{\kappa}_t)} \left[\Xi_t R_t^o + (1-\Xi_t) q'(\bar{\kappa}_t) \right]. \tag{2.28}$$

The labor market equilibrium of this economy is determined by that combination $\{\bar{W}_t, \bar{L}_t\}$ which solves equations (2.25) and (2.28) simultaneously for

the given bargaining power structure Ξ_t.
Without further assumptions on $q(\cdot)$ and $v(\cdot)$, we are not able to specify $\bar{W}_t$ and $\bar{L}_t$ explicitly; but for the subsequent analysis, two properties of the efficient bargaining solution are quite important. We state them in the following lemmas:[12]

Lemma 1 The contract curve is upward-sloping in the wage-employment-space.

Lemma 2 Both the real wage $\bar{W}_t$ and the employment $\bar{L}_t$ are increasing in union's bargaining power Ξ_t.

Finally, we have to deal with the problem that firms usually earn non-zero profits in efficient wage bargains. Since they are understood as an extra return on capital, the firm is obliged to distribute them amongst capital owners. To obtain the profits of the representative firm, we plug the bargaining outcome $\{\bar{W}_t, \bar{L}_t\}$ in the profit equation (2.18):

$$\bar{\Pi}_t = (1 - \Xi_t)[q'(\bar{\kappa}_t) - R_t^o]K_t^o \tag{2.29}$$

Suppose that profits are distributed according to the capital owners' contribution to the firms' capital stock. Thus, the extra return on capital is given by

$$R_t^+ \equiv \bar{\Pi}_t / K_t^o = (1 - \Xi_t)[q'(\bar{\kappa}_t) - R_t^o] \tag{2.30}$$

per unit of capital.
A look in the proof of lemma 2 shows that R_t^+ is non-negative so that the full return on capital $\bar{R}_t$ is at least as high as the guaranteed return R_t^o:

$$\bar{R}_t \equiv R_t^o + R_t^+ = \Xi_t R_t^o + (1 - \Xi_t) q'(\bar{\kappa}_t) \geq R_t^o. \tag{2.31}$$

Once again, we focus on the steady state of the economy: Note that even if capital has completely adjusted to the long-run growth rates of productivity and population, the capital intensity $\bar{\kappa}_t$ may vary in a steady-state equilibrium of a corporatist economy because employment $\bar{L}_t$ varies with changes in union's bargaining power Ξ_t.
In other words, only if Ξ_t is constant, the steady-state capital intensity $\bar{\kappa}_t$ will also be constant over time. This, however, implies that

$$R_t^o = q'(\kappa^*) \tag{2.32}$$

$$W_t^o / \Theta_t = q(\kappa^*) - \kappa^* q'(\kappa^*) \tag{2.33}$$

are constant in the steady state because we have $\Xi_t = 0 \; \forall \, t$ in that case.
From equation (2.33), we draw the important conclusion that union membership is only driven by population growth and therefore exogenous in the steady state:

$$M_t = M \, e^{nt} \tag{2.34}$$

[12] See appendix A.2 for the proofs.

This allows us to decompose the bargained employment level $\bar{L}_t$ into a population growth and a bargaining effect:

$$\bar{L}_t \equiv L(\Xi_t, t) = L(\Xi_t)\, e^{nt} \tag{2.35}$$

where $L(\Xi_t)$ is the employment level adjusted for population growth. Remind from lemma 2 that $L(\Xi_t)$ is increasing in its argument. For convenience, we normalize $L(\frac{1}{2})$ to unity. So, the following inequalities hold:

$$\text{(i)} \quad L(0) \leq L(\Xi_t) \quad \forall\ \Xi_t \in [0;1] \qquad \text{and} \qquad \text{(ii)} \quad L(0) < 1. \tag{2.36}$$

Finally, we summarize in the following proposition the main results of this section:

Proposition 2 In the steady-state equilibrium of an economy with exogenous labor-augmenting technical change and population growth, the corporatist solution defined as an efficient bargain on real wage and employment is characterized by labor's share varying in the bargaining power structure. Real wage is increasing in labor productivity and union's bargaining power; employment grows at the rate of population and is additionally increasing in union's bargaining power.

2.2.3 An approximation to the labor market equilibrium

In the present model, the equilibrium on the labor market is not determined by equating labor demand and supply; it is rather some locus on the contract curve (2.25) dependent on the actual bargaining power structure Ξ_t. Using equations (2.28) and (2.32), we know that some steady-state bargaining outcome $\{\bar{W}_t, \bar{L}_t\}$ must solve the following expression

$$\bar{S}_t = 1 - \frac{\bar{\kappa}_t}{q(\bar{\kappa}_t)} \left[\Xi_t q'(\kappa^*) + (1 - \Xi_t) q'(\bar{\kappa}_t)\right] \tag{2.37}$$

with $\bar{\kappa}_t \equiv K_t^o/(\Theta_t \bar{L}_t)$, $\kappa^* \equiv K_t^*/(\Theta_t L_t^*)$, and $K_t^o = K_t^*$.
For convenience, we suppose that the production technology is described by a simple Cobb-Douglas production function:

$$q(\kappa_t) = \kappa_t^\rho \qquad \rho \in [0;1]. \tag{2.38}$$

Thus, equation (2.37) simplifies to

$$\bar{S}_t = 1 - \rho \left[\Xi_t \left(\frac{\kappa^*}{\bar{\kappa}_t}\right)^{\rho - 1} + (1 - \Xi_t)\right]. \tag{2.39}$$

Using the definitions of κ^* and $\bar{\kappa}_t$ as well as equation (2.35), we end up with

$$\bar{S}_t = 1 - \rho \left[\Xi_t \left(\frac{L(\Xi_t)}{L(0)}\right)^{\rho - 1} + (1 - \Xi_t)\right]. \tag{2.40}$$

Equation (2.40) shows that labor's share is solely determined by the actual bargaining power structure Ξ_t in an economy with efficient wage negotiations. The same is true for the realized employment level (net of population growth). In other words, the two endogenous variables, $\bar{S}_t$ (or $\bar{W}_t$) and $\bar{L}_t$, are driven by the same stochastic process which is represented by union's bargaining power Ξ_t in a model with efficient bargains.
Since the bargaining power sequence Ξ_t is not observable, we can only determine the equilibrium relation between the two observable variables, $\bar{S}_t$ and $\bar{L}_t$. In order to apply robust estimation techniques, it seems appropriate to approximate the non-linear expression in equation (2.40) through a first-order Taylor-expansion in logs.
Since there is a direct correspondence between Ξ_t and $\bar{L}_t$, equation (2.40) may be rewritten (omitting time indices and bars for a moment):

$$S(L) = 1 - \rho\left[\Xi(L)\left(\frac{L}{L(0)}\right)^{\rho-1} + (1 - \Xi(L))\right]. \tag{2.41}$$

The derivative of $S(L)$ with respect to L yields

$$\frac{d\,S(L)}{d\,L} = \rho\frac{\Xi}{L}\left[\lambda(L)\left[1 - \left(\frac{L(0)}{L}\right)^{1-\rho}\right] + (1-\rho)\left(\frac{L(0)}{L}\right)^{1-\rho}\right] \tag{2.42}$$

with

$$\lambda(L) \equiv \frac{d\,\Xi}{d\,L}\frac{L}{\Xi} \geq 0. \tag{2.43}$$

$\lambda(L)$ is the inverse elasticity of employment to changes in union's bargaining power.
Because of inequalities (2.36), we infer that the derivative is non-negative:

$$\frac{dS(L)}{dL} \geq 0 \quad \forall\ L. \tag{2.44}$$

To linearize the model, we write equation (2.40) in logs and compute a Taylor-expansion of first order around the "normalized" employment level ($t = 0$) at equilibrated bargaining power ($\Xi = \frac{1}{2}$) which has been normalized to unity in the last section:

$$\ln S(L) = \ln S(1) + \frac{\rho}{2S(1)}\left[\lambda(1)\left(1 - L(0)^{1-\rho}\right) + (1-\rho)L(0)^{1-\rho}\right](L-1) \tag{2.45}$$

Likewise through a Taylor-expansion of first order, we can express the "normalized" employment $L = L(\Xi_t)$ by the log of actual employment and a time trend:

$$L = 1 + \ln L(\Xi_t, t) - nt. \tag{2.46}$$

Plugging equation (2.46) in (2.45), we end up with the log-linearized form of equation (2.40):[13]

$$\ln \bar{S}_t = \ln S(1) + \frac{\rho}{2S(1)}\left[\lambda(1)\Big(1 - L(0)^{1-\rho}\Big) + (1-\rho)L(0)^{1-\rho}\right](\ln \bar{L}_t - nt). \quad (2.47)$$

So, a linear approximation to the labor market equilibrium of a corporatist economy may be expressed by the following equation:

$$\ln \bar{S}_t + b_1 \ln \bar{L}_t + b_2 t + b_3 = 0 \quad (2.48)$$

with the following parameter restrictions:

$$\begin{array}{llll} \text{(i)} & b_1 & \equiv & -\frac{\rho}{2S(1)}\left[\lambda(1)\Big(1 - L(0)^{1-\rho}\Big) + (1-\rho)\hat{L}^{1-\rho}\right] < 0, \\ \text{(ii)} & b_2 & \equiv & -b_1 n > 0, \\ \text{(iii)} & b_3 & \equiv & -\ln S(1) > 0. \end{array} \quad (2.49)$$

2.3 Comparison

At this stage, it it worth highlighting the main differences between a competitive and a corporatist steady-state labor market equilibrium. Although real wage and employment are the most important labor market variables, the differences between the two models become perhaps most obvious in comparing the equilibrium labor share equations (2.17) and (2.28): We directly recognize that labor's share is constant over time in a competitive economy, whereas it is driven by union's bargaining power Ξ_t in a corporatist economy.

Of course, the former statement is empirically testable because labor's share is an observable variable. However, more effort is needed to end up with a testable specification for a corporatist labor market equilibrium because the union's bargaining power is not observable.

To solve this problem, we have had to specify the equilibrium expression of employment: In our definition of a corporatist economy, employment is jointly determined by the bargaining participants. Thus, it is affected by union's bargaining power Ξ_t and through the union membership also by population growth n. These considerations have led us to specify the bargained employment level by equation (2.35).

Since union's bargaining power drives (at least) two observable labor market variables, we are able to establish an equilibrium relation that eliminates the bargaining power variable Ξ_t (but not the bargaining effect) from the equation. In an efficient bargaining setup, this relation is found in the contract curve which is in fact independent of the unobservable Ξ_t. In other

[13] We return now to the notation with time indices and bars: $\bar{S}_t \equiv S(L)$ and $\bar{L}_t \equiv L(\Xi_t, t)$.

words, we simply suggest that the equilibrium allocations of a corporatist labor market should always be situated on the contract curve (2.25).
Since the contract curve is usually a nonlinear function in observable variables, we approximate it by a Taylor expansion of first order. This finally leads to a linear equilibrium relation between labor's share and employment, i.e. equation (2.48) together with the parameter restrictions (2.49). Thus, we do not know union's bargaining power affecting both labor's share and employment, but we do know that these observable variables (approximatively) satisfy equation (2.48) which is sufficient for the econometric analysis that follows.

3 Econometric analysis

As already mentioned in the introduction, previous research on corporatism has usually searched for empirical evidence on this matter. But to our best knowledge, multiple time series methods have not been used yet in this respect.
Without going into details, we shall argue shortly that a cointegrated VAR model is a quite appropriate basis for an empirical analysis in the present context: Since the cointegrating vectors can be interpreted as the long-run or equilibrium relations of the respective variables, implications of the theoretical models can be examined by analyzing the cointegrating space of the empirical specifications.
It is worth stressing that the Granger representation theorem is the keystone in finding an empirical specification of the corporatist model:[14] As already mentioned, labor's share and employment are driven by a common but unobservable stochastic trend; we have called it bargaining effect. Consequently, we cannot estimate the model in its reduced form (or in its common trends representation). The Granger representation theorem, however, says that the reduced form can be equivalently written as a vector error correction model. In the latter, the unobserved common trend is eliminated so that estimation techniques can be applied.
Hence, we are able to estimate the corporatist model without knowing union's bargaining power in each period.

[14] The Granger representation theorem is stated and proven in ENGLE and GRANGER [1987] or in JOHANSEN [1991].

