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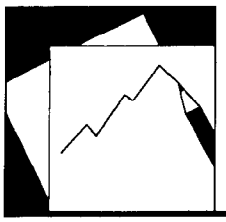

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The Wage-Price Spiral: Industrial Country Evidence and Implications

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The Wage-Price Spiral: Industrial Country Evidence and Implications

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Abstract

Using quarterly time-series data for a sample of twelve industrial countries, the paper investigates the dynamics of nominal wage and price adjustments in the face of aggregate demand shocks. The evidence illustrates patterns of the wage-price spiral and accompanying fluctuations. During economic expansions, the overlap of nominal adjustments in labor and product markets prolongs output expansion while maintaining or increasing the standard of living. In contrast, structural and institutional settings appear to have moderated the severity of the effects of contractionary demand shocks on real output growth and the standard of living in the variety of countries under investigation.

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I. INTRODUCTION

The spillover effects of nominal adjustments across labor and product markets are commonly known as the wage-price spiral. An increase in aggregate demand prompts firms to adjust prices upward to maintain or increase their markup of prices over wages. Concurrently, workers attempt to adjust nominal wages upward to maintain or increase their real wages. After a decrease in aggregate demand, the process of adjustment of nominal wages and prices is consistent with a simultaneous reduction in profit markups and real wages. Wage-price setting may be instantaneous or staggered, allowing for a slow process of nominal adjustment.

Theory predicts that the more inflexible real wages and markups are with respect to demand shifts, the slower the process of nominal adjustment toward full-equilibrium and the longer lasting are output fluctuations. Intuitively, nominal adjustment, for example—in the face of expansionary demand shocks—would start an upward spiral of wage-price adjustments that would stop only if the reduction in real money balances offsets demand expansion.

The proposition of this paper is that the dynamics of the wage-price spiral are likely to vary with conditions in labor and product markets of various economies. Further, these conditions may differentiate the dynamics of adjustments within a given economy in the face of positive and negative demand shocks. Given similar conditions of monopoly power and price setting in labor and product markets, the wage-price spiral does not produce a systematic correlation between output and real wage adjustments to demand shocks. This is the result of attempts by workers to maintain their real wages and by firms to maintain their profit markups.

A greater degree of wage flexibility in the labor market produces a positive correlation between real wage and output adjustments to demand shocks. In contrast, a higher degree of price flexibility in the output market produces a negative correlation between the real wage and output adjustments to demand shocks. Further, the varying degree of monopoly power between labor and product markets is likely to highlight asymmetry in real wage adjustments to demand shocks. The higher the degree of monopoly power in the labor market, the bigger is the increase in the real wage during expansions and the smaller is the decrease during contractions. In contrast, the higher the degree of monopoly power in the product market, the bigger is the increase in the profit markup during expansions and the smaller is the decrease during contractions. The former scenario produces the possibility of an increase in the real wage during expansions and contractions. In contrast, workers may suffer a reduction in the real wage during expansions and contractions, the higher the degree of monopoly power in the product market.

The empirical investigation is for a sample of 12 industrial countries. In contrast to previous investigations on the subject, the analysis in this paper focuses on a detailed time-series response of the nominal wage and price using quarterly data. In addition, asymmetry in the cyclical adjustment of the real wage and output is studied over time during expansions and contractions. The combined evidence illustrates patterns of the wage-price spiral and accompanying fluctuations. During expansions, the simultaneous overlap of nominal adjustments in labor and product markets prolongs output expansion while maintaining or

improving the real standard of living. In contrast, structural and institutional settings appear to have moderated the severity of output contraction and the reduction in agents' real standards of living during economic downturns in many of the countries under investigation.[2]

II. Theoretical Background

To illustrate the dynamics of the wage-price spiral, a theoretical model is briefly outlined following the detailed framework in Blanchard (1986).

A. The Model

Conditions in the goods and labor markets specify the dynamics of the nominal wage and price adjustments to demand shocks. The output and labor markets are characterized with monopolistic competition. Goods produced by firms are imperfect substitutes. The demand for each good varies with real money balances and the relative price to the aggregate price level. The demand for each type of labor varies with the demand for goods. An increase in aggregate demand generates a larger demand for labor, the faster the reduction in return to scale. The demand for a specific type of labor varies also negatively with the relative wage. An increase in the real wage increases the marginal cost of labor, increasing firm's relative output price.

An increase in real money balances increases aggregate demand. Assuming decreasing return to scale, an increase in aggregate demand increases the output relative price. As the union wants to supply more labor, its relative wage decreases. Thus, the union's relative wage varies positively with the profit markup. An increasing marginal disutility of work also induces an increase in the union's relative wage. A decrease in the return to scale causes a higher relative wage in response to the increased aggregate demand.

B. Monopoly Power in Labor and Product Markets

There are two factors that determine the relation between the markup of prices over wages and real money balances: (i) the degree of monopoly power in the goods market and (ii) return to scale. An increase in aggregate demand has a larger effect on the profit markup, the higher the degree of monopoly power in the product market, and the faster the reduction in return to scale. Unless there is constant return to scale, an increase in aggregate demand following the increase in real money balances requires firms to raise their profit markup.

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[2] The empirical literature on the cyclical behavior of the real wage can be classified into aggregate and disaggregate studies. The former includes Bodkin (1969), Neftci (1978), Geary and Kennan (1982), Sumner and Silver (1989), Cho and Cooley (1990), Cushing (1990), Kandil (1996) and Kandil and Woods (2002). Disaggregate studies include Bils (1985), Barsky and Solon (1989), Keane, Moffit and Runkle (1989), Solon, Barsky and Parker (1994), Kandil and Woods (1995, 1997), and Kandil (1999) and (2002b). For surveys of the empirical evidence, see Kniesner and Goldsmith (1987), and Abraham and Haltiwanger (1995).

