Inside Money and the Great Depression

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Abstract

This paper considers the quantitative importance of inside money holdings in accounting for the Great Depression. Using a standard, business-cycle model with nominal-wage rigidity and the observed deposit-currency ratio, household preferences for purchasing consumption with currency relative to deposits are extracted from the model, and simulations subject to these preference shocks are compared to the episode. While supporting previous conclusions that a sticky-wage channel is a crucial feature to an explanation of the Depression, the model indicates that an observable shift away from deposits accounts for slightly more than the 38 percent drop in output observed in 1933 (41 percent) and all of the persistence throughout the episode.

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I Introduction

A great deal of research has identified factors which may have caused or contributed to the depth and persistence of the Great Depression: the 1929 stock market crash (Frederic S. Mishkin, 1978 and Christina D. Romer, 1990); the nonmonetary effects of banking crises (Ben S. Bernanke, 1983); the increase in world tariffs (Allan H. Meltzer, 1976 and Mario J. Crucini and James Kahn, 1996); an adherence to the gold standard (Barry Eichengreen, 1992 and Peter Temin, 1989); an autonomous drop in consumption (Temin, 1976); and the failure of the Federal Reserve to offset a financial-panic induced decline in the monetary stock (Milton Friedman and Anna J. Schwartz, 1963).\(^1\) However, quantitatively accounting for the severe and protracted drop in output observed throughout the episode has been difficult in models with these features.

This paper considers the quantitative importance of inside money holdings in explaining the output path throughout the episode. In particular, an environment is constructed with the goal of determining whether the panic-induced decline in broad monetary aggregates can generate a nominal shock large enough to replicate features of the US economy from 1929 to 1939. The model incorporates household preferences for consumption goods purchased with both currency and deposits and interprets a financial collapse to be an exogenous preference shock towards valuing cash goods relative to deposit goods. The model is simulated by inputting a series of these shocks which allow the model to track the observed deposit-currency ratio from 1929 to 1939.

A crucial issue within this monetary explanation pertains to the mechanism through which nominal shocks yield real effects. Michael D. Bordo et. al. (2000) explicitly test the ability of the sticky-wage hypothesis in explaining the Great Depression.\(^2\) By treating shocks to broad monetary aggregates as exogenous, they account for 75 percent of the initial downturn of the episode, but none of the persistence. Harold L.

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\(^2\)See Barry Eichengreen and Jeffery Sachs (1985), Ben S. Bernanke (1995), and Ben S. Bernanke and Kevin Carey (1996) for empirical studies which support the sticky-wage story.
Cole and Lee E. Ohanian (2000) account for roughly 60 percent of the persistence by considering inefficient New Deal policies. Recent work by V. V. Chari et. al. (2003) and Lawrence J. Christiano et. al. (2004) show that these particular inefficiencies are crucial in understanding the episode.

Following Bordo et. al. (2000), real effects from changes in the price level are transmitted in the model through nominal-wage contracts as in James B. Taylor (1980). The crucial difference between this paper and theirs is that they model only one broad monetary aggregate (i.e. M1) and treat shocks to this variable as exogenous, while this exercise makes the explicit distinction between outside money (i.e. high-powered currency) and inside money. This distinction allows the model to track narrow and broad monetary aggregates which can be affected by shocks to monetary policy as well as household behavior.

The belief that households faced a shock to their perception of the financial sector and ultimately to their preferences for holding inside money is not new. For instance, Russell W. Cooper and P. Dean Corbae (2002) have made this argument explicit in a model where increasing returns-to-scale and cost sharing mechanisms in the financial intermediation sector give rise to strategic complementaries among depositing agents. This results in multiple (sunspot) equilibria where households’ perception of financial sector health lead to optimistic (pessimistic) states with thick (thin) deposit markets. While an environment with these explicit features is beyond the scope of this paper, the preference shock discussed above may be interpreted along these lines, and provide a quantitative test of this line of reasoning.

