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Linkages Between Secondary and Primary Markets for Mortgages

The Role of Retained Portfolio Investments of the Government-Sponsored Enterprises

GLORIA GONZÁLEZ-RIVERA

GLORIA GONZÁLEZ-RIVERA is an associate professor of Economics at the University of California at Riverside, and senior economist at Freddie Mac.

Since their foundation, the government- sponsored enterprises (GSE), Fannie Mae and Freddie Mac, have provided liquidity to the mortgage market mainly through securitization. The GSE purchase conforming mortgages from lenders in the primary market, in exchange for which the lenders receive cash or mortgage-backed securities (MBS), which in turn fund new mortgages.

While securitization has been their traditional activity, in the 1990s the GSE experienced a tremendous growth in their "retained portfolios"—cash purchase mortgages and MBS sold through Wall Street dealers to the GSE. These investments are financed with callable and non-callable debt instruments.

Since the beginning of 1994, securitization has declined slightly in proportional terms. At the end of 1999, GSE securitization activity accounted for 24% of total mortgage debt. The retained portfolios, however, have grown steadily during the 1990s from 5% in 1990 to 16% of total mortgage debt in 1999. In absolute terms, at the end of 1999, the amount in retained portfolios was $847 billion: Fannie Mae $523 billion, and Freddie Mac $324 billion.

There are economic reasons that explain the switch from securitization to retained portfolio investments; see Roll [2000]. The GSE are heeding the financial needs of mortgage investors who have shown a preference for callable and non-callable debt over MBS.

The main risk involved in investment in MBS is prepayment risk. Investment in non-callable debt removes the possibility of prepayment risk, whose management is entirely left to the competence of the GSE. Investment in callable debt exposes investors to market risk, which is at least more predictable than prepayment risk.

If assessment of prepayment risk is a difficult task for domestic investors, it is even more so for international investors. The successful placement of GSE debt in international markets points toward further growth in the retained portfolios of FNMA and FHLMC.

There is an extensive literature on the benefits of the securitization activity of GSE in the mortgage markets. A representative sample includes Hendershott and Shilling [1989], Rothberg, Nothaft, and Gabriel [1989], Cotterman and Pearce [1995], and Kolari, Fraser, and Anari [1998]. The effects of retained portfolio investments have not yet been empirically documented, although we now have roughly a decade of data in these activities.

Our objective is to document the effects of retained portfolio investments. We explore the linkages between the Fannie Mae and Freddie Mac retained portfolios and the mortgage yield spreads in the secondary and primary markets for mortgages. The results indicate that the retained portfolio activities of the GSE have at least two beneficial effects for the mortgage markets.

First, by being active participants in the purchases of MBS for their retained portfolios, GSE not only are providers of liquidity but also exercise control over the spread. A long-run investment function links mortgage yields to the volume of their portfolio investments. The presence of this function guarantees that the spread cannot diverge indefinitely.

Second, and most important, this behavior is translated directly to primary market mortgage rates, so the borrower is an ultimate beneficiary of skillful management of the retained portfolio.

I. RETAINED PORTFOLIO PURCHASES AND SECONDARY MARKET YIELD SPREADS

We collect monthly retained portfolio purchases of Fannie Mae and Freddie Mac for the period 1994:12 through 1999:12, with a total of 61 observations. The spread is calculated as the difference between the monthly 30-year current-coupon yield of MBS and the 10-year constant-maturity Treasury rate. Both rates come from the Salomon Yieldbook. Exhibit 1 provides some descriptive statistics of the two variables of interest.

EXHIBIT 1
Descriptive Statistics

1994/12 to 1999/12	Mean	St. Deviation	Maximum	Minimum
Portfolio Purchases (billions $)	13.71	8.82	38.96	3.01
Spread to Treasury (bp)	117.77	20.73	167.00	90.50

