"Union-Nonunion Wage Differentials and Macroeconomic Activity"

by

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“Union-Nonunion Wage Differentials and Macroeconomic Activity*”

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Abstract

This research is concerned with identifying the differing responses of union and nonunion wages to shocks to real output growth, inflation, and the stance of monetary policy. Aggregate measures of union and nonunion wages and salaries are used to construct a time series of the wage differential for several major industrial sectors over the 1976-2001 period. The literature documents the existence of a union wage premium; however, previously the focus has primarily been at the micro-level, and on whether or not a union worker receives greater compensation than an otherwise comparable nonunion worker [e.g., Wunnava and Ewing (1999, 2000)]. Research also links the wage differential to the stage of the business cycle [Wunnava and Okunade 1996] and to the industrial sector [Okunade, Wunnava, and Robinson (1992)]. Theoretical macroeconomic models imply that wages will respond in certain ways to unanticipated changes in aggregate measures of economic activity [e.g., Romer (1996)]. Given the differences in compensation level of union and nonunion workers, and the link to the stage of the business cycle and industry, it is expected that the aggregate wage differentials both for the entire private sector and by industry will respond to macroeconomic shocks in a predictable manner. The relationship among these wage differentials and the macroeconomy is examined in the context of a vector autoregression. In addition, the paper employs the newly developed technique of *generalized* impulse response analysis [Koop, et al. (1996), Pesaran and Shin (1998)], a method that does not impose *a priori* restrictions on the relative importance that each of the macroeconomic variables may play in the transmission process. The results show the extent and the magnitude of the relationship between the union-nonunion wage differentials and several key macroeconomic factors. Finally, the paper documents how the responses of these wage differentials vary by industrial sector.

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"Union-Nonunion Wage Differentials and Macroeconomic Activity"

1. Introduction

This research identifies the differing responses of union and nonunion wages to shocks to real output growth, inflation, and the stance of monetary policy. The literature documents the existence of a union wage premium; however, previously the focus has primarily been at the micro-level, and on whether or not a union worker receives greater compensation than an otherwise comparable nonunion worker [e.g., Wunnava and Ewing (1999, 2000)]. Research also links the wage differential to the stage of the business cycle [Wunnava and Okunade 1996] and to industrial structure [Okunade, Wunnava, and Robinson (1992)].

Theoretical macroeconomic models imply that the response of employment to changes in aggregate measures of economic activity depends on the degree to which wage and price rigidities exist [e.g., see Romer (1996)]. For example, in explaining the labor market dynamics of Keynesian-type models when wages are rigid relative to output prices, Sargent (1987) shows that employment rises with an increase in the price level.[1] Sargent goes on to say that "sticky" money wages might occur in the presence of long term labor contracts, such as those often found in the union sector. Certainly, it is possible that the degree to which this stickiness exists differs by union and non-union status as well as by economic sector. Given the differences in compensation level of union and nonunion workers, and the link to the stage of the business cycle and industry, it is expected that the response of union-nonunion wage differentials to macroeconomic shocks may vary by industrial sector.

The relationship between the union-nonunion differential and macroeconomic factors is examined by computing *generalized* impulse response functions derived from the estimation of vector autoregression models.[2] These response functions allow us to compare and contrast the effects of unanticipated changes in the macroeconomic factors on the wage differential within an industrial sector as well as between industrial sectors. An innovation to any of the variables may be interpreted as (unexpected) economic *news*. Clearly, firms and workers, and thus the wage gap, may be affected by movements in any of these macroeconomic variables. Knowledge of what leads to movements in the union-nonunion wage gap and how long shocks may last, might be of concern to workers, firm owners and managers, as well as and policymakers.

2. Macroeconomic Factors and the Union-Nonunion Wage Differential

An event (i.e., economic news) that affects either the union labor market or the nonunion labor market, should influence the union-nonunion wage gap. At the aggregate level, the stage of the business cycle – whether the economy is in a growth period or recession – affects demand for labor. Therefore, news about upturns (downturns) in the

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[1] This simple analysis assumes diminishing marginal product of labor and no adjustment costs.

[2] The paper employs the recently developed econometric technique of generalized impulse response analysis [Koop et. al (1996); Pesaran and Shin (1998)].

economy should correspond to a general rise (fall) in labor demand. Hsing (2001) and Neumark and Wachter (1995) discuss the behavior of union wages vis-à-vis non-union wages during different stages of the business cycle. When the economy is near full employment, an increase in union wages may place upward pressure on nonunion wages due to the threat effect. During a recession, firms have an incentive to lay off high paid union workers in an effort to lower costs. However, the accompanying increase in the pool of labor may lower nonunion wages. Consequently, changes in real output can be expected to affect the union-nonunion wage gap. Moreover, a number of papers have suggested a relationship between aggregate economic activity and the union-nonunion wage gap. For example, Medoff (1979) and Wachter (1986) suggest a countercyclical wage gap based on theories of wage rigidities in long-term union contracts as well as the prevalence of union seniority rules for assigning layoffs in recessions. In contrast, Rees (1989) suggests that recessions induced by price shocks may widen the wage gap. Moreover, it is possible that the wage gap is unresponsive to the business cycle, either because firms are able to adjust their employment of labor and productive factors at relatively low cost or because nominal price and wage rigidities do not exist, as might be suggested by real business cycle models. Since union representation and strength varies by industry, the effect of changes in real output on aggregate measures of the wage gap should be examined by industrial sector [Okunade, Wunnava, and Robinson (1992)].

