The Effect of a Discount Rate on Price Change Behavior: An Empirical Analysis

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Abstract: This paper examines if there is any empirical evidence to support the results of a multi-period general equilibrium extension of Mankiw's menu cost model (Nath and Stretcher, 2003) that indicate that with high discount rates firms will be less likely to change prices in response to a monetary shock. Using the level of medium term real interest rates as a proxy for the discount rate and producer price indices for fifteen major commodity groups we examine how interest rates affect firms' decisions to change prices. Impulse responses calculated from a simple multivariate VAR model of producer prices and real interest rate suggest that except for a few commodity groups, namely 'farm products', 'processed foods and feeds', 'fuels, related products and power' and 'lumber and wood products', a higher interest rate seems to persuade most firms in the other commodity groups not to change prices.

Keywords: Discount rate; Menu cost; Multivariate VAR; Impulse response

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1. Introduction

It is by now a commonly accepted view among economists that nominal rigidities are the most apt characterization of the short run behavior of the economy. However, the theories that have been proposed to explain sluggish adjustments of prices and wages are varied and numerous. One of the theories that gained popularity among a section of economists in recent years suggests that firms are required to incur some costs to change prices. These costs are often associated with printing menus, and therefore referred to as 'menu costs'. According to this menu costs theory, since changing prices is costly, many firms do not respond immediately to a shock by changing prices, and as a result, real variables such as output have to bear the brunt. Some economists, however, cast doubts on this explanation because these menu costs are evidently small.

Mankiw (1991) uses partial as well as general equilibrium models to show that these small menu costs are in fact capable of producing large business cycles. Considering monopolistically competitive firms that set prices, he argues that though menu costs may be small, the incremental profits that result from price changes may be even smaller and, therefore, firms are better off by not changing prices in response to a demand shock. In Mankiw's model, the decision of the firm depends on a comparison between one-time menu costs and the change in single-period profit. Nath and Stretcher (2003) argue that if the firms consider changes in their future stream of profits (that would result from the decision to change price) then 'small menu costs' may not be able to dissuade them from changing prices. This extends the results of Stretcher (2002), which presents a partial equilibrium analysis of non-market clearing firm behavior to

show that introduction of the opportunity cost of capital to discount future incremental profits will reduce the ability of 'small menu costs' to generate large business cycles.

One of the implications of Nath-Stretcher extension of Mankiw Model is that with a high real interest rate (a proxy for discount rate), firms are less likely to change prices and with a low real interest rate they are more likely to change prices for given menu costs. In other words, small changes in the aggregate price level are associated with high interest rate and large changes are associated with low interest rate. This paper examines if there is any empirical evidence to support these results indicated by a multi-period general equilibrium extension of Mankiw's menu cost model (Nath and Stretcher, 2003). Using the level of medium term real interest rates as a proxy for the discount rate and producer price indices for fifteen major commodity groups, we examine how interest rates affect firms' decisions to change prices.

Simple correlation between the inflation-adjusted medium term interest rate and changes in the producer prices indicates significant negative or weak relationship only for a few commodity groups, and is not very informative. However, impulse responses calculated from a simple VAR model of producer prices and real interest rate suggest that except for a few commodity groups, namely 'Farm products', 'Processed foods and feeds', 'Fuels, related products and power' and 'Lumber and wood products', a higher interest rate seems to persuade most firms in other commodity groups not to change prices.

The following considerations should be taken into account while evaluating the contributions of this paper. First, there are no reliable data on menu costs for most industries in the economy. There have been only a handful of studies that collect and

analyze menu costs data for selected U.S. industries. Second, it would be more appropriate to use actual price data rather than price indices. Moreover, the fact that we use aggregate PPIs (which roughly correspond to 2-digit SIC industries) camouflages the underlying price movements, thus revealing little about individual firm's pricing behavior. Last but not least, if discount rate influences firm's pricing behavior via its use in calculation of present value of future profits, it is difficult to know which discount rates the firms actually use or if there are wide differences in discount rates used by different firms. In spite of these caveats, this paper is, to our knowledge, a first attempt in examining the effects of discount rates on the pricing behavior of the firms. The fact that there is some evidence of high interest rates persuading firms not to change prices also provides further encouragement for future research.

The rest of the paper is organized as follows. Section 2 discusses the theoretical background of the current empirical investigation. In section 3, we discuss data and empirical methodology. Section 4 presents the results, and provides an analysis of the results. In section 5, we include our concluding remarks.

