Inflation without a quantity of money: a simple Wicksellian model outlined

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Abstract

The paper advances a simple and tractable Wicksellian model of inflation, in which the price level is determined by the interaction of the nominal rate of return on capital with a rule that governs the interest rate at which the Central Bank supplies money, and in which the equality of the supply of money with its demand has no explanatory role to play.

JEL codes: E31, E52, E58

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That the Quantity Theory is an inadequate explanation of inflation – or is seen to be an inadequate explanation – has received recent acknowledgment across a wide spectrum of economic thought. Thus it has been observed that the LM curve – the relation that captures the equality of the demand and supply of money – has evaporated from thinking about macroeconomics.

*The LM curve no longer plays any role in serious analysis, having been supplanted by the assumption that the central bank controls the short-term nominal interest rate.*

Alan S. Blinder (1997) ¹

Lucas and his co-authors draw the implications of the Blinder type position for the Quantity Theory very plainly.

*A consensus has emerged among practitioners that the instrument of monetary policy ought to be the short-term interest rate, that policy should be focused on the control of inflation, and inflation can be reduced by increasing short-term interest rates. At the center of this consensus is a rejection of the quantity theory.*

Lucas et al (2001)

But perhaps the most eloquent testimony to the demise of the Quantity Theory lies in a stark, two line statement of the Federal Reserve of the United States of America.

¹ Blinder adds ‘It is high time we changed our teaching in this way too’.
On March 23, 2006, the Board of Governors of the Federal Reserve System will cease publication of the M3 monetary aggregate.


To any spectator of the battle over inflation in the 1970s, to traverse the field again after 30 years is to walk in a landscape of giant, fallen statues.

What might be raised to do service in the place of the Quantity Theory?

One answer is found in an attempt to explain the inflation rate by reference to central bank policy regarding nominal interest rates. Here Wicksellian ideas have been revived (eg Woodford 2002). In these Wicksellian models the price level is determined by the interaction of the return on capital with some rule that governs the nominal rate of interest at which the Central Bank supplies money.

But in several important dimensions the Neo-Wicksellian approach remains underdeveloped. It is yet to be assimilated outside of readers of academic journals. It is uninvestigated empirically. It has been little used in historical investigations of inflation. The impression is that neo-Wicksellian approach remains recherché, and as if confined behind glass. If the Quantity Theory was massive, granite landmark in the economist’s intellectual landscape, the Wicksellian approach is yet to be more than a shimmering hologram.
It is beyond the aim of this paper to right these shortcomings. But it does aim to assist the commencement of their righting by supplying, on the basis of Coleman (2007), a simple, tractable statement of a Wicksellian model.

**The Wicksellian vision**

The Wicksellian vision is one that turns from supposing that money has the value that makes its demand equal to its supply, and towards the supposition that money has the value that makes the *demand price of credit* equal the *supply price of credit*. This is the Wicksellian theory of the value of money.

The Wicksellian model is motivated by the menace posed to the Quantity Theory by the conditions of the supply of money in the modern economy. The Quantity Theory commonly takes the quantity of outside money as something given by the central bank. In truth, the Quantity Critic contends, the modern central bank stands ready to lend, at a certain interest rate, whatever amount of money the public wishes to borrow. Rather than being ‘given’, M is, ultimately, a matter of the public’s wishes. Rather than the elasticity of the supply of M to P being zero, it is infinite. This consideration eviscerates the logic of the Quantity Theory. It can no longer be the task of P to equalise the supply and demand for money, since no such task need be performed. The central bank always supplies whatever amount is demanded.

If we admit the critique as cogent, we are left with a problem: if value of money is no longer determined by the demand and supply for money, how is the price level determined?
This paper outlines a Wicksellian answer to this problem. This Wicksellian solution locates price level determination in the credit market, rather than the money market. It supposes that the value of money affects both the ‘supply price’ of credit (the minimum nominal interest rate lenders will accept), and the demand price of credit (the maximum nominal interest rate that borrowers will tolerate), and that the value of money adjusts so that the supply price of credit equals the demand price of credit; and the rate of interest is no lower than lenders will accept, and no higher than borrowers will tolerate.

The Wicksellian theory discards the equality of money demand and money supply as having any causal role to play in the determination of $P$. The Wickellian theory, therefore, constitutes a radical alternative to the Quantity Theory, in which the money supply disappears from relevance and is replaced by measures of central bank willingness to lend.