The expected rate of inflation affects the real wage and would, therefore, affect employment decisions. In the presence of nominal wage rigidity, an inflation shock lowers the real wage. If constraints such as contracts, etc. make union compensation less flexible than nonunion compensation, then the fall in the real wage of nonunion workers will exceed that of the union workers and the wage gap will widen. Note that the widening may occur with a lag in the presence of contracts and employment wage agreements or when wages are set at the beginning of the period, as in Sargent's (1987) depiction of the Keynesian model. Over time, as contracts are renegotiated new wage agreements are made, the money wage is expected to adjust upward and the equilibrium real wage is restored. Furthermore, there is another avenue in which inflation shocks may affect the wage gap. Unanticipated inflation, by creating volatility and uncertainty in price changes, may restrict production activity and, thus, firm hiring. Union firms may have less ability to optimally adjust employment levels due to seniority or layoff rules and contract provisions. Consequently, if low wage (short tenure) union workers and nonunion workers are the first to be let go, then the wage gap should widen. Moreover, if it takes some time for the price uncertainty to be resolved, perhaps as economic information is revealed and processed by agents, then the response of the wage gap to the inflation shock may persist for a number of periods.

Thorbecke (1997) and Ewing (2001) argue that money may have real effects and that monetary policy may represent a significant source of business cycles. Tighter monetary policy tends to reduce aggregate demand through an interest rate effect and, in the presence of rigidities, output falls and employment is affected. In general, a rise in the fed funds rate places upward pressure on rates to rise. In the short run, the fed's actions may have a more pronounced effect on nonunion wages than on union wages. If nonunion wages fall relatively more than union wages, the differential becomes wider. This might be the case if union firms face restrictions on their ability to optimally adjust employment levels. Thus, it is expected that the wage gap will rise with a sudden monetary tightening, and the response will be more pronounced in those sectors that are sensitive to interest rate movements.

As the above discussion attests to, the union-nonunion wage gap may be linked to macroeconomic factors. This paper adds to the literature on unions and macroeconomic activity by providing insight into the response of the wage gap to innovations in real output growth, monetary policy, and inflation.

3. A Simple Reduced-Form Model of the Union-Nonunion Wage Differential

In this section, we briefly outline a reduced-form model of the union-nonunion wage differential derived from general specifications of supply and demand in the market for union and nonunion workers. We specify supply and demand in the nonunion worker market as follows:

$$N^S = N^S(X^{NS}, w_N) + \nu^{NS}$$

$$N^D = N^D(X^{ND}, w_N, (w_U\text{-}w_N)) + \nu^{ND}$$

where X^{NS} and X^{ND} are vectors of exogenous variables which affect the supply and demand for nonunion workers, respectively, w_N is the nonunion (log) real wage and w_U is the union (log) real wage. ν^{NS} and ν^{ND} are shocks to supply and demand for nonunion workers that are assumed to have zero mean and are uncorrelated.

Similarly, the supply and demand for union workers may be represented as:

$$U^S = U^S(X^{US}, w_U) + \nu^{US}$$

$$U^D = U^D(X^{UD}, w_U, (w_U\text{-}w_N)) + \nu^{UD}$$

where X^{US} and X^{UD} are vectors of exogenous variables which affect the supply and demand for union workers. ν^{US} and ν^{UD} are shocks to supply and demand that are assumed to have zero mean and are uncorrelated.

The underlying structural equations can be solved to obtain the reduced-form equation for the union-nonunion wage differential:

$$GAP = (w_U\text{-}w_N) = F(X^{NS}, X^{ND}, X^{US}, X^{UD}) + E$$

The size of the wage gap will respond to changes in the exogenous variables that affect supply and demand in the markets for union and nonunion workers. Based on the reasons given above, we treat real output growth, inflation, and the stance of monetary policy as these variables.

4. The Data

Shocks to real output, monetary policy, and inflation are examined over the period 1976Q3 through 2001Q1 to see how union-nonunion wage differentials respond to innovations in these macroeconomic variables.[3] Following the work of Bernanke and Blinder (1992), Thorbecke (1997), and Ewing (2001), we use changes in the fed funds rate as a proxy for the stance of monetary policy. The consumer price index for all urban consumers is used to compute the inflation rate [Park and Ratti (2000)]. Real economic activity is gauged by the growth rate in real gross domestic product. We use the Employment Cost Index (ECI) series for wages and salaries of (private industry) union workers and nonunion workers to construct the union-nonunion wage gaps. Wage gaps are computed for total private industry, goods-producing industries, manufacturing industries, non-manufacturing industries, and service-producing industries. Each ECI index is seasonally adjusted. The five wage gaps are defined as the log difference between wages and salaries of union workers and nonunion workers. Thus, the quarterly data consist of changes in the fed funds rate, growth in real gross domestic product, consumer price inflation, and five union-nonunion wage differentials. All data were extracted from the Economagic database. Table 1 provides more detailed information on data and variable definitions.

Table 2 presents descriptive statistics for the variables. Somewhat surprisingly, the largest mean wage gap is found in service-producing industries while the smallest is in manufacturing. Table 3 shows the associated estimated (contemporaneous) correlation matrices. Generally speaking, union-nonunion wage gaps are negatively correlated with changes in real output and positively correlated with inflation. Monetary policy changes are negatively correlated with the wage gaps in non-manufacturing and service-producing industries as well as with (total) private industry. In contrast, monetary policy is positively correlated with the wage gaps in manufacturing and goods-producing industries.

