Does the Business Cycle matter for France?
A Business Cycle Accounting Approach

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Abstract

This paper applies the business cycle accounting procedure to French 1978-2007 data. The main source of business cycle fluctuations in France is shocks to TFP, not changes in the labor wedge. More importantly, the French business cycle is shown to be the mere residual of two counterbalancing effects: a structurally worsening labor wedge and a structurally improving efficiency wedge that (almost) cancel each other out. The 30-year drop in per-capita hours worked is mainly explained by a worsening labor wedge, not by TFP and only marginally by the investment wedge. For future theoretical work concentrating on France, modeling these long-run phenomena is of more importance and promise that modeling the structural sources of fluctuations. A model consistent with these results based on increasing union power and increasing competition on the goods market is introduced.

Cet article applique la méthodologie de la “comptabilité des cycles” aux données françaises de 1978 à 2007. La source principale des fluctuations économiques en France sont les chocs de productivité, et non les variations du “coin fiscal”. Plus important, on montre également que ces fluctuations sont la résultante de deux effets contraires: une aggravation structurelle du coin fiscal et une amélioration structurelle de la productivité. La baisse de trente ans du nombre d’heures travaillées par habitant est due essentiellement au coin fiscal. La PTF n’en est pas la cause, au contraire, et la baisse des investissements seulement de façon marginale. Identifier les causes de ces effets à long terme est donc une voie de recherche plus prometteuse qu’identifier les sources des fluctuations elles-même. Un modèle théorique, construit sur un plus grand pouvoir de négociation des syndicats et une plus grande compétition sur le marché des biens, est proposé.

Keywords: Business cycle accounting, France, Eurosclerosis.

JEL Classification Numbers: E2, E32.
1 Introduction

This paper applies the business cycle accounting procedure to French 1978-2007 data. Business cycle accounting, developed\textsuperscript{1} by Chari \textit{et al.} (2006, 2007), is an econometric framework used to identify the sources of business fluctuations, i.e., the main shocks and frictions that drive GDP away from trend. This procedure, by comparing actual data to the solution of a prototypical real business cycle model, identifies the kind of reduced-form frictions ("wedges") that detailed models need to generate in order to explain the fluctuations.

This procedure has been applied to a number of countries\textsuperscript{2} but not (to the best of my knowledge) yet to modern-day France\textsuperscript{3}. In terms of data sources and the period and type of economy covered, the paper that compares best to the present article is Kersting (2008), who applies the business cycle accounting procedure to the 1979-1989 period in the UK to show that it was the improvement of the "labor wedge", i.e., the decrease of the distortion of the labor-leisure decision, that drove the recovery from the early 1980's recession in the UK. This leads the author to confirm that the "Thatcher reforms", namely a loosening of labor market constraints, can indeed be found to have been instrumental in the improvement of the UK economy.

This raises the natural question to wonder what an application of the same procedure to French data would tell us, given that France had a left-wing government throughout most of the 1980’s and 1990’s and its labor market regulations have undergone quite the opposite of Thatcherite reforms. In this paper I show that, contrary to the UK and the US (Chari \textit{et al.}, 2007), the only main source of variations in France is the efficiency wedge, in other words technology shocks. Distortions to the labor-leisure decision play no significant role in the French business cycle pattern.

More importantly, the procedure uncovers long-run shifts in the distortions that affect the French economy. This allows for a novel use of the business cycle accounting procedure, which so far has only been used to interpret fluctuations in wedges, not long-run shifts. I draw two conclusions from this exercise. (1) The drop in per-capita hours is best explained by a long-run increase in the wedge between the marginal product of labor and the marginal utility of leisure, i.e., the labor wedge. Distortions in the investment decision play a minor role, and TFP growth plays a counteracting role. If it had not been for TFP growth, the drop in hours worked would have been even larger. (2) TFP has grown faster than output, which has been "pushed down" by the drop in hours worked.

\textsuperscript{1}One should also mention Mulligan (2002) and Prescott (2002) as precursors.
\textsuperscript{2}A few examples, in addition to the papers cited in the main text, would be Chile (Simonovska and Soderling, 2008), Ireland (Ahearne \textit{et al.}, 2005), Japan (Kobayashi and Inaba, 2006), Mexico (Meza, 2008) and Portugal (Cavalcanti, 2007).
\textsuperscript{3}Bridji (2013) conducts the same exercise for the French great recession in the 1930’s.
Thus the business cycle might not be the main issue French policymakers would want to worry about. Of more importance are the aforementioned counterbalancing effects: a structurally worsening labor wedge and a structurally improving efficiency wedge (i.e., TFP) that roughly cancel each other out. The business cycle accounting procedure, developed to guide economic modeling towards more promising models, clearly indicates that models aiming at modeling the French economy need to link these two effects. I suggest a model containing worker bargaining power and imperfect competition on the product market that is consistent with the data. In the conclusion, I surmise that models that link a high minimum wage and a rigid labor market to the gradual elimination of low productivity labor are also a promising area of research.

The paper is organized as follows. The next section lays out the main facts of the French business cycle pattern. I perform the business cycle accounting procedure for France and analyze the effects of each distortion in sections 3 and 4. In section 5, I introduce a model of union bargaining power and imperfect competition on the goods market and show that it “reduces” (i.e., is equivalent) to a prototypical real business cycle model with labor and efficiency wedges similar to the ones computed for France. Section 6 concludes.

2 French business cycle facts

Figure 1 shows linearly detrended aggregate per-capita data for France, and Tables 1 and 2 summarize the main second moment facts of the French business cycle and its components.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\sigma(X)/\sigma(Y)$</th>
<th>Cross-correlation $X(t)$ and $Y(t-k)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>5.44</td>
<td>$-0.32$ $-0.39$ $-0.42$ $-0.49$</td>
</tr>
<tr>
<td>Hours</td>
<td>1.97</td>
<td>$0.32$ $0.39$ $0.42$ $0.49$</td>
</tr>
<tr>
<td>Gov. Cons.</td>
<td>3.04</td>
<td>$0.68$ $0.79$ $0.85$ $0.82$</td>
</tr>
</tbody>
</table>

Note: $Y$ denotes output. Statistics based on logged and HP-filtered series.