**The structure of the Wicksellian model**

**The common core**

In order to focus on the key differences from the Quantity Theory, the Wicksellian model that this paper advances retains almost all the assumptions of a very ‘classical’ Quantity Theory. Thus the model this paper advances retains the assumption full employment. It accepts a dichotomisation of the economy into real and monetary sectors. It is content

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2 The model of this paper borrows its name from Knut Wicksell (1851-1926), whose *Interest and Prices* (1898) supplied the one serious rival to the Quantity Theory. Although there are hints of Wicksellianism in the *General Theory*, it remained largely in the mausoleum of ideas until the 1980s.
for real money holdings, $h$, to appear in the utility function. Thus both the Wicksellian model of this paper and the Quantity Theory accept the following equimarginal, optimisation conditions,

$$U_c = \frac{U_c}{1 + \rho}$$  \hspace{1cm} \text{capital}  \hspace{1cm} (0.1)$$

$$U_c = \frac{U_c}{1 + \pi}$$  \hspace{1cm} \text{money}  \hspace{1cm} (0.2)$$

$$U_c = \frac{1 + i}{1 + \pi}$$  \hspace{1cm} \text{bonds}  \hspace{1cm} (0.3)$$

where $\rho = \frac{\partial Y}{\partial K_1}$ = rate of profit

$U_c$ = marginal utility of consumption

$U_h$ = marginal utility of real balances

$\pi$ = rate of inflation

The supply price of credit: the Interest Rate Reaction Function

In only one assumption does the Wicksellian model outlined here differ from the Quantity Theory: in the supply of money. The Quantity Theory supposes the nominal supply of (‘outside’) money, $M$, is given. The Wicksellian model, by contrast, supposes

3 The sacrifice of one unit of consumption for the sake of an extra unit of real balances this period costs $U_c$ in utility, but adds $U_h$ in utility this period, plus the utility from consuming in the following period the extra unit of real balances acquired this period, $\frac{U_{c1}}{1 + \pi}$. 

the central bank is willing to lend, on certain terms, the public any amount of (‘outside’) money the public wishes to borrow.

But the present modelling of the Wicksellian vision will assume, and this is critical, that the terms at which the central bank lends money is not exogenous, but depends on the relativity of the actual price level, $P$, to a ‘reference price level’, $P_R$. The higher the excess of $P$ over $P_R$, the higher the interest rate the central bank requires from its borrowers. All that is required is of this relation between the price level and the Central bank’s lending rate is that it be continuous and (positively) monotonic. But, purely for reasons of convenience, it will be assumed here that the relation is in logs.

$$i = \bar{i} + \phi [\ln P - \ln P_R] \quad \phi > 0 \quad (0.4)$$

This is the ‘interest rate reaction function’ (IRRF).

$\bar{i}$ is the ‘benchmark rate of interest’; it is the rate of interest at which the central bank supplies money when the price level equals the reference price level ( = the rate of interest the central bank settles upon when it has the price level it wants.) $\phi$ is the response in the interest rate to a proportionate deviation of $P$ from $P_R$. Its magnitude is an indicator of the sensitivity of monetary policy. The smaller $\phi$ the less sensitive the reaction in interest rates.

Four points about the IRRF can be usefully made:
• No optimising rationalisation for the IRRF is here advanced. The IRRF is a broadly plausible description of actual central bank behaviour.\footnote{A reference price level may exist implicitly, even it does not exist explicitly. We might imagine, for example, a central bank adjusting the rate of interest in accordance with the deviation of the actual price of foreign exchange from some ‘reference’ exchange rate. If the actual exchange rate conforms with purchasing power parity then the central bank is, without necessarily realising it, adjusting the rate of interest in accordance with the deviation of the actual price level from some reference price level.} But the function is otherwise taken as a given, just as the nominal money supply is taken as a given in the Quantity Theory.

• The Rule does not make the interest rate a policy instrument, properly speaking. The central bank chooses the benchmark interest rate, and \( \text{P}_R \). But it does not choose \( i \). Nevertheless, as \( \phi \) gets close to zero, the IRRF approaches an interest rate peg, as very large variations in \( P \) imply on very small changes in \( i \).

• The IRRF is an interest rate rule. There is nothing left to the central bank’s discretion, or judgement. There is nothing to judge. The IRRF could be executed automatically.

• It is assumed that the IRRF is known by all. It is part of market participants’ information set.

The deployment of an IRRF in place of a given money supply makes for a difference in the causal significance of the three optimisation conditions that both theories share; (0.1), (0.2) and (0.3). The Quantity Theory uses the optimisation condition for capital, (0.1), and that for money, (0.2), to derive a demand for money function, which it then
equates to a given supply of money. The third optimisation condition (for bonds, (0.3)) is disregarded as redundant to the determination of the value of money. The Wicksellian model, by contrast, disregards the optimisation condition for money as redundant for the determination of the value of money. It instead takes the supply price of credit from the IRRF and equates it with a demand price for credit obtained from the optimisation conditions for capital, (0.1) and that for bonds (0.3).

The demand price of credit: the Fisher Condition

In turning now from the supply price of credit (the IRRF) towards the demand price for credit, we turn from the minimum rate lenders will tolerate, to the maximum rate borrowers will accept. That maximum rate is determined by the equimarginal conditions for capital and bonds. Together, they imply, \[1 + i = [1 + \rho][1 + \pi].\] Taking logs,

\[i = \rho + \ln P_1 - \ln P\]  \hspace{1cm} (0.5)

This ‘Fisher Condition’, and gives the maximum rate borrowers will bear.