There are three factors that determine the relation between the real wage and real money balances: (i) the degree of monopoly power in the labor market, (ii) return to scale, and (iii) the marginal disutility of employment. The positive effect of aggregate demand on the real wage increases in response to a higher degree of monopoly power in the labor market, a faster reduction in return to scale, or a higher marginal disutility of employment. Unless there is constant marginal disutility of work, an increase in aggregate demand following the increase in real money balances requires unions to increase the real wage.

If firms and unions do not exploit their monopoly power, they take prices and wages as given. Accordingly, the profit markup is lower at any level of output without monopoly power. The implication is that the markup is more upwardly flexible during expansions and more downwardly rigid during contractions the higher the degree of monopoly power.[3] Similarly, the real wage implied by competitive equilibrium is lower at any level of employment without union's monopoly power. That is, the real wage implied by competitive equilibrium is lower for high and low levels of aggregate demand. The implication is that the real wage is more upwardly flexible during expansions and more downwardly rigid during contractions the higher the degree of monopoly power.[4]

The combined implications are that the higher (lower) the degree of monopoly power in the labor market relative to the output market, the real wage is likely to increase (decrease), implying a reduction (increase) in the profit markup during expansions and contractions. That is, asymmetry in the real wage (markup) is likely to become more pronounced the higher the difference in the degree of monopoly power between labor and product markets. Further, the degree of monopoly power in labor and product markets determines the correlation between the real wage and output fluctuations in the face of aggregate demand shocks. The higher the degree of monopoly power in the labor market relative to the product market, an increase in the real wage correlates with an increase in output during expansions. In contrast, the reduction in output is not likely to be correlated with a reduction in the real wage during contractions. Note that money is still neutral under the assumption of monopolistic competition. That is, proportional change in wages and prices leaves output ultimately unchanged. The contribution of this framework is that the path of adjustment towards full-equilibrium is dependent on the relative degree of monopoly power in labor and product markets. The degree of monopoly power determines the correlation (positive or negative) between the output and real wage response to demand shocks in the short-run.

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[3] Intuitively, firms are more reluctant to raise prices during expansions the higher the degree of market competition. In contrast, firms are more inclined to lower prices during contractions the higher the degree of market competition.

[4] Intuitively, unions are more reluctant to raise wages during expansions the higher the degree of market competition. In contrast, unions are more inclined to lower wages during contractions, the higher the degree of market competition.

C. Conditions in Labor and Product Markets

Conditions in labor and product markets are further dependent on the staggering of wage and price adjustments over time. Price setting is staggered over two years. Further, setting decisions in labor and product markets overlap. The predetermined nominal price is a weighted average of the optimal price, which depends on the current nominal wage, and on the expected value of the optimal price, which depends on the expectation of the nominal wage and nominal money for period t+1. For each interval during which price is fixed, firms predetermine price such that the expected average markup is a nondecreasing function of expected average aggregate demand.

Staggering of the nominal wage over a two-year period is similar. The nominal wage chosen is a weighted average of the optimal wage, which depends on past values of the price level and the money supply, and the expected nominal wage, which is a function of the price and nominal money expected to prevail. With staggering, the union predetermines the nominal wage such that the expected average real wage is a nondecreasing function of expected average aggregate demand.

With wage and price staggering, the relative flexibility of wage and price determines the dynamics of the wage-price spiral as follows. At time t=0, after an increase in the money supply, for example, firms increase their nominal price only to the extent that they want and can increase their markup to supply more output. At time t=1, wages increase because prices are higher and the demand for labor has increased. Unions increase their nominal wage only to the extent that they want and can increase their real wage to supply a higher level of labor. As wages become more flexible, prices adjust again and so on.

The process of wage and price adjustments to change in aggregate demand is well described as a wage-price spiral. After an increase in demand, attempts by workers and by firms to maintain or increase real wages (markups) lead to a general increase in nominal wages and prices. The process continues until wages and prices have risen proportionately to the increase in aggregate demand and desired real wages, markup and output are all again consistent with full-equilibrium levels. The slower is the wage-price spiral, the higher the degree of price level inertia and the slower the process of adjustment towards full-equilibrium. Also, the model implies the following dynamics. The rate of inflation is largest at the beginning, when output and employment are highest and desired increases in real wages and markup are largest, and then decreases overtime as output returns to normal.[5]

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[5] The real effects of the shocks may persist, however, if the monetary authority attempts to maintain the higher level of output by partially accommodating the increase in nominal prices. In this case, the higher the degree of accommodation is, the stronger and the longer lasting the wage-price spiral. The monetary authority is, therefore, able to maintain output at a higher level for a longer period of time but at the cost of a higher initial increase in prices and a longer period of inflation.

Provided that workers and firms enjoy a comparable degree of wage and price flexibility, the real wage oscillates (increasing or decreasing) in its adjustment towards full-equilibrium. This is because workers attempt, for every interval during which nominal wages are fixed, to obtain a higher real wage. Firms, on the other hand, also attempt for every interval during which nominal prices are fixed, to obtain a higher markup. These attempts are consistent because the two intervals described above do not coincide but overlap; implying the existence of a path of increases in nominal prices and wages such that the average markup and the average real wage are higher in turn. Accordingly, this scenario (flexible nominal wages and prices) implies no persistent deviation of the real wage from its equilibrium value: the real wage simply oscillates around this value as output returns to equilibrium. According to this scenario, the process of adjustment under staggering wage and price decisions implies that there be no systematic relation between real wages and output in response to demand shocks.

D. Hypotheses

Conditions governing wage and price adjustments to demand shocks are likely to be complicated by a number of factors. Based on the theoretical illustrations above, the empirical evidence will seek to shed light on the following hypotheses:

- The pattern of adjustment of wages and prices in the face of demand shocks: instantaneous versus staggering.

- More inflexible real wages are consistent with a higher degree of price inertia and a longer lasting effect on real output.

- The rate of inflation is the largest at the beginning when desired increases in real wages and markup are the largest and then decreases over time as output returns to normal.

- Similar conditions in labor and product markets imply no systematic correlation between output and real wage adjustments to demand shocks.

- Structural parameters may differentiate the degree of staggering nominal wage and price flexibility in the face of demand shocks. Higher wage flexibility produces a positive correlation between real wage adjustment and output fluctuations.