3.1 An empirical model of the labor market

3.1.1 A cointegrated vector error correction model

A quite general representation of an empirical labor market model may be a vector autoregression model of order p (VAR(p), henceforth).[15]
Consider a K-dimensional vector y_t, $t = 1, ..., T$, of appropriate labor market variables:[16]

$$y_t = \mu_0 + \mu_1 t + x_t \,, \quad t = 1, 2, ..., T \tag{3.1}$$

where x_t follows a VAR(p)-process:

$$x_t = A_1 x_{t-1} + ... + A_p x_{t-p} + \varepsilon_t \,, \quad t = 1, 2, ..., T. \tag{3.2}$$

μ_0 and μ_1 are unknown $(K \times 1)$ vectors, A_j are $(K \times K)$ coefficient matrices, and a white-noise error term $\varepsilon_t \sim (0, \Omega)$ with Ω positive definite.[17]
Equation (3.2) can be written in vector error correction form (VECM(p), henceforth):

$$\Delta x_t = \Pi x_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta x_{t-j} + \varepsilon_t \tag{3.3}$$

where $\Pi \equiv -(I_K - A_1 - ... - A_p)$ and $\Gamma_j \equiv -(A_{j+1} + ... + A_p)$, $j = 1, ..., p-1$.
Since Nelson and Plosser's [1982] work, we know that most economic time series are integrated of order one (I(1), henceforth). Hence, we allow that the components of x_t are I(1) and cointegrated (of order 1,1) which implies that the matrix Π has reduced rank:

$$r \equiv \text{rk}(\Pi) < K. \tag{3.4}$$

If we decompose Π as follows

$$\Pi = \alpha\beta' \tag{3.5}$$

where α and β are $(K \times r)$ matrices of full rank, we infer from Johansen's [1991] formulation of the Granger representation theorem that equation (3.3) is balanced because $\beta' x_t$ is (asymptotically) stationary with zero mean.
Under the cointegration condition (3.5), the model as defined in equations (3.1) and (3.2) may be written more compact as a VECM(p) in y_t:

$$\Delta y_t = \gamma_0 + \alpha[\beta' y_{t-1} + \tau_1(t-1) + \tau_0] + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + \varepsilon_t \tag{3.6}$$

---

[15] The subsequent analysis of the VAR-model follows closely the presentation used in Lütkepohl and Saikkonen [2000], section 2.

[16] After deriving the general structure of this VAR-model, we are going to specify which economic variables belong to the K-dimensional vector y_t.

[17] We assume here that p presample values of y_t are also available.

where $\gamma_0 \equiv \alpha_\perp(\alpha'_\perp \alpha_\perp)^{-1}\alpha'_\perp \Psi \mu_1$, $\tau_1 \equiv -\beta' \mu_1$, $\tau_0 \equiv (\alpha'\alpha)^{-1}\alpha'\Psi\mu_1 - \beta'\mu_0$ with $\Psi \equiv I_K - \sum_{j=1}^{p-1} \Gamma_j$, and the $(K \times (K-r))$-matrix $\alpha_\perp$ is the orthogonal complement of α satisfying the condition $\alpha'_\perp \alpha = 0$.
Now, the link to the theoretical model of section 2.2 becomes obvious: Presume that all components of y_t are I(1) and the cointegrating rank is $r = 1$. Then, the expression in brackets is usually interpreted as the long-run equilibrium of the system (3.1) and (3.2).
Allowing for more flexibility, we decompose labor's share into its two components, real wage and labor productivity so that a quite general empirical representation of the labor market would be equation (3.6) where y_t is defined as a trivariate vector:[18]

$$y_t \equiv (w_t, a_t, l_t)' \tag{3.7}$$

where w_t is the log of real wage, a_t the log of labor productivty, and l_t the log of employment. In table 1, we report to which variables in the theoretical models the time series used in the empirical analysis do correspond.

Table 1: Variable declaration

Variable	Theoretical models		Empirical model (in logs)
	Competition	Corporatism	
real wage	W_t^*	$\bar{W}_t$	w_t
output	Y_t^*	$\bar{Y}_t$	y_t
employment	L_t^*	$\bar{L}_t$	l_t
productivity	A_t^*	$\bar{A}_t$	a_t

3.1.2 Parameter restrictions and statistical hypotheses

In this section, we work out to which empirical specification the different theoretical models correspond. Since we have derived steady-state labor market equilibria, we are only able to predict parameter values of the cointegrating matrices and impose restrictions on the cointegrating space.
From the theoretical analysis, it should be clear that the corporatist labor market model implies exactly one cointegrating vector of the following form:

$$w_t + \tilde{\beta}_2 a_t + \tilde{\beta}_3 l_t + \tau_1 t + \tau_0 \sim \mathrm{I}(0) \tag{3.8}$$

where $\tilde{\beta}_2 = -1$ (theoretically expected) and the same parameter restrictions on $\tilde{\beta}_3$, τ_1, and τ_0 like on b_1, b_2, and b_3 in equation (2.49).

[18] Unfortunately, the variable y_t has two meanings: when y_t is a vector, it is defined as below. Instead, when y_t is a scalar, it is the log of real output (see table 1). The latter meaning, however, occurs only once in the text, namely in equation (3.12).

Table 2: Statistical hypotheses

$$\begin{array}{ccccccc} \mathrm{H}^*(0) & \subset & \mathrm{H}^*(1) & \subset & \mathrm{H}^*(2) & \subset & \mathrm{H}^*(3) \\ \| & & \cup & & \cup & & \\ \mathrm{H}_1(0) & \subset & \mathrm{H}_1(1) & \subset & \mathrm{H}_1(2) & & \end{array}$$

This table is part of the table 5.1 in JOHANSEN [1995], p.81, for the case $K = 3$. The hypothesis $\mathrm{H}_1(3)$ does not exist in the present setup because three cointegrating relations in the model with a unrestricted constant would imply that y_t is stationary. This, however, is excluded because y_t is assumed to be trending in at least one component.

In contrast, the competitive labor market equilibrium requires a constant labor share which leads to the empirical hypothesis that real wage and labor productivity are (deterministically) cointegrated:

$$w_t - \bar{\beta}_2 a_t + \bar{\tau}_0 \sim \mathrm{I}(0) \tag{3.9}$$

where $\bar{\beta}_2 = -1$ once again.
This means that the competitive labor market model is nested in the corporatist model. Thus, statistical test procedures may be applied to discriminate between the two specifications.
Multiple time series analysis usually consists of two steps: tests on the cointegrating rank and estimation of the model given this rank. The former issue, however, causes some trouble in the empirical investigation because the limiting distribution of cointegrating tests are shown to be dependent on the deterministic part of the model (see JOHANSEN [1994]).
Cointegration tests in a corporatist economy should be conducted in the model

$$\mathrm{H}^*(r): \quad \Delta y_t = \gamma_0 + \alpha[\beta' y_{t-1} + \tau_1(t-1) + \tau_0] + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + \varepsilon_t,$$

but in the model

$$\mathrm{H}_1(r): \quad \Delta y_t = \gamma_0 + \alpha[\beta' y_{t-1} + \tau_0] + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + \varepsilon_t$$

when a competitive economy is considered.
The difference between $\mathrm{H}^*(r)$ and $\mathrm{H}_1(r)$ is actually that the cointegrating matrix β eliminate not only the stochastic nonstationarity, but also the deterministic time trend in $\mathrm{H}_1(r)$ because $\tau_1 = 0$ obviously implies

$$\beta' \mu_1 = 0. \tag{3.10}$$

Condition (3.10) is a restriction on the cointegrating space. PARK [1992] and PERRON and CAMPBELL [1993] have introduced the label "deterministic cointegration" for that case. If $\beta'\mu_1 \neq 0$ instead, the variables are said to be "stochastically cointegrated".

Hence, we end up with a nonlinear order of statistical hypotheses which is sketched in table 2. In the horizontal direction, the hypotheses on the cointegrating rank of the respective model are ordered. The usual cointegration test procedures are based on this ordering. Both of our theoretical specifications require a cointegrating rank $r = 1$. Thus, we have to test first whether the data reject the hypothesis of no cointegration at all.

Although table 2 shows that both empirical models are equivalent under no cointegration, it is important to test this hypothesis in the more general model with a restricted time trend because the alternative hypothesis also matters: To see this, presume that the corporatist labor market model does in fact hold for some country; then, hypothesis testing along the second row in table 2 would lead to invalid statistical inference and possibly false conclusions. Hence, the first step of our empirical investigation consists of a usual cointegration analysis in the model (3.6) where the time trend is restricted to the cointegrating space.

The vertical ordering in table 2 also shows that $H_1(r)$ is always nested in $H^*(r)$ for a given cointegrating rank r. Thus, provided that the estimated cointegrating rank is $r = 1$, we are able to test the competitive labor market specification against the corporatist model by allowing only for an unrestricted constant in the model. Namely, we test $H_1(1)$ against $H^*(1)$ which is shown to be $\chi^2(1)$ distributed.[19]

From the theoretical analysis, we know that the employment series will disappear from the cointegrating space together with the linear trend if the labor market equilibrium is competitive. Hence, under $r = 1$, we also test the hypothesis $H_0 : (\tilde{\beta}_3 = 0 \;\&\; \tau_1 = 0)$ against $H^*(1)$ which is $\chi^2(2)$ distributed.

With this successive test procedure, we have determined the cointegrating rank as well as the deterministic terms and thus, we are able to estimate the model. Of course, the resulting coefficients should satisfy the restrictions of the theoretical models. Insofar the former test procedures are necessary for the corporatist and the competitive labor market hypothesis, respectively; sufficient, however, is that the estimated coefficients satisfy the parameter restrictions in the respective model.

It is worth summarizing the main empirical features of the corporatist and the competitive labor market equilibrium, respectively. Provided that all series are integrated and trending, the corporatism hypothesis requires exactly one cointegrating relation with a linear trend indicating population growth. In a competitive labor market scenario, however, real wage and

[19] See JOHANSEN [1995], theorem 11.3, p.162.

labor productivity are deterministically cointegrated.
An exception, however, arise if employment is not trending.[20] Then, the linear trend might disappear from the cointegrating relation, even if the corporatism hypothesis holds. Corporatism, however, requires in this scenario that the employment coefficient is significantly negative.
Another exception is given when a weak version of the competitive labor market model holds: Presume that the three series are I(1), trending, and deterministically cointegrated. Then, the resulting estimated cointegrating vector

$$w_t + \bar{\beta}_2 a_t + \bar{\beta}_3 l_t \sim \mathrm{I}(0) \tag{3.11}$$

may also be written as

$$w_t + \bar{\beta}_2 y_t + \left(\bar{\beta}_3 - \bar{\beta}_2\right) l_t \sim \mathrm{I}(0) \tag{3.12}$$

where y_t is the log of aggregate output.
We call this version weak because it does not fulfill the linear restriction on the coefficients in front of y_t and l_t defining labor productivity. Nevertheless, this version cannot be interpreted as a corporatist labor market equilibrium, although the cointegrating vector is statistically equivalent to that of the first exception. There are two reasons for that: First, the three series are deterministically cointegrated although employment is trending. Thus, there is no bargaining effect which has been modeled as the deviation of the employment series from a time trend indicating population growth. Second, the bargaining effect requires a negative employment coefficient even if population growth is absent. Note that $(\bar{\beta}_3 - \bar{\beta}_2)$ may be positive or negative in the cointegrating relation (3.11).

3.2 Estimation and test results

In this section, we apply the usual methodologies of multiple time series analysis to check our theory for OECD countries. Data is taken from the OECD Business Sector Data Base. The exact description of the used time series is given in appendix C together with the plots of all series.
As reported in table 3, the samples of most countries start in the beginning 1960s. The only exception is the Netherlands where no data is available before 1969:1. The original series of the French labor productivity and the Japanese real wage contain an extreme outlier in 1968 and 1974, respectively, for which we have corrected the corresponding series. The samples usually end in the second half of the 1990s except for Finland, Germany, and Sweden. We observe structural breaks (at least in the employment series) in the beginning 1990s. Since we have more than 100 observations for each country, we have decided not to model those breaks. The samples of Finland and Sweden end in 1990:4, the sample of Germany in 1990:2.

[20] This is true for Belgium and the United Kingdom.

The empirical analysis starts with unit root tests for all series to ensure that the used time series are I(1). Then, we conduct an unrestricted VAR analysis to select the lag order p. The core of the analysis, however, are the tests on cointegration. Besides the standard methodology pioneered by JOHANSEN [1991], we also apply an alternative procedure proposed by LÜTKEPOHL and SAIKKONEN in several papers. We finally report the estimated cointegrating vectors.