Compared to the UK and the US, the stylized fact that recessions are both shallower and longer in France is confirmed — for instance, the output drop for the early 1980’s recession for the UK was 10% (Kersting, 2008). As shown by Table 1 and the previous graph, government consumption is counter-cyclical, three times more variable than output and shows no structural decline. Investment is very pro-cyclical and variable, and shows a structural decline the first 15 years followed by an rise the next 15 years. By far the most
interested data series is hours worked per capita: it shows no more cyclical variations
than output, and is in steady decline since the 1970’s: the drop is close to 20%. This is
in contrast to France’s official unemployment rate. It has risen, but shows much more
cyclical variation (see Figure 2).

Figure 2 is of course one of the main events of recent French economic history: its
stubbornly high unemployment rate since the eighties. It compared favorably to the UK’s
and the US’ rate up until the late 1970’s, but rose dramatically during the early 1980’s
recession and, contrary to the UK and the US, has never dropped below 8% since. In
particular, during 1990’s boom it starts to drop much later and for a much shorter period.
The 2000’s have been better, but only relatively so.

From 1981 to the mid 1990’s, France has tightened labor market regulation in reac-
tion to rising unemployment (Askenazy, 2008) and increased the cost of work through
longer paid vacation and a higher minimum wage. From the mid 1990’s, mainly by let-
ting fixed-term contracts play a larger role and subsidizing low wages, the French labor

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Figure 1: Output, investment, hours worked and government consumption in France.
Detrended per-capita data, 1978=1.

<table>
<thead>
<tr>
<th>Variable X</th>
<th>Variable Z</th>
<th>k =</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>Hours</td>
<td>0.67</td>
<td>0.68</td>
<td>0.66</td>
<td>0.61</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td>Gov. Cons.</td>
<td>-0.56</td>
<td>-0.67</td>
<td>-0.75</td>
<td>-0.60</td>
<td>-0.44</td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>Gov. Cons.</td>
<td>-0.45</td>
<td>-0.46</td>
<td>-0.44</td>
<td>-0.43</td>
<td>-0.41</td>
<td></td>
</tr>
</tbody>
</table>

Note: Y denotes output. Statistics based on logged and HP-filtered series.

The market has become more flexible (Askenazy, 2008; Blanchard and Landier, 2002), which counterbalanced new tightenings of labor law such as the reduction of the workweek to 35 hours. All this has of course generated a wide literature\(^4\), mainly insisting on the structural nature of France’s unemployment.

3 Business cycle accounting

In a nutshell, the business cycle accounting (henceforth BCA) procedure is a framework that seeks to identify the *proximate* sources of business fluctuations; i.e., the time-varying stochastic “wedges” that temporarily drive GDP and other macroeconomic variables away from trend, without giving these wedges any structural interpretations. The BCA procedure is not meant to validate existing models but is most useful as a guide to the most promising direction of research when modeling a given fluctuation episode.

3.1 Intuition of the business cycle accounting procedure

As a starting point one should note that most business cycle models come down to the introduction of frictions in a frictionless stochastic growth model. The usual approach is to specify real-world frictions, be it for instance unions, adjustment costs or financial constraints on firms, solve the resulting model and econometrically show how well the model explains the data. These real-world frictions result in a distortion of one or more

\(^4\)See Blanchard (2006) for a good analytical overview.
of the following: the intratemporal labor/leisure trade-off, the intertemporal consumption/investment trade-off, total factor productivity and the resource constraint. Each of these distortions drives a (time-varying stochastic) wedge between the optimal decision path of an agent in a frictionless model and his optimal decision path given these wedges.

However, this approach in a sense “puts the horse before the cart” (to quote Chari et al., 2007). It is not clear when looking at the data what class of model looks most promising. Should one concentrate on distorting investment decisions to explain the data? Or rather the labor market? The BCA procedure seeks to guide builders of business cycle models in their choice of model. It does so by decomposing the observed fluctuations as the sum of deviations from trend caused by distortions to the labor/leisure trade-off, distortions to the consumption/investment trade-off, variations in total factor productivity and variations in the resource constraint.

This decomposition is done by formulating a prototypical real business cycle (henceforth RBC) model with time-varying wedges that distort labor and investment, and shocks to TFP and government consumption (see section 3.2 for the exact model and assumptions). Given that agents’ decisions (consumption, investment, etc.) are observable, the BCA procedure answers the following question: what values should these wedges take for these observable decisions to be optimal? The BCA procedure solves the model and estimates the stochastic process for the wedges such that the actual data is the exact solution to the model. By construction, if one writes down a stochastic growth model with these wedges and “feeds” it the actual realization of the underlying stochastic process (i.e., the realization that generated the real-world data), the data generated by the model is exactly identical to the real-world data that was used to estimate the wedges.

These measured “wedges” that generate the deviations from trend only quantify the value of shocks and how choices have to be distorted away from the frictionless equilibrium but offer no insights as to what structural causes these shocks and frictions might have. They formally take the same form as taxes but they may not represent any actual taxes. In that sense the BCA procedure is an “accounting” procedure. It depends primarily on the data and tries to make as few modeling assumptions as possible.

What is the use of this accounting procedure if the measured wedges cannot be given any real-world interpretation? The purpose of the BCA procedure does not lie in the (in)validation of a given detailed model of the business cycle but as an inquiry tool. What Chari et al. (2007) show with their “equivalence” result is that the distortions created by a host of non-tax frictions have the same effect, in a formal RBC model, as taxes. In other words, a large class of business cycle models, including many of the most commonly used ones, is equivalent to a RBC model with time varying wedges. By computing the value of these wedges, the BCA procedure tells the researcher what
the end-point of his model should be. For instance, Chari et al. (2007) conclude, based on their quantitative identification of distortions to the labor/leisure decision and TFP shocks as the main drivers of the 1982 recession, that models that have as their main driver a financial friction that distorts the investment decision (Bernanke and Gertler, 1989, for instance) are not likely to be fruitful avenues of research.