- The degree of monopoly power is likely to differentiate the real wage response to expansionary and contractionary demand shocks. Higher monopoly power in the labor market compared to the output market increases the growth of the real wage during expansions and moderates its reduction during contractions.

III. Empirical Investigation

The data under investigation are for a sample of twelve industrialized countries for which quarterly data are available. The price level is measured by CPI and real output is measured by industrial production.[6]

The period covered is from 1960.I to 2000.IV. The first decade was dominated by fixed exchange rates under the Bretton Woods system. Subsequently, exchange rates have become flexible in industrial countries. The sample period is also characterized by different monetary policy choices. Various countries at various times over this period adopted inflation targeting, interest rate targeting, and nominal monetary growth rules.

The empirical investigation will illustrate the dynamics of aggregate demand shocks on price inflation, nominal wage inflation, real output growth, and real wage growth. Aggregate demand shocks are measured by the shocks to nominal GNP or GDP. This is a broad measure of aggregate spending that accounts for a variety of domestic shocks as well as imported shocks into open economies that have varying effects within countries over time.[7] Further, the cross-country investigation is intended to provide an objective assessment given variation in country size, the degree of openness, collective bargaining, and labor market institutions which may affect the response of macro variables to aggregate demand shocks. Hence, the results will prove useful to draw a general conclusion on the degree of wage flexibility relative to price flexibility and accompanying effects on the real wage and output over the business cycle.

It is assumed that aggregate economic variables fluctuate in response to aggregate demand shocks and a major source of supply-side shocks, energy price shocks. Shocks are randomly distributed over the time span under investigation with a zero mean and a constant variance. Positive shocks represent unanticipated increase in the growth of aggregate demand above its anticipated steady-state value. Negative shocks represent unanticipated reduction in the growth of aggregate demand below its anticipated steady-state value. Detailed econometric methodology is provided in Appendix I. A detailed description and sources of all data are provided in Appendix II.

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[6] Quarterly data for real GNP or GDP and its deflator are not available over long time-series span for all countries. Where available, the results are robust with respect to alternative series for output and price. The effects of nominal GDP (aggregate demand) shocks, while correlated, are not distributed fully between CPI and industrial production. Hence, it is necessary to estimate separate equations for output and price.

[7] Rather than focusing on money balances (illustrated in theory), the empirical investigation will test theory's implications using a broad measure of aggregate demand. Since the data are for different countries, the effects of monetary shocks may be dependent on the stance of monetary policy, limiting implications for theoretical hypotheses under investigation.

The empirical models replicate the reduced-form equations for the nominal wage, the price level, the real wage, and real output in theory. Demand shifts are separated into anticipated and unanticipated components. Nominal variables adjust fully to anticipated demand shifts at the points of setting wages or prices. Accordingly, anticipated demand shifts are likely to determine real output until nominal variables have adjusted fully and the real wage is back to its full-equilibrium value.[8] Further, unanticipated demand shocks are distributed between nominal and real variables. The allocation is dependent on nominal wage and price rigidity. The slower nominal wage and/or price adjustment, the longer the duration of the output response to demand shocks. The relative flexibility of the nominal wage and price determines the real wage adjustment to demand shocks. To test asymmetry in the dynamics of the wage-price spiral, shocks to aggregate demand are decomposed into positive and negative components.[9] To complete the specification of empirical models, variables are assumed to vary in response to anticipated and unanticipated energy price shifts.[10] Accordingly, the empirical models are specified as follows:

$$Dp_t = a_0 + \sum_{i=0}^{x} a_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} a_{2pi} pos_{t-i} + \sum_{i=0}^{x} a_{2i} neg_{t-i} + \sum_{i=0}^{x} a_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} a_{4i} Dqs_{t-i} + \eta_{pt} \quad (1)$$

$$Dw_t = b_0 + \sum_{i=0}^{x} b_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} b_{2pi} pos_{t-i} + \sum_{i=0}^{x} b_{2i} neg_{t-i} + \sum_{i=0}^{x} b_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} b_{4i} Dqs_{t-i} + \eta_{wt} \quad (2)$$

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[8] This prediction arises also in a framework that assumes price rigidity only (see, e.g., Ball, Mankiw, and Romer(1988)) or nominal wage rigidity only (see, e.g., Gray and Kandil (1991)).

[9] The relative degree of monopoly power in labor and product markets may determine asymmetry of the real wage adjustment in the face of expansionary and contractionary demand shocks. Conditions on the supply side may establish, however, that nominal flexibility is asymmetric in the face of positive and negative demand shocks. Supply-side asymmetry may be the result of varying incentives for nominal wage indexation in the face of expansionary and contractionary demand shocks (see, e.g., Kandil (2002a)). The implication of this scenario is consistent with a higher degree of monopoly power in the labor market. Alternatively, Ball and Mankiw (1994) propose an explanation for asymmetric price adjustment in the face of expansionary and contractionary demand shocks. The implication of this scenario is consistent with a higher degree of monopoly power in the product market.

[10] It is important to account for major sources of supply-side shifts to increase the accuracy of approximating the effects of demand shifts. Quarterly data are not available to measure productivity for various countries over time.

$$Drw_t = c_0 + \sum_{i=0}^{x} c_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} c_{2pi} pos_{t-i} + \sum_{i=0}^{x} c_{2ni} neg_{t-i} + \sum_{i=0}^{x} c_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} c_{4i} Dqs_{t-i} + \eta_{rwt} \quad (3)$$

$$Dy_t = d_0 + \sum_{i=0}^{x} d_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} d_{2pi} pos_{t-i} + \sum_{i=0}^{x} d_{2ni} neg_{t-i} + \sum_{i=0}^{x} d_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} d_{4i} Dqs_{t-i} + \eta_{yt} \quad (4)$$

