

Accounting for the French Great Depression (First Draft)

Slim Bridji*

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Abstract

To understand the driving forces of the French Great Depression, we use the *business cycle accounting* methodology (Chari et al. (2006)) which decomposes macroeconomic fluctuations into several wedges linked to specific markets and economic behaviors. The wedges associated with the efficiency in the final good production and the investment behavior are the major contributors to the downturn, but with opposite effects. The strongly depressive efficiency wedge would have lead to a deeper depression without the expansive investment wedge. This conclusion contrasts with previous analyses focusing on labor market changes to explain great depressions in France and the United States.

Keywords: Business cycle accounting; French economy; Great Depression.

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*Université Paris X Nanterre and EconomiX. Email: sbridji@u-paris10.fr. I thank Fabien Tripier and Michel Juillard for helpfull comments and guidance. All remaining errors are mine.

1 Introduction

As Bernanke (1995) says, “[to] *understand the Great Depression is the Holy Grail of macroeconomics*”. Many countries, among which the U.S. and the European countries, have been affected by depressions during the 1930s. For some years past, several economists, as Cole and Ohanian (1999) and Christiano, Motto and Rostagno (2003), have assessed the ability of the Dynamic Stochastic General Equilibrium (DSGE) models to replicate the economic collapses in the 1930s. These economists face the following questions: Which shocks have hit the economies? Through which mechanisms have these shocks led the economies to a deep depression? The economic theory proposes many propagation mechanisms, such as the sticky wage mechanism or agency cost problems in the financial market, which are likely to cause a recession. However, which ones are able to drive an economy to a depression similar to the 1930s one? Clearly, it is not an easy task to identify key distortive mechanisms. In this paper, we study the French Great Depression and in order to understand the mechanisms at work, we propose to use the *business cycle accounting* methodology, developed by Chari, Kehoe and McGrattan (2006a).

Thus, Chari, Kehoe and McGrattan (2006a) (CKM hereafter) propose a new tool, the business cycle accounting (BCA hereafter), to discriminate some mechanisms from others¹. First, they emphasize that many models

¹Notice that the methodology Chari, Kehoe and McGrattan (2006a) propose is designed for any business cycle fluctuations, not only for depressions.

with frictions and/or market imperfections could be reconstructed as a neo-classical growth model with four shocks which are a measure of technological change, time-varying labor and investment taxes, and time-varying government expenditures. This model is labeled a prototype model. Within this framework, CKM rename these shocks, respectively, efficiency wedge, labor wedge, investment wedge and government consumption wedge. The equivalence between a sophisticated model (model with frictions and/or market imperfections) and a prototype model rests on the following result: the frictions modelised in a sophisticated model are captured, in a prototype model, by either the efficiency wedge, labor wedge, investment wedge or the government consumption wedge. Thus, the problem becomes the following: Which wedge or combination of wedges would allow the understanding of the event in study? Second, to address this issue, CKM propose to perform an accounting exercise, similar to the well-known growth accounting procedure.

Wedges measure the deviation of the fluctuations described by the neo-classical growth model from those observed in the actual data. Thus, one can first, generate series for the wedges from data and the equilibrium conditions of a prototype model, second, feed them back into the prototype model, one at a time then in combinations. With this exercise, one can assess the contribution of the wedges (individually or in combination) on the observed fluctuations in the variables of interest, and then answer the problem.

CKM have applied their methodology to the U.S. Great Depression. They find that the deterioration in both efficiency and labor wedges accounts fairly

well for the collapse in the U.S. economic activity. These results suggest, according to the authors, that models where frictions which manifest themselves as efficiency wedge, such as the input financing problems², and those which take the form of a labor wedge, such as the worker monopoly power³ are good candidates to understand the U.S. Great Depression.

Many works have been done, within a DSGE framework, on the U.S. Great Depression but few on the French Great Depression. Actually, Beaudry and Portier (2002) have assessed the ability of the standard Real Business Cycle model to replicate the observed fluctuations in France during the 1930s. They find that the technological change, appears neither sufficient nor necessary to understand the French depression. Thus, it is interesting to apply the business cycle accounting methodology to the French Great Depression and then compare our results with those of Beaudry and Portier (2002) and those of CKM.

We find that the efficiency and investment wedges play important roles during 1930s in France. The efficiency and investment wedges have opposite effects on the French economic activity. The former is depressive while the latter is expansive. However, the efficiency wedge comes to be much stronger than the investment wedge. Besides, our results suggest that the labor wedge is neither sufficient nor necessary to understand the persistence of the depression. Thus, the *Front Populaire* policies of 1936 do not seem to distort the

²As originally suggested by Bernanke (1983).

³As recently stressed by Cole and Ohanian (2004) and Christiano et al. (2003).

French economy, at least, as a labor wedge does. The government wedge plays no role in the depression. So our results appear to be quite different from those of Beaudry and Portier (2002) and CKM. Indeed, Beaudry and Portier (2002) suggest, in their study, that the institutional changes which occur in the 1930s in France, as those led by the *Front Populaire* in the labor market, may be at the origin of the absence of recovery. CKM find that the labor wedge explains fairly well the U.S. weak recovery and then suggest that models with unionization are promising to understand the U.S. Great Depression. In the end, we can say that the contribution of the investment wedge to the French depression is the most puzzling aspect of our results.

The paper is organized as follows. Section 2 inspects the French data over the Great Depression period. Section 3 describes the business cycle accounting methodology. Section 4 presents our application. Section 5 concludes.

2 An Overview of the Data

In this section, we do a quick inspection of the French data over pre-World War 2 period (1896-1939) and more precisely over the 1930s to introduce our work⁴. Our study is based on the annual data collected by Villa (1993). We pick up, from this database, the private consumption, the public consumption, the household investment, the firm investment and the public investment aggregates. All of these series are expressed in billions of 1938 French francs. We also pick up the employment level, the workweek length and the total

⁴For a more detailed French data description, see Beaudry and Portier (2002).

population⁵.

In the remaining of this section, we firstly present the changes we have made in the original data to construct the macroeconomic variables of interest, secondly we discuss the behavior of these macroeconomic variables of interest, during the 1930s.

2.1 The Data Treatments

We want to construct five real macroeconomic variables, which are the output, consumption, investment, government consumption and hours worked. The household, firm and public investments are aggregated to obtain a single investment variable. We keep the private and public consumption in two separated variables, *i.e.* consumption variable and government consumption variable respectively. As we are only interested in understanding the domestic causes of the Great Depression in France, we define the output variable as the sum of the private consumption, the total investment and the public consumption. The hours worked variable refers to the share of available time the households spend working. Thus, this variable is computed as it follows: firstly, we multiply the employment level by the workweek length, then we divide the result by the available time length. We assume that the available time length, on average, is 4160 hours per year⁶. However, there are missing values between 1914 and 1918 in both employment and workweek

⁵It would be better to have a measure of the working-age population rather than a measure of total population but, as far as we know, the former is not available.

⁶We suppose that households could allocate 16 hours per day, 5 days per week and 52 weeks per year between market and non market activities.

length series. Thus, we linearly interpolate the missing values to obtain a complete series for the hours worked variable.

To observe precisely the fluctuations in output, consumption and investment, we should express these variables in per capita term and remove their growth trend. According to the economic theory, these variables should grow at a same constant rate in the long-run. To fix this growth rate, we take the average growth rate of output variable over the period 1896-1929, excluding the World War 1 to remove the war effect. We find the value of 1.84% per year⁷.

We also compute the per capita hours worked variable. We find that the series for this variable presents a decreasing linear trend over the complete sample, that is 1896-1939. This can be seen in Figure 1.

We adjust the hours worked series for its decreasing trend to have a better idea of the hours worked cyclical movements. This is shown in Figure 2.

2.2 Some Data Observations

Figure 3 and Table 1 show the movements of the output, consumption, investment and hours worked in the 1930s, in France. All the variables are per capita, detrended and normalized to 100 in 1929. We observe, as Beaudry and Portier (2002), that the movements in output satisfies the great

⁷Notice that our growth rate is quite different from the one computed by Beaudry and Portier (2002) which is 2.98%. Indeed, they calculated it over a longer period, that is 1896-1994 excluding the two World Wars periods and the 1930s. We think that the economic environment in the early twentieth century was quite different from the one in the post-World War 2.

depression definition proposed by Kehoe and Prescott (2002). Indeed, the output decreases over the entire decade. There is a large and quick drop in output between 1930 and 1932. In 1932, the output is 13.65% below its 1929 level. And worse, the recovery phase do not occur. In 1939, the output is 24.34% below its 1929 level. The investment also fall considerably between 1930 and 1932. After that, the decline is slower. The investment do not recover, not even slightly. In 1939, this variable is around 60% below its 1929 value. The consumption decreases from 1929 onwards. However, the consumption decline is quite regular. Again, there is not any hint of consumption recovery over the decade. In 1939, the consumption is 24.22% below its 1929 value. The hours worked drop between 1929 and 1932 and between 1936 and 1938. But the second time the fall is less large. The hours worked are 13.8% and 17.76% below their 1929 level in 1932 and 1938 respectively. After 1938, the hours worked variable starts its recovery.

3 The Business Cycle Accounting Approach

In this section, we present the BCA methodology, pioneered by CKM. The purpose of this method is to help us to find out the key mechanisms which would best explain what happened in France during the Great Depression.

