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GNMA PASSTHROUGH SECURITIES

Futures Trading and Volatility in the GNMA Market

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FUTURES MARKETS FOR AGRICULTURAL commodities have existed for well over 100 years. Recently there has been a major expansion of futures trading into non-traditional areas, particularly interest-bearing securities and foreign currencies—the so-called "financial futures." The introduction of exchange traded futures contracts for Treasury Bills, GNMA pass-through certificates, and other securities has created new hedging, arbitrage, and speculative opportunities for the investors, issuers, and dealers who are active in the cash markets for these securities. Futures trading has also opened these markets to participation by new classes of traders, particularly private and smaller institutional investors.

Through the process of arbitrage, a financial futures market will be closely linked to the cash market for the underlying securities. An important concern of the regulatory authorities is what effect opening a futures market is likely to have on an existing cash market. The purpose of this paper is to analyze the impact of futures trading in Government National Mortgage Association (GNMA) pass-through certificates on price volatility in the cash market for these securities.

There are several major ways in which opening futures trading can increase efficiency and smooth price variations in a cash market. Most importantly, futures provide a mechanism for those who buy and sell the actual security or commodity to hedge themselves against unfavorable price changes. Through the futures market, risk can be spread across a large number of investors, and transferred away from those hedging spot positions to professional speculators who are more willing and able to bear it. This risk transfer may substantially improve the functioning of the spot market because it reduces the need to incorporate risk premia in cash market transactions to compensate for the risk of price fluctuations.

Second, futures market may increase the informational efficiency of a cash market. Since futures prices are determined in a unified, highly visible market by traders who specialize in gathering and evaluating information, the futures market is expected to be an "efficient" market, in the sense that prices will reflect the best estimate of true future values given the information currently available. If anything, an informationally efficient futures market should lead to more efficient pricing in the cash market.

The importance of both of these effects will depend upon the structure of the existing cash market. The more developed and integrated is the cash market, the

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smaller will be the impact of futures trading. The cash GNMA market, for example, already permitted hedging and risk transfer through forward contracts. Further, the informational effect of trading in a centralized futures market is likely to be more significant when the cash market consists of small dealers in geographically separated locations, as is the case for a number of agricultural commodities. The cash GNMA market is made by a comparatively small number of large dealers who are constantly in contact by telephone.

It is also possible that in certain circumstances futures market activity can increase cash price variability. Most obvious is when futures prices are distorted by technical factors or manipulation. These difficulties can be effectively eliminated by properly designed futures contracts and adequate regulation. Still, the Treasury and Federal Reserve felt it necessary recently to request that the Commodity Futures Trading Commission impose a moratorium on authorizations for new futures contracts in Treasury issues while they studied the impact of futures trading in government securities.[1]

A second possibility is that a futures market could induce a significant amount of new hedge trading without attracting enough speculation to permit an effective risk transfer. The hedging pressure in futures can then spill over into the cash market where the dealers and other market makers end up bearing risk transferred through both the cash and the futures market. This problem may partly account for the difficulties of the ill-fated onions futures market. Although Congress banned futures trading in onions in 1958 because of the alleged destabilizing effects of "excessive" speculation, evidence presented by Working (1960, Chart l) suggests that trading in onions futures was in fact almost entirely hedge trading.

Finally, futures trading may increase price volatility if investors in futures do not have as good information as participants in the cash market. Even if the futures price accurately reflects the information available to traders in that market, if they are not as well informed as cash market traders, their actions can push cash market prices away from their most appropriate values. This situation will present profit opportunities to the better informed cash market participants, whose trading will act to stabilize futures prices while allowing greater volatility in cash prices.

Given these possibilities, it becomes an empirical question what impact a particular futures market will have on the associated cash market. In the next section we present an overview of the GNMA market and discuss the likely effects of futures trading for this case. Section III contains an empirical analysis of price volatility in the GNMA market. We find volatility to be related to a number of factors, including futures market activity. In contrast to the results of earlier studies on commodity futures, the evidence presented below indicates that futures trading in GNMA securities has, if anything, increased the volatility of the cash market. We suggest that the most probable explanation for this finding

[1] The study (Treasury/Fed 1979) was completed in May 1979. It suggested that most serious potential problems with financial futures occurred when the futures contract called for delivery of a narrow class of securities, particularly if they are not issued until near the expiration date of the future. This problem does not affect GNMA futures.

is that the existence of the futures market has led to trading by new classes of investors who, on average, do not have access to as good information as traders in the existing cash market.