All dependent variables, real output, price, the nominal wage and the real wage, are tested for non-stationarity. The specification of the test follows the suggestions of Nelson and Plosser (1982). Based on the results of the Dickey-Fuller test (see, e.g., Dickey and Fuller (1981)), the null hypothesis of nonstationarity is accepted for all dependent variables in the various countries under investigation. Given these results, the empirical models are specified in first-difference form where D(.) is the first-difference operator.[11] n_{t-i} denotes the log value of aggregate demand (nominal GNP or GDP) at time *t-i*. E_{t-i} denotes the expectation of a variable at time *t-i*. pos_{t-i} and neg_{t-i} denote the positive and negative components of unanticipated growth in aggregate demand conditioned on information at time *t-i-1*. q_{t-i} denotes the log value of the energy price at time *t-i*. Dqs_{t-i} denotes unanticipated change in the energy price conditioned on information at time *t-i-1*.[12]

Given the interest in detecting dynamics of adjustments over time, the estimates will illustrate the cumulative effects of the shocks on variables for lag length x=1, 2, 3, 4, 6, and 8 quarters.[13] Accordingly, the evidence will detect the detailed movement of variables in the face of aggregate demand shocks, over time. To conserve space, the analysis below will focus on this dynamics. Detailed results are available upon request.

$\sum a_{2p_i}$ and $\sum a_{2ni}$ approximate the inflationary and deflationary effects of demand shocks on price over time. These are the cumulative effects of the shocks over time, as approximated by the impulse response function. Negative cumulative effects will indicate price rigidity, i.e., price inflation moves countercyclically to aggregate demand shocks.[14] $\sum b_{2pi}$ and

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[11] Cointegration test results reject the hypothesis of a common stochastic trend between the nonstationary dependent variables and nonstationary right-hand side variables (anticipated energy price and aggregate demand).

[12] The energy price is measured by an index of average world crude petroleum price. This index is likely to capture the combined effects of fluctuations in the international price and the exchange rate on the supply side of the economy.

[13] Shocks may have persistent effects if structural and/or institutional constraints interfere with agents' ability to accommodate the shocks.

[14] For example, price control measures may be in effect or the effect of supply shocks may be more dominant on price inflation.

$\sum b_{2ni}$ approximate the inflationary and deflationary effects of demand shocks on the nominal wage over time. The combined effects of expansionary and contractionary shocks on the real wage are approximated by $\sum c_{2pi}$ and $\sum c_{2ni}$. Finally, $\sum d_{2pi}$ and $\sum d_{ni}$ approximate the expansionary and contractionary effects of aggregate demand shocks on real output over time.

IV. Estimation Results

To estimate the empirical models (1) through (4), empirical proxies are formed to approximate shocks to aggregate demand and the energy price. Given the interdependence among variables in the economic system, the empirical models (1) through (4) are estimated jointly with equations that approximate agents' forecasts of variables in the empirical models (see Appendix A for details).

This section summarizes the detailed time-series evidence of the dynamics of aggregate demand shocks on variables by country. Statistical significance will be established based on the cumulative response of variables to positive and negative demand shocks. These responses are judged as statistically significant at the five or ten percent levels.

A. During Expansions

Table 1 summarizes the cumulative response of dependent variables to expansionary demand shocks, $\sum_i^x = pos_{t-i}$, for i=0,1,2,3,4,6,8.[15] Price inflation is evident by the positive and significant response of price to expansionary demand shocks. Cumulative negative response indicates rigidity of price inflation in the face of expansionary demand shocks. Judged by the cumulative response, price inflation is persistent in the face of expansionary demand shocks in Australia, France, Italy, Sweden, the United Kingdom, and the United States.

Nominal wage inflation appears significant and persistent in the face of expansionary demand shocks in Australia, France, Germany, Japan, Sweden, the United Kingdom, and the United States.

Nominal wage flexibility exceeds price flexibility, increasing real wage growth in the face of expansionary demand shocks in Australia, France, Germany, Japan, Sweden, and the United States.

The evidence of a significant reduction in real wage growth in the face of expansionary demand shocks is limited to Finland and Italy. For the remaining countries, the dynamics of the wage-price spiral has insulated real wage growth from significant fluctuations in the face of expansionary demand shocks. That is, nominal wage inflation and price inflation adjust

[15] Detailed coefficient estimates are available upon request.

closely in the face of expansionary demand shocks, neutralizing the effects of these shocks on the real wage.

Output expansion appears significant and persistent in the face of expansionary demand shocks in Austria, Canada, Finland, France, Germany, Japan, the Netherlands, the United Kingdom, and the United States.

B. During Contractions

Table 2 summarizes the cumulative response of dependent variables to contractionary demand shocks, $\sum_{i=0}^{x} = neg_{t-i}$, for x=0,1,2,3,4,6,8. Price deflation is evident by the positive and significant response of price to contractionary demand shocks. Cumulative negative response indicates rigidity of price deflation in the face of contractionary demand shocks.

Judged by the cumulative positive response, price deflation appears significant and persistent in the face of contractionary demand shocks in France, Italy, the Netherlands, and Sweden.

Nominal wage deflation is significant and persistent in the face of contractionary demand shocks in Australia, France, Germany, the Netherlands, and Sweden.

Nominal wage flexibility exceeds price flexibility, decreasing real wage growth in the face of contractionary demand shocks in France, the Netherlands and Sweden. In the remaining countries, nominal wage and price inflation adjust closely in the face of contractionary demand shocks, neutralizing the effects of these shocks on real wage growth. The negative and statistically significant cumulative response of the real wage for Italy *(x=6)* indicates an increase in the real wage during contractions. That is, price deflation is not correlated with a comparable wage deflation in the face of contractionary demand shocks.

Output fluctuations appear significant and persistent in the face of contractionary demand shocks in Canada, Germany, Italy, Japan, the Netherlands, and the United States.

Figures 1 through 4 contrast the cumulative responses of variables to aggregate demand shocks during expansions and contractions.