Note that the BCA procedure does not tell the researcher anything about which real-world frictions might lead to this end-point. Say for instance that the BCA procedure indicates for a given economy that the labor/leisure distortion is the main driver of business cycle fluctuations. This does not necessarily mean that labor market frictions are the culprit. The labels of the wedges refer to the distortions, not to the underlying structural causes, about which the BCA procedure is mum. It is entirely possible that a friction on the labor market leads to a distortion of the investment decisions of firms. Or that a financial friction distorts hiring decisions. The BCA procedure simply says “whatever friction you have in mind, once your detailed RBC model is solved, this friction should distort the labor/leisure trade-off”.

3.2 The model

The starting point is a standard stochastic growth model with time-varying wedges. For the exposition, I essentially follow Kersting (2008). Consumers maximize discounted expected utility over per-capita consumption \( c_t \) and labor \( l_t \);

\[
\max_{c_t, l_t, x_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t, l_t) N_t
\]

subject to the budget constraint

\[
c_t + (1 + \tau_x t) x_t = (1 - \tau_l t) w_t l_t + r_t k_t
\]

and the law of capital accumulation

\[
N_{t+1} k_{t+1} = N_t [(1 - \delta) k_t + x_t].
\] (1)

Firms maximize profits given their constant-returns-to-scale production function \( F \) and the cost of inputs:

\[
\max_{l_t, k_t} A_t F(k_t, (1 + \gamma)^t l_t) - r_t k_t - w_t l_t
\]

The notation is standard. \( c_t, x_t, l_t \) and \( k_t \) denote resp. per-capita consumption,
investment, labor and capital. Total time available per period (i.e., for leisure and labor) is normalized to 1. \( w_t \) and \( r_t \) are the wage rate and the rental rate for capital. \( \beta \) is the discount factor, \( \delta \) the depreciation rate of capital and \( N_t \) the total working age population. \( 1 + \gamma \) is the rate of labor-augmenting technological progress and \( 1 + \lambda = \frac{N_{t+1}}{N_t} \) is the rate of population growth, both assumed constant. Output is written as

\[
y_t = A_t F(k_t, (1 + \gamma)^t l_t) \tag{2}
\]

The time varying wedges are the “investment wedge” \( \tau_{xt} \), the “labor wedge” \( \tau_{lt} \), the “efficiency wedge” \( A_t \) and the “government consumption wedge” \( g_t \). The latter, a bit of a misnomer (I stick to the standard terminology), is not truly a wedge since it does not distort individual decisions but rather an aggregate waste: the amount of per-capita production that, in the aggregate, cannot be used for consumption nor investment. Section 3.8 discusses the choice of these wedges.

A competitive equilibrium in this economy is defined as a path for the representative consumer’s decision variables \( c_t, l_t \) and \( x_t \), a path for the representative consumer’s state variable \( k_t \), prices \( r_t \) and \( w_t \) and the representative firm’s allocations of capital and labor such that:

- Given the prices and the stochastic wedges, the representative consumer solves his maximization problem subject to his budget constraint and the capital accumulation equation;
- Given the prices and the stochastic efficiency wedge, the representative firm solves his cost minimization problem;
- The resource constraint \( c_t + x_t + g_t = y_t \) is satisfied;
- The markets for goods, capital and labor clear.

By writing down first order conditions, canceling out factor prices and using the market clearing conditions for factors, the equilibrium paths of consumption, labor, investment and capital of this model satisfy the following equations: the capital accumulation equation (1), the resource constraint

\[
c_t + x_t + g_t = y_t, \tag{3}
\]

the intratemporal labor/leisure trade-off equation

\[
- \frac{U_{lt}}{U_{lt}} = (1 - \tau_{lt})(1 + \gamma)^t A_t F_{lt} \tag{4}
\]


and the intertemporal investment/consumption trade-off (i.e., Euler) equation

\[ U_{ct}(1 + \tau_{xt}) = \beta E_t[ U_{c,t+1} + (1 - \delta)(1 + \tau_{x,t+1})] \] (5)

with the notational convention that, generically, \( V_{zt} \) denotes the partial derivative of function \( V \) with respect to variable \( z \) evaluated in period \( t \). Note that the expectation in equation (5) is conditional on information known at time \( t \).

3.3 Solving and estimating the model

The principle of the BCA procedure is to back out the wedges from the data. The main hurdle is the Euler equation (5); the difficulty comes from its intertemporal nature. To solve this equation for \( \tau_{xt} \), one needs to compute expectations, and thus know the stochastic process that governs the four wedges. Even though the government, labor and efficiency wedge are backed out from intratemporal equations, their time-varying nature indirectly distorts the Euler equation, so the stochastic process of all four wedges, not only the investment wedge, matters for the equilibrium. Since this stochastic process is unknown, I need to make assumptions to estimate it from the data.

One very simple assumption would be perfect foresight (Kobayashi and Inaba, 2006), which allows to ignore the stochastic process and get rid of expectations altogether, and directly back out the investment wedge from the Euler equation written without expectations. This assumption is not satisfactory. In RBC theory, business cycles are driven by unexpectedly (un)favorable realizations of a stochastic process\(^5\) that cannot immediately be absorbed by the economy (hump-shaped responses). Thus if one misspecifies the stochastic process as non-stochastic, agents in the model will smooth much more than in reality. This will result in all variations around trend in the data being attributed to the investment wedge alone, and not to other propagation mechanisms (such as the capital level).

