Designing the Optimal Length of Working Time

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Abstract

How many hours per week should workers in the United States and Germany spend at their paying jobs? The present paper addresses this question by constructing policymakers' reaction functions capable of modelling the optimal length of working time as a function of the relevant labour market variables. The empirical analysis is based on the optimal control algorithm. Given a policymaker's loss function and a structural model of the labour market we define alternative specifications of reaction functions where the response coefficients indicate how policymakers should react to any news in the labour market in order to stabilize employment and wages. We also perform a comparative analysis on the ability of the rules to correspond to historical working-time records. The results suggest that simple rules perform quite well and that the advantages obtained from adopting an optimal control-based rule are not so great. Moreover, the analysis emphasizes the success of the wage-based rule and of the employment-based rule in the US and Germany, respectively. Finally, we propose a policy rule to capture the dynamics of the weekly working hours. According to our rule the length of the workweek is an inverse function of the deviation between the actual and potential employment level.

Keywords: Working-time, Policy Rule, Dynamic Optimization
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1 Introduction

The study analyzes the performances of different reaction functions to be used as possible guidelines for the setting of weekly working hours. The reaction function, summarizing how policymakers should alter their policy in response to economic development, can be useful in assessing the current stance, as well as the future direction, of labour market policy.
The question of rules versus discretion has generated a great deal of debate in many areas of the social sciences. The recent past has increasingly been characterized by a massive presence of rules in the proceedings of economic policies. Examples in such a direction are for all to see; to quote some: "The Stability and Growth Pact", Maastricht convergence criteria, ECB strategies, inflation targeting strategies and so on.
In order to evaluate the various results a policymaker obtains from adopting a particular rule, a preliminary definition of what constitutes rule-based labour market policy in practice must be given. As no policymaker will be bound to the prescription of any simple rule (or any optimal control algorithm), the distinction between rule-based and discretionary labour market policy is crucial. In particular, while a discretionary policy takes into account current macroeconomic conditions, ignoring past development in the economic system, a rule-based policy is based on a "timeless perspective", i.e. the rule is constructed as if the current conditions were not known. According to this definition, when following a discretionary policy, the policymakers re-optimizes its decision-making process periodically, while in a rule-based policy, labour market authorities implement a contingency formula chosen to be applied for an infinite number of time periods. Nevertheless, in the rule-based framework, the possibility of revising a rule is also contemplated, once the policymaker gets new information on the state of the economy. Any binding rule is, of course, a constraint on behaviour. Hence the question, why should policymakers deliberately choose to impose constraints on his own freedom of action?
The reason why a policymaker should adopt a policy rule, instead of having a discretionary behaviour, has a theoretical basis in time-consistency literature of monetary policy. In this literature, to which the seminal contribution was made by Kydland and Prescott (1977) and Barro and Gordon (1983), it is shown that if a central bank does not commit itself to a rule, the policymakers will be tempted to choose a suboptimal inflation policy. The contribution of Barro and Gordon is of particular interest for the issues analyzed in the paper because the "rules vs. discretion" dichotomy is separated from the debate on "activist vs. non-activist" central bank policy.

This separation has resulted in the possibility for monetary policymaking to concentrate on the issue of policy rules.

The remainder of the paper proceeds as follows. Section 2 presents some empirical evidence on the determinants of workweek length in Germany and the US. Section 3 reports a theoretical model designed to summarize the main channels through which policymakers might affect employment and wages. Section 4 introduces a set of instrument rule retrieved by using a quadratic loss function over some policy targets. Moreover, the section focuses on the historical analysis of policy rules as well as on the efficiency of the estimated working-time policy rules. In Section 5, we propose a rule that captures the historical pattern of the weekly hours. Section 6 ends the paper with concluding remarks.

2 The Determinants of Workweek Length

In recent years, and indeed over the twentieth century in general, recorded yearly average number of hours worked per employee sharply declined in most countries of the industrialised world; the long-term decline in average annual hours has slowed down in almost all OECD countries, with trends even occasionally reversed. In addition, usual European working hours are shorter with respect to countries such as Japan or the US. Various elements affect hours worked across OECD countries, relating to matters (Bishop, 2004) such as regulations and legislation, preferences and culture, wages, tax rates, business cycle effects and structural changes in the economy.

As regards regulations and legislation, countries may be classified in three groups (Bollé, 2001): a first group, encompassing the UK and Ireland, where there is individual flexibility between employers and workers; a second with countries such as France, Spain and Finland where state-driven flexibility is under way, and finally negotiated flexibility is the rule in countries such as Denmark, the Netherlands and Germany. Although the 93/104/EC Directive states the maximum working week duration is 48 hours throughout EU countries, national systems operate in the direction of imposing shorter hours (such as France, Denmark, Sweden and the UK) or sometimes longer hours[1]. Wage levels, nonetheless, may affect the level of hours worked although in this case an income and substitution effect operate concerning the choice between consumption and leisure. In an interesting paper Prescott (2004) addresses the importance of the tax rate in the allocation between

[1] For more details in this direction see EIRO (2004) "Working time-developments in EU and national regulation", available at www.eiro.eurofound.ie.

market and non-market activities; to this extent Prescott (2004) in dealing with the question as to why Americans work much more than Europeans, underlines the role played by taxes in accounting for the differences in labour supply across countries and times although Schettkat (2003) suggests that once time in household production is included the differences disappear. In addition none can neglect that labour market variables are influenced by movements in the business cycle; as a consequence, we observe that total hours growth is positive in expansion and negative in recession. Finally, but not least, the change in the structure of the economy may deeply influence working hours. Most countries of the Western world have repeated the "revolution" begun in England, i.e. the transition from an agricultural to an industrial economy; this process although advanced furthest in the US is found in practice in all developed countries. Nowadays almost all highly industrialised countries have become "service economies" if we look at them in terms of the share of workers employed in service industries (Schettkat and Yocarini, 2003)[2]. As a consequence it comes as no surprise that patterns in working time tend to be more flexible with varied working hours since service-based economies tend to be more flexible than industrial economies.

If we turn our attention to data we observe that hours worked in the US are much longer than those typically worked in European countries. To this extent it is useful to have a look at Figure 1 where average weekly hours worked in manufacturing (unadjusted data) are reported for the US and Germany (1976:01-2004:03).

