

## MONETARY POLICY SHOCKS AND REAL FARM PRICE: EVIDENCE FROM IDENTIFICATION SCHEME USING FEDERAL FUNDS RATE SHOCKS\*

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*This paper examines the effects of monetary policy shocks on the real farm price using VAR models in the U.S. This paper identifies monetary policy shocks with the Federal Funds rate shocks, instead of M1 shocks that have been frequently used in past studies on monetary policy shocks and farm price. The main results are: 1) contractionary monetary policy shocks significantly decrease the real or relative farm price in the short run; 2) although the overall contribution of monetary policy shocks on the real farm price is relatively small, monetary policy shocks were the dominant source of the real farm price fluctuations in a few historical episodes such as the early 80's farm financial crisis; 3) detailed dynamics of nominal and real farm price support the overshooting hypothesis only partially.*

JEL Classification: Q11, Q14, E52, C32

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### I. INTRODUCTION

The impact of monetary and macroeconomic shocks on agricultural markets may not be trivial. U.S. farm problems may not have solely come from agricultural market shocks themselves but from monetary and macroeconomic

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shocks. The early-1980's farm financial crisis following the monetary regime change was an important historical episode that made many economists rethink the importance of monetary policy shocks on agricultural markets. After the farm crisis, a number of economists studied the dynamic responses of the real farm price or the relative price of farm and non-farm sectors to monetary policy shocks and reported controversial empirical evidence. Beyond the academic controversy, two distinct results have entirely different policy implications. If monetary policy shocks do in fact have a substantial effect on the real or the relative farm price, a counteractive farm policy may be needed to keep the farm sector's real profits and purchasing powers stable by offsetting the changes in the real or the relative farm price in the presence of monetary disturbances. However, if not, a counteractive farm policy is not necessary and the monetary policy that stabilizes the general economy without much consideration to sector-specific impacts may be justified.

Past theoretical studies suggested two types of models in which monetary policy can affect the relative or the real farm price in the short-run. Some studies such as Lapp(1990) and Belongia (1991) suggested a "Barro-type" (see Barro (1976)) "misperception" model in which unexpected changes in money supply may affect the relative or the real farm price due to the differences in supply elasticities or income elasticities of demand between farm and non-farm sectors. Others such as Frankel (1986) and Stamoulis and Rausser (1988) suggested an "overshooting" model in which the flexible (nominal) farm price may overshoot the long run level in the presence of a sticky non-farm price or a sticky general price level under monetary policy shocks, and as a result, the relative or the real farm price may change.

There have been quite a few empirical studies (Chambers and Just (1982), Chambers (1984), Devadoss and Meyers (1987), Lapp (1990), Han, Jansen, and Penson (1990), Belongia (1991), Dorfman and Lastrapes (1996), and Issac and Rapach (1997)), on the issue, most of which have used VAR (Vector-Autoregression) models.<sup>1</sup> The empirical evidence in these studies is somewhat controversial, especially regarding whether monetary policy shocks have (statistically) significant effects on the real or the relative farm price. Some (e.g., Chambers (1984), Devadoss and Meyers (1987), and Dorfman and Lastrapes

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<sup>1</sup> Some studies (for example, Belongia (1991)) estimated the AR equation in money, and then regressed the residuals in that equation on the real or the relative farm prices. Others such as Han, Jansen, and Penson (1990) estimated a multivariate ARCH model. We can think of such models as branches of the VAR models.

(1996)) reported that monetary policy shocks affect the relative farm price significantly, whereas others (e.g., Lapp (1990), Belongia (1991), and Issac and Rapach (1997)) documented that the effects are not significant. On the other hand, there seems to be a recent consensus on the relatively weak overall contribution of monetary shocks on the relative or real farm price fluctuations. Recent studies such as Belongia (1991), Dorfman and Lastrapes (1996), and Issac and Rapach (1997), documented that monetary policy shocks explain less than 10 % of the real or the relative farm price fluctuations.