Table 3: Series and lag order selection

Country	Sample		Obs.	Lag order		
				AIC	*HQ*	*SC*
Australia	1964:1	1998:2	138	**1**	**1**	**1**
Austria	1964:1	1995:4	128	4	**2**	**2**
Belgium	1960:1	1996:4	148	11	**7**	**7**
Canada	1961:1	1998:2	150	3	**2**	1
Denmark	1960:1	1995:4	144	**2**	**2**	**2**
Finland	1960:1	1990:4	124	5	**2**	**2**
France	1965:1	1997:4	132	3	3	**2**
Germany	1960:1	1990:2	122	**2**	**2**	**2**
Greece	1961:1	1997:4	148	11	**7**	3
Italy	1960:1	1997:4	150	**2**	**2**	**2**
Japan	1965:1	1998:2	134	10	**1**	**1**
Netherlands	1969:1	1996:4	112	11	**3**	**3**
Norway	1962:1	1997:4	144	5	**2**	1
Spain	1961:1	1997:4	148	**7**	**7**	2
Sweden	1963:1	1990:4	112	9	6	**2**
Switzerland	1960:1	1995:4	144	7	**3**	**3**
UK	1961:1	1997:1	149	3	**2**	1
USA	1960:1	1998:2	154	**2**	**2**	**2**

The numbers in the columns of the right-hand side indicate the lag order minimizing the respective selection criterion, AIC, HQ, and SC. The boldface number is the lag order used in the subsequent analysis.

Unit root tests. We apply the standard methodologies, the augmented DICKEY/FULLER- and PHILLIPS/PERRON-test, as well as the test procedure proposed by KWIATKOWSKI et al. [1992]. Since all series are trending (except for Belgian and British employment), test equations contain a constant

and a trend when we have tested on unit roots in levels; in testing on unit roots in differenced series, only a constant has been added.
The results are not reported because they are not surprising for most countries: Series are integrated of order one because the presence of a unit root have not been rejected in levels, but have had to be rejected in differences. The productivity time series, however, turns out to be borderline (between I(1) and trend-stationary[21]) in some cases.[22] This may be caused by the fact that the productivity series is composed by the log of aggregate output and the log of employment. If an empirical cointegrating relation between output and employment existed and were $(1, -1)$, labor productivity would in fact be trend-stationary.[23]

Lag order selection. Before we can run reduced rank regressions, we have to know which autoregressive order the underlying data generating process has got. Although we are only interested in the long-run structure of the model, the selection of p should be done with caution because sometimes the estimates of the cointegrating rank as well as the cointegrating vectors may vary extremely for different lag lengths.
The process y_t as defined in equations (3.1) and (3.2) has the following VAR(p) representation

$$y_t = \nu_0 + \nu_1 t + A_1 y_{t-1} + ... + A_2 y_{t-p} + \varepsilon_t, \quad t = 1, 2, ..., T \tag{3.13}$$

where $\nu_0 \equiv -\Pi\mu_0 + (\Psi + \Pi)\mu_1$ and $\nu_1 \equiv -\Pi\mu_1$.
As proposed in LÜTKEPOHL [1993], for example, we fit this VAR(p) model without any restriction on Π for different orders $p = 1, ..., p_{max}$ with $p_{max} =$ 12 and compute convenient model selection criteria like the AKAIKE's information- (AIC), the HANNAN/QUINN- (HQ), and the SCHWARTZ-criterion (SC). Since only the latter two are consistent criteria and the AIC is shown to overestimate the true order asymptotically, we opt for lag orders proposed by either the HQ- or the SC-criterium in general.
Table 3 reports the optimal lag length proposed by the different selection criteria. For eleven countries, the consistent criteria do not differ from each other and so, we choose this lag length. In three further cases, the HQ-suggestion is 2 and the SC-criterium proposes 1. To allow for some short-run dynamics, we take the HQ-proposition. For the remaining countries, we search for a parsimonious specification. Hence, we choose the SC-suggestion for France and Sweden. For Greece and Spain, however, a longer lag order provides more robust estimation results.

[21] A process is said to be trend-stationary if it can be decomposed into a stationary process and a linear time trend.

[22] We found signs of potential trend-stationarity in the labor productivity series of Canada and Norway as well as in those of Austria, France, the Netherlands, and the United States to a weaker extent.

[23] The linear trend stems from the exogenously given productivity growth.

In sum, in 16 out of 18 cases, we choose the lag order proposed by the HQ-criterion, and in almost two thirds the lag length is 2.

Cointegration analysis. Given the optimal lag order p, we can test on cointegration by using the Gaussian maximum likelihood estimates.
As mentioned before, we test first in the model with a restricted linear trend. Thus, it is appropriate to write equation (3.13) in the following VECM(p):

$$\Delta y_t = \nu + [\Pi \, : \, \nu_1] \begin{bmatrix} y_{t-1} \\ t-1 \end{bmatrix} + \sum_{j=1}^{p-1} \Gamma_j \Delta y_{t-j} + \varepsilon_t \tag{3.14}$$

where $\nu \equiv -\Pi\mu_0 + \Psi\mu_1$ and $\nu_1 \equiv -\Pi\mu_1$.
The following hypotheses are sequentially tested:

$$H^*(r) : \ \mathrm{rk}(\Pi^+) = r \quad \text{vs.} \quad A^*(r) : \ \mathrm{rk}(\Pi^+) > r \ \ \forall \ r = 0, ..., K-1$$

where $\Pi^+ \equiv [\Pi \, : \, \nu_1]$ and A^* the alternative hypothesis. α and β are therefore $(K \times r)$ matrices. The test sequence terminates if the null hypothesis cannot be rejected for the first time.
In the recent years, a battery of test procedures have been suggested to test on the cointegrating rank. Here, we first apply the standard methodology, the LR trace tests pioneered by JOHANSEN [1991]. Additionally, we apply an alternative methodology proposed by LÜTKEPOHL and SAIKKONEN (L&S, henceforth) because these procedures have been explicitly derived to deal with cointegrating relations containing a linear time trend.
To save space here, we put the detailed description of these test methodologies in the appendix B. The test results are reported in tables 4 and 5.
The most obvious result is that the null hypothesis of no cointegration is rejected in all cases by the JOHANSEN methodology and except for Belgium, Finland, Japan, and the Netherlands by the L&S-procedure. Thus, it is quite evident that at least one cointegrating relation exists in all data sets. Moreover, whereas $r = 1$ is also rejected in some cases (Austria, France, Greece, Italy, Spain, Sweden, USA) using JOHANSEN's trace test, the alternative test procedure supports the hypothesis of more than one cointegrating relation only for Greece. For France and the USA, JOHANSEN's test even rejects $r = 2$ implying that all series be trend-stationary. Since this result clearly contradicts the results of the unit root tests, it turns out that the JOHANSEN procedure suffices for an overrejection problem (despite the correction in the statistic LR^*).
All in all, the hypothesis of one cointegrating relation can be accepted for all countries—with a caveat in the case of France, Greece, and the United States. Consequently, we impose r=1 and proceed with the above-mentioned procedure.

Table 4: Cointegration tests with restricted trend I

Country	r	JOHANSEN $\hat{\lambda}_j$	JOHANSEN LR(r)	JOHANSEN LR*(r)	L&S LM(r)	L&S $\mathrm{LR}^{LS}(r)$
Australia	0	0.326	78.94**	77.21**	53.88**	62.76**
	1	0.096	24.89(*)	24.34(*)	6.76	6.91
	2	0.077	11.01(*)	10.77(*)	0.28	0.01
Austria	0	0.221	61.93**	58.98**	31.47*	34.09**
	1	0.157	30.47**	29.02*	11.84	12.66
	2	0.069	8.98	8.55	1.17	1.52
Belgium	0	0.188	46.30*	39.40(*)	21.39	22.22
	1	0.066	16.90	14.38	7.40	7.57
	2	0.051	7.33	6.24	1.59	1.32
Canada	0	0.212	60.04**	57.61**	37.80**	41.04**
	1	0.093	24.82(*)	23.82(*)	11.82	12.27
	2	0.068	10.42	10.00	1.08	0.85
Denmark	0	0.186	54.61**	52.30**	26.83(*)	28.47*
	1	0.106	25.37*	24.30(*)	5.83	5.87
	2	0.064	9.42	9.02	0.00	0.43
Finland	0	0.247	54.56**	51.88**	16.73	17.42
	1	0.095	20.01	19.03	6.81	6.92
	2	0.062	7.83	7.45	0.85	0.80
France	0	0.189	59.33**	56.59**	34.33**	36.79**
	1	0.138	32.17**	30.69**	5.45	5.57
	2	0.095	12.94*	12.34*	0.00	0.01
Germany	0	0.248	52.80**	50.16*	26.69(*)	28.51*
	1	0.090	18.59	17.66	8.69	8.59
	2	0.059	7.31	6.95	4.27	2.44
Greece	0	0.184	61.58**	52.41*	35.58**	37.80**
	1	0.162	32.86**	27.96*	19.18*	20.42*
	2	0.05	7.85	6.68	0.47	1.39

Critical values for the JOHANSEN's LR trace test are taken from OSTERWALD-LENUM [1992], table 2*: 48.45, 42.44, 39.06 for $r = 0$; 30.45, 25.32, 22.76 for $r = 1$; 16.26, 12.25, 10.49 for $r = 2$. Critical values for the L&S-tests are taken from LÜTKEPOHL and SAIKKONEN [2000], table 1, p.188: 33.54, 28.47, 25.90 for $r = 0$; 20.37, 15.92, 13.89 for $r = 1$; 10.19, 6.83, 5.43 for $r = 2$. For all tests, $^{\star\star}, ^{\star}, ^{(\star)}$ indicate rejection of the respective null hypothesis on the 1%, 5%, 10% level.

Table 5: Cointegration tests with restricted trend II

		Johansen			L&S	
Country	r	$\hat{\lambda}_j$	LR(r)	LR*(r)	LM(r)	LR^{LS}(r)
Italy	0	0.194	61.33**	58.87*	29.41*	31.23*
	1	0.142	28.93*	27.77*	4.57	4.55
	2	0.038	5.86	5.63	0.00	1.63
Japan	0	0.495	114.24**	111.66**	20.37	21.32
	1	0.116	23.26$^{(\star)}$	22.74	8.46	8.61
	2	0.050	6.81	6.65	2.34	0.73
Netherlands	0	0.297	62.06**	56.94**	23.91	25.66
	1	0.132	23.67$^{(\star)}$	21.71	6.65	7.01
	2	0.072	8.18	7.51	0.00	0.38
Norway	0	0.223	54.72**	52.41**	33.62**	36.64**
	1	0.086	18.98	18.18	8.96	9.20
	2	0.043	6.24	5.97	0.31	1.08
Spain	0	0.299	85.06**	72.48**	40.43**	45.19**
	1	0.152	34.52**	29.41*	7.00	7.05
	2	0.075	11.15$^{(\star)}$	9.50	0.02	1.73
Sweden	0	0.351	74.50**	70.44**	37.65**	43.10**
	1	0.136	26.98*	25.50*	3.28	3.24
	2	0.094	10.90$^{(\star)}$	10.31	0.00	0.83
Switzerland	0	0.219	55.29**	51.76**	33.61**	35.43**
	1	0.077	20.44	19.14	8.71	8.95
	2	0.063	9.17	8.59	0.19	0.15
UK	0	0.151	46.91*	44.99*	27.98$^{(\star)}$	29.64*
	1	0.115	22.77$^{(\star)}$	21.84	3.80	3.95
	2	0.032	4.85	4.65	0.25	0.56
USA	0	0.186	70.22**	67.45**	37.35**	39.86**
	1	0.136	38.92**	37.38**	9.87	10.01
	2	0.104	16.67**	16.01*	1.53	0.28

Critical values for the Johansen's LR trace test are taken from Osterwald-Lenum [1992], table 2*: 48.45, 42.44, 39.06 for $r = 0$; 30.45, 25.32, 22.76 for $r = 1$; 16.26, 12.25, 10.49 for $r = 2$. Critical values for the L&S-tests are taken from Lütkepohl and Saikkonen [2000], table 1, p.188: 33.54, 28.47, 25.90 for $r = 0$; 20.37, 15.92, 13.89 for $r = 1$; 10.19, 6.83, 5.43 for $r = 2$. For all tests, **,*,$^{(\star)}$ indicate rejection of the respective null hypothesis on the 1%, 5%, 10% level.