2. Theoretical Background

Nath and Stretcher build a general equilibrium model which differs from the one in Mankiw (1991) in two ways: first, the representative consumer maximizes life-time utility that involves inter-temporal transfer of resources. Second and more importantly, the monopolistically competitive firm bases its decision to change price on a comparison of the menu costs either with the change in single-period profit, or with the discounted

present value of the changes in all future profits, depending upon whether it perceives the aggregate demand shock to be temporary or permanent.

In their model, the representative consumer maximizes her lifetime utility given by the following function:

$$U = \sum_{t=0}^{\infty} \beta^t \left((1-\phi)^{-1} \int_0^1 y_{i,t}^{1-\phi} di + \theta \log\left(\frac{M_t^d}{P_t} \right) - L_t \right) \quad (1)$$

where $0<\beta<1$ is the discount factor, $y_{i,t}$ is the quantity of good i she consumes in period t, ϕ is the reciprocal of the elasticity of substitution between different goods produced by the firms and $0<\phi<1$, M_t^d is her money demand in period t, P_t is the general price level, L_t is the labor supply, and θ is the money demand parameter ($\theta>0$). The general price level P_t is the geometric average of all $P_{i,t}$s, where $P_{i,t}$ is the nominal price of the good produced by firm i in period t, and is given as follows:

$$P_t = \exp\left(\int_0^1 \log P_{i,t} di \right) \quad (2)$$

The consumer faces the following budget constraint

$$\int_0^1 P_{i,t} y_{i,t} di + B_t + M_t^d = W_t L_t + R_{t-1} B_{t-1} + M_t + \Pi_t \quad (3)$$

where W_t is the nominal wage[3] in period t, B_t is the amount lent in period t, R_t is the interest rate in period t, M_t is the money supply and Π_t is the total profits of the firms.

Each firm produces its output using labor only, and the technology is given by the production function:

$$y_{i,t} = L_{i,t} \quad (4)$$

[3] Since labor is mobile across firms, nominal wage rate is the same in all firms.

where $L_{i,t}$ is the labor input used by firm i in period t. The firm faces a demand function implied by the utility maximization and the firm chooses $y_{i,t}$ and $P_{i,t}$ in each period such that its profit is maximized. The firm is also required to incur a cost to change price, the menu cost as represented by the following function:

$$z_{i,t} = g_t(i)\, W_t = g_t(i)\, \frac{M_t}{\theta} \tag{5}$$

The firm's decision to change price depends on a comparison of these costs with potential gains from such a change. Following a monetary shock that is perceived to be transitory, if $z_i > \left(\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right) W_1$, then firm i does not change its price. Here y_0 and y_1 are profit maximizing levels of output of firm i associated with two different levels of money supply *before* and *after* the monetary shock, and the expression on the right hand side of the inequality represents incremental profits that result from price change. However, if the monetary shock is perceived to be permanent, the decision to change price will depend on a comparison between z_i and discounted present value of incremental profits, $\left(\left[\left(y_0^{1-\phi} - y_1^{1-\phi}\right) - \left(y_0 - y_1\right)\right] \frac{1}{(1-\beta)}\right) W_1$.

Nath and Stretcher recognize that the single-period Mankiw model is consistent with an infinite discount rate (therefore future changes in profit are essentially zero in the present). Adjustment of the Mankiw model to include a reasonable (finite) discount rate results in the following conclusion: if the firms perceive the aggregate demand shock to be permanent they may require not 'small' but 'relatively large' menu costs to dissuade them from changing prices. In that case, their decision to change prices will depend on a comparison between one-time menu costs and discounted present value of all future incremental profits that would result from such price changes. Thus in this empirical

investigation we will focus on the case in which monetary shocks are perceived to be permanent.

3. Data and Empirical Approach

3.1 Data

We use monthly data on producer price index[4] (PPI hereafter) for 15 major commodity groups, for a period from January 1969 to October 2000. These are 2-digit commodity groups covering agriculture, forestry, mining and manufacturing - as defined by the Bureau of Labor Statistics (BLS). The data have been extracted from the ftp site for Producer Price Index maintained by the BLS. We also use monthly data on 1- year interest rate – interest rate on one-year treasury notes – for the same sample period, obtained from the Board of Governors, Federal Reserve System. Because we are interested in examining the effects of real *and not* nominal interest rate on the price change behavior, we calculate real interest rate by using the Fisher equation

$$r_t = i_t - \pi_t^e \tag{6}$$

where r_t is the real interest rate in period t, i_t is the nominal interest rate and π_t^e is the expected inflation in period t. Expected inflation rate, π_t^e, is defined as log first difference in PPI (for all items) between period $t+1$ and t.

