Journal of Post Keynesian Economics

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/mpke20

More on the monetary transmission mechanism: mortgage rates and the federal funds rate

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Published online: 10 Dec 2014.

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Abstract: *This study extends the research of Atesoglu (2003–4; 2004) with respect to the horizontalist and structuralist money supply endogeneity hypotheses to the case of fixed mortgage rates. The momentum threshold autoregressive model of Enders and Siklos (2001) reveals that the fixed mortgage rate and federal funds rate are cointegrated with incomplete interest rate pass-through and asymmetric adjustment. Specifically, the results of the asymmetric error correction model indicate unidirectional causality from the federal funds rate to the fixed mortgage rate, lending support for the horizontalist endogeneity hypothesis.*

Key words: *cointegration, interest rate pass-through, threshold autoregressive models.*

In a series of articles published in *JPKE,* Atesoglu (2003–4; 2004) utilizes the Johansen (1995) cointegration/vector error correction model to examine the Post Keynesian horizontalist and structuralist hypotheses on money supply endogeneity with respect to the long-run relationship between the federal funds rate, prime rate, as well as the AAA corporate bond rate and 30-year U.S. Treasury note rate. In brief, the horizontalist hypothesis asserts that the short-term cost of funds is determined by the central bank with banks placing a markup over the cost of funds in the provision of loans. Hence, the loan supply schedule is horizontal with the amount of bank lending determined by loan demand. On the other hand, the structuralist hypothesis suggests that loan supply is influenced by

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0160–3477/2007 $9.50 + 0.00.
DOI 10.2753/PKE0160-3477290204

central bank policies and positively sloped with bank lending determined by both loan demand and supply (Palley, 1991, p. 398).[1]

Atesoglu's (2003–4; 2004) analysis begins in 1987:2, corresponding with the Fed's operating procedure of federal funds rate targeting. From 1987:2 to 1994:1, Atesoglu (2003–4) finds less than complete pass-through (0.80) from the federal funds rate to the prime rate along with bidirectional causality between the two rates in support of the structuralist hypothesis. However, from the period 1994:2 to 2002:5, there is complete pass-through (1.00) from the federal funds rate to the prime rate with unidirectional causality from the federal funds rate to the prime rate, evidence in favor of the horizontalist hypothesis. Atesoglu (ibid.) attributes the increase in pass-through in the post-1994:1 period to the Fed's greater transparency in monetary policy in the announcement of the federal funds rate target. In a subsequent study on long-term interest rates over the post-1987:2 period, Atesoglu (2004) finds incomplete pass-through from the federal funds rate to both the AAA corporate bond rate (0.720) and 30-year U.S. Treasury note rate (0.575) with unidirectional causality from the federal funds rate to each of the long-term interest rates, lending further support for the horizontalist hypothesis.

This study extends Atesoglu's (2003–4; 2004) research by examining the relationship between the federal funds rate and the fixed mortgage rate. Understanding the response of mortgage rates to changes in the federal funds rate is crucial in assessing the impact of monetary policy actions on the housing market as well as in providing additional evidence on the interest rate channel of monetary policy. In the aftermath of deregulation in the banking industry during the 1980s, Sellon (2002) argues that the response of mortgage rates to changes in monetary policy has increased due in part to the elimination of deposit rate ceilings as well as the securitization of mortgage loans. First, especially in periods of tight monetary policy, the elimination of deposit rate ceilings enabled lenders to ration credit based on mortgage rates rather than impose quantity restrictions. Second, besides providing lenders with another source of funding, the securitization of mortgage loans has moved mortgage rates closer to capital market interest rates (Allen et al., 1999; Scholnick, 1999). Furthermore, Atesoglu's (2003–4; 2004) research is extended to account for the possibility of asymmetries in the error correction process when

[1] This brief explanation by no means addresses the depth of the horizontalist and structuralist views of the endogeneity of money. For a more detailed analysis, see Davidson (2002), Lavoie (1996), Moore (1988; 1991), Pollin (1991), and Rousseas (1992).

testing for cointegration by using the momentum threshold autoregressive model of Enders and Siklos (2001).[2]