3.1 The Benchmark Prototype Model

The first idea CKM put forward is that many *sophisticated* models — as the models with market frictions and/or imperfections — could be rewritten

as a Real Business Cycle alike model⁸. So, the latter, named the prototype model, can be thought as a reduced form model or a meta-model. Once the model is described and the equilibrium equations are derived, this point will be clearer.

Consider a closed and real model economy where there are three infinitely living agents — households, firms and a government — two markets — the good and labor market — and an homogenous good produced by the firms. Both markets are competitive. The good could be used as well as a private consumption good, as an investment good or as a public consumption good. In the following, we present the structure of this economy directly with per capita and stationary variables. These variables are written in lower case letter to show that they are divided by the working-age population and with a hat on to show that they are detrended by technical progress⁹.

The representative household is supposed to choose its flow of consumptions, investments and labor supplies which maximize its expected intertemporal utility function, subject to their budget constraint and the capital accumulation law, and taking the real wage rate, the real capital rental rate

⁸This is the *equivalence result* in Chari, Kehoe and McGrattan(2006a).

⁹Note that this formulation is equivalent to the one with non-stationary variables.

and the tax rates as given:

$$\begin{aligned}
& \text{Max}_{\{\hat{c}_t, l_t, \hat{k}_{t+1}\}} E_0 \sum_{t=0}^{+\infty} \tilde{\beta}^t \frac{(\hat{c}_t(1-l_t)^\psi)^{(1-\sigma)}}{1-\sigma} \\
& \text{subject to } \hat{c}_t + (1 + \tau_{xt})\hat{x}_t = (1 - \tau_{lt})\hat{w}_t l_t + r_t \hat{k}_t + \hat{t}r_t \\
& (1 + \eta_n)(1 + \eta_z)\hat{k}_{t+1} = (1 - \delta)\hat{k}_t + \hat{x}_t \quad (1) \\
& \hat{c}_t, \hat{x}_t \geq 0
\end{aligned}$$

$\hat{c}_t$ denotes consumption, $\hat{k}_t$ capital stock, $\hat{x}_t$ investment, l_t labor input, $\hat{t}r_t$ lump-sum transfers. η_n, η_z are respectively the working-age population growth rate and the labor-augmenting technical progress growth rate. $\hat{w}_t, r_t$ indicate respectively the wage rate and the capital rental rate. τ_{lt}, τ_{xt} are labor and investment tax rates, respectively. Moreover, δ denotes the capital depreciation rate parameter, ψ the household preference parameter for leisure, σ the relative risk of aversion parameter and $\tilde{\beta}$ the modified discount factor parameter¹⁰. Note that the labor input, the capital rental rate and the tax rates variables are written without a hat on. Indeed, it is assumed that these variables are already stationary ones.

The representative firm chooses, each period, the quantities of capital and labor inputs it needs to maximise its profits, subject to a Cobb-Douglas technology and taking the real wage rate and the real capital rental rate as

¹⁰Suppose that the household discount factor is noted β then the modified discount factor, the one which suits to an per capita and detrended economy, is equal to $\beta(1 + \eta_n)(1 + \eta_z)^{1-\sigma}$, that is the discount factor is scaled by both the economy growth rate and the working-age population growth rate.

given:

$$\begin{aligned} \text{Max}_{\{\hat{k}_t, l_t\}} (1 + \eta_n)^t (1 + \eta_z)^t (\hat{y}_t - r_t \hat{k}_t - \hat{w}_t l_t) \\ \text{subject to } \hat{y}_t = \hat{k}_t^\theta (z_t l_t)^{1-\theta} \end{aligned}$$

where $\hat{y}_t$ is the output and z_t is a measure of the stationary part of the labor-augmenting technical progress.

The government raises taxes on labor and investment and makes public expenditures. He uses the lump-sum transfers to the households (or from the households, if these transfers are negative) to balance his budget constraint:

$$\hat{g}_t + \hat{t}r_t = \tau_{lt} \hat{w}_t l_t + \tau_{xt} \hat{x}_t$$

where $\hat{g}_t$ denotes the government expenditures.

The resource constraint of this economy is given by the following equation:

$$\hat{c}_t + \hat{x}_t + \hat{g}_t = \hat{y}_t$$

The resolution of the agents' optimisation problems leads to the following stationary equilibrium equations:

$$\hat{c}_t + \hat{x}_t + \hat{g}_t = \hat{y}_t \tag{2}$$

$$\hat{y}_t = z_t^{1-\theta} \hat{k}_t^\theta l_t^{1-\theta} \tag{3}$$

$$\psi \frac{\hat{c}_t}{1 - l_t} = (1 - \tau_{lt})(1 - \theta) \hat{k}_t^\theta z_t^{1-\theta} l_t^{-\theta} \tag{4}$$

$$\begin{aligned} \hat{c}_t^{-\sigma} (1 - l_t)^{\psi(1-\sigma)} &= \hat{\beta} E_t \hat{c}_{t+1}^{-\sigma} (1 - l_{t+1})^{\psi(1-\sigma)} \\ &\quad \frac{\theta \hat{k}_{t+1}^{\theta-1} (z_{t+1} l_{t+1})^{1-\theta} + (1 - \delta)(1 + \tau_{xt+1})}{1 + \tau_{xt}} \end{aligned} \tag{5}$$

where $\hat{\beta} = \frac{\tilde{\beta}}{(1+\eta_n)(1+\eta_z)}$.

There are two ways to interpretate these equilibrium conditions. On the one hand, we can say that they simply characterize a Real Business Cycle model with a government agent, that is a business cycle model with technological, z_t , taxes, τ_{lt} , τ_{xt} and government expenditure, $\hat{g}_t$, shocks. In other words, from this point of view, they are the explicit equilibrium conditions of the model we have just described above. On the other hand, we can understand $\hat{g}_t$, $z_t^{1-\theta}$, $1 - \tau_{lt}$ and $\frac{1}{1+\tau_{xt}}$ as measures of the distortions which run in the economy at the equilibrium. More precisely, along this second interpretation, $\hat{g}_t$ measures the difference between the private demand and the supply in the economy, $z_t^{1-\theta}$ measures the efficiency with which labor and capital inputs are used in the production sector, $1 - \tau_{lt}$ measures the deviation of the marginal rate of substitution between leisure and consumption from the marginal product of labor and $\frac{1}{1+\tau_{xt}}$ measures the deviation of the intertemporal marginal rate of substitution in consumption from the marginal product of capital. Thus, these equilibrium equations concern a more larger class of models than the one presented above, according to this second interpretation. Actually, we will focus on the latter reading. In the next subsection, we will explain this choice.

3.2 The Meaning of the Wedges

CKM named the distortion measure $\hat{g}_t$ the *government consumption wedge*, $z_t^{1-\theta}$ the *efficiency wedge*, $1 - \tau_{lt}$ the *labor wedge* and $\frac{1}{1+\tau_{xt}}$ the *in-*

vestment wedge. An interesting question one may ask is the following: How should these different time-varying wedges move along the business cycles according to the equilibrium conditions (2) – (5)? A growing government consumption wedge, in absolute value, induce an important gap between the output supply and the private domestic demand *i.e.* the private consumption plus the investment. A positive gap means that the government consumption wedge prevents the output from decreasing and the private domestic demand from increasing even though these two quantities do not coincide. In the same way, a negative gap means that the government consumption wedge prevents the output from increasing and the private domestic demand from decreasing. A greater level of output should be produced from a better use of the capital and labor inputs. Then, a higher efficiency wedge, with respect to its steady state level, ought to be a source of an expansion, and conversly, a lower efficiency wedge ought to be a source of a recession. When the marginal rate of substitution between leisure and consumption is becoming smaller and smaller than the marginal product of labor, it is in the interest of the representative household to supply more labor, and of the representative firm to demand more labor. However, the distortions which manifest themselves as labor wedge, prevent the representative household and firm from reaching their goal. Which means, that a recessive economy could be driven by a moving down labor wedge and an expansive economy by a moving up labor wedge. Following the same reasoning as the one used for the labor wedge, a decreasing investment wedge prevents the representative

household from investing more and prevents the representative firm from demanding more capital. Such a scenario could be observed during a recession. Hence, the equilibrium conditions above, show us, through each wedge, the overall distortions that operate in the economy, which means that they do not tell us how much of these distortions are borne by the households or by the firms.

This is the wedge-based interpretation which will best suit our concern here. Indeed, CKM show that one can rewrite a sophisticated model with market imperfections or explicit frictions as a neoclassical growth model with one or several wedges. All the terms which characterize the market imperfections or the frictions in the sophisticated model will be synthesized by the wedges. For example, CKM demonstrate that a model with an input financing problem is closed to a prototype model with an efficiency wedge. A model with sticky wage and monetary shock is close to a prototype model with a labor wedge. A model with investment financing problem could be reconstructed as a prototype model with an investment wedge. And a model with international lending and borrowing is equivalent to a prototype model with a government consumption wedge¹¹. Thus, a researcher who has identified the main wedges responsible of the economic fluctuations observed in the data¹², is able to choose which family of sophisticated models he should

¹¹For more details, see Chari, Kehoe and McGrattan(2000a).

¹²The fact that only the overall distortions operating in the economy is put in light here, is not a deficiency in the interpretation since, according to CKM, one “*focus on the overall wedges because what matters in determining business cycle fluctuations is the overall wedges, not each distortion separately*”.

head for.