Table 1 presents the summary statistics of price changes and real interest rate. As we can see from the table, 'fuels and related products' has the largest mean price change

[4] Because we are investigating the price setting behavior of the firms PPI is more appropriate than CPI or other price data. Ideally, we would like to use data on actual prices and not price indices, as set by the firms. Since it is difficult to find a comprehensive data set on actual prices we would be content with price index. Since price indexes are averages of all underlying prices which may vary in terms of their sluggish behavior, the following analysis that uses aggregate price indices will be indicative rather definitive.

over the sample period. It is also the most volatile commodity group. 'pulp, paper and allied products' and 'misc. products' are two other categories that experience relatively higher average price changes. In terms of volatility, 'farm products' are almost as volatile as 'fuels and related products'. Among other categories, 'lumber and wood products' and 'processed foods and feeds' are relatively more volatile than others.

3.2 Empirical Approach

As explained above, if the firms make decisions about changing prices based on a comparison between menu costs and the discounted present value of future profits then one would expect a negative correlation between real interest rate and changes in prices: high real interest rates will be associated with low price changes and low real interest rate with high price changes[5]. In order to have a very general idea of the nature of the relationship between real interest rate and price changes, we shall first calculate the correlation between $\pi_{i,t}$, the change in price of commodity *i* between period *t* and *t-1*, and r_{t-1}, the real interest rate in period *t-1*. Moreover, since the objective is to examine if the levels of real interest rate affect firm's decision to change price we are not interested in the direction of price changes. Rather we would be more interested in the magnitudes of price changes. Therefore, we shall also calculate the correlation between the absolute value of price changes and one period lagged real interest rate.

However, the correlation coefficient does not say much about the dynamics of a relationship between two variables and thus, may conceal important information about the effect of interest rates on the price change behavior. Therefore, we shall resort to a

[5] Ideally, high interest rates will be associated with no price change (price change = 0) and low interest rates will be associated with some nonzero price change (price change ≠ 0) if the predictions of the model are to be correct. Since we use price indices which are essentially weighted averages of various prices, it makes more sense to expect relatively 'low' and 'high' price changes in absolute terms.

more advanced time series technique to investigate the relationship between real interest rate and changes in prices. We shall examine the impulse response functions derived from a multivariate vector autoregression (VAR) model of different commodity prices and real interest rate. Intuitively, as we allow different prices and the real interest rate to interact among themselves in a multivariate VAR setting, we can find out from the impulse responses how sluggish different commodity prices are in response to a positive change in the real interest rate.

We use the following vector autoregression (VAR) model of commodity prices and real interest rate:

$$Y_t = \sum_{i=1}^{P} \Phi_i Y_{t-i} + \varepsilon_t \tag{7}$$

where: Y_t is a 16×1 vector of 15 PPIs and real interest rate[6] in period t; Φ_i a 16×16 matrix of coefficients of Y at lag i; ε_t is a 16×1 vector of white noise error terms. Note that i indexes the lag length and p is the maximum number of lags included in the VAR model. We shall use various information criteria (Akaike Information Criterion, Schwarze-Bayes Criterion, Hannan-Quinn Information Criterion) to select the appropriate lag length. Once we estimate the appropriate model, we use the parameter estimates to derive the impulse response functions. In particular, we are interested in the responses of PPIs to a one percentage point increase in real interest rate.

[6] Because we are not interested in the time series properties of the series at hand and are narrowly focused on how real interest rate affects pricing behavior, we are not worried about the order of integration for the data series we use in the VAR model. As Sims (1980), Doan (1992) and others argue, the goal of VAR analysis is to determine the interrelationships among the variables, *not* the parameter estimates. However, Augmented Dickey Fuller tests indicate that all prices are unit root processes and therefore, they need to be differenced for stationarity.

4. Results

In Table 2, we present the correlation coefficients between price changes and one period lagged real interest rates for each commodity group over the sample period. In column 2, we report the correlation coefficients of one period lagged real interest rate with the absolute value of price changes. A comparison between column 1 and column 2 reveals that only for 'processed foods and feeds' the correlation changes from 'highly statistically significant' to 'highly statistically insignificant'. Among others, for 'hides, skins, leather, and related products' and 'metals and metal products', the correlation coefficients changes from being negative to being positive though in both cases they continue to remain insignificant.

Only for 'farm products' and 'lumber and wood products', the correlation coefficient is significantly negative. Moreover, for commodity groups namely, 'processed foods and feeds', 'hides, skins, leather, and related products', 'fuels and related products and power' and 'metal and metal products' the correlation coefficients between absolute values of price changes and real interest rates are small and statistically insignificant, indicating week relationship. It seems to suggest that these prices do not respond to real interest rates in a systematic way. However, it may include cases in which no/small changes in prices are associated with large real interest rates which, in turn, will be evidence in support of the predictions of the model.