In judging the social value of the GNMA futures market, it is important to recognize that increased cash price volatility is only one aspect of the question. Against the "costs" associated with wider price variation one must weigh the significant benefits of extending the possibility of hedging interest rate risks to a much wider market. This is especially important in view of problems encountered recently by the GNMA cash forward market, [see Shriver (1978)], which may serve to increase the viability of futures vis-a-vis forward contracts for hedging.

I. The GNMA Market

A GNMA pass-through certificate represents a pro rata share in a pool of at least $1 million principal value of FHA or VA insured residential mortgages. The monthly payments of principal and interest are guaranteed by the Government National Mortgage Association and are "passed through" from the home buyers to the holders of the certificates. After its inception in the late 1960's, the GNMA market has grown rapidly. Outstanding GNMA certificates currently amount to more than $100 billion and new issues in 1979 were over $20 billion. The major participants in the GNMA cash market are the 800 or so mortgage bankers and other "originators" who set up and process the underlying pools of mortgage loans; the investment banks, savings and loan associations, pension funds, and other institutional investors who buy the GNMA's for their portfolios; and the dealers who make the markets in GNMA securities. The dealer-oriented cash GNMA market is a highly developed, liquid market with extensive trading for immediate and forward delivery out to four months and further in the future, and for repurchase as well as standby (option) agreements.

In October 1975 the Chicago Board of Trade initiated trading in GNMA futures. The contract calls for delivery of $100,000 principal value of 8% coupon GNMA's or an equivalent amount of GNMA's with different coupons.[2] There are four delivery months per year, and at any one time, there is trading in contracts for delivery out to nearly 3 years in the future. GNMA futures have proved to be very successful and the market has expanded rapidly since 1975. By July 1979, open contracts were outstanding for more than $7 billion face value of GNMA's.

While in theory the principal function of a futures market is to facilitate hedging of positions taken in the physical commodity, in the case of GNMA's, this function was already performed to a large extent by the existing forward market. For many cash market participants, exchange-traded futures did not greatly increase hedging possibilities, but simply represented the addition of one more trading vehicle to a unified market that already permitted a wide variety of spot and forward transactions. There are however, several important differences between the GNMA forward and futures market.

[2] Actually the contract calls for delivery not of GNMA certificates themselves but rather a "Collateralized Depository Receipt," essentially a warehouse receipt for GNMA's held by a third party. This makes delivery against a futures contract more complicated than against a forward contract with a dealer.

One difference is that futures trading created a centralized, highly visible market, while forward contracts are made by individual dealers. The existence of one market eliminates the search cost of soliciting quotes from several dealers, and assures the investor of getting the best execution currently available. Since the futures price is easily observable, possibilities for arbitrage among spot, forwards, and futures will keep rates closely aligned in all segments of the market. It is also possible that the futures market may increase the informational efficiency of the GNMA market by aggregating information that would otherwise remain dispersed throughout the fragmented dealer market.

Another important difference is that a future contract specifies a standardized set of terms while a forward contract is negotiated between buyer and seller. By fixing delivery date, quantity, coupon, and so on, futures gain liquidity at the cost of flexibility. Thus, there can be a fairly liquid market for futures contracts calling for delivery several years ahead, while the forward market is quite thin beyond six months. On the other hand, for a hedger the loss of flexibility in futures leads to "basis risk", the risk that the price relationship between the position he is hedging and the standard futures contract will change over the holding period, leading to a loss.

Many hedgers find the basis risk in GNMA futures unacceptably large and continue to hedge with forwards, where the hedge can be made perfect.[3] Another factor that has discouraged hedging in futures is that a futures trade requires an initial margin deposit and "marking to the market" when paper losses are incurred. Forward contracts are generally made without margin or marking to the market for those institutions that meet the dealer's credit criteria. Thus, even without basis risk, the forward market is more attractive than futures for many hedgers.

In sum, for the major participants in the cash GNMA market, the advent of futures trading probably did not change the nature of business very greatly. The one exception is the possibility of strategies involving far future contracts which were not previously available. It is not known how important these have been practically.