There are several explanations proposed to explain asymmetries in interest rate adjustments (Scholnick, 1999). The bank concentration hypothesis states that banks are less likely to decrease lending rates in fear of disrupting collusive arrangements established between banks. The consumer behavior hypothesis asserts that the greater the proportion of unsophisticated consumers relative to sophisticated consumers along with the search and switching costs enables banks to have greater market power in the adjustment of interest rates to their advantage. Both the bank concentration and consumer behavior hypotheses support the proposition that lending rates are rigid downward (Berger and Hannan, 1989; Hannan and Berger, 1991; Neumark and Sharpe, 1992). On the other hand, the customer reaction hypothesis argues that banks operating in a highly competitive environment may fear a negative reaction from customers in response to increasing lending rates. The adverse selection hypothesis suggests that higher interest rates will tend to attract riskier borrowers and greater loan defaults. In response, banks will not increase lending rates, but instead ration credit in an attempt to avoid the costs associated with loan defaults. Thus, lending rates are rigid upward with respect to both the customer reaction and adverse selection hypotheses (Hannan and Berger, 1991; Neumark and Sharpe, 1992; Stiglitz and Weiss, 1981).

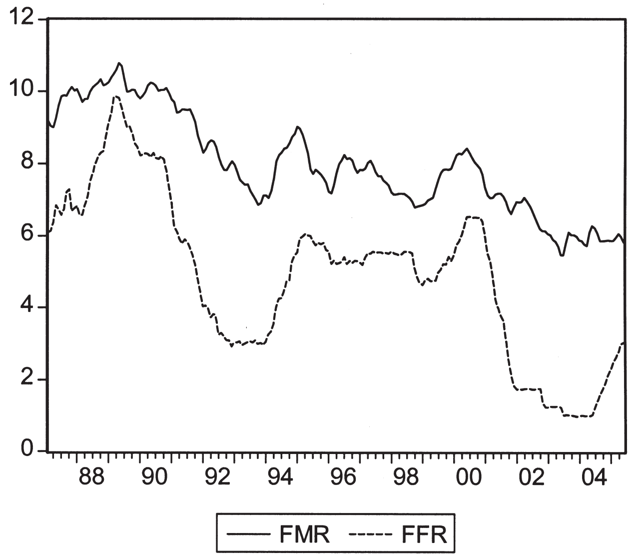
Specifically, this study will attempt to answer the following questions: (1) Does the horizontalist or structuralist hypothesis on money supply endogeneity exist with respect to mortgage lending? (2) To what extent are changes in monetary policy, as reflected by changes in the federal funds rate, transmitted to mortgage rates in the short run? (3) Is there complete pass-through from the federal funds rate to mortgage rates in the long run? (4) Do mortgage rates adjust asymmetrically to changes in the federal funds rate in the long run?

The data, methodology, and results

Monthly data from 1987:2 to 2005:6 on the fixed mortgage rate (FMR) for conventional single-family mortgages for all homes and the federal

[2] Although not in the context of the Post Keynesian views on money supply endogeneity, a few studies have examined the extent of interest rate pass-through and the adjustment of mortgage rates. See Heffernan (1997) and Hofmann and Mizen (2004) in the case of the United Kingdom and Frost and Bowden (1999) for New Zealand.

Figure 1 Fixed mortgage rate and federal funds rate, 1987:2 to 2005:6



funds rate (FFR) are used in the analysis. The starting date of 1987:2 corresponds to Atesoglu (2003–4; 2004) and the Fed's operating procedure of targeting the federal funds rate. Figure 1 displays the time series behavior of the fixed mortgage rate in relation to the federal funds rate. It appears that the fixed mortgage rate and federal funds rate exhibit some degree of comovement with a correlation of 0.879.

Panel A of Table 1 reports the augmented Dickey–Fuller (ADF) (1979), Phillips–Perron (PP) (1988), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (1992) unit root tests. The ADF and PP unit roots are based on the null hypothesis that the respective time series are difference stationary whereas the KPSS unit root test is based on the null hypothesis of trend stationarity. The ADF and PP unit root tests with and without a linear trend term along with the KPSS unit root test without a linear trend suggest that the fixed mortgage rate and federal funds rate are each integrated of order one (i.e., require first-differencing). However, the KPSS unit root test with a linear trend term indicates that the fixed mortgage rate is integrated of order zero (i.e., stationary in levels). Given the majority of the unit root tests suggest that each time series is integrated of order