The exercise indicates that changes in the deposit-currency ratio can account for many features of the Great Depression. The model accounts for slightly more (41 percent) than the 38 percent drop in output in 1933, and the entire persistence of the episode. The model also does well in predicting persistent declines in consumption, investment, labor hours, and prices; but underpredicts the initial decline of consumption, and overpredicts the initial declines of investment and labor hours. These results are not greatly changed when simulating the economy with the addition of observed shocks to the outside monetary base (i.e. currency), but these shocks alone do not
account for much of the episode. While these results support previous conclusions that a sticky-wage channel is a crucial feature of the episode, they show the importance of inside money holdings in identifying the source of a monetary shock which captures the depth and persistence of the Great Depression.

Considering inside and outside monetary aggregates independently enables the model to also explore the validity of the Friedman-Schwartz hypothesis that expansionary monetary policy from the Federal Reserve would have been able to mitigate the effects of the financial collapse. It is shown through impulse response functions that a preference shock away from bank deposits and a high-powered money growth shock have opposing effects on prices and output, suggesting that expansionary monetary policy would have been able to assuage the outcome of households’ increased preference to holding currency relative to deposits. This coincides with results of Cooper and Corbae (2002) and Christiano et. al. (2004).

The remainder of the paper is as follows: the economic model and definition of equilibrium are presented in Section II; the quantitative analysis of the model and a comparison to the Great Depression are presented in Section III; and Section IV concludes.

II The Model

The model used in this paper follows the widely known cash-credit goods model of Robert E. Lucas Jr. and Nancy L. Stokey (1987) with two exceptions. Instead of the standard model assumption that goods can be purchased with either cash or credit, it is assumed that households purchase goods with cash and deposits held at a financial intermediary. This change is to consider a portion of household wealth which can be interpreted as inside money and be used to purchase a portion of consumption and ultimately affect the price level. In addition, significant monetary nonneutrality is introduced into the environment assuming that nominal wages are agreed upon in staggered contracts. The remainder of this section discusses the model environment and concludes with a definition of equilibrium.
A Environment

The model is in discrete time, with an infinite horizon. The economy is populated by a large number of identical and infinitely-lived households, productive firms, and a single monetary authority. A single production technology produces all goods to be used for either consumption or investment, and implies that all trade at an identical price \((P_t)\). Investment \((i_t)\) in period \(t\) produces productive capital in period \(t + 1\), and the capital stock evolves according to

\[
k_{t+1} = (1 - \delta) k_t + i_t,
\]

where \(\delta \in (0, 1)\) is the depreciation rate. Output at time \(t\) is a CRS function of capital and labor \((h_t)\): \(y_t = z k_t^\theta h_t^{1-\theta}, \theta \in (0, 1)\), where \(z\) is a normalizing constant.

The preferences of a representative household are given by

\[
E_0 \sum_{t=0}^\infty \beta^t [\alpha_t \log (c_{1t}) + (1 - \alpha_t) \log (c_{2t})],
\]

where \(c_{1t}\) denotes consumption of a ‘cash good,’ \(c_{2t}\) denotes consumption of a ‘deposit good,’ and \(\alpha_t\) is an exogenous process which determines the relative weights given to the consumption of these two good types. It is assumed that \(\alpha_t \in (0, 1)\) evolves according to \(\alpha_t = \kappa_\alpha + \rho_\alpha \alpha_{t-1} + \varepsilon_{at}\) with \(\rho_\alpha \in [0, 1)\) and \(\varepsilon_{at} \sim N(0, \sigma_\alpha^2)\). In addition, \(E_0\) denotes the expectation operator conditional on information available at time 0, and \(\beta \in (0, 1)\) is the discount rate.

At the beginning of period \(t\), a household has currency holdings equal to \(m_t + T_t\), where \(m_t\) is currency carried over from the previous period and \(T_t\) is a nominal lump-sum transfer from the monetary authority. Currency is valued in this environment by assuming that cash goods must be purchased with previously held balances,

\[
c_{1t} \leq \frac{m_t + T_t}{P_t}.
\]
Household allocations must also satisfy a sequence of budget constraints,

\[(4) \quad c_{1t} + c_{2t} + i_t + \frac{m_{t+1}}{P_t} \leq w_t h_t + r_t k_t + \frac{m_t + T_t + \Pi_t}{P_t},\]

where \(w_t\) is the real wage rate, \(r_t\) is the real rental price of capital, and \(\Pi_t\) is the nominal profits of the representative firm which is assumed to be owned by the household.

