Abstract. This paper describes a simple Wicksellian macroeconomic model that can be used in undergraduate macroeconomics courses. It is designed as an alternative to the Romer (2000) model that is slowly replacing IS-LM/AS-AD in many textbooks. The chief advantages of the Wicksellian model over the Romer model are that it accounts for the term structure of interest rates, and it uses the federal funds rate as a freely-determined monetary policy instrument rather than imposing a monetary policy rule. The model can be used to analyze a number of interesting issues in monetary policy that are difficult to handle in the IS-LM/AS-AD or Romer model framework involving permanent versus temporary expenditures shocks, anticipated expenditures shocks, and shocks to the term structure of interest rates. The model can easily be simplified for use in a principles course or extended for use in upper-level macroeconomics courses.
1. INTRODUCTION

The IS-LM/AS-AD model has been the centerpiece of intermediate macroeconomics textbooks for more than half a century. In recent years, however, researchers and policymakers have largely adopted an alternative framework for the analysis of monetary policy. This framework, surveyed in Woodford (2003) and elsewhere, is characterized by the use of interest rates rather than the money supply as the instrument of monetary policy, an emphasis on the natural rate of interest as an important macroeconomic variable, and a focus on monetary policy rules.

The disconnect between the way macroeconomic theory is presented in the classroom versus the way it is used by researchers and policymakers is a cause for concern. Romer (2000) attempts to bridge the gap between undergraduate instruction and state of the art theory by proposing an alternative to the IS-LM/AS-AD framework for use in undergraduate textbooks. His model, which he calls the IS-MP-IA model, has a simple three equation structure: a monetary policy rule equation specifying how the central bank sets the interest rate, an IS equation linking the interest rate to output, and an inflation adjustment equation linking the deviation of output from potential output to changes in the inflation rate. The model has a simple graphical representation that is appropriate for undergraduate courses. Because of its simplicity and consistency with modern monetary theory, variants of Romer’s model have replaced IS-LM/AS-AD in a number of textbooks. These include Taylor’s (2003) and Frank and Bernanke’s (2004) principles textbooks and DeLong and Olney’s (2006) intermediate macroeconomics textbook.

While Romer’s model is an important step forward, it has a number of shortcomings. First, the model does not take full advantage of the possibilities presented by the Wicksellian
approach. In particular, though the natural rate of interest appears in the model, the model is not used to trace out the effects of changes in the natural rate. The chief reason the model is not used in this way is that the natural rate of interest is a long-run equilibrium concept, and the Romer model makes no distinction between long-run and short-run interest rates. I show below that adding a term structure equation to the Romer model allows one to make interesting statements about the effect of changes in the natural rate of interest and to distinguish between the effects of temporary and permanent shocks.

In addition, the central role Romer gives to the monetary policy rule equation in his model poses two problems. First, and most importantly, Romer’s monetary policy rule is not consistent with the behavior of an optimizing central banker: in his model, demand shocks cause the inflation rate to drift permanently away from the target rate. Thus the predictions of and policy implications drawn from the Romer model are at odds with state-of-the-art monetary theory. Carlin and Soskice (2005) consider modifications of the Romer model that correct this problem, but in doing so add considerably to the complexity of the model. The second problem is pedagogical. Since the monetary policy rule is specified at the outset of the presentation of the model, students may be inclined to treat it as a structural equation rather than one possible policy choice among competing alternatives. Students are deprived of the opportunity to experiment with alternative monetary policy responses – including suboptimal responses – and from this experience discover for themselves the properties of the optimal rule.

In this paper I propose a version of the Wicksellian model that addresses the shortcomings in Romer’s model. First, the proposed model adds a term structure equation to Romer’s IS and inflation adjustment equations. Introduction of the term structure equation makes it possible to use the model to analyze the effects of anticipated policy actions and the difference
between temporary and permanent macroeconomic shocks at a low cost in terms of added complexity. The model can also be used to analyze the reasons for and the effects of changes in the yield curve. Second, the model treats the federal funds rate as an exogenous monetary policy instrument rather than assuming that the central bank follows a monetary policy rule. Students take the perspective of policymakers, using the model to explore the consequences of alternative monetary rules. Without the monetary policy rule equation the model has a simple recursive structure that makes it simpler to solve than the Romer model, despite the addition of the term structure equation. The model can be used to derive a stabilizing monetary policy rule that is similar to that in Carlin and Soskice (2005).