The main objective of this paper is to empirically re-investigate the various issues on the effects of monetary policy shocks on the real farm price, while improving on past studies in various aspects. First of all, we use an improved empirical model for identifying monetary policy shocks by using the Federal Funds rate shocks as the measures of monetary policy shocks, following the recent literature on identifying monetary policy actions (e.g., Bernanke and Blinder (1991), Sims (1992), Gordon and Leeper (1994), Christiano, Eichenbaum, and Evans (1996, 1999), and Kim (1999)). Past studies on the effects of monetary policy shocks on farm price have used broad monetary aggregate shocks (such as M1 shocks) as monetary policy shocks. However, recent studies on identifying monetary policy actions suggested that the Federal Funds rate shocks are better measures than broad monetary aggregate shocks. First, the FED's monetary policy operating procedure suggests that the Federal Funds rate is the monetary instrument that the FED controls directly, especially in recent periods. Second, the impulse responses of key macro variables to the Federal Funds rate shocks are more reasonable as monetary policy shocks than those to broad monetary aggregate shocks. Third, broad monetary aggregate shocks may not represent truly exogenous monetary policy actions since other structural forces such as money demand shocks and other financial market shocks also lead to changes in broad monetary aggregates.

In addition, we historically examine the contribution of monetary policy shocks on the real farm price. Past studies examined the overall role of monetary policy shocks for the full sample period, based on impulse response functions and/or forecast error variance decomposition. This paper further examines the role of monetary policy shocks in each historical episode, based on historical decomposition. As a result, we can address the role of monetary policy shocks during the period of particular interest such as the early 1980's farm financial crisis. Further, we examine whether there are any historical episodes or

sub-periods where monetary policy shocks were the dominant source of the real or the relative farm price fluctuations. The evidence is crucial since even if the overall contribution of monetary policy shocks is relatively small as claimed in the recent studies, we cannot simply disregard the role of monetary policy if there were such periods.

Finally, to examine the relevance of the two theories, we analyze the effects of monetary policy shocks on the nominal farm price and the general price level separately, along with the real farm price, even though most past studies examined the real or the relative farm price alone. By comparing the responses of the two prices, we examine whether the misperception model, which emphasizes the differences in the size of price reactions between farm and non-farm sectors, or the overshooting model, which emphasizes the differences in the speed of price adjustment between farm and non-farm sectors matches the data better. In addition, we investigate the nominal farm price dynamics more closely to address whether the nominal farm price overshoots the long run level and whether the maximum effect is found immediately as predicted by the overshooting model.

The remainder of this paper is organized as follows. Section II develops the empirical model to identify monetary policy shocks. Section III reports the empirical results on the effects of monetary policy shocks on farm price. Section IV concludes with the summary of results.

## II. IDENTIFYING MONETARY POLICY SHOCKS

In the literature on identifying monetary policy shocks using time-series models, progress has been made by recognizing that the identified monetary policy shocks in previous studies do not represent 'exogenous' monetary policy actions.<sup>2</sup> The literature examined whether the effects of identified monetary policy shocks on a minimum set of key macroeconomic variables (such as price, interest rate, and money) are consistent with the priors or consensus on the effects of monetary policy which are shared by most academic researchers. If they do not satisfy these minimum conditions, they are discarded because they more than likely represent other structural shocks than monetary policy shocks.

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<sup>2</sup> There is another stream of literature called the narrative approach such as Friedman and Schwartz (1963), and Romer and Romer (1989). Sims (1992), Hoover and Perez (1994), and Bermanke and Mihov (1998) among others discussed the (identification) problems of the narrative approach.