The household’s problem is to choose \(\{c_{1t}, c_{2t}, m_{t+1}, k_{t+1}\}_{t=0}^{\infty}\) to maximize (2) subject to (1), (3), and (4). With wages set in advance, there may occur instances where optimal labor supply and demand may not clear. Therefore, following Bordo et. al. (2000), it is assumed that households supply all labor that is demanded by the firms conditional on a nominal wage rate \(W_t = P_t w_t.\)

Firms have access to the production technology and rent labor and capital services from households taking \(w_t\) and \(r_t\) as given. The problem of a representative firm is:

\[(5) \quad \max_{\{k_t, h_t\}} \frac{\Pi_t}{P_t} = z k_t^\theta h_t^{1-\theta} - r_t k_t - w_t h_t.\]

Profit maximization results in the firm demanding each input up until its marginal product is equated with its marginal cost.

\[(6) \quad r_t = z \theta \left( \frac{h_t}{k_t} \right)^{1-\theta}\]

\[(7) \quad w_t = z (1 - \theta) \left( \frac{k_t}{h_t} \right)^{\theta}\]

Since it is assumed that the nominal wage rate is set in advance, (7) pins down the equilibrium amount of labor hours demanded subject to the price level and terms of the nominal wage contract (discussed below).

The monetary authority controls the currency base denoted at the beginning of period \(t\) as \(M_t\). The currency base evolves according to \(M_{t+1} = \mu_t M_t\), where \(\mu_t\) is the growth rate which evolves according to \(\mu_t = \kappa_\mu + \rho_\mu h_{t-1} + \varepsilon_t\mu\) with \(\rho_\mu \in [0, 1)\) and

\[\text{Footnote: This assumption is made to simplify the exercise and does not greatly affect the predictions of the model. See Timothy Cooley and Gary D. Hansen (1995) which models the gap between labor supply and demand as a perception error in realized wages.}\]

6
\[\varepsilon_{it} \sim N(0, \sigma_{\varepsilon}^2).\] Changes in the currency base are financed through nominal lump-sum transfers to the households \((T_t)\), and the monetary authority’s budget constraint is given by

\[(8) \quad T_t = M_{t+1} - M_t.\]

### B Wage Determination

Following Bordo et. al. (2000), the labor force is considered to be divided into equal-sized cohorts with the number of cohorts equal to the quarterly length of the contract. Specifying a one-year contract implies that the economy consists of four cohorts of workers. At the beginning of each quarter, a cohort agrees to a nominal wage \((x_t)\) for the next four quarters.\(^4\) The aggregate nominal wage is an index of the nominal wages offered to all cohorts in period \(t\).

\[(9) \quad W_t = x_t^{\phi_0} x_{t-1}^{\phi_1} x_{t-2}^{\phi_2} x_{t-3}^{\phi_3}\]

The contracted wage of the cohort presently renegotiating is given by

\[(10) \quad \ln(x_t) = E_t \left( \sum_{i=0}^{3} \phi_i \left( \ln(W_{t+i}) + \gamma \left( \bar{h} - h_{t+i} \right) \right) \right),\]

where \(\bar{h}\) denotes a time-invariant target value of labor hours (i.e. steady-state labor supply) and \(\gamma < 0.\)\(^5\) Assuming equal weight given to all cohorts \((\phi_i = 0.25, \forall i)\), repeated substitution of (9) into (10) yields

\[(11) \quad \ln(x_t) = E_t \left\{ \frac{\ln(x_{t-3})}{12} + \frac{\ln(x_{t-2})}{6} + \frac{\ln(x_{t-1})}{4} + \frac{\ln(x_{t+1})}{4} + \frac{\ln(x_{t+2})}{6} + \gamma \sum_{i=0}^{3} \left( \bar{h} - h_{t+i} \right) \right\}.\]

Two features of the wage contract are worth noting. First, past contract wages

\(^4\)For example, cohort 1 agrees to a nominal wage in quarter 1, and will receive this wage for quarters 1 through 4.