Thus the stochastic process cannot be assumed away. Although it was left out of the preceding equations to keep the notation easy to read, the value of a wedge should be understood as depending on the realization of the state, i.e., \( A_t = A(s_t) \), \( \tau_t = \tau(s_t) \), etc. and expectations are computed using the (conditional) probability distribution of the process. Following the literature (in particular Chari et al., 2007), I assume that the values of the wedges are a sufficient statistic to uncover the underlying state. With this

\(^5\)Usually technology shocks are the prime driver, although other shocks have also been used in the literature. For an overview, see Rebelo (2005).
assumptions, I can set

\[ s_t = [\ln (A_t), \tau_{lt}, \tau_{xt}, \ln (g_t)]' \]

without loss of generality. Furthermore, still following the literature, I assume that the process is Markovian and follows a VAR(1):

\[ s_{t+1} = P_0 + Ps_t + Q\epsilon_{t+1} \]  

(6)

with \( \epsilon \) an i.d.d. shock with a standard normal distribution \( N(0, I_4) \) and \( Q \) a lower triangular matrix. The matrices \( P_0, P \) and \( Q \) are estimated from the data with a standard maximum likelihood procedure using the last equations and equilibrium equations (2), (4) and (5).

### 3.4 Implementation

For the implementation, functional forms have to be assumed for \( U \) and \( F \). Following the literature, I assume the following

\[ U(c, l) = \ln (c) + \phi \ln (1 - l) \]  

(7)

\[ F(k, l) = k^\alpha l^{1-\alpha} \]  

(8)

Since the number of parameters to be estimated is large (\( P_0, P \) and \( Q \), i.e. 30 parameters), a non-linear numeric maximum likelihood estimation is computationally too demanding. Thus I log-linearize the decision rules around the steady state and rewrite the model in linear state-space form to get closed-form expressions. Log-linearization around a steady state is conceptually a straightforward exercise, and it is done in detail by Chari et al. (2006). Since the algebra is quite involved (and of no added value to the analysis), I summarize the main steps of their solution and refer the reader to their appendix for all the computational details.

Denoting by \( \hat{v} \) the log-deviations from the detrended steady-state of generic variable \( v \), the equilibrium conditions (1), (3), (4) and (5) are log-linearized around the steady state, using the assumed stochastic process (6) for \( s_t \) when computing expectations. The state-space form of the log-linearized model is

\[ X_{t+1} = AX_t + B\epsilon_{t+1} \]

\[ Y_t = CX_t \]

where \( X_t = [\hat{k}_t, \hat{A}_t, \tau_{lt}, \tau_{xt}, \hat{g}_t, 1]' \) is the state variables vector,
\[ Y_t = [\hat{y}_t, \hat{x}_t, \hat{l}_t, \hat{g}_t]' \] is the vector of observables, and

\[
A = \begin{bmatrix}
\Psi & 0 & P \\
0 & P & P_0 \\
0 & 0 & 1
\end{bmatrix}
\]

\[ B = \begin{bmatrix} 0 \\ Q \\ 0 \end{bmatrix}. \]

\( C \) is \( 4 \times 6 \), \( \Psi \) is \( 1 \times 6 \) and the 0 block matrices have the appropriate dimensions. \( C \) and \( \Psi \) depend only on known parameters of the model\(^6\).

### 3.5 Maximum likelihood

Maximum likelihood for such a linear system is a standard procedure. The main reference is Anderson et al. (1996), which contains all the proofs. The principle is as follows. The parameters to be estimated, stacked in \( \Theta \), govern the stochastic process \( s_t \), i.e., \( P_0, P \) and \( Q \). The Kalman filter is used to generate optimal one-step-ahead predictions for \( X_{t+1} \), given a set of parameters \( \Theta \). The difference of these predictions with actual data, called innovations, enter the function \( L \) to be minimized. Small innovations generate small values for \( L \) and vice-versa.

The optimal one-step-ahead predictions for \( X_{t+1} \) is

\[ \tilde{X}_{t+1} = A\tilde{X}_t + K_t u_t, \]

with \( K_t \) the Kalman gain and \( \Sigma_t \) the state covariance. The innovation vector and its covariance are

\[ u_t = Y_{t+1} - CA\tilde{X}_t \]
\[ \Omega_t = Eu_tu_t' \]

and the (quasi) log-likelihood function to be minimized is:

\[ L(\Theta) = \sum_{t=0}^{T-1} \ln |\Omega_t| + \text{trace}(\Omega_t^{-1}u_tu_t'). \]

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\(^6\)Again, the reader is referred to Chari et al. (2006) for the algebra. I followed their assumption to set measurement error to 0.
3.6 Data

The data used and methods of construction are very similar to those described in the very useful data appendices in Cavalcanti (2007) and Kersting (2008), who performed a similar exercise on resp. Portuguese and UK data. The parameters \( \alpha, \beta, \delta, \gamma, \phi \) and \( \lambda \), all standard RBC parameters, are considered known parameters for the estimation procedure. Table 3.6 sums up the values used in the estimation and the reasons for these values.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha ) Capital share</td>
<td>0.34</td>
<td>The average of the ratios of gross operating surplus over GDP of the years 1979-2007.</td>
</tr>
<tr>
<td>( \beta ) Discount factor</td>
<td>0.992</td>
<td>Chosen such that yearly time preferences is 3%.</td>
</tr>
<tr>
<td>( \delta ) Depreciation</td>
<td>1.53%</td>
<td>Standard RBC value, 6% yearly.</td>
</tr>
<tr>
<td>( \gamma ) Labor-augmenting technological progress</td>
<td>0.379%</td>
<td>From the data using a growth accounting equation.</td>
</tr>
<tr>
<td>( \phi ) Leisure preference factor</td>
<td>2.24</td>
<td>Chari et al. (2007).</td>
</tr>
<tr>
<td>( \lambda ) 15-64 population growth</td>
<td>0.145%</td>
<td>Directly from the data.</td>
</tr>
</tbody>
</table>

Table 3: Parameter values and data sources.

The available quarterly data are \( y_t, g_t, x_t, \) and \( l_t \). The main source is the OECD database, except if noted otherwise. Per capita variables are computed using yearly data on the population age 15 to 64, with linear interpolation for missing quarters. Deflating is done using the deflator from the St. Louis Fed’s FRED database. \( y_t \) is quarterly per-capita real GDP. \( g_t \) is the sum of quarterly per-capita real government consumption, net exports and the national accounts’ residual item (which is negligible and included for completeness’ sake). \( x_t \) is quarterly per-capita real gross capital formation. The quarterly maximum number of hours available for work or leisure is assumed to be 1250. \( l_t \) is the ratio of the number of per capita worked hours, both by workers and business owners (INSEE data), and this maximum.

