*Federal Reserve Bank of Minneapolis Quarterly Review*
Spring 2003, Vol. 27, No. 2, pp. 2–8

# Accounting for the Great Depression

V. V. Chari
Paul W. Frenzel Land Grant
Professor of Liberal Arts
and Professor of Economics
University of Minnesota
and Consultant
Research Department
Federal Reserve Bank of Minneapolis

Patrick J. Kehoe
Monetary Adviser
Research Department
Federal Reserve Bank of Minneapolis
and Paul W. Frenzel Professor
of International Economics
University of Minnesota
and Research Associate
National Bureau of Economic Research

Ellen R. McGrattan
Senior Economist
Research Department
Federal Reserve Bank of Minneapolis
and Adjunct Professor of Economics
University of Minnesota
and Research Economist
National Bureau of Economic Research

**Abstract**

Economists have offered many theories for the U.S. Great Depression, but no consensus has formed on the main forces behind it. Here we describe and demonstrate a simple methodology for determining which theories are the most promising. We show that a large class of models, including models with various frictions, are equivalent to a prototype growth model with time-varying efficiency, labor, and investment wedges that, at least on face value, look like time-varying productivity, labor taxes, and investment taxes. We use U.S. data to measure these wedges, feed them back into the prototype growth model, and assess the fraction of the fluctuations in 1929–39 that they account for. We find that the efficiency and labor wedges account for essentially all of the decline and subsequent recovery. Investment wedges play, at best, a minor role. This article originally appeared in the *American Economic Review*. © American Economic Association.

*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.*

The Great Depression is not yet well understood. Economists have offered many theories for both the massive decline and the slow recovery of output during 1929–39, but no consensus has formed on the main forces behind this major economic event. Here we describe and demonstrate a simple methodology for determining which types of theories are the most promising.

Several prominent theories blame the Great Depression on frictions in labor and capital markets. The *sticky wage theory* is that wage stickiness together with a monetary contraction produces a downturn in output. (See Bordo, Erceg, and Evans 2000.) The *cartelization theory* is that an increase in cartelization and unionization leads to a slow recovery. (See Cole and Ohanian 2001.) The *investment friction theory* is that monetary contractions increase frictions in capital markets that produce investment-driven downturns in output. (See Bernanke and Gertler 1989, Carlstrom and Fuerst 1997.) We think the critical feature of both the sticky wage and cartelization theories is that their frictions lead to a wedge between the marginal rate of substitution between leisure and consumption and the marginal product of labor. The critical feature of the investment friction theory is that capital market frictions introduce a wedge between the intertemporal marginal rate of substitution in consumption and the marginal product of capital.

We show that the aggregate properties of a class of models with sticky wages and with cartels or unions are the same as those of a growth model with suitably constructed taxes on labor. We also show that a class of models with investment frictions is equivalent in terms of aggregate properties to a growth model with suitably constructed taxes on investment. We then consider an *input friction theory* in which frictions in financing inputs lead to a wedge between aggregate inputs and outputs. Such models have the same aggregate properties as a growth model with suitably constructed productivity. (See Bergoeing, Kehoe, and Kehoe 2002 for other frictions that show up as time-varying productivity.) These observations lead us to conclude that a large class of business cycle models are equivalent to a prototype growth model with time-varying wedges that, at least at face value, look like time-varying labor taxes, investment taxes, and productivity. We refer to these wedges as *labor wedges*, *investment wedges*, and *efficiency wedges*.

These equivalence results lead us to propose a method for accounting for economic fluctuations in general: *business cycle accounting*. We first use a parameterized prototype growth model to measure in the U.S. data the wedges we have identified.† We then feed the values of these wedges back into the growth model to conduct our accounting exercise, namely, to assess what fraction of the output movements can be attributed to each wedge separately and in combination. (In a deterministic model, by construction, all three wedges account for all of the observed movements in output.)

The goal of this business cycle accounting is to guide researchers to focus on developing detailed models with the kinds of frictions that can deliver the quantitatively relevant types of observed wedges in the prototype economy. For example, both the sticky wage and cartelization theories are promising explanations of the observed labor wedges, while the simplest models of capital market frictions are not. Theorists attempting to develop models of particular channels through which shocks cause large fluctuations in output will benefit from asking whether those channels are consistent with the fluctuations in wedges that we document.