Table 6: Corporatism versus competition

Country	$\tau_1 = 0$	$\tilde{\beta}_3 = \tau_1 = 0$	Country	$\tau_1 = 0$	$\tilde{\beta}_3 = \tau_1 = 0$
Australia	$20.14^{\star\star}$ [0.000]	$32.84^{\star\star}$ [0.000]	Austria	$9.90^{\star\star}$ [0.002]	$10.48^{\star\star}$ [0.005]
Belgium	$4.23^{\star}$ [0.040]	$10.32^{\star\star}$ [0.006]	Canada	$16.01^{\star\star}$ [0.000]	$16.87^{\star\star}$ [0.000]
Denmark	$8.63^{\star\star}$ [0.003]	$8.63^{\star}$ [0.013]	Finland	$20.26^{\star\star}$ [0.000]	$23.26^{\star\star}$ [0.000]
France	2.27 [0.132]	2.59 [0.274]	Germany	$5.88^{\star}$ [0.015]	$9.55^{\star\star}$ [0.008]
Greece	1.86 [0.172]	2.94 [0.230]	Italy	$5.28^{\star}$ [0.022]	$5.30^{(\star)}$ [0.071]
Japan	0.28 [0.597]	$12.40^{\star\star}$ [0.002]	Netherlands	$12.46^{\star\star}$ [0.000]	$13.53^{\star\star}$ [0.001]
Norway	$21.80^{\star\star}$ [0.000]	$23.54^{\star\star}$ [0.000]	Spain	$5.97^{\star}$ [0.015]	$10.68^{\star\star}$ [0.005]
Sweden	$28.71^{\star\star}$ [0.000]	$30.98^{\star\star}$ [0.000]	Switzerland	$8.72^{\star\star}$ [0.003]	$9.02^{\star}$ [0.011]
UK	$2.77^{(\star)}$ [0.096]	3.79 [0.150]	USA	$8.26^{\star\star}$ [0.004]	$10.10^{\star\star}$ [0.006]

Results of the χ^2-type tests $H_0 : \tau_1 = 0$ and $H_0 : \tilde{\beta}_3 = \tau_1 = 0$ against $H^*(r = 1)$. p-values are given in brackets. $^{\star\star}, ^{\star}, ^{(\star)}$ indicate rejection of the respective null hypothesis on the 1%, 5%, 10% level.

Testing on the competition hypothesis. We are going to test on the presence of the linear trend in the cointegrating relation. This is a test on the weak version of a competitive labor market (as long as employment is trending). But we also test the competition hypothesis directly against the alternative of corporatism, that is $\tilde{\beta}_3 = \tau_1 = 0$. Table 6 reports the test statistics on both hypothesis described in the previous section. Both hypotheses are only accepted for France Greece, and the United Kingdom. Whereas Japan accepts only the weak competition hypothesis, Italy rejects $\tau_1 = 0$ but accepts $\tilde{\beta}_3 = \tau_1 = 0$. In all other cases, both hypotheses are clearly rejected so that corporatism is likely in the respective countries.

Reduced rank regressions. To get further insight, we also estimate the models imposing the restriction of only one cointegrating relation and interpret the resulting estimates of the cointegrating vector. Table 7 reports the normalized cointegrating vectors (with standard errors in parentheses) for all countries where the linear trend cannot be omitted in the cointegrating relation. Except for Australia, Germany, the Netherlands, and Sweden, the cointegrating vectors of all countries exhibit the right signs with relatively small standard errors. Hence, the sufficient condition for the corporatism

Table 7: Cointegrating vectors (corporatism)

Country	w	a	l	t	c
Australia	1	-2.68 (0.23)	-0.31 (0.23)	0.0084 (0.0013)	4.45
Austria	1	-1.68 (0.12)	-1.07 (0.17)	0.0044 (0.0007)	20.30
Belgium	1	-1.37 (0.20)	-2.56 (0.49)	0.0040 (0.0011)	43.20
Canada	1	-3.17 (0.89)	-0.76 (0.10)	0.0109 (0.0028)	10.29
Denmark	1	-1.83 (0.16)	-0.53 (0.22)	0.0041 (0.0007)	11.57
Finland	1	-3.44 (0.45)	-0.90 (0.31)	0.0162 (0.0027)	13.02
Germany	1	-2.12 (0.25)	-0.21 (0.65)	0.0058 (0.0015)	5.38
Netherlands	1	-3.35 (0.44)	-0.65 (0.66)	0.0128 (0.0029)	-1.30
Norway	1	-7.07 (2.06)	-1.11 (0.48)	0.0371 (0.0108)	11.89
Spain	1	-1.44 (0.10)	-0.94 (0.08)	0.0053 (0.0004)	20.40
Sweden	1	0.28 (0.36)	-7.11 (0.99)	0.0145 (0.0020)	113.39
USA	1	-2.46 (0.71)	-1.96 (0.62)	0.0130 (0.0038)	35.64

Normalized cointegrating vectors of the model $H^*(r = 1)$ with standard errors in parentheses.

hypothesis is satisfied in the remaining countries of table 7. The employment coefficients take the right sign but are insignificant for Australia, Germany, and the Netherlands. In the Swedish case, the impact of labor productivity is insignificant in the cointegrating vector.

On the other hand, table 8 reports the cointegrating vectors of all feasible models in the case of France, Greece, Italy, Japan, Switzerland, and the United Kingdom. Except for Switzerland, they are those countries where at least one competition hypothesis has been accepted. We also report the unrestricted case, that is corporatist cointegrating vector: Except for Greece and Italy, the time trend turns out to be insignificant. Hence, we remove it and recognize that the employment coefficient is insignificant then except for Japan.

The competitive specification seems to be the best fit in the case of France, Greece, Switzerland, and the UK. For Japan, the weak competitive model

Table 8: Cointegrating vectors (competition)

Country	w	a	l	t	c	best
France	1	−1.60 (0.68)	−0.46 (0.76)	0.0044 (0.0020)	11.46	
	1	−0.13 (0.35)	−1.40 (0.82)		30.13	
	1	−0.54 (0.28)			6.12	×
Greece	1	−1.60 (0.17)	−3.03 (0.74)	0.0117 (0.0031)	49.19	
	1	−1.23 (0.22)	0.29 (0.35)		1.73	
	1	−1.09 (0.20)			5.93	×
Italy	1	−1.55 (0.15)	−1.49 (0.26)	0.0056 (0.0008)	31.88	×
	1	−0.30 (0.51)	−0.30 (1.86)		7.17	
	1	−0.30 (0.55)			2.56	
Japan	1	−1.23 (0.10)	0.18 (0.47)	0.0013 (0.0021)	2.40	
	1	−1.24 (0.10)	0.46 (0.13)		−2.52	×
	1	−0.82 (0.08)			4.88	
Switzerland	1	−1.47 (0.38)	−1.93 (1.67)	0.0073 (0.0068)	31.99	
	1	−0.83 (0.28)	−0.13 (0.22)		7.50	
	1	−0.81 (0.34)			5.66	×
UK	1	−1.57 (0.25)	−0.32 (0.29)	0.0031 (0.0015)	8.05	
	1	−0.96 (0.04)	0.51 (0.38)		−3.30	
	1	−1.01 (0.03)			5.17	×

Normalized cointegrating vectors in the models $H^*(r=1)$ and $H_1(r=1)$ with standard errors in parentheses.

holds. The competitive model, however, is not the best specification when we look on the resulting cointegrating vector of the Italian data set, although the previous statistical test have supported the competition hypothesis.

Table 9: Corporatism rankings

B&S	C&D	LEHMBRUCH
Austria	Austria	Austria
Germany	Norway	Netherlands
Netherlands	Sweden	Sweden
Norway	Denmark	Norway
Sweden	Finland	Denmark
Switzerland*	Germany	Germany
Denmark	Netherlands	Finland
Finland	Belgium	Switzerland*
Belgium	Australia	**Japan**
Japan	**France**	**France**
UK	**UK**	**UK**
France	**Italy***	**Italy***
Italy*	**Japan**	USA
Australia	Switzerland*	Canada
Canada	USA	Australia
USA	Canada	

The rankings of corporatism are taken from TEULINGS and HARTOG [1998], table 1.1, p.30: The original sources are BRUNO and SACHS [1985] (B&S), CALMFORS and DRIFFILL [1988] (C&D), and LEHMBRUCH [1984]. In the last ranking, Belgium is omitted. Greece and Spain are ordered in neither ranking. Countries which have been tested to be competitive are written in boldface. The controversial countries are marked with an asterisk.

3.3 Interpretation

The model specifications chosen by the statistical test procedure lead to estimates of the cointegrating vectors which will be justified by on of our theoretical models in 16 out of 18 cases: Namely, the continental European countries, Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Norway, Spain, and Sweden, are corporatist countries. More surprisingly, this specification is also found for Austalia and Canada. In the U.S. data, a nice corporatist vector is also found when $r = 1$ is imposed. This supposition, however, is not supported by JOHANSEN's test on the coin-

tegrating rank.[24] Instead, the competitive model holds for France, Greece, and the UK in its pure form, and in its weak version for Japan.
The results are ambiguous in the case of Italy and Switzerland: Whereas the test procedure rejects the competitive model for Switzerland, the corporatist cointegrating vector indicates both an insignificant employment parameter and an insignificant time trend; instead, the competitive specification is quite robust. In contrast, the opposite is true for Italy: While statistical test results support the competitive specification, the corporatist cointegrating vector is more robust than the competitive one.
When comparing our results with the corporatism ranking known from the literature (Bruno and Sachs [1985] (B&S), Calmfors and Driffill [1988] (C&D), Lehmbruch [1984]), we come to a striking result: In table 9, we see that apart from the non-European Countries, Australia, Canada, and the United States, the proposed test procedure leads to a perfect discrimination between more corporatist and more competitive countries taking the reported corporatism rankings for granted. The countries we have tested to be competitive (in boldface) are found at the bottom of the rankings without exception.[25]
Hence, we conclude that the different macroeconometric specifications of the labor market equilibrium for corporatist and competitive economies derived in the theoretical part lead not only to robust estimates, these estimates are also in accordance to previous research on corporatism.
Unfortunately, this conclusion only holds for the European countries. Since the test procedure comes to counter-intuitive results especially for Canada and the United States, we have to concede that the theoretical framework and/or the applied econometric methodology including the set of assumptions seems not to capture the American labor market structures.

4 Conclusion

We have derived the steady-state labor market equilibrium of a competitive and a corporatist economy in a standard macroeconomic model with labor-augmenting technical change and population growth. Whereas a competitive equilibrium is characterized by perfect competition in all markets, the corporatist labor market equilibrium is modeled by the contract curve

[24] Taken additionally the (not reported) results of unit root tests into account, it rather turns out that the used econometric methodology is by no means appropriate for the investigation of the suggested theory because the USA is the sole country where all labor market series are tested to be trend-stationary around a broken trend with unknown breakpoint. To derive this result, we employed the test suggested by Zivot and Andrews [1992]. As a matter of fact, the general assumption of nonstationary series possessing common stochastic trends is likely to fail for the United States.

[25] The discrimination in the C&D-ranking is not perfect because Switzerland is ordered below the competitive countries. This may be caused by the fact that the C&D-ranking is focused on the centralization of wage bargaining structures rather than on corporatism.

of the so-called efficient bargaining solution.
Real wage (net of labor productivity) and employment (net of population growth) are driven by the same stochastic process in a corporatist labor market equilibrium. Since this effect (we have called it bargaining effect) is unobservable, we have only been able to derive an equilibrium relation between the two observables, real wage and employment. Furthermore, it is usually nonlinear so that we have computed a Taylor approximation of first order around the steady state in order to linearize it.
The results of the competitive equilibrium are well known: Real wage is only driven by labor productivity, employment is determined by population growth, and firms always produce efficiently so that labor's share is constant on the balanced growth path.
In the empirical part, we have formulated a trivariate vector autoregressive model whose cointegrating relation might be interpreted as the long-run equilibrium of the labor market. From the theoretical part, it is clear that a competitive equilibrium requires that real wage and labor productivity is deterministically cointegrated, whereas real wage, labor productivity and employment are stochastically cointegrated with certain parameter restrictions in the corporatist setup. Since the former is nested in the latter hypothesis, we have been able to construct a statistical test on this hypothesis.
We have used time series data of 18 OECD countries to check whether their labor markets are better described by the competitive or the corporatist structure. Besides the standard methodology, JOHANSEN's LR trace test, we have also applied the test procedure recently suggested by LÜTKEPOHL and SAIKKONEN to test on the cointegrating rank.
For most countries, exactly one cointegrating relation has been found. Under this restriction, we have then tested the parameter restrictions of the competitive specification and estimated the final model to examine the coefficients of the cointegrating vectors.
The empirical analysis ends up with a set of countries which fulfills the corporatism hypothesis, and some countries which are better described by the competitive labor market equilibrium. It is a striking result that the applied test procedures very well sort at least the European countries. Thus, we have concluded that the set of assumptions as well as the theoretical concepts used in the paper may give useful hints when one is searching for an appropriate macroeconometric specification of (European) labor market structures.