Inspection of Figure 1 suggests that roughly during the first decade (1976-1986) German workers used to work longer weekly hours than their US counterparts while from the mid-80s onwards a substantial decrease in hours worked in Germany (determining an overall negative trend for the period considered) and an increase for the US ones (positive trend) is observed. Although, as stated, Prescott (2004) underlines the role played by tax rates on labour income, interestingly once we shift our attention to non-agricultural activities[3] the story reverts in the sense that the weekly working week duration for the US turns being lower than the corresponding German one with values running from 35.8 and 40.9 (respectively US and Germany – 1977:01) to 33.8 and 37.1 (2004.01). If in addition we recall that indus-

[2] An accurate analysis on the causes of the shift to the services economy is contained in Schettkat and Yocarini (2003).

[3] Belong to this sector (ILO definitions): Mining and quarrying; manufacturing, gas and water; construction; wholesale and retail trade, restaurants and hotels; transport, storage and communication; financing, insurance, real estate and business services; community, social and personal services; activities not adequately defined.

trialised economies are, in fact, service economies it comes as no surprise that if a rule governing working time behaviour should be found in order to minimise employment loss, this has to be dealt with by considering non-agricultural activities rather than mainly manufacturing since the former encompasses the higher share of employment.

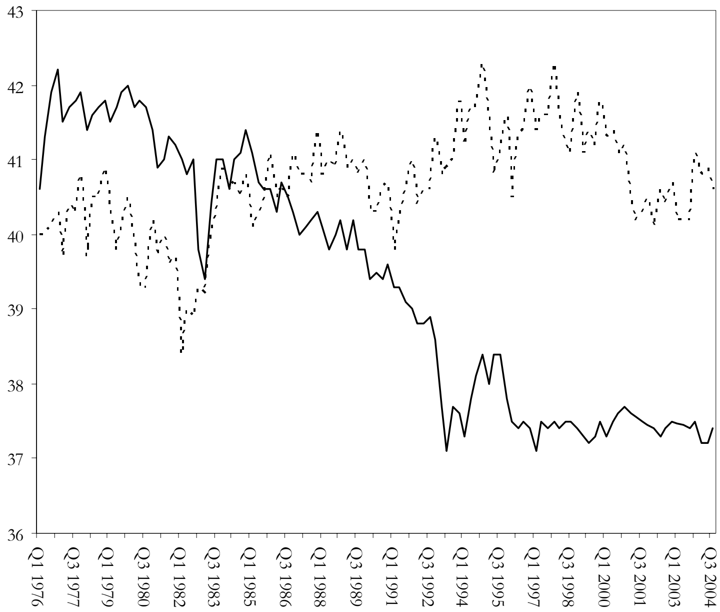

Figure 1: Working Hours in Manufacturing in Germany (dashed) and the US (solid)

3 A Structural Model of Labour Market Dynamics

The model used in the analysis is a backward-looking, closed-economy model. The specification of equations is thought to be representative of the main effects that policymakers might have on employment and wages.

The model consists of a labour supply equation of the form:

$$w_{t+1} = \sum_{i=1}^{j} \alpha_i w_{t+1-j} + \alpha_{j+1} \widetilde{n}_t + u_{t+1}^w \tag{1}$$

This equation relates the growth rate of real hourly wages (w), i.e. $[100 \times (\log W_t - \log W_{t-4})] - [100 \times (\log CPI_t - \log CPI_{t-4})]$ where W is the nominal wage and CPI is the consumer price index, to its own lags and to a lagged employment gap ($\widetilde{n}$), measured as a percent gap between the actual employment level and the potential employment[4]. The specification of labour supply is consistent with an adaptive representation of wage expectations. The expectations are treated implicitly by the inclusion of lagged values of the variables.

Equation (2) identifies the labour demand equation:

$$\widetilde{n}_{t+1} = \sum_{i=1}^{k} \beta_i \widetilde{n}_{t+1-k} - \beta_{k+1} h_t - \beta_{k+2} w_t + \beta_{k+3} \widetilde{y}_t + u_{t+1}^{n} \tag{2}$$

According to the above equation, the employment gap is related to the output gap ($\widetilde{y}$), the variation of hourly wages (w), the growth rate of weekly hours and to its own lags. This specification implies that working hours (h) are an exogenous variable under the complete control of policymakers.

Finally, we assume that the output gap follows a stationary univariate AR(2) process:

$$\widetilde{y}_{t+1} = \delta_1 \widetilde{y}_t + \delta_2 \widetilde{y}_{t-1} + u_{t+1}^{y} \tag{3}$$

This specification is chosen for simplicity. Additional variables can be incorporated in the above equation without causing any difficulties. The timing of the model can be summarized as follows: an increase in weekly working hours h_t in period t affects employment with one period lag; it takes another period, i.e. at time $t+2$, for employment to affect wages.

The model was estimated by applying the SURE technique[5]. The data are quarterly and are taken from the ILO statistics[6]. The sample period goes from 1975:1 to 2004:1. All variables were de-meaned prior to estimation. The estimated equations are (standard errors are reported in brackets):

[4] Potential employment as well as potential output was computed by using the Hodrick-Prescott (HP) filter. As we have quarterly data, we set the smoothing parameter to 1600.

[5] The order of the autoregressive coefficients in equation (1) and equation (2) is tested for both countries by implementing standard test statistics. We computed the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), Hannan-Quinn, and FPE for both equations. The criteria do not give completely coherent results, but the choice of using a fourth order autoregressive structure is the most appropriate. AIC and HQ suggest a maximum lag equal to four, whereas the Schwarz criterion recommends adding only one and two autoregressive components per variable for the United States and Germany, respectively. We then fix the number of lags at four for both countries.

[6] See Appendix 1 for the details on the variables used in the empirical analysis.

Germany

$$\widetilde{n}_t = \underset{(0.11)}{1.19}\widetilde{n}_{t-1} - \underset{(0.12)}{0.26}\widetilde{n}_{t-2} - \underset{(0.09)}{0.03}\widetilde{n}_{t-3} - \underset{(0.06)}{0.01}\widetilde{n}_{t-4} - \underset{(0.04)}{0.15}h_t - \underset{(0.08)}{0.58}w_t + \underset{(0.02)}{0.11}\widetilde{y}_t$$

$$w_t = \underset{(0.1)}{0.67}w_{t-1} - \underset{(0.11)}{0.14}w_{t-2} + \underset{(0.12)}{0.18}w_{t-3} + \underset{(0.08)}{0.19}w_{t-4} + \underset{(0.06)}{0.13}\widetilde{n}_t$$

$$\widetilde{y}_t = \underset{(0.09)}{0.76}\widetilde{y}_{t-1} + \underset{(0.1)}{0.19}\widetilde{y}_{t-2}$$