EXHIBIT 2
Time Series Plots

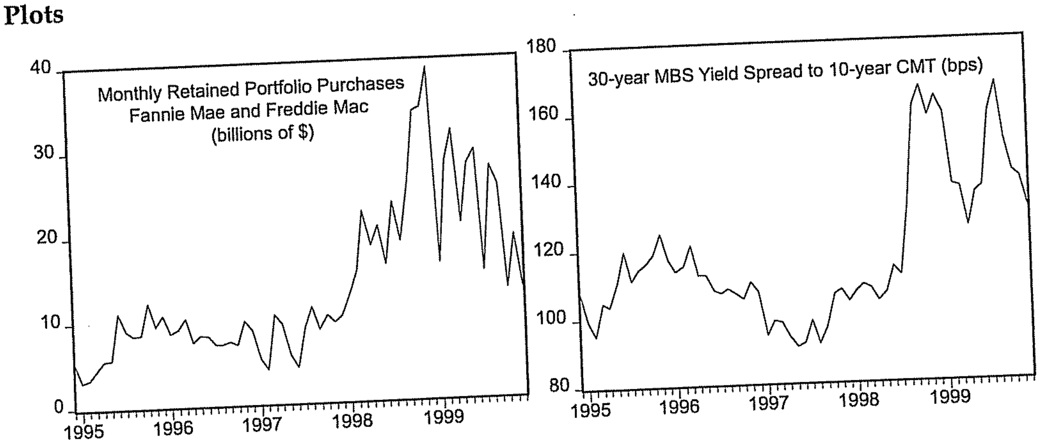


EXHIBIT 3
Unit Root Tests

	ADF		PP	
	Constant	Constant + Trend	Constant	Constant + Trend
Purchases	-1.44	-1.23	-2.42	-3.95*
Spread	-1.58	-2.03	-1.79	-2.31

In the auxiliary regression, the ADF test has two lags for purchases and zero lags for spread.
**Unit root rejected at 5% significance level but not rejected at 1% significance level.*

More informative than these descriptive statistics are plots of the time series of both variables. In Exhibit 2, we can see the growth experienced in the monthly purchases for the retained portfolio of the GSE in the last half of the 1990s, reaching a maximum of \$38.96 billion in December 1998. The tremendous jump in 1998 coincides with the liquidity crisis in the third quarter of 1998 when the spread reached more than 160 basis points. The contemporaneous correlation between spread and purchases is 0.77. This correlation may be spurious if purchases and spread are non-stationary, i.e., non-mean-reverting. Consequently, we run tests for unit roots, the augmented Dickey-Fuller (ADF), and the Phillips-Perron (PP) tests, for purchases and spread. The results are tabulated in Exhibit 3.

ADF and PP tests with two different specifications are unable to reject the null hypothesis of a unit root. With this empirical evidence, we choose to model spread and purchases as non-stationary processes.[1]

Long-Run Investment Function

We define a long-run investment function as the amount of liquidity provided by the retained portfolio investments triggered by movements in the spread level. The objective is to find a function such as

$$P_t = \beta_0 + \beta_1 S_t \tag{1}$$

where P_t is the level of purchases for the retained portfolio at time t, and S_t is the level of the spread at time t.

Under what conditions does this function exist? Since purchases and spread are non-stationary, any formal analysis has to consider the possibility that the correlation between purchases and spread may be spurious and the relationship in Equation (1) will not pertain. There is only one instance in which this will not be the case: if purchases and spread are *cointegrated*.[2] That is, there must be a common component to both series that links their movements in the long run, and guarantees that they cannot diverge indefinitely from each other.

The cointegration property of the data justifies the existence of a long-run investment function such as (1), where the parameters β_0 and β_1 need to be estimated. The long-run multiplier is β_1, which represents the marginal change in purchases due to a marginal change in the spread.

Formally speaking, for a long-run investment function to exist, it is necessary and sufficient that purchases and spread can be decomposed as

$$\begin{aligned} P_t &= a_p f_t + \tilde{P}_t \qquad a_p \neq 0 \\ S_t &= a_s f_t + \tilde{S}_t \qquad a_s \neq 0 \end{aligned} \tag{2}$$

where f_t is the integrating factor that characterizes the permanent (long-run) component, common to both purchases and spread, and $\tilde{P}_t$ and $\tilde{S}_t$ are the transitory (short-run) components of purchases and spread, respectively.

Assume an $n \times 1$ non-stationary I(1) vector of variables $X_t = [x_{1t}, x_{2t}, \ldots, x_{nt}]$. Suppose that X_t can be decomposed into two components:

$$X_t = A_{n \times s} f_t + \tilde{X}_t \tag{3}$$

where f_t is an $s \times 1$ vector of $s(s < n)$ common unit root factors, and $\tilde{X}_t$ is an $n \times 1$ vector of stationary components. Every element in the vector X_t can be explained by a linear combination of a smaller number of I(1) common factors f_{jt} (permanent component) plus an I(0) or transitory component (for instance, $x_{it} = \sum_{j=1}^{s} a_{ij} f_{jt} + \tilde{x}_{it}$). In the long run, the variables x_{it} move together because they share the same stochastic trends.