Table 1
Unit root and cointegration tests: 1987:2 to 2005:6

Panel A: Unit root tests

Variable	ADF(C)	ADF($C+T$)	PP(C)	PP($C+T$)	KPSS(C)	KPSS($C+T$)
FMR_t	–0.80	–2.92	–0.84	–2.62	1.570[a]	0.108
ΔFMR_t	–8.92[a]	–8.91[a]	–6.85[a]	–6.83[a]	0.056	—
FFR_t	–1.67	–2.93	–1.38	–2.08	1.011[a]	0.127[c]
ΔFFR_t	–4.83[a]	–4.82[a]	–8.77[a]	–8.75[a]	0.070	0.069

Notes: Critical values for the ADF(C) and PP(C) unit root tests, which include only a constant: [a] (1 percent) –3.46, [b] (5 percent) –2.87, and [c] (10 percent) –2.57. Critical value for the KPSS(C) unit root test, which includes only a constant: [a] (1 percent) 0.739, [b] (5 percent) 0.463, and [c] (10 percent) 0.347. Critical values for ADF($C+T$) and PP($C+T$) unit root tests, which include both a constant and trend: [a] (1 percent) –4.00, [b] (5 percent) –3.43, and [c] (10 percent) –3.14. Critical values for KPSS($C+T$) unit root test, which includes both a constant and trend: [a] (1 percent) 0.216, [b] (5 percent) 0.146, and [c] (10 percent) 0.119.

Panel B: Engle–Granger cointegration test

	$\beta = 1$	ADF	k
$FMR_t = 5.34 + 0.538 FFR_t$ $(0.152)^a$ $(0.027)^a$	–17.11[a]	–2.29	1

Notes: Newey–West heteroskedasticity-consistent standard errors are reported in parentheses with a 1 percent significance level denoted by “a.” Engle–Granger (1987) ADF critical values for cointegration test: [a] (1 percent) –3.93, [b] (5 percent) –3.17, and [c] (10 percent) –2.91. k denotes the number of augmented lags in the tests of cointegration to yield serially uncorrelated residuals.

one along with the relatively slow decay of the autocorrelation function for each time series, the analysis proceeds with the first-differencing of each rate.[3]

With the fixed mortgage rate and federal funds rate integrated of the same order, the degree of interest rate pass-through in the long run from the federal funds rate to the fixed mortgage rate is estimated as follows:

$$FMR_t = \alpha + \beta FFR_t + \varepsilon_t, \tag{1}$$

where the slope estimate, β, measures the degree of pass-through. Complete pass-through exists if the slope coefficient is equal to one. If the slope coefficient is less than one, there is incomplete pass-through perhaps attributable to switching costs and informational asymmetries. Panel B of Table 1 presents the results of estimating Equation (1) along with the residuals-based cointegration procedure of Engle and Granger (1987). The slope estimate is 0.538 and significantly less than one, indicative of incomplete pass-through. However, the null hypothesis of noncointegration is not rejected at the 10 percent level, ADF = –2.29.

Enders and Siklos (2001, pp. 168–169) demonstrate that standard cointegration tests such as the Engle–Granger (1987) and Johansen (1995) procedures have low power in the presence of asymmetric adjustment in the error correction process. Specifically, standard cointegration tests assume symmetric adjustment; therefore, these tests are misspecified if the adjustment is indeed asymmetric. It is possible that cointegration may be present once allowance is made for such asymmetries. The possibility of asymmetries in the error correction process is examined through

[3] Perron's (1997, pp. 358–359) endogenous unit root test was performed on the fixed mortgage rate and federal funds rate. The break date selected was based on the minimum ADF test statistic for testing the null hypothesis of a unit root. Although each series exhibited a break (fixed mortgage rate 1993:12 and federal funds rate 1993:11), each time series still contained a unit root (i.e., integrated of order one). The test statistics associated with the null hypothesis of a unit root were –4.32 for the fixed mortgage rate and –4.25 for the federal funds rate with each test statistic less than the 10 percent critical value of –4.82 (ibid., p. 362, table 1). As typically required in cointegration tests, the momentum threshold autoregressive (MTAR) model requires the variables to be integrated of order one (i.e., first-differences stationary).

the momentum threshold autoregressive (MTAR) model of Enders and Siklos (2001).[4]