We also present the scatter plots of the absolute price changes and one period lagged real interest rates in Figure 1. Although for a few commodity groups there are some discernible patterns as reflected by the correlation coefficients, for most there are relatively fewer observations on high real interest rates being associated with low price

changes. In most cases the observations are concentrated around 5 percent for real interest rate, and price changes below 1 percent.

As discussed in the previous section, we would like to investigate the relationship between real interest rate and the price change behavior of the firms from a dynamic point of view. Therefore, we estimate a VAR of 15 PPIs and real interest rate. The first consideration in a VAR estimation is to select the appropriate lag length of the endogenous variables. The standard practice is to start with a reasonably long lag length and pare it down to the appropriate lag by looking at various information criteria (see Enders (1995) for a discussion). Since we use monthly data, we start with 12 lags and calculate Akaike Information Criterion (AIC), Schwarze-Bayes Information Criterion (SBIC) and Hannan-Quinn Information Criterion (HQIC). The values are reported in Table 3. The lag length with the lowest value of the relevant information criterion is considered to be the most appropriate. As we can see from the table, these criteria select three different lag lengths: SBIC selects a lag length of 1; HQIC selects 2 and AIC selects 12.

We estimate two specifications of the VAR model: with lag 1 and with lag 2. We then use the parameter estimates to derive impulse response functions for each of the 15 PPIs in response to a change in real interest rates. We examine the responses of these prices to a one percent point increase in real interest rate, in the period following the change. Intuitively, as the real interest rate increases the discounted value of all future profits will be lower and as a result it is more likely that fewer firms will change prices for given menu costs. The absolute values of changes in PPIs in response to a change in real interest rate derived from the estimates of both specifications of the VAR models are

reported in Table 4. As we can see from the table, except for 'Farm products', 'Processed foods and feeds', 'Fuels and related products and power' and 'Lumber and wood products', most changes are negligible. That seems to suggest that with higher real interest rates most firms in these commodity groups (other than the four mentioned above), are less willing to change prices.

We also present the graphs of the impulse response functions in Figure 2 and Figure 3 derived from the estimations of the two specifications of the VAR model respectively. As we can see from these figures, except for the four commodity groups mentioned above, none of the others experiences large changes in PPIs over 12 month time horizon. For 'fuels and related products and power' and 'lumber and wood products', the changes continue to get bigger over the 12 month time horizon. For 'farm products' and 'processed foods and feeds', on the other hand, the changes start getting smaller after a few months.

One should be extremely careful in interpreting the results. First, we have not explicitly talked about aggregate monetary shocks. Nor do we explicitly incorporate changes in money supply in our VAR model. Because all firms in the economy are subject to same monetary shock, except for its implications for relative price changes in the short run (which, by the way, may result from different degrees of price rigidities across firms/industries that we investigate here) we do not include the monetary variable in our model. Second, one underlying assumption of the menu cost model is that the firms are monopolistically competitive so that they can set prices. However, some firms may have little or no power to set prices. Accordingly, there may be wide differences in the degree of competitiveness among the industry groups. For competitive industries the

results may not be analyzed in the light of the predictions of Nath-Stretcher model. Moreover, as pointed out by Nath (2002), in the short-run, sector-specific factors play a dominant role for changes in prices of most commodity groups. Although such factors may include price setting behavior of firms with market power, they may also include other factors. Finally, the relationship between price changes and real interest rates may be characterized by important nonlinearity. For example, if interest rate is already relatively high an increase may be immaterial for price change behavior of the firms. On the other hand, at a relatively low level of real interest rate, this may not be the case. The estimated model in this paper does not make a distinction between these two cases. To capture such nonlinearity, we need a much richer framework. Nevertheless, the current study provides a very general idea about the effect of real interest rate on the price change behavior - which is indicative of empirical support for the predictions of Nath-Stretcher extension of Mankiw model.

5. Conclusion

This paper examines if there is any empirical support for the results of a multi-period general equilibrium extension of Mankiw's menu cost model (Nath and Stretcher, 2003) that indicates that with high discount rates firms will be less likely to change prices in response to a monetary shock. Using the level of medium term real interest rates as a proxy for the discount rate and producer price indices for fifteen major commodity groups we examine how interest rates affect firms' decisions to change prices in response to aggregate monetary shocks. However, impulse responses calculated from a simple VAR model of producer prices and real interest rate suggest that except for a few

commodity groups, namely ‘farm products’, ‘processed foods and feeds’, ‘fuels, related products and power’ and ‘lumber and wood products’, a higher interest rate seems to persuade most firms in other commodity groups not to change prices.