What the futures market did do, however, was to permit and encourage trading by new classes of investors who had not previously been active in the cash market. Smaller regional mortgage lenders and other institutional investors who did not really have access to the dealer forward market were now able to hedge in the futures market. The futures market also attracted substantial speculative capital from private investors who do not trade in the cash market. The influx of new traders into the integrated cash-futures GNMA market may have had several different effects. Futures market theory emphasizes the importance of a large volume of speculative interest to provide a liquid market in which hedging can be done without disrupting prices. In the cash GNMA market, speculative capital for price stabilization is provided mainly by the dealers, who buy or sell out of inventory in response to market pressures. Opening the futures market brought new hedging pressure, which might tend to stretch the dealers' capitalization more thinly as they try to offset demand imbalances in an expanded market

[3] The Shriver report (1978) cites this factor as a major reason mortgage bankers have not been especially active in the futures market.

environment. But futures trading also brought new speculative capital into the market. If speculators in the futures market act to offset temporary market imbalances in the same way as dealers in the cash market, their presence should help to smooth prices in the integrated market. On the other hand, futures trading may increase price volatility if there is little speculative interest in futures relative to the amount of new hedging, if futures prices are distorted by manipulation or technical factors, or if futures market speculators simply have less information and are less able to evaluate the true worth of GNMA securities than are the dealers.

We can get some insight into the makeup of the futures market investor population and the balance between hedging and speculation from a survey of futures market participants done by the Commodity Futures Trading Commission in November 1977 (Hobson 1978). Open positions were classified as hedging or speculative, and were broken down into "commercial" traders (investment companies, securities dealers, mortgage banks, S & L's, etc.) and "others" (primarily members of the futures industry and private investors). Nearly 80% of traders were classified as noncommercial speculators, and this group held more than half of the open interest in GNMA futures. By contrast, at the beginning of 1977, only 1.1% of all outstanding GNMA certificates were owned by private investors (Hobson, Table 6-3).

The report does show a reasonable balance between hedging and speculation, comparable to that measured for wheat and corn futures (37% and 48%, respectively), so that the futures market is not deficient in speculative interest.[4] Further, the safeguards on futures trading imposed by the Board of Trade, the CFTC, and the brokerage firms, as well as the large volume of deliverable securities outstanding, have effectively eliminated the possibility of manipulation. Thus it is unlikely that GNMA cash price variability has been increased by insufficient speculative activity or manipulation in the futures market.

However, it is quite possible that futures traders on average do not have as good information about the true value of GNMA securities as do GNMA dealers and other cash market traders. The dealers have access to all of the same information available to other futures market participants, but in addition they have extensive knowledge of supply and demand conditions in the cash forward and spot market. If futures traders are less informed than those in the cash market, futures prices will contain more "noise" than would cash forward prices in the absence of futures trading. The existence of such noise presents speculative and arbitrage profit opportunities to the dealers. Because of the linkage between the cash and futures markets, futures prices will be stabilized by the activities of the cash market traders, while cash prices will fluctuate more widely compared to a situation in which the markets were strictly separated.

II. Volatility in the GNMA Market

Earlier research on the effects of futures trading in commodities has generally concluded that the existence of a futures market tends to stabilize prices in the

[4] More "speculative" markets like frozen pork bellies and Maine potatoes show a substantially lower proportion of hedging (7.5% and 18%, respectively), (Hobson 1978, p. 23).

cash market. Two papers on the onions market (Gray 1963, Working 1960) found that futures trading reduced the range between high and low cash onions prices over a crop year. A study of live cattle futures (Taylor and Leuthold 1974) compared the variance of prices around their long run mean between a period with futures trading and one without futures trading. By this criterion, cash prices were more stable when the futures market was in existence. And another study of cattle and pork bellies (Powers 1970) produced evidence of the stabilizing influence of futures trading using a variate difference method to isolate the "noise" component of the price series.

Because the cash markets for financial instruments are more highly developed and integrated than those for commodities, the results of this research cannot automatically be applied to financial futures. Further, none of the measures of market stability used in these studies is entirely satisfactory. Looking at a trading range alone is insufficient because it takes no account of price fluctuations between the high and the low, while variance around a long run mean is misleading when prices contain a trend. Finally, in differencing a series to isolate the "noise", a good part of what we would probably call instability will be smoothed out in the process, while the effect of true noise such as data errors is magnified.