\(^5\)The wage contract is independent upon realizations of \(\alpha_t\) due to the assumption of cash and deposit goods being perfectly substitutable in production and having an identical price.
appear in (11). This backward-looking component captures the fact that the current wage index depends upon the wages paid to all cohorts. Second, the only channel forcing nominal wages to adjust are current and expected future labor hours relative to the time-invariant level. The speed at which nominal wages adjust depend upon the value of $\gamma$: the lower the absolute value of $\gamma$, the slower the adjustment of nominal wages.

C Equilibrium

An equilibrium is defined as a list of prices \(\{r_t, w_t, P_t, x_t\}_{t=0}^{\infty}\) and allocations to households \(\{k_{t+1}, m_{t+1}, c_{1t}, c_{2t}\}_{t=0}^{\infty}\), and firms \(\{k_t, h_t\}_{t=0}^{\infty}\) such that

1. Households maximize (2) subject to (3) and (4), taking prices as given.
2. Firms maximize (5) taking prices as given.
3. Cohorts choose nominal wage rates which satisfy (11), and equilibrium labor hours are chosen by firms to satisfy (7).
4. Markets for goods \((c_{1t} + c_{2t} + i_t = y_t)\) and money \((m_t = M_t)\) clear.

Assuming positive nominal interest rates and household rationality is sufficient to ensure that (3) and (4) will bind for all \(t\). Substituting (1), (3), and (4) results in households solving

\[
\max_{\{m_{t+1}, k_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t [\alpha_t \log (c_{1t}) + (1 - \alpha_t) \log (c_{2t})]
\]

where

\[
c_{1t} = \frac{m_t + T_t}{P_t}
\]

\[
c_{2t} = w_t h_t + (r_t + 1 - \delta) k_t - \frac{m_{t+1} - \Pi_t}{P_t} - k_{t+1}.
\]

It is easy to see from (13) how \(c_{1t}\) can be given the interpretation of a cash good. However, it is not readily seen from (14) that \(c_{2t}\) can be given the interpretation of a
deposit good. To shed some light on this issue, suppose that a household deposits all of her noncurrency assets into a financial intermediary at the beginning of every period, after receiving information about the monetary shock and her wage and rental income. She then allocates her deposits into a portfolio of short-term and long-term deposits. For example, the household sets aside a real amount $c_{2t} + \frac{m_{t+1}}{P_t}$ in a checkable account, and $k_{t+1}$ in a time deposit. After the household withdraws $m_{t+1}$ in currency, the end of period deposit-currency ratio can be defined as $\frac{c_{t+1}}{c_{1t}}$; that is, the real amount held in deposits (before checks clear) divided by the real amount purchased with currency.\(^6\) This ratio will be crucial to the following calibration and simulation of the model.

### III Quantitative Analysis

#### A Calibration and Model Solution

The model parameters are $[\beta, \theta, \delta, \mu, \alpha, \rho, \rho_{\alpha}, \phi, \gamma, z]$ and are summarized in Table 1. The discount parameter is calibrated so the real return on capital is 6 percent annually, which is the 1929 real interest rate reported by Cole and Ohanian (1999). In steady state, investment is one quarter of output. With an annual depreciation rate of ten percent, this implies that the ratio of the capital stock to annual output is 2.5. Capital’s share of production ($\theta$) is calibrated so labor’s share of national income is roughly two-thirds, and $z$ is calibrated so average allocation of a household’s time (net of sleep and personal care) to market activity is 0.3. A measure for the amount of sluggishness in the nominal contracts, $\gamma$, is set to $-0.01$ which is taken from Bordo et. al. (2000).\(^7\)

The parameters defining the growth rate of the currency base were taken from analyzing a quarterly series taken from Nathan S. Balke and Robert J. Gordon (1983), transformed into per capita terms. Throughout the Depression (1929:Q1-1939:Q4),

\(^6\)See Scott Freeman and Finn E. Kydland (2000) and Scott J. Dressler (2004) for environments which explicitly model the purchasing of goods with both inside and outside money.