The representation in Equation (3) is known as the *common factor representation*. Its existence is guaranteed if and only if there are $n - s$ cointegrating vectors among the elements of the vector X_t (see the Granger representation theorem in Engle and Granger [1987]). A major result of the Granger representation theorem is that a cointegrated system can be written as a vector error correction (VEC) model:

$$\begin{aligned} \Delta X_t = \mu + \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \\ \ldots + \Gamma_{p-1} \Delta X_{t-p+1} + \varepsilon_t \end{aligned} \tag{4}$$

where Π and Γ_i are $n \times n$ matrices, and Π has reduced rank $n - s$. The matrix Π can be written as $\Pi = \alpha\beta'$, where α is an $n \times (n - s)$ matrix of coefficients, and β is an $n \times (n - s)$ matrix of cointegrating vectors.

Using this expression for Π, we have $\Pi X_{t-1} = \alpha\beta' X_{t-1} = \alpha Z_{t-1}$, where $Z_{t-1} = \beta' X_{t-1}$ is known as the error correction term or short-term disequilibrium, and α is the matrix of adjustment coefficients. The elements of the matrix β cancel the common unit roots in X_t and, in the long run, link the movements of the elements of X_t.

In this context, our long-run investment function requires that s = 1 because we are searching for purchases and spread to share the same long-run information. The common factor representation in (3) becomes that in Equation (2). Searching for one common factor is equivalent to searching for one cointegrating vector. Our long-run investment function is the cointegrating relation $\beta' X_t = (1, -\beta_1)\binom{P_t}{S_t}$ plus the constant β_0, and the cointegrating vector is $(1, -\beta_1)$.

Long-Run Investment Function for the GSE

We show there is a common integrating factor for purchases and spread justifying the presence of a long-run investment function.

We test for cointegration between purchases and spread within the multivariate framework proposed by Johansen [1988, 1991]. We perform Johansen's likelihood ratio test for the null hypothesis of no cointegration versus the alternative of cointegration. The trace statistic is 14.82. The 5% critical value is 15.41, and the 10% critical value is 13.33. We reject the null hypothesis of no cointegration at roughly the 7% significance level.

This test seems to point toward marginal statistical evidence of cointegration between purchases and spread. We find stronger statistical evidence for cointegration in the analysis of the vector error correction model later.

The estimated long-run investment function of the GSE is

$$P_t = -51.35 + \underset{(0.11)}{0.554} S_t + \hat{Z}_t$$

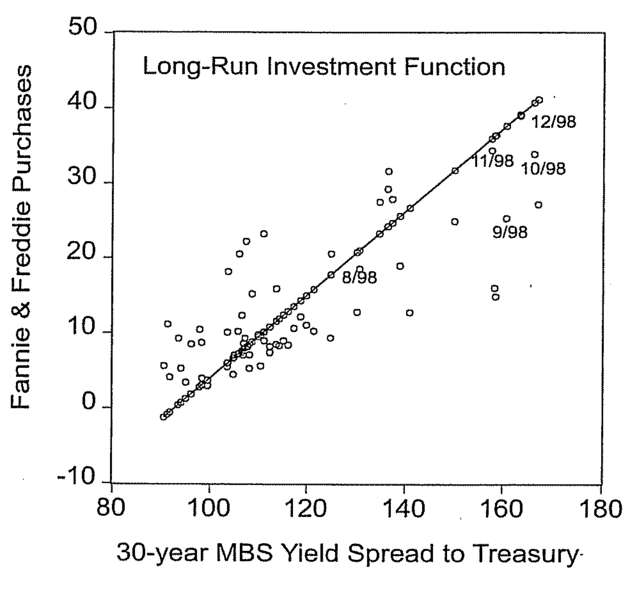
On average, a one basis point change in the yield spread prompts the GSE to pump \$554 million in purchases into the retained portfolio. The standard error of the β_1 component of the cointegrating vector (in parentheses above) is highly significant, confirming the presence of cointegration between purchases and spread.