Our accounting yields clear results for the Great Depression: Almost all of the decline in output from 1929 to 1933 is due to a combination of efficiency wedges and labor wedges, while much of the slow recovery from 1933 to 1939 is due to labor wedges alone. Investment wedges play, at best, a minor role in the decline and recovery.

While numerous theories lead to labor wedges, relatively few lead to efficiency wedges. We find it uninteresting to view the efficiency wedge as emanating from a loss of knowledge or a decline in the quality of blueprints. Rather, we think the observed movements in measured productivity are the results of poor government policies interacting with shocks. These policies turn what otherwise would be modest downturns into prolonged depressions. Developing models with these properties is the key to unlocking the mysteries of the Great Depression.

## Equivalence Results

Here we show how various models with underlying distortions map into a prototype economy with one or more wedges. We choose simple models to illustrate this mapping. Since many models map into the same configuration of wedges, identifying one particular configuration does not uniquely identify a model; rather, it identifies a whole class of models consistent with that configuration. In this sense, our method does not uniquely determine the most promising model; rather it guides researchers to focus on the key margins that need to be distorted.

### *The Prototype Economy*

The prototype economy is a growth model with three stochastic variables: $A_t$, $\tau_{lt}$, and $\tau_{xt}$. Using standard notation, we say that in any period $t$, consumers maximize expected utility over consumption $c_t$ and labor $l_t$, $E_t\sum_t\beta^t U(c_t,l_t)$, subject to the economy's budget constraint:

$$(1) \qquad c_t + (1+\tau_{xt})[k_{t+1} - (1-\delta)k_t] = (1-\tau_{lt})w_t l_t + r_t k_t + T_t$$

where $k_t$ is the capital stock; $w_t$, the wage rate; $r_t$, the rental rate on capital; $\beta^t$, the discount factor; $\delta$, the depreciation rate of capital; and $T_t$, lump-sum taxes; $\tau_{xt}$ and $\tau_{lt}$ are the tax rates on investment and labor, respectively. The firms' production function is $F(k_t,l_t)$, their productivity is $A_t$, and their aggregate output is $y_t$. Firms maximize $A_tF(k_t,l_t) - r_tk_t - w_tl_t$. The equilibrium is summarized by the resource constraint, $c_t + k_{t+1} = y_t + (1-\delta)k_t$, together with

$$(2) \qquad y_t = A_tF(k_t,l_t)$$

$$(3) \qquad -U_{lt}/U_{ct} = (1-\tau_{lt})A_tF_{lt}$$

$$(4) \qquad (1+\tau_{xt})U_{ct} = \beta E_tU_{ct+1}[A_{t+1}F_{kt+1} + (1+\tau_{xt+1})(1-\delta)].$$

We call $A_t$ the *efficiency wedge*, $1 - \tau_{lt}$ the *labor wedge*, and $1/(1+\tau_{xt})$ the *investment wedge*.

### *Efficiency Wedges*

Our input friction theory has a simple deterministic economy with financing frictions that lead to distortions in the

allocation of inputs across two types of firms. Before firms can produce, both types must borrow to pay for an input, say, labor. Firms of the first type, located in sector 1, are financially constrained in that they must pay a higher price for borrowing than do firms of the second type, located in sector 2. We think of these frictions as capturing the idea that some firms, which can be thought of as small, find borrowing harder than others do. One source of the higher price paid by the financially constrained firms is that moral hazard problems are more severe for small firms. (While this theory is reminiscent of that of Bernanke and Gertler (1989), the margins that get distorted in our model and in theirs are quite different.)

In each period $t$, firms borrow at the beginning of the period to finance inputs and repay their loans at the end of the period. Final output $y_t$ is produced from the outputs of sectors 1 and 2, $y_{1t}$ and $y_{2t}$, according to $y_t = y_{1t}^{\gamma} y_{2t}^{1-\gamma}$. The representative firm producing final output maximizes $y_{1t}^{\gamma} y_{2t}^{1-\gamma} - p_{1t}y_{1t} - p_{2t}y_{2t}$, where $p_{it}$ is the price of the output of sector $i$. Firms in sector $i$ hire labor $l_{it}$ to produce output according to $y_{it} = l_{it}^{\alpha}$ and maximize $p_{it}l_{it}^{\alpha} - R_{it}w_t l_{it}$, where $w_t$ is the wage rate and $R_{it}$ is the gross interest rate paid on loans by firms in sector $i$. We imagine that firms in sector 1 are more financially constrained than those in sector 2, so that $R_{1t} > R_{2t}$. Let $R_{it} = R_t(1+\tau_{it})$, where $R_t$ is the rate savers earn and $\tau_{it}$ measures the difference, induced by financing constraints, between the rate paid to savers and the rate paid by borrowers in sector $i$. Since savers do not discount utility within the period, $R_t = 1$. Consumers choose consumption $c_t$ and labor $l_t$ to maximize $\sum_{t=0}^{\infty}\beta^t U(c_t,l_t)$ subject to $c_t = w_t l_t + \Pi_t$, where $\Pi_t$ is the period $t$ profits earned by firms. The resource constraints are $l_t = l_{1t} + l_{2t}$ and $c_t = y_t$.