\(^7\)Their estimates of this parameter range from -0.0037 to -0.0093, where lower absolute values imply more nominal rigidity. The stability of this parameter is considered at the end of this section.
the series has an average quarterly growth rate of 2.27 percent and an AR1 regression yields $\rho_\mu = 0.37$.

The steady-state value of the relative preferences between purchasing goods with cash or deposits ($\alpha$) is calibrated to match the 1929 deposit-currency ratio, which is defined in the model to be $\frac{\alpha}{\alpha_1}$. Setting $\alpha = 0.0858$ results in a deposit-currency ratio of 11 which is reported by Friedman and Schwartz (1963). The final parameter, $\rho_\alpha$, represents the persistence of the shock valuing cash goods relative to deposit goods. Using the observed deposit-currency ratio series as a proxy for $\alpha_t$, an AR1 regression yields $\rho_\alpha = 0.9457$. A sensitivity analysis on the choice of this parameter (and others) is conducted at the end of this section.

After normalizing all nominal parameters by the stock of currency ($\hat{m}_t = \frac{m_t}{M_t}$, $\hat{P}_t = \frac{P_t}{M_{t+1}}$, and $\hat{x}_t = \frac{x_t}{M_{t+1}}$) and substituting the money market clearing condition, the model is reduced to five equations in $\{k_{t+1}, \hat{P}_t, \hat{x}_t, \alpha_t, \mu_t\}$. The system is linearized around its stationary steady state and the decision rules for the household are solved via a method of undetermined coefficients suggested by Lawrence J. Christiano (2002).

**B Impulse Responses**

Figures 1 and 2 examine the model dynamics by subjecting the economy to a one percent shock in $\alpha_t$ and $\mu_t$. The response from a positive impulse to the monetary growth rate ($\mu_t$) is standard: the increase in the currency supply is larger than the induced demand, resulting in an increase in the price level and a decrease in the real wage rate, which further increases labor demand from firms and ultimately results in increases in output and investment. Note the response to the type of consumption purchases: an increase in the supply of currency will induce an agent to substitute out of cash goods due to the increased opportunity cost for holding currency. Eventually, the consumption of both good types will move above trend due to the output increase.

The response from a one percent shock to the level of $\alpha_t$ is also straightforward. For most variables, an increase in the demand for cash goods relative to deposit goods has a qualitatively opposite effect of the currency growth shock: an increase in demand for currency balances due to the increase relative preference for cash goods
results in a drop in the price level, which further increases the real wage, decreases the
demand for labor, and puts downward pressure on output with a degree of persistence
rival to the impact of a $\mu_t$ shock.

These opposing responses add support to the Friedman-Schwartz hypothesis that
the monetary authority could have expanded the stock of high-powered money and
alleviated the effects of the financial crises. The figures clearly show that a monetary
authority would be able to at least partially offset the predicted effects of a shock to
the households’ perception of the intermediation sector with expansionary monetary
policy.

C A Comparison with the Great Depression

This section presents the ability of the model to predict particular features of the
Great Depression when subjected to a variety of measured, exogenous shocks. The
data used for comparison is taken from Cole and Ohanian (1999).

Three cases are considered. First, a series of shocks to households’ preference for
cash goods (i.e. the $\alpha_t$ shocks) are extracted from the model so that the predicted
deposit-currency ratio tracks the data assuming a constant currency growth rate (i.e.
$\mu_t = \mu, \forall t$). Second, the preference shocks are extracted like in the first case while
simultaneously subjecting the model to shocks in the currency growth rate derived
from the Balke and Gordon (1983) data. Finally, to get an additional assessment
of the importance of shocks to inside money, the model is simulated with currency
growth shocks assuming $\alpha_t = \alpha, \forall t$. For all of these cases, the determination of the
shock process is constrained by the model requirement that net nominal interest rates
must always be strictly positive. Otherwise, it is well known that the assumption of
(3) binding, as well as the definition of equilibrium would be violated.\textsuperscript{8}

The calibrating observations and resulting shock processes are illustrated in Figure
3. The top graph illustrates the annual deposit-currency ratio taken from Friedman
and Schwartz (1963), made quarterly by linear interpolation. Note the large (50

\textsuperscript{8}The algorithm is explicitly discussed in an appendix.
percent) initial drop in this ratio, as well as it remaining well below the 1929 level for the rest of the decade. The second graph illustrates the series of growth rates to the currency base derived from the Balke and Gordon (1983) data. The third graph illustrates the two extracted series for the preference variable $\alpha_t$ described above, measured as percentage changes from its steady-state level.