C. The Wage-Price Spiral: Summary and Implications

The combined evidence in Tables 1 and 2 illustrates some asymmetry in real wage adjustment to expansionary and contractionary demand shocks. To formalize the evidence, Table 3 presents the difference in the cumulative response of real wage growth to expansionary and contractionary demand shocks at varying lag lengths, x=0-4, 6,8. Where the evidence is statistically significant, the increase in real wage growth during expansions appears pronouncedly larger compared to the reduction during contractions in Australia (x=0,1), Finland (x=0), France (x=0,1), Germany (x=2,3), Japan (x=6,8), the United Kingdom (x=6), and the United States (x=3-8). Asymmetry may indicate a higher degree of monopoly power in the labor market compared to the output market. Therefore, nominal wage inflation exceeds price inflation during expansions. In contrast, the relative adjustment of wages and

prices does not reveal comparable reduction of the real wage during contractions. Further, there is no evidence of a larger reduction in real wage growth during contractions compared to its increase during expansions in any country. The remaining evidence indicates symmetry in real wage adjustment to expansionary and contractionary demand shocks, i.e., a comparable degree of monopoly power in labor and product markets in many countries. That is, institutional and structural conditions do not pronouncedly differentiate incentives for relative adjustments of wage and price in the face of expansionary and contractionary demand shocks.

Table 3 also presents the difference in the cumulative response of output growth to expansionary and contractionary demand shocks at varying lag lengths.[16] Where the evidence is statistically significant, the increase in output growth during expansions appears pronouncedly larger compared to the reduction during contractions in Austria (x=0-4,6,8), Finland (x=0-2), Germany (x=4,8), Japan (x=0-4,6,8), and the United Kingdom (x=1,3,4,6). The decrease in real output growth during contractions appears pronouncedly larger compared to the increase during expansions in Canada (x=2), Italy (x=0), and the United States (x=0-4,6). Overall, output fluctuations appear longer lasting during expansions compared to contractions in the majority of countries.

To shed additional light on patterns of asymmetry in Table 3, consider correlations between significant fluctuations in real output and the real wage. During expansions (see Table 1), the increase in real wage growth correlates with an increase in output growth in France, Germany, Japan, and the United States. In Australia, France, and Sweden, the increase in real wage growth does not correlate with a significant increase in output growth during expansions. In contrast, the increase in output growth does not correlate with a significant increase in real wage growth during expansions in Austria, Canada, Finland, Italy, the Netherlands, and the United Kingdom.

During contractions (see Table 2), the reduction in real output growth does not correlate with a significant reduction in real wage growth in Canada, Finland, Germany, Italy, Japan, the Netherlands, the United Kingdom, and the United States. The close adjustments of wages and prices (where these adjustments are significant) have protected workers' real standard of living in the face of contractionary demand shocks in the majority of countries under investigation.

In general, the real wage adjustment to expansionary and contractionary demand shocks indicates that the wage-price spiral does not present serious challenge to workers' real standard of living in the sample of countries under investigation. The slow adjustment of wages and prices has resulted in persistent expansionary and contractionary effects on real output growth in many countries. These persistent effects do not correlate with systematic reduction of the real wage in the majority of countries. The implication is that wage and price

[16] Statistical significance is established by calculating the t-statistic for the asymmetry coefficient. The difference between the cumulative coefficients for positive and negative shocks is divided by the standard deviation of the difference.

adjustments overlap simultaneously over time. More importantly, workers were able to secure higher and faster adjustments of the nominal wage that dominate that of price during expansions in a few countries.

Figure 5 illustrates asymmetry in the response of real wage growth and output growth to aggregate demand shocks during expansions and contractions.

V. Summary and Conclusion

This investigation has focused on the dynamics of nominal wage and price adjustments in the face of aggregate demand shocks. The spillover effects of nominal adjustments across labor and product markets are commonly known as the wage-price spiral. The spillover dynamics are likely to vary with conditions in labor and product markets of various economies. Further, these conditions may differentiate the dynamics of adjustments within a given economy in the face of positive and negative demand shocks.

The empirical investigation analyzes quarterly data for a sample of 12 industrial countries. For each of the countries, an empirical time-series model was estimated. The results indicate the dynamics of wage and price adjustments in the face of expansionary and contractionary demand shocks. To complete the evidence, empirical models are also estimated to measure the effects of expansionary and contractionary demand shocks on the growth of real output and the real wage. The evidence is consistent with slow adjustments of nominal wages and prices in the face of demand shocks. Consistently, demand shocks have persistent effects on real output in several countries. Interestingly, these persistent effects are not correlated with systematic fluctuations in the real wage in the face of demand shocks in many countries. Overall, comparable adjustments in labor and product markets have insulated real wage growth from significant fluctuations in the face of demand shocks. Where fluctuations in the real wage appear significant, the evidence is consistent with an increase in real wage growth in the face of expansionary demand shocks in several countries. In contrast, the evidence supports a significant reduction in real wage growth during contractions in a smaller number of the countries under investigation.

In summary, the evidence for a sample of 12 industrial countries indicates that the wage-price spiral neutralizes, or may even improve, workers' real standards of living in the face of demand shocks. In addition, significant output fluctuations appear to be longer lasting during expansions than contractions in the majority of countries.

The paper's evidence clearly illustrates the function of the wage-price spiral that occurs as workers attempt to maintain their real wages and firms aspire to secure their profit markups (the battle of the markups) in the face of demand shocks. During expansions, the simultaneous overlap of nominal adjustments in labor and product markets prolongs output expansion while maintaining or improving the real standard of living. During contractions, the effects of the wage-price spiral (or the lack of such a spiral) appear limited in prolonging output contractions or decreasing agents' real standards of living. Structural and institutional settings appear to have moderated the severity of contractionary demand shocks on real output growth and the real standard of living in the variety of countries under investigation.