The Fisher Condition is equally shared by the Quantity and Wicksellian models. But they differ on how to interpret the direction of causality in the Condition.

Quantity Theorists suppose causality in the Fisher Condition runs from inflation to the rate of interest. Inflation is the independent variable, and the interest rate is the

\[\ln[1 + i] = \ln[1 + \rho] + \ln P_1 - \ln P.\] We are measuring the interest and the profit rate as if it was continuously compounded within the period.

5
dependent. The Wicksellian approach allows that there may also be a causal arrow running from $i$ to $\pi$. In other words, a higher rate of $i$ generates a higher rate of inflation. How could this causal arrow be rationalised? By means of an endogeneity in $P$. A higher $i$ must be accompanied by a higher rate of inflation, by the Fisher Condition. But if $P_1$ is exogenous, then a higher inflation rate necessitates a fall in $P$, as a matter of arithmetic. So, to illustrate, consider a durable asset that has a price $100$ in both the current period and the next. Its nominal return is 6 percent, and the interest rate is 6 percent: there is equilibrium. But if $i$ rises to 9 percent, then the commodity will be sold off until its price has fallen to $97$, thereby creating a prospective 3 percent increase in price (and so return), that compensates for the 3 percent increase in the rate of interest.

By a parallel logic, the Wicksellian approach also allows a higher $\rho$ to affect $\pi$. For a given $i$, a higher $\rho$ must be accompanied by a lower rate of inflation. But if $P_1$ is exogenous, a lower inflation rate necessitates a rise in $P$, as a matter of arithmetic.

In contemplating this reverse causation we glimpse the shape of the Wicksellian theory; a higher $i$ spells a lower $P$, and a higher $\rho$ spells a higher $P$. Yet such a characterisation of the Wicksellian approach is somewhat misleading, given that the interest rate is not exogenous in the Wicksellian approach. It is, quite critically, a function of the price level. So equilibrium is a matter of simultaneous causation, with causal arrows pointing from $i$ to $P$, and from $P$ to $i$.

The equilibrium of the Wicksellian model
The equality of the demand price of credit with the supply price of credit.

Equilibrium requires that the interest rate satisfy both the Fisher Condition and the Interest Rate Reaction Function.

\[ i = \rho + \pi \]
\[ i = \tilde{i} + \phi[\ln P - \ln P_R] \]
\[ \pi = \ln P_1 - \ln P \]  \hspace{1cm} (0.6)

Corresponding equalities hold for all other periods

\[ i_1 = \rho_1 + \pi_1 \]
\[ i_1 = \tilde{i}_1 + \phi[\ln P_1 - \ln P_{R,1}] \]
\[ \pi_1 = \ln P_2 - \ln P_1 \]  \hspace{1cm} (0.7)

\[ i_2 = \rho_2 + \pi_2 \]
\[ i_2 = \tilde{i}_2 + \phi[\ln P_2 - \ln P_{R,2}] \]
\[ \pi_2 = \ln P_3 - \ln P_2 \]  \hspace{1cm} (0.8)

etc

The comparative–statics of this system of equilibrium conditions turn on a key property of the system of: future endogeneous variables are exogenous with respect to current endogeneous variables. This can be seen by noting that \( P_{-1} \) is absent from the equilibrium system above. Thus, on the assumption that the above system is determinate, we infer that \( P \) is completely independent of \( P_{-1} \). That is, \( P \) is exogenous with respect of \( P_{-1} \). But if \( P \) is exogenous with respect of \( P-1 \), then \( P1 \) is exogenous with respect of \( P \) Thus the equalities,

\[ i = \rho + \ln P_1 - \ln P \]
\[ i = \tilde{i} + \phi[\ln P - \ln P_R] \]  \hspace{1cm} (0.9)
constitute a system of two equations in two unknowns: \( P \) and \( i \). The equality on the left gives the ‘demand price for credit’. The equality on the right gives the ‘supply price of credit’. The equality of these two implies,

\[
\ln P = \frac{\phi}{1 + \phi} \ln P_R + \frac{1}{1 + \phi} \ln P_i + \frac{1}{1 + \phi} [\rho - \bar{i}] \tag{0.10}
\]

Figure 1 represents this solution.

\[\text{Figure 1: The determination of } P \text{ in the Wicksellian model}\]
It will be observed that in the expression for the price level (0.10), and in Figure 1, the money supply is completely absent. The supply of money may still be supposed to equal the demand for money, but the requirements of the equality of money demand to money supply have nothing to do with the determination of P. Thus a shock to money demand have zero impact on P; it will be met by more lending from the central bank. And a shock to the money supply a will also have no impact on P. Any helicopter drop of money will be unwanted, and used to repay debt to the central bank, or buy assets from them. Any helicopter drop of money is the equivalent of cancelling a debt the public owes to government. An increase in the autonomous supply of inside money also has no affect on P. The public will simply have an excess supply of money, and it will use its holdings of outside money to pay off its debts to government.