Because of the added emphasis on the concept of the natural rate of interest, the model is more explicitly Wicksellian (Wicksell, 1898) than the Romer or Carlin and Soskice models. In the Wicksellian model, the natural rate of interest is the reference point for the central bank’s interest rate policy: when the interest rate is set below the natural rate output and inflation rise and when it is set above the natural rate output and inflation fall. Maintenance of a stable inflation equilibrium requires the central bank to adjust the interest rate towards its natural level over time. Permanent changes in expenditures affect the natural rate of interest which shows up immediately in long-term interest rates. Thus permanent shocks may have different effects – and require different policy responses – than temporary shocks. Anticipated shocks also may have an immediate impact on the economy through their effects on long-term rates.

Section 2 of this paper describes Romer’s model and Carlin and Soskice’s variant. Section 3 introduces the Wicksellian model and shows that in simple applications it produces results similar to the other two models. The analysis of monetary and fiscal policy shocks is used to derive the conditions for an optimal monetary policy rule. Section 4 shows how the model can
be used to answer questions that are not naturally addressed using the Romer model – the
difference between temporary and permanent shocks, the effect of anticipated shocks, and the
effect of shocks to the term structure of interest rates. Section 5 discusses some theoretical issues
raised by the Wicksellian model and Section 6 concludes.

2. **THE ROMER MODEL**

The version of the Romer model described below is similar to Carlin and Soskice’s
exposition. The Romer model consists of three equations: an IS equation, an aggregate supply
(AS) equation, and a monetary policy (MP) equation. While the model is not laid out
algebraically in Romer’s paper, algebraic versions appear in Carlin and Soskice (2005) and
DeLong and Olney (2004). In order to draw comparisons to the Wicksellian model, I focus on
the following characterization:

(IS) \[ y_t = a_0 - \alpha r_t \] \hspace{1cm} (2.1.1)

(AS) \[ \pi_t = \pi_{t-1} + \lambda y_t \] \hspace{1cm} (2.1.2)

(MP) \[ r_t = r^* + \beta (\pi_t - \pi^*) \] \hspace{1cm} (2.1.3)

where \( y_t \) is the output gap, \( a_0 \) is autonomous expenditures, \( r_t \) is the real interest rate, \( \pi_t \) is
inflation, \( r^* \) is the target real interest rate (implicitly, the natural rate), and \( \pi^* \) is the target
inflation rate. The IS curve says that the equilibrium output gap rises when the real interest rate
falls. Changes in autonomous expenditures shift the IS curve. The AS curve says that the
inflation rate rises when the output gap is positive and falls when the output gap is negative. It
can be interpreted as an expectations augmented aggregate supply curve under the assumption of
adaptive expectations.\(^1\) The MP curve says that the central bank has a target for the real interest

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\(^1\) In Romer’s article the output gap enters the AS equation with a lag so that inflation is purely exogenous in the
current period. He calls this equation an “inflation adjustment” (IA) equation.
rate that it seeks to maintain in normal times. When inflation rises above the central bank’s inflation target the central bank raises the real interest rate above its target level; when inflation falls below the inflation target the central bank cuts the real interest rate.

Romer derives an aggregate demand curve by combining the IS and MP relations. The result is a negative relationship between the output gap and inflation:

\[
(AD) \quad y_t = a_0 - \alpha r^*_t - \alpha \beta (\pi_t - \pi^*)
\]  

(2.1.4)

Changes in autonomous expenditures, the target real interest rate, and the inflation target shift the AD curve. An increase in inflation causes the output gap to fall due to the central bank’s policy response; hence the AD curve has a negative slope like the AD curve in the IS-LM/AS-AD model.

The key differences between the Romer model and IS-LM/AS-AD are the focus on the real interest rate rather than the money supply as the monetary policy instrument and the fact that the AS and AD curves are drawn in inflation-output space rather than price level-output space. The model gives straightforward answers to the basic questions posed in an intermediate macroeconomic theory class. Furthermore, the graphical analysis is virtually identical to that in the standard IS-LM/AS-AD model, though the story behind the graphs is different. Figure 1 shows how the Romer model is used to analyze the effects of expansionary fiscal and monetary policies.