Table 1. The Cumulative Effects of Expansionary (pos) Demand Shocks on Economic Variables

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} pos_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Australia	Dp_t	0.13	0.22	0.41	0.37	0.74	0.84*	0.98*
		(0.92)	(1.00)	(1.60)	(1.40)	(1.35)	(2.87)	(3.34)
	Dw_t	0.40*	0.96*	0.79*	0.66**	0.42	0.86**	1.11*
		(2.00)	(3.50)	(2.45)	(1.77)	(1.10)	(1.85)	(2.09)
	Drw_t	0.26	0.75*	0.38	0.29	0.042	0.031	0.0022
		(1.32)	(2.54)	(1.10)	(0.73)	(0.094)	(0.059)	(0.0034)
	Dy_t	0.20	0.52	-0.19	0.034	0.49	0.32	-0.27
		(0.61)	(1.05)	(-0.32)	(0.51)	(0.69)	(0.42)	(-0.32)
Austria	Dp_t	0.062**	0.052	0.043	0.0048	0.026	0.067	0.05
		(1.70)	(1.06)	(0.67)	(0.07)	(0.35)	(0.79)	(0.49)
	Dw_t	-0.031	0.07	-0.04	-0.017	-0.09	0.034	-0.01
		(-0.38)	(0.63)	(-0.29)	(-0.11)	(-0.38)	(0.23)	(-0.038)
	Drw_t	-0.093	0.018	-0.077	-0.02	-0.12	-0.03	-0.03
		(-1.11)	(0.15)	(-0.54)	(-0.12)	(-0.62)	(-0.13)	(-0.11)
	Dy_t	0.11	0.19**	0.22**	0.36*	0.34*	0.37*	0.24*
		(1.57)	(1.89)	(1.76)	(2.50)	(2.15)	(2.02)	(2.84)
Canada	Dp_t	0.098	0.25	0.088	-0.11	-0.26	0.053	-0.07
		(0.62)	(1.16)	(0.36)	(-0.43)	(-0.99)	(0.21)	(-0.24)
	Dw_t	0.073	-0.07	-0.065	0.33	0.59	0.37	0.50
		(0.34)	(-0.24)	(-0.18)	(0.83)	(1.35)	(0.80)	(0.98)
	Drw_t	-0.024	-0.31	-0.30	0.44	0.84	0.32	0.57
		(-0.11)	(-0.94)	(-0.74)	(0.96)	(1.68)	(0.58)	(0.94)
	Dy_t	0.70*	0.53*	0.33	0.50**	0.44	0.48	0.67
		(4.00)	(2.28)	(1.21)	(1.69)	(1.12)	(1.34)	(1.68)

Notes: See notes to Table 2.

Table 1. The Cumulative Effects of Expansionary (pos) Demand Shocks on Economic Variables (Continued)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} pos_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Finland	Dp_t	-0.075	-0.20*	-0.23*	-0.08	-0.28	-0.18	-0.50*
		(-1.24)	(-2.47)	(-2.33)	(-0.58)	(-1.28)	(-0.99)	(-1.96)
	Dw_t	0.15	-0.48*	-0.31	-0.02	0.18	0.42	0.095
		(1.01)	(-2.76)	(-1.44)	(-0.06)	(0.17)	(0.83)	(0.098)
	Drw_t	0.23	-0.30**	-0.09	0.04	0.39	0.59	0.38
		(1.63)	(-1.77)	(-0.44)	(0.12)	(0.97)	(1.12)	(0.47)
	Dy_t	0.35*	0.52*	0.59*	1.25*	0.72	1.20*	0.41
		(2.33)	(2.48)	(2.27)	(3.14)	(1.55)	(2.10)	(0.49)
France	Dp_t	0.049	0.36*	0.46*	0.47*	0.33*	0.64*	0.55*
		(0.54)	(3.96)	(4.72)	(4.17)	(4.34)	(4.34)	(3.13)
	Dw_t	0.24**	0.59*	0.80*	1.11*	1.13*	1.077*	1.19*
		(1.81)	(3.86)	(4.64)	(6.32)	(5.82)	(4.50)	(4.44)
	Drw_t	0.19**	0.23	0.32**	0.65*	0.58*	0.43	0.76*
		(1.73)	(1.47)	(1.74)	(3.31)	(2.65)	(1.57)	(2.35)
	Dy_t	1.36*	0.99*	0.90*	0.82*	0.72*	0.84**	0.68
		(6.81)	(3.93)	(3.24)	(2.61)	(2.00)	(1.89)	(1.29)
Germany	Dp_t	0.19	0.17	0.0017	-0.022	0.18	0.072	-0.014
		(1.16)	(0.75)	(0.0063)	(-0.07)	(0.59)	(0.17)	(-0.026)
	Dw_t	0.089	0.75*	0.98*	1.04*	1.01*	1.54*	1.37*
		(0.51)	(3.53)	(3.97)	(3.77)	(3.29)	(4.55)	(3.24)
	Drw_t	-0.097	0.59**	0.97*	1.06*	0.82**	1.47*	1.39
		(-0.40)	(1.83)	(3.36)	(2.45)	(1.76)	(2.49)	(0.84)
	Dy_t	0.80*	0.65*	0.61*	0.49*	0.45*	0.28	0.37
		(8.17)	(4.96)	(4.11)	(3.19)	(2.73)	(1.29)	(1.41)