A Proofs

A.1 Omitted parts of section 2.1

A.1.1 Sufficient conditions for a profit maximum

The firms' profit maximization program as described in definition 1 leads to the following Hesse matrix

$$H_t = \begin{bmatrix} \frac{q''(\kappa_t)}{\Theta_t L_t} & -\frac{\kappa_t q''(\kappa_t)}{L_t} \\ -\frac{\kappa_t q''(\kappa_t)}{L_t} & \frac{\Theta_t \kappa_t^2 q''(\kappa_t)}{L_t} \end{bmatrix}. \tag{A.1}$$

Sufficient for a profit maximum is that H_t is negative semi-definite. This is in fact fulfilled because

$$\frac{q''(\kappa_t)}{\Theta_t L_t} \leq 0, \quad \frac{\Theta_t \kappa_t^2 q''(\kappa_t)}{L_t} \leq 0, \quad |H_t| = 0 \tag{A.2}$$

with $q'' < 0$.

A.1.2 Existence and uniqueness of the labor market equilibrium

Existence and uniqueness of the labor market equilibrium are proved in showing that the graphs of equations (2.5) and (2.6) intersect exactly once in the first quadrant of a wage-employment-diagram.
The slopes of the two graphs are determined by totally differentiating both equations: Equation (2.5) is downward-sloping because

$$\frac{d\,W_t}{d\,L_t} = -\frac{\Theta_t \kappa_t^2 q''(\kappa_t)}{L_t} < 0 \quad \forall \kappa_t > 0 \tag{A.3}$$

and $q'' < 0$, while equation (2.6) is upward-sloping because

$$\frac{d\,W_t}{d\,L_t} = -\left[\eta L_0 (W_t/\Theta_t)^{\eta-1} e^{nt}\right]^{-1} > 0 \quad \forall \kappa_t > 0. \tag{A.4}$$

Hence, uniqueness follows.
To prove existence, note that equation (2.6) is a ray through the origin, whereas equation (2.5) comes from infinity for very small values of L_t:

$$W_t = \Theta_t[q(\kappa_t) - \kappa_t q'(\kappa_t)] \to \infty \quad \text{for} \quad L_t \to 0 \tag{A.5}$$

because $q(\kappa_t) \to \infty$ and $q'(\kappa_t) \to 0$ for $\kappa_t \to \infty$.
Hence, we infer that the curves must intersect in the first quadrant. Thus, existence of a labor market equilibrium is also proven. ■

A.1.3 Proof of the existence of a steady state

We will show here that the imposed structure implies a steady-state equilibrium where the capital stock grows at the rate $m^* = n + \theta$ and the capital intensity (per unit of effective labor) is constant over time.[26]
Because of constant returns to scale, we can write the production function in equation (2.2) as

$$\frac{Y_t}{K_t} = Q\left(1, \frac{\Theta_t L_t}{K_t}\right) = \tilde{q}\left(\frac{\Theta_t L_t}{K_t}\right). \tag{A.6}$$

Using equations (2.1) and (2.3), we obtain

$$\frac{Y_t}{K_t} = \tilde{q}\left(\frac{L_0}{K_0}\left(\frac{W_t}{\Theta_t}\right)^{\eta} e^{(n+\theta-m)\,t}\right) \tag{A.7}$$

[26] The proof follows partly the argumentation in Barro and Sala-i-Martin [1995], p.54/55.

where the capital stock is assumed to grow at the rate m so that

$$K_t = K_0 e^{mt} \tag{A.8}$$

with K_0 the capital stock in the initial period.
We divide the market-clearing condition of the capital market by the equilibrium capital stock K_t^*

$$\frac{sY_t}{K_t} = \frac{dK_t^*/dt}{K_t^*} \tag{A.9}$$

and use the equations (A.7) and (A.8):

$$s\,\tilde{q}\left(\frac{L_0}{K_0}\left(\frac{W_t^*}{\Theta_t}\right)^{\eta} e^{(n+\theta-m^*)\,t}\right) = m^* \tag{A.10}$$

where m^* is the growth rate of the capital stock in the equilibrium.
We finally use the first-order condition (2.5) to end up with the expression

$$s\,\tilde{q}\left(\frac{L_0}{K_0}\left[q(\kappa_t^*) - \kappa_t^* q'(\kappa_t^*)\right]^{\eta} e^{(n+\theta-m^*)\,t}\right) = m^*. \tag{A.11}$$

By recalling the definition of the capital intensity $\kappa_t \equiv K_t/(\Theta_t L_t)$, we conclude that $m^* = n + \theta$ implying $\kappa_t^* = \kappa^*\ \forall\, t$ is a solution to equation (A.11). ■

A.2 Proofs of lemma 1 and lemma 2

To prove lemma 1, we calculate the total derivative of the contract curve, i.e. equation (2.25):

$$\frac{d\bar{W}_t}{d\bar{L}_t} = \frac{\Theta_t \bar{\kappa}_t q''(\bar{\kappa}_t)[v'(\bar{W}_t/\Theta_t)]^2}{\bar{L}_t v''(\bar{W}_t/\Theta_t)[v(\bar{W}_t/\Theta_t) - v(W_t^o/\Theta_t)]} \geq 0 \tag{A.12}$$

because $q'' < 0$ and $v'' < 0$. This proves lemma 1.
To prove lemma 2, we apply an idea suggested by Oswald [1985]: Add (W_t^o/Θ_t) on both sides of equation (2.25) and multiply it by $v'(\bar{W}_t/\Theta_t)$. After restructuring the resulting equation, we end up with

$$\begin{aligned} v\left(\frac{\bar{W}_t}{\Theta_t}\right) - v\left(\frac{W_t^o}{\Theta_t}\right) - v'\left(\frac{\bar{W}_t}{\Theta_t}\right)\left[\left(\frac{\bar{W}_t}{\Theta_t}\right) - \left(\frac{W_t^o}{\Theta_t}\right)\right] \\ = v'\left(\frac{\bar{W}_t}{\Theta_t}\right)\left[\left(\frac{W_t^o}{\Theta_t}\right) - \Big[q(\bar{\kappa}_t) - \bar{\kappa}_t q'(\bar{\kappa}_t)\Big]\right]. \end{aligned} \tag{A.13}$$

The left-hand side is positive because $v'' < 0$. Hence, we must have

$$W_t^o \geq \Theta_t[q(\bar{\kappa}_t) - \bar{\kappa}_t q'(\bar{\kappa}_t)]. \tag{A.14}$$

Since $W_t^o = W_t^* = \Theta_t[q(\kappa_t^*) - \kappa_t^* q'(\kappa_t^*)]$, we obtain with $K_t^o = K_t^*$

$$\bar{\kappa}_t \leq \kappa_t^* \quad \Longleftrightarrow \quad \bar{L}_t \geq L_t^*. \tag{A.15}$$

Remind that the efficient bargaining solution replicates the competitive solution (W_t^*, L_t^*) for $\Xi_t = 0$. Hence, for some $\Xi_t > 0$, $\bar{L}_t > L_t^*$; and together with lemma 1, the statement of lemma 2 follows. ■

B Description of the used cointegration tests

B.1 Johansen's LR trace test

Johansen's test methodology is based on the result that Π^+ has r non-zero eigenvalues under $H^*(r)$.[27] To obtain these eigenvalues, we find it convenient to rewrite equation (3.14)

[27] See Johansen [1988], lemma 4 for this result in the general case. In Johansen [1994], the adjustments of this result to the case applied here are have been done.

in a more compact form.
Following LÜTKEPOHL [1999], we define

$$
\begin{aligned}
\Delta Y &\equiv [\Delta y_1 \dots \Delta y_T], \\
Y_{-1} &\equiv [y_0^+ \dots y_{T-1}^+] \qquad \text{with} \quad y_t^+ \equiv [y_t \,:\, t]' \;\forall\, t, \\
U &\equiv [\varepsilon_1 \dots \varepsilon_T], \\
\Gamma &\equiv [\gamma_0 \,:\, \Gamma_1 \,:\, \dots \,:\, \Gamma_{p-1}], \\
X &\equiv [X_0 \,:\, \dots \,:\, X_{T-1}] \qquad \text{with} \quad X_{t-1} \equiv [1 \,:\, \Delta y'_{t-1} \,:\, \dots \,:\, \Delta y'_{t-p+1}]'.
\end{aligned}
$$

With this notation, equation (3.14) can be written as

$$\Delta Y = \Pi^+ Y_{-1} + \Gamma X + U. \tag{B.1}$$

An estimator for Π^+ under $H^*(r)$ can be found by a reduced rank regression. JOHANSEN suggests solving the following generalized eigenvalue problem

$$|\,\lambda S_{11} - S'_{01} S_{00}^{-1} S_{01}\,| = 0 \tag{B.2}$$

where $S_{00} \equiv T^{-1}\Delta Y M \Delta Y'$, $S_{01} \equiv T^{-1}\Delta Y M Y'_{-1}$, and $S_{11} \equiv T^{-1} Y_{-1} M Y'_{-1}$ with $M \equiv I_T - X'(XX')^{-1}X$.
The estimated eigenvalues are ordered such that $\hat{\lambda}_1 \geq \dots \geq \hat{\lambda}_K$. By using the asymptotic result that only the first r eigenvalues are non-zero under $H^*(r)$, JOHANSEN proposes the following trace statistic

$$\mathrm{LR}(r) = -T \sum_{j=r+1}^{K} \ln(1 - \hat{\lambda}_j) \tag{B.3}$$

testing whether $\hat{\lambda}_{r+1} = \dots = \hat{\lambda}_K = 0$.
The limiting distribution of this test is non-normal and dependent on the deterministic part of the model. We use here the critical values tabulated by OSTERWALD-LENUM [1992]. Since several Monte Carlo investigations detect an overrejection in finite samples when the null is true, a "corrected" trace statistic LR*(r) is suggested which considers the number of estimated coefficients:[28]

$$\mathrm{LR}^*(r) = -(T - Kp) \sum_{j=r+1}^{K} \ln(1 - \hat{\lambda}_j). \tag{B.4}$$

Of course, LR and LR* may lead to different conclusions if a high lag order is chosen.

B.2 Tests based on prior trend adjustment

LÜTKEPOHL and SAIKKONEN have recently suggested an alternative methodology to test for the cointegrating rank when the cointegrating relation includes a linear time trend. The main idea of this test procedure is to remove the linear trend first and apply suitable cointegration tests on the trend-adjusted data then.
Let us define the $(K \times (K-r))$ matrices $\alpha_\perp$ and $\beta_\perp$ as the orthogonal complements of α and β, respectively.
The test procedure consists of three steps: First, a reduced rank regression like in JOHANSEN's procedure is run in order to estimate the parameters of equation (3.6). In a second step, the trend parameters μ_0 and μ_1 are estimated in an appropriate manner. We use here the general least squares (GLS) method suggested in SAIKKONEN and

[28]See, for example, BANERJEE et al. [1993], p.285/286, or LÜTKEPOHL [1993], p.386, and the cited literature there.

LÜTKEPOHL [2000].[29]
There, it is proposed to rewrite equation (3.1) as

$$A(L)y_t = G_t\mu_0 + H_t\mu_1 + \varepsilon_t \tag{B.5}$$

where $A(L) \equiv I_K - A_1L - ... - A_pL^p$, $y_t = 0\ \forall\, t \leq 0$, $G_t \equiv A(L)g_t$, and $H_t \equiv A(L)h_t$ with

$$g_t \equiv \begin{cases} 1 & \text{for } t \geq 1 \\ 0 & \text{for } t \leq 0 \end{cases}, \quad h_t \equiv \begin{cases} t & \text{for } t \geq 1 \\ 0 & \text{for } t \leq 0 \end{cases}. \tag{B.6}$$