5. Tests of Stationarity

The proper specification of a vector autoregression (VAR) model depends on the univariate properties of the variables under investigation. In particular, it is important to ascertain the data generating process of each series. The purpose of this section is to make a distinction between a trend stationary process and a unit root process. In the former case, the (perhaps detrended) level of a series would be appropriate to use in the VAR, while if the series has a unit root, it is necessary to first-difference the series to render a stationary process. Further, if two or more series are each integrated of order one (e.g., contain unit roots), it is possible that a linear combination of them is stationary. In this case, the appropriate VAR to be estimated would be of the class of error correction models.

[3] The raw data series start before this date but due to data transformations (e.g., growth rates) the usable or adjusted sample period begins in 1976Q3.

In order to determine whether or not a series is stationary, we perform unit root tests based on the method of Dickey and Fuller (1981). The augmented Dickey-Fuller test (ADF) is used to check for the presence of unit roots and is based on the ordinary least squares regression of equation (1).

$$(1) \qquad \Delta X_t^j = \rho_0 + (\rho_1 - 1) X_{t-1}^j + \rho_2 t + \sum_{k=1}^{m} \alpha_k \Delta X_{t-k}^j + e_t$$

where X^j is the individual series under investigation, Δ is the first-difference operator; t is a linear time trend, e_t is a covariance stationary random error and m is determined by Akaike's information criterion to ensure serially uncorrelated residuals. The null hypothesis is that the variable is a nonstationary time series and is rejected if $(\rho_1\text{-}1) < 0$ and statistically significant. The finite sample critical values for the ADF test developed by MacKinnon (1991) are used to determine statistical significance.

An alternative unit root test developed by Phillips and Perron (1988) allows for weak dependence and heterogeneity in the error term and is robust to a wide range of serial correlation and time-dependent heteroskedasticity. The test is based on the following regression:

$$(2) \qquad X_t^j = \eta_0 + \eta_1 (t - T/2) + \lambda X_{t-1}^j + v_t$$

where $(t\text{–}T/2)$ is the time trend with T representing the sample size and v_t is the error term. The null hypothesis of a unit root, H_o: λ=1, is tested against the alternative hypothesis that X_t^j is stationary around a deterministic trend (H_a: λ<1). As in the ADF test, MacKinnon critical values may be used to determine statistical significance for the Phillips-Perron test.

The results of the unit root tests are presented in Table 3. The first-difference of each wage gap measure is stationary and, thus, a shock to a change in the union-nonunion wage gap will revert to the mean. Consistent with previous research, such as Ewing (2001) and Park and Ratti (2000), GROWTH, MPOLICY, and INF[4] are all found to be stationary series.[5]

6. Vector Autoregression and Generalized Impulse Response Analysis

Dynamic analysis of vector autoregressive (VAR) models can be conducted using innovation accounting methods such as impulse response functions. However, this method has been criticized because results from impulse response analysis are subject to the "orthogonality assumption" and may differ markedly depending on the ordering of the variables in the VAR [Lutkenpohl (1991)]. To overcome this problem, we employ the

[4] The results for INF are not as clear as the those for the other variables. However, given the findings of Engle (1982), the Phillips-Perron test is probably more appropriate than the ADF for the case of inflation.

[5] It was determined that the variables were not cointegrated. The results of Johansen-Juselius cointegration tests, which allowed for deterministic trends in the (levels of the variables), are available on request.

"generalized" impulse response function developed by Pesaran and Shin (1998) and Koop, et. al (1996). This method is not sensitive to the ordering of the variables in the VAR. Ewing, Levernier and Malik (2002) provide additional explanation on the use of this method.

Pesaran and Shin (1998) describe the generalized impulse response analysis in the following way.[6] Consider the infinite moving average representation of the VAR:

(3) $$\mathbf{x}_t = \Sigma_{j=0}^{\infty}\mathbf{A}_j\mathbf{u}_{t-j}$$

where $\mathbf{x}_t$ is an m×1 vector of the variables under investigation, $\mathbf{A}_j = \Phi_1\mathbf{A}_{j-1} + \Phi_2\mathbf{A}_{j-2} + \ldots + \Phi_p\mathbf{A}_{j-p}$, j = 1, 2, …, with $\mathbf{A}_0 = \mathbf{I}_m$ and $\mathbf{A}_j = \mathbf{0}$ for $j < 0$.[7]

Let us denote the generalized impulse response function (G) for a shock to the entire system, $\mathbf{u}^0_t$, as:

(4) $$G_{\mathbf{s}} = \mathrm{E}(\mathbf{x}_{t+N}\,|\,\mathbf{u}_t = \mathbf{u}^0_t\,,\,\Omega^0_{t-1}) - \mathrm{E}(\mathbf{s}_{t+N}\,|\,\Omega^0_{t-1})$$

where the history of the process up to period t-1 is known and denoted by the information set Ω^0_{t-1}. Assume $\mathbf{u}_t$ N(0, Σ), and $\mathrm{E}(\mathbf{u}_t\,|\,u_{jt} = \delta_j) = (\sigma_{1j}, \sigma_{2j}, \ldots, \sigma_{mj})'\sigma^{-1}_{jj}\delta_j$, where $\delta_j = (\sigma_{jj})^{-1/2}$ denotes a one standard error shock. Further, $\mathbf{e}_i$ is m×1, with the *i*th element equal to one and all other elements equal to zero. The generalized impulse response function for a one standard deviation shock to the *i*th equation in the VAR model on the *j*th variable at horizon N is:

(5) $$G_{ij,N} = (\mathbf{e}'_j\mathbf{A}_N\Sigma\mathbf{e}_i) / (\sigma_{ii})^{1/2}\quad,\qquad i,j = 1, 2, \ldots, m$$

A key feature of the generalized impulse response function is that the generalized responses are invariant to any re-ordering of the variables in the VAR.[8] Thus, the generalized impulse response function provides more robust results than the orthogonalized method. Another key feature is that, because orthogonality is not imposed, the generalized impulse response function allows for meaningful interpretation of the initial impact response of each variable to shocks to any of the other variables.