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + \left(1 - I_t\right)\rho_2\hat{\varepsilon}_{t-1} + \sum_{t=1}^{p}\alpha_i\Delta\hat{\varepsilon}_{t-p} + \hat{u}_t, \tag{2}$$

where $\hat{u}_t$ ~ i.i.d.$(0,\sigma^2)$ and the lagged values of $\Delta\hat{\varepsilon}_t$ yield uncorrelated residuals. The Heaviside indicator function is denoted as follows:

$$I_t = \begin{cases} 1 & \text{if } \Delta\hat{\varepsilon}_{t-1} \geq \tau \\ 0 & \text{if } \Delta\hat{\varepsilon}_{t-1} < \tau, \end{cases} \tag{3}$$

where the threshold, τ, is endogenously determined using Chan's (1993) method in order to differentiate the possible asymmetries in the adjustment process.[5] The MTAR model uses the residuals generated from Equation (1), $\hat{\varepsilon}_t$, and estimates Equations (2) and (3) where the indicator variable depends on the previous period's change in the residuals, $\Delta\hat{\varepsilon}_{t-1}$. If $\Delta\hat{\varepsilon}_{t-1}$ is above the threshold, the asymmetric adjustment is captured by $\rho_1\hat{\varepsilon}_{t-1}$; on the other hand, if $\Delta\hat{\varepsilon}_{t-1}$ is below the threshold, the asymmetric adjustment is measured by $\rho_1\hat{\varepsilon}_{t-1}$. The MTAR model is especially valuable when the adjustment is believed to exhibit more momentum in one direction than the other.

Within the MTAR model the null hypothesis of noncointegration can be tested by the restriction $\rho_1 = \rho_2 = 0$, while the null hypothesis of symmetry can be tested by the restriction $\rho_1 = \rho_2$. Panel A of Table 2 reports that the null hypothesis of noncointegration is rejected at the 1 percent level based on the Enders–Siklos test statistic, $\Phi^*(M) = 10.01$. Thus, while the standard Engle–Granger cointegration test failed to reject the null hypothesis of noncointegration, the Enders–Siklos asymmetric cointegration procedure indicates that the fixed mortgage rate and federal funds rate are indeed cointegrated. Furthermore, the null hypothesis of symmetric adjustment is rejected at the 1 percent level (F-statistic = 14.45). It appears that the adjustment toward the long-run equilibrium between the fixed mortgage rate and the federal funds rate is asymmetric.

[4] Bohl and Siklos (2004) use the MTAR model to examine the asymmetric behavior exhibited by the Bundesbank's inflationary policy. As noted by Enders and Siklos (2001, p. 168), the MTAR model exhibits greater power relative to the alternative assumption of symmetric adjustment implicitly assumed in the Engle–Granger (1987) and Johansen (1995) cointegration tests.

[5] The Chan (1993) procedure arranges the values $\Delta\hat{\varepsilon}_t$ for the MTAR model in ascending order and excludes the smallest and largest 15 percent. The consistent estimate of the threshold is the parameter that yields the smallest residual sum of squares over the remaining 70 percent.

Table 2
Tests of cointegration/symmetry and error correction models, 1987:2 to 2005:6

Panel A: Tests of cointegration and symmetry: MTAR

Equations (2) and (3)

MTAR	τ	ρ_1	ρ_2	$\rho_1 = \rho_2 = 0$	$\rho_1 = \rho_2$	$Q(4)$	k
	0.103	–0.131 (–4.46)[a]	–0.005 (–0.34)	10.01[a]	14.45 [0.00][a]	3.82 [0.43]	1

Notes: τ represents threshold value. $\rho_1 = \rho_2$ denotes the null hypothesis of no cointegration with critical values obtained from Enders and Siklos (2001, p. 172, table 5, Panel B, $n = 250$ and one lagged change), $F^*(M)$: [a] (1 percent) 8.84, [b] (5 percent) 6.63, and [c] (10 percent) 5.57. $\rho_1 = \rho_2$ denotes the null hypothesis of symmetry in ρ_1 and ρ_2. $Q(4)$ is the Box–Pierce Q-statistic for serial correlation up to four lags. k is the number of lags in the MTAR specification in Equation (2). t-statistics are in parentheses while probability values are in brackets. The estimates satisfy the stationarity conditions.