In this study we will examine price volatility, the standard deviation of day to day price changes. Volatility avoids the problems mentioned above, and has been used extensively in research on the stock market, and particularly options, although the concept has not been applied in the present context before.

Consider a time series of prices $p_1, \cdots p_t \cdots$ In a perfectly stable market, the price would be constant over time and all P's would be equal. But no market is perfectly stable. The most widely accepted model for the movement of security prices is the "random walk", or its generalization, the "martingale" model, shown in equation (1).

$$p_t = p_{t-1} + u_t, \qquad \begin{aligned} E(u_t) &= 0 \\ \mathrm{Var}(u_t) &= V_t^2 \\ \mathrm{Cov}(u_t, u_s) &= 0 \text{ for } t \neq s. \end{aligned} \tag{1}$$

The price change from one period to the next is random with zero mean and standard deviation, or volatility, V_t, and is independent of changes in other periods. A martingale differs from a random walk in that the volatility may change over time for a martingale, while it is a fixed constant for a random walk. Volatility is an ideal measure of price variation because it captures the intuitive notion of stability being related to the magnitude of random fluctuations, and is consistent with accepted theories of price behavior in efficient financial markets. We will examine the volatility of day to day fluctuations in the prices of 8% and 9% cash GNMA's, and in GNMA futures prices.

In the only previous study of the interaction between cash and futures GNMA trading, Froewiss (1978) related the weekly change in GNMA prices to the behavior of 10 year government bonds. Although he did not consider volatility directly, the paper is valuable in that it tries to deal with a problem which affects all of the studies cited above. Many factors influence any given market and it is unreasonable to ascribe all differences in behavior between a period without and one with futures trading to the existence of the futures market. By relating the GNMA cash market to the bond market, Froewiss tries to judge whether GNMA's behaved differently compared to other securities after futures trading began.

We take this approach a step further by constructing a model of daily volatility in GNMA cash prices in which we try to incorporate all important factors, including futures market activity, which might affect it. We consider four primary factors: volatility in related markets, breadth and liquidity of the cash GNMA market, the level of GNMA prices, and futures market activity. The variables used to measure these factors are discussed in detail below.

Cash market volatility was calculated using daily data on the prices for GNMA 8% and 9% coupon issues from January and February 1975, respectively, through February 1979.[5] These are the issues which might be most affected by futures trading. The 8% coupon is nominally the delivery security for the futures contract, but different coupon GNMA's can be substituted according to a set formula. During the period considered, the structure of GNMA prices was such that it was nearly always more advantageous to deliver the 9's. This tended to tie the futures market to the higher coupon issue.[6]

A monthly volatility series was constructed for each issue in which the estimate of the daily volatility during month t, is given by

$$V_t = \left(\sum_{s=1}^{N_t} (p_s - p_{s-1})^2/N_t\right)^{1/2} \tag{2}$$

where N_t is the number of observations in the month.

Financial markets go through turbulent periods and periods of relative calm. In studying the volatility of one market one should take into account the stability of interest rates in general. We constructed similar volatility series for yields on a 10 year government bond and an index of 10 year federal agency issues as two comparable kinds of securities. Volatility series were also constructed for prices of "near" and "far" GNMA futures. These are defined as the contracts which expired in 1 to 4 months, and 5 to 8 months, respectively.

Table 1 shows the average price volatility in each of these markets (yield volatility for the bond and agency issues) and the matrix of correlation coefficients among them. These correlations show how closely the behavior of volatility in one market resembled that in each other market. The first thing we notice is that the 8% coupon GNMA's were somewhat more volatile than the 9's. The standard deviation of day to day price changes was 0.28 (of 1% of par) for the 8's and 0.22

[5] All yields and prices for GNMA cash and futures markets and for 10 year government bonds and agency issues were taken from the Rapidata data base. In some cases, missing or clearly erroneous data were filled in by interpolation, using other related series such as those for different coupons or maturities.

[6] The average market prices observed in the month of December 1978 show this phenomenon clearly. GNMA 8's were selling at 90.83 percent of par and the 9's were at 95.47. The terms of the futures contract permit delivery of $93,167.70 face value of the 9% coupon in place of $100,000 of 8's. At the prevailing prices this amount of 9's could be bought for $88,948—nearly $2000 less than the cost of the "equivalent" quantity of 8's. The problem is that while the conversion factor is based upon prices which equate the yields on the different coupon certificates, their market yields are in general not equal.