7. Discussion of Results

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[6] For a more detailed discussion, including proofs, see Pesaran and Shin (1998). Additional background material on the development of generalized impulse response analysis can be found in Koop, et. al. (1996).

[7] The traditional orthogonalized impulse response employs a Cholesky decomposition of the positive definite m×m covariance matrix, Σ, of the shocks ($\mathbf{u}_t$).

[8] Pesaran and Shin (1998) state that "generalized impulse responses are unique and fully take account of the historical patterns of correlations observed amongst the different shocks." (p. 20). Thus, they caution against using orthogonalized responses since there is generally no clear guidance as to which of many possible parameterizations to employ. Note that generalized and orthogonalized impulse responses coincide only when the covariance matrix is diagonal.

A total of five vector autoregressions were estimated, one for each wage gap measure. Each VAR contained the four equations corresponding to MPOLICY, INF, GROWTH, and the particular ΔGAP. A constant term was included in each equation. The order of each VAR was determined to be one based on Akaike's information criterion, Schwartz Bayesian criterion, and likelihood ratio tests. If the shocks to the respective equations in a VAR are contemporaneously correlated, then orthogonalized and generalized impulse responses may be quite different. Re-ordering the variables may lead to a number of vastly different conclusions based on orthogonalized responses. Thus, before proceeding to an examination of the dynamic responses of the union-nonunion wage gaps to macroeconomic shocks, we performed tests to determine if innovations in the four individual equations in each of the VARs were contemporaneously correlated. The null hypothesis is that the off-diagonal elements in the covariance matrix equal zero and is tested against the alternative that none of the off-diagonal elements is equal to zero. Log-likelihood ratio test statistics are computed as $LR = 2(LL_u – LL_r)$ where LL_u and LL_r are the maximized values for the log-likelihood functions for the unrestricted and restricted models, respectively.[9] The LR statistic is distributed χ^2 with 4 degrees of freedom and was significant at less than the 5% level for each case examined. Thus, it is appropriate to examine generalized impulse response functions.

Figures 1-5 present the generalized impulse response functions and are plotted out to the tenth quarter. Figure 1 shows the response of the change in the (total) private industry union-nonunion wage gap to one standard deviation shocks to ΔGAPPI, GROWTH, MPOLICY, and INF. As can be seen in Figure 1, an unexpected positive change in the private industry wage gap fully dissipates after one quarter.[10] Neither a sudden monetary tightening, as evidenced by an unanticipated rise in the fed funds rate, nor a shock to real output growth have a significant effect on ΔGAPPI. In fact, the only significant response occurs from a shock to INF, and that occurs with a lag. The response becomes positive and significant after one quarter and lasts for about 5-6 quarters before dying out.

The responses of ΔGAPGP to macroeconomic shocks are shown in Figure 2. Similar to the case of private industry, a real output growth shock does not significantly affect the change in the goods-producing wage gap. However, the response of ΔGAPGP to a monetary policy shock is actually negative and significant one quarter after the shock then, as expected, becomes positive and significant for two quarters. This suggests that Fed actions can affect the union-nonunion wage gap in the goods-producing sector. Moreover, the unexpected monetary tightening leads to an observed "cycling" of the wage gap. This type of response to monetary shocks of economic aggregates is found in many macroeconomic models that incorporate expectations that rely on a standard IS-LM framework with predetermined prices. A significant impulse response to MPOLICY

[9] LL_u is the system log-likelihood from the VAR and LL_r is computed as the sum of the log-likelihood values from the individual equations in the VAR.

[10] Significance is determined by the use of confidence intervals representing plus/minus two standard deviations. See Runkle (1987) for a discussion on confidence intervals.

suggests that firms in the goods-producing sector are sensitive to interest rate changes. In particular, the labor market responses of firms in this sector may results from a reliance on such things as inventory financing. A rise in borrowing costs and thus the use the user cost of capital, as would be the case with a monetary tightening, may alter the optimal labor-capital mix. If firms in this sector respond by increasing union worker hours and employment relative to that of nonunion workers, then the wage gap should rise. The initial impact of an inflation shock on the goods-producing industry wage gap is insignificant but is positive and significant at one quarter following the shock. The effect of an inflation shock occurs with a short lag and lasts for 5-6 quarters. As in the case of private industry, the own impulse response lasts for one quarter.

Figure 3 presents the responses of change in the manufacturing sector wage gap to the macroeconomic shocks. The responses are quite similar to those found in the goods-producing sector with few exceptions. A shock to GROWTH has no effect, while a shock to MPOLICY has a positive effect following a two quarter lag. The MPOLICY effect then lasts for about 4-5 quarters (i.e., up to about 7 quarters following initial impact). As in the case of the goods-producing wage gap, we attribute the response of the manufacturing sector wage gap to an unanticipated monetary tightening to these firms' interest rate sensitivity. Like the goods-producing sector, the response of ΔGAPGP to an inflation shock is positive and significant following a one quarter lag. The response is a bit stronger than that found in the goods-producing sector but persists for about the same length of time. Similar to the other wage gaps, the own impulse response lasts for one quarter.