The Wicksellian model, then, is a model of the price level without a quantity of money. The Wicksellian model explains P by means of the reference price level, the benchmark interest rate and the future price level.

We will go through these in turn.

A higher reference price level increases P.

The expression for lnP, (0.10) implies,

\[
\frac{\hat{\phi}}{\hat{\phi}} = \frac{\phi}{1+\phi} > 0
\]  

(0.11)
To increase the reference price level is to increase the actual price level. To give an intuition for this result, it is helpful to imagine an adjustment process in which the nominal interest rate always equals the ‘supply price’ of credit, but, following a disturbance, only equals the ‘demand price’ of credit with a lag. Equivalently, \( i \) always is ‘on’ the IRRF, but, following a disturbance, only gets back ‘on’ the Fisher Condition with a lag. \( P \), at any period, is pre-determined, but adjusts upwards over time to any excess of the return on capital over \( i \).

The increase in \( P \) following an increase in \( P_R \) may be read thus. An increase in \( P_R \) for a given \( P \), reduces \( P \) relative to \( P_R \). \( i \) is reduced, in accordance with the IRRF. But that fall in \( i \) means the rate of interest is now less than the rate of return on capital. Money is borrowed from the central bank in order to buy capital, and the money price of capital (and so output) is bid up. But that rise in \( P \) induces the central bank to raise rates, in accordance with the IRRF. That same rise in \( P \) reduces prospective inflation, as a matter of arithmetic (as \( \pi \equiv \ln P - \ln P \)), and so reduces the rate of return on capital. These two responses combined restore the equality of the rate of interest to the nominal rate of return on capital.

In terms of the Figure the IRRF shifts down. The immediate response is a fall in \( i \), and no change in \( P \). This leaves \( i \) below the FC. \( i \) and \( P \) move north-east.
Figure 2: A higher reference price level increases $P$

By how much will $P$ rise? $P$ will not rise equipropotionately with $P_R$. $P$ is inelastic to $P_R$.

If $P$ was unit elastic with $P_R$, then $i$ would be unchanged in accordance with the IRRF; yet expected inflation would (as a matter of arithmetic) still be reduced by the higher price level, leaving the nominal return on capital smaller than $i$. To preserve equilibrium, therefore, $P$ rises by less than $P_R$, and thereby producing a fall in $i$.

A higher profit rate increases $P$.

$$\frac{\partial \ln P}{\partial \rho} = \frac{1}{1+\phi} > 0$$

(0.12)
An increase in $\rho$ means capital earns a greater nominal rate of return than bonds. So profit is made by borrowing money and buying capital. So money is borrowed, and capital is bid for. That raises prices. That rise reduces expected inflation as a matter of arithmetic, and so helps restore equilibrium. It also induces the central bank to raise $i$, and that also helps restore equilibrium. And so equilibrium is restored.

How much $P$ rises depends on the magnitude of $\phi$. If $\phi$ is large - a sensitive IRRF - the interest rate is will do ‘most the work’ to restore the equality of to the rate of return on capital, and $P$ need barely rise. But if $\phi$ is near zero - an insensitive IRRF- then $P$ ‘does most of the work’, and it adjusts upwards so as to engender an expectation of deflation almost equal to the increase in the rate of profit. These results are captured in the expression for the semi-elasticity of $P$ to $\rho$, which depends on the magnitude of $\phi$. If $\phi$ is near zero the semi-elasticity is near one.
A higher benchmark interest rate reduces $P$

$$\frac{\partial \ln P}{\partial \tilde{i}} = -\frac{1}{1+\phi} < 0$$  \hspace{1cm} (0.13)

Intuitively, an increase in the benchmark rate increases $i$ in accordance with the revised IRRF. Bonds now offer a higher rate than capital, and capital is sold with the intention of lending the proceeds to the central bank. That process reduces $P$. That reduction in $P$ increases prospective inflation, and causes part of the initial increase in $i$ to be reversed, and thereby secures an equality between $i$ and the nominal rate on capital.

As $\phi$ varies between zero and infinity, the semi-elasticity of $P$ to $\tilde{i}$ varies between one and zero.