3.7 Results

The numerical results\(^7\) of the maximum likelihood estimation are in Table 3.7. The matrices \( P_0, P \) and \( Q \) are used by the agents in equation (6) to form their expectations about the future values of the wedges. Figure 3 shows output, the labor wedge \( 1 - \tau_{lt} \), the investment wedge \( 1/(1 + \tau_{xt}) \) and the efficiency wedge \( A_t \). I slightly redefine the wedges to make the graphs more readable: drops of a wedge on the graph contribute to

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\(^7\)MATLAB code available upon request. I gratefully acknowledge the code made available by Ellen McGrattan that I used as a starting point for my own work.
a drop in output and *vice-versa*. The wedges are displayed with 1 as their starting value in 1978.

![Graph](image)

Figure 3: Output and wedges, 1978=1

The interpretation of these results, given the assumptions made about the underlying stochastic process, is that these are the wedges a RBC model needs for the French data to be its solution. If one wants to build a micro-founded RBC model that matches the French data with detailed frictions that have a structural meaning, the reduced-form wedges these frictions introduce into the various optimal decisions (i.e., first order equations) should be as close as possible to the measured wedges displayed on Figure 3.

### 3.8 Discussion of the specification of the wedges

How depended are these results on the exact specification of the wedges in the BCA procedure? At an abstract level the specification is of prime importance. One could very well write down a RBC model with different wedges, and compute these different wedges using the same procedure. There are many ways in which one can distort first order conditions. At first sight, it would thus seem that the accounting procedure is very model dependent, limiting its usefulness.

However, the choice of wedges by Chari *et al.* (2007) is not haphazard. They have chosen wedges that correspond to the type of distortions that are very relevant in economics. The efficiency wedge has been the prime driver of much research in the RBC field. The labor wedge has recently become equally important (Shimer, 2009, 2010). The investment wedge has been more open to discussion (in particular by Christiano and
Note: statistical indicators are computed using a bootstrap with 500 replications. The first number between brackets is the standard deviation. The following interval between parenthesis is a 90% confidence interval.

Table 4: Result of the maximum likelihood estimation.
Cross-correlation \( X(t) \) and \( Y(t-k) \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>( \sigma(X) / \sigma(Y) )</th>
<th>( k = -2 )</th>
<th>( -1 )</th>
<th>( 0 )</th>
<th>( 1 )</th>
<th>( 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>0.77</td>
<td>0.51</td>
<td>0.61</td>
<td>0.67</td>
<td>0.50</td>
<td>0.33</td>
</tr>
<tr>
<td>Labor</td>
<td>1.32</td>
<td>0.38</td>
<td>0.40</td>
<td>0.42</td>
<td>0.45</td>
<td>0.47</td>
</tr>
<tr>
<td>Investment</td>
<td>0.99</td>
<td>0.50</td>
<td>0.62</td>
<td>0.69</td>
<td>0.72</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Note: \( Y \) denotes output. Statistics based on logged and HP-filtered series.


Davis, 2006) since there are several natural ways of modeling it. But Chari et al. (2007) show that their results depend very little on the exact specification of the investment wedge. The government wedge, finally, has a much more limited role in the procedure and, given that it is modeled as a lump-sum waste (at least intratemporally), does not interact much with the model. Lastly, the equivalence results show that these specific wedges arise naturally as the reduced-form effect of a host of detailed real-world frictions.

In conclusion, the BCA accounting is not “model free”. It is, however, minimally model dependent in as far as one is willing to accept the choice of wedges as a natural choice given what past research has concentrated on and given the equivalence results.

4 Interpretation of the results

4.1 A first pass

What is striking for France in Figure 3 is that the wedges show little cyclical behavior. In previous work, in particular in the case of the UK and the US, each wedge displayed a clear cyclical or counter-cyclical pattern, which allowed to identify which wedges are most likely driving the business cycle, and which ones dampen it. These observations logically lead to the next step: to solve the same RBC model keeping one or more wedges constant and compare the results to the actual data to isolate the marginal effect of each wedge.

This is not to say that there is nothing to learn from the BCA procedure about the cyclical variations of French output. Table 5 sums up the statistical properties of the wedges. All three wedges are positively correlated with output, but not that strongly, and are about as variable. But what first meets the eye is the large deterioration of the labor wedge and the investment wedge, compensated by the large improvement of the efficiency wedge (i.e., TFP). The labor wedges drops by 25% over 20 years, meaning, ceteris paribus, a drop of 25% in detrended wages. The reason wages haven’t collapsed is the strong above-trend growth of TFP (20% over the years), which explains the growth of
the “pre-wedge” wages. This leads to the conclusion that the French business cycle seems to be more of a “residual” phenomenon, of lesser importance, and that the economically interesting questions should be the reasons for the long-run evolution of these wedges.

However, simply analyzing Figure 3 to determine the effects of each wedge, although informative as a first pass, is not a sound approach. Because of general equilibrium effects, one cannot infer from the graph which wedge drives what. For instance, the investment wedge might very well have an influence of the number of hours worked through its effects on the capital level, and hence on wages. Hence the last step in the BCA procedure is to isolate the marginal effects of each wedge. This is done in the next section, where I compute the equilibrium of the RBC model economy while shutting down on or more wedges to analyze the marginal contribution of each wedge.

4.2 Description and discussion of the computation of the marginal effects

To account for these general equilibrium effects, I conduct an experiment where some wedges are allowed to fluctuate in the prototypical RBC model used above and others are held constant (as in Chari et al., 2007). For instance, to assess the effects of the efficiency wedge, I compute the data generated by the prototypical RBC model where all wedges but the efficiency wedge are held constant. Specifically, in each simulation the state of the economy $s_t$ fluctuates according to the exact same stochastic process as before, given by equation (6). Hence the formation of the conditional expectations about the future states is identical in these simulations as in the original prototypical model. What does change is that not all four wedges fluctuate with the stochastic state anymore. Some wedges are kept constant at their long-run average, and the prototypical RBC model is solved anew.