Table 1. The Cumulative Effects of Expansionary (pos) Demand Shocks on Economic Variables (Continued)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} pos_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Italy	Dp_t	0.18	0.41*	0.57*	0.66*	0.70*	1.76*	1.75*
		(1.39)	(2.19)	(2.21)	(2.30)	(2.04)	(4.29)	(3.32)
	Dw_t	0.39**	0.33	0.51	0.45	-0.12	0.20	0.49
		(1.93)	(1.15)	(1.31)	(1.21)	(-1.08)	(0.28)	(0.24)
	Drw_t	0.20	-0.075	0.18	-0.21	0.61	-1.55*	-1.19
		(0.87)	(-0.22)	(0.39)	(-0.40)	(0.17)	(-2.89)	(-0.92)
	Dy_t	0.048	0.30*	0.065	0.066	-0.06	-0.47**	-0.89*
		(0.52)	(2.31)	(0.42)	(0.35)	(-0.22)	(-1.84)	(-2.43)
Japan	Dp_t	0.013	0.11	0.17	0.0093	-0.17	-0.088	-0.18
		(0.08)	(0.50)	(1.44)	(0.029)	(-0.40)	(-0.21)	(-0.37)
	Dw_t	0.0098	0.12	0.74**	0.62	0.40	1.38*	1.16
		(0.04)	(0.34)	(1.70)	(1.15)	(0.69)	(2.073)	(1.48)
	Drw_t	-0.003	0.019	0.62	0.62	0.003	1.47*	1.34**
		(-0.01)	(0.053)	(1.36)	(1.11)	(0.89)	(3.30)	(1.85)
	Dy_t	1.17*	1.09*	1.15*	1.32*	1.48*	1.65*	1.68*
		(7.01)	(4.81)	(3.82)	(3.62)	(4.46)	(3.21)	(2.79)
Netherlands	Dp_t	0.18*	0.15	-0.22	0.0004	0.052	0.068	-0.12
		(1.96)	(1.15)	(-1.32)	(0.002)	(0.21)	(0.23)	(-0.34)
	Dw_t	-0.069	0.35	0.004	0.014	-0.19	0.22	-0.048
		(-0.42)	(1.60)	(0.015)	(0.45)	(-0.48)	(0.41)	(-0.076)
	Drw_t	-0.25	-0.05	-0.12	0.14	-0.16	0.15	0.087
		(-1.56)	(-0.23)	(-0.45)	(0.46)	(-0.40)	(0.50)	(0.24)
	Dy_t	0.82*	0.85*	0.85*	0.99*	1.04*	0.92**	1.15*
		(8.78)	(6.49)	(5.09)	(4.98)	(4.29)	(1.78)	(2.11)

Table 1. The Cumulative Effects of Expansionary (pos) Demand Shocks on Economic Variables (Concluded)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} pos_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Sweden	Dp_t	0.019	0.11*	0.16*	0.16	0.13	-0.23	-0.28
		(0.75)	(3.14)	(3.32)	(1.21)	(0.78)	(-0.94)	(-0.79)
	Dw_t	-0.017	0.26*	0.58*	0.88*	0.58	0.21	-0.77
		(-0.23)	(2.31)	(4.84)	(2.95)	(1.57)	(0.32)	(-0.93)
	Drw_t	-0.036	0.13	0.40*	0.62	0.43	0.44	-0.57
		(-0.48)	(1.12)	(3.02)	(1.64)	(0.89)	(0.65)	(-0.58)
	Dy_t	0.027	-0.044	-0.12	0.002	-0.18	0.40	2.067
		(0.42)	(-0.43)	(-0.86)	(0.005)	(-0.30)	(0.41)	(1.32)
United Kingdom	Dp_t	0.42*	0.70*	0.75*	0.89*	0.95*	0.49	1.076*
		(2.62)	(3.51)	(3.06)	(3.22)	(3.05)	(1.18)	(2.20)
	Dw_t	0.27**	0.67*	0.52*	0.57*	0.51	0.78**	0.90
		(1.88)	(3.45)	(2.28)	(2.16)	(1.59)	(1.75)	(1.39)
	Drw_t	-0.15	-0.034	-0.22	-0.33	-0.47	0.28	-0.18
		(-0.83)	(-0.13)	(-0.69)	(-0.92)	(-1.11)	(0.49)	(-0.25)
	Dy_t	0.78*	0.60*	0.48*	0.53*	0.50*	0.77*	0.64**
		(5.97)	(4.08)	(2.70)	(2.75)	(2.29)	(2.64)	(1.82)
United States	Dp_t	0.29*	0.41*	0.41**	0.30	0.13	-0.44	-0.29
		(1.97)	(2.11)	(1.84)	(1.18)	(0.44)	(-1.30)	(-0.72)
	Dw_t	0.48*	0.59*	0.97*	1.22*	1.31*	1.063*	0.91*
		(3.85)	(3.23)	(4.23)	(4.55)	(4.48)	(2.74)	(2.10)
	Drw_t	0.19	0.18	0.55*	0.93*	1.15*	1.50*	1.21*
		(1.34)	(0.85)	(1.99)	(2.64)	(2.77)	(3.15)	(2.16)
	Dy_t	0.56*	0.46*	0.25	0.24	0.22	0.58*	0.68**
		(4.95)	(2.85)	(1.27)	(0.82)	(0.92)	(1.95)	(1.78)

Table 2. The Cumulative Effects of Contractionary (neg) Demand Shocks on Economic Variables

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} neg_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Australia	Dp_t	0.092	0.072	0.11	0.092	0.30	0.58	0.52
		(0.57)	(0.30)	(0.36)	(0.17)	(0.76)	(1.32)	(1.12)
	Dw_t	-0.17	-0.061	0.39	0.44	0.63	1.19**	0.62
		(-0.79)	(-0.21)	(1.025)	(0.94)	(1.18)	(1.70)	(0.74)
	Drw_t	-0.27	-0.14	0.31	0.34	0.35	0.67	0.16
		(-1.20)	(-0.44)	(0.77)	(0.69)	(0.58)	(0.84)	(0.16)
	Dy_t	0.028	0.31	0.54	0.15	-0.24	-0.14	-0.17
		(0.08)	(0.58)	(0.79)	(0.18)	(-0.25)	(-0.12)	(-0.12)
Austria	Dp_t	-0.04	-0.05	-0.02	0.057	0.12	0.21	0.28
		(-1.12)	(-0.95)	(-0.26)	(0.49)	(0.97)	(1.40)	(1.19)
	Dw_t	0.0096	0.11	0.14	0.25	0.11	0.39	0.54
		(0.12)	(0.92)	(0.81)	(0.91)	(0.02)	(1.19)	(0.84)
	Drw_t	0.05	0.16	0.17	0.20	-0.0092	0.18	0.13
		(0.60)	(1.28)	(0.94)	(0.55)	(-0.023)	(0.44)	(0.20)
	Dy_t	-0.12	-0.28*	-0.35*	-0.21	-0.46**	-0.75*	-0.91**
		(-1.61)	(-2.59)	(-2.22)	(-0.85)	(-1.89)	(-2.75)	(-1.72)
Canada	Dp_t	0.09	0.09	-0.059	-0.51**	-0.52**	-0.19	0.0018
		(0.56)	(0.41)	(-0.24)	(-1.95)	(-1.88)	(-0.63)	(0.004)
	Dw_t	0.094	0.25	0.19	-0.17	-0.19	0.28	0.92
		(0.43)	(0.83)	(0.52)	(-0.41)	(-0.53)	(0.51)	(1.29)
	Drw_t	0.004	0.15	0.37	0.37	0.31	0.47	0.92
		(0.02)	(0.45)	(0.91)	(0.78)	(0.58)	(0.72)	(1.083)
	Dy_t	0.82*	0.71*	1.01*	0.92*	0.65**	0.45	0.11
		(4.58)	(3.01)	(3.74)	(2.96)	(1.87)	(1.057)	(0.20)