United States

$$\widetilde{n}_t = \underset{(0.09)}{1.75}\widetilde{n}_{t-1} - \underset{(0.18)}{1.22}\widetilde{n}_{t-2} + \underset{(0.16)}{0.51}\widetilde{n}_{t-3} - \underset{(0.07)}{0.16}\widetilde{n}_{t-4} - \underset{(0.02)}{0.12}h_t - \underset{(0.04)}{0.15}w_t + \underset{(0.05)}{0.14}\widetilde{y}_t$$

$$w_t = \underset{(0.07)}{1.3}\,w_{t-1} - \underset{(0.1)}{0.94}w_{t-2} + \underset{(0.09)}{0.82}w_{t-3} - \underset{(0.06)}{0.21}w_{t-4} + \underset{(0.07)}{0.18}\widetilde{n}_t$$

$$\widetilde{y}_t = \underset{(0.08)}{1.12}\widetilde{y}_{t-1} - \underset{(0.08)}{0.27}\widetilde{y}_{t-2}$$

For our purposes, the key coefficients in the tables are the β_{k+1}'s, which represent the effect of the weekly hours on employment gap; the coefficients on the lagged labour supply curve that represent the inertia of the wage process, i.e. α_h's; and α_{j+1} which measures the effect of an increase in the employment gap on the wage rate, i.e. the slope of the labour supply. At first glance, the model seems to perform rather well. Almost all coefficients are significant at the 5% level. The parameter β_{k+1} ranges from -0.12 in United States to -0.15 in Germany. On average, a one-point increase in the weekly hours reduces the employment gap by almost 13 basis points. Concerning the effects of the employment gap on wages, the estimated coefficients vary from 0.13 in Germany to 0.18 in the United States.

4 Working-Time Policy Rules

The class of rules considered in the analysis are instrument rules retrieved by using a quadratic loss function over some policy targets. In particular, the labour market authorities are assigned to minimize an intertemporal loss function that increases if there is a deviation between a target variable and the target level for this variable.

The loss function takes the following general form:

$$L = E_t \left\{ \sum_{\tau=0}^{\infty} \vartheta^{\tau} [\lambda w_{t+\tau}^2 + \varphi \widetilde{n}_{t+\tau}^2 + \gamma (h_{t+\tau} - h_{t+\tau-1})^2] \right\} \tag{4}$$

where E_t refers to expectations conditional upon the available information set at time t, while ϑ is a given discount factor, with $0 < \vartheta < 1$. The above expression describes a flexible wage target where the goal variables describing central bank preferences are w_t, i.e. the deviation of actual wages growth from a constant, given wage target; n_t, i.e. the employment gap and $h_t - h_{t-1}$, a weekly hours smoothing term. Moreover, λ, $\varphi$and γ are non-negative weights that the government attaches to stabilize wages, employment and weekly hours, respectively. If φ and γ are set at zero, we are in a situation of strict wage-targeting.

Concerning the variables that enter into the loss function it is worth noting that, from a practical point of view, the difficulty in measuring the employment gap and public familiarity with the concept of wages supports the choice of wages for policymakers communication and econometrics estimation purposes, respectively. Nevertheless, employment stabilization is also important to labour market authorities. Finally, the inclusion of the objective of weekly hours rate smoothing is proposed to account for the aversion that policymakers have to frequently changing the direction of their strategy.

It is possible to show that for $\vartheta = 1$ the optimization problem can be rewritten interpreting the intertemporal loss function as the unconditional mean of the period loss function; this means that the intertemporal loss function can be written as the weighted sum of the unconditional variances of goal variables:

$$E\left[L_t\right] = \lambda Var\left[w_t\right] + \varphi Var\left[\widetilde{n}_t\right] + \gamma Var\left[h_t - h_{t-1}\right] \tag{5}$$

In the following, this loss function will be used, assuming, therefore, the limiting case $\vartheta = 1$.

4.1 State-Space Representation

The State space representation of the estimated model is:

$$X_{t+1} = AX_t + Bh_t + v_{t+1} \tag{6}$$

This compact form summarizes the structure underlined by the dynamic model. More precisely, in the above equation the 13×1 vector X contains the state variables, the 13×13 matrix A and the 13×1 column vector B contains the estimated parameters, and the 13×1 column vector v_t is the disturbance term. This representation summarizes the dynamic structure of the economy and the uncertainty that the government faces regarding this structure. The matrix A and the vector B govern the dynamics of the state vector. Uncertainty enters through the additive stochastic vector v_{t+1}. The terms in equation (6) can be written as:

$$A = \begin{bmatrix} \sum_{i=1}^{j} \alpha_i e_i + \alpha_{j+1} e_{h+1} \\ e_1 \\ \vdots \\ e_j \\ \beta_{k+2} e_1 + \sum_{i=1}^{k} \beta_i e_{i+j} + \beta_{k+3} e_{(j+k+1)} - \sum_{z=1}^{3} \beta_{k+1} e_{i+j+2+z} \\ e_{j+1} \\ e_{j+k} \\ e_0 \\ e_{j+k+3} \\ e_{j+k+4} \end{bmatrix}$$

Where e_i denotes a $1 \times (k+j+5)$ row vector with all elements equal to zero and with the elements $i = 1, ...k + j + 4$ equal to unity. Note that all variables entering the state-space representation are expressed as a function of lagged data only. This condition comes from the particular model considered in the analysis which is a backward-looking model.

$$X_t = \begin{bmatrix} w_t \\ w_{t-1} \\ \vdots \\ \vdots \\ \vdots \\ w_{t-j} \\ \widetilde{n}_t \\ \widetilde{n}_{t-1} \\ \vdots \\ \vdots \\ i_{t-1} \\ i_{t-2} \\ i_{t-3} \end{bmatrix}, \qquad B = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ -\beta_{k+3} \\ 0 \\ \vdots \\ \vdots \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} \qquad \text{and} \qquad \nu_t = \begin{bmatrix} u_t^w \\ 0 \\ \vdots \\ \vdots \\ \vdots \\ u_t^n \\ 0 \\ \vdots \\ \vdots \\ u_t^y \\ \vdots \\ \vdots \\ 0 \end{bmatrix}$$

Writing the target variables, w_t, n_t and $h_t - h_{t-1}$ as a function of the state variable X_t we get:

$$Y_t = \begin{bmatrix} w_t \\ \widetilde{n}_t \\ h_t - h_{t-1} \end{bmatrix} = C_X X_t + C_i i_t, \text{where} C_X = \begin{bmatrix} e_{1\,:\,j} \\ e_{j+1} \\ -e_{j+k+3} \end{bmatrix} \text{ and } C_i = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