Identifying monetary policy shocks with broad monetary aggregate shocks (M0, M1, M2 *etc.*) has led to the “liquidity puzzle”. That is, positive monetary aggregate shocks (monetary *expansions*) tend to be associated with increases in interest rates, which are expected in monetary *contractions* (e.g., Reichenstein (1987) and Leeper and Gordon (1991)). Confronting the liquidity puzzle, Sims (1992) argued that broad monetary aggregate shocks reflect other structural shocks (especially money demand shocks) in addition to monetary policy shocks, and so they are not exogenous. Several researchers suggested other measures of monetary policy shocks that are less likely to reflect non-policy shocks. Bernanke and Blinder (1991) and Sims (1992) suggested innovations in short-term interest rates, while Eichenbaum (1992), Strongin (1995), Christiano, Eichenbaum, and Evans (1996) and others suggested narrow monetary aggregate shocks.<sup>3</sup>

Even after resolving the “liquidity puzzle”, previous studies suffered from the “price puzzle”, that is, positive interest rate shocks and negative narrow monetary aggregate shocks (monetary *contractions*) are associated with increases in the price level, which are expected in monetary *expansions*. Sims (1992) conjectured that these shocks reflect not only exogenous monetary policy shocks but also the monetary authority’s systematic responses to structural shocks generating inflationary pressures. After controlling such systematic monetary reactions by including some variables representing inflationary pressure such as the commodity price index in the model, research has resolved the price puzzle (see Sims and Zha (1995), Christiano, Eichenbaum, and Evans (1996, 1999), and Kim (1999))

Most past studies on farm price (e.g., Chambers (1984), Devadoss and Meyers (1987), Lapp (1990), Belongia (1991), Isaac and Rapach (1997)) identified monetary shocks with broad monetary aggregate (M1) shocks. However, based on recent developments in identifying monetary policy shocks, we can see that past studies in identifying monetary policy shocks on farm price may be misleading because the identified broad monetary aggregate shocks more than likely represent other structural shocks than monetary policy shocks, as reflected in the puzzling impulse responses of key macro-variables to broad monetary aggregate shocks.<sup>4</sup>

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<sup>3</sup> Another approach uses non-recursive VAR models by separating money demand and money supply shocks, for example, Gordon and Leeper (1994), Sims and Zha (1995), Bernanke and Mihov (1998), and Kim (1999).

In this paper, we identify monetary policy shocks with the Federal Funds rate shocks.<sup>5</sup> Further supports for our choice of the Federal Funds rate come from the FED's monetary policy operating procedures; the Federal Funds rate is the monetary instrument that the FED controls directly, especially in recent periods. As documented by some studies (such as Bernanke and Blinder (1991) and Friedman and Kuttner (1993)), Federal Funds rate shocks seem to be good measures of monetary policy stances based on the FED's monetary policy operating procedure.

The structure of the empirical model employed in this paper is based on Christiano, Eichenbaum, and Evans (1996, 1999). The model includes eight variables, {IP, CPI, PC, FFR, NBRD, TR, M1, X} (contemporaneously exogenous variables are ordered first), where IP is Industrial Production, CPI is Consumer Price Index, PC is the commodity price index, FFR is the Federal Funds rate, NBRD is the non-borrowed reserves plus extended credit, TR is total reserve, M1 is a monetary aggregate, and X is the variable under consideration.<sup>6</sup> The model assumes that the monetary authority sets the Federal Funds Rate with the information on current and lagged IP, CPI, and PC, and lagged FFR, NBRD, TR, M1, and X. For more details on the justification of the model structure, refer to Christiano, Eichenbaum, and Evans (1996, 1999).

To examine the effects on farm price, first we include the index of (nominal) price that farmers receive (as "X" in the model), which has been frequently used in past studies to represent the "farm price." In addition, to examine the effects on the real or the relative farm price, we include the ratio of the index of nominal price that farmers receive to CPI (as "X" in the model).<sup>7</sup> All variables are entered in logarithm form except for the Federal Funds rate.<sup>8</sup> The estimation period is from January 1965 to March 1997.<sup>9</sup>

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<sup>4</sup> The exception is Dorfman and Lastrapes (1996) using the long-run identification scheme.

<sup>5</sup> In the preliminary estimations, we experiment with narrow monetary aggregate shocks such as non-borrowed reserve shocks. However, in such systems, though we do not find a significant price puzzle, responses of basic prices (CPI, GDP deflator, and commodity price) are very weak (not very significantly different from zero), and the model does not seem to be appropriate to examine the responses of any other prices (in our case, farm prices).