Figure 4 shows how ΔGAPNMF responds to macroeconomic shocks. In contrast to the other sectors, the non-manufacturing wage gap falls with a real output shock. In particular, the response is negative and significant one quarter after the shock and remains significant for about one quarter. This finding is consistent with the countercyclical wage gap theories. No significant response is found for MPOLICY suggesting that the labor market actions of firms in this sector are relatively insensitive to interest rate changes.. The wage gap responds positively and significantly to an inflation shock, after a two quarter lag. The inflation effect, while smallest in magnitude compared to the other sectors, persists for around four quarters. As with the other wage gaps, the own impulse response lasts for one quarter.

The response to macroeconomic shock of changes in the service-producing union-nonunion wage gap is presented in Figure 5. Shocks to GROWTH and to MPOLICY are insignificant, while an inflation shock is significant and positive following a two quarter lag. The inflation effect persists for only about three quarter and is the shortest in duration of all the sectors. The relatively faster dissipation of inflation shocks suggests that the firms in the service-producing sector exist in a competitive market environment in which prices changes are absorbed into wages more quickly. Consistent with the other wage gaps, the own impulse response for this sector lasts for just one quarter.

8. Concluding Remarks

This paper has examined and documented the response of union-nonunion wage differentials to shocks in three key macroeconomic variables using the newly developed technique of generalized impulse response analysis. The technique is robust in terms of the choice of ordering variables in the VAR, thus one can accurately examine and compare both the severity and extent of shocks to these variables on the wage gaps. The results add to the literature on the relationship between the macroeconomy and the union-nonunion wage gaps.

The results can be summarized as follows. For each sector as well as the total private industry, an inflation shock leads to a widening of the wage gap and occurs after a short lag and may last for several quarters. Generally speaking, a monetary policy shock is associated with a wider gap, which appears only after a couple of quarters, in each sector (and overall) except non-manufacturing and service-producing industries. Finally, growth shocks are found to be significant and negative only in the non-manufacturing sector.

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Table 1

Variable Definitions

GAPGP	log difference between (seasonally adjusted) wages and salaries of union workers and nonunion workers in goods-producing industries
GAPMF	log difference between (seasonally adjusted) wages and salaries of union workers and nonunion workers in manufacturing industries
GAPNMF	log difference between (seasonally adjusted) wages and salaries of union workers and nonunion workers in non-manufacturing industries
GAPPI	log difference between (seasonally adjusted) wages and salaries of union workers and nonunion workers in (total) private industry
GAPSP	log difference between (seasonally adjusted) wages and salaries of union workers and nonunion workers in service-producing industries
GROWTH	growth rate in (seasonally adjusted) Gross Domestic Product, billions of chained 1996 dollars, computed as $(x_t-x_{t-1})/(x_{t-1})$
MPOLICY	change in the federal funds rate
INF	growth rate in consumer price index, all urban consumers, computed as $(x_t-x_{t-1})/(x_{t-1})$

Note: Wages and salaries data are from Employment Cost Index and are for private industry.

Table 2

Descriptive Statistics

(Adjusted Sample Period is 1976Q3-2001Q1)

	Mean (×100)	Standard Deviation (×100)
GAPGP	0.3622	3.2565
GAPMF	0.3364	3.3515
GAPNMF	2.0964	4.4952
GAPPI	1.5258	4.0977
GAPSP	2.1445	4.1026
GROWTH	0.7889	0.8134
INF	1.1511	0.7921
MPOLICY	-0.9663	110.7479
Number of observations	99	

Table 3

Estimated Correlation Matrices

Panel A: Goods-producing industry

	ΔGAPGP	GROWTH	MPOLICY	INF
ΔGAPGP	1.0000	---	---	---
GROWTH	-0.1720	1.0000	---	---
MPOLICY	0.0480	0.2188	1.0000	---
INF	0.2173	-0.0794	0.2565	1.0000

Panel B: Manufacturing industry

	ΔGAPMFI	GROWTH	MPOLICY	INF
ΔGAPMF	1.0000	---	---	---
GROWTH	-0.1035	1.0000	---	---
MPOLICY	0.0670	0.2177	1.0000	---
INF	0.2975	-0.0780	0.2583	1.0000

Panel C: Non-manufacturing industry

	ΔGAPNMF	GROWTH	MPOLICY	INF
ΔGAPNMF	1.0000	---	---	---
GROWTH	-0.2139	1.0000	---	---

MPOLICY	-0.1524	0.2177	1.0000	---
INF	0.1524	-0.0780	0.2583	1.0000

Table 3, continued

Estimated Correlation Matrices

Panel D: Private industry

	ΔGAPPI	GROWTH	MPOLICY	INF
ΔGAPPI	1.0000	---	---	---
GROWTH	-0.2855	1.0000	---	---
MPOLICY	-0.0636	0.2188	1.0000	---
INF	0.2657	-0.0794	0.2565	1.0000

Panel E: Service-producing industry

	ΔGAPSP	GROWTH	MPOLICY	INF
ΔGAPSP	1.0000	---	---	---
GROWTH	-0.2083	1.0000	---	---
MPOLICY	-0.0703	0.2188	1.0000	---
INF	0.2114	-0.0794	0.2565	1.0000