Table 1

Volatility Correlation Matrix for Various Markets

		Correlation Matrix					
Market	Mean	GNMA 8	GNMA 9	US Bond	US Agencies	Near Future	Far Future
1. GNMA 8's	.28	1.00	—	—	—	—	—
2. GNMA 9's	.22	.47	1.00	—	—	—	—
3. 10 Year US Bond	.038	.15	.40	1.00	—	—	—
4. 10 Year US Agencies	.041	.09	.28	.86	1.00	—	—
5. Near GNMA Future	.26	.52	.37	.61	.55	1.00	—
6. Far GNMA Future	.26	.64	.23	.36	.39	.53	1.00

for the 9's. It was suggested in conversation with GNMA dealers that this could be because the 8's were the current coupon, that is, new GNMA issues bore 8% coupons, during much of the period under consideration. Most of the cash market trading is in the current coupon issue, and other coupon GNMA's tend to move more sluggishly.

It is somewhat surprising that while correlation between the volatilities of the 10 year government bond and the agency issues was a high .86, as we expected for comparable securities, neither was particularly closely related to volatility of the GNMA 8's and 9's.[7] Volatility of the GNMA futures market, especially the near future, was more comparable to that of the bond and agency issues. It is interesting that the correlation between volatility of the cash 8's and 9's was as low as .47 even though these markets should be closely linked. Apparently a substantial portion of the fluctuation in GNMA prices is due to factors that are specific to the individual issues. Finally, comparing volatilities of the cash and futures markets, we find them to be about equal on average, but futures volatility is more correlated with the cash 8's than the 9's.

In addition to the stability of financial markets in general, volatility in GNMA's should be affected by factors that influence market liquidity. In general, the larger the total stock of securities outstanding, the more liquid and more stable the market. We expect volatility to decrease as the number of GNMA's outstanding rises. We might also expect increased liquidity when the volume of securities supplied to the market increases. Two variables are available to measure this effect: the volume of new issues in each month, and the number of secondary market transfers. The latter variable represents the face value of GNMA's reregistered during a given month. Most newly issued GNMA's enter the cash market as deliveries against forward contracts made some months earlier. In a sense, these securities are present in the market at the time they are sold, long before they are actually issued. To explore the importance of trading of GNMA's before issue, we included future issues, defined as the sum of new issues over the

[7] This may be because GNMA's are actually quite different instruments from bonds or agency issues. Unlike those securities, GNMA's feature an uncertain cash flow pattern. Also, the 12 year average life assumption used in quoting yields is simply a convention. A GNMA pool will make payments as long as the underlying mortgages are in existence, which may be 25 to 30 years. Thus the linkage between these markets may be weak.

next four months, as an additional variable. All of these variables are measured in millions of dollars of principal value.

The level of prices is another factor which should be examined, although the expected sign of the effect is not clear *a priori*. There is evidence that the variability of inflation increases when inflation rates are higher. To the extent that yields incorporate inflation expectations through the Fisher equation, higher average yields and lower prices might also be expected to be associated with increased volatility. On the other hand, if the fundamental variable is considered to be a GNMA security's price rather than its yield, one might expect larger absolute price movements when prices are high, as is found in the stock market. Another aspect of the price volatility relation is that since the main stabilizing force in the cash market is the willingness of GNMA dealers to buy and sell out of inventory, larger inventories could lead to a less volatile market. Dealers should carry more securities when prices are low because they earn a higher yield on their holdings, and also since they stand to make capital gains if prices return to higher levels. If this effect is important, lower prices will lead to reduced volatility.

Finally, there are the variables relating to futures market activity. We include open interest for the month, defined as the average of the beginning of month and end of month figures, as a measure of the size of the futures market, and total trading volume for the month as an indicator of current trading activity. Another variable that was included in some equations was the volatility of the futures market itself. This variable is somewhat problematical, since we do not really think that futures volatility *causes* volatility in cash market yields. Rather, both cash and futures reflect the underlying factors that influence stability in the integrated GNMA market. However, using futures volatility as an explanatory variable may give some insight into what affects stability in the cash market *relative* to the futures market. The equations containing futures market volatility were run only over the period during which the futures market was in existence. This reduced the number of degrees of freedom in those regressions.