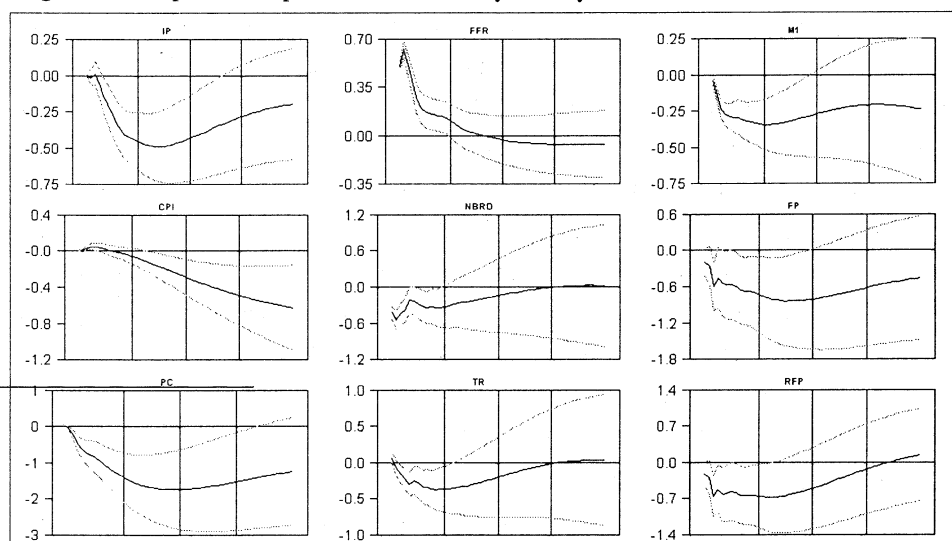
<sup>6</sup> The price index for sensitive materials is used, as in Christiano, Eichenbaum, and Evans (1996, 1999).

<sup>7</sup> The impulse responses of the other seven variables are almost the same in the model with the nominal farm price and the model with the real farm price.

<sup>8</sup> Regarding possible non-stationarity in the data, our statistical inference is not affected by the presence of non-stationarity such as unit roots and cointegration since we follow a Bayesian inference (see, Sims (1988) and Sims and Uhlig (1991)).

Figure 1 reports the impulse responses to contractionary monetary policy shocks (identified as positive Federal Funds rate shocks in our system) over a 48 month horizon. Dotted lines are 90% probability bands.<sup>10</sup> The responding variable names are noted at the top of each graph. The scale of percentage change is noted at the left of each graph. Vertical lines are inserted for each year after the shocks.

[Figure 1] Impulse Responses to Monetary Policy Shocks



First, we examine the impulse responses of the basic variables. In response to monetary policy shocks, FFR increases on impact, and then back to the original level in about one or two years. All monetary aggregates (NBRD, TR, and M1) decrease. IP decreases temporarily. CPI decreases over time. PC also decreases. All these changes differ from zero with 90% probability. These responses are broadly consistent with the priors or consensus on the effects of monetary policy

<sup>9</sup> The data source is the Federal Reserve Bank of St. Louis database (FRED) except for PC (Survey of Current Business) and farm price (DRI database). We also estimated the model with quarterly data. In the quarterly estimations, the model is {RGDP, PGDP, PC, FFR, NBRD, TR, M2, X}, where RGDP is real GDP and PGDP is the GDP deflator. The major results are similar. We report the monthly estimation results since the monthly model has weaker identifying assumptions, and can be treated as a more general model than the quarterly model. The contemporaneous exogeneity assumptions (embedded in the ordering of the VAR model) are weaker since monthly data implies only one-month exogeneity.

<sup>10</sup> Standard error bands are calculated from 500 draws following Doan.

on key macro variables that are shared by most academic researchers, therefore our choice of the Federal Funds rate shocks as monetary policy shocks is supported.