Since this model is appropriate for our purpose, we fully solve it, that is we derive its decision rules: $\hat{y}_t(\hat{k}_t, s_t)$, $\hat{c}_t(\hat{k}_t, s_t)$, $\hat{x}_t(\hat{k}_t, s_t)$ and $\hat{l}_t(\hat{k}_t, s_t)$ where $s_t = (\log z_t, \tau_{lt}, \tau_{xt}, \log \hat{g}_t)'$ and $\hat{k}_t$ is generated with the capital law of accumulation (1). To do so, we need to define a stochastic process for s_t . Hereafter, we name the elements in the vector s_t the *wedge variables* to distinguish them from what we call the wedges. The stochastic process for the wedge variables which is considered in the BCA approach, is a first order vector autoregressive process:

$$s_{t+1} = P_0 + P s_t + \varepsilon_{t+1} \quad (6)$$

where $\varepsilon_t \rightsquigarrow i.i.d. N(0, V)$. The computation solution method one should use depends on the characteristics of the business cycle under study. We will turn back to this problem when we present our BCA application.

3.3 The Accounting Procedure

In the previous subsection, we have presented the model from which all the distortions that would exist in a given economy — in a reduced form — have been put in light. Now the questions which remain are, on the one hand, how one could uncover the realizations of the wedges, on the other hand, how one could identify the effect of each wedge or combinations of these wedges on the movements of the real macro-aggregates.

3.3.1 Uncovering the wedges

As we said earlier, the researcher needs to measure the four wedges in order to assess the weight of each wedge or the combinations of these wedges on economic fluctuations. The government consumption wedge is calculated using the available data on public spending and net exports, by adding them. Indeed, the difference between the private demand and the supply in a given economy, as was defined the government consumption wedge, is basically filled by these two terms. Moreover, the efficiency wedge and the labor wedge could be deduced from the production function — equation (3) — and the static first order condition — equation (4) — respectively¹³. However, one can not use the intertemporal Euler equation to generate the realizations of the investment wedge, at least one would keep the stochastic dimension of the model. Indeed, the intertemporal Euler equation is an equation which is expressed in term of expectation over the next period values of household consumption, capital stock, labor, efficiency wedge and investment wedge. Thus, the researcher should use one decision rule of this model, say the investment decision rule, to infer a series for the investment wedge. Notice, by the way, that the way the wedges are uncovered must be consistent with

¹³Formally, the efficiency and labor wedges are generated from:

$$\begin{aligned} z_t^{1-\theta} &= \frac{\hat{y}_t}{\hat{k}_t^\theta l_t^{1-\theta}} \\ 1 - \tau_{lt} &= \frac{\psi}{1-\theta} \frac{\hat{c}_t}{\hat{y}_t} \frac{l_t}{1-l_t} \end{aligned}$$

the observations of the economic variables: the prototype model, with all the four wedges, would be able to generate data close to those observed.

With the decision rules of the prototype model and the series for the wedges and assuming the structural parameters of the model as well as the matrices P and V are known, it is possible to conduct the simulation exercises, that is the decomposition of the wedge effects on the economic fluctuations. The way these experiments should be conducted is presented in the next point.

3.3.2 Decomposing the wedge effects

The purpose of this last step of the accounting procedure is to evaluate, through simulation exercises, the importance of each wedge or combinations of the wedges on the movements of the real macro-aggregates. Let us take an example to explain how to implement the decomposition. Suppose we want to evaluate the effects of the efficiency wedge on output, consumption, and so on. Call the economy we try to describe, *efficiency wedge economy*. So we have to stop the three other wedges — labor, investment and government consumption wedges — from having any effect on the real macro-aggregates, that is hold the labor, investment and government consumption variable wedges constant over time. This amounts to computing the decision rules of the *efficiency wedge economy* denoted $\hat{y}_e(\hat{k}_t, s_{e,t})$, $\hat{c}_e(\hat{k}_t, s_{e,t})$ and so on, with $s_{e,t} = (\log z_t, \pi, \tau_x, \log \hat{g})'$ and $\hat{k}_t$ calculated with the capital accumulation law (1). Then we compare the simulated series for output, consumption,

investment and labor with their respective realizations. Notice that we must be aware that the probability distribution of the efficiency variable wedge, in the *efficiency wedge economy* should be the same as the one in the economy where all the four wedges fluctuate. To make sure that the experiment does not change the probability distribution of the efficiency and labor variable wedges, the experiment should neutralize the effects of the government consumption, labor and investment variable wedges on the decision rules but not their effects on the expectations of the fluctuating variable wedge.

4 The Great Depression in France

In this section, we present our application of the BCA procedure to the French Great Depression¹⁴.

4.1 The Solution Method and the Parameter Values

In the description of the BCA approach, above, we skipped the model solution method and the parameter values assignment problems, in order to focus on the methodology, strictly speaking. We come back to these important questions now.

The structural parameters of the prototype model are all calibrated. We choose the capital share $\alpha = 0.34$, the household preference parameter for leisure $\psi = 0.8485$, the technology growth rate $\eta_z = 0.0184$ and the population growth rate $\eta_n = 0.0037$. The capital depreciation rate is calculated on

¹⁴To perform the Business Cycle Accounting procedure, we use the Ellen R. McGrattan's codes.

the base of a Villa (1993)'s measure of capital stock, $\delta = 0.0577$. We evaluate the households discount factor to 0.9777, so the parameter $\hat{\beta} = 0.96$. We fix the relative risk of aversion parameter $\sigma = 1$ to obtain a log utility function.

However, the matrices P and V have to be estimated. We define a matrix Q such that $V = QQ'$. The matrix Q is constrained to be a lower triangular matrix in order to ensure that V is positive semidefinite. More precisely, the matrices P and Q have the following form:

$$P = \begin{pmatrix} \bar{P} & 0 \\ 0 & p_{44} \end{pmatrix} Q = \begin{pmatrix} \bar{Q} & 0 \\ 0 & q_{44} \end{pmatrix} \quad (7)$$

where $\bar{P}$ is a non-constrained $(3, 3)$ square matrix and $\bar{Q}$ is a lower triangular $(3, 3)$ square matrix. The zeros in these matrices are imposed to prevent the large fluctuations in government consumption during the World War 1 from biasing the estimation. Moreover, actually what we estimate are P and Q , V will be deduced afterward from Q .

It is more convenient to estimate the matrices P and Q using the decision rules of the prototype model when the latters are log-linearly approximated. To do so, we apply a log-linear method on the equilibrium equations (2)–(5). We then obtain the model solution on a state space form:

$$X_{t+1} = A(\gamma)X_t + B(Q)v_{t+1} \quad (8)$$

$$Y_t = C(\phi)X_t + \omega_t \quad (9)$$

where

$$\begin{aligned} Y'_t &= \begin{pmatrix} \log \hat{y}_t & \log \hat{x}_t & \log l_t & \log \hat{g}_t \end{pmatrix} \\ X'_t &= \begin{pmatrix} \log \hat{k}_t & \log z_t & \tau_{lt} & \tau_{xt} & \log \hat{g}_t & 1 \end{pmatrix} \end{aligned}$$

$E\omega_t\omega_t' = R\forall t$, $\gamma = (P, P_0)$ and ϕ indicates the decision rule parameters.

Following CKM, we estimate P and Q by maximum likelihood using the annual data on output, investment, hours worked and government consumption over the period 1896-1939. As we consider that the state vector X is inobservable, we construct the likelihood function with the Kalman Filter¹⁵. The results of the estimation are reported in Table 2.

According to CKM, in a great depression case, it is more accurate to implement the simulation exercises with non-linear decision rules, even if the estimation was based on log-linear decision rules. However for a first attempt, we judge better to run the simulations on log-linear decision rules.

4.2 The Results

Now, we present the results we obtain when we apply the BCA procedure for the Great Depression in France. We are interested in the fluctuations in output, investment and hours worked variables, and our discussion focus on the effects of the efficiency, labor and investment wedges on the aggregate fluctuations. As we find that the government consumption wedge accounts for none of the movements in output, investment and hours worked, we do not report, here, the findings relative to the government consumption wedge¹⁶.

¹⁵For the details, see Chari, Kehoe and McGrattan(2006b).

¹⁶We report them in the appendix.

4.2.1 The movements in the wedges

We plot in Figure 4 the realizations of the efficiency, labor and investment wedges as well as the actual output, over the Great Depression period, that is 1929-1939. The efficiency wedge, $z_t^{1-\theta}$, starts to deteriorate from 1930 as the output does. It decreases in a regular way between 1930 and 1936. From 1936 we can observe an attempt of recovery. However, it does not last since the efficiency wedge falls again from 1938. The labor wedge falls dramatically between 1929 and 1932. Then, it improves over the period 1932-1936 but not in a sufficient way. Indeed, the labor wedge gets worse between 1936 and 1937. The next two years, it remains stable. The investment wedge remains above its 1929 level over all the Great Depression period even though it fluctuates during this period.

Thus, there are some differences and similarities between the realizations of the wedges in France and those in U.S. during the 1930s. The efficiency wedge, after a large fall, returns to its 1929 level by 1939 in U.S. while it do not in France. Globally, we can say that the movements in labor wedge are quite similar in both countries even though it declines much stronger in U.S. than in France. As in U.S., the investment wedge do not appear as a recessive factor for the French economy during the Great Depression. The scale of the increase in the investment wedge in France is close to the U.S. one. Notice also, that our finding about the efficiency wedge is quite different from the total factor productivity (TFP) constructed by Beaudry and Portier (2002). Indeed their TFP recovers totally between 1936 and 1939 whereas

the efficiency wedge is sluggish.