An expansionary monetary policy is best modeled as an increase in the target inflation rate from \(\pi^*\) to \(\pi^{**}\) in Figure 1. The increase in the inflation target causes the central bank to reduce the real interest rate, shifting the MP curve down and the AD curve to the right. The output gap rises, causing inflation to rise, causing the MP curve to shift up partway towards its original position (the new MP curve in the graph reflects the net effect on the interest rate). In the
short run the economy is at an equilibrium with output at $y_0$ and inflation at $\pi_0$. Over time the AS curve shifts up, causing inflation to rise further. As inflation rises the central bank takes back more of the initial interest rate cut. In the long run, the interest rate returns to $r^*$, the output gap returns to zero, and inflation settles at the new target level, $\pi^{**}$.

An expansionary fiscal policy shifts the IS and AD curves to the right, causing output and inflation to rise. The Fed responds to higher inflation by raising the interest rate, so the MP curve shifts up. The economy is at a short run equilibrium with $r=r_0$, $y=y_0$ and $\pi=\pi_0$. Over time, adjustment of inflation expectations causes the AS curve to shift up. Inflation rises further, causing further increases in the interest rate that reduce output. In the long run the economy approaches a new equilibrium with the output gap equal to zero but inflation and the interest rate at higher levels, $\pi^{**}$ and $r^{**}$ on the graph. This example makes clear that Romer’s monetary policy rule is not a stabilizing one – the inflation rate can drift permanently away from its target in response to expenditures shocks. Consequently, the Romer model makes predictions that are at odds with the mainstream of modern monetary theory, which holds that an optimizing central bank will stabilize the inflation rate around its target value (see, for example, Clarida, Gali and Gertler 1999). Romer’s model is at odds as well with monetary policy as it is actually practiced under explicit or implicit inflation targeting.

Carlin and Soskice modify the Romer model to correct this problem. They derive a monetary policy rule from an explicit loss-minimization problem:

$$\begin{align*}
(MR-AD) \quad y_t &= -\alpha \beta(\pi_t - \pi^*)
\end{align*}$$

(2.1.5)

where $\beta$ is the coefficient on inflation in the central bank’s quadratic loss function. The key difference here is that $a_0$ and $r^*$ to not enter into the reaction function. Expenditures shocks therefore do not shift the MR-AD curve and inflation must stabilize around $\pi^*$ in the long run.
To enable expenditures shocks to affect output in the short run, Carlin and Soskice assume that the interest rate affects output with a one-period lag.

Figure 2 shows how an expansionary fiscal shock is treated in the Carlin-Soskice model. In period 0 there is an expansionary fiscal shock that shifts the IS curve to the right. Given the interest rate set in period -1, the new equilibrium is at point B on the IS and AD-AS graphs. Output rises to $y_0$ and inflation to $\pi_0$. In period 1, expected inflation rises to $\pi_0$, causing the AS curve to shift up, while the IS curve remains at its new location. Anticipating the shift in the AS curve, the Fed sets the period 0 interest rate at $r_0$. The equilibrium is at point C on the graphs: output falls to $y_1$ and inflation falls to $\pi_1$. In subsequent periods downward shifts of the AS curve cause the economy to move down the AD curve towards the original equilibrium point, point A. Thus the Carlin-Soskice version of the Romer model imposes a stabilizing monetary policy rule that is consistent with optimizing behavior on the part of the central bank. The assumption that monetary policy affects output with a lag means that unanticipated demand shocks affect output rather than being instantaneously offset by the central bank, which is an attractive feature. The cost, however, is a significantly more complicated model.

3. **THE WICKSELLIAN MODEL**

3.1 **Structure of the model**

This section presents an alternative formulation of the Romer model which I refer to as the “Wicksellian” model. Though the Romer and Carlin-Soskice models can also be thought of as Wicksellian, the Wicksellian features of these models are not fully exploited. The Wicksellian model differs from the Romer and Carlin-Soskice models in two ways: it includes a term

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2 Since the MR-AD curve is interpreted as showing not the actual level of output in each period but rather the Fed’s target level of output in the following period, the new equilibrium is allowed to lie off the MR-AD curve.
structure equation relating the central bank’s choice of short-term interest rate (hereafter the Federal Reserve’s choice of federal funds rate) to the real long-term interest rate, and it does not impose a monetary policy rule equation from the outset.

The equations of the Wicksellian model are

\[(TS) \quad r_t = (1-\omega)r^* + \omega(f_t + \tau - \pi_t) \quad (3.1.1)\]

\[(IS) \quad y_t = \hat{\alpha} - \alpha(r_t - r^*) \quad (3.1.2)\]

\[(AS) \quad \pi_t = \pi_t^e + \lambda y_t \quad (3.1.3)\]

The AS equation is in the form of an expectations-augmented AS curve. Under the assumption of adaptive expectations:

\[\pi_t^e = \pi_{t-1}. \quad (3.1.4)\]

it is identical to that in the Romer model.