Furthermore, one defines

$$Q = \left[\Omega^{-1}\alpha(\alpha'\Omega^{-1}\alpha)^{-1/2} \,:\, \alpha_\perp(\alpha_\perp'\Omega^{-1}\alpha_\perp)^{-1/2}\right] \tag{B.7}$$

implying $QQ' = \Omega^{-1}$ to estimate μ_0 and μ_1 by multivariate least squares from the regression model

$$\tilde{Q}'\tilde{A}(L)y_t = \tilde{Q}'\tilde{G}_t\mu_0 + \tilde{Q}'\tilde{H}_t\mu_1 + \eta_t \tag{B.8}$$

where $\tilde{Q}$, $\tilde{A}(L)$, $\tilde{G}_t$, $\tilde{H}_t$ are computed by using the estimates of the reduced rank regression of the first step.
It is shown that $\tilde{\mu}_0$ is estimated consistently in the direction of β but not in the direction of $\beta_\perp$, whereas $\tilde{\mu}_1$ is estimated consistently in both directions.
We end up with the estimates $\tilde{x}_t = y_t - \tilde{\mu}_0 - \tilde{\mu}_1\, t$.
In the third step, LM- and LR-type methods are applied to test on the cointegrating rank of the trend-adjusted VECM(p).
LÜTKEPOHL and SAIKKONEN [2000] suggest a LM-type test exploiting that $\beta(\beta'\beta)^{-1}\beta' + \beta_\perp(\beta_\perp'\beta_\perp)^{-1}\beta_\perp' = I_K$. Equation (3.3) may be rewritten as

$$\Delta\tilde{x}_t = \kappa u_{t-1} + \rho v_{t-1} + \sum_{j=1}^{p-1}\Gamma_j\Delta\tilde{x}_{t-j} + \tilde{\varepsilon}_t \tag{B.9}$$

where $u_t \equiv \beta'\tilde{x}_t$, $v_t \equiv \beta_\perp'\tilde{x}_t$, $\kappa \equiv \Pi\beta(\beta'\beta)^{-1}$, $\rho \equiv \Pi\beta_\perp(\beta_\perp'\beta_\perp)^{-1}$.
Premultiplying this equation by $\alpha_\perp'$, we obtain

$$\alpha_\perp'\Delta\tilde{x}_t = \rho_* v_{t-1} + \sum_{j=1}^{p-1}\Gamma_j^*\Delta\tilde{x}_{t-j} + \tilde{\varepsilon}_t^* \tag{B.10}$$

where $\rho_* \equiv \alpha_\perp'\rho$, $\Gamma_j^* \equiv \alpha_\perp'\Gamma_j$, and $\varepsilon_t^* \equiv \alpha_\perp'\varepsilon_t$.
Notice that $\rho = 0$ and thus $\rho_* = 0$ if the null hypothesis does hold. Using this, the LM-type test statistic is given as

$$\mathrm{LM}(r) = \mathrm{tr}\{\hat{\rho}_*\, M_{vv\cdot\Delta X}\, \hat{\rho}_*'\, (\alpha_\perp'\Omega\alpha_\perp)^{-1}\} \tag{B.11}$$

where $\hat{\rho}_*$ is the least squares estimator of ρ_*, $(\alpha_\perp'\Omega\alpha_\perp)$ an approximation to the residual covariance matrix of $\tilde{\varepsilon}_t$, and

$$\begin{aligned} M_{vv\cdot\Delta X} \quad \equiv \quad & \sum_{t=1}^{T} v_{t-1}v_{t-1}' - \sum_{t=1}^{T} v_{t-1}\Delta X_{t-1}' \times \\ & \times \left(\sum_{t=1}^{T}\Delta X_{t-1}\Delta X_{t-1}'\right)^{-1}\sum_{t=1}^{T}\Delta X_{t-1}v_{t-1}' \end{aligned} \tag{B.12}$$

with $\Delta X_{t-1} \equiv (u_{t-1}', \Delta\tilde{x}_{t-1}', ..., \Delta\tilde{x}_{t-p+1}')'$.
In SAIKKONEN and LÜTKEPOHL [2000], a "LR" test based on the trend-adjusted data is

[29] This method is less complicated than that of LÜTKEPOHL and SAIKKONEN [2000] and turns out to have better power and size properties (see HUBRICH et al. [1998]).

also suggested. Namely, given the estimates $\tilde{x}_t$ which have been trend-adjusted under the cointegrating rank r, the feasible model

$$\Delta\tilde{x}_t = \Pi\tilde{x}_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta\tilde{x}_{t-j} + \varepsilon_t \qquad \text{(B.13)}$$

provides the following "LR" trace statistic

$$\text{LR}^{LS}(r) = \sum_{j=r+1}^{K} \ln(1 + \tilde{\lambda}_j^{LS}) \qquad \text{(B.14)}$$

where $\hat{\lambda}_1^{LS} \geq ... \geq \hat{\lambda}_j^{LS}$ solve the generalized eigenvalue problem

$$|\,\tilde{\Pi}\tilde{M}_T\tilde{\Pi}' - \lambda\tilde{\Omega}\,| = 0 \qquad \text{(B.15)}$$

where $\tilde{\Pi}$ is the unrestricted least squares estimator of Π obtained from equation (B.13), $\tilde{\Omega}$ the corresponding residual covariance matrix, and

$$\begin{aligned} \tilde{M}_T \quad \equiv \quad & \sum_{t=1}^{T} \tilde{x}_{t-1}\tilde{x}'_{t-1} - \sum_{t=1}^{T} \tilde{x}_{t-1}\Delta\tilde{X}'_{t-1} \times \\ & \times \left(\sum_{t=1}^{T} \Delta\tilde{X}_{t-1}\Delta\tilde{X}'_{t-1} \right)^{-1} \sum_{t=1}^{T} \Delta\tilde{X}_{t-1}\tilde{x}'_{t-1} \end{aligned} \qquad \text{(B.16)}$$

with $\Delta\tilde{X}_{t-1} \equiv (\Delta\tilde{x}'_{t-1}, ..., \Delta\tilde{x}'_{t-p+1})'$.
The asymptotic distribution of these test statistics are nonstandard but independent of the deterministic components of the model.

C Data

Data is taken from the OECD Statistical Compendium, edition 01/1999, Business Sector Data Base (BSDB). This data base contains seasonally adjusted, quarterly data from 27 OECD countries starting in 1960:1 earliest (see OECD [1999] for a closer look).
Out of this set, we use data from Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
For all countries, the used time series are uniquely computed as follows:

- real wage $\equiv WSSS/(PCP \times EE)$;
- labor productivity $\equiv GDPV/EE$;
- employment $\equiv EE$

where

- $WSSS \equiv$ compensation of employees, total economy, current prices;
- $PCP \equiv$ deflator, private consumption;
- $GDPV \equiv$ gross domestic product at market prices, total economy, constant prices;
- $EE \equiv$ number of employees, total economy.

Note that all aggregates are concerned to the total economy, i.e. the public sector is always included.

In figures 1 through 18, all used time series are plotted.

Figure 1: Plot of series (Australia)

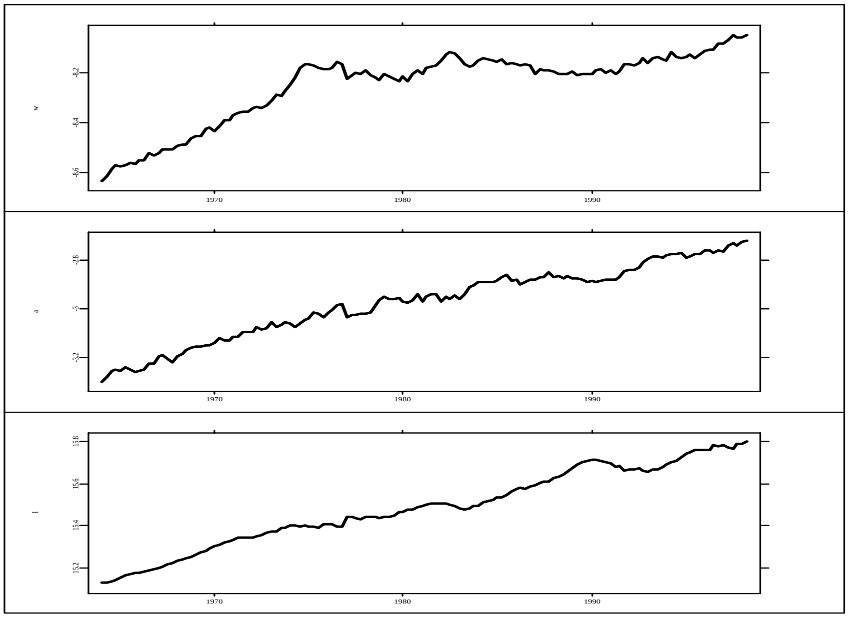


Figure 2: Plot of series (Austria)

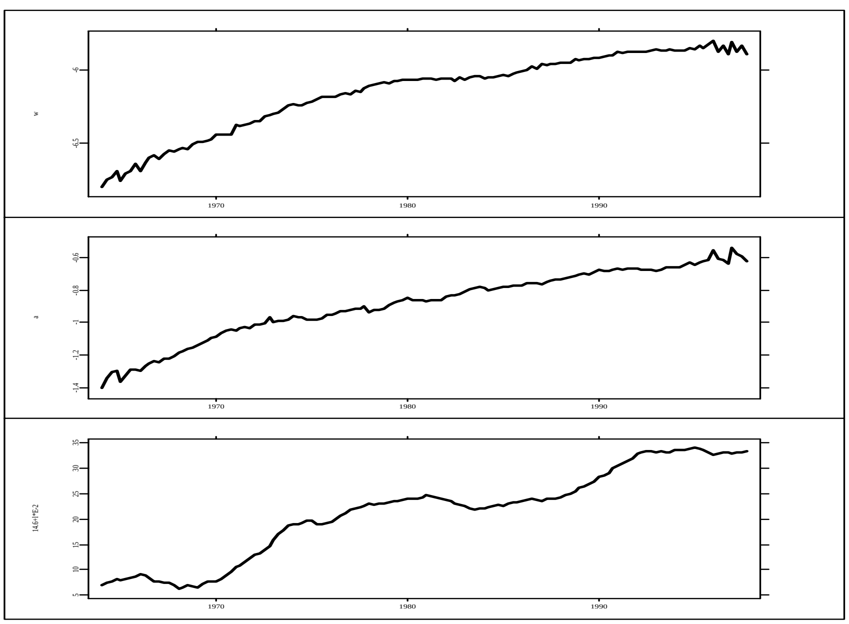


Figure 3: Plot of series (Belgium)

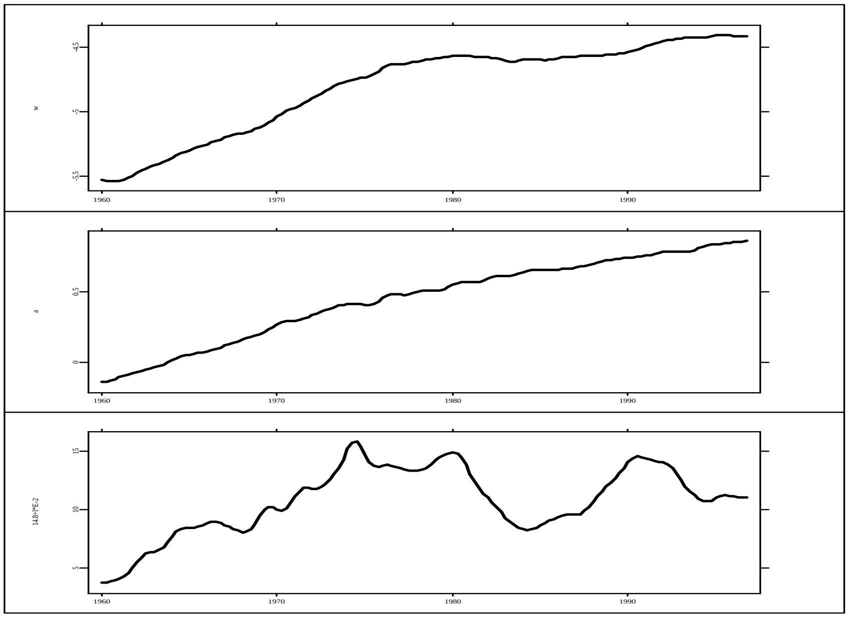


Figure 4: Plot of series (Canada)

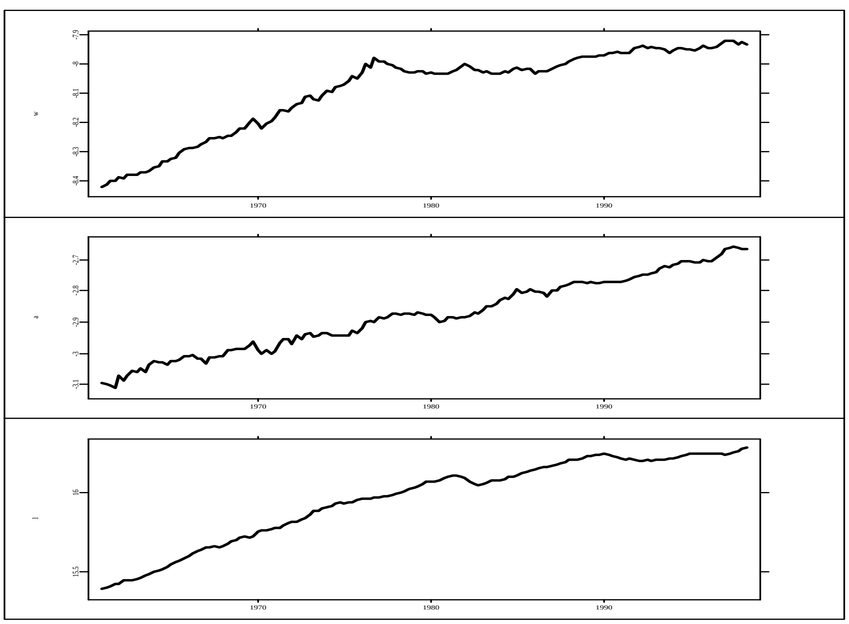


Figure 5: Plot of series (Denmark)