However, the study of the wedge realizations tells us a little about the effect of the different wedges on the fluctuations in the aggregate variables. To assess the contribution of these wedges in the business cycle fluctuations we should perform the decomposition exercises described above.

4.2.2 The accounting

Here we present the results of the decomposition exercises to evaluate the contribution of the efficiency, labor and investment wedges in the movements of output, investment and hours worked during the Great Depression in France. To do so, we define six different economies. By efficiency wedge economy, we understand a benchmark prototype model where only the efficiency wedge is time-varying. The labor wedge economy is a benchmark prototype model where only the labor wedge is time-varying. The investment wedge economy is, then, defined by a benchmark prototype model where only the investment wedge moves. In the same way, the no efficiency wedge economy, no investment economy and no labor wedge economy are described by benchmark prototype models where all the wedges but, respectively, efficiency wedge, investment wedge and labor wedge fluctuate.

Let us focus first on the fluctuations in output. In the top left part of Figure 5, we plot the actual output in the 1930s together with the predictions of both efficiency wedge economy and labor wedge economy for output. These plots suggest that the deterioration of the efficiency wedge during the 1930

explains well the fall of output over this period. However, the labor wedge economy predicts a milder drop in output than what we can observe in the data. Comparing Tables 3 and 4 with Table 1 would make these comments clearer.

In 1932, after a large drop, the actual output is 13.65% below its 1929 value. The efficiency wedge economy predicts for output, also a large fall which drives the latter to be, in 1932, 17.87% below its 1929 value. In 1936, according to the efficiency wedge economy prediction, the output should be 25% below its 1929 value. The data say that it is actually 22.47% below its 1929 value. In 1939, the simulation of the efficiency wedge economy suggests that the output is 23.5% below its 1929 value, which is not far from the data observations since the output is actually 24.34% below. This result suggests that the fit of the efficiency wedge economy is quite good for the output.

The labor wedge economy predicts for output an important drop between 1929 and 1932. Leaving aside the fact that the output starts declining, in the actual economy, one year later than it does in the labor wedge economy, the predicted and actual output appear quite close until 1932. Indeed, in 1932 the actual and simulated output are respectively 13.65% and 15.26% below their 1929 levels. After that, the two series have different patterns. While the actual output keeps on decreasing, the predicted output initiates a recovery until 1936. Thus, in 1936, the labor wedge economy predicts that the output is 9.42% below its 1929 value while in the actual economy it is 22.47% below. Between 1936 and 1939, the predicted output drops and then initiates a new

recovery. In 1939, the predicted and actual output are, respectively, 12.94% and 24.34% below their 1929 values. Thus the labor wedge is not able to capture on its own the persistence of the depression.

In the top left part of Figure 6 we illustrate the actual output and the output simulated with the investment wedge economy during the 1930s. Clearly, the investment wedge has an expansionary effect on the output. Even though the predicted output fluctuates during the 1930s, it remains above its 1929 value. In 1939, the predicted output is 2.2% above its 1929 value while the actual output is 24.34% below its 1929 value, as it can be seen in Table 5.

What can we say about the marginal effects of the efficiency, labor and investment wedges on the movements in the investment and hours worked during the Great Depression? According to Figure 5 and Table 3, in the efficiency wedge economy the drop in investment appears more dramatically than what it is observed in the data. For example, the predicted investment is 71% below its 1929 level in 1932 and 73.43% below its 1929 level in 1939. However, according to the data, the actual investment is 36% and 60.13% below its 1929 value in 1932 and 1939 respectively. Even though the labor wedge economy prediction for the investment is globally decreasing during the 1930s, it does not behave exactly as in the data. Between 1929 and 1932 the predicted investment is lower than the actual. Then the predicted investment initiates a recovery over the period 1932-1936 which drives it above the actual investment. Again, during the next two years, the predicted investment goes successively below and above the actual investment. In 1939, according to

the labor wedge economy the investment is 46.85% below its 1929 value while it is actually 60.13% below. Moreover, in an economy where only the investment wedge is time-varying, the investment would fluctuate, during the Great Depression, highly above its 1929 value, as we can see in Figure 6 and Table 5.

Figure 5 and Tables 3 and 4 help us, also, to understand the separate contributions of the wedges on the movements in hours worked. The efficiency wedge economy and labor wedge economy predictions for the hours worked go, globally, with the data. However, the hours worked simulated with the labor wedge economy fall more than the actual ones. Besides, Figure 6 and Table 5 show that the investment wedge has an expansionary effect on the hours worked since the predicted hours worked remain higher than their 1929 value.

Notice that even though the investment wedge drives the output, investment and hours worked up, it seems to play an important role in the Great Depression in France. Indeed, Figure 7 and Table 6 demonstrate that in an economy where all the wedges but the investment wedge are time-varying, the output, investment and hours worked would have more strongly collapsed than these variables do in the data. Thus, the no investment wedge economy prediction for the output in 1939 is 35% below its 1929 value while the actual output is 24.34% below. This economy predicts also that, in 1939, the investment and hours worked would be respectively 86% and 31.4% below their 1929 value while actually they are 60.13% and 13.26% below, respectively.

According to Figure 7 and Table 6, the efficiency wedge appears necessary to understand the Great Depression in France, at least for the decline in the output and investment. Indeed, the no efficiency wedge economy prediction for the hours worked capture well the movements in the actual hours worked. However, this economy clearly underestimates the drop in the output and investment observed in the data.

Figure 8 and Table 7, which present the prediction of the no labor wedge economy, confirm these remarks. The efficiency and investment wedges explain almost all the movements in the output, investment and hours worked observed in the data during the 1930s, even though they do not play the same role. Although the investment wedge together with the efficiency wedge do not explain as well as it does together with the labor wedge, the fluctuation in the hours worked, the no labor wedge economy prediction for this variable is quite good. In 1939, the no labor wedge economy predictions for the output, investment and hours worked are very close to what we can observe in the data, since they are respectively, 24%, 68% and 12.22% below their 1929 values.

4.3 Discussion

To sum up our finding, we can say that in the French economy, during the 1930s, there are two kinds of frictions which present opposite roles. First, there are the frictions which influence the way the labor and capital inputs are used in the production process *i.e.* the efficiency wedge. Second, there

are the frictions which manifest themselves as the investment wedge. The former has a depressive effect and the latter an expansionary effect on the French economy during the period in study. However, the efficiency wedge appear much stronger than the investment wedge.

It is interesting to compare our study with those of CKM and Beaudry and Portier (2002). CKM apply their method to the U.S. Great Depression. They emphasize that the distortions which manifest themselves as efficiency and labor wedges are the main contributors to the deep depression that occurs in the U.S. during the 1930s. More precisely, they conclude first, that the decline in economic activity is mainly explained by a large deterioration in the efficiency wedge, second that the slow recovery in economic activity is mainly captured by a moving down labor wedge. The investment wedge has an expansionary effect on the economy. Consequently the distortions which take the form of an investment wedge are not interesting to understand the U.S. Great Depression. Besides the government consumption wedge does not account for the observed movements in the variables of interest. According to our finding, the story is quite different in France over the decade. We stress that a moving down efficiency wedge is responsible for the output downturn which lasts all the 1930s. As for the U.S., the investment wedge has a positive effect on the fluctuations in France. However, this wedge plays an important role during the 1930s. Indeed the investment wedge prevents the French Great Depression from getting worse. Moreover, contrary to the U.S. case, the labor wedge is neither sufficient nor necessary to account for

the Great Depression in France. The government consumption wedge, as in U.S., does not contribute to the drop in the French economic activity.

Beaudry and Portier (2002) focus on the role of total factor productivity (TFP) in the French Great Depression. These authors use the neoclassical growth model and do some growth accounting exercises to assess the ability of the TFP to explain the French depression. So, we can compare our results with those of Beaudry and Portier (2002). They find that the measured movements in TFP do not provide an interesting explanation for the downturn. Clearly, our results are the opposite of those given by these authors, since we find that the efficiency wedge is an important factor to understand what happened during the 1930s in France. They find that the TFP remains constant from 1930 to 1935 then decreases between 1935 and 1936. After that, it strongly increases in the next two years, reaching higher level than the 1929 one, then declines a little. We find, rather, that the efficiency wedge declines over all the decade.

5 Conclusion

We have applied the Business Cycle Accounting methodology to the French Great Depression. This study enlightens three results. First, the distortions which manifest themselves as the efficiency and investment wedges are good candidates for understanding what happened in France during the 1930s. Second, these two wedges have opposite effects on the French economic activity. More precisely, the moving down efficiency wedge leads the

output, investment and hours worked to fall deeply. The moving up investment wedge dampens the depressive effect of the efficiency wedge, failing to cancel it. Third, the labor wedge appears neither sufficient nor necessary to explain the French Great Depression. So, the 1936 institutional changes in the labor market which manifest themselves as a labor wedge, do not provide an interesting direction to study more deeply the French depression.

This study would be pursued in the following direction. We would identify the mechanisms which create the distortions behind the efficiency and investment wedges. Here, the more astonishing result is the contribution of the investment wedge which slows down the French depression. Thus the questions one may want to ask are: Which kind of frictions manifest themselves as an expansive investment wedge during the 1930s in France? Are financial frictions the cause of the existence of both efficiency and investment wedges? How does an expansive wedge interact with a depressive wedge? To answer these questions, we should inspect the French financial data and look for what we can learn from the economic history of France during the interwar period.

