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The Impact of Growth, Labour Cost and Working Time on Employment: Lessons from the French Experience

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The Impact of Growth, Labour Cost and Working Time on Employment: lessons from the French experience

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Abstract. In order to account for the evolution of employment at the macro-economic level, we have developed a model wherein employment is explained by added value, working time and real labour cost. Estimations using quarterly French macro-economic data are carried out in a multivariate framework for three sets of sectors. We obtain a relationship in which employment rises when there is growth and falls when labour cost or working time rises, in both industrial sectors and non-industrial ones. This model then allows the contributions of each of the variables with respect to employment inflections since the mid-eighties to be measured retrospectively.

Keywords. Per capita productivity, hourly productivity, labour demand, employment, working time, co-integration, VAR-ECM model.

Classification JEL. E 24, J 22, J 23.

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1. INTRODUCTION

In the 1990s, macro productivity gains in Europe slowed down whereas they accelerated in the US. An inverse trend was also observed for employment figures on both sides of the Atlantic. There was a sharp increase in the employment ratio in the US, in contrast to its slight decrease in Europe. However, the difference in productivity depends on the indicators and data used (Aiginger, 2002). It is pervasive and robust for the second half of the nineties, for output per person and specifically for manufacturing sectors. It is rather small for growth in Multi-Factor-Productivity (MFP) and for macro productivity per hour.

Many researchers have tried to explain these differences in employment and productivity trends. Within a long-run perspective, Gordon (2002) for instance, showed that the catching-up process reduced the gap between European and US productivity growth until the early 1990s. To account for the break during the second half of the nineties, the diffusion of new information and communication technologies is usually considered, as well as more traditional determinants of employment and productivity, such as labour cost, growth or working time (see Basu et al., 2001, Gilles et L'Horty 2004, Hansen, 2001, Gust and Marquez, 2002).

Since the early eighties, productivity gains in France have once again shown a decrease and growth content has risen in employment. For the same rate of growth it seems as if the French economy has become able to generate more jobs. Evidence shows that 300,000 - 500,000 jobs, essentially in the service sector, have been preserved, despite the slowing down of activity since the 1993 recession. Many researchers have tried to explain this "enrichissement de la croissance en emploi" (enrichment in employment growth). Some of them pointed out the effects of the strong surge in part-time jobs since 1992, which would have increased the number of employees occupied without really affecting hours worked. Others, like Duchêne, Forgeot and Jacquot (1997), discussed the impact of workforce reallocations, the substitutions between capital and labour or between skilled and unskilled labour, as well as the effects of employment policies. Lerais (2001) emphasized the role of service sectors, which would explain most productivity slowdown, as well as the effect of the reduced rate of social welfare taxes and the spread of part-time jobs. These diverging and finally inconclusive diagnoses call into question the tools used for the long-run analysis of employment, supposedly exclusively explained by productivity rhythm.

The purpose of this study is to try to propose a model of French employment and to see if it holds up when compared to quarterly macro-economic data using multivariate econometric techniques. We consider employment determinants by providing a general and theoretical specification. The estimations are based on a definitive series of quarterly accounts covering the 1976.1 - 1996.4 period, concerning non-agricultural private sectors, as well as industrial and non-industrial ones (composed mainly of the service sector) [1].

In section 2 we present a productivity model and econometric estimations using Johansen's methodology (1988, 1995). In this specification, employment depends on three main determinants: added value, working hours and real labour cost. Higher growth, working hours or labour cost reduction has a positive impact on employment and allows a satisfactory reproduction of the evolution in French unemployment over the past twenty years. A final section reviews our main findings.

2. Modelling productivity and employment

Macro-econometric estimations of the link between growth and employment distinguish between the short-run dimension reflecting the productivity cycle, and the long-run dimension related to the trend in productivity gains. To obtain the long-run target, one can regress a productivity indicator on a temporal polynomial, generally a linear or quadratic trend. The trend productivity target constitutes the error correcting term mechanism of an error correction model.

From a theoretical point of view, this type of modelling rests upon rather restrictive assumptions. It supposes that employment is connected in a stable way to growth, independently of any other determinants. It is thus implicitly assumed that labour cost,

[1] At the end of 1996 industrial private sectors amount to 4.2 million salaried employees and non-industrial non-agricultural sectors to 9.1 million, including 8 million in the service sectors and 1.1 million in the building trade.

capital cost, or working time have no long-term influence on employment or productivity at a macro-economic level.

From a theoretical point of view, it seems preferable to retain a less restrictive form of the employment equation where the elasticities of its different determinants, output, labour cost, and working time are not *a priori* constrained. It is such estimations that Laffargue and L'Horty (1997) carried out in a univariate framework. The explanation becomes more generally applicable without presupposing consequences on employment. This lack of restriction is also in accordance with what the data indicate. Whether it is specified in manpower or in hours worked, labour productivity is actually a non-stationary variable in the usual field of observation. Thus productivity in conventional modelling leads systematically to non-stationary residuals at the 5 % level. As it is shown by the estimations and the tests in appendix 2, this report is verified whether productivity is specified in manpower or in hours worked, whether we consider non-agricultural private sectors, or only industrial or non-industrial ones and finally whether labour cost is included or not in the estimation[2].

For these theoretical and empirical reasons, our approach considers whether adopting more general specifications compatible with non-constant scales of return and/or an imperfect substitutability of persons to hours worked can lead to more satisfactory empirical modelling. Before testing this, it is necessary to first have a theoretical framework leading to a general employment equation that corresponds to a calculable long-term relationship. This is necessary in order to give a structural interpretation of the parameters which determine employment.

[2] On the other hand, Maurel (1990) found that only hourly productivity was non-stationary using quarterly data covering the 1970-1989 period .

2.1 The theoretical determinants of employment

The model presented in this sub-section is both simple and generally applicable. First, it is simple because we only focus on two production factors: labour and capital, which are expressed in effective units. We thus consider a representative firm which minimises its production costs and we only consider the conditional elasticities of employment relative to these three determinants. The log-linear expression of our employment equation can be written as $n = ay + bw + ch$, where n represents occupied manpower, y production level, w real labour cost, and h the length of working time (hereafter working time), all these variables being expressed in natural logarithms. The coefficient of each variable denotes the conditional elasticities of employment to the corresponding variables. It is obvious that a labour cost increase modifies the employment level both for a given production through the substitution possibilities between factors, and also *via* the modification of the production level related to the price variation which accompanies the modification of production costs ("volume" effect). Unconditional elasticities take all these effects into account whereas conditional elasticities only correspond to the effects for a given production, i.e., without the "volume" effect. Here, we focus exclusively on conditional elasticities because they can be deduced directly from our econometric estimations. In any case, the difference at the aggregate level is likely to be low since market power is higher at a macroeconomic level and since volume effect decreases with it.