### III. EFFECTS OF MONETARY POLICY SHOCKS ON FARM PRICE

#### 3.1. Impulse Responses

Figure 1, under 'FP' and 'RFP' reports the impulse responses of the nominal and the real farm price to monetary policy shocks, respectively. In response to contractionary monetary policy shocks, the real farm price decrease by about 0.2% on impact, and further decreases up to 0.7% in a few months. The decrease in the relative farm price differs from zero up to about one and half years, with more than 90% probability. In about one and half years, the relative price starts to increase toward the initial level. In about four years, the relative farm price increases back to the initial level. Overall, the impulse responses suggest that (contractionary) monetary policy shocks decrease the relative farm price with statistical significance.

These results contrast some recent studies documenting the insignificant effects of monetary policy shocks on the real or the relative farm price and renders support to other studies documenting the significant effects. Notably, Isaac and Rapach (1997) documented that monetary shocks identified as M1 shocks do not have significant effects on the real or the relative farm price over similar sample periods, using several empirical models employed in past studies such as Devadoss and Meyers (1987), Lapp (1990), and Belongia (1991). The differences in results may come from the differences in the empirical model that identifies monetary policy shocks. In this regard, we claim that our results are more reliable since our empirical models using Federal Funds rate shocks are superior to the models using M1 shocks for the reasons that we discussed in the previous sections.<sup>11</sup>

We further investigate the dynamic responses of the nominal and real farm price to examine whether they are consistent with the predictions of the theoretical models. The misperception model suggested by Lapp (1990) and

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<sup>11</sup> Dorfman and Lastrapes (1996) identified monetary policy shocks without any puzzling responses of basic macro variables also reported the significant effect, which supports our claim that the insignificant effect in some past studies is likely to be due to the problems in the identification method.



Belongia (1991) emphasizes the differences in the size of price reactions in the farm and non-farm sectors, either due to the differences in the income elasticities of demand or due to the differences in the elasticities of supply in the farm and non-farm sectors. On the other hand, the overshooting model suggested by Frankel (1986) and Stamoulis and Rausser (1988) hinges on the differences in the speed of price adjustment in the farm and non-farm sectors; farm price is flexible while the general price level (or non-farm prices) is sticky.

From the dynamic responses of the nominal farm price and CPI, we can easily infer why the real farm price decreases. The general price level seems to be sticky, so that it decreases slowly over time while the nominal farm price responds more quickly and strongly. These dynamics are consistent with the theoretical underpinning of the overshooting model that the farm price is more flexible than the general price level.

The nominal farm price decreases about 0.2% on impact, and further decreases up to 0.8% over about one and half to two years. The decrease in the nominal farm price differs from zero for about two years with 90% probability. In about one and half to two years, the nominal farm price starts to increase, and as a result, the overall decrease is not very significant after two years. Overall, these dynamics do not seem to exactly match the predictions of the overshooting model. The overshooting hypothesis suggests that in response to contractionary monetary policy shocks, the nominal farm price decreases sharply on impact, but subsequently increases back to the long run level over time, that is, the maximum effect is expected to be found immediately. However, in our results, the nominal farm price further decreases after the impact. That is, the maximum effect is not found immediately following monetary policy shocks, which is not consistent with the overshooting hypothesis.<sup>12</sup>

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<sup>12</sup> The dynamic responses may be consistent with the undershooting case (for example, Stamoulis and Rausser (1988) provided a model that both undershooting and overshooting may occur). However, given wide probability bands of impulse responses at long horizons, we do not strongly argue that the responses are very much consistent with the undershooting case. On the other hand, some past studies on the effects of monetary policy shocks on the exchange rate (such as Eichenbaum and Evans (1995) and Kim and Roubini (2000)) also suggested that the empirical evidence is not exactly consistent with the overshooting hypothesis.