References

- [1] Bernanke, B. (1983). “Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression.” *American Economic Review*, 73, 257-276.
- [2] Bernanke, B. (1995). “The Macroeconomics of the Great Depression: A Comparative Approach.” *Journal of Money, Credit and Banking*, 27, 1-28.
- [3] Beaudry, P., and F. Portier (2002). “The French Depression in the 1930s.” *Review of Economic Dynamics*, 5, 73-99.
- [4] Chari, V., P. Kehoe and E. McGrattan (2002). “Accounting for the Great Depression.” *American Economic Review*, 87, 893-910.
- [5] Chari, V., P. Kehoe and E. McGrattan (2006a). “Business Cycle Accounting.” *Research Department Staff Report 362, Federal Reserve Bank of Minneapolis*, Forthcoming in *Econometrica*.
- [6] Chari, V., P. Kehoe and E. McGrattan (2006b). “Appendices: Business Cycle Accounting.” *Research Department Staff Report 328, Federal Reserve Bank of Minneapolis*.
- [7] Chari, V., P. Kehoe and E. McGrattan (2007). “Comparing Alternative Representations and Alternative methodologies in Business Cycle

Accounting.” *Research Department Staff Report 384, Federal Reserve Bank of Minneapolis.*

- [8] Christiano, L., R. Motto and M. Rostagno (2003). “The Great Depression and the Friedman-Schwartz Hypothesis.” *Journal of Money, Credit and Banking*, 35, 1119-1198.
- [9] Christiano, L. and J. Davis (2006). “Two Flaws in Business Cycle Accounting.” *Manuscript, Northwestern University.*
- [10] Cole, H. and L. Ohanian (1999). “The Great Depression in the United States from a Neoclassical Perspective.” *Federal Reserve Bank of Minneapolis Quaterly Review*, 23, 2-24.
- [11] Cole, H. and L. Ohanian (2004). “New Deal Policies and the Persistence of the Great Depression: A General Equilibrium Analysis.” *Journal of Political Economy*, 112, 779-816.
- [12] Kehoe, T. and E. Prescott (2002). “Great Depressions of the 20th Century.” *Review of Economic Dynamics*, 5, 1-18.
- [13] Mulligan, C. (2002). “A Dual Method of Empirically Evaluating Dynamic Competitive Equilibrium Models with Market Distortions, Applied to the Great Depression and World War II.” *Working Paper 8775, National Bureau of Economic Research.*
- [14] Prescott, E. (1999). “Some observations on the Great Depression.” *Federal Reserve Bank of Minneapolis Quaterly Review*, 23, 25-31.

- [15] Villa, P. (1993). “Une Analyse macro-économique de la France au XXème siècle.” *Paris: Presses du CNRS*.

A Figures

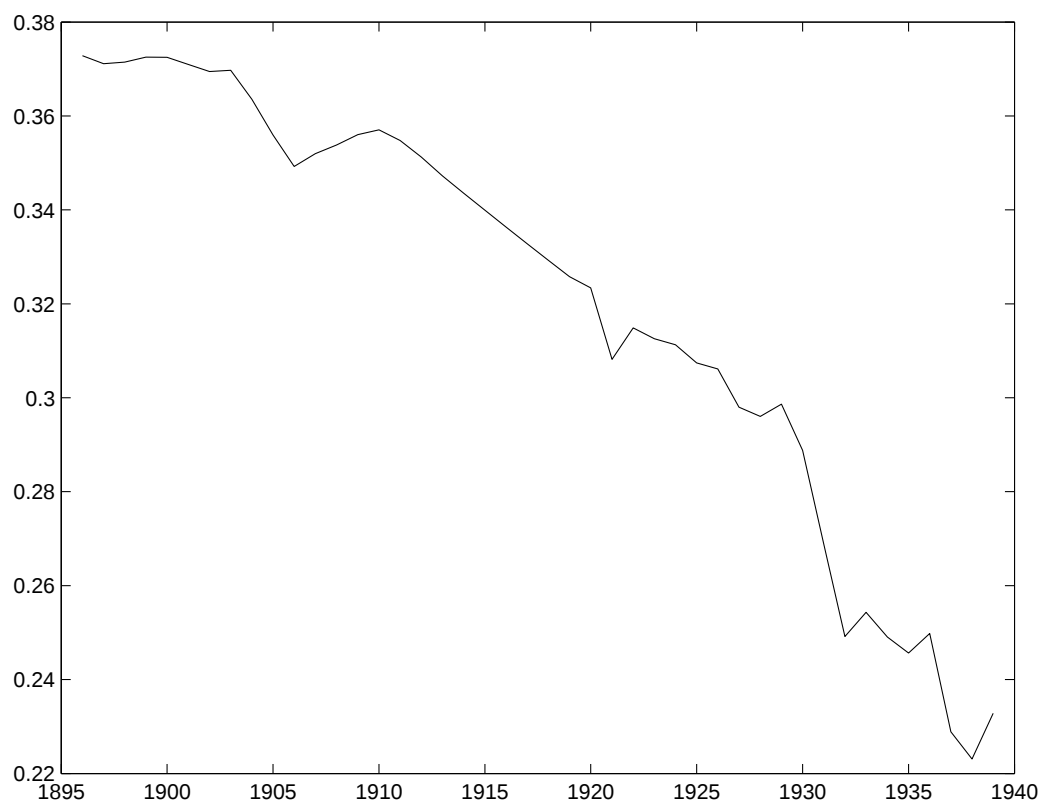


Figure 1: Non-stationary hours worked.

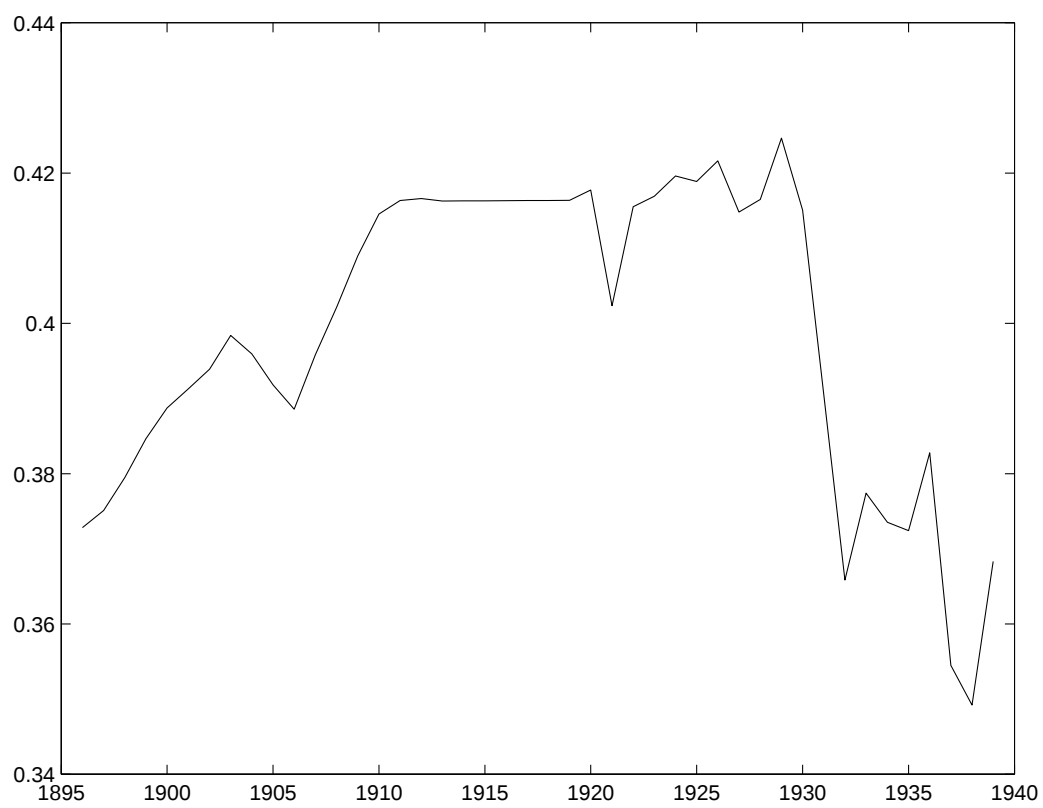


Figure 2: Stationary hours worked.