The IS equation relates the output gap to the difference between the actual real interest rate and the Wicksellian natural rate, \(r^*\). It is derived from Romer’s IS curve in the following way. Define \(a^*\) to be the “normal” (permanent or trend) level of autonomous expenditures. Define \(r^*\) to be the value of \(r\) that sets the output gap equal to zero in equation 2.1.1 when autonomous expenditures are equal to their normal level. That is,

\[r^* = a^*/\alpha. \quad (3.1.5)\]

Finally, subtract \(\alpha r^* (=a^*)\) from the right hand side of Romer’s IS equation and define \(\hat{\alpha} = a_0 - a^*\) to get equation 3.1.2.³

Thus \(r^*\) rises when the normal level of autonomous expenditures increases, for example due to a permanent decline in the national savings rate or a permanent increase in investment...
demand. Temporary changes in expenditures, for example due to temporary tax cuts, affect ã but not r*.

The TS, or term structure, equation is based on the expectations theory of the term structure of interest rates. The Federal Reserve sets the federal funds rate, f_t. The long-term nominal interest rate, i_t^L, is a weighted average of the current federal funds rate and the “normal” value of the federal funds rate, f_t^*, plus a term premium, τ.⁴ That is,

\[ i_t^L = \omega f_t + (1-\omega)f_t^* + \tau \]  

(3.1.6)

Here \( \omega \) refers to the fraction of the life of the long-term bond over which the federal funds rate is expected to be equal (on average) to its current value as opposed to its normal level. For example, if the bond in question is a ten year bond and \( \omega \) is 0.5, the assumption is that bond markets expect the current federal funds rate to prevail for the next five years, after which it will return to its normal level. The real long-term interest rate, r_t, is the nominal long-term interest rate minus expected inflation, or

\[ r_t = \omega f_t + (1-\omega)f_t^* + (\tau - \pi_t^e) \]

(3.1.7)

The normal federal funds rate is the value of \( f_t \) that – given \( \tau \) and \( \pi_t^e \) – sets \( r_t \) equal to the natural rate \( r^* \). In other words, bond markets expect that in the long run the Fed sets the federal funds rate at the level where the real interest rate equals the natural rate and output is at its full employment level. Substituting \( f_t^* \) for \( f_t \) in the equation above yields

\[ f_t^* = r^* - \tau + \pi_t^e \]

(3.1.8)

Substituting \( f_t^* \) into the equation for \( i_t^L \) gives us the TS curve above.

Figure 3 provides a graphical representation of the Wicksellian (TS-IS-AS) model. The TS curve shows that increases in the federal funds rate cause the real interest rate to rise. The

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⁴ A formal derivation of this relationship for a particular stochastic process for short term rates is provided in the Appendix.
slope is $\omega < 1$, reflecting the fact that the long end of the term structure is anchored by the natural rate of interest. The IS curve shows that the equilibrium output gap rises as the real long-term interest rate falls. The AS curve shows that a rise in the output gap causes inflation to rise above its expected level. When the federal funds rate is at its normal level, the real interest rate is at the natural rate, the output gap is zero, and actual inflation is equal to expected inflation. Throughout the paper it will be assumed that actual and expected inflation are initially at the Fed’s long-term target, $\pi^*$. This situation is a long-run equilibrium.

The model has a recursive structure. An increase in the federal funds rate, for example, causes the real interest rate to rise along the TS curve, which causes output to fall along the IS curve and inflation to fall along the AS curve. An increase in expenditures has no immediate effect on the TS curve but shifts the IS curve to the right, causing an increase in inflation along the AS curve. An increase in non-labor input prices or inflation expectations causes the AS curve to shift up – resulting in an increase in inflation – while having no direct impact on the TS or IS curves.\(^5\)

### 3.2 Effects of monetary and fiscal policy shocks

This section repeats the analysis of monetary and fiscal policy shocks for the Wicksellian model. In the Romer and Carlin-Soskice models, the monetary policy rule equation dictates a monetary policy response that guides the economy to a stable long-run equilibrium. Here we begin the analysis by assuming that the Federal Reserve keeps the federal funds rate constant and show that this leads to an explosive path. This result is used to motivate the development of a

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\(^5\) Exceptions to this analysis are discussed below. In particular, it will be shown that permanent changes in expenditures affect the natural rate of interest, which causes the TS curve to shift. Also, shocks to the price of oil generally affect the IS curve in addition to the AS curve since most countries are net importers or net exporters of oil.
stabilizing monetary policy rule in which the federal funds rate is adjusted to keep the inflation rate at its target level.