The model will nevertheless be very general insofar as production function will not be specified and will only be assumed to be homogenous by degrees θ. The nature of the scale returns, market structures, the capital-labour substitutability degree or the men to the substitutability degree of hours worked also remains unspecified.

The conditional labour demand that minimises the production costs for a given output level verifies the Shephard Lemma: $\overline{L} = C_W(W, R, Y)$, where C_W is the derivative of the cost function with regard to labour cost. By differentiating this equation and introducing the elasticities of employment to labour cost, capital and output level, we obtain an expression of the conditional labour demand where the employment rate growth only depends on the relative labour cost growth rate and on the production growth rate. The conditional elasticity of employment to labour cost can then be expressed with respect to the substitution elasticity between capital and labour $\sigma = \frac{CC_{WR}}{C_W C_R}$ and with respect to the wage share in the added value (denoted s). As for the production elasticity to employment, it is equal to the homogeneity degree of the cost function, which is opposite that of the production function, θ.

$$\frac{dL}{L} = -\sigma(1-s)\left(\frac{dW}{W} - \frac{dR}{R}\right) + \frac{1}{\theta}\frac{dY}{Y} \quad (1)$$

The conditional labour demand decreases when the relative labour cost goes up, all the more as the substitution possibilities are high, and when production decreases. This expression is very general and is in particular independent of the technology used, i.e. of the nature of the production function, or of the functions which can be deduced from it (cost or profit function).

Employment measured in effective units (L) corresponds to the product of manpower (N) by an effort function, e(h) which depends on working time. It differs from employment in hours worked (H), which is by definition equal to the product of employment expressed in manpower (N) by working time (h). Working time is then likely to affect the employment level through three relays: its impact on hourly labour productivity, its impact on equipment use length and the wage compensation degree related to working time variations. The effort elasticity to working time is denoted η_h^e, the elasticity of the length of equipment use to working time is denoted η_h^d, the impact of a length of working time variation on the hourly wage depends on the wage compensation degree, denoted γ (the wage compensation is equal to zero when $\gamma = 0$, it is complete when $\gamma = 1$). It can be shown that at optimum productivity, the labour cost elasticity to working time depends on the three above parameters related to working time introduction.

$$\eta_h^W = 1 - \gamma - \eta_h^e + \eta_h^d \quad (2)$$

The complete expression of the labour demand equation is then given by:

$$\frac{dN}{N} = -\sigma(1-s)\left(\frac{dW}{W} - \frac{dR}{R}\right) + \frac{1}{\theta}\frac{dY}{Y} - \left[\sigma(1-s)\left(1 - \gamma - \eta_h^e + \eta_h^d\right) + \eta_h^e\right]\frac{dh}{h} \quad (3)$$

Finally, by integration we obtain a log linear expression of employment in level whose elasticities have a clear theoretical meaning. This expression will be used to interpret our estimation results.

$$n = -\sigma(1-s)(w-r) + \frac{1}{\theta}y - \left[\sigma(1-s)\left(1-\gamma-\eta_h^e+\eta_h^d\right)+\eta_h^e\right]h + cste \qquad (4)$$

Occupied manpower decreases when relative labour cost goes up, all the more as substitution possibilities are high, and rise with activity (when scale returns are constant this employment equation becomes a productivity equation). The impact of working time is less straightforward a topic. A working time decrease leads to a reduction of hours worked if it increases labour cost (η_h^W negative) and this will be the case if it is compensated for by an increase of hourly wages (γ close to one), if it comes along with reorganisations in production processes (η_h^d close to zero) and if it has a limited impact on hourly productivity (η_h^e close to one). The working time reduction will then have a negative impact on employment when it is measured in effective units or in hours worked, but it will nevertheless always be favourable to employment measured in occupied manpower (if and only if $\eta_h^e > \eta_h^L$).

The effort elasticity to working time, η_h^e, which measures the substitutability degree of people to hours, or the impact of a length of working time reduction on hourly productivity, is therefore a crucial parameter. Two opposite effects are at work. When the effort elasticity in working time is high, a working time reduction has a limited upward impact on hourly productivity, or even decreases hourly productivity if this elasticity is higher than unity (the «warm-up effect» is in this case stronger than the «tiredness effect»). This hourly productivity decrease is favourable to employment in a strict logic of people to hours worked substitution, but it is unfavourable to employment because it renders hourly labour cost more expensive and decreases hours worked. This negative effect depends on the substitution possibilities between factors, which is not the case for the former. All in all, if substitution possibilities are not too great, ($\sigma < \frac{1}{1-s}$), the positive effect is higher than the negative one: a high effort elasticity to working time thus strengthens the positive effects of a length of working time reduction on occupied manpower.

2.2 Unrestricted multivariate econometric estimations of employment equations

The use of multivariate estimations provides a way to describe the interdependencies between employment, added value, working time and labour cost without making any *a priori* assumption on the value of the elasticities linking those variables and to test the existence of long-run relationships. This sub-section proposes a non-constrained error-correction (VAR-ECM) model for these four variables and for each sector under study[3]. The estimation sample covers the 1970-1 to 1996-4 period.

One specific problem is related to the measure of capital cost. In the empirical studies surveyed by Hamermesh (1993), the effort made by the empirical researcher to measure other price factors than labour, particularly that of capital is not much rewarded by a noticeable modification of the results obtained. On macroeconomic data, Dormont (1997) estimated a model where labour and capital cost were separated but found that capital cost was systematically non-significant. These results lead us to retain a specification where capital cost is not included in the relative factor costs and where only labour cost is considered.

The econometric methodology implemented here (cf. appendix 3 for further details) provides the following estimations of the long-run relationship among our four variables, for each of the three sectors under consideration:

$n_t = 0.764\ y_t\ - 0.023\ h_t - 0{,}256\ (w\text{-}p)_t$ (Non-agricultural private sectors NAMS)

$n_t = 1.172\ y_t\ - 0.762\ h_t - 0.304\ (w\text{-}p)_t - 0.006\ \text{trend}$ (Industrial sectors, IS)

$n_t = 0.555\ y_t - 0.254\ h_t - 0.212\ (w\text{-}p)_t + 4.068$ (Non-industrial sectors, NIS)

[3] It is important to bear in mind that the structural model being tested is of course the same for each of the three sectors and is given by an equation (1). However empirically, we have to specify and to estimate three distinct error-correction specifications, one for each sector, which leads us at times to speak of three VAR-ECM models.