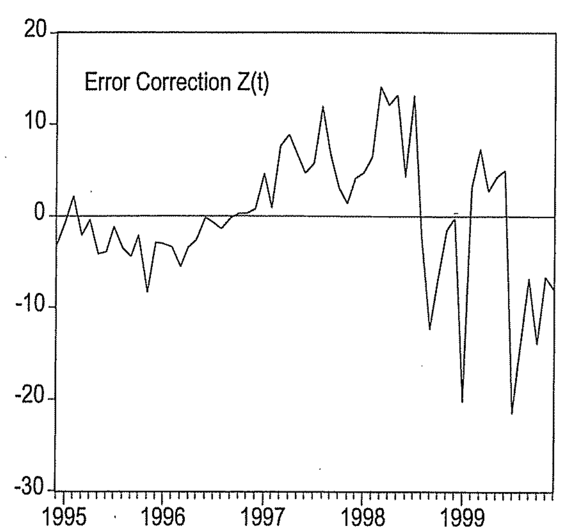
Exhibit 4 shows the empirical long-run investment function and the error correction process associated with it. The solid line is the long-run behavior. In the short run, we observe deviations from the long run. The points above the line are overreactions, and the points below are underreactions. The vertical distance between the point and the line is the error correction Z_t.

In equilibrium, the error correction should be zero. The property of cointegration guarantees that this will be the case. Short-run disequilibrium will be corrected because appropriate changes in the spread and in purchases are set in motion to bring the system to its long-run equilibrium path.

EXHIBIT 4

Investment Function and Error Correction Process





It is interesting to see that during the liquidity crisis of fall 1998, the GSE were underreacting, buying less than the level of purchases indicated by the long-run investment function. In September 1998, for instance, purchases were about $15 billion below the equilibrium level that would correspond to a spread of 160 bp approximately. Nevertheless, the GSE reacted with further purchases in the following months October 1998-December 1998, when finally they reach the equilibrium levels dictated by the long-run investment function.

Deviations from the Long-Run Investment Function

To analyze the short-run movements of the spread and purchases when there is an overreaction or underreaction with respect to the long-run investment function, we estimate a system of equations as in (4). The number of lags is chosen so that the residuals are serially uncorrelated:

$$\begin{bmatrix}\Delta P_t\\ \Delta S_t\end{bmatrix} = \begin{bmatrix}\alpha_1\\ \alpha_2\end{bmatrix} Z_{t-1} + \Gamma_1 \begin{bmatrix}\Delta P_{t-1}\\ \Delta S_{t-1}\end{bmatrix} + \Gamma_2 \begin{bmatrix}\Delta P_{t-2}\\ \Delta S_{t-2}\end{bmatrix} + \begin{bmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\end{bmatrix}$$

The estimation results are the following (t-statistics in parentheses):

$$\begin{aligned}\Delta P_t = {} & \underset{(1.04)}{0.11 Z_{t-1}} - \underset{(-5.38)}{0.80 \Delta P_{t-1}} - \underset{(-3.88)}{0.51 \Delta P_{t-2}} + \\ & \underset{(2.57)}{0.20 \Delta S_{t-1}} + \underset{(2.14)}{0.17 \Delta S_{t-2}} + \hat{\varepsilon}_{1t} \qquad \text{Adj. } R^2 = 0.39\end{aligned}$$

$$\begin{aligned}\Delta S_t = {} & \underset{(3.29)}{0.61 Z_{t-1}} - \underset{(-1.92)}{0.50 \Delta P_{t-1}} - \underset{(-0.67)}{0.15 \Delta P_{t-2}} + \\ & \underset{(2.42)}{0.32 \Delta S_{t-1}} + \underset{(0.38)}{0.05 \Delta S_{t-2}} + \hat{\varepsilon}_{2t} \qquad \text{Adj. } R^2 = 0.13\end{aligned}$$

Several partial features of the estimation are worth emphasizing. We observe that the error correction term Z_{t-1} is statistically significant at the 1% level in the equation for the spread. This represents further evidence for cointegration between spread and purchases.[3] The error correction term in the equation for purchases is not statistically significant at the conventional levels. This means that it is mainly movements in the spread that will carry out the adjustment toward equilibrium, in the very short term.