Figure 4 shows the effect of an expansionary monetary policy shock, defined as a decrease in the federal funds rate, in the Wicksellian model. The decline in the federal funds rate from \( f^* \) to \( f_0 \) causes the real long-term interest rate to fall from \( r^* \) to \( r_0 \), which causes the output gap to rise to \( y_0 \) and inflation to rise to \( \pi_0 \). This is the same as the short-run effect of a decrease in real interest rates in the Romer model shown in Figure 1.\(^6\) To continue the analysis into the medium- to long-run, we need to specify a process for the formation of inflation expectations. Assuming that the public has adaptive expectations as in equation 3.1.4, in the period following the expansionary monetary policy shock inflation expectations rise. The AS curve shifts up to \( AS_1 \) and the TS curve shifts down to \( TS_1 \) (at a given nominal federal funds rate, the real long-term interest rate is lower). As a result, the real interest rate falls to \( r_1 \), output rises to \( y_1 \), and inflation rises to \( \pi_1 \). If the federal funds rate is held constant over time, the economy will follow an explosive path of rising output and inflation as shown by the bold arrows on the AS graph.

In the Wicksellian model, expenditures shocks have different effects depending on whether they are perceived to be temporary or permanent. A temporary increase in expenditures is represented by an increase in \( \hat{a} \), but not \( r^* \), in the IS equation, whereas a permanent increase in expenditures causes \( a^* \) and therefore \( r^* \) to rise as well (see section 4.1 for an analysis of permanent and anticipated expenditures shocks). Figure 5 shows the effect of a temporary expansionary fiscal policy shock. The shock causes the IS curve to shift to the right. With no change in the federal funds rate the long-term real interest rate is unchanged and output rises to \( y_0 \). This in turn causes inflation to rise to \( \pi_0 \) in the AS graph. In the following period, assuming

\(^6\) In the present case a shock to monetary policy is defined as a change in the federal funds rate, whereas in the Romer model it is defined as a change in the inflation target.
the Fed holds the federal funds rate constant and that inflation expectations are adaptive, expected inflation rises. The AS curve shifts up and the TS curve shifts down as in Figure 4. Since the fiscal expansion was temporary, the IS curve shifts back to IS\(_0\). The real interest rate is \(r_1\), output is \(y_1\), and inflation is \(\pi_1\). The next period, the AS curve shifts up again to AS\(_2\) and the TS curve shifts down to TS\(_2\), causing the real interest rate to fall to \(r_2\), output to rise to \(y_2\), and inflation to rise to \(\pi_2\). From this point on the economy is on an explosive path as in Figure 4, as shown by the bold arrows.

### 3.3 Stabilizing monetary policy rules

The analysis in the preceding section can be used to describe to students the consequences of a suboptimal monetary policy rule (in this case, a fixed interest rate rule). This naturally leads to a discussion of the properties of a stabilizing monetary policy rule. The first principle of a stabilizing monetary policy rule is that, to the extent possible, the Fed should offset shocks to the TS or IS curves in order to keep output at the full employment level. If the Fed fails to do this, the result will be a change in expected inflation that – absent a correction on the part of the Fed – will push the economy onto an explosive path. This situation is shown in Figure 6. In period 0 some event caused inflation to rise from \(\pi^*\) to \(\pi_0\).\(^7\) In period 1, expected inflation is therefore equal to \(\pi_0\), and the AS and TS curves are shifted accordingly. Working backwards from the AS curve, one can see that a stabilizing monetary policy response would be one that ensures that \(\pi_1\) is less than \(\pi_0\), \(\pi_2\) is less than \(\pi_1\), and so on. This requires that the real interest rate be higher than \(r^*\) in period 1, falling to \(r^*\) gradually as inflation declines. This in turn requires that the federal funds rate be raised to a level higher than \(f\) in Figure 6. That is, the federal funds rate must be raised by more than the increase in inflation expectations – this is the “Taylor

\(^7\) Alternatively, the rise in inflation expectations could be due to a “sunspot” shock.
Principle” (see, for example, Clarida, Gali and Gertler, 1999). To ensure a smooth path back to the inflation target (as opposed to a cyclical adjustment path), the Fed should not raise the federal funds rate above \( \bar{r} \). Hence a stabilizing monetary policy rule has the Fed raising the federal funds rate to a level between \( \bar{r} \) and \( \bar{r} \) following an increase in expected inflation. Whether the Fed chooses a value for \( f \) closer to \( \bar{r} \) or one closer to \( \bar{r} \) depends on the Fed’s preferences over output and inflation. A Fed that cares more about inflation will choose a federal funds rate closer to \( \bar{r} \), resulting in an adjustment path along the “monetary policy response function” curve MPRF\(_A\), while one that cares more about output will set \( f \) closer to \( \bar{f} \), resulting in an adjustment path along MPRF\(_B\).