In these three estimations the set of coefficients has a sign in accordance with the predictions of the theoretical model. Real labour cost (w-p) and working time appear with a negative sign. In the long term, and when the independences between variables are taken into account, the reduction of real labour cost and the reduction of working time thus go hand in hand with an employment increase in non-agricultural private sectors as well as in industrial and non-industrial ones. The differences between these two sets of sectors are, however, strong.

A structural interpretation of these results can be obtained from the theoretical model. An identification of the various parameters resulting from it is given in table 1. First of all, the scale returns (parameter θ) would be shown as slightly increasing in the non-agricultural private sectors, slightly decreasing in the industrial ones and increasing in the non-industrial ones, where productivity is lower and growth content richer in employment. Then, capital and labour would be less substitutable for the set of sectors, and hence employment would be little sensitive to its cost at the aggregate level. We again find a traditional result of French macro-econometric models, carefully commented on by Dormont (1997). However, as she suggested, the possibilities of substitution would be more important at a disaggregated level. The elasticities of substitutions are indeed higher in the non-industrial sectors and still higher in the industrial ones where the possibilities of substitution are close to those of a Cobb-Douglas production function[4]. The elasticity of employment to labour cost would be close to 0.2 in the non-industrial sectors and 0.3 in industrial ones, which corresponds to the central value given by Hamermesh (1993) in his survey of applied studies carried out in other countries than France.

[4] Higher substitution possibilities at the disaggregated level than at the aggregate one suggest some phenomena of draining of employment between sectors when labour cost modifications happen, phenomena which are not captured by the aggregate elasticities. These phenomena also explain distances between aggregate and disintegrated levels for the other parameters.

Table 1 – **Interpretation and identification of structural parameters**

	Scale returns (θ)	capital to labour substitution elasticity (σ)	Elasticity of employment to its cost ($\overline{\eta}^{L}_{W}$)	Elasticity of manpower to working time (η^{N}_{h})
NAMS	1.31	0.85	-0.26	-0.28
IS	0.85	1.01	-0.3	-1.07
NIS	1.80	0.71	-0.21	-0.47

Note: for all sectors, the share of wages in the added value is supposed to be equal to 70 %. (= 0.7). In the estimations of the three co-integrating relationships labour cost is a per capita one and not an hourly one, which modifies the elasticity of manpower to working time.

The effect of working time reduction on occupied manpower is always positive but this is clearer at the disaggregated level than at the aggregate one. In non-industrial sectors, a working time reduction of 10 % induces a rise of occupied manpower close to 5 % (and hence a decrease of hours worked by 5 %). We obtain a little less than "the rule of three" in these sectors. The impact is the most significant in industrial sectors where a reduction in working time has no effect on the hours worked, or slightly increases them, and strongly increases occupied manpower (we are then close to "the rule of three") [5].

This result for industrial sectors is all the more remarkable as employment seems to be more sensitive to labour cost than in non-industrial ones, which is not a favourable condition for employment. To interpret this more significant effect of working time in industrial sectors, it is important to decompose what is connected to the effort elasticity to working time on the one hand, and what comes from the other parameters, on the other. Our estimation strategy does not allow us to identify each of the theoretical parameters but we can always calculate the value of one of them conditionally on the value assumed for the others. We proceed thus in table 2 where we consider two extreme assumptions for the wage compensation degree and the equipment uses length elasticity to labour, in order to deduce the value of the effort elasticity to working time

[5] Let us recall that here we only measure the long-run effects of working time reduction as it occurred in France from the beginning of 1976 to the end of 1996: this is not a forward-looking report which would be valid for a collective length of working time reduction as the one implemented in France since the 1998 law on the switch to a 35- hour workweek whose modalities are historically original.

Table 2 – **Conditional identification of the effort elasticity to the length of working time (η_h^e)**

	Minimal value ($\eta_h^d - \gamma = 1$)	Central value ($\eta_h^d - \gamma = 0$)	Maximal value ($\eta_h^d - \gamma = -1$)
NAMS	-0.31	0.03	0.37
IS	0.66	1.09	1.53
NIS	0.054	0.32	0.59

It would appear theoretically impossible to interpret the differences of behaviours among the sets of sectors without making differences in the effort elasticity to working time, which play an important role. Differences between sectors concerning the wage compensation degree and the reorganization dimension would thus play a secondary role in the explanation of the effects of working time on employment. The effort elasticity to working time would be the lowest at the aggregate level, where a working time reduction would entail a high increase in hourly productivity of labour. It would have an intermediate value in non-industrial sectors and would be all the higher in industrial ones. In these sectors, people and hours worked are more substitutable than elsewhere. A working time reduction is even likely to have no effect on hourly productivity and it consequently decreases labour measured in effective unity. If industrial sectors are those where working time reduction produces the most favourable effects on occupied manpower, it is because it raises the hourly productivity of labour less than in other sectors, which is favourable to employment through a sharing effect.

3. A retrospective explanation

We thus obtain a better representation of the employment determinants when we take growth, working time and labour cost into account at the same time. It is theoretically less restrictive than the conventional approach and in accordance with the statistical properties of data. What are the lessons to be learned by this representation?