Possible extensions of this study will include similar analyses using more disaggregated price data, possibly actual price data. Further knowledge of various discount rates monitored by different firms or/industries will also be useful.

Table 1: Summary Statistics of Monthly Price Changes and Real Interest Rate : January 1969 – October 2000 (Variables are in percentages)

Commodity Groups	Mean	Standard Deviation	Minimum	Maximum
Farm Products	0.22 (0.13)	2.48	-8.22	21.17
Processed foods and feeds	0.30 (0.07)	1.30	-5.67	12.64
Textile products and apparel	0.22 (0.02)	0.38	-1.25	2.27
Hides, skins, leather, and related products	0.35 (0.05)	1.01	-2.50	8.54
Fuels and related products and power	0.54 (0.13)	2.50	-9.27	12.79
Chemicals and allied products	0.39 (0.04)	0.81	-1.52	6.37
Rubber and plastic products	0.28 (0.03)	0.54	-0.87	4.17
Lumber and wood products	0.36 (0.08)	1.49	-7.31	5.40
Pulp, paper, and allied products	0.43 (0.03)	0.62	-1.07	6.03
Metals and metal products	0.35 (0.04)	0.73	-1.08	4.24
Machinery and equipment	0.31 (0.02)	0.41	-0.27	2.97
Furniture and household durables	0.26 (0.02)	0.33	-0.40	2.48
Nonmetallic mineral products	0.38 (0.03)	0.50	-1.22	3.21
Transportation equipment	0.30 (0.03)	0.65	-3.99	3.53
Miscellaneous products	0.40 (0.05)	0.93	-6.88	7.47
Real interest rate	6.97 (0.14)	2.68	2.67	16.58

Note: Standard errors are in parentheses.

Table 2: Correlation of monthly price changes with one period lagged real interest rate: January 1969 – October 2000

Commodity Groups	Monthly price changes and real interest rate	Absolute value of monthly price changes and real interest rate
	(1)	(2)
Farm Products	-0.22***	-0.10**
	(-4.40)	(-2.02)
Processed foods and feeds	-0.18***	-0.04
	(-3.60)	(-0.79)
Textile products and apparel	0.14***	0.17***
	(2.80)	(3.42)
Hides, skins, leather, and related products	-0.06	0.04
	(-1.12)	(0.68)
Fuels and related products and power	-0.06	-0.01
	(-1.08)	(-0.28)
Chemicals and allied products	0.09*	0.11**
	(1.74)	(2.15)
Rubber and plastic products	0.15***	0.16***
	(2.90)	(3.14)
Lumber and wood products	-0.24***	-0.09*
	(-4.72)	(-1.76)
Pulp, paper, and allied products	0.16***	0.11**
	(3.24)	(2.20)
Metals and metal products	-0.01	0.02
	(-0.17)	(0.44)
Machinery and equipment	0.31***	0.29***
	(6.42)	(5.86)
Furniture and household durables	0.20***	0.22***
	(4.06)	(4.32)
Nonmetallic mineral products	0.12**	0.13***
	(2.44)	(2.59)
Transportation equipment	0.16***	0.20***
	(3.12)	(3.93)
Miscellaneous products	0.07	0.12**
	(1.35)	(2.32)

Notes: t-statistics for the test of significance of the correlation coefficients are in parentheses. The sample size is 382.
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

Table 3: Lag order selection criteria for appropriate VAR model of 15 PPIs and real interest rate in the U.S.: January 1969 – October 2000

Lag	AIC	SBIC	HQIC
0	81.50	81.67	81.57
1	25.39	28.26	26.53
2	23.93	29.52	26.15
3	24.11	32.40	27.40
4	24.20	35.20	28.57
5	24.26	37.96	29.70
6	24.24	40.66	30.76
7	24.35	43.47	31.94
8	24.31	46.14	32.98
9	24.36	48.90	34.11
10	24.03	51.28	34.85
11	23.68	53.63	35.57
12	23.28	55.94	36.25

Table 4: Changes in PPIs in response to real interest rate changes by 1 percent point

Commodity Groups	Lag length = 1	Lag length = 2
Farm Products	0.62	1.21
Processed foods and feeds	0.29	0.61
Textile products and apparel	0.03	0.01
Hides, skins, leather, and related products	0.08	0.05
Fuels and related products and power	0.26	0.61
Chemicals and allied products	0.03	0.04
Rubber and plastic products	0.02	0.02
Lumber and wood products	0.34	0.35
Pulp, paper, and allied products	0.02	0.05
Metals and metal products	0.05	0.07
Machinery and equipment	0.00	0.00
Furniture and household durables	0.02	0.05
Nonmetallic mineral products	0.01	0.00
Transportation equipment	0.01	0.02
Miscellaneous products	0.04	0.12