EXHIBIT 5

Dynamics of Purchases and Spread

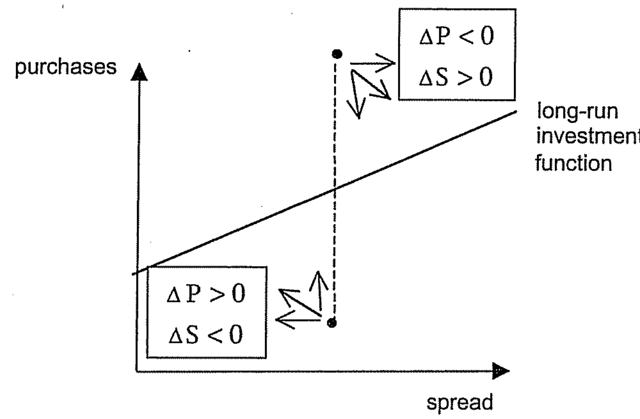


Exhibit 5 explains the short-term dynamics of the spread and purchases. Suppose that the error correction Z_{t-1} is negative; that is, there is underreaction with respect to the investment function (a point below the function). According to the estimated system, we expect changes in the spread and in purchases that eventually will correct the disequilibrium. The spread will narrow, correcting approximately 60% of the disequilibrium in the following period. The level of purchases will increase because of the significant negative signs in the lag structure of purchases. If the error correction is positive (a point above the investment function), the dynamics are the opposite; the level of purchases will decrease, and the spread will widen.

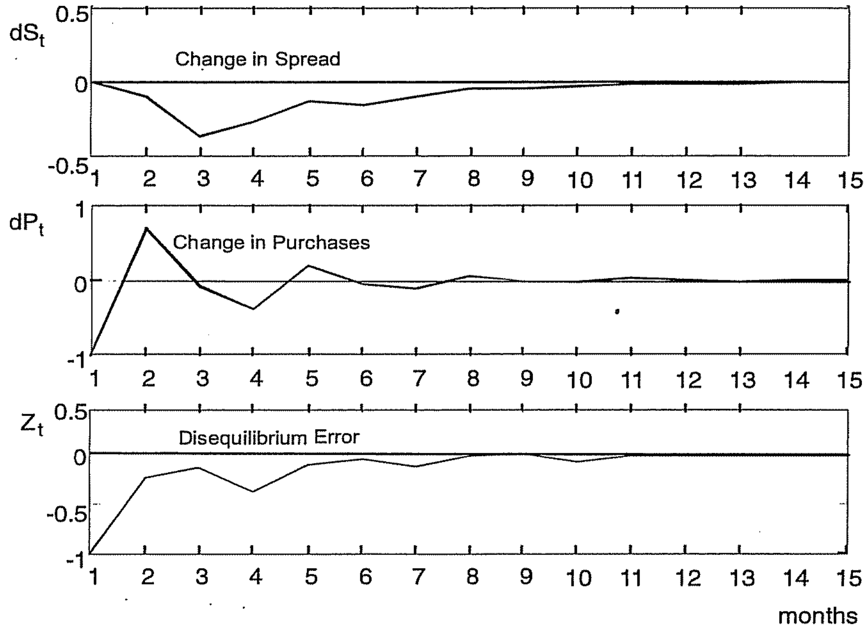
Hence, in the short run, changes in the spread and changes in the level of purchases are negatively correlated until the disequilibrium is corrected, and a new long-run equilibrium is reached along the investment function.

Furthermore, the estimation results of the vector error correction model point toward Granger causality in both directions. That is, changes in the spread are informative with regard to forecasting future changes in purchases, and vice versa—changes in purchases can help to predict changes in the spread. In the spread equation we observe that in the short term, everything else equal, an increase of $1 billion in purchases will reduce the spread by 0.50 bp in the next month. Changes in purchases will Granger-cause spread changes.

Causality also runs in the opposite direction; changes in the spread are informative with regard to forecasting

EXHIBIT 6

Dynamics of Spread and Purchases



changes in purchases. Everything else equal, a change of one basis point in the spread increases purchases by roughly $200 million in the following month.

These short-term multipliers show the intimate connection between retained portfolio investments and MBS yield spreads. A formal test for Granger causality, where the null hypothesis is non-causality, reveals that the causality is statistically stronger from spread to purchases ($\chi_2^2 = 11.08$, p-value = 0.003) than from purchases to spread ($\chi_1^2 = 3.67$, p-value = 0.055).