An increase in future prices increases current $P$.

$$\frac{\partial \ln P}{\partial \ln P_t} = \frac{1}{1+\phi} > 0$$  \hspace{1cm} (0.14)

Intuitively, an increase in $P_t$ means capital initially outperforms bonds. Capital is bought, that raises prices, and that both raises $i$ and reduces prospective inflation, and so restores equilibrium.
Future Shocks

The preceding analysis is incomplete: it begs a question about the determination of $P_1$. That question can be answered by the equality of the demand price and supply price of credit in period 1. That equality implies,

\[
\ln P_1 = \frac{\phi}{1+\phi} \ln P_{R,1} + \frac{1}{1+\phi} \ln P_2 + \frac{1}{1+\phi} [\rho_1 - \bar{i}_1] \quad (0.15)
\]

and similarly for following periods,

\[
\ln P_2 = \frac{\phi}{1+\phi} \ln P_{R,2} + \frac{1}{1+\phi} \ln P_3 + \frac{1}{1+\phi} [\rho_2 - \bar{i}_2] \quad (0.16)
\]

e tc

Repeated substitution into (0.10) yields,

\[
\ln P = \frac{\ln P_{R,\phi}}{1+\phi} + \frac{\ln P_{R,1}}{1+\phi} \frac{1}{1+\phi} + \frac{\ln P_{R,2}}{1+\phi} \frac{1}{1+\phi} [\rho - \bar{i}] \frac{1}{1+\phi} + [\rho_1 - \bar{i}_1] \frac{1}{1+\phi} + \ldots
\]

(0.17)

\[\text{6} \quad \phi \text{ must be positive in order for the series to converge; an illustration of the necessity for } \phi \text{ to be positive.}\]
The price level is, evidently, a matter of all reference prices, profit rates and benchmark rates, both current and future. Thus any increase in the profit rate – be it in the future as well as present - will increase \( P \). An increase in the benchmark rate of interest – be it in the future as well as present - will reduce \( P \). An increase in the reference price level – be it in the future as well as present - will increase \( P \).

Table 1 gives details.

<table>
<thead>
<tr>
<th>( P_{R,t} )</th>
<th>( \rho_t )</th>
<th>( \tilde{i}_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\phi}{1 + \phi} \cdot \left[ \frac{1}{1 + \phi} \right] &lt; 1 )</td>
<td>( \frac{1}{1 + \phi} &lt; 1 )</td>
<td>( -\frac{1}{1 + \phi} &lt; 1 )</td>
</tr>
</tbody>
</table>

*Table 1: Sensitivities of the price level to shocks (elasticity/semi-elasticity).*

Table 1 has implications regarding the relative importance of ‘the present’ and ‘the future’. A nearer shock is always more significant than a further shock. But as \( \phi \) approaches indefinitely small (that is, as the IRRF approaches an interest rate peg), future magnitudes assume an almost equal impact with current ones. The larger \( \phi \) (the more response i) the more ‘present biased’ is price determination. As \( \phi \) approaches infinity, all future variables are irrelevant.

The complete expression for \( P \) may be expressed more compactly by using ‘permanent’ magnitudes of the reference price level, etc.
\[
\ln P = \ln P_0^* + \frac{\rho^* - \bar{i}^*}{\phi}
\]  
(0.18)

where,
\[
\ln P_0^* 1 + \frac{\rho^*}{\phi} = \ln P_0 + \ln P_{r,1} + \ln P_{r,2} + \ldots
\]  
(0.19)

\[
\rho^* 1 + \frac{\rho^*}{\phi} = \rho + \rho_1 + \rho_2 + \ldots
\]  
(0.20)

\[
\bar{i}^* 1 + \frac{\bar{i}^*}{\phi} = \bar{i} + \bar{i}_1 + \bar{i}_2 + \ldots
\]  
(0.21)

(0.18) brings out that it is the permanent magnitudes that count.

**Inflation**

A compact expression for inflation can be derived using the permanent concepts, including a ‘permanent rate of reference inflation’

\[
\pi = \pi_0^* + \rho^* - \rho + \bar{i} - \bar{i}^*
\]  
(0.22)
where $\pi^*$, the permanent rate of reference inflation, is defined as the hypothetical constant rate of reference inflation that has the same ‘present value’ as the ‘present value’ of the actual profile of reference inflation rates.

$$\pi^*_R \frac{1 + \phi}{\phi} = \pi_R + \frac{\pi_{R,1}}{1 + \phi} + \frac{\pi_{R,2}}{(1 + \phi)^2} \ldots$$  

(0.23)

The moral of the expression for inflation, (0.23) is that it is the permanent magnitude of $\pi_R$, $\pi^*_R$, that is significant for inflation. Not this period’s $\pi_R$. Or next period’s. Or any other single period. So, for example, $\pi_R$ may be negative this period, but if the permanent rate is positive there will be inflation this period. The moral is that current inflation is insensitive to the ambitions of authorities for inflation in the current period. It is their ambitions over the long period that counts.