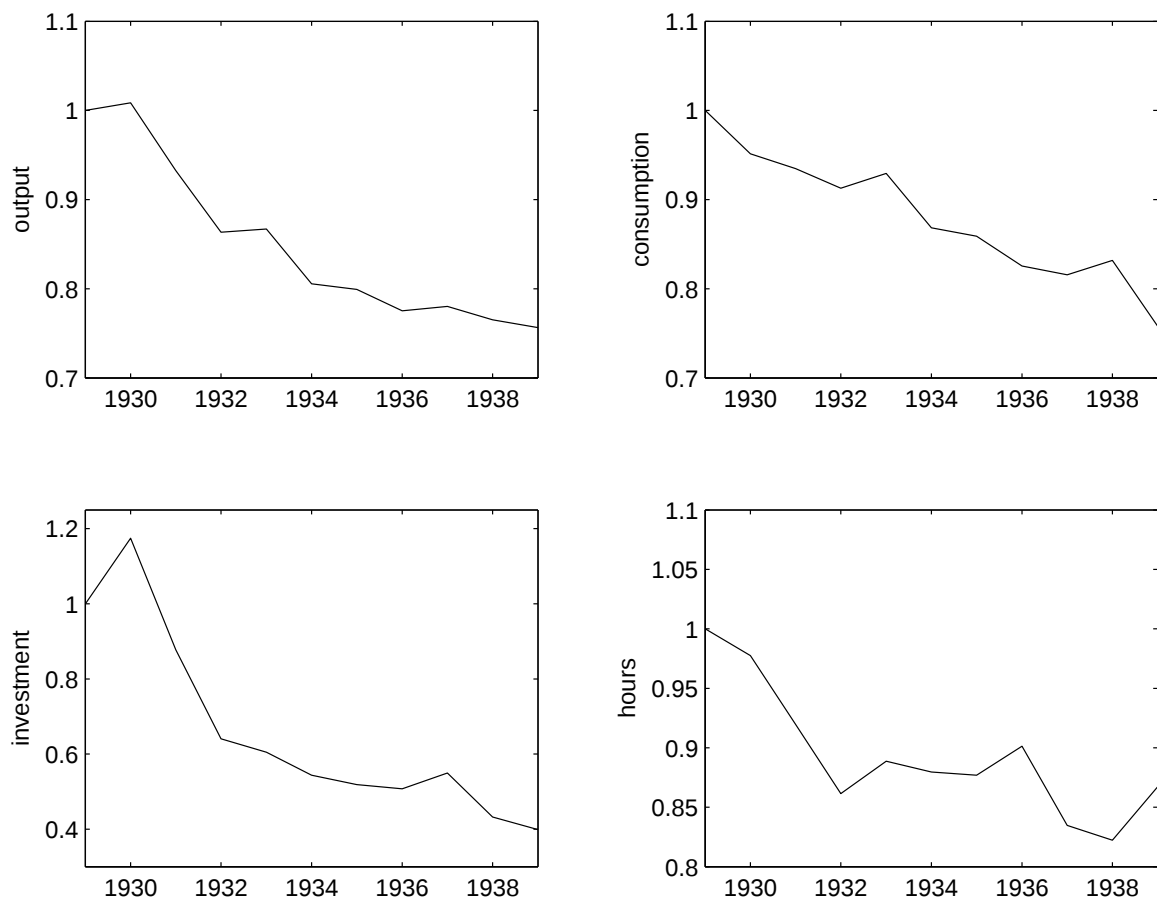


Figure 3: Detrended French output, consumption, investment and hours worked, 1929 = 100.

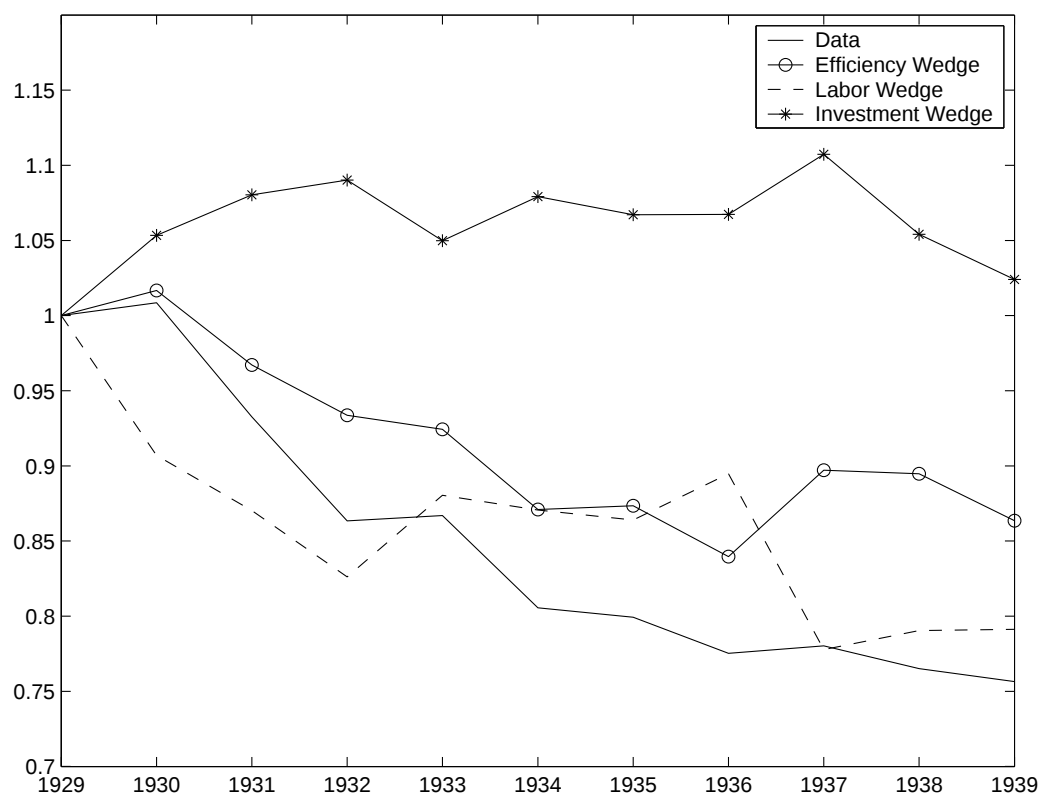


Figure 4: Output and measured wedges, 1929 = 100.

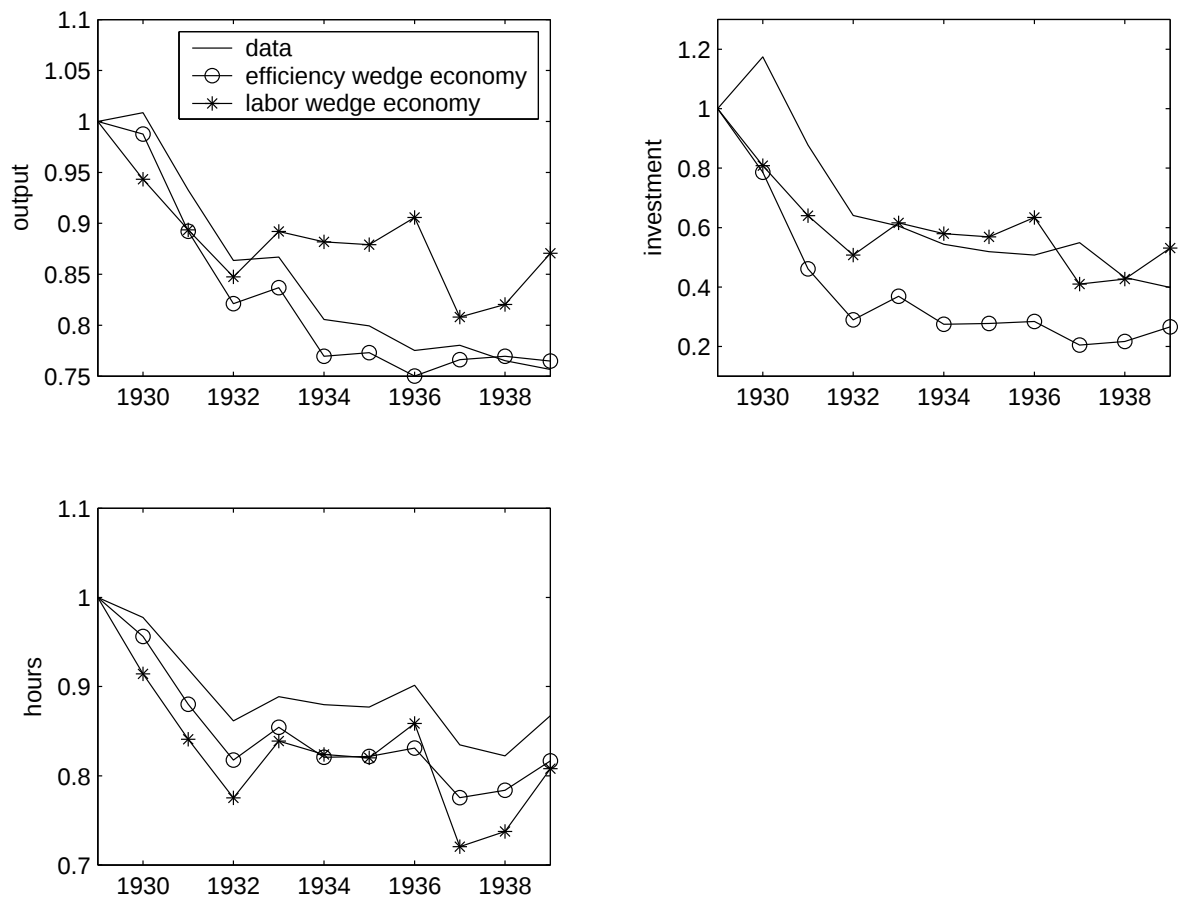


Figure 5: Efficiency wedge economy and labor wedge economy, 1929 = 100.