There are several points to note about these graphs. First, the preference shocks illustrated in the third graph are small; within two percent of the steady-state value of $\alpha$. Second, the shocks do not change a great deal whether or not they are extracted in the presence of currency growth shocks. The inclusion of $\mu_t$ shocks add volatility to the series.

With the shock processes in hand, we can now examine the macroeconomic predictions of the model. Figures 4 and 5 illustrate the model’s predictions with the preference path alone (the $\alpha_t$ shocks), and the preference path with the addition of shocks to currency growth. Both simulations do a remarkable job at predicting the initial output decline of the Great Depression. The model actually overpredicts the drop observed by 1933: 107 percent accounted for using preference shocks, and 116 percent accounted for using both preference and currency shocks. The model also predicts a great deal of persistence which lasts well into the next decade: 97 percent of the 1939 level of output accounted for using preference shocks, and 41 percent accounted for using both. The persistent decline in the deposit-currency ratio results in a persistent decline in inside money and output.

The model makes some stark predictions with respect to other observations. The model predicts large drops in investment and total consumption, but underpredicts the initial drop in consumption (13 percent in both cases verses 28 percent in the data) and overpredicts the drop in investment (over 100 percent in both cases verses 78 percent in the data). This implies that households in the model would rather disinvest than suffer large declines in consumption given the drop in output. The model does however predict a persistent decline in total consumption under both cases (between 70 and 90 percent of that observed in 1939). The model with preference shocks predicts similar persistence with respect to investment, but this is lessened with the
addition of currency growth shocks. This coincides with the predicted path of labor hours and the sharp drop in the real wage rate. With respect to the nominal variables, the model overpredicts the paths of the price level, the nominal wage rate, and M1.\(^9\) The excessive decline in the price level in the model stems from a combination of the large (40 percent) increase in cash goods and the clearing of the money market. These price movements lead to the similar predictions for the paths of M1 and nominal wages.

The preceding results illustrate how small shocks to households’ preference towards currency for purchases can yield large and plausible predictions for the US economy during the Great Depression. It was stated earlier that the calibration exercise was constrained by the assumption that net nominal interest rates must remain positive in all periods. The gross nominal interest rate is illustrated in Figure 6. Note that the exercise was only constrained between the years 1930 and 1933, which explains the deviation from the deposit-currency ratio in the model and data within these years illustrated in the lower-right graph of Figure 4.\(^{10}\) Once the constraint stops binding, nominal interest rates shoot up to an extremely large level. This increase is attributable to the (counterfactual) increase in real interest rates and the sharp increase in the price level towards what is observed in the data. These extreme predictions stem from the fact that a decrease in the deposit-currency ratio in the model implies a one-for-one increase in the demand for goods purchased with cash, and places strong downward pressure on the price level due to the binding of the cash-in-advance constraint.\(^{11}\)

Figures 7 and 8 continue the analysis by illustrating the predictions of the model with shocks to the currency base assuming the preference process is held fixed at its 1929 level (i.e. \(\alpha_t = \alpha, \ \forall t\)). As the figures indicate, the model cannot predict a

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\(^{9}\)M1 is defined in the model as the sum of currency and the nominal value of consumption purchased with inside money: \(M1_t = \mu_t M_t + P_t c_{2t}\).

\(^{10}\)It was verified in all exercises that the net nominal interest rate never exactly reaches zero.

\(^{11}\)The nominal interest rate constraint binds much more frequently in a version of the model with frictional costs to changes in investment which was explored to suppress the extreme predictions of investment. However, this version resulted in a larger increase in the demand for cash goods, resulting in further downward pressure on prices and an inability of the model to track the deposit-currency ratio.
persistent decline in any of the real variables, supporting the notion that shocks to
the households’ holdings of inside money is the principle source of the nominal shock.