How legitimate and informative is it to “shut down” wedges? This process should not be likened to the better known structural VAR approach. In a SVAR, one would look for orthogonal shocks with a clear real-world meaning, and then specify a linear combination of these shocks that equals the reduced-form shocks of the VAR. After estimating the VAR, one can invert this linear combination and study the effect of these primitive shocks individually. Generically, each of these shocks affect all wedges. It allows to make statements such as “monetary shocks have such and such effect”. However, this procedure requires a detailed model, both to be able to give the primitive shocks a real-world meaning (“naming the shock”) and to be able to specify the linear combination that transforms the primitives into the reduced-form errors that are observable. Coming back to the previous example: a different model with different identifying assumptions would
generically make a different statement about the effects of monetary shocks.

To keep the spirit of an accounting method, I do not want to make any of the identifying assumptions that are implicit in the choice of primitive shocks and their linear combination. The purpose of the BCA procedure is to point researchers in the direction of promising models, making structural assumptions would again be putting the horse before the cart. By shutting down wedges selectively, I document the effect that each wedge has on output movements without making any assumptions on the identity or structure of the underlying primitives. That the wedges are not orthogonal, as opposed to primitive shocks in a SVAR, does not matter for my purpose. I am not trying to isolate the effect of each element of $\epsilon_t$ on equilibrium outcomes, which is what an SVAR does with primitive shocks, and for which one does need orthogonality. I am trying to document the partial effect of each wedge. In looser words, I’m not trying to say “shock $X$ causes these output fluctuations” but, less ambitiously and more generally (no identifying assumptions needed) “a RBC model with just wedge $X$ but the same underlying stochastic structure will have the following output fluctuations”. This tells researchers on which wedges they should concentrate most when building a detailed model, and which wedges they can afford to ignore (meaning they can afford to potentially misspecify the structural causes of these wedges).

4.3 Marginal effects of the wedges: cyclical variations and long-run shifts

I do these computations for each wedge but the government wedge\(^8\), i.e., I compute output, number of hours and investment for a model economy where only one wedge is kept active according to the above described procedure. The results are displayed in Figure 4 and summary statistics are in Table 6. I then repeat the exercise by keeping all but one wedge active, again except for the government wedge. The results are displayed in Figure 5.

From a business cycle perspective, both the graph and the table tell the same story. It is clear that business cycle fluctuations are driven by the sole efficiency wedge. Neither the labor wedge nor the investment wedge create fluctuations that are of the right amplitude and/or cross-correlation. The labor wedge create counter-cyclical fluctuations and thus dampens the business cycle (as does the government wedge). Furthermore, Figure 5 shows that leaving out the efficiency wedge cancels most of the fluctuations. This is in

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\(^8\)The government “wedge” is a lump-sum aggregate waste, and therefore not very interesting to look at. Models that try to use government expenditures and/or deficits worry about tax distortions, timing issues, credibility etc., none of which would show up in the “government” wedge. Therefore I do not look at this wedge.
contrast to Kersting’s (2008) results for the UK, who shows that it is changes in the labor wedge, which he matches to the Thatcher reform in the labor market, that drove the UK’s recover from the 1980’s recession. My conclusion is that France’s (shallower) business cycles are the result of fluctuations of TFP, and are dampened by the labor wedge.

As noted in section 4.1, the most notable aspect of the wedges is not their cyclical aspect, but the long-run behavior. Is it legitimate to look at long-run shifts in a procedure called business cycle accounting? It is important to understand what these long-run trends in the wedges mean in principle. As a reminder, all data is per-capita, and output, investment and government consumption have been detrended for growth. Furthermore, the specification of the utility function in equation (7) implies that there are no wealth
Cross-correlation $X(t)$ and $Y(t-k)$

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\sigma(X)/\sigma(Y)$</th>
<th>$k$ =</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>1.63</td>
<td>0.67</td>
<td>0.80</td>
<td>0.87</td>
<td>0.73</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>1.14</td>
<td>-0.17</td>
<td>-0.25</td>
<td>-0.27</td>
<td>-0.20</td>
<td>-0.10</td>
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</tr>
<tr>
<td>Investment</td>
<td>0.54</td>
<td>0.16</td>
<td>0.25</td>
<td>0.27</td>
<td>0.38</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Gov cons.</td>
<td>0.44</td>
<td>-0.45</td>
<td>-0.55</td>
<td>-0.60</td>
<td>-0.64</td>
<td>-0.60</td>
<td></td>
</tr>
</tbody>
</table>

Note: $Y$ denotes output. Statistics based on logged and HP-filtered series.


effects. Lastly, the prototypical RBC model does not allow for any structural changes, whether in preferences or in technology. Hence the prototypical RBC model has been constructed to assign any long-run shifts in detrended per-capita data to long-run shifts in the wedges. The wedges do not, however, reflect long-run growth.

Again, it is worth remembering that these wedges are backed out from the data. This mapping from data to wedges is mediated by a model, and wedges are not directly generated by their respective data series. For instance, there is no one-on-one correspondence from the drop in hours to a worsening of the labor wedge. It is entirely possible to generate a drop in hours in a prototypical RBC model solely with a worsening investment wedge causing a drop in capital, for example. The wedges of Figure 3 are the only combination of wedge that explain the level of production, the investment behavior (hence the capital stock, hence the relation setting the wage level) and the choice of hours made by the agents. So leaving aside long-run growth, which has been removed from the data series, there is no reason in theory one should not interpret these long-run patterns in the wedges. This was not done in the original research by Chari et al. (2007), but only because their wedges did not display any long-run patterns.