### 3.2. Variance Decomposition and Historical Decomposition

We examine the contribution of monetary policy shocks to the real farm price fluctuations. Table 1 reports the forecast error variance decomposition of the nominal and real farm price due to monetary policy shocks for 12, 24, 36, and 48-month horizons. The standard errors are also reported. Monetary policy shocks explain 7-9 % fluctuations in the real farm price. Though the role of monetary policy shocks in explaining the real farm price fluctuations is a bit larger than some past studies which reported a negligible role (e.g., Issac and Rapach (1997) and Belongia (1991)), still the overall contribution of monetary policy shocks to the relative farm price fluctuations is relatively small (less than 10%), consistent with recent studies documenting a relatively small role of monetary policy shocks.

[Table 1] Forecast Error Variance Decomposition due to FFR and M1 Shocks

Horizon	FFR Shocks		M1 Shocks	
	FP	RFP	FP	RFP
12 month	5.4	7.1	2.1	1.6
<i>St. Error</i>	3.9	5.1	2.2	1.8
24 month	9.1	8.1	2.9	3.2
<i>St. Error</i>	6.5	6.1	2.7	2.6
36 month	10.9	8.6	4.7	6.0
<i>St. Error</i>	7.9	6.7	3.7	6.4
48 month	11.6	8.9	6.1	7.5
<i>St. Error</i>	8.5	6.6	4.7	5.3

Based on such a small overall role of monetary policy shocks, some past studies concluded that monetary policy shocks do not matter much for the real farm price fluctuations. For example, Belongia (1991) concluded "VAR results consistently show that monetary innovations explain less than 10 percent of the forecast error variance of the farm/non-farm price ratio..... they are economically unimportant."

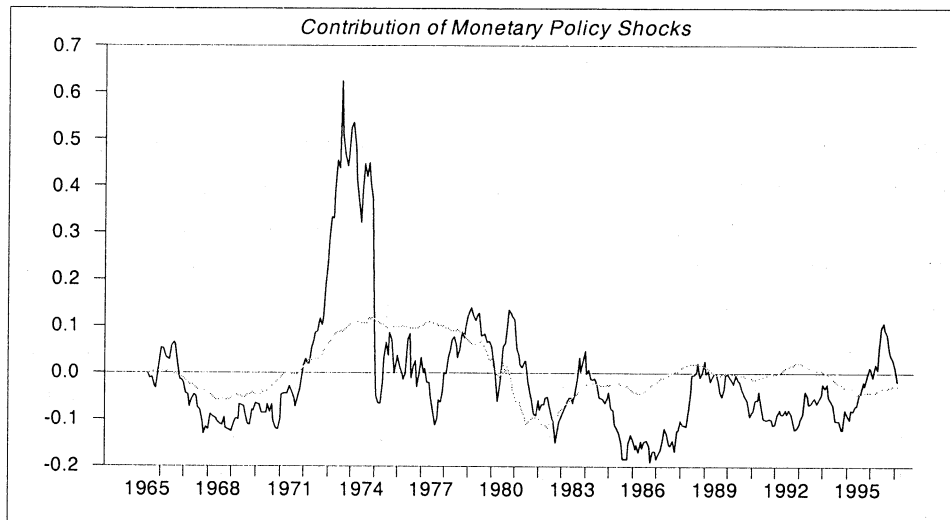
However, we cannot simply conclude that monetary policy shocks do not matter since there may be some sub-periods or episodes in which monetary policy shocks were very important. For example, if monetary policy shocks' role were crucial in a few episodes or if the early 1980's farm financial crisis was mainly due to monetary policy shocks, we may conclude that monetary policy shocks still matter for the real farm price fluctuations even though the overall

contribution is relatively small.

In order to further assess the role of monetary policy shocks in sub-periods, we use the historical decomposition. We decompose the historical values of the relative farm price series into a base projection of the model and accumulated effects of current and past structural disturbances. By this decomposition, the unanticipated movements of the relative farm price are attributed to each structural disturbance at each date, so that the proportion of monetary policy shocks explaining the forecast error of the relative farm price at each date can be examined.<sup>13</sup>

Figure 2 displays the historical decomposition of the real farm price over the whole sample period. The base projection is calculated at the initial date of the estimation. The solid line displays the forecast error of the real farm price series, and the dotted line displays the forecast error of the real farm price due to monetary policy shocks (or explained by monetary policy shocks).