Inspection of (0.23) also reveals that it is the excess of the permanent rate of profit over the current rate, $\rho^* - \rho$, that creates inflationary pressure. If the tendency of future profit rates is to exceed the current profit rate, then prices will rise faster than they would otherwise. This makes sense. We have learnt a higher profit rate produces a higher price level. So if future profit rates are higher than current ones, then future prices will be higher than the current one: inflation. Thus it is the trend, or escalation in the profit rate, yielding $\rho^* > \rho$, that produces inflation, not the ‘height’ of the profit rate. This implies that any change in the profit rate which is permanent has no impact on inflation, except in the period in which it occurs.
Conversely, inspection reveals that it is the excess of the permanent benchmark rate over the current benchmark rate that that creates deflationary pressure. Thus if the tendency of future benchmark rates is to exceed the current benchmark, rate then prices will be falling. We have learnt that a higher benchmark rate produces a lower price level. So if future benchmark rates are higher than current ones, then future prices are lower than the current one: deflation. Thus it is the trend, or escalation in the benchmark rate, yielding $\tilde{i}^* > \tilde{i}$, that produces deflation, not the ‘height’ of the benchmark rate. Thus any change in the benchmark rate which is permanent has no impact on inflation, except in the period in which it occurs. Notice that a permanent reduction in the benchmark rate does not create inflation. This underlines the property that there is no ‘inflation neutral’ benchmark rate.\(^7\)

To try to summarise, if one was to ask ‘Why is there inflation?’, one acceptable answer would be to point to three circumstances which are sufficient for inflation: (a) A positive trend in the Reference Price Level (other factors unchanging), or (b) a positive trend in the rate of profit (other factors unchanging), or (c) a negative trend in the benchmark rate of interest (other factors unchanging).

If one was to ask ‘Why is there deflation?’ one answer would be to point to three circumstances which are sufficient: (1) An reducing Reference Price Level (other factors

\(^7\) Contrary to the view of some central bankers, there is no ‘inflation neutral’ benchmark rate: there is no unique benchmark rate that will ensure zero inflation, continually over time. There will always be some magnitude of the benchmark rate that will secure zero inflation in a given period. But that magnitude will, flukes aside, change over time. Nevertheless, the benchmark has a role in securing zero inflation. As the later part of the section argues, the disturbances to $P$ from $\rho$ are eliminated if the benchmark rate moves in tandem with the profit rate.
unchanging) or (b) a continuous reducing the rate of profit (other factors unchanging), or (c) a continuous increase in the benchmark rate of interest (other factors unchanging).

A continuous increase in the profit rate, or decrease in the benchmark rate, is unlikely to be sustained for long, or to be very large. Thus if we are concerned with ‘secular’ rates of inflation it is the reference inflation rate is crucial. Price trends are largely to be explained in terms of the change in the Reference Price level. If there is 15 percent inflation it is on account of an unwillingness of the central bank to raise the interest rate except when prices rise more than 15 percent - and a willingness to reduce them if prices rise by less than 15 percent. It is such policy produces an inflation rate of approximately 15 percent. If there is to be 1 percent inflation the central bank must be willing to raise the interest rate as soon as inflation exceeds 1 percent- and lower it as soon as it is less than 1 percent. If there is any inflation, it is on account of the central bank unwillingness to raise interest rates whenever prices are rising, be it ever so small.

‘Interest and prices’

We have explored the Wicksellian model’s determination of prices. But the Wicksellian model also determines the rate of interest. This determination is worth explicating because of the presumption – which is borne out here – that in any Wicksellian model the nominal interest rate and the price level are tied up together

The equilibrium expression for the interest rate is,
\[ i = \bar{i} + \phi \left( \frac{\ln P_r \phi}{1+\phi} \ln P_{r_2} \phi + \frac{1}{1+\phi} \ln P_{r_2} \phi \left( \frac{1}{1+\phi} \right)^2 + \cdots + \left( \rho - \bar{i} \right) \frac{1}{1+\phi} \left( \rho_1 - \bar{i} \right) \left( \frac{1}{1+\phi} \right)^2 + \cdots - P_k \right) \]

(0.24)

This can be more compactly expressed,

\[ i = \pi^*_g + \rho^* + \bar{i} - \bar{i}^* \]

(0.25)\(^8\)

The expression suggests that, with one exception, it is permanent magnitudes that determine the rate of interest. It is the permanent rate of reference inflation that features in the expression for \(i\), not reference inflation in the current period. It is permanent magnitude of \(\rho\) that appears, and not the current magnitude. The moral is purely temporary fluctuations in the reference inflation rate or the profit rate are pretty much irrelevant to the nominal interest rate; they are swamped by the action of future rates.

However, the nominal interest rate does respond to, and on a one-to-one basis, temporary changes in the benchmark rate. Thus the interest rate is smooth (‘sticky’ in appearance) save for central bank playing about with benchmark rate.

\(^8\) We can find the expression for \(i\) when all magnitudes are unchanging over time,

\[ i = \rho + \pi_g \]
Co-movements and Paradoxes

i and P are so tied up with one another that there is considerable co-movement in the interest rate and the price-level, both positive and negative.