What one sees from the efficiency-wedge-alone graph is that if it had not been for the investment and labor wedge, employment in 2007 (in number of hours per capita) would be ca. 5% higher than its 1978 level, output per capita would be far higher (20% more) and investment per capita would have almost doubled, meaning France would have had a far larger capital base. In contrast, the no-efficiency-wedge economy shows a dramatic drop in output and investment (resp. by 20% and 40%), while keeping labor more or less equal to the data. The labor-wedge-only economy replicates the 30-year drop in hours well, but it is unable to replicate output and investment, which are much lower in the simulated economies. The economy without the labor wedge does not display any drop in hours, somewhat higher output and significantly more investment. The investment-wedge-only economy sits in between these results. It displays a drop in output and hours

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9 As Figure 4 shows, the labor wedge alone actually generates an even worse drop in hours than the data shows!
(ca. 5% and 8%) between 1978 and 2007, whereas the data does not display a drop in output (by definition of the detrending procedure) and a much larger drop in hours. The investment-wedge-alone economy is also unable to replicate the long-run pattern of investment, which drops more in the simulation than in the data. The no-investment-wedge economy displays a lower drop in hours as the data, but which is still significant (about 12%). It displays much higher investment, comparable to the no-efficiency-wedge economy, and a small upward shift in output.

This leads to three conclusions. (1) Detailed models that try to explain the 30-year drop in hours should concentrate on frictions that affect the labor wedge. The investment wedge plays a secondary role. However, detailed models that try to use a lack of technological progress as the driver of the drop in hours in France have little
chance of succeeding. There was no drop in the efficiency wedge, quite the opposite\textsuperscript{10}, and a simulated economy without the efficiency wedge replicates a similar drop in hours. (2) Detailed models that seek to explain the 15-year drop followed by a 15-year rise in investment will need frictions that affect all three wedges in the way computed by the BCA accounting procedure. No wedge can be neglected. (3) Any detailed RBC model that seeks to incorporate a realistic measure of technological progress will most likely generate more growth than observed in reality\textsuperscript{11}. A long-run downward shift in the labor wedge and the investment will be needed to “push” growth down.

In terms of policy, this leads to the following observation: if one were able to keep the efficiency wedge as it is and eliminate constraints on labor and investment (meaning: keeping them at their 1978 level), France could considerably increase employment and output per capita\textsuperscript{12}. Of course, since the wedges have no structural meaning, it is impossible at this stage to pinpoint which policy measures (if any) could achieve this. One can however explore two possibilities.

Tentatively, one possible conclusion to draw would be to promote market labor reform and a freer investment climate — the policies promoted by the OECD in recent years — with the aim to bring output and employment to the levels of the efficiency wedge-only economy. This would be giving a straightforward structural interpretation to the results of the (reduced-form) BCA procedure.

As an alternative, it could also be that these wedges are jointly determined. It has long been suggested in the literature that labor market rigidities alone do not explain the French (or, more generally, the European) employment performance and that distortions on both the goods and the labor market combined have to be studied\textsuperscript{13}. The basic idea is that higher competitive pressure on the goods market could lower unemployment, or, more to the point in France, dampen the effects of more stringent labor market regulations. The following section develops a model that contains these two distortions and that explores whether such a combination of tightening competition on the goods market and stricter labor market regulation can deliver the data patterns just analyzed.

\textsuperscript{10}Actually, once one accounts for detrending, the efficiency wedge grew at a rate that is of the same order of magnitude as in the US.

\textsuperscript{11}Unless the detailed specification of technological progress does not affect the efficiency wedge, which would make for an unusual model.

\textsuperscript{12}See Prescott (2002) for a similar result.

\textsuperscript{13}See the original OECD “Jobs study” (OECD, 1994) that initiated this line of thinking. For the theory see Nickell (1999) and Blanchard and Giavazzi (2003) and for empirical studies see Bertrand and Kramarz (2002) and Nicoletti and Scarpetta (2005).
5 A model with imperfect labor and goods markets

The following model is inspired by Cole and Ohanian (2004) and preliminary work by Chari et al. (2002). Time is discrete and the environment is stochastic. To keep notation easy to read, the dependence of each variable on the current state of the economy $s_t$ is not written explicitly but implied by the subscript $t$. There is a continuum of monopolistically competitive producers, indexed by $i \in [0, 1]$, who rent capital $k_t(i)$ at the interest rate $r_t$ and buy labor of each type $l_t(i,j)$ at wage $w_t(j)$ to produce an intermediate good according to the following production function:

$$y_t(i) = f(k_t(i), l_t(i)) = A_t k_t(i)^{\alpha} l_t(i)^{1-\alpha}$$

with $l_t(i) = \left[ \int_0^1 l_t(i,j)^{\nu_t} dj \right]^{\frac{1}{\nu_t}}$

These intermediate goods producers sell their goods for price $p_t(i)$ to a representative final good producer who behaves competitively and who produces the final capital-consumption good in quantity $y_t$ from the intermediate goods as follows:

$$y_t = \left[ \int_0^1 y_t(i)^{\delta} di \right]^{\frac{1}{\delta}}$$

(9)

The price of the final good is the numéraire and normalized to 1. Firms maximize each period’s profits and, if profits are positive, redistribute dividends $d_t$ lump sum to all consumers.

There is a continuum of consumers, indexed by $j \in [0, 1]$. Each type $j$ of consumers is organized as a union and sells its labor for a wage $w_t(j)$ set by the union. Consumers accumulate capital at the interest rate $r$ and depreciation rate $\delta$ and maximize discounted expected utility by consuming the final good:

$$\max_{c_t(j), l_t(j), k_t(j)} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t(j), l_t(j))$$

subject to $c_t(j) + k_{t+1}(j) = w_t(j)l_t(j) + (1 + r_t - \delta)k_t(j) + d_t$

(10)

The interpretation of the model is as follows. The monopolistically competitive labor market introduces a (structural) wedge between the competitive wage and the higher wage employees are able to demand. These unions are a reduced form meant to capture the various non-competitive characteristics of the labor market in France, such as firing regulations and taxes, mandated wage increases, actual unions, etc., that give insiders a better bargaining position. $\nu_t$ indexes these labor market and is allowed to vary over
time to reflect changes in labor market regulations. The monopolistically competitive intermediate goods market is meant to capture the lack of competition on (certain) goods markets (retail for instance, see Bertrand and Kramarz, 2002). It drives a wedge between the competitive level of production and the lower level chosen by firms with some monopoly power. It is indexed by $\theta_t$, which again can be allowed to vary over time to reflect changes in legislation or policy. Note that both $\nu_t$ and $\theta_t$ are in $[0, 1]$ and that the closer each of these variables is to 1, the more competitive the corresponding market is.