Exhibit 6 summarizes the global short-term dynamics of purchases and spread. That is, we consider the joint effect of the estimated error corrections and short-term multipliers. We assume that at time $t = 1$ there is a shock that moves the system out of equilibrium, $P_1 - P^* = -1$ (below the investment function), where P^* is the equilibrium level of purchases. The first graph in Exhibit 6 shows the adjustments in the spread over the months after the shock; the second graph shows the adjustments in the level of purchases, and the third one how the disequilibrium error is fully corrected over time.

For instance, after two periods ($t = 2$, and $t = 3$) the GSE have increased the level of purchases by roughly $600 million, and the spread has been reduced by approximately 0.5 bp. At the same time, the error correction is narrowing. Within two periods, 85% of the error is absorbed by the system. When the disequilibrium is fully corrected, adding all the negative changes over time in the spread, we observe that the spread has narrowed by 1.40 bp.

To put this number into perspective, consider the liquidity crisis in the fall of 1998. In Exhibit 4, we see that in the fall of 1998, the GSE were running purchases below their long-run equilibrium levels, given the level of the spread. In September 1998, for instance, the error correction was approximately -$15 billion in purchases. To correct this disequilibrium and under the assumption that there are no further shocks, the GSE increased their level of purchases and the spread narrowed by 21 basis points (1.40×15).

II. LINKAGES BETWEEN SECONDARY AND PRIMARY MARKET YIELD SPREADS

To analyze the linkages between the secondary and primary markets for mortgages, we expand the system $\binom{P_t}{S_t}$ to include mortgage spreads in the primary market. The data consist of monthly average effective mortgage rates from the Primary Market Mortgage Survey for the period December 1994 through December 1999. The spread is calculated with respect to the ten-year constant-maturity Treasury rate. For this period, the mean spread is 181 bp with a standard deviation of 21 bp.

Exhibit 7

Primary and Secondary Market Spreads

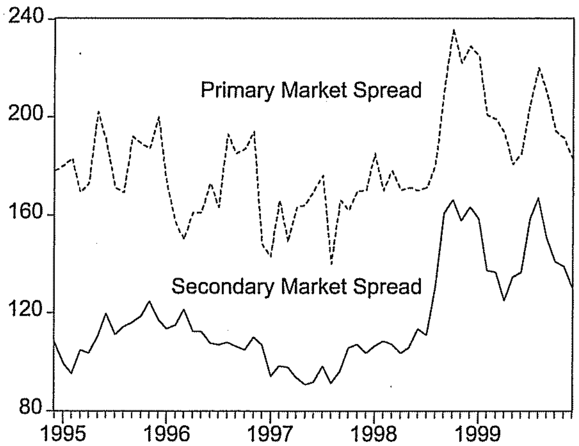


Exhibit 7 shows the time series of both spreads. The contemporaneous correlation between both series is 0.81. Secondary and primary market yield spreads are synchronized. Lower spreads in the secondary market are passed on to the primary market, where ultimately the homeowner benefits.

We define a long-run spread linkage as the response of the primary market spread to movements in the secondary market spread. In order to find this function, we examine a trivariate system that consists of purchases for the retained portfolio (P_t), yield spread in the primary market (SP_t), and yield spread in the secondary market (SS_t). We test for cointegration among the three series.

The Johansen's trace statistic testing for the null hypothesis of at most two cointegrating vectors is equal to 3.37. The 5% critical value is 3.76, so we fail to reject the null. The fundamental implication of this finding is that the three series are linked by a common integrating factor. As before, we can write the decompositions:

$$P_t = a_p f_t + \tilde{P}_t \qquad a_p \neq 0$$

$$SP_t = a_{sp} f_t + \tilde{SP}_t \qquad a_{sp} \neq 0$$

$$SS_t = a_{ss} f_t + \tilde{SS}_t \qquad a_{ss} \neq 0$$

The integrating factor f_t links the primary market to the secondary market activities. The estimated cointegrating relations are the long-run investment function and the spread linkage:

$$\underset{}{P_t = -53.1 + \underset{(0.11)}{0.568}SS_t + \hat{Z}_{1t}} \rightarrow \text{long-run investment function}$$

$$SP_t = 81.5 + \underset{(0.14)}{0.844}SS_t + \hat{Z}_{2t} \rightarrow \text{long-run spread linkage}$$