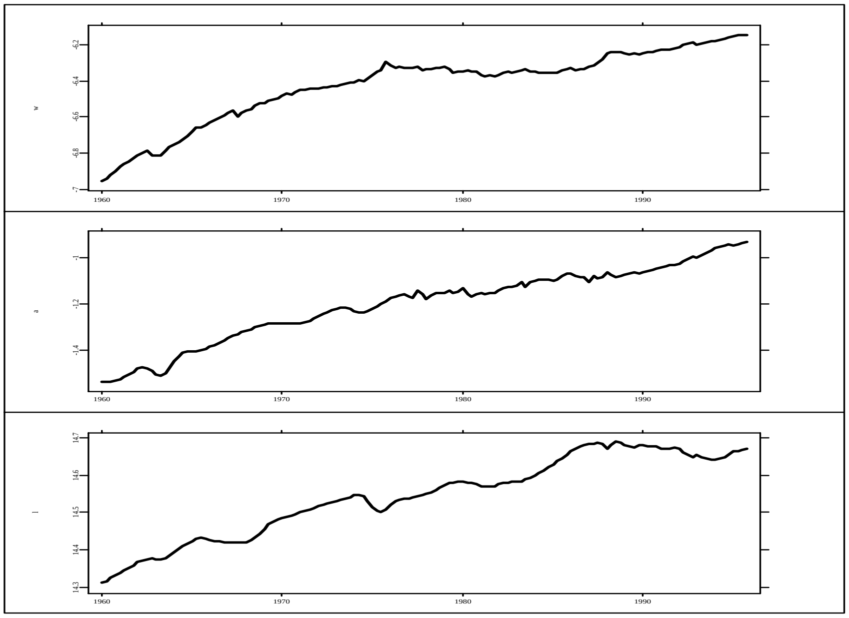


Figure 6: Plot of series (Finland)

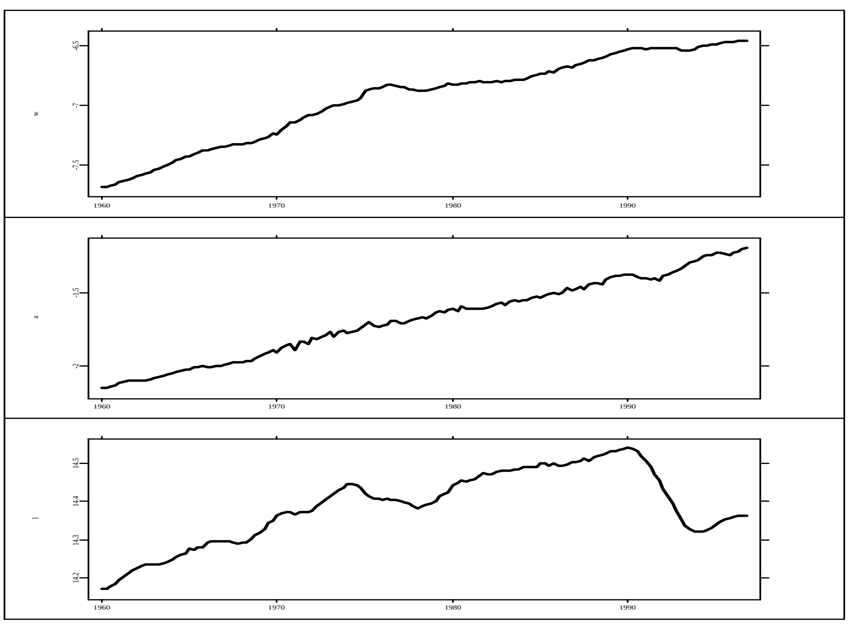


Figure 7: Plot of series (France)

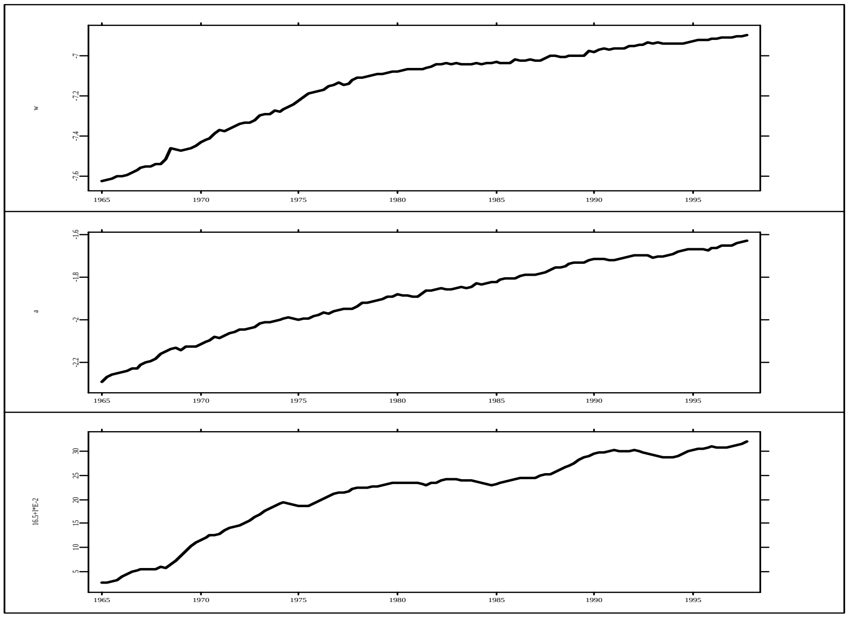


Figure 8: Plot of series (Germany)

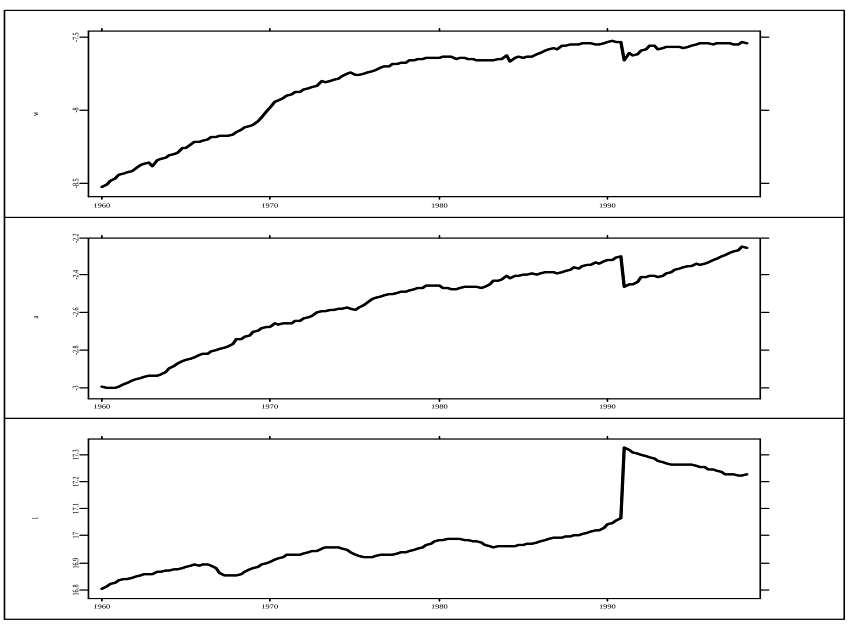


Figure 9: Plot of series (Greece)

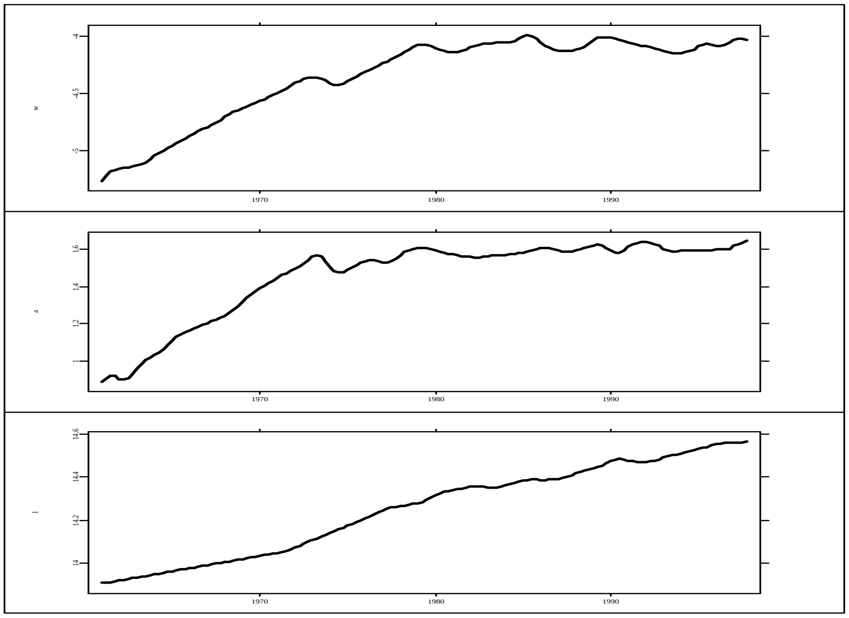


Figure 10: Plot of series (Italy)

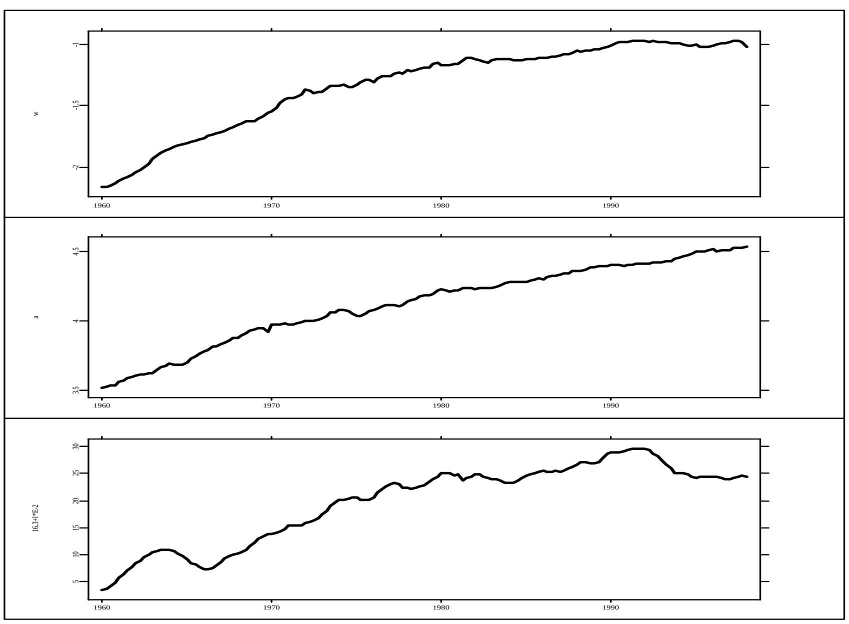


Figure 11: Plot of series (Japan)

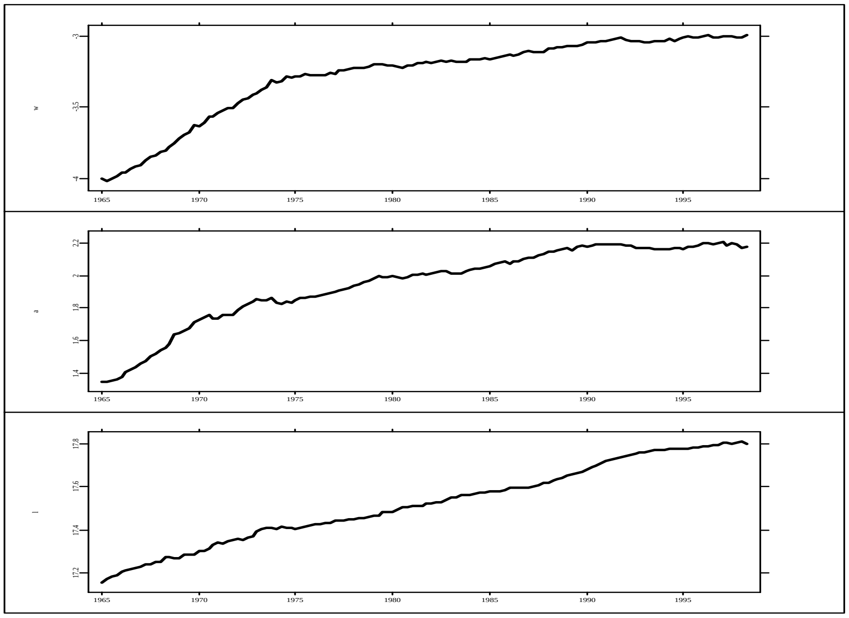


Figure 12: Plot of series (Netherlands)