Figure 1: Scatter plots of Absolute Value of Price Changes and One Period Lagged Real Interest Rates January 1969 – October 2000

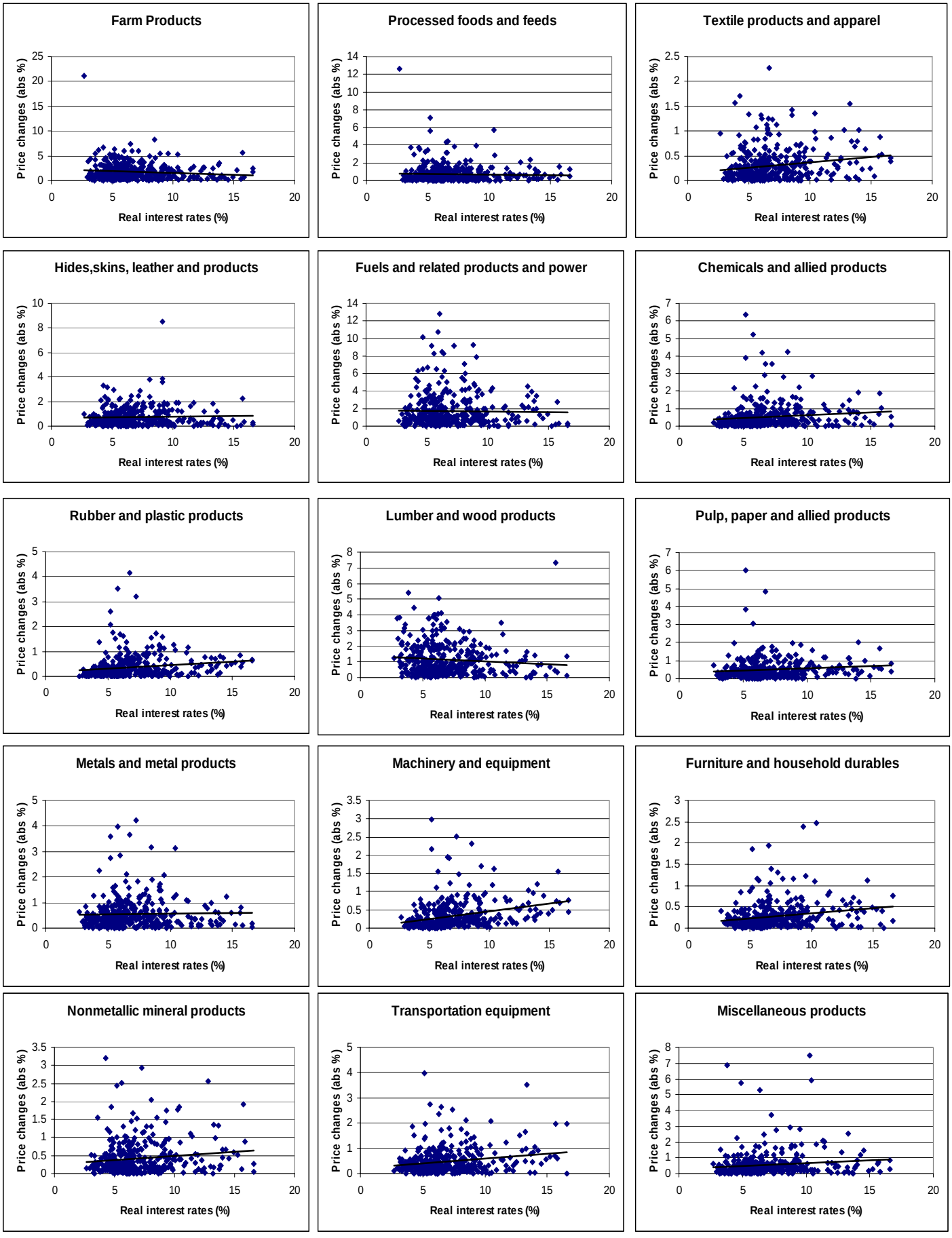


Figure 2: Impulse responses of 15 PPIs to a 1 percent point increase in real interest rate derived from estimated VAR with lag length 1