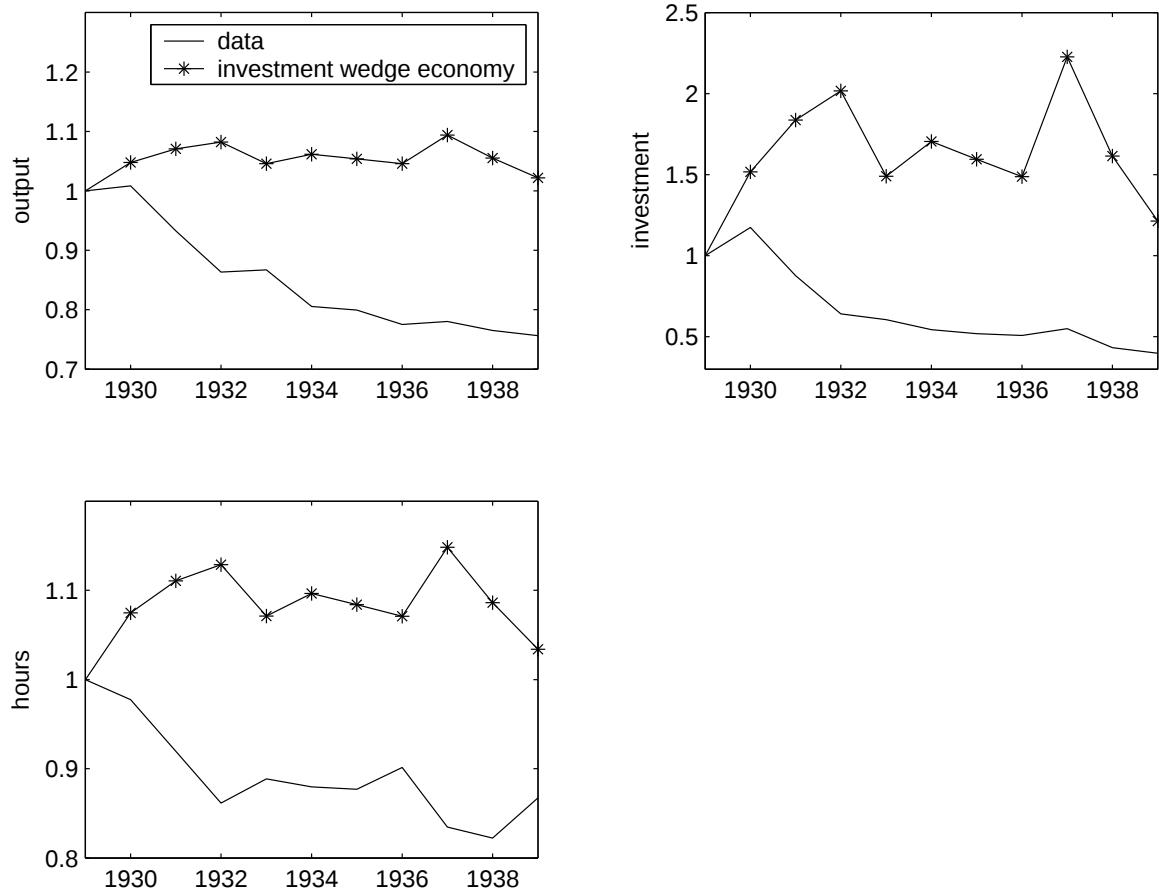


Figure 6: Investment wedge economy, 1929 = 100.

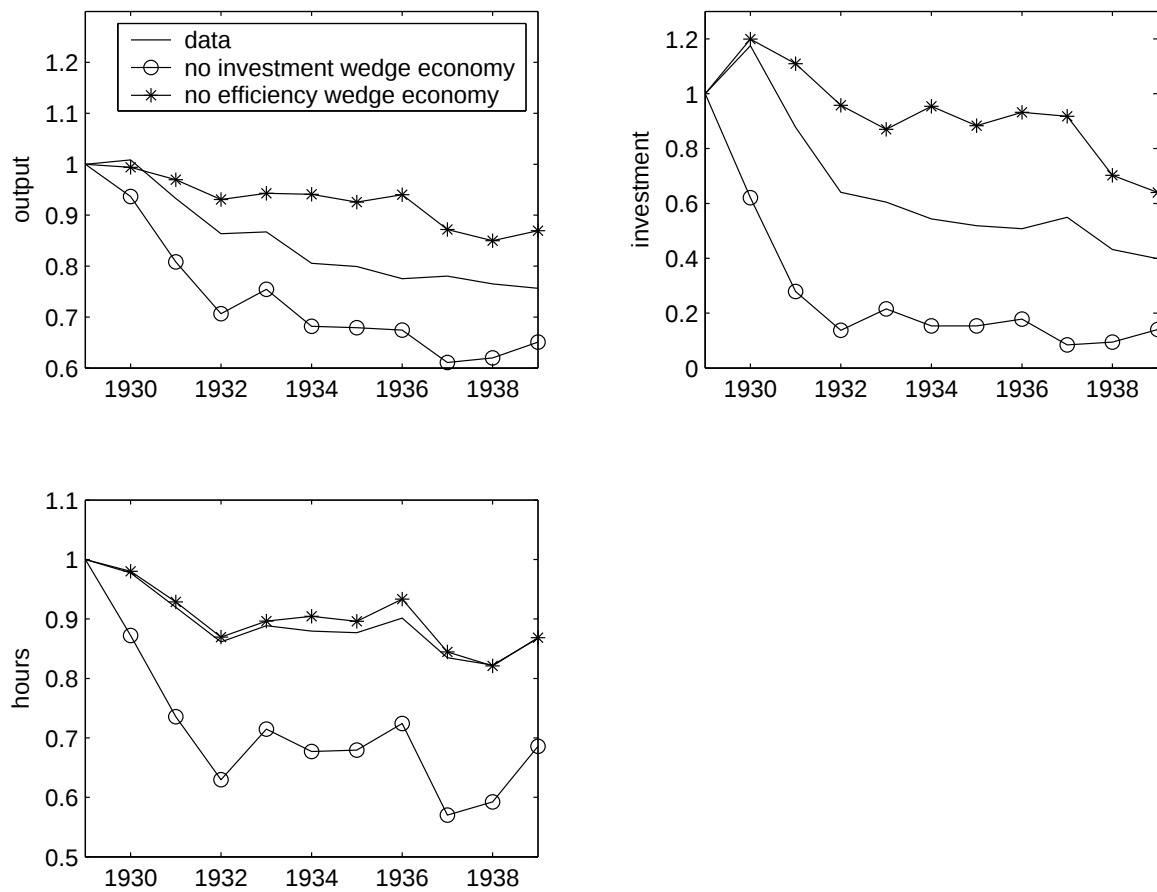


Figure 7: No efficiency wedge economy and no investment wedge economy, 1929 = 100.

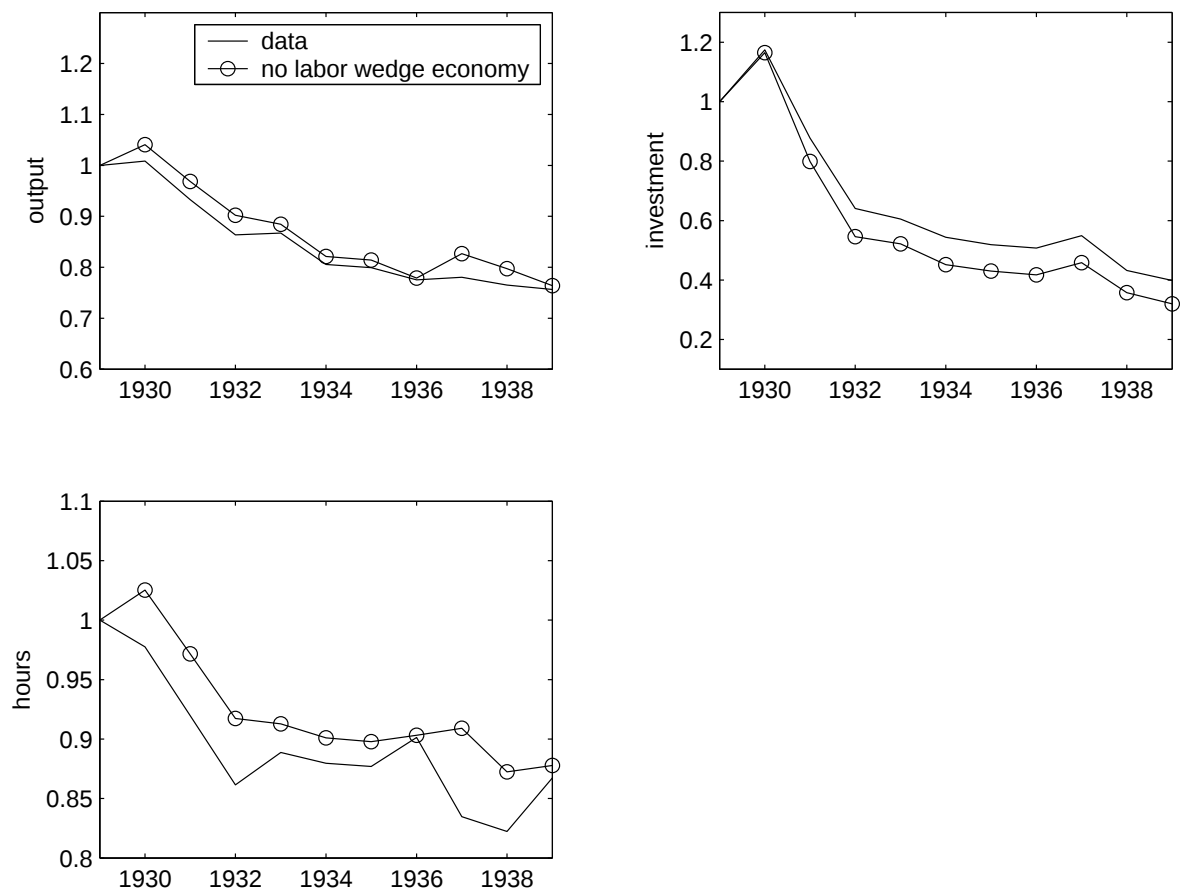


Figure 8: No labor wedge economy, 1929 = 100.