4. ADVANCED APPLICATIONS OF THE WICKSELLIAN MODEL

The Wicksellian model can be applied to all of the topics conventionally covered in an intermediate macroeconomics course, including monetary and fiscal stabilization policy, disinflation, rational expectations, central bank credibility, international trade and capital flows, and so on. In addition, the Wicksellian model can be used to analyze a wide range of issues that are of importance to policymakers and academic economists but which the Romer model and IS-LM have difficulty handling. This section discusses two of these issues: permanent and anticipated expenditures shocks and shocks to the term structure of interest rates. Other applications are discussed in a set of lecture notes available from the author.

4.1 Permanent and anticipated expenditures shocks

Section 3.2 discussed the effect of temporary expenditures shocks, defined as a change in \( \dot{a} \). A shock to expenditures that is perceived to be permanent has different effects. A permanent
increase in expenditures – for example, “permanent” tax cuts or an increase in consumption and investment demand due to an acceleration of productivity growth – is represented by a simultaneous increase in $a_0$ and $a^*$, leaving $\dot{a}$ unaffected. Equation 3.1.5, however, shows that the increase in $a^*$ causes the natural rate of interest to rise proportionately. Since the natural interest rate anchors the long end of the term structure, long-term real interest rates rise, depressing output. This is shown in Figure 7. The IS curve shifts to the right due to the increase in $a^*$. If this were a temporary event the interest rate would remain at $r^*$ and output would rise to $y_1$. Since the increase in expenditures is perceived to be permanent, however, the natural rate of interest rises to $r^{**}$ – this is the real interest rate that is now consistent with full employment. The TS curve shifts up towards $r^{**}$, causing the long-term real interest rate to rise to $r_1$. Interest rates do not rise immediately all the way to $r^{**}$ because the federal funds rate, which has not changed, anchors the short end of the term structure. As a result, output rises to $y_1'$ and inflation rises to $\pi_1'$. 

This analysis is consistent with news analyses of, for example, the debate over tax cuts following the recession of 2001, as exemplified by this passage from an article in the New York Times:

The president's promise to extend his 10-year schedule of tax cuts well into the future, as the centerpiece of a stimulus package, has been one of the most disputed proposals.

"Given the possibility of huge deficits down the road, making the president's tax cut permanent strikes me as something that is probably moving in the wrong direction," said Peter A. Diamond, a professor of economics at the Massachusetts Institute of Technology. "If you wanted to do a stimulation package that didn't drive you deeper into debt, you would do it with a temporary cut combined with a later boost." …

Professor Diamond offered a two-sided plan, which coupled a cut now with a tax

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8 The effect of trend expenditures on the natural rate of interest can also be explained using the loanable funds model.
increase in the future, as an alternative. He predicted that it might actually help today's economy more, by convincing investors that long-term interest rates would stay low, rather than rise on fears of ever-larger budget deficits. (Altman, 2003)

A related argument has been made concerning the effect of the deficit reduction plan enacted by Congress in 1993. Some economists (e.g. Blinder and Yellen, 2001) argue that the plan had a stimulative effect on the economy because the bulk of the tax increases and spending cuts were put off to future years. The anticipated reduction in the budget deficit lowered long-term bond rates, the stimulative effect of which outweighed the contractionary effect of the modest budget tightening that took place immediately. The Wicksellian model’s treatment of this argument is shown in Figure 8. The IS curve does not shift because taxes and spending are left unchanged in the current period. But the promised reduction in the budget deficit will eventually shift the IS curve left to the position shown by the dashed line. When the cuts take place, the natural interest rate will fall to r**. Seeing this, bond markets factor a lower interest rate into long-term bond rates, causing the TS curve to shift down. The real long-term interest rate falls to r₁, which causes output to rise to y₁ and inflation to π₁. Given that in 1993 the economy was still not fully recovered from the 1990-91 recession, the upward pressure on inflation in that case was slight, and in fact the Fed augmented the policy by keeping the federal funds rate below the level that would otherwise have been expected.