Table 2 presents regressions of the volatilities of GNMA cash 8's and 9's, and the near and far futures on the variables discussed above. Columns (1) and (4) show regressions of cash price volatility on all of the independent variables. Column (2) eliminates some of the variables with little explanatory power, and Columns (3) and (5) show equations including futures market volatility as an explanatory variable. Overall, the cash market models capture 30 to 40% of the variation in cash market volatility after adjustment for the degrees of freedom used in estimating the regression equation. The equation for the 9's fits somewhat better than the one for the 8's, but the coefficients are quite similar across equations. This increases our confidence in the model since Table 1 showed that the 8's and 9's do exhibit individual behavior. There was no significant autocorrelation in any equation.

The variables measuring volatility in related markets did not contribute very much in these equations. The U.S. agency volatility had to be eliminated because of serious multicollinearity with the 10 year bond volatility. The latter had a positive coefficient which was nearly significant in equation (4), indicating some similarity in the behavior of volatility between markets.

Most of the coefficients on the variables chosen to measure liquidity had the

Table 2

Regressions Results
(*t*—Statistics in Parentheses)

	Dependent Variable						
	Cash 8 Volatility			Cash 9 Volatility		Near Future	Far Future
Explanatory Variables	1	2	3	4	5	6	7
10 Year Bond Volatility	.84	—	—	1.45	—	3.65	1.75
	(.83)			(1.98)		(5.14)	(1.63)
Outstanding GNMA's $\times 10^{-5}$	−1.13	−.91	−.45	−1.11	−1.07	−.26	−.49
	(2.01)	(2.66)	(1.25)	(2.77)	(2.61)	(.69)	(1.00)
New Issues $\times 10^{-5}$	−13.01	−11.04	−16.51	−16.29	−11.83	−7.22	−.18
	(1.92)	(1.73)	(2.79)	(3.34)	(2.55)	(1.79)	(.03)
Future Issues $\times 10^{-5}$	−2.19	—	—	−3.99	−5.43	2.58	−.93
	(1.00)			(2.43)	(2.74)	(1.35)	(.35)
Secondary Market $\times 10^{-5}$	4.63	—	—	7.70	6.89	1.52	−.17
	(1.00)			(2.43)	(2.45)	(.61)	(.04)
Average Price[a]	.036	.037	.041	.016	.026	.003	.014
	(2.62)	(3.65)	(3.92)	(1.32)	(1.82)	(.22)	(.85)
Open Interest $\times 10^{-6}$	9.06	7.58	7.26	5.40	7.25	1.25	3.55
	(2.57)	(2.50)	(2.58)	(1.49)	(1.74)	(.33)	(.97)
Futures Volume $\times 10^{-6}$	.85	.94	.46	3.80	3.92	−.43	.44
	(.43)	(.60)	(.35)	(2.64)	(3.19)	(.38)	(.25)
Near Future Volatility	—	—	—	—	.40	—	—
					(2.66)		
Far Future Volatility	—	—	0.78	—	—	—	—
			(4.63)				
Constant	−2.91	−3.05	−3.72	−1.15	−2.19	−.16	−.99
	(2.23)	(3.21)	(3.79)	(.96)	(1.64)	(.14)	(.67)
R^2 Adjusted	.29	.30	.57	.38	.53	.44	.01
Degrees of Freedom	41	45	33	40	30	30	30

[a] The average price for 8% coupon GNMA's was used in Cols. 1, 2, 3, and 7. The 9% coupon issue was used in the other regressions.

expected negative sign. The size of the market, as measured by the face value of outstanding GNMA securities (in millions of dollars), was an important variable. Volatility decreases as the amount of GNMA's outstanding grows. New issues over the next four months also came in with a negative sign, but again was only significant for the 9's. Secondary market transfers were estimated with a positive coefficient that was statistically significant in equation (4). The unexpected sign may be due to multicollinearity with the other liquidity variables, since the simple correlation with both volatility measures is negative.

The average price of GNMA 8's and 9's proved to be a relatively important variable. A price increase of 1% of par was associated with a volatility increase of .02 to .04. On a day to day basis, the effect of higher inflation variability was apparently not very important, while the opposite effect working through dealer inventories may have been much more significant.