B Tables

Table 1: Actual economy

	Output	Investment	Hours	Consumption
1929	100.00	100.00	100.00	100.00
1930	100.85	117.48	97.74	95.14
1931	93.25	87.74	91.96	93.48
1932	86.34	64.07	86.14	91.27
1933	86.69	60.48	88.87	92.94
1934	80.56	54.35	87.96	86.82
1935	79.93	51.86	87.69	85.89
1936	77.52	50.76	90.13	82.55
1937	78.02	54.93	83.47	81.57
1938	76.51	43.22	82.23	83.18
1939	75.65	39.86	86.73	75.77

Table 2: Estimated parameters of vector AR(1) stochastic process.

Coefficient matrix P on lagged states ^a			
$\begin{bmatrix} 0.8479 \\ (0.4068) \end{bmatrix}$	$\begin{bmatrix} 0.4031 \\ (0.9094) \end{bmatrix}$	$\begin{bmatrix} 0.3547 \\ (0.8134) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.1224) \end{bmatrix}$
$\begin{bmatrix} 0.0605 \\ (0.1046) \end{bmatrix}$	$\begin{bmatrix} 0.8524 \\ (0.1994) \end{bmatrix}$	$\begin{bmatrix} -0.1551 \\ (0.1224) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.5208) \end{bmatrix}$
$\begin{bmatrix} -0.0228 \\ (0.2191) \end{bmatrix}$	$\begin{bmatrix} 0.2739 \\ (0.4937) \end{bmatrix}$	$\begin{bmatrix} 0.9686 \\ (0.5208) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.8784) \end{bmatrix}$
$\begin{bmatrix} 0 \\ (0.0926) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0926) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0926) \end{bmatrix}$	$\begin{bmatrix} 0.8784 \\ (0.0926) \end{bmatrix}$
Coefficient matrix Q such that $V = QQ'$			
$\begin{bmatrix} -0.0692 \\ (0.0124) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0070) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0115) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.3322) \end{bmatrix}$
$\begin{bmatrix} -0.0008 \\ (0.0081) \end{bmatrix}$	$\begin{bmatrix} 0.0171 \\ (0.0070) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0115) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.3322) \end{bmatrix}$
$\begin{bmatrix} -0.0276 \\ (0.0282) \end{bmatrix}$	$\begin{bmatrix} -0.0284 \\ (0.0236) \end{bmatrix}$	$\begin{bmatrix} -0.0132 \\ (0.0115) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.3322) \end{bmatrix}$
$\begin{bmatrix} 0 \\ (0.0250) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0250) \end{bmatrix}$	$\begin{bmatrix} 0 \\ (0.0250) \end{bmatrix}$	$\begin{bmatrix} 0.3322 \\ (0.0250) \end{bmatrix}$
The wedge steady state values s			
$\begin{bmatrix} 0.7620 \\ (0.4161) \end{bmatrix}$	$\begin{bmatrix} 0.3715 \\ (0.1158) \end{bmatrix}$	$\begin{bmatrix} 0.5616 \\ (0.2134) \end{bmatrix}$	$\begin{bmatrix} -3.4459 \\ (0.2791) \end{bmatrix}$

^aThe parameter matrices P and Q are estimated by maximum likelihood with French Villa (1993) data over the period 1896-1939. Numbers in parentheses are the standard errors.

Table 3: Efficiency wedge economy

	Output	Investment	Hours
1929	100.00	100.00	100.00
1930	98.76	78.58	95.61
1931	89.22	46.10	88.01
1932	82.12	28.93	81.76
1933	83.68	36.91	85.43
1934	76.94	27.43	82.07
1935	77.30	27.71	82.16
1936	75.00	28.39	83.10
1937	76.61	20.47	77.54
1938	76.95	21.70	78.36
1939	76.49	26.56	81.66

Table 4: Labor wedge economy

	Output	Investment	Hours
1929	100.00	100.00	100.00
1930	94.33	80.85	91.41
1931	89.35	64.03	84.10
1932	84.73	50.78	77.51
1933	89.20	61.61	83.88
1934	88.17	57.92	82.39
1935	87.90	56.90	82.00
1936	90.57	63.39	85.87
1937	80.80	40.98	72.04
1938	82.04	42.67	73.75
1939	87.05	53.14	80.79

Table 5: Investment wedge economy

	Output	Investment	Hours
1929	100.00	100.00	100.00
1930	104.79	151.77	107.47
1931	107.06	183.66	111.07
1932	108.19	201.70	112.88
1933	104.57	148.97	107.12
1934	106.17	170.46	109.64
1935	105.37	159.45	108.39
1936	104.56	148.77	107.10
1937	109.40	222.68	114.82
1938	105.52	161.42	108.62
1939	102.19	121.31	103.39

Table 6: No investment wedge economy

	Output	Investment	Hours
1929	100.00	100.00	100.00
1930	93.66	62.06	87.20
1931	80.81	27.85	73.57
1932	70.65	13.73	62.98
1933	75.45	21.56	71.47
1934	68.19	15.35	67.70
1935	67.91	15.35	67.92
1936	67.45	17.79	72.41
1937	61.06	8.43	57.02
1938	61.97	9.44	59.23
1939	65.09	14.00	68.59

Table 7: No labor wedge economy

	Output	Investment	Hours
1929	100.00	100.00	100.00
1930	104.05	116.51	102.52
1931	96.82	79.88	97.16
1932	90.21	54.55	91.72
1933	88.45	52.14	91.27
1934	82.11	45.18	90.09
1935	81.41	43.03	89.78
1936	77.87	41.76	90.31
1937	82.68	45.83	90.89
1938	79.71	35.71	87.24
1939	76.40	31.96	87.78

C The Government Wedge Economy

Let us define the government consumption wedge economy as an economy described by a benchmark prototype model where only the government consumption wedge is time-varying. Figure 9 hereafter demonstrates that the government consumption wedge has no effect on the French economic activity.

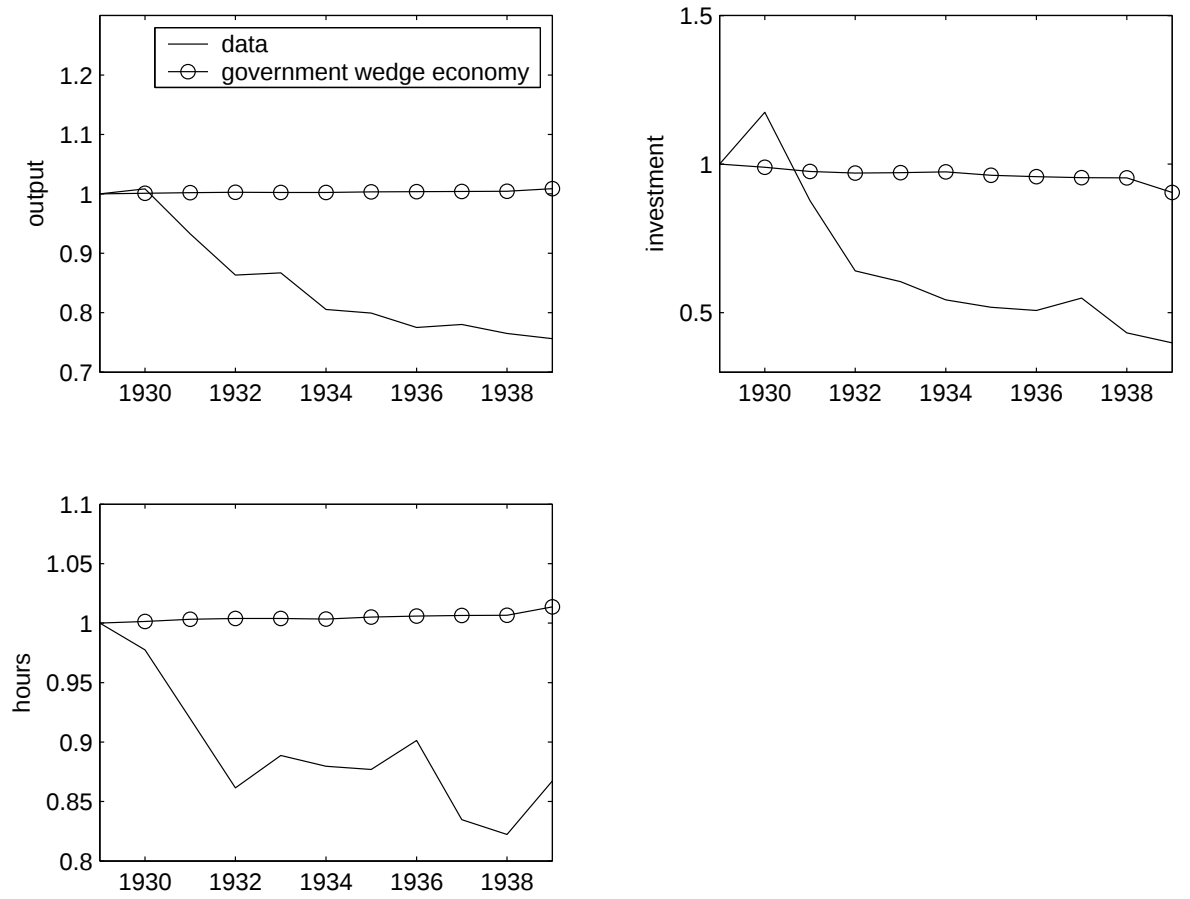


Figure 9: Government consumption wedge economy, $1929 = 100$.