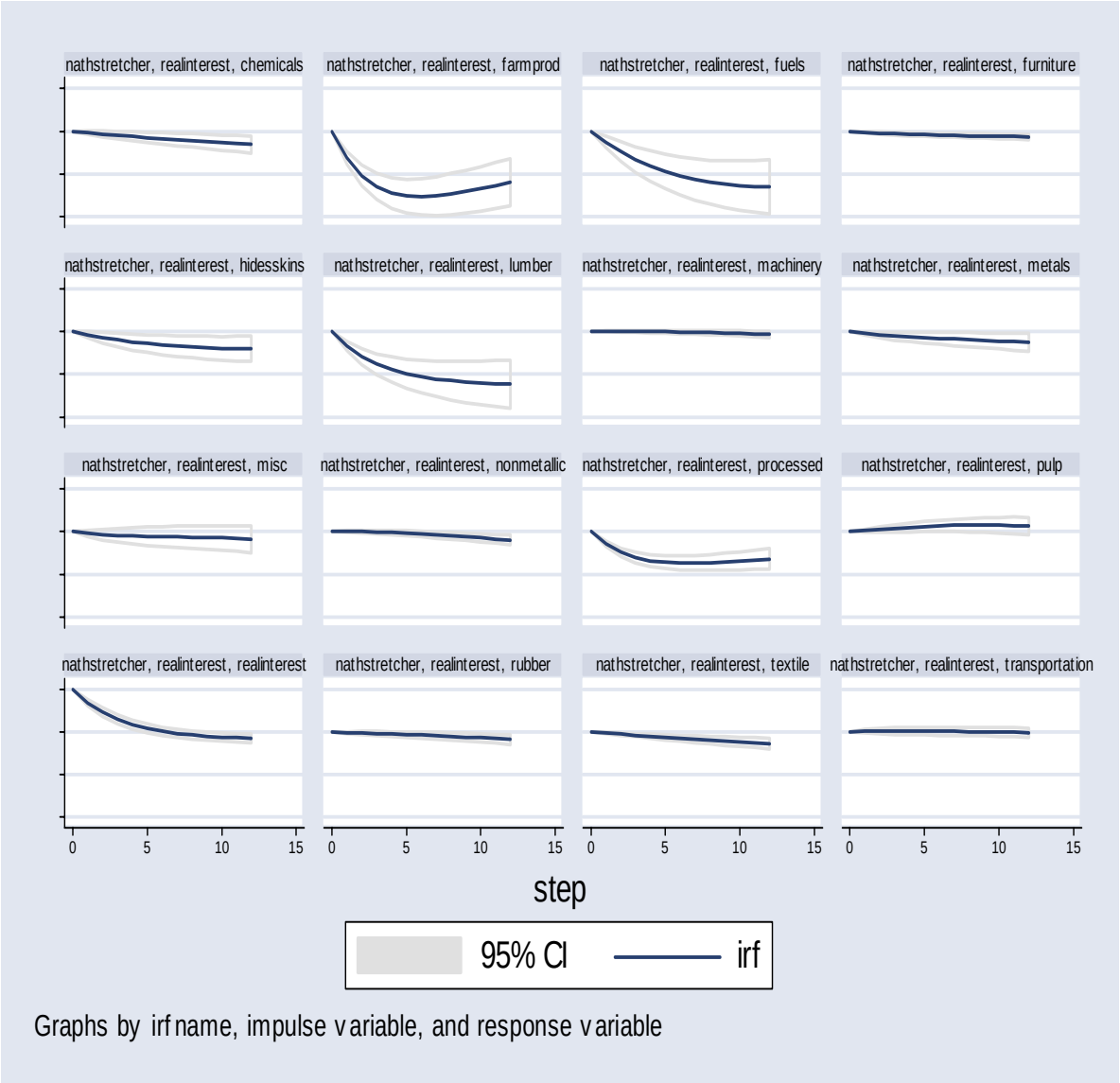
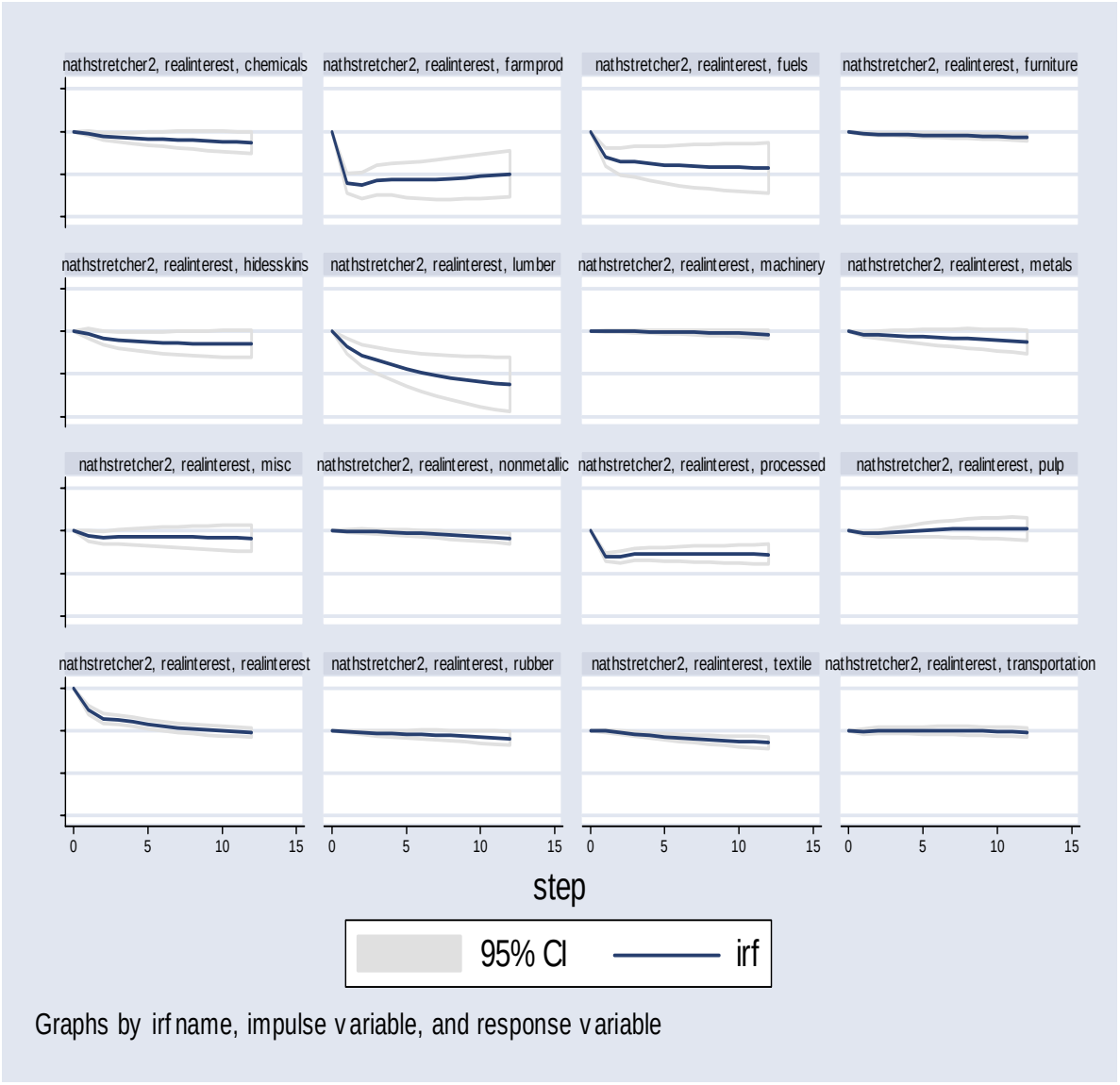