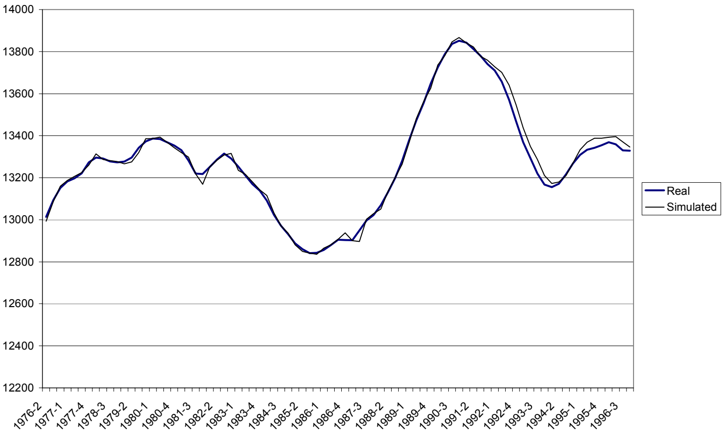
3.1 No break in the 1990s

First of all, the model does not exhibit any significant break in the 1990s. The Chow tests, which measure the parameter stability through time, confirm it (cf. appendix 2). Graph 1 illustrates this stability model and represents the dynamic simulation results from 1985 carried out with the model re-estimated over the 1976-1 to 1992-4 period. In the studies on the enrichment growth content in employment, this type of simulation exhibits an important downturn in employment beyond the estimation period. It is this downturn which has been at the heart of the issue of the enrichment growth content in employment. Here things are different since the simulated series remains very close to the ones observed in the three sets of sectors (including services). Specifically, no permanent excess of the simulated employment appears with respect to effective employment. The fact of having begun dynamic simulations in 1985 should all the same favour such downturns.

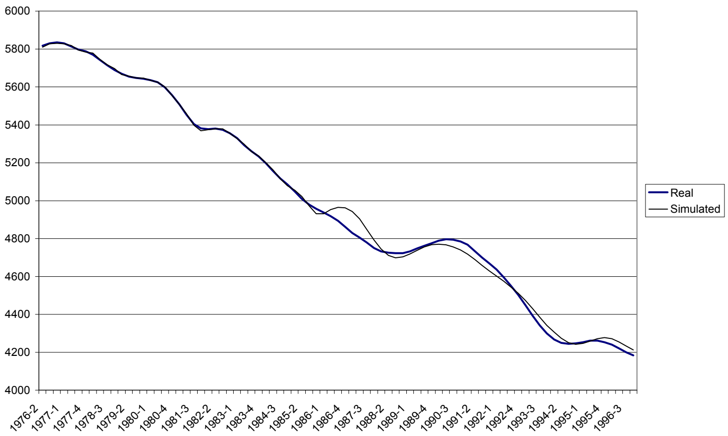
In addition, effective employment is lower than simulated employment, contrary to what the notion of employment growth enrichment suggests. The gap reached 160,000 jobs in 1993 but was quickly reduced before increasing again at the end of the period when it reached 62,000 jobs. In industrial sectors effective employment was also lower than simulated employment, with a gap that gradually increased to reach over 100,000 jobs at the end of 1996. It was only in industrial sectors where the evolution corresponded to the theme of the enrichment growth content in employment: the gain was about 115,000 jobs in 1995 and it was lower after that (it was 62,000 jobs at the end of the period). Once again we found a result similar to that obtained by other studies, which highlighted the aspect of sector on services in the enrichment growth content in employment (Lerais, 2001), even if the gaps here remain modest.

Graph 1. Simulation of employment

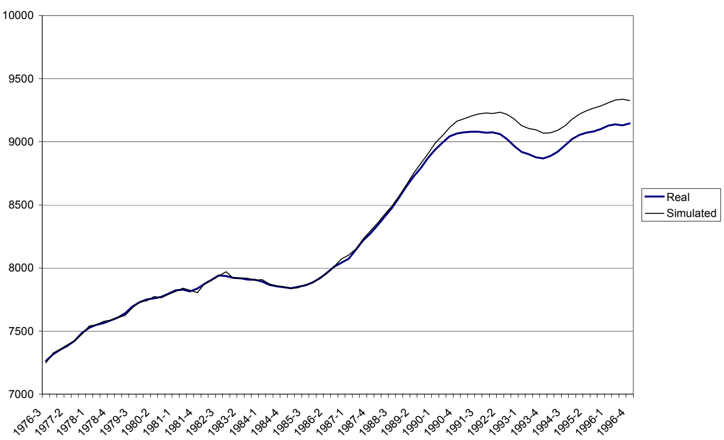
1-a. All sectors



1-b. Industrial sectors



1-c. Non-industrial sectors



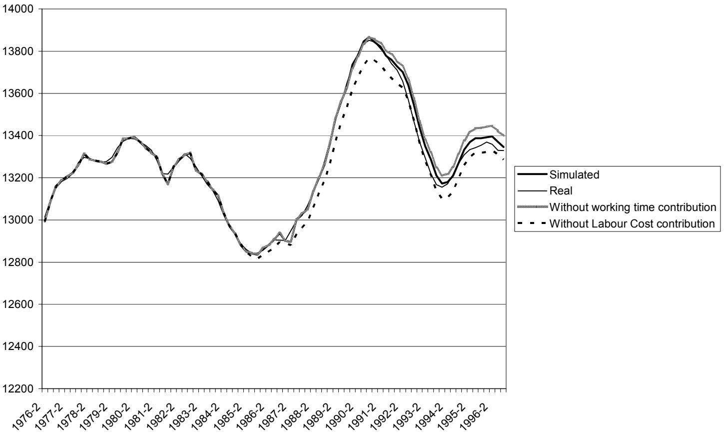
3.2 The retrospective contributions of growth, working time and labour cost

If there are no breaks in employment behaviour, we can use our model to estimate the retrospective contribution of working time, or labour cost. To this end, we used all the sets of data (estimation period: 76-1, 96-4) in order to estimate a complete model for each sector. They include a long-run target as well as the short-run dynamics in which the non-significant terms have been deleted. A first dynamic simulation was carried out from 1985 with the actual values of growth, working time and labour cost. To estimate the working time contribution, we implemented a second dynamic simulation supposing that working time remained fixed to its value of the first quarter of 1981. To estimate the labour cost contribution, we carried out a third simulation supposing that real cost progressed after 1985 at the same rhythm as previously. Over the 1975 to 1985 decade this progress was 2.5 %, 2.7 % and 2.4 % every year for private, industrial, and non-industrial sectors respectively, whereas it was of 1 %, 1.2 % and 1.05 % afterwards. Then, the simulated employment corresponds to that which we would have obtained in the absence of such labour cost moderation. The results of these three simulations for three sectors are reported on graph 2.