Table 4

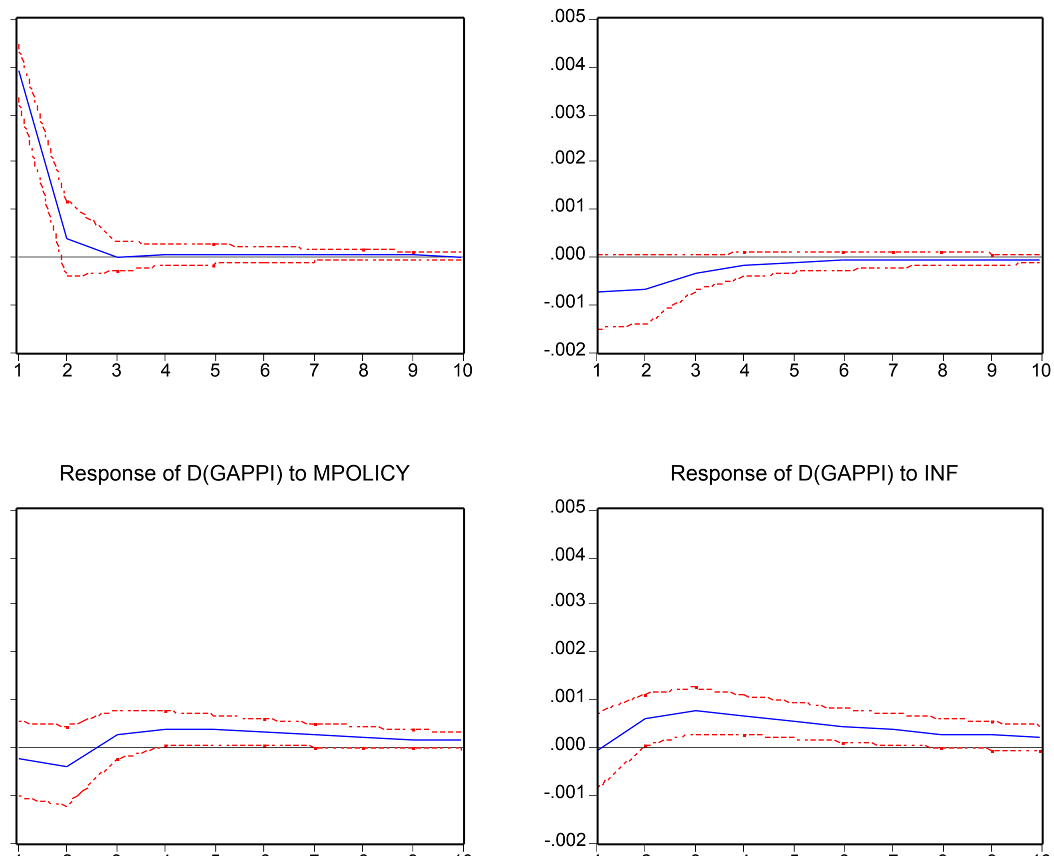
Tests of Stationarity

Variable	ADF	Phillips-Perron
ΔGAPGP	-7.13[a]	-9.25[a]
ΔGAPMF	-6.27[a]	-9.31[a]
ΔGAPNMF	-5.32[a]	-8.62[a]
ΔGAPPI	-5.58[a]	-8.00[a]
ΔGAPSP	-4.95[a]	-9.75[a]
GROWTH	-5.52[a]	-7.41[a]
MPOLICY	-2.36	-2.63[b]
INF	-7.79[a]	-8.56[a]

Notes: Superscripts a, b denote significance at the 1% and 10% levels based on critical values in MacKinnon (1991). Δ denotes the first-difference operator. One lag were used on the augmenting term, as suggested by Akaike's information criterion, and were sufficient to ensure the absence of autocorrelation in the residuals.