Panel B: Fixed rate–federal funds rate asymmetric error correction model

Equation (4a)				Independent variables			
	$\alpha_1 = \alpha_2 = 0$	$\gamma_1 = \gamma_2 = 0$	δ_1	δ_2	Q(4)	$F_{6,213}$	$\bar{R}^2$
ΔFMR_t	62.88 [0.00][a]	1.79 [0.16]	–0.081 (–3.14)[a]	0.002 (0.16)	1.20 [0.88]	27.18 [0.00][a]	0.418
Equation (4b)				Independent Variables			
	$\tilde{\alpha}_1 = \tilde{\alpha}_2 = 0$	$\tilde{\gamma}_1 = \tilde{\gamma}_2 = 0$	$\tilde{\delta}_1$	$\tilde{\delta}_2$	Q(4)	$F_{6,213}$	$\bar{R}^2$
ΔFFR_t	1.70 [0.18]	32.55 [0.00][a]	0.058 (1.47)	0.009 (0.46)	5.09 [0.28]	17.46 [0.00][a]	0.310

Notes: Partial F-statistics for lagged values of changes in the fixed mortgage rate and federal funds rate, respectively, are reported under the specified null hypotheses. $Q(4)$ is the Box–Pierce Q-statistic for serial correlation up to four lags. $F_{6,213}$ is the overall F-statistic for the respective equations. t-statistics are reported in parentheses while probability values are reported in brackets. Significance levels are denoted as follows: [a] (1 percent), [b] (5 percent), and [c] (10 percent).

To explore further both the short-run and long-run dynamics associated with the fixed mortgage rate and federal funds rate, the following asymmetric error correction model is estimated:

$$\Delta FMR_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \Delta FMR_{t-i} + \sum_{i=1}^{q} \gamma_i \Delta FFR_{t-i} + I_t \delta_1 \breve{\varepsilon}_{t-1} + (1 - I_t) \delta_2 \breve{\varepsilon}_{t-1} + u_{1t} \tag{4a}$$

$$\Delta FFR_t = \tilde{\alpha}_0 + \sum_{i=1}^{n} \tilde{\alpha}_i \Delta FMR_{t-i} + \sum_{i=1}^{q} \tilde{\gamma}_i \Delta FFR_{t-i} + I_t \tilde{\delta}_1 \breve{\varepsilon}_{t-1} + (1 - I_t) \tilde{\delta}_2 \breve{\varepsilon}_{t-1} + u_{2t}, \tag{4b}$$

where $u_{1,2t} \sim$ i.i.d.$(0,\sigma^2)$; $\hat{\varepsilon}_{t-1} = FMR_{t-1} - \hat{\alpha} - \hat{\beta} FFR_{t-1}$; and I_t takes the form given in Equation (3). The results for the asymmetric error correction model are reported in Panel B of Table 2. The Box–Pierce Q-statistics for Equations (4a) and (4b) indicate that each equation is free of serial correlation. Moreover, Equations (4a) and (4b) exhibit predictive power given the respective overall F-statistics are significant at the 1 percent level. The partial F-statistics for Equations (4a) and (4b) indicate there is no feedback between the fixed mortgage rate and federal funds rate in the short run. The error correction coefficient, δ_1, representing asymmetric adjustment from above the threshold is statistically significant at the 1 percent level in the fixed mortgage rate equation (Equation (4a)), although the error correction coefficient, δ_2, for asymmetric adjustment from below the threshold is statistically insignificant. In regard to the adjustment from above the threshold, only about 0.08 percent of the adjustment in the fixed mortgage rate is completed within one month after the change in the federal funds rate. With respect to the federal funds rate equation (Equation (4b)), the respective asymmetric error correction coefficients are statistically insignificant. In summary, the asymmetric error correction model provides evidence to support unidirectional causality from the federal funds rate to the fixed mortgage rate and the horizontalist hypothesis.

Concluding remarks

This study extends the work of Atesoglu (2003–4; 2004) to mortgage rates in order to differentiate between the horizontalists' and structuralists' money supply endogeneity hypotheses as well as answer questions related to interest rate pass-through and the corresponding adjustment process. Although the residual-based cointegration procedure of Engle and Granger (1987) failed to reject the null hypothesis of noncointegration, the Enders and Siklos (2001) asymmetric cointegration procedure rejected the null hypothesis of noncointegration. With respect to the short run, there is no feedback between the fixed mortgage rate and federal funds rate. However, it appears that the fixed mortgage rate adjusts asymmetrically to changes in the federal funds rate in the long run. The results indicate unidirectional causality from the federal funds rate to the fixed mortgage rate lending support for the horizontalist hypothesis. This finding provides further confirmation of the results reported by Atesoglu (2003–4; 2004) with respect to the prime rate after 1994:1 and long-term interest rates (AAA corporate bond rate and 30-year U.S. Treasury note rate). Furthermore, the extent of incomplete pass-through (0.538) from the federal funds rate to the fixed mortgage rate is comparable to that found by Atesoglu (2004) in the case of the 30-year U.S. Treasury note rate (0.575).

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