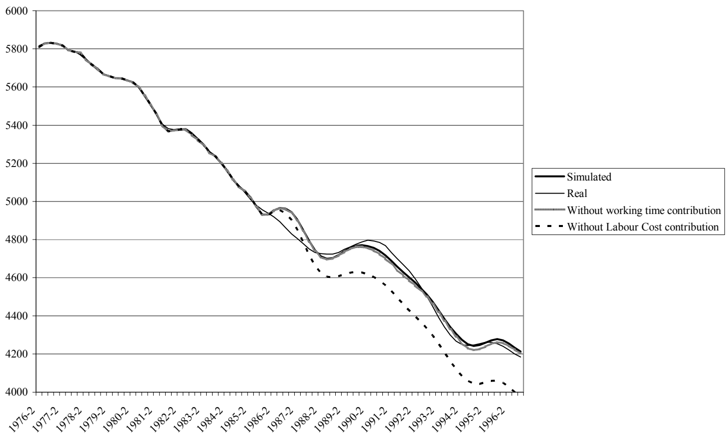
These simulations show a positive contribution of the working time reduction and of the labour cost moderation in the three sets of sectors. The models being estimated separately, the sum of the contributions for the industrial and non-industrial sectors should not be identical to that calculated for the total set of sectors. In fact, however, the impact obtained for private sectors is lower than the cumulated impacts for industrial and non-industrial ones. The differences of behaviour between sectors highlighted in section 2 do not lead us to retain the aggregate estimation and to focus on the disaggregated estimations. Therefore, in the portion that follows, our focus will be the disaggregated results.

Graph 2. Retrospective contributions

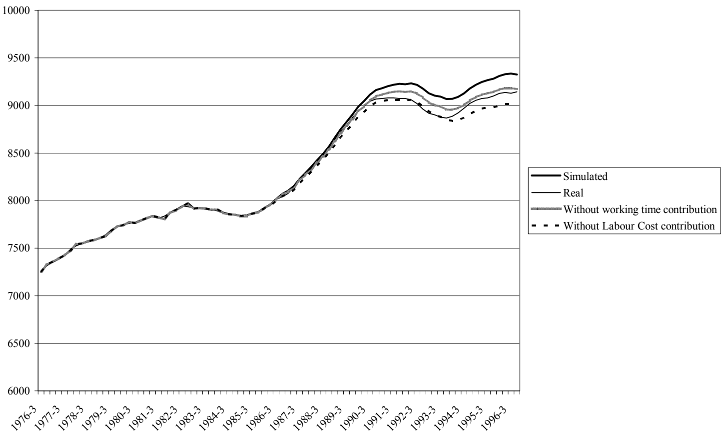
2-a. All sectors



2-b. Industrial sectors



2-c. Non-industrial sectors



In all simulations, it is the impact of labour cost moderation that is the most noticeable, since the mid-eighties. This moderation would have led to the creation of 240,000 jobs in industrial sectors and 330,000 in non-industrial sectors, which corresponds to increases of 5.6 % and 3.6 % in employment in those two sets of sectors respectively. These findings concur with the elasticities reported in section 2, given the labour cost moderation dimension in the two sets of sectors. They indicate a tighter link between employment and labour cost in industrial sectors (areas which are also the most exposed to international competition).

Furthermore, these job creations are more massive at the end of the period: of the 330,000 jobs gained in non-industrial sectors since 1985, 125,000 occurred between the second quarter of 1993 and the end of 1996, after reductions in social welfare taxes were implemented in France. This is the case for 60,000 of 240,000 jobs in industrial sectors. Even though the method used here cannot allow us to precisely correlate this increase in jobs created to a lessening in social welfare taxes, our results suggest that these measures were of considerable impact.

With the working time reduction to 35 hours per week, 155,000 jobs were gained in non-industrial sectors. Nearly half of these new jobs were created after 1992, i.e., after the part-time job development expansion, which followed the implementation of national welfare tax reductions. In industrial sectors, we count in excess of 10,000 jobs. These figures represent 1.7 % and 0.2 % of the simulated employment in the two sets of sectors respectively. The working time effect thus seems overall more modest than that of labour cost. Let us stress, however, that if working time was supposedly unchanged at its level at the beginning of 1981, where it was still legally at 40 hours, simulations only began after 1985. Consequently, we have only measured the effects of working time reduction since 1985, a period during which it was very low in the two sets of sectors.

Activity growth accounts for the set of other employment inflections. From the beginning of 1985 to the end of 1996, growth would thus explain 1,005,000 jobs created in non-industrial sectors and 1,090,000 jobs lost in industrial ones. For the set of non-agricultural private sectors, the net effect is a loss of 85,000 jobs.

CONCLUSIONS

The aim of this study has been to consider macroeconomic employment determinants through an analysis of trends in France since the mid-1970s, using multivariate estimations of employment equations on quarterly macroeconomic data. These estimations have been implemented in non-agricultural private sectors as well as apportioned in industrial and non-industrial sectors respectively, in order to allow for eventuality of behaviour specific to a given sector. The main conclusions emerging from this research follow.

Employment does not only depend on growth rhythm. The difference between growth and employment progression and per capita productivity gains is not stationary through time. The same holds true for hourly productivity. The conventional models, which suppose a regular progression of productivity in time, are thus not compatible with the statistical properties of data. They are also theoretically restrictive. The observation of employment growth enrichment obtained with such modelling, which would have appeared in France since 1992-1993, can therefore be questioned.

Employment also depends on working time and labour cost in industrial sectors as well as in non-industrial ones. The working time reduction increases hourly labour productivity, men and hours being imperfect substitutes. Taking working time into account in employment determinants is both the necessary and sufficient condition to get a stationary relationship.

When the set of interdependencies between employment, activity, working time and labour cost are taken into account in a multivariate framework, we obtain a relationship where employment rises with growth and decreases when labour cost or working time rises, both in industrial and non-industrial sectors. This relationship is effectively an employment equation since the three other variables are weakly exogenous. It does not show any particular instability in the 1980s whatever the sector under consideration. Therefore, there is not any particular excess of new jobs created over this period with respect to this growth trend when both the inflexions of working time and those of labour costs are taken into account.

More precisely, the actual manpower in private sectors is lower than in simulated employment, contrary to what the notion of enrichment growth content suggests in employment. This is also the case in industrial sectors. Only in non-industrial sectors, is the trend in keeping with the theme of the enrichment growth content in employment, hence confirming the very sectorial aspect of this enrichment.

Dynamic simulations allow us to determine the contributions of these three factors respectively. In industrial sectors, these simulations explain how the 840,000 jobs lost from the beginning of 1985 to the end of 1996 are divided. This weakness in activity would have led to the loss of 1,090,000 jobs, but it was partially compensated for by a labour cost moderation (+ 240,000 jobs) and in a more marginal way, by the weak decrease of working time reduction (+10,000 jobs). In non-industrial sectors, where simulations have led to 1,490,000 new jobs since 1985, growth is responsible for 1,005,000 jobs, labour cost moderation for 330,000 and working time reduction for 155,000.