We specialize our prototype economy to have a fixed capital stock normalized to 1 and consider any period. In Chari, Kehoe, and McGrattan 2002a, we prove the following:

PROPOSITION 1. *The equilibrium allocations for an economy with input financing frictions coincide with those of the prototype economy with efficiency wedge $A_t$ and labor wedge $1 - \tau_{lt}$, where*

$$(5) \qquad A_t = [\gamma(1+\tau_{2t})]^{\alpha\gamma}[(1-\gamma)(1+\tau_{1t})]^{\alpha(1-\gamma)} \div [(1-\gamma)(1+\tau_{1t}) + \gamma(1+\tau_{2t})]^{\alpha}$$

*and*

$$(6) \qquad 1 - \tau_{lt} = [\gamma/(1+\tau_{1t})] + [(1-\gamma)/(1+\tau_{2t})].$$

Suppose that the fluctuations in the underlying distortions $\tau_{1t}$ and $\tau_{2t}$ are such that the constructed wedge $1 - \tau_{lt}$ is constant. That is, on average, financing frictions are unchanged, but relative frictions fluctuate. An outside observer using a one-sector growth model to fit the data generated by the economy with input financing frictions would identify the fluctuations in relative distortions with fluctuations in technology and would see no fluctuations in the labor tax rate. In particular, periods in which the relative distortions increase would be misinterpreted as periods of technological regress. We thus want a more neutral label than "technology" for $A_t$. We instead call it the *efficiency wedge* since it is a simple measure of aggregate production efficiency.

More generally, fluctuations in the input financing wedges $\tau_{1t}$ and $\tau_{2t}$, which lead to fluctuations in $\tau_{lt}$, show up in the prototype economy as fluctuations in both the efficiency wedge $A_t$ and the labor wedge $1 - \tau_{lt}$.

### *Labor Wedges*

Now consider two economies that give rise to labor wedges. In one, wages are sticky, so that fluctuations in monetary policy induce fluctuations in output. In the other, unions have monopoly power, so that fluctuations in the government's pro-competitive policies toward unions induce fluctuations in output.

Consider a sticky wage economy with utility function $U$ and production function $F$, and let $-U_{lt}^*/U_{ct}^*F_{lt}^*$ be evaluated at the equilibrium of this economy. In Chari, Kehoe, and McGrattan 2002a, we prove the following:

PROPOSITION 2. *The aggregate allocations in a prototype economy with taxes on labor income given by*

$$(7) \qquad 1 - \tau_{lt} = -U_{lt}^*/U_{ct}^*F_{lt}^*$$

*coincide with those of the sticky wage economy.*

We call the constructed labor tax rate $1 - \tau_{lt}$ the *labor wedge*. This wedge reflects the gap between the marginal product of labor and the marginal rate of substitution between leisure and consumption in the intratemporal first-order condition for labor. An outside observer using the prototype economy to fit the data of the sticky wage economy would interpret output fluctuations which arise from fluctuations in monetary policy as arising from fluctuations in labor wedges.

An exactly analogous proposition holds for an economy with monopoly unions. An outside observer of a unionized economy would interpret output fluctuations arising from fluctuations in the government's pro-competitive policies as arising from fluctuations in labor wedges.

### *Investment Wedges*

For investment frictions, the link between the original economy and a prototype economy is immediate. Many of the frictions discussed in the literature end up affecting the economy by raising the firms' cost of investment, from 1 to $1 + \tau_{xt}$. These show up in the prototype economy as an *investment wedge*, a gap between the intertemporal marginal rate of substitution in consumption and the marginal product of capital in (4).