Figure 1

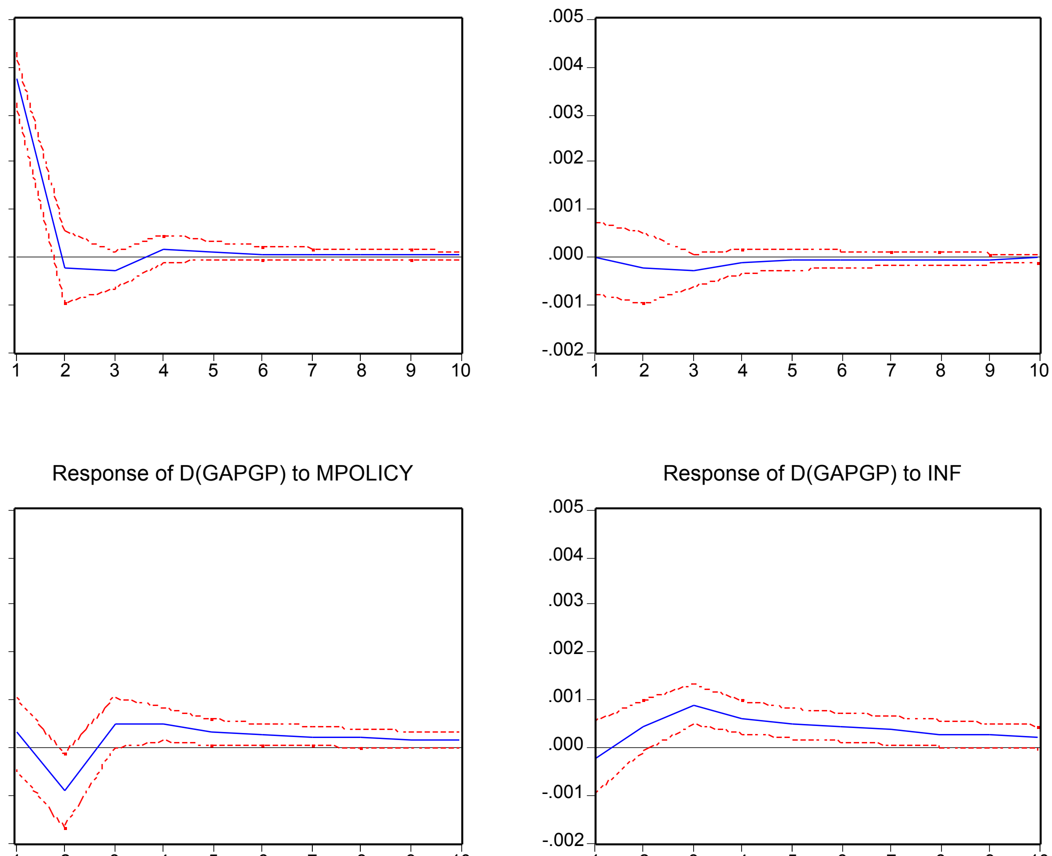
Private industry



Notes: Horizon is measured in quarters. D denotes first-difference operator.

Figure 2

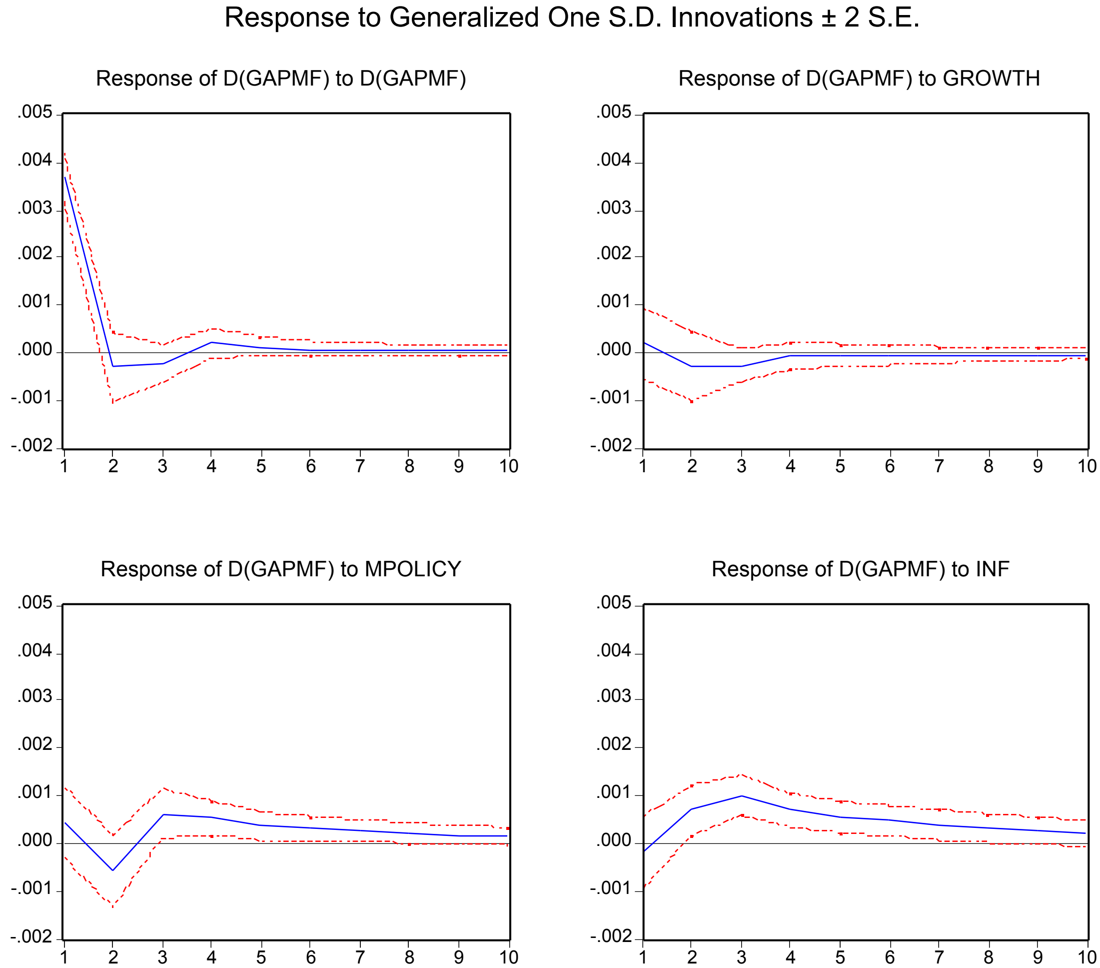
Goods-producing industries



Notes: Horizon is measured in quarters. D denotes first-difference operator.