The loss function can now be expressed as:

$$L_t = E\left[Y_t' K Y_t\right], \text{where } K = \begin{bmatrix} \lambda & 0 & 0 \\ 0 & \varphi & 0 \\ 0 & 0 & \gamma \end{bmatrix}.$$

The class of linear feedback rules considered here takes the following generic form:

$$h_t = f X_t \tag{7}$$

where f denotes a $1 \times (k + j + 5)$ vector. Using the foregoing relations, the dynamics of the model follow:

$$X_{t+1} = M X_t + v_{t+1}, M = A + Bf$$
$$Y_t = C X_t, C = C_X + C_i f$$

The optimal linear feedback rule is an instrument rule that, given the economic structure implied by the rule, is able to minimize the labour market authorities loss function. Thus, the optimal linear feedback rule can be expressed as:

$$f = -\left(R + B'VB\right)^{-1}\left(U' + B'VA\right) X_t$$

where the matrix V satisfies the Riccati equation:

$$V = Q + Uf + f'U' + f'Rf + M'VM$$

and where:

$$Q = C_X' K C_X, U = C_X' K C_i \text{ and } R = C_i' K C_i$$

In this section, different specifications of instrument rules will be estimated. Within this class of rule, the policymakers' instrument is expressed as a function of the available information. The analysis considers six instrument rules. The first is the unrestricted optimal control rule:

$$h_t = fX_t$$

where f denotes a $1 \times (k + j + 5)$ vector of response coefficients. In this case, government responds to changes in every state variable.

The second rule is the Wage-Employment-Output rule. This rule (henceforth WEOR), assumes that weekly hours are a function of the current values of output, employment and wages:

$$h_t = f_n \widetilde{n}_t + f_w w_t + f_y \widetilde{y}_t$$

where f_n, f_w and f_y are the response coefficients of employment, wages and the output gap respectively.

By setting the coefficient on the output gap at zero we obtain the third rule, i.e. the Wage-Employment rule (WER):

$$h_t = f_w w_t + f_n \widetilde{n}_t$$

The fourth and fifth rules are pure wage rules (WR) and pure employment rules (ER) of the form:

$$h_t = f_w w_t \text{ and } h_t = f_n \widetilde{n}_t$$

Finally the sixth rule is a forward-looking rule (FLR). Specifically, the policymakers are allowed to respond to a real wages forecast rather than to current wages:

$$h_t = f_w \overline{w}^e_{t+8|t} + f_n \widetilde{n}_t + f_h h_{t-1}$$

where $\overline{w}^e_{t+8|t}$ is the 8-quarter ahead wages forecast for a given amount of weekly working hours and is calculated as:

$$\overline{w}^e_{t+8|t} = e_{1\ :\ h}(AX_t + Bh_t)^8$$

The forecasts are also computed conditional upon the current state variables X_t[7] f are:

$$f = f_w e_{1\ :\ j}(A + Bh)^8 + f_n e_{j+1}$$

Figure 2 shows, for both countries, the forecast used to compute the forward-looking rule together with the actual growth rate of hourly wages.

[7] This means that the restrictions on

As shown in figure 2, the forecasts appear to capture the dynamic of the wages.

Table 1 presents the estimated response coefficients of the selected policy rules. In principle, there are several factors affecting the particular specification of the rule that a policymaker can follow. In fact, different values of the state variable, X, different impacts of labour policy, A and B, and different government preferences over employment and wages, K, may result in a different weekly hours policy, i.e. a different rule. The differences in the response coefficients reflect all those variables.

The table gives some interesting results. Consistent with a priori beliefs, the first weekly-hours smoothing coefficients are quite high, 0.52 on average, while the third and fourth lag coefficients are much lower. Table 1 also suggests that Germany is the country where a rise in expected wages produces the larger response from the policymakers in terms of weekly-hours reaction; an increase of one percent induces the labour market authorities to decrease the weekly-hours growth rates by 45 basis points on average.

Another interesting result regards the employment gap estimated coefficients. In both countries, a rise in the employment gap induces policymakers to decrease weekly hours. According to the optimal feedback rule, a one-percent increase in the employment gap in Germany, for example, should induce the policymakers to decrease the weekly hours by almost 100 basis points on the average. However, the estimated response to a change in the employment gap is higher in the US than in Germany.

We can conclude that the trade union presence mainly affects the level of hours worked, as trade unions encourage the adjustment of hours, rather than employment, in order to protect the insider power of existing workers. In the US, where there is higher flexibility, firms are more likely to adjust employment rather than hours worked.

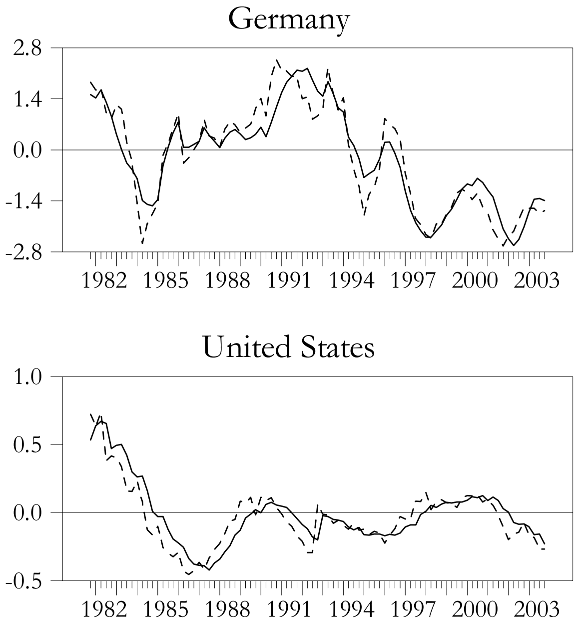

Figure 2: Wage Forecast (dashed) vs. Actual Hourly Wages (solid)