<table>
<thead>
<tr>
<th></th>
<th>Derivative of lnP</th>
<th>Derivative of i</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρ</td>
<td>( \frac{1}{1+\phi} )</td>
<td>( \frac{1}{1+\phi} )</td>
</tr>
<tr>
<td>PR</td>
<td>( \frac{\phi}{1+\phi} )</td>
<td>- ( \frac{\phi}{1+\phi} )</td>
</tr>
<tr>
<td>( \dot{i} )</td>
<td>- ( \frac{\phi}{1+\phi} )</td>
<td>( \frac{\phi}{1+\phi} )</td>
</tr>
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</table>

Table 2: Relative impacts on P and i of shocks in the Wicksellian model

The first row indicates that shocks to the profit rate will push i and P in the same direction: upwards, and by the same amount. This one-for-one co-movement means that if profit rate shocks were the only shocks then the interest rate and the log of the price level would be perfectly ‘correlated’. This is reminiscent of Gibson’s Paradox.⁹

The presence of other shocks, however, will spoil any perfect co-movement in prices and nominal interest levels. The second row indicates that current shocks to lnPR and \( \dot{i} \) will shift i and P in opposite directions, by equal amounts.

⁹ Whether this is a plausible explanation is another question. Few economies had central banks in the 18th and 19th century.
However, future shocks to $\tilde{i}$ will shift $i$ and $P$ in same directions, and same amount. And future shocks to $\ln P_R$ will shift $i$ and $P$ in the same direction, and by the same amount.

$$\frac{\partial i}{\partial \ln P_{R,t}} = \frac{\partial \ln P}{\partial \ln P_{R,t}} = \frac{\phi}{1 + \phi} \left[ \frac{1}{1 + \phi} \right]^t$$  \quad t \geq 1 \quad (0.26)

$$\frac{\partial i}{\partial i_t} = \frac{\partial \ln P}{\partial i_t} = \left[ \frac{1}{1 + \phi} \right]^t$$  \quad t \geq 1 \quad (0.27)

What then is the impact of permanent changes on $i$, as compared with the impact of permanent changes on $P$? A permanent increase in rho will $i$. These contrary future and present impacts of benchmark rate balance each other out in that the impact of permanent change in benchmark rate will have no impact on $i$. Similarly for $\ln P_R$.

**Interest and Price Stability**

The discussion prepares the way for the analysis of the requirements of price stability.

Wicksell contended that price stability requires that the interest rate assume some ‘right’ level; the nominal rate of interest to equal the rate of profit. For Wicksell’s contention to be a prescription for price stability the interest rate must be taken to be a policy instrument, and exogenous to prices.\(^{10}\) As the interest rate is endogenous within this model, Wicksell’s prescription cannot be strictly rationalised within this model.

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\(^{10}\) Wicksell’s prescription is presumably more than just a restatement of the Fisher Hypothesis, that trivially implies an equality of the interest rate and the profit rate whenever there is price stability.
Nevertheless, the benchmark interest rate is exogenous in the present model, and a closely kindred prescription is true. Recall,

\[ \pi = \pi_R + \rho - \rho + \tilde{i} - \tilde{i}^* \]  

(0.28)

It can easily be inferred, that atable and zero inflation (and \( \ln P = \ln P_R \)) can be secured by a double pronged policy;

\[ \pi_{R,t} = 0 \quad \text{and} \quad \tilde{i}_t = \rho, \text{ all } t \]  

(0.29)

Price stability is secured by the benchmark rate jiggering up and down with the rate of profit.

Two remarks

- The price stabilisation rule implies

\[ i_t = \rho_t \text{ for all } t \]  

(0.30)

but this implication should not be considered a prescription. A rule which amounted to an injunction to peg the nominal rate at the rate of profit,

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The critical thing is for the benchmark rate to move one-for-one with the profit rate. It is not necessary for it equal the profit rate. A stable and zero inflation can also be reached by,

\[ \pi_{R,t} = 0 \quad \text{and} \quad \tilde{i}_t = \rho_t + \beta \]
would not secure price stability. It would imply price-indeterminacy. It is the willingness to make \( i \) different from \( r \), in the face of \( P \) diverging from \( P_r \), that provides price stability.

- The price stability in no way rests upon the central bank being willing to raise the interest rate by *so much* if \( P \) rises so much above the target. All price stability requires is that \( i \) be raised by some amount if there is any inflation in the current period, and increase it again by some amount more next period if there is any more inflation the following period, (and increase it yet again by some amount in the period after if there is any more inflation the period after,… etc). It is the willingness to keep on raising \( i \) the further \( P \) departs from its initial value that is critical.\(^\text{12}\)

### Fact and theory

The Wicksellian analysis has been motivated in these pages by the more intelligible modeling of the money supply process it provides. But the real test of its worth lies elsewhere. Does it throw any light of historical episodes of inflation and deflation? Does it do this any better than the Quantity Theory?

\(^{12}\) The insignificance of the size of the coefficient of reaction, \( \phi \), for the success of the price stabilisation rule, might seem to ascribe great power to microscopic increases in the benchmark rate of interest. The model implies that a willingness to raise \( i \) by, say, one hundredth of a percentage point for every 10 percent that \( P \) exceeds the stable counterfactual is sufficient to ensure price stability. Is this plausible? It may be that in the real world a merely minute increase in \( i \) may throw doubts on the central bank’s willingness to persist, and that is critical.
In evaluating the Wicksellian model’s predictive performance it is helpful to distinguish between trend and cycle components of inflation.