4.2 Shocks to the term structure of interest rates

The fact that long-term interest rates been so low recently despite a long period of increases in the federal funds rate is one of the great macroeconomic puzzles of recent years. Ben Bernanke, chairman of the Federal Reserve, addressed this “conundrum” in several speeches. In
a speech before the Economic Club of New York (Bernanke 2006), for example, Bernanke offered three alternative interpretations of the flattening of the yield curve in early 2006. One possibility was that long-term rates were low because bond markets anticipated a slowdown in the economy. Another was that low long-term rates reflected a reduction in the natural rate of interest, perhaps due to a “savings glut” in other countries. Each of these interpretations would imply that the Fed would need to lower the federal funds rate to stabilize the economy. A third explanation, however, was that long-term rates were low because of a number of forces – the most plausible of which were greater perceived stability in inflation rates and output due to the improved conduct of monetary policy in the 1980s and 1990s, and large purchases of government securities by foreign central banks – that caused the term premium to fall.

This argument is analyzed using the Wicksellian model in Figure 9. The decrease in the term premium ($\tau$) causes the TS curve to shift down. Holding the federal funds rate fixed, the long-term real interest rate falls to $r_1$, which causes output to rise to $y_1$ and inflation to $\pi_1$. The Fed’s optimal response in this case is to raise the federal funds rate to $f^{**}$, the new neutral rate. The model demonstrates Bernanke’s point, which is that the optimal monetary policy response to falling long-term interest rates depends critically on the ultimate source of the decline in rates.

The Wicksellian model can be used in a similar way to analyze other phenomena related to the term and risk structure of interest rates – that is, factors that may drive a wedge between the Fed’s monetary policy instrument and the real long-term rate it seeks to control – such as the attraction of dollar-denominated assets as a “safe haven” following international financial crises such as those in 1997 and 1998, the increase in the risk premium on corporate debt following the corporate accounting scandals of 2002-03, and the effect of anticipated changes in the federal funds rate.
5. THEORETICAL ISSUES RELATED TO THE WICKSELLIAN MODEL

Two theoretical propositions figure prominently in undergraduate economic textbooks: the long-run neutrality of money and the crowding out phenomenon. The Wicksellian model takes a different perspective on each of these issues from that of the IS-LM and Romer models.

5.1 Neutrality of money

On the surface, the analysis in section 3.2 (Figure 4) seems to suggest that monetary policy is not neutral in the long run, since a decision by the Fed to hold the federal funds rate below its neutral level forever would cause output and inflation to rise indefinitely. This would conflict with the lesson of the IS-LM and Romer models, which show that in the long run changes in monetary policy affect only inflation, not output. Upon closer scrutiny, however, there is nothing in the Wicksellian model inconsistent with the treatment of monetary policy in the IS-LM and Romer models. The difference has to do with how each model defines a monetary policy shock. The story told in IS-LM is one in which the monetary shock is a once and for all increase in the stock of money. The initial effect is to lower the interest rate, but the interest rate eventually rises back to its original level. In the Wicksellian model the interest rate rather than the money supply is the instrument of monetary policy. The story told in section 3.2 assumes that the interest rate is lowered and then held at its new level permanently. The only way to keep the interest rate below the Wicksellian neutral rate in the face of rising output and inflation is to continually increase the rate of growth in the money supply. Ultimately, if the Fed is committed to maintaining a stable inflation rate it will have to reduce the rate of growth of the money supply and let interest rates rise.
The monetary policy shock discussed in the Romer model is a change in the target rate of inflation. This requires the Fed to raise or lower interest rates in the short run, but once the new target inflation rate is achieved the assumption that the Fed follows a stabilizing monetary policy rule requires that the Fed reverse its initial interest rate policy. Absent the monetary policy rule equation, the Romer model would exhibit the same type of instability as the Wicksellian model. In essence, the analysis of monetary policy in the Wicksellian model in section 3.2 is a demonstration of Friedman’s (1968) argument against interest rate targeting and Woodford’s (2003) counterargument in favor of targeting rules such as the Taylor rule.