	OFR		WEOR		WER		WR		ER		FLR	
	DE	USA	DE	USA	DE	USA	DE	USA	DE	USA	DE	USA
w^e_{t+4}	-	-	-	-	-	-	-	-	-	-	-0.54	-0.42
w_t	-0.44	-0.3	-0.44	-0.34	-0.46	-0.37	-0.34	-0.43	-	-	-	-
w_{t-1}	-0.13	-0.21	-	-	-	-	-0.11	-0.3	-	-	-	-
w_{t-2}	-0.1	-0.12	-	-	-	-	-0.09	-0.16	-	-	-	-
$\underset{\sim}{w}_{t-3}$	-0.07	-0.08	-	-	-	-	-0.08	-0.1	-	-	-1.21	-1.144
$\underset{\sim}{n}_t$	-0.93	-1.29	-0.83	-1.05	-0.87	-1.15	0	0	-0.91	-1.26	-	-
$\underset{\sim}{n}_{t-1}$	0.33	1.1	-	-	-	-	-	-	-0.32	-0.24	-	-
$\underset{\sim}{n}_{t-2}$	0.05	-0.52	-	-	-	-	-	-	-0.05	-0.15	-	-
$\underset{\sim}{n}_{t-3}$	0.03	0.25	-	-	-	-	-	-	-0.03	-0.09	-	-
$\underset{\sim}{y}_t$	-0.23	-0.06	-0.25	-0.12	-	-	-	-	-	-	-	-
y_{t-1}	-0.05	-0.01	-	-	-	-	-	-	-	-	-	-
h_t	0.53	0.52	-	-	-	-	-	-	-	-	-	-
h_{t-1}	-0.11	-0.1	-	-	-	-	-	-	-	-	-	-
h_{t-2}	0.02	0.04	-	-	-	-	-	-	-	-	-	-

Table 1: Estimated Response Coefficients for the six Policy Rules

4.2 The Historical Functioning of Working-hours

This section focuses on the historical analysis of weekly-hours policy rules. Analysis of the historical behaviour of the working-time can give useful insights for the conduct of labour market policy. In particular, the section analyzes the differences between the estimated policy action and the rule the policymakers have been using during the past decades. The deviation of the actual policy rules, summarized by the standard-weekly hours, from the estimated rules might be considered a "policy mistake". We can then assess whether the value of the weekly hours implied by the six policy rules considered in the previous section are significantly different from actual policymakers' behaviour.

Figures 3 and 4 show, for Germany and the US, the growth rate of the weekly hours of work implied by the six estimated policy rules (dashed lines) versus their historical values (solid lines).

From this analysis, it is clear that all the rules perform quite well in replicating historical working hours' movements. The forward-looking rule successfully describes the historical behaviour of working hours. The possibility for policymakers to respond to forecasts about future wages is then to be considered as a realistic feature of policy-making.

The figures also capture the sources of the deviations of the rules from the historical records. Looking at figure 4, for example, we can see that at the beginning of the sample, there was a sharp increase in wage growth. This reflects the high response of policymakers for these periods when using rules that react to wages, i.e. WR, WER and WEOR. However, if, during the same periods, the policymakers had followed the employment rule, they would not have changed the working hours so much.

The same consideration applies to the German case concerning the reaction to employment gap changes. The employment rule fails to capture the historical records of weekly hours during the German unification years (1990-92). This is mainly because at the time of unification between West and East Germany there was a huge change in the employment level. This results in a higher deviation of the rule from the historical weekly hours when policymakers follow the employment rule.

The ability of the optimal feedback-rule (OFR) to reproduce the historical weekly hours is shown in Figures 5. The figures also show the estimated policy mistakes. The two series of policy mistakes are obtained by subtracting the estimated values of the optimal feedback rule from the historical values of the weekly hours. A positive value in the figure indicates that for that period the number of weekly hours actually worked was higher than the number of hours the policymakers should have fixed in order to stabilize the labour market. The vertical axis shows the deviation of the historical weekly hours from the estimated rule.

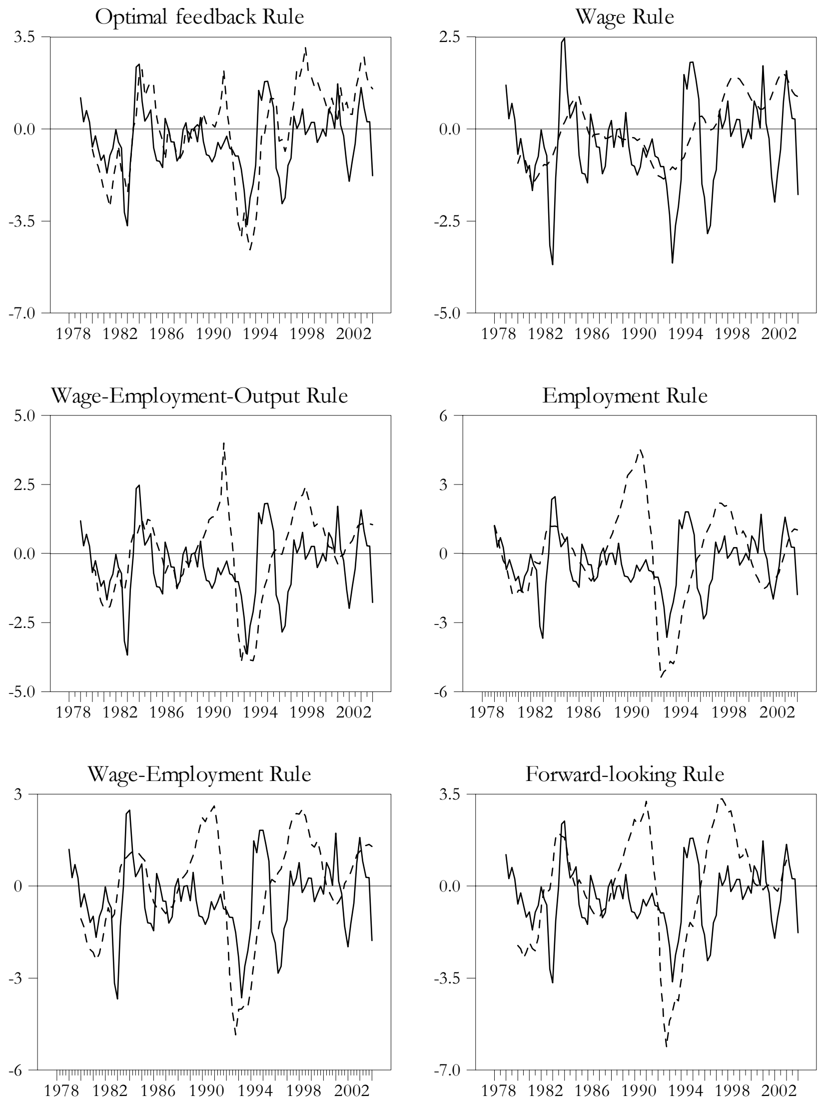

Figure 3: Estimated Rules (dashed lines) vs. Actual Hours (solid lines) in Germany