Bernanke and Gertler (1989) and others have pointed to agency costs as the source of investment distortions. Carlstrom and Fuerst (1997) embed the frictions studied by Bernanke and Gertler into a standard growth model. In Chari, Kehoe, and McGrattan 2002a, we find, as Carlstrom and Fuerst do, that the Carlstrom-Fuerst model is equivalent to the prototype growth model with investment wedges and adjustment costs in investment. Most interesting, we think, is that the equivalent prototype model has neither efficiency wedges nor labor wedges.

## Business Cycle Accounting

Now we try to measure our three wedges and determine how much of actual U.S. output fluctuations they can account for. (For details underlying this section, see Chari, Kehoe, and McGrattan 2002b.)

Given data on $y_t$, $k_t$, $l_t$, and $c_t$, we use equations (2)–(4) to construct series for efficiency and labor wedges. In Chart 1 we display real detrended output, the detrended efficiency wedge, and the labor wedge. All the series are normalized to equal 100 in 1929. As is clear in Chart 1, output is 35 percent below trend in 1933 and is still 20 percent below trend by 1939. In 1933, the efficiency wedge is 17 percent below its 1929 level, but by 1939 it has essentially recovered. In 1933, the labor wedge is 28 percent lower than its 1929 level, and in 1939 it is still that low. Thus, the underlying distortions that manifested themselves as efficiency and labor wedges became substantially worse from 1929 to 1933. By 1939, the efficiency wedge had disappeared, but the labor wedge remained as large as it had been in 1933.

If we assume no uncertainty, we can use equation (4) to measure the investment wedge as well. With that assumption, however, we find that $1/(1+\tau_{xt})$ is higher than its 1929 level throughout the 1930s: according to this measurement, the underlying distortions that manifested themselves as investment wedges actually diminished in the Great Depression. This conclusion is not plausible; hence, we will propose an alternative method for assessing investment wedges.

### *The Prototype Economy With Efficiency and Labor Wedges . . .*

First, we ask, What fraction of output fluctuations can be accounted for by the efficiency and labor wedges? We answer this question by simulating our prototype economy with our measured wedges and comparing the result to actual U.S. data. We find that together these wedges can account for essentially all of the fluctuations in U.S. output between 1929 and 1939.

We start by independently inserting the series for each of the two wedges into the prototype model and setting the other wedges to their 1929 levels. We assume consumers believe that in each year from 1930 through 1932 it is equally likely that, in the following year, the wedges will stay at their current levels, revert to the 1929 levels, or take on the values in the data. From 1933 on, we assume perfect foresight.

With the efficiency wedge alone, the prototype economy generates much of the observed downturn in output, but much too rapid a recovery. As can be seen in Chart 2, for example, by 1933 output falls about 26 percent in the model and about 35 percent in the data. By 1939, the efficiency wedge model generates an output decline of only 6 percent rather than the observed 20 percent. As can also be seen in Chart 2, the reason for this rapid recovery is that the efficiency wedge model completely misses the continued sluggishness in labor from 1933 onward. For investment, this model shows a similar fall as in the data from 1929 to 1933, but a faster recovery. (Here and throughout, labor is per capita manhours, while investment is detrended and normalized by output in 1929.)

In our model with only labor wedges, output falls only about half as much by 1933 as output actually fell: 17 percent vs. 35 percent. By 1939, output in both this model and the data have fallen about 20 percent. The labor wedge model misses the sharp decline in investment from 1929 to 1933, but it does generate the sluggishness in labor input after 1933.

These observations suggest investigating a prototype economy with both efficiency and labor wedges. We thus simulate an economy with our constructed series for these two wedges with the investment wedge set to its 1929 level. Chart 3 shows that the resulting model captures both the downturn in output and the slow recovery remarkably well. It also generates the sluggishness in labor after 1933 and does reasonably well on investment.

### *. . . And With an Investment Wedge*

What fraction of output fluctuations can be accounted for by the investment wedge? Our difficulties in inferring a reasonable level of that wedge from the U.S. data make us wary of trying to answer this question by simply putting in the wedge $1/(1+\tau_{xt})$ inferred from a deterministic version of equation (4). Instead, we consider a prototype economy with the efficiency and labor wedges set to their 1929 levels and let the investment wedge be whatever it must be in order for the model to generate the actual investment series. In a sense, by attributing all movements in investment to this wedge, we are overstating its contribution to output fluctuations.

In Chart 4, we see that the prototype economy with an investment wedge generates only a modest fall in output from 1929 to 1933 and does not generate the recovery after 1933. While this economy does generate a recovery in labor, the effect on output is offset because the capital stock is lower due to the cumulative effect of the decade-long investment slump.