Figure 3

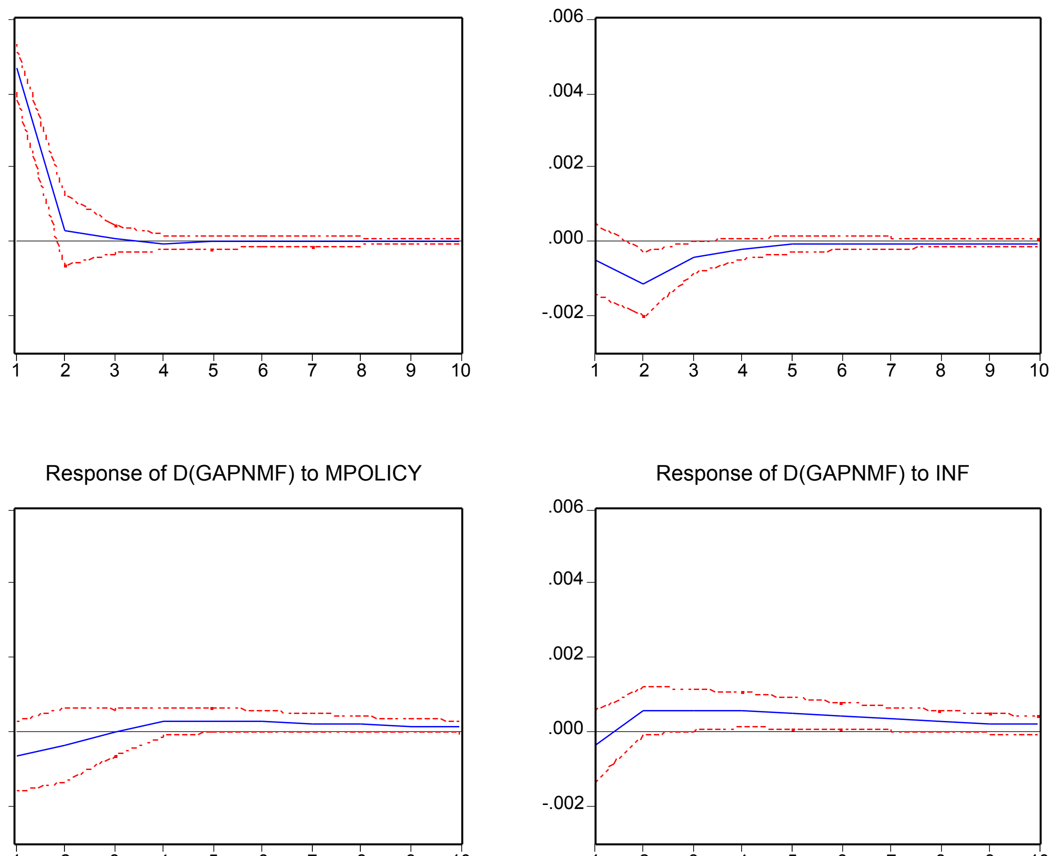
Manufacturing industries



Notes: Horizon is measured in quarters. D denotes first-difference operator.

Figure 4

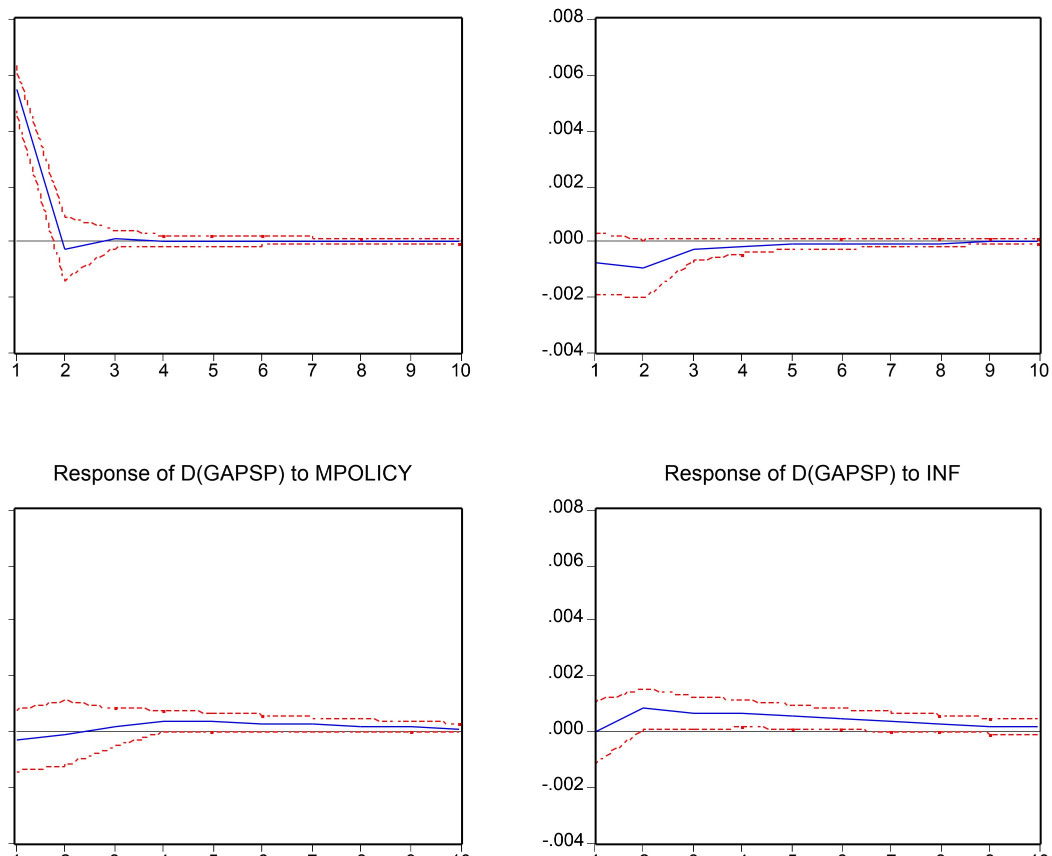
Non-manufacturing industries



Notes: Horizon is measured in quarters. D denotes first-difference operator.

Figure 5

Service-producing industries



Notes: Horizon is measured in quarters. D denotes first-difference operator.