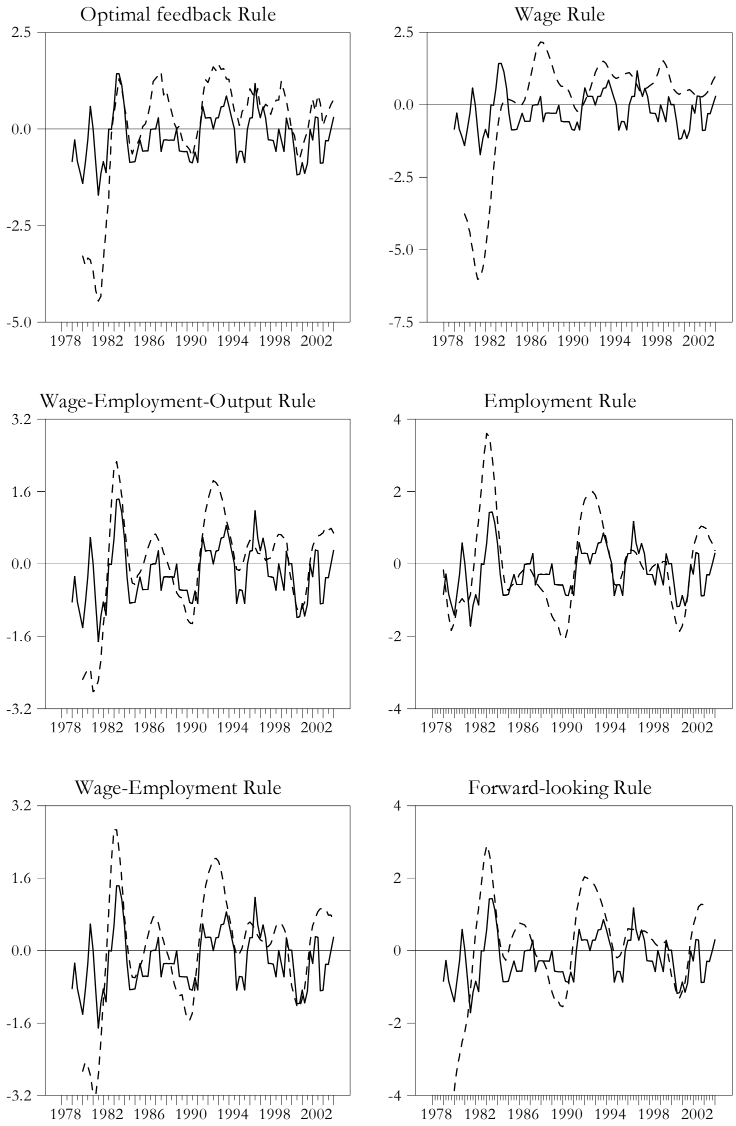

Figure 4: Estimated Rules (dashed lines) vs. Actual Hours (solid lines) in the US

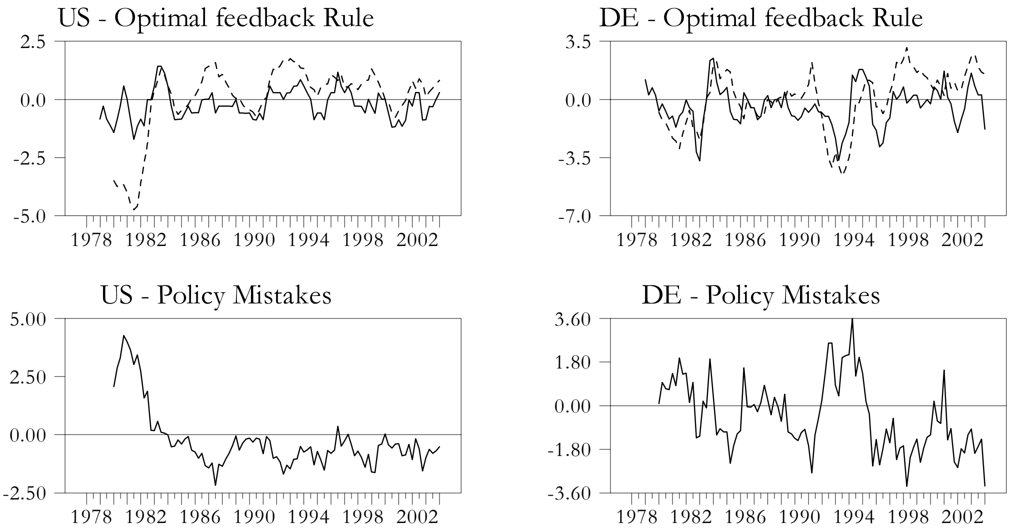

Figure 5: OFR (dashed lines) vs. Actual Hours (solid lines) and the Policy Mistakes

Consistently across countries, we can characterize three periods of labour market policy history.

In the first period, covering the early 1980s, historical weekly hours appear to be well above the estimated policy rules. This suggests that the number of weekly hours implemented by the policymakers of the two countries was too high. Specifically, the number of hours that exceeded the optimal level implied by the dynamic control algorithm were 1.5 and 0.9 for the US and Germany, respectively.

The second period, occurring in the early 1990s, embraces the European monetary system crises. In this period, the behaviour of the labour market authorities in the two countries was quite dissimilar. The differences basically derive from the different economic situation the two countries faced in that period. Indeed, the OFR replicates well the dynamics of the weekly hours in the US but fails to do so for Germany. The reason is that in the early 1990s the unification of East and West Germany together with the ERM crises produced a recessionary effect on the German economy. In order to stabilize the labour market, Germany should have reduced the number of weekly hours.

The third period goes from the mid 1990s to the end of the sample. In this period, the outcome of the estimated rules in the US appears to be much closer to the historical weekly hours. Although the OFR suggests an increase in the number of weekly hours, the changes in the hours of work in the late 1990s were estimated to be about the right magnitude.

Also in Germany, apart from 2001, the OFR suggests a rise in the length of the workweek. However, the deviation, and then the policy mistake, is much larger. Accordingly, Germany should increase the number of weekly hours by almost 3.5%.

We can conclude that, over the last two decades, macroeconomic performance has improved markedly in the US rather than in Germany. Better macroeconomic performance has not only resulted in a higher employment gap: it has also improved the stability of the wages and the employment. On the contrary, German labour market authorities have not met their stabilization objectives.

4.3 The Efficiency of the Working-time Policy Rules

This section analyzes the efficiency of the estimated rules. An efficiency analysis of alternative policy rules cannot solely rely on the differences between actual and estimated reaction functions. In fact, a policy rule has to be considered optimal if it minimizes a weighted sum, where the weights are set by the tastes of policymakers, of employment variance and wages variance. In our case, given the specification of the loss function in equation [4], a term in weekly hours smoothing is also taken into account. In other words, the efficiency of a rule results from its ability to stabilize employment, wages and working hours changes around their target values for an infinite number of periods.