## Conclusion

Our business cycle accounting suggests that research on the Great Depression should focus on building detailed models with underlying distortions that produce efficiency and labor wedges. Building models of investment wedges is not likely to yield a high payoff.

*This article is reprinted, with permission, from the *American Economic Review* (May 2002, vol. 92, no. 2, pp. 22–27). © 2002 by the American Economic Association. The article was edited for publication in the *Federal Reserve Bank of Minneapolis Quarterly Review*.

The authors thank the National Science Foundation for financial support. The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System. The basic data, computer codes, and a detailed technical appendix for this study are available at http://www.minneapolisfed.org/research/wp/wp619.html or, more directly, at ftp://ftp.mpls.frb.fed.us/pub/research/mcgrattan/wp619/.

†Mulligan (2002) measures the labor wedge in the Great Depression, as we do, and provides a variety of interpretations of this wedge, including those we do.

## References

Bergoeing, Raphael; Kehoe, Patrick J.; Kehoe, Timothy J.; and Soto, Raimundo. 2002. A decade lost and found: Mexico and Chile in the 1980s. *Review of Economic Dynamics* 5 (January): 166–205. Reprinted 2002. Decades lost and found: Mexico and Chile since 1980. *Federal Reserve Bank of Minneapolis Quarterly Review* 26 (Winter): 3–30.

Bernanke, Ben, and Gertler, Mark. 1989. Agency costs, net worth, and business fluctuations. *American Economic Review* 79 (March): 14–31.

Bordo, Michael D.; Erceg, Christopher J.; and Evans, Charles L. 2000. Money, sticky wages, and the Great Depression. *American Economic Review* 90 (December): 1447–63.

Carlstrom, Charles T., and Fuerst, Timothy S. 1997. Agency costs, net worth, and business fluctuations: A computable general equilibrium analysis. *American Economic Review* 87 (December): 893–910.

Chari, V. V.; Kehoe, Patrick J.; and McGrattan, Ellen R. 2002a. Business cycle accounting. Research Department Working Paper 625. Federal Reserve Bank of Minneapolis.

_____. 2002b. Technical appendix: Accounting for the Great Depression. Research Department Working Paper 619. Federal Reserve Bank of Minneapolis.

Cole, Harold L., and Ohanian, Lee E. 2001. New Deal policies and the persistence of the Great Depression: A general equilibrium analysis. Research Department Working Paper 597. Federal Reserve Bank of Minneapolis.

Kendrick, John W. 1961. *Productivity trends in the United States.* General Series 71, National Bureau of Economic Research. Princeton, N.J.: Princeton University Press.

Mulligan, Casey B. 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.

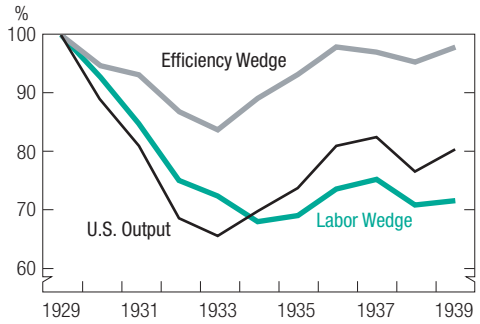
U.S. Department of Commerce. Bureau of Economic Analysis. Various dates. National income and product accounts of the United States. *Survey of Current Business.* Available at http://www.bea.doc.gov.

_____. Bureau of the Census. 1975. *Historical statistics of the United States: Colonial times to 1970.* Washington, D.C.: U.S. Department of Commerce.