[Figure 2] Historical Decomposition of Real Farm Price



<sup>13</sup> The historical decomposition is based upon the following partition of the (structural form) moving average representation  $y_{T+j} = \sum_{s=0}^{j-1} \Psi_s u_{T+i-s} + [X_{T+j}\beta + \sum_{s=j}^{\infty} \Psi_s u_{T+j-s}]$  where  $y$  is the data vector,  $u$  is the vector of structural disturbances, and  $X_{T+j}\beta$  is the deterministic part of  $y$ . The first term in the equation represents the part of  $y_{T+j}$  due to structural disturbances in periods  $T+1$  to  $T+j$  while the second term is the forecast for  $y_{T+j}$  based on information available at time  $T$ . Figure 3 plots the first term ( $T$  = initial date of the estimation), conditional on all shocks and conditional on only monetary policy shocks.

There are a few sub-periods where monetary policy shocks played a very important role. In the early 80's, the total forecast errors of the real farm price (solid line) and those due to monetary policy shocks (dotted line) are negative. Further, the size of the total forecast errors is roughly equal to the size of those due to monetary policy shocks in the early 80's. That is, monetary policy shocks explain most parts of negative forecast errors of the real farm price observed in the early 80's. The result is particularly interesting since it is consistent with the conventional notion that the early 80's farm crisis was due to monetary policy shocks. There are some other sub-periods in which monetary policy shocks played a dominant role in explaining the real farm price fluctuations. In the late 60's, monetary policy shocks explained about 50% of negative forecast errors of the real farm price.<sup>14</sup>

In conclusion, we find a few sub-periods in which monetary policy shocks were the dominant source of the relative farm price fluctuations. This result rejects the claim that monetary policy shocks are economically unimportant for the real farm price fluctuations.

#### IV. CONCLUSION

This paper examines the effects of monetary policy shocks on the real farm price using VAR models, improving on past studies in the following aspects. First, in contrast to past studies using broad monetary aggregate shocks (M1 shocks) as monetary policy shocks, we use the Federal Funds rate shocks, which may be a better measure of monetary policy stances. Second, we examine the role of monetary policy shocks in each historical episode, in addition to the overall role of monetary policy shocks that most past studies examined. Third, to examine the empirical relevance of theoretical models, we investigate the dynamic responses of the nominal farm price and the general price level separately, in along with the real farm price.

The result suggests that contractionary monetary policy shocks significantly decrease the real farm price and the effects are statistically significant. The

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<sup>14</sup> As a reference, we calculate one measure for those sub-periods (1967-1970, 1979-1983) and other sub-periods (1971-1978, 1984-1997): the ratio of the sum of squared forecast error to the sum of squared forecast error due to monetary shocks. The measure shows 0.23, 0.15, 0.78, and 0.06 for the periods of 1967-1970, 1971-1978, 1979-1983, and 1984-1997, respectively. This result is consistent with the conclusion that monetary policy shocks were important in explaining the movement of real farm price during the late 1960s, and especially in the early 1980s.

effects are more significant than some past studies using M1 shocks as a measure of monetary policy shocks. Further investigations suggest that the real farm price decreases in response to contractionary monetary policy shocks because the price level is sticky and reacts slowly whereas the farm price is more flexible and quickly reacts to monetary policy shocks, which is consistent with the theoretical underpinnings of the overshooting model. However, the exact dynamic responses of the nominal farm price are not consistent with the overshooting hypothesis. The maximum effect on the nominal farm price is not found immediately following monetary policy shocks.

The overall contribution of monetary policy shocks in explaining the real farm price fluctuations is relatively small (7-9 %), though it tends to be a bit larger than some findings in past studies. However, we find a few sub-periods in which monetary policy shocks were the dominant source of the real farm price fluctuations. One such episode of particular interests was the early 1980's, which is consistent with the conventional wisdom that the early 1980's farm crisis was mainly due to monetary policy shocks. This finding rejects the claim that monetary policy shocks are economically unimportant for the real farm price fluctuations.

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