Equilibrium is defined in the standard way: quantities solve the consumers’ and firms’ maximization problems given prices, the resource constraint is met and all markets clear. I concentrate on the distortions introduced by the two monopolistic markets, labor and intermediate goods. The final good producer maximizes his profits:

$$\max_{y_t(i)} \left\{ \left[ \int_0^1 y_t(i)^{\theta_t} di \right]^{\frac{1}{\theta_t}} - \int_0^1 p_t(i) y_t(i) di \right\}$$

which implies, through the first order conditions, the following demand function for intermediate goods:

$$y_t(i) = y_t p_t(i)^{\frac{1}{\theta_t - 1}}. \quad (11)$$

The intermediate goods producers hence face a downward-sloping demand curve, and they maximize the following program:

$$\max_{k_t(j), l_t(i,j), j \in [0, 1]} \left\{ p_t(i) f(k_t(i), l_t(i)) - r_t k_t(i) - \int_0^1 w_t(j) l_t(i,j) dj \right\}$$

Taking wages and final output as given, the first order conditions imply:

$$r_t = \Phi f_k(k_t(i), l_t(i)) \quad (12)$$

$$w_t = \Phi f_l(k_t(i), l_t(i))$$

$$l_t(i,j) = \left[ \frac{w_t}{w_t(j)} \right]^{\frac{1}{\nu_t - 1}} l_t(i)$$

$$w_t = \left[ \int_0^1 w_t(j)^{\frac{\nu_t - 1}{\nu_t}} dj \right]^{\frac{\nu_t - 1}{\nu_t}} \text{ the wage aggregator}$$

and  $\Phi = \theta_t \left[ \frac{y_t(i)}{y_t} \right]^{\theta_t - 1} \quad (13)$

The unions choose their wage in order to maximize the utility of their members (i.e., equation (10)) given all other wages and prices. Maximization of (10) implies, for any
\( j \in [0, 1] : \)

\[ w_t(j) = -\frac{1}{\nu_t} \frac{U_i(c_t(j), l_t(i))}{U_c(c_t(j), l_t(i))} \quad (14) \]

At the equilibrium, using a simple argument of symmetry (all unions and all intermediate firms are identical, hence demand identical wages/prices and produce identical labor/intermediate goods) one has the following first order condition (denoting equilibrium values with a *) for all \( i \) and \( j \) in \([0, 1]\):

\[ r^*_t = \theta_t f_k(k^*_t(i), l^*_t(i)) \quad (15) \]

\[ -\frac{U_i(c^*_t(j), l^*_t(i))}{U_c(c^*_t(j), l^*_t(i))} = \nu_t \theta_t f_l(k^*_t(i), l^*_t(i)) \quad (16) \]

Note that, in equilibrium, \( \Phi^* = \theta_t \).

Now compare this economy with a detrended version of the prototypical RBC model of section 3.2, with the following wedges:

\[ A_t = \theta_t \quad (17) \]

\[ (1 - \tau_t) = \nu_t \quad (18) \]

Then I claim the following theorem:

Given a stochastic process for \( \theta_t \) and \( \nu_t \), the economy with imperfect labor and goods markets described above and the detrended prototypical RBC model with perfectly competitive markets and the wedges as in equations (17) and (18) have identical prices and allocations in equilibrium.

The proof is immediate, one needs only to compare the first order conditions of the prototypical RBC model (i.e., equations (4) and (5)) and the first order conditions of the economy with imperfect labor and goods markets (i.e., equations (15) and (16)). Note that this is a novel result, and that this model can thus be added to the list of models that are equivalent to a prototypical RBC model.

To replicate the patterns shown in Figure 3, one needs a gradually increasing \( \theta_t \) and a gradually decreasing \( \nu_t \), i.e., increasingly competitive goods markets and increasingly rigid labor market. This is a believable story: according to Askenazy (2008), labor market rigidities have indeed increased over time until the early 2000s. Goods market competition has also gradually improved over time, mainly through membership in the European Union which brought higher exposure to competitive foreign producers and
tough Europe-wide competition policies (the treaties of 1986 and 1992 in particular)\textsuperscript{14}.

6 Conclusion

I apply the business cycle accounting procedure to French aggregate data 1978-2007. I conclude from the estimation and simulations that fluctuations in TFP explain most of the fluctuations of French output. These fluctuations, however, are of secondary importance in comparison to the 30-year long increase in efficiency (after growth-detrending the data) and increase in the wedge between the labor/leisure trade-off. Exploring the latter phenomenon seems a very fruitful avenue of research. I show that an RBC model built on increased union power and increased liberalization of goods markets is consistent with both these results and with the evolutions of French and European legislation of the last 30 years.

\textsuperscript{14}One should note that the BCA procedure, by construction, does not allow to match a model with the data nor run any statistical tests; it can only highlight the most relevant reduced-form wedges that drive the data and hence indicate promising (and unpromising) types of models. To formally bring the preceding model to the data, one would need to start by constructing a time series for $\theta_t$ and $\nu_t$, a notoriously difficult undertaking. My work shows that in principle, combining product and labor market rigidities can explain the data in a credible way, not that it does. This is as far as one can go with the BCA procedure. This is nevertheless not a trivial result: models that reduce to prototypical RBC models with different wedges, or with wedges that cannot realistically increase or decrease over long lapses of time, would not be able to explain the data.
References