The unconditional variances of employment, wages and weekly hours rate are calculated using the method developed in Rudebush (spelt differently in references) and Svensson (1998). More precisely, the 3×3 covariance matrix of the goal variables is given by:

$$\sum\nolimits_{YY} \equiv E\left[Y_t Y_t^{'}\right] = C \sum\nolimits_{XX} C^{'}$$

where the $(k+h+3) \times (k+h+3)$ matrix $\sum_{XX}$ represents the unconditional covariance matrix of the state variables and satisfies the following relationship:

$$\sum\nolimits_{XX} \equiv E\left[X_t X_t^{'}\right] = M \sum\nolimits_{XX} M^{'} + \sum\nolimits_{vv}$$

In order to recover the covariance matrix of the state variables we can use[8]:

$$
\begin{aligned}
vec\left(\sum\nolimits_{XX}\right) =& vec\left(M \sum\nolimits_{XX} M'\right) + vec\left(\sum\nolimits_{vv}\right) \\
&= (M \otimes M)\, vec\left(\sum\nolimits_{XX}\right) + vec\left(\sum\nolimits_{vv}\right)
\end{aligned}
$$

Finally we can solve for $(\sum_{XX})$:

$$
vec\left(\sum\nolimits_{XX}\right) = [I - (M \otimes M)]^{-1}\, vec\left(\sum\nolimits_{vv}\right)
$$

Table 2 provides the results for the volatility of goal variables, measured as the unconditional variances, implied by the six estimated rules under the hypothesis that $\lambda = 0.4$, $\varphi = 0.4$ and $\gamma = 0.2$. With this assumption, the analysis is implicitly carried out under the hypothesis that, for the policymakers, the volatility of employment and wages is equally undesirable $(\lambda = \varphi)$ while the variability of weekly-working hours is much less costly $(\gamma = 0.2)$. These tables also report the loss implied by the rules and the relative ranking in terms of loss in the fourth and fifth columns of Table 2, respectively.

In both countries, the variability of optimal feedback rules outperforms, in terms of minimum losses, the other rules. This means that the volatility of the goal variables is minimized once the policymakers adopt an optimal feedback rule.

The employment rule and the wage rule are the second top-performing rule in the US and Germany, respectively; the results in terms of the volatility of target variables and, therefore, in terms of losses are very close to those of the optimal feedback rule. However, the performance of the WR in Germany is very poor.

The forward-looking rule outperforms both the WER and WEOR. It follows that the inclusion of a forward-looking dimension in a labour market authorities' decision process seems to improve the performance of the simple rule.

From the comparative analysis we can conclude that the pure employment rule is able to stabilize labour market variables almost as well as the OFR.

[8] The relationships used are: $vec(A+B) = vec(A) + vec(B)$ and $vec(ABC) = vec(C' \otimes A) + vec(B)$.

	S.D.(w)	S.D.(ñ)	S.D.(h)	Loss	Rank
			Germany		
Optimal Feedback rule	0.78	1.17	0.79	1.12	1
Wage-Employment-Output rule	1.87	1.20	0.74	2.57	5
Wage-Employment rule	1.57	1.22	0.52	2.04	4
Wage rule	0.47	3.43	0.10	6.01	6
Employment rule	1.60	0.75	0.12	1.56	2
Forward-looking rule	1.77	0.95	0.09	2.01	3
			United States		
Optimal Feedback rule	0.90	0.87	1.10	1.03	1
Wage-Employment-Output rule	4.03	3.50	1.32	14.58	5
Wage-Employment rule	3.99	3.88	1.02	15.71	6
Wage rule	0.84	1.54	1.43	1.95	2
Employment rule	2.41	0.61	0.11	3.09	3
Forward-looking rule	4.12	1.53	0.10	9.66	4

Table 2: Results of Employment and Wage Volatility

To augment the tables, Figure 6 shows the efficiency frontiers of each rule in Germany and the US. These curves illustrate the trade-off between employment gap variability and wage variability. They are obtained by varying the weight on wages from 0.01 to 0.8 and assuming $\gamma = 0.2$. The weight on wage stabilization implicitly determines the weight on employment stabilization since φ is set equal to $1 - \lambda$. Thus, as the weight on wages stabilization is increased by 0.01, the weight on employment stabilization is reduced by the same amount at each step. As λ increases, the rules correspond to points further to the right on the curve.

The trade-off resulting from the optimal rule is shown as a solid line. The dashed lines show the rule indicated in the caption. The efficiency frontiers basically confirm the results of the tables. Moreover, they provide the following insights. First, the performances of the rules seem to be very close to one another even though the performances of the optimal and the employment rules are the best. This is particularly true for Germany, as in the US the efficiency frontier of the wage rule is lower than that estimated for the employment rule.

The figure confirms the success of the US strategy in stabilizing wages and employment during the sample period. The results also highlight the poor performance of Germany when following the wage rule. Consistently with the previous analysis, the results show the poor performance of WEOR and WER. A closer performance of these rules in both countries was then expected.

Altogether, these results support the choice of employment rule as a role framework in designing the labour market strategy.