The Wicksellian model nominates profit rates and benchmark rates as the leading candidates for explaining cyclical movements in inflation. The Wicksellian model therefore seems to disregard almost every indicator that has been found useful, or thought to have been found useful, as a proximate cause of short run movements in prices: scarce inventories, booming commodity prices, falling exchange rates, oil shortages, bottlenecks, labour market pressures. The relevance of several of these things to inflation is, however, consistent with the Wicksellian emphasis on the profit rate. Clearly inventories have a rate of return, and that will be high whenever inventories are scarce. Commodities, too, are assets, whose prospective rate return will often be high when they have been appreciating in the recent past. It is ‘theoretically possible’ that reduction in energy inputs may increase the rate of return on capital. Bottlenecks may increase also the rate of return on capital, as whole, and thereby be inflationary by the account of Wicksellian theory. Technical change may simultaneous increase the demand for labour (‘labour market pressure’) and, critically, capital. Even more definitely in favour of Wicksellianism capacity is the tendency for inflation to drop in a recession, as rates of return drop.

Trend movements in inflation are much less easily explained by profit rates and benchmark rates, as they themselves must have a trend in order to explain a trend. The Wicksellian resource for explaining the trend inflation is in the trend in the reference price level. So, to illustrate, the Wicksellian explanation of the end of the Great Inflation
of the 1970s is that the reference price level increased more quickly than it did in the 1960s; the actual price level, in other words, could rise more quickly than it did before without the Central Banks raising the interest rate.\textsuperscript{13} And the Wicksellian explanation of the end Great Inflation was decline in the rate of reference price inflation: the actual price level, in other words, could no longer rise so quickly as before without the Central Banks raising the interest rate. In Wicksellian conception, the unexpectedly high interest rates of Paul Volker’s chairmanship of the federal reserve signaled that.

But is there any evidence that the reference price level increased more quickly in the 1970s? A great difficulty in answering that question is that in being a behavioral parameter, and not a ‘thing’ (as the money supply is), the reference price level is difficult to observe – and has not been observed. One response would be to brave the difficulties and seek to gather observations, even if the ‘observations’ can be no more than ‘soft data’. For example, a monetary authority’s prediction of inflation, that is unaccompanied by predictions of higher interest rates, might be taken to be a report of the rate of increase in the reference price level. Any announced ‘inflation target’ may be even more readily identified with the rate of increase in the reference price level, as long as no change in the interest rate is foreshadowed.

Another way of assessing whether the reference price level increased more rapidly in the 1970s would be to see if the central bank’s behaviour changed in this decade: if the interest rate chosen in response to the price level changed. Was there, in other words, a

\textsuperscript{13} It is not necessary for the success of the hypothesis to suppose Central Banks thought in terms of a relation between the interest rate and the price level. The institutional arrangement might have led them to act according to such a relation. A commitment, for example, to a fixed exchange rate and unchanged interest rate in the face of imported inflation is, in effect, a decision to let the reference price level inflate more rapidly.
structural shift in the interest rate reaction function? Such an inquiry would be easier if
the reference price level was thought to have undergone a one-off shift upwards in level
in the 1970s. Such a one-off shift in level would be manifested as a change in the
constant term in the interest rate reaction function, and a change in a constant term can
be assessed by standard methods. But the Wicksellian hypothesis of the Great Inflation
is, surely, that the rate of increase in reference price level increased. Under this
hypothesis there is no constant term in the interest rate reaction function, but instead an
(unobserved) exogenous variable (the reference price level) increasing according to a
(possibly variable) trend. Nevertheless, the Wicksellian hypothesis might be still be
investigated by treating the interest rate as a function of the ‘trend adjusted price level’-
the price level deflated by the trend of price level – which could be used a proxy for the
reference price level. One might estimate a reaction function, on the basis of that proxy,
for the 1950s and 1960s, and investigate how well it performs out of sample in the
1970s. If it overpredicts the actual interest rate in the 1970s, then one might infer there
was a ‘loosening in interest rate policy’ in the 1970s; in other words the interest rate in the
1970s was not raised in circumstances where in previous decades it would have been.

It is not obvious that there was a ‘loosening of interest rate policy’ in the 1970s. Interest
rates were much higher than the 1960s. But this surely reflects the operation of the
Fisher Hypothesis, which is also an integral part of the Wicksellian model. We are
confront, then, the problem that in the Wicksellian model both the interest rate and the
price level are endogenous variables, and trying to estimate a reaction function in the
context of this endogeneity is beset with difficulty.
We are left with estimating reduced form equation for the price level, but still beleagured by the unobservability of the reference price level. Nevertheless proxies might be advanced to allow the investigation of the implication of the Wicksellian model that the price level is negatively related to those proxies.
References