D Stability Analysis

Several points must be addressed to assess the stability of the results reported above:
the sluggishness of the nominal contracts (\(\gamma\)), the persistence of the preference shocks
(\(\rho_\alpha\)), and the steady-state level of the deposit-currency ratio (\(\alpha\)). These three issues
are addressed in Figure 9. The top two graphs illustrate the predicted paths of output
under different values of \(\gamma\) and \(\rho_\alpha\). For these exercises, the preference shocks were ex-
tracted under the new parameter values. The bottom graph plots the predicted paths
of output using the extracted shocks from the baseline exercise (assuming constant
currency growth), while changing the values of \(\alpha\).

Higher absolute values of \(\gamma\) imply a faster adjustment of the nominal wage con-
tracts and less nominal rigidity. The extracted shocks have larger effects when assum-
ing a smaller absolute value of \(\gamma\). The higher the persistence of the shocks to \(\alpha_t\), the
smaller are the actual effects of the shocks. This is due to the fact that the persistence
parameter allows past changes in the deposit-currency ratio to play a more prominent
role in matching present changes in the deposit-currency ratio, especially in the case
of the Great Depression where the changes in this ratio where predominantly in the
downward direction. Therefore, the effects of present changes in preferences towards
cash goods relative to deposit goods are played down, and the model looses some of its
initial decline and persistence. This argument adds support to the model, consider-
ing that smaller amounts of persistence to this preference shock seem more plausible
than larger amounts.\(^{12}\) The final stability exercise considers changes in the initial
conditions of the model by altering the steady-state value of \(\alpha\). A higher value of
alpha places more weight on cash goods. The higher the initial weight placed on cash
goods, the smaller are the extracted effects. This result is straightforward considering

\(^{12}\)When \(\rho_\alpha = 0.8\), the additional volatility in the predicted path for output is due to the binding
of the nominal interest rate constraint since lower persistence places more weight on present shocks
to \(\alpha_t\) in the calibration algorithm.
that a higher steady-state consumption of cash goods implies that a relative change in preferences would have a smaller effect on prices in percentage terms. It should be noted that this exercise uses the shocks extracted from the baseline case due to the fact that the calibration exercise relies on a match between the predicted and observed deposit-currency ratios. This exercise implies that the alternative interpretation of the model, and accompanying calibration exercise adds additional mileage to the framework in a vital way towards quantifying the distinction between goods purchased with cash and goods purchased with deposits.

IV Conclusion

The goal of this paper was to quantify the importance of inside money in accounting for the Great Depression. By extending a standard model to include preferences between cash goods and deposit goods and nominal wage rigidity, the analysis suggests that capturing the observed decline in the deposit-currency ratio can deliver a large enough nominal shock to predict the observed drop in output as well as its persistence. The model also captures persistent declines in other macroeconomic variables such as prices, consumption, and investment, but the model underpredicts the drop in consumption and over predicts the drop in investment and nominal variables. Nonetheless, the model suggests that observations which make the distinction between inside and outside money can be useful tools for analyzing the episode.

This exercise does not refute any of the previous evidence that nominal wage rigidity was a crucial feature of the episode. It does however stress the importance of inside money balances in providing a potential source of the monetary shock. The next step is to make this shock endogenous by explicitly modelling a financial intermediation sector along the lines of Cooper and Corbae (2002). In this type of environment, changes in the cost of intermediation will not imply a one-for-one change in the demand for cash goods; lessening the downward pressure of the price level during the financial collapse and doing away with the concern of negative nominal interest rates. Furthermore, shocks extracted from this present exercise were very
small, implying that subsequent changes in costs to financial intermediation needed to coincide with these shocks would not be unreasonably high as suggested by the analysis of Cole and Ohanian (2000). This paper suggests that a more elaborate environment incorporating these features could potentially shed further light on the source of nominal shocks previously taken to be exogenous in the literature.