5.2 Crowding out

The Wicksellian model offers an alternative interpretation of the crowding out phenomenon that is more consistent with the types of stories told in the financial press. Crowding out occurs when an increase in government expenditures forces a reduction in investment and net exports due to increases in the interest rate. In the IS-LM model, crowding out occurs in the short run because given a fixed stock of money, increased expenditures leads to higher money demand and a higher interest rate. Crowding out is partial except when the interest elasticity of money demand is zero (a vertical LM curve). Crowding out does not occur in the short run if the Fed runs an “accommodating” monetary policy, i.e. keeps the interest rate constant. In the Romer model, crowding out may occur in the short run as a result of a conscious decision on the part of the Fed to offset the stimulative effect with higher interest rates, as in Figure 1.

By contrast, in the Wicksellian model permanent increases in government expenditures partially crowd out investment and net exports even when the Fed accommodates the fiscal

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9 Albeit, as discussed above, one that is not consistent with optimizing behavior.
expansion by keeping the federal funds rate fixed. This occurs because the anticipation of higher interest rates in the future causes long-term rates to rise in the present, as shown in Figure 7. The crowding out effect as it operates through long-term interest rates is a common theme in the financial press, an example of which is the New York Times article quoted above. It is also more intuitively appealing than the IS-LM story.

6. CONCLUSION

The Wicksellian model presented in this paper can be simplified or extended to suit the needs of any particular undergraduate macroeconomics course. For an introductory macroeconomics course it may make sense to omit the term structure component, leaving a model that is very similar to the version of the Romer model found, for example, in Frank and Bernanke (2004). The key difference in this case is the omission of the monetary policy rule equation. Omitting this part of the Romer model has some pedagogical advantages as discussed above. The model as presented here is suitable for an intermediate theory course. In a money and banking or upper-level monetary policy course the model can be extended to incorporate rational expectations, imperfect credibility, and the formal derivation of optimal monetary policy rules. Such a course would presumably place greater emphasis than the intermediate theory course on financial market (term structure) shocks. A set of lecture notes containing a large number of analytical and numerical examples is available from the author.
Appendix: derivation of term structure equation

The pure expectations theory of the term structure of interest rates states that

\[ i_{nt} = \frac{1}{n} \left[ f_{1t} + E_t f_{1,t+1} + E_t f_{1,t+2} + \ldots + E_t f_{1,t+n-1} \right] \]

where \( i_{nt} \) is the yield on an n-year bond purchased at date t and \( f_{1,t+s} \) is the yield on a one-year bond purchased in period \( t+s \). The yield on one-year bonds is taken to be equivalent to the federal funds rate (\( f_t \) in the text), reflecting the assumption that the federal funds rate anchors the short end of the term structure.

Suppose the federal funds rate is determined by a first-order autoregressive process:

\[ E_t f_{1,t+1} = \rho f_{1t} + (1-\rho) f^* \]

This implies that

\[ E_t f_{1,t+n-1} = \rho^{n-1} f_{1t} + (1+\rho+\rho^2+\ldots+\rho^{n-2})(1-\rho) f^* \]

so that, after a great deal of algebraic manipulation,

\[ i_{nt} = \frac{1}{n} \left[ \frac{1-\rho^n}{1-\rho} f_{1t} + \left( n - \frac{1-\rho^n}{1-\rho} \right) f^* \right]. \]

Note that

\[ \frac{1}{n} \left[ \frac{1-\rho^n}{1-\rho} + \left( n - \frac{1-\rho^n}{1-\rho} \right) \right] = 1. \]

This implies that if we define \( \omega = \frac{1}{n} \left[ \frac{1-\rho^n}{1-\rho} \right], \) we can write

\[ i_{nt} = \omega f_{1t} + (1-\omega) f^* \]

which is the equation for long-term nominal bond rates (equation 3.1.6) in the text.
References


Figure 1. The Romer model

Expansionary monetary policy

Expansionary fiscal policy
Figure 2. Expansionary fiscal policy in the Carlin-Soskice model
Figure 3. The Wicksellian Model

TS: \( r_t = (1-\omega)r^* + \omega(f + \tau - \pi_t) \)

IS: \( y_t = \hat{a} - \alpha(r - r^*) \)

AS: \( \pi_t = \pi_{t-1} + \lambda y_t \)
Figure 4. The effect of an expansionary monetary policy shock
Figure 5. The effect of a temporary expansionary fiscal policy shock
Figure 6. Derivation of a stabilizing monetary policy rule
Figure 7. Effect of a permanent increase in autonomous expenditures
Figure 8. Effect of an anticipated decrease in autonomous expenditures
Figure 9. The effect of a decrease in the term premium