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Appendix 1
Database

The notation is the following: upper-case letters denote variables in level and lower-case letters indicate the natural logarithm of the corresponding variable, q : added value, l : salaried employment (in manpower), h : the working time, (w-p) : real labour cost.

Every series used for non-agricultural private sectors (SMNA), industrial sectors (SINA) and non-industrial sectors (SNI) are directly extracted from quarterly accounts except for the series of labour cost that has been the subject of a specific construction. The estimation sample covers the 1976-1 to 1993-4 period and corresponds to INSEE final statistics.

The labour cost series used in our study has been constructed for each of the three sectors with some approximations. We detail here the calculation for non-agricultural private sectors: the overall labour cost (for all salaried employees) is gross wage (R11_V007) to which one must add employers' tax contribution and subtract payment subsidies (R3122_SR7). Here payment subsidies have been replaced by development subsidies (R30_SR7). Furthermore, social welfare taxes are calculated by applying company and quasi-company tax rates to the SMNA gross wage. Real labour cost is then calculated by deflating this total cost (by added value price PN1_V007/PN1_V008) and dividing it by salaried employees in non-agricultural private sectors.

The working time series used is neither the one of quarterly accounts extracted from ACEMO which does not take part-time job development into account, nor the synthetic indicator calculated by the French Labour Ministry, which explicitly takes part-time job development into account but was being re-evaluated when this study was being written. We have instead used the series of effective working time of national accounts that we have quarterised. It actually has very little impact on the estimations, the series being very close to those of the French Labour Ministry and also close to each of the three sectors shown here. The use of the French Labour Ministry indicator or that of the annual accounts does not modify the sign and the coefficient value of regressions (the main differences being captured by the constant coefficient).

Appendix 2

Univariate estimations of productivity targets

TABLE 1 - **Estimation and test of the existence of a long-run relationship on the 76.1 - 96.4 period**[6]

Series in logarithm	Stationary Residual at 5 %	Estimated long-run relationship
Non-agricultural private sectors	no[7]	$y_t - (n + h)_t = 0.415\ (w-p)_t - 3.790 + 0.004\ t + u_t$ (3.97)[8] (-12.22) (13.52) Standard Error = 0.02178 $R^2 = 0.9792$ $\overline{R}^2 = 0.9787$
	no	$y_t - (n + h)_t = -2.557 + 0.006\ t + u_t$ (-457.91) (56.75) Standard Error = 0.02366 $R^2 = 0.9751$ $\overline{R}^2 = 0.9748$
Industrial sectors	no	$y_t - (n + h)_t = 0.335\ (w-p)_t - 3.707 + 0.006\ t + u_t$ (3.050) (-11.30) (15.55) Standard Error = 0.02196 $R^2 = 0.9874$ $\overline{R}^2 = 0.9871$
	no	$y_t - (n + h)_t = -2.704 + 0.007\ t + u_t$ (-497.03) (75.96) Standard Error = 0.02305 $R^2 = 0.9859$ $\overline{R}^2 = 0.9858$
Non-industrial sectors	no	$y_t - (n + h)_t = 0.355\ (w-p)_t - 3.507 + 0.003\ t + u_t$ (3.07) (-10.29) (10.01) Standard Error = 0.02460 $R^2 = 0.9587$ $\overline{R}^2 = 0.9576$
	no	$y_t - (n + h)_t = -2.459 + 0.004\ t + u_t$ (-403.87) (41.18) Standard Error = 0.02583 $R^2 = 0.9538$ $\overline{R}^2 = 0.9533$

N.B. Each series is extracted from quarterly accounts. Employment is in salaried employment (in manpower).

[6] When the (w-p) is not included in the equation, it actually boils down to testing the stationarity of hourly productivity around a linear trend.

[7] « no » means the absence of a co-integrating relationship.

[8] The figure in brackets denotes T Stats.

TABLE 2 - **Estimation and test of the existence of a long-run relationship on the 76.1 - 96.4 period**[9]

Series in logarithm	Stationary Residual at 5 %	Estimated long-run relation
Non-agricultural private sectors	no[10]	$y_t - n_t = -0.082\ (w-p)_t + 3.754 + 0.005\ t + u_t$ (-1.59)[11] (24.44) (30.06) Standard Error = 0.01078 $R^2 = 0.9921$ $\bar{R}^2 = 0.9920$
	no	$y_t - n_t = 3.509 + 0.004\ t + u_t$ (1365.68) (100.53) Standard Error = 0.01088 $R^2 = 0.9919$ $\bar{R}^2 = 0.9918$
Industrial sectors	no	$y_t - n_t = -0.077\ (w-p)_t + 3.587 + 0.007\ t + u_t$ (-0.81) (12.61) (19.57) Standard Error = 0.01904 $R^2 = 0.877$ $\bar{R}^2 = 0.9874$
	no	$y_t - n_t = 3.355 + 0.007\ t + u_t$ (748.20) (81.00) Standard Error = 0.01900 $R^2 = 0.9876$ $\bar{R}^2 = 0.9875$
Non-industrial sectors	no	$y_t - n_t = -0.182\ (w-p)_t + 4.149 + 0.004\ t + u_t$ (-3.24) (25.02) (22.95) Standard Error = 0.01197 $R^2 = 0.919$ $\bar{R}^2 = 0.9815$
	no	$y_t - n_t = 3.610 + 0.003\ t + u_t$ (1209.50) (62.80) Standard Error = 0.01264 $R^2 = 0.9796$ $\bar{R}^2 = 0.9793$

[9] When the (w-p) is not included in the equation, it actually boils down to testing the stationarity of hourly productivity around a linear trend.

[10] « no » means the absence of a co-integrating relationship.

[11] The figure in brackets denotes T Stats.

Appendix 3
The econometric methodology

Estimation results

The choice of the lag length used in the specification of the unrestricted VAR-ECM model can significantly influence the estimation results (see Boswijk and Franses, 1992). Hence, it is crucial that it be determined in both economic and statistical considerations (see Gonzalo, 1994). We have used three criteria: (i) the Schwarz Bayesian information criterion, the Hannan-Quinn criterion and global Fisher tests, (ii) the absence of autocorrelation and heteroscedasticity in the residuals of the model equations, (iii) the coherence of the estimated parameters with the theoretical expectations. Finally, the model adopted has a lag of four quarters for non-agricultural private sectors (NAMS) and industrial sectors (IS) and of five quarters for non-industrial ones (NIS).