Chart 1

## Actual U.S. Output and Two Measured Wedges

Percentage of Each Series' Value in 1929; Annually, 1929–39



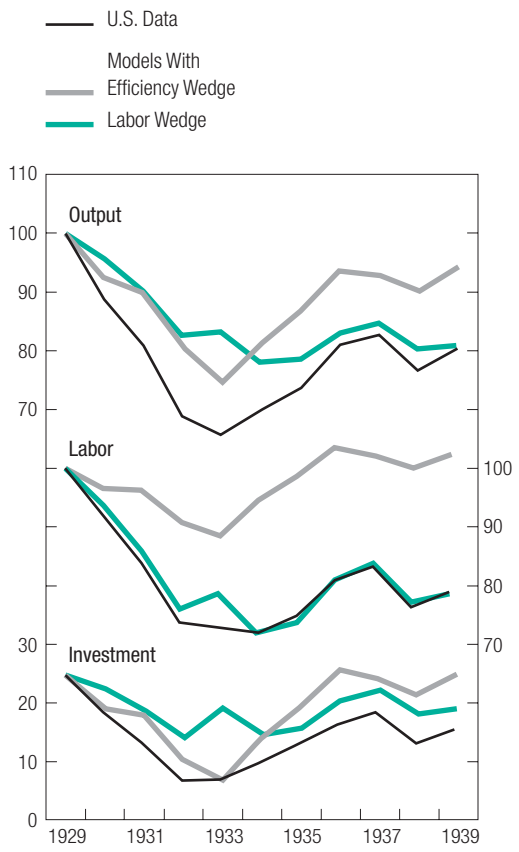

Sources of basic data: U.S. Commerce, various dates and 1975; Kendrick 1961

Charts 2 and 3

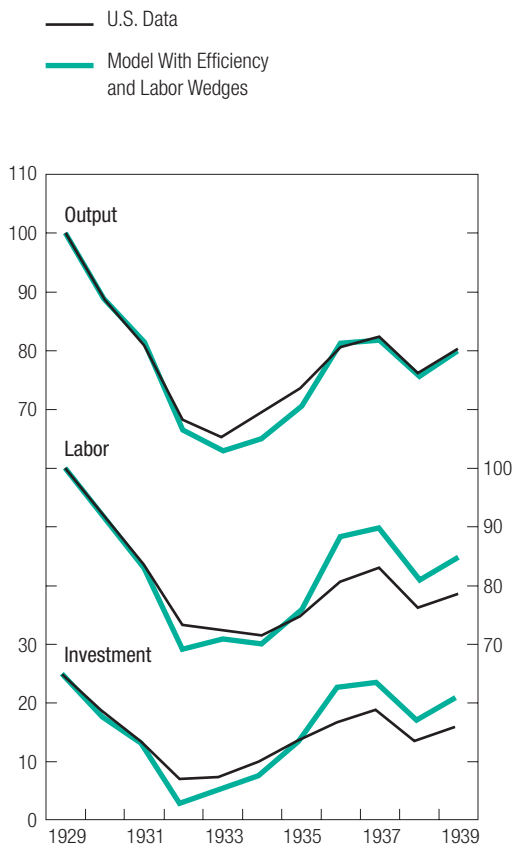
## Model Predictions With Efficiency and Labor Wedges

Per Capita Output, Labor, and Investment; Annually, 1929–39*

### Chart 2 Models With One Wedge




### Chart 3 Model With Both Wedges



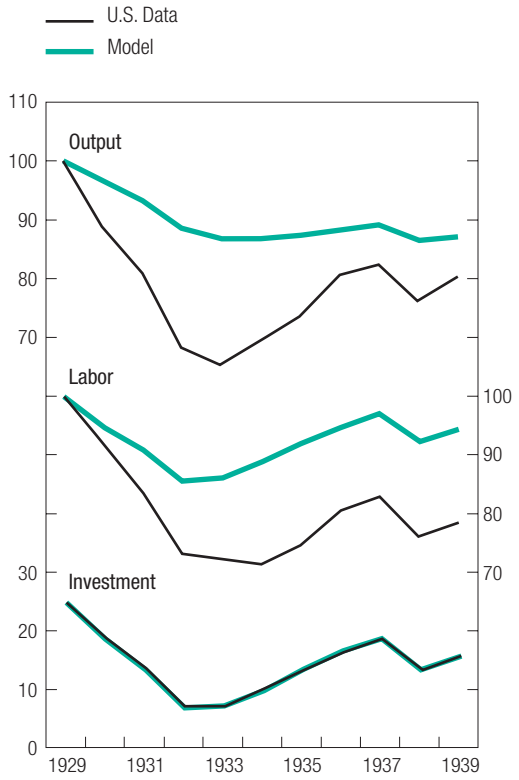

*The output and investment series are detrended by 1.6 pecent per year.
The output and labor series are shown relative to their 1929 values (1929=100); the investment series, as a percentage of 1929 output.

Sources of basic data: U.S. Commerce, various dates and 1975; Kendrick 1961

Chart 4

## Model Predictions With an Investment Wedge

Per Capita Output, Labor, and Investment; Annually, 1929–39*




*The output and investment series are detrended by 1.6 pecent per year.
The output and labor series are shown relative to their 1929 values (1929=100); the investment series, as a percentage of 1929 output.

Sources of basic data: U.S. Commerce, various dates and 1975; Kendrick 1961