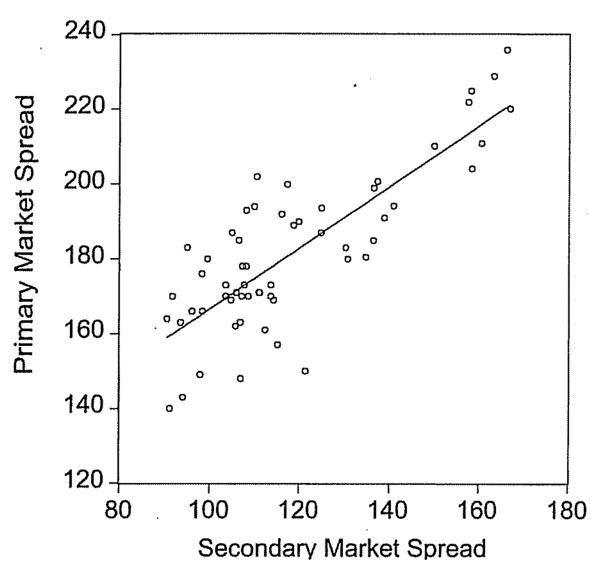
Not surprisingly, the long-run investment function is roughly the same as that found before. The long-run multiplier implied by the spread linkage is 0.84; that is, a one basis point increase in the secondary market spread translates into an 0.84 bp increase in the primary market spread (Exhibit 8).

The numbers in parentheses are the standard errors of the multipliers. Both are highly significant, confirming the cointegration property in both markets. More important, a hypothesis that spread changes in the secondary market are transmitted one-to-one to the primary market cannot be rejected at the conventional significant levels, meaning these markets are highly efficient in the transmission of information.

Analysis of the vector error correction model reveals an important feature of the short-run changes in the primary market spread. The primary market spread seems to react only to disequilibrium with respect to the long-run spread linkage, that is, Z_{2t}. The primary market spread is not directly responsive to disequilibrium with respect to the long-run investment function, although it is indirectly linked to it through the secondary market spread.

Exhibit 8

Long-Run Spread Linkage



This means that the secondary market spread plays an important role as the intermediary variable. On the one hand, secondary market spread and portfolio purchases affect each other's levels. On the other hand, secondary market spreads control the primary market spreads.

III. CONCLUSIONS

We have demonstrated the role of the retained portfolio investments of FNMA and FHLMC to influence the behavior of the spread in the secondary and primary markets for mortgages.

The GSE react to the liquidity needs of the secondary market of mortgages by maintaining a long-run investment function and a spread linkage between the secondary and primary markets. The investment function links mortgage yields to the volume of their portfolio investments. Retained portfolio purchases can be considered an important instrument that influences the spread so that the spread cannot diverge indefinitely. The retained portfolio investments bring the spread to its long-run equilibrium levels, adding stability to the secondary market activities.

We have estimated that a one basis point increase in the spread produces an infusion of $554 million in the secondary market. When the GSE deviate from their long-run equilibrium investment levels, short-run dynamics (changes in purchases and spread) are set in motion to correct the disequilibrium.

We have shown that purchase changes and secondary market spread changes are negatively correlated in the short run. A notable instance is the liquidity crisis of 1998. At the beginning of the liquidity crisis in fall 1998, the GSE were buying below their equilibrium levels. In September 1998, retained portfolio purchases were $15 billion below the equilibrium level of purchases. We have estimated that, on average and without further shocks to the spread, correction of this disequilibrium through an increase in purchases would produce a reduction of 21 bp in the spread.

The linkage between the long-run movements of the spread in the secondary and the primary markets for mortgages shows that these markets are efficient. We have estimated that a reduction of 1.0 bp in the secondary market spread reduces the primary market spread by 0.84 bp, but this number is not statistically different from 1.00.

We conclude that the government-sponsored enterprises have a powerful instrument in their retained portfolio activities. They directly influence the liquidity of the secondary market. In doing so, they influence the secondary market spread, while at the same time transferring the benefits of the secondary market to the primary market.

ENDNOTES

The author thanks Marsha Courchane, Edward Golding, David Nickerson, and Richard Roll for helpful discussions.

[1]Arbitrage arguments may run against the apparent non-stationarity of the spread, but we choose to model the spread as a near non-stationary process because we can take advantage of the theory of cointegration. Furthermore, assuming variables are stationary when they are not poses more severe econometric consequences than assuming variables are non-stationary when they may not be.

[2]Purchases and spread are cointegrated if there is a linear combination of both variables that is stationary.

[3]According to the Granger representation theorem, if a system is cointegrated, the error correction term must be statistically significant in at least one of the equations.

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