The variables relating to futures market activity, open interest and trading volume (in contracts of $100,000) both came in strongly with a positive sign. In no equation do they both achieve statistical significance at the 5% level by a *t*-

test. But testing for joint significance using an F-test rejects the hypothesis that both coefficients are zero at the 1% level in equations (4) and (5). The estimated coefficients imply that holding other things constant, a rise of 10,000 contracts ($1 billion principal value) in open interest is associated with an increase of about .07 in volatility, while a similar increase in futures trading volume may add between .01 and .04 to volatility.

When the volatility of the futures market itself is included as an explanatory variable, it enters positively and is significant in equations (3) and (5). The coefficients on the other variables are not greatly changed, which indicates that the factors they measure are not especially collinear with futures market volatility.

The regression evidence in Table 2 points to the conclusion that futures trading in GNMA securities has led to increased price volatility in the GNMA cash market. Before drawing this conclusion, however, we should consider the possibility of reverse causation. For example, if instability in the cash market induces increased hedging in the futures market, there can be a positive association between cash price volatility and futures activity but with the direction of causation opposite to what has been discussed above.

Unfortunately, direction of causality is much more difficult to prove statistically than is correlation. Our results on this question must be regarded as suggestive rather than definitive. The most rigorous approach to analyzing causality uses techniques suggested by Granger and Sims, which involve regressing one variable on lagged and future values of the other. This method is best suited to cases where the causing variable has its effect with a distributed lag. It turned out not to be particularly meaningful in the present context where correlation is mostly contemporaneous.

There are two factors which indicate that reverse causation is probably not too important in these regressions. First, the futures market variables are statistically significant when included in equations with other explanatory variables. If they are simply reflecting the response of the futures market to cash price volatility generated by other factors, they should not be significant when variables measuring these factors are also in the regression. In particular, the possibility that the futures variables are serving as proxies for general interest rate volatility or variations in the availability of GNMA securities can be ruled out. Second, if reverse causation is significant, futures price volatility should follow cash price volatility in responding to the same variables included in the cash market regressions. Columns (6) and (7) show regressions of near and far futures volatility on these variables. Only the near futures equation had any explanatory power, and this was due largely to the highly significant coefficient on bond market volatility. Coefficients on the other explanatory variables in both equations were statistically insignificant and unstable under alternative specifications. Both of these results suggest that the positive coefficients on the futures variables in equations (1) to (5) reflect causation running from futures market activity to price volatility in the cash market, rather than in the opposite direction.

III. Concluding Comments

The GNMA futures market has been one of the most successful of the new financial futures. It has extended the possibility of hedging interest rate risks on an important class of securities to a much wider group of investors and institutions. But, as was suggested in Section I, the real benefits from the futures market accrue mainly to the new participants who are not already active in the cash market. The existing dealer-oriented cash GNMA market provides hedging possibilities through forward contracts that are generally more attractive to those who regularly trade in that market.

The empirical evidence presented in Section II showed that price volatility in the GNMA cash market was related to several factors. Increased liquidity, measured by GNMA's outstanding and proxies for the volume of cash market activity, and lower average prices tended to stabilize the market, while futures market activity increased the volatility of prices.

Several possible reasons for this result were discussed, but we found no evidence of insufficient speculative activity in futures relative to hedging, and ruled out any likelihood of price manipulation because of the extensive safeguards against it. Instead we concentrated on the fact that futures prices are determined largely by the actions of new classes of traders who were likely to have less good information than the GNMA dealers who set prices in the cash market. When the additional "noise" in futures prices is transmitted to the cash market, price volatility increases. To some extent information differences may simply be due to relative inexperience of some futures traders with GNMA securities. If so, the effect should diminish as they become more seasoned. Still, one can not expect futures traders ever to have access to as complete information about cash market conditions as do the GNMA dealers.

It is important for these results to be viewed in perspective. While increased cash market volatility may be undesirable, in judging the overall value of the GNMA futures market it must be weighed against the significant benefits the market provides. The nature of cash market trading excludes all but the largest and most creditworthy institutions from the GNMA forward market. By substituting the performance guarantee of the exchange for that of the individual transactor, the GNMA futures market has extended the possibilities for hedging and risk management for an important class of securities to a much wider investor population. This broadening of the population of GNMA traders has opened the cash market to larger price fluctuations.

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