The next stage is to test for the number of co-integrating relationships that exist between the four variables for each sector. In the first step, the tests were carried out in a system with an unrestricted constant, as well as a linear drift constrained to lie in the co-integrating space[12]. Then, the co-integrating rank and status of these deterministic components were tested simultaneously. The two LR test statistics (trace test and Lambda max test) were used to test for co-integration and the critical values were taken from de Osterwald-Lenum (1992). Both the trace test and Lambda max support the choice of r = 1 co-integrating vector for NAMS, IS, and NIS[13] and are thus consistent with the theoretical representation (4) given in Section 3. Table 1 states the maximum likelihood estimations of the co-integrating vectors for each sector.

Table 1 - **Maximum likelihood estimations of normalised co-integrating vectors**

Variables	Normalised co-integrating vectors		
	NAMS	***IS***	***NIS***
n	1.000	1.000	1.000
y	-0.764	-1.172	-0.555
h	0.023	0.762	0.254
(w-p)	0.256	0.304	0.212
constant	-	-	-4.068
trend	-	0.006	-

Tests of robustness

Before interpreting these estimation results, it is useful to make the following comments on their robustness. Systematic Likelihood Ratio tests on the deterministic components were implemented. These tests led us to accept a specification of the VAR-ECM with no deterministic component for the NAMS, a linear deterministic trend constrained to lie in the co-integrating relationship for the IS sectors, and with a constant in the long-run for the NIS sector. Furthermore, the norm adopted was sufficient in both cases to identify the parameters of the co-integrating relationship. Moreover, several test statistics were calculated in order to verify the quality of the multivariate estimation (Lagrange Multiplicator test for serial correlation of order 5; White heteroskedasticity test, 1980;

[12]Let us recall that if the linear deterministic trend is not constrained to lie in the co-integrating space, the presence of a non-zero deterministic trend outside the long-run relations indicates the presence of a quadratic trend in every component of the system taken in level, since the system is written in first differences, which is not economically satisfactory.

[13] The results of these conventional cointegration tests are not reported here to save space but are available upon request.

ARCH tests, Autoregressive Conditional Heteroscedasticity; Jarque-Bera normality test). These tests indicate that the VAR-ECM representation is congruent with the data since the usual hypotheses concerning residuals were checked for the four equations of the three estimated VAR-ECM.

Three kinds of additional tests were also implemented:

- Firstly, there were tests of the individual variables and their role in the system. The test of long-run exclusion investigates whether any of the variables can be excluded from the co-integration space, implying no long-run relationship with the remaining variables. It can be formulated as a zero row in β , i.e.: $H^i_\beta : \beta_i = 0$ where H^i_β is the hypothesis that the variable x_i, i = 1, ..., 4, does not enter the co-integration space.
- Secondly, the test of long-run weak exogeneity investigates the absence of long-run levels feed-back and is formulated as a zero row of α, i.e. $H^i_\alpha : \alpha_i = 0$, where H^i_α is the hypothesis that the variable x_i, i = 1, ..., 4, does not adjust to the equilibrium errors $\beta' x_t$. If accepted, the variable in question can be considered a driving variable in the system: it 'pushes' the system, but is not being 'pushed' by it[14]. These tests verify if the structural hypothesis imposed *a-priori* by applied researchers in univariate employment equations, i.e. the exogeneity of the variables appearing in the right members checks out empirically[15].
- Finally, the test of stationarity investigates whether any of the variables can be assumed stationary by themselves by testing whether the variable in question corresponds to a unit vector in the co-integration space. Accepting the hypothesis implies that the variable in question can be considered I(0).

These tests, carried out at a 5% level of significance, are not reported here because of limited space[16], but can easily be summarized as follows since clear patterns emerge from them.
It appears that for each sector no variable can be excluded from the co-integration space, that the variables (output, labour cost and working time) can be assumed individually weakly exogenous. The test of all three being jointly weakly exogenous was accepted for each sector, implying that one can pursue a valid inference without any loss of information from the employment equation alone on the 76.1-96.4 period without explicitly modelling the three equations describing the evolution of output, working time and labour cost. Finally, for each sector none of the variables can be considered stationary over the sample period.

Structural hypotheses have also been tested, as the equality of manpower coefficients to 1 and the joint hypothesis of manpower and working time coefficients to 1, but they have all been rejected whatever the sector considered.

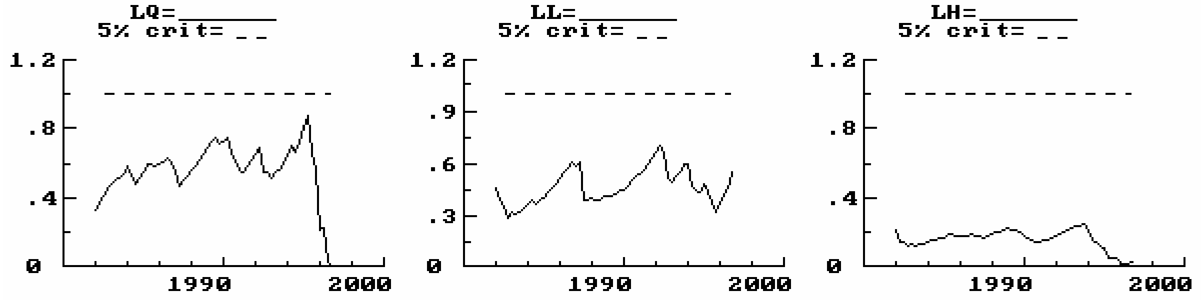
Finally the system has been re-estimated by recursive least squares until 1996-4. This estimation method is commonly used in empirical studies since it enables the evolution of the estimated vector of coefficients to be followed when we add a new piece of information at each step in this estimation. Moreover, it also offers the possibility of building graphs and carrying out tests in order to appreciate the parameter stability through time and to perform Chow tests so as to detect a possible break. The graphs reported in appendix 4 were constructed by successively re-estimating the model, but each time for a longer period (the first estimation was done for the 76.1 - 83.2 period). The graph examination does not reveal any particular break in the three sectors, so that the parameters of these three multivariate models seems to be steady through time, as confirmed by the overall stability graphs.
Thus, the misspecification and constancy tests indicate the three estimated VAR-ECM models to be a satisfactory representation of the data.