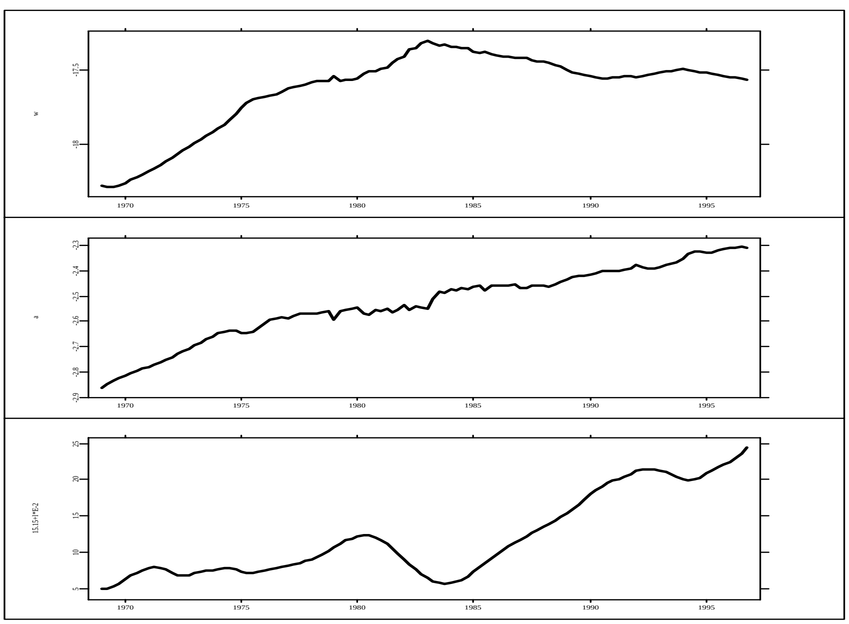


Figure 13: Plot of series (Norway)

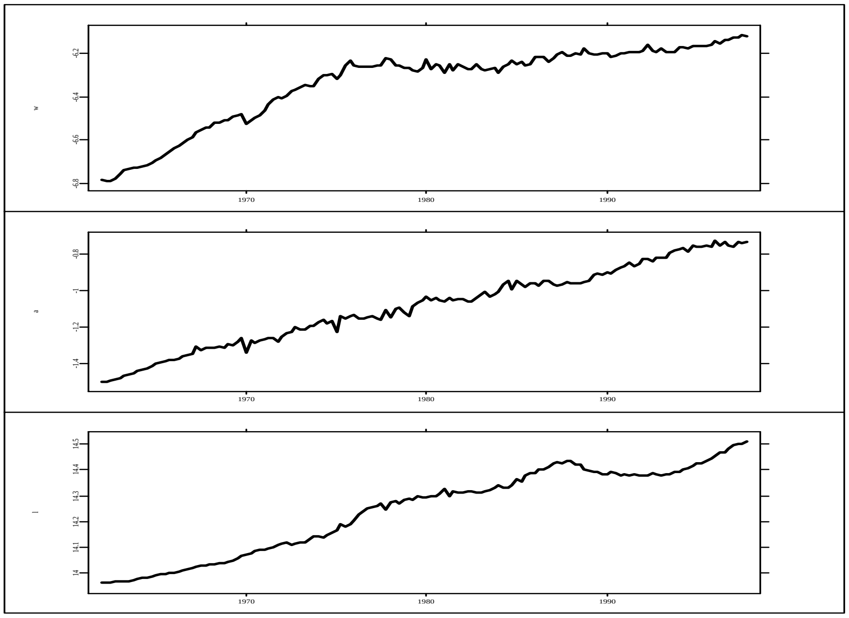


Figure 14: Plot of series (Spain)

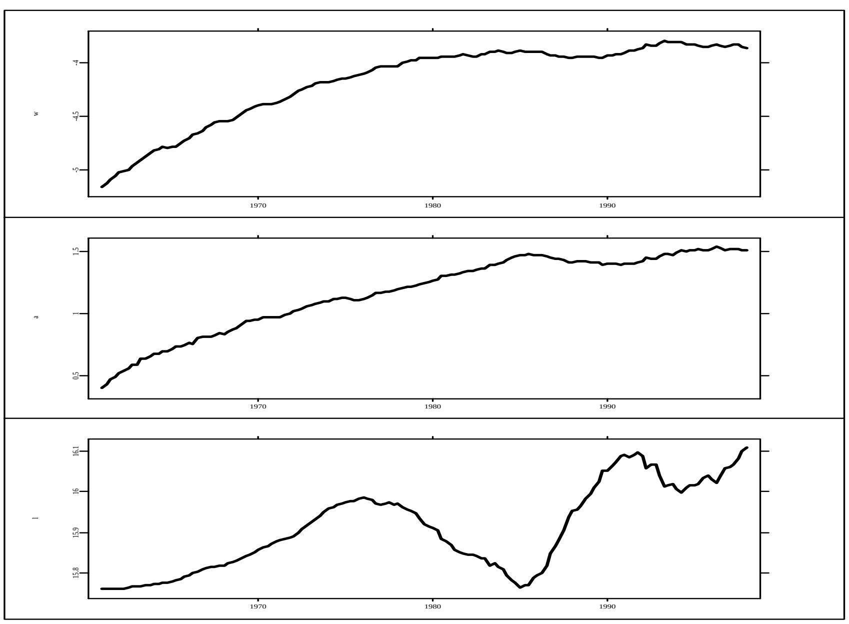


Figure 15: Plot of series (Sweden)

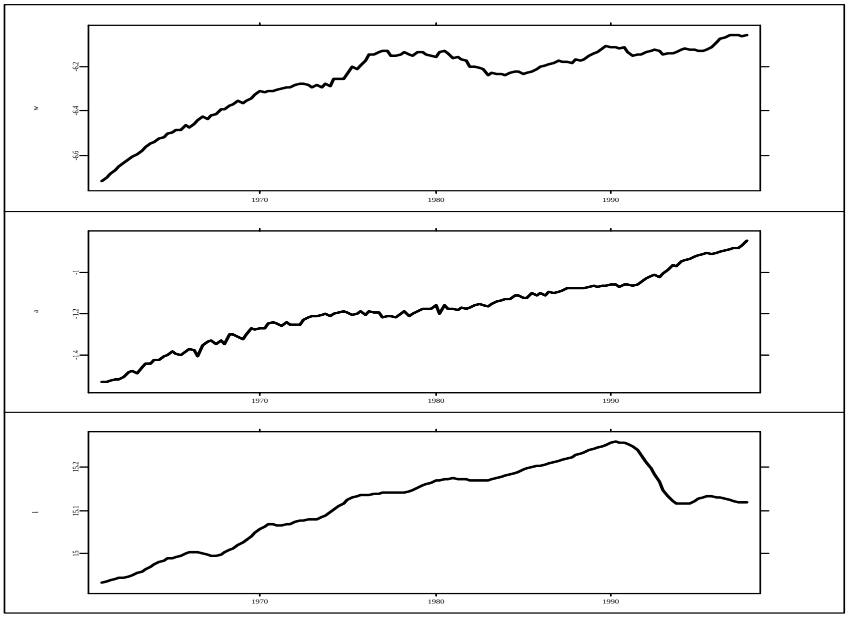


Figure 16: Plot of series (Switzerland)

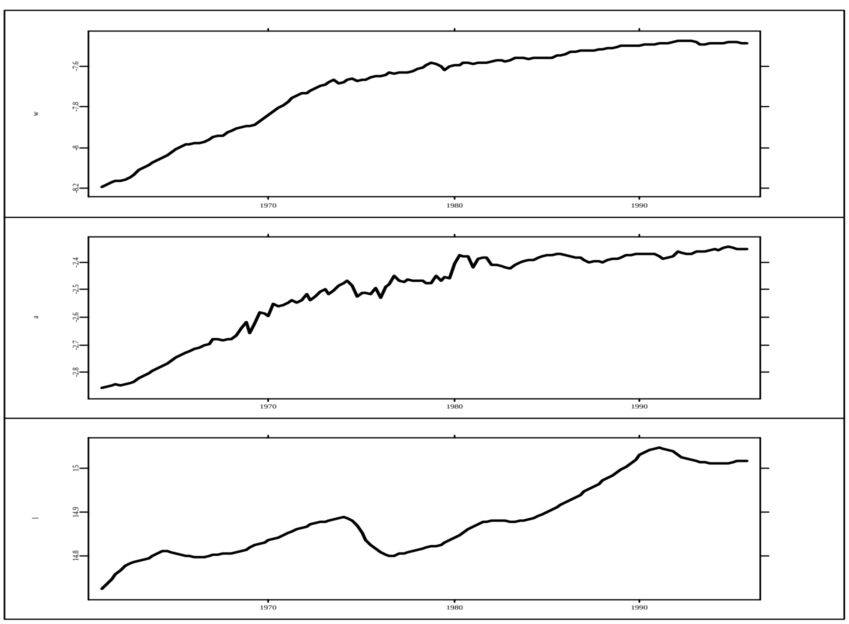


Figure 17: Plot of series (United Kingdom)

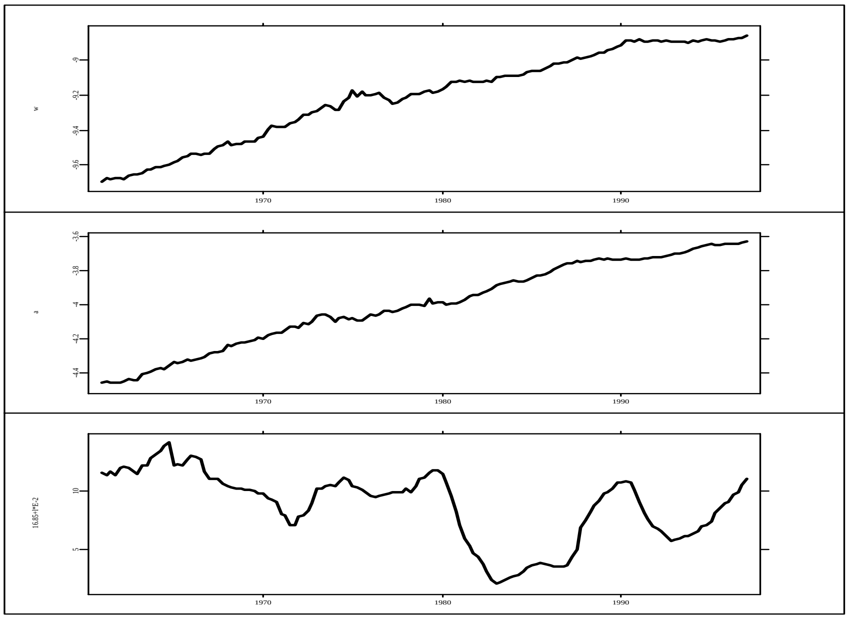
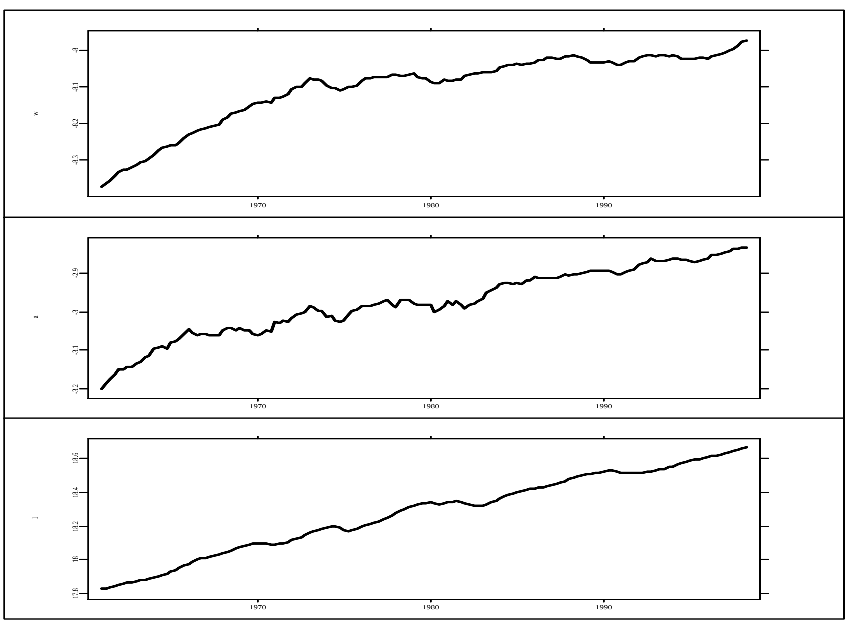


Figure 18: Plot of series (United States)



D Software

The JOHANSEN cointegration test methodology including all hypothesis tests are programed in XploRe 4.2a. This software package is also used for the plots of time series.

The L&S-tests are conducted with a GAUSS 3.2 routine programed by CARSTEN TRENKLER (Institute of Statistics and Econometrics, Humboldt-Universität zu Berlin).

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