A Calibration Algorithm

Define $DC_t$ to be the deposit-currency ratio observed at time $t$ (where $t = 1$ implies 1929), and $R_t$ to be the gross nominal interest rate ($r_t + \pi_t - 1$, since $r_t$ and $\pi_t$ are also in gross terms). The algorithm uses the linearized decision rules of the model and works forward by solving the following constrained minimization problem for every period ($t = 1, 2, ..., 11$).

$$
\min_{\{\varepsilon_{at}\}} \left| \frac{c_1 \left( k_t, \hat{P}_t, \alpha_t, \mu_t \right)}{c_2 \left( k_t, \hat{P}_t, \alpha_t, \mu_t \right)} - DC_t \right|
$$

subject to

$$
\alpha_t = \kappa_\alpha + \rho_\alpha \alpha_{t-1} + \varepsilon_{at}
$$

$$
R_t > 1
$$

The algorithm chooses the value of $\varepsilon_{at}$ taking previous values of $\alpha_t$ as given. The initial value of $\alpha_0$ was chosen to equal the steady-state value $\alpha$ stated in the text.

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13Kuznets (1937, p. 731) calculates that the value added of financial intermediation ranged between 1 to 2 percent of GDP during the Great Depression.
References


Table 1: Calibrated Parameter Values

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<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
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<tr>
<td>$\theta$</td>
<td>capital’s share</td>
<td>0.3879</td>
</tr>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.9855</td>
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<tr>
<td>$\delta$</td>
<td>depreciation rate</td>
<td>0.0241</td>
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<tr>
<td>$\mu$</td>
<td>monetary base growth (qtr.)</td>
<td>2.27</td>
</tr>
<tr>
<td>$\rho_\mu$</td>
<td>AR coefficient (base growth)</td>
<td>0.37</td>
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<tr>
<td>$\alpha$</td>
<td>cash good’s share</td>
<td>0.0858</td>
</tr>
<tr>
<td>$\rho_\alpha$</td>
<td>AR coefficient (preference shock)</td>
<td>0.9457</td>
</tr>
<tr>
<td>$\phi_i$</td>
<td>relative weight of cohort $i$ ($\forall i$)</td>
<td>0.25</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>contract adjustment parameter</td>
<td>$-0.01$</td>
</tr>
<tr>
<td>$z$</td>
<td>normalizing constant</td>
<td>0.8554</td>
</tr>
</tbody>
</table>
Figure 1: Impulse Responses

- Output
  - $\alpha$ shock
  - $\mu$ shock
- Investment
- Cash Goods
- Deposit Goods
- Total Consumption
- Deposit-Currency Ratio

Percentage Change

Quarters
Figure 2: Impulse Responses

Price Level

Percentage Change

Real Wage

Labor Hours

Percentage Change

Nominal Wage

Percentage Change

M1

Real Interest Rate

Nominal Wage

Percentage Change

Real Interest Rate

Percentage Change
Figure 3: Calibrating Information

Deposits / Currency

- Interpolated Data
- Annual Data

Monetary Base growth ($ \mu $)

Growth Rate (qtr)

$ \alpha $ Shocks

Percentage Change

w/o $ \mu $ shocks
- with $ \mu $ shocks

1930 1932 1934 1936 1938
Figure 4: Model Simulations

- Output
- Investment
- Cash Goods
- Deposit Goods
- Total Consumption
- Deposit-Currency Ratio

Percentage Change

Data
$\alpha$ shocks
$\{\alpha, \mu\}$ shocks

$\alpha$ shocks
$\{\alpha, \mu\}$ shocks
Data
Figure 5: Model Simulations

- **Price Level**
- **Labor Hours**
- **Real Wage**
- **Nominal Wage**
- **M1**
- **Real Interest Rate**

Data points for various economic indicators from 1930 to 1938, including percentage changes in price level, labor hours, real wage, nominal wage, M1, and real interest rate, showing the impact of shocks on these indicators.
Figure 6: Nominal Interest Rates

![Nominal Interest Rates Graph]

- Level w/o $\mu$ shocks
- Level with $\mu$ shocks
Figure 7: Model Simulations

- Output
- Investment
- Cash Goods
- Deposit Goods
- Total Consumption
- Deposit-Currency Ratio
Figure 8: Model Simulations

- Price Level
- Labor Hours
- Real Wage
- Nominal Wage
- M1
- Real Interest Rate

Percentage Change 1930 - 1938
Figure 9: Stability Analysis