Figure 3: Impulse responses of 15 PPIs to a 1 percent point increase in real interest rate derived from estimated VAR with lag length 2



References

Blinder, Alan S, Elie E.D. Canetti, David E. Lebow and Jeremy B. Rudd, 1998, Asking About Prices: A New Approach to Understanding Price Stickiness. New York: Russell Sage Foundation

Doan, Thomas, 1992, RATS User's Manual. Evanston, Ill:Estima.

Enders, Walter, 1995, Applied Econometric Time Series, New York: John Wiley & Sons, Inc.

Mankiw, N. Gregory, 1991, *Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly*, in N. Gregory Mankiw and David Romer (eds): New Keynesian Economics, vol 1, Cambridge, MA: The MIT Press.

Nath, Hiranya K, 2002, *Relative Importance of Sectoral and Aggregate Sources of Price Changes*, manuscript.

Nath, Hiranya K., and Robert Stretcher, 2003 *Small Menu Costs and Large Business Cycles: An Extension of the Mankiw Model*. Proceedings: Academy of Economics and Economic Education Research, 2003.

Sims, Christopher, 1980, *Macroeconomics and Reality*, Econometrica 48, pp. 1-49.

Stretcher, Robert, 2002, *Discounting Price Rigidities*, Journal of Economics and Economic Education Research, vol. 3(2): 93-103.

Taylor, John B. 1998, *Staggered Price and Wage Setting in Macroeconomics*, NBER Working Paper # 6754, Cambridge, MA.