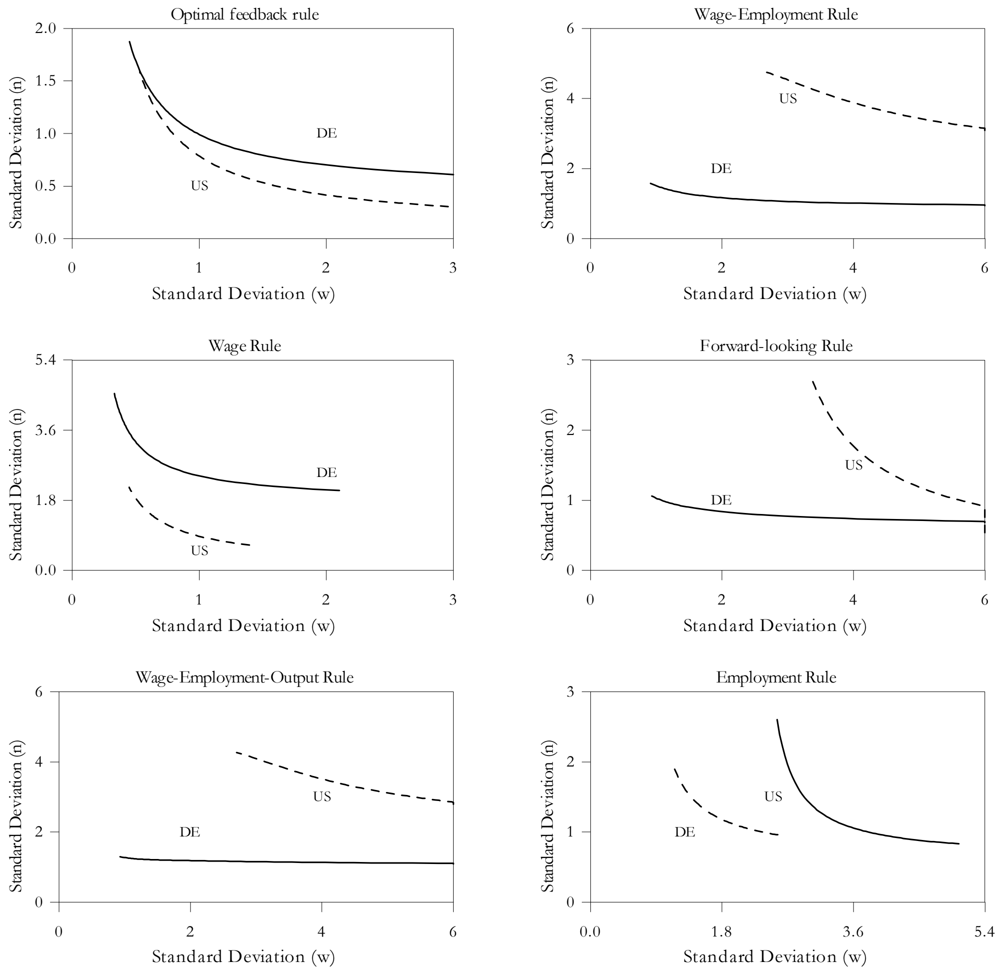

Figure 6: The Efficiency Frontiers for the Six Rules in Germany and the US

4.4 Searching for Working time regularities: A Guideline rule

Based on the estimated results we propose a rule to capture the historical pattern of the weekly hours. A proposal should be based not only on the ability of the rule to give a better representation of the historical weekly hours dynamic, but also on the efficiency of the rules, measured in terms of volatility.

According to our rule, the growth rate of the hours of work increases when the employment level is lower than its potential level, i.e. $dh_t = -(n_t - n^*)$.

The reason why we select this rule is that we believe that labour market variables are affected by movements in the business cycle.

As we can observe from figure 7, the rule replicates the historical records quite well. In particular, according to the proposed rule the growth in total hours is positive when there is a negative deviation of the actual employment level to the potential employment level, i.e. when we are in expansion. On the contrary, during recessionary periods, where the potential level of employment is most likely to exceed its actual level we observe a decrease in the weekly hours. This result of the previous sections suggests that by using a rule that concentrates on the employment gap not only do we obtain a good approximation of the historical pattern, but policymakers also minimise the volatility of real wages and the employment gap.

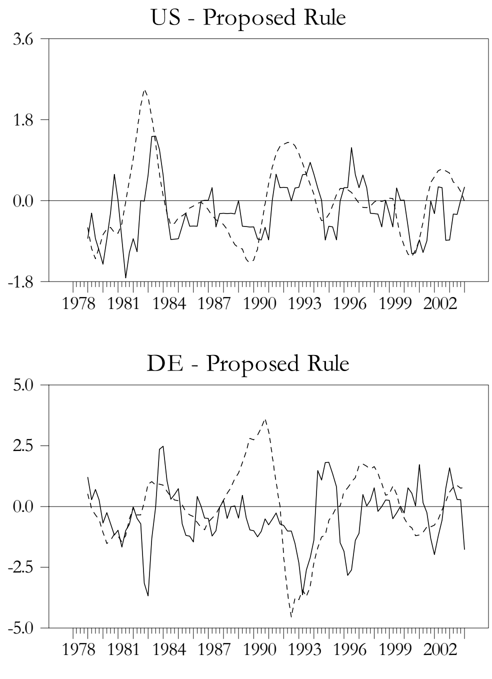

Figure 7: Actual Hours (solid) vs. Proposed Rule (dashed)

5 Concluding Remarks

This paper attempts to analyze the performance of different rules capable of modelling how the labour market authorities of Germany and the US have made policy decisions affecting weekly working hours. In particular, the study focuses on six different rules relating the hours of work, which the policymakers are assumed to control, to a set of variables thought to affect labour market authority behaviour. The set of rules includes an optimal feedback rule, a wage-employment-output rule, a wage-employment rule, a wage rule, an employment rule and a forward-looking rule. All the rules are calculated from an intertemporal optimization problem of a loss function penalizing the volatility of employment gap, real wages and weekly hours changes under the constraints given by a small, backward-looking structural model.

The estimated coefficients of the rules are used to detect the main differences they imply in terms of labour market policy strategy. Once the rules are estimated, we study their performance by using two different analyses.

The first relies on the historical behaviour of labour market authorities. A comparison between the actual and optimal policy rules gives rise to some important observations.

First, for most countries the estimated rules suggest that the number of weekly hours was higher than needed in the early 1980s, while lower hours would have been advisable during the early 2000s.

Second, the selected rules ably predict weekly hours' behaviour during the early 1990s for the US but fail to do so for Germany. Another interesting observation that arises from the analysis is that in the US rather than in Germany the actual policy rule has come closer to the optimal rule since the mid-1990s.

Another issue considered in the analysis is the ability of the rules to replicate historical weekly hours movements. The results emerging from the study stress that simple rules perform quite well in following workweek historical records. The ability to mimic working hours changes increases once an employment term is included in the reaction function. Moreover, considering a forward-looking dimension that takes into account expectations of future wage movements seems to give a further improvement.

Finally, the study focuses on the efficiency of the estimated reaction functions. Our analysis suggests that the rule obtained by solving an optimal control algorithm is the top-performing rule. Nevertheless, the performance of a simple employment rule is almost as stabilizing as the optimal feedback rule. Thus, the gains obtained by policymakers in following a complicated rule are not so high.

Further conclusions arise from comparing the efficiency frontiers across the two countries. The outcome confirms the success of the US strategy in stabilizing employment and wages during the sample period. It also highlights the poor performance of the German models of labour market policy when following a wage rule.

Based on these results we propose a policy rule to capture the dynamics of the weekly working hours. According to our rule the length of the work-week is an inverse function of the deviation between the actual and potential employment level. This conclusion is based on the belief that labour market variables are affected by movements in the business cycle.

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