[14] See Rault (2000) and Pradel and Rault (2003) for a discussion on weak-exogeneity and non-causality.
[15] This assumption has actually no specific reason to hold empirically.
[16] They are available upon request.

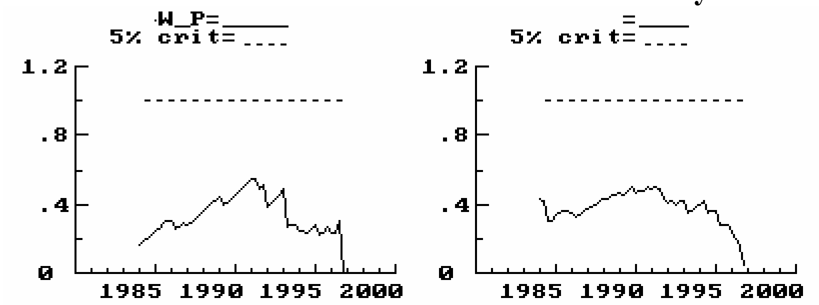
Appendix 4

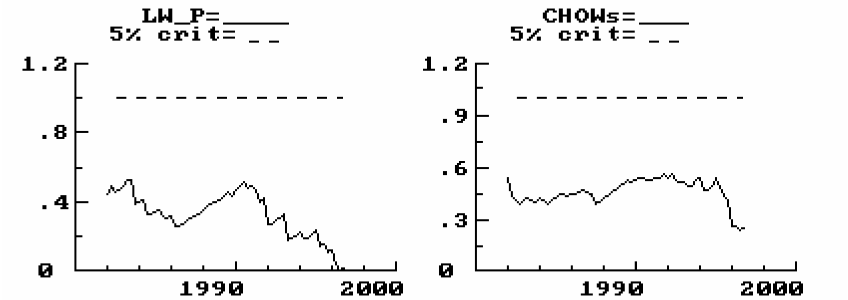
Chow tests to evaluate coefficient stability in the multivariate estimation

- Non agricultural private sectors

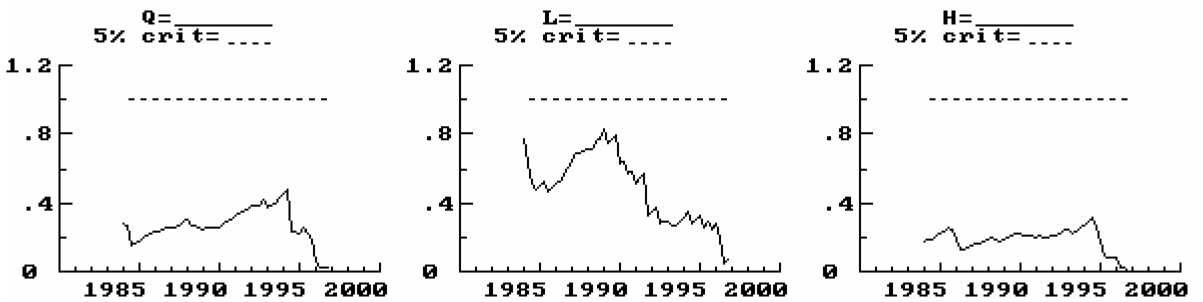


Overall Stability

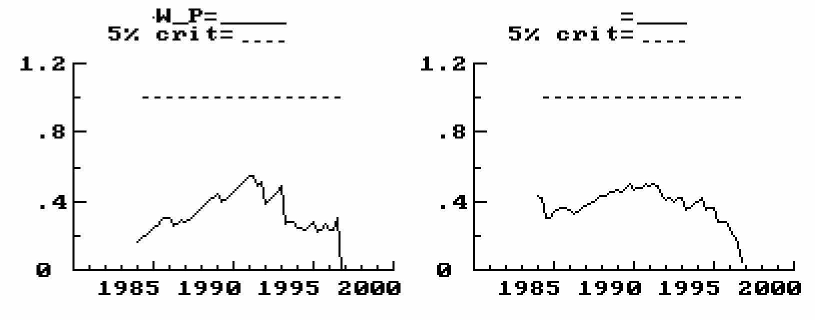




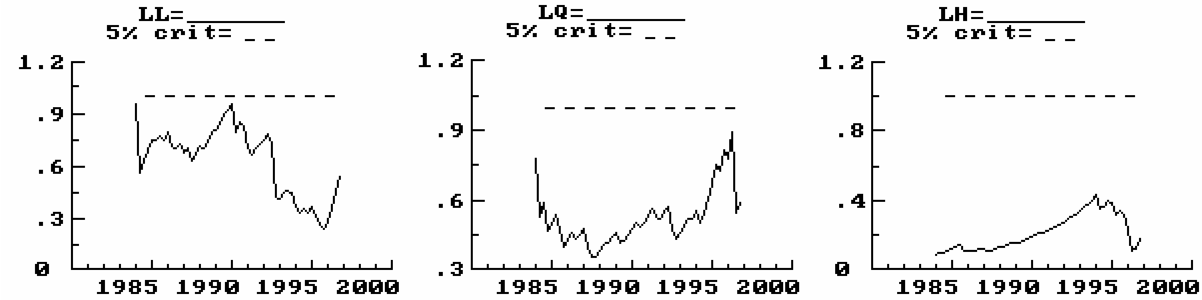
- Industrial sectors



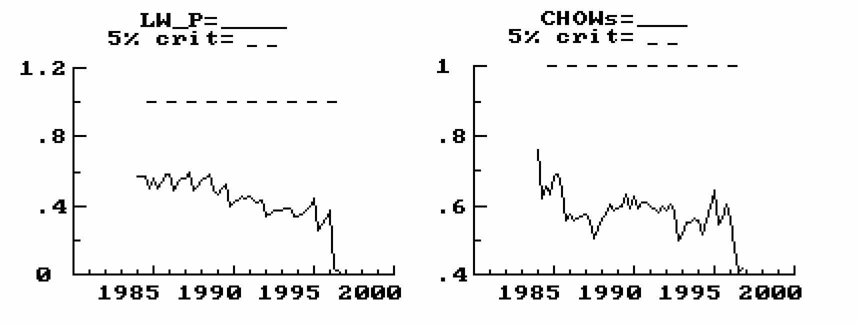
Overall Stability



- Non-industrial sectors



Overall Stability



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