Table 2. The Cumulative Effects of Contractionary (neg) Demand Shocks on Economic Variables (Continued)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} neg_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Finland	Dp_t	0.037	-0.026	0.013	0.19	0.13	0.12	-0.17
		(0.76)	(-0.37)	(0.14)	(1.26)	(0.75)	(0.61)	(-0.63)
	Dw_t	-0.10	-0.023	-0.06	0.32	0.76	0.60	0.38
		(-0.82)	(-0.15)	(-0.29)	(0.88)	(0.95)	(1.10)	(0.46)
	Drw_t	-0.14	0.014	-0.07	0.12	0.61	0.74	0.67
		(-1.20)	(0.095)	(-0.35)	(0.33)	(1.41)	(1.24)	(0.78)
	Dy_t	-0.25*	-0.49*	-0.26	0.85*	0.14	0.64	0.27
		(-2.05)	(-2.67)	(-1.03)	(1.99)	(0.28)	(0.99)	(0.31)
France	Dp_t	0.098	0.48*	0.54*	0.54*	0.50*	0.65*	0.77*
		(1.12)	(4.52)	(4.49)	(3.84)	(3.21)	(3.14)	(2.97)
	Dw_t	-0.13	0.37*	0.78*	1.06*	1.07*	0.95*	1.20*
		(-1.04)	(2.07)	(3.76)	(4.80)	(4.43)	(2.80)	(3.11)
	Drw_t	-0.23*	-0.095	0.19	0.52*	0.57*	0.13	0.55
		(-2.14)	(-0.52)	(0.84)	(2.12)	(2.09)	(0.34)	(1.21)
	Dy_t	1.37	0.76	0.44	0.32	0.26	0.79	0.095
		(1.28)	(0.81)	(0.58)	(1.29)	(0.13)	(1.29)	(0.13)
Germany	Dp_t	-0.062	-0.014	0.17	0.19	0.093	0.27	0.28
		(-0.37)	(-0.06)	(0.57)	(0.19)	(0.33)	(0.37)	(0.28)
	Dw_t	0.063	0.12	0.37	0.28	0.34	1.052**	0.57
		(0.33)	(0.56)	(1.34)	(0.36)	(0.79)	(1.82)	(0.73)
	Drw_t	0.12	0.14	0.20	0.088	0.23	0.78	0.26
		(0.50)	(0.41)	(0.47)	(0.16)	(0.50)	(0.77)	(0.19)
	Dy_t	0.90*	0.78*	0.59*	0.30	0.044	0.15	-0.41
		(8.89)	(5.86)	(3.53)	(1.54)	(0.18)	(0.41)	(-0.85)

Table 2. The Cumulative Effects of Contractionary (neg) Demand Shocks on Economic Variables (Continued)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} neg_{t-}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Italy	Dp_t	0.035	0.18	0.42	0.89*	0.87**	2.11*	1.96*
		(0.22)	(0.74)	(1.23)	(2.27)	(1.78)	(3.51)	(2.39)
	Dw_t	0.15	0.22	0.41	0.20	-0.64	-0.27	0.97
		(0.61)	(0.59)	(0.79)	(0.32)	(-0.19)	(-0.25)	(0.58)
	Drw_t	0.11	0.037	0.061	-0.69	0.25	-2.38*	-0.79
		(0.41)	(0.084)	(0.10)	(-0.95)	(0.70)	(-2.27)	(-0.39)
	Dy_t	0.32*	0.36*	0.19	0.08	-0.034	-0.40	-1.08**
		(2.84)	(2.14)	(0.92)	(0.31)	(-0.11)	(-1.069)	(-1.88)
Japan	Dp_t	0.092	0.17	-0.11	0.16	0.35	0.31	0.066
		(0.51)	(0.72)	(-0.37)	(0.46)	(0.85)	(0.53)	(0.076)
	Dw_t	0.44	0.60	-0.086	0.19	0.49	-0.17	-0.75
		(1.48)	(1.58)	(-0.19)	(0.33)	(0.72)	(-0.18)	(-0.53)
	Drw_t	0.35	0.43	-0.045	-0.033	0.13	-0.48	-0.82
		(1.22)	(1.11)	(-0.094)	(-0.054)	(0.082)	(-1.11)	(-0.63)
	Dy_t	0.46*	0.48*	0.48	0.069	-0.13	-0.68	-1.11
		(2.49)	(1.95)	(1.51)	(0.18)	(-0.27)	(-0.94)	(-1.018)
Netherlands	Dp_t	0.089	0.18	0.23	0.38*	0.29	0.22	0.18
		(0.87)	(1.33)	(1.36)	(1.96)	(1.30)	(0.91)	(0.69)
	Dw_t	0.22	0.10	0.48**	0.48	0.52	0.83**	0.77
		(1.19)	(0.44)	(1.79)	(1.57)	(1.49)	(1.92)	(1.65)
	Drw_t	0.13	-0.081	0.21	0.16	0.22	0.61*	0.58*
		(0.71)	(-0.36)	(0.78)	(0.54)	(0.64)	(2.51)	(2.22)
	Dy_t	0.91*	0.82*	0.78*	0.68*	0.68*	0.78**	0.80**
		(8.85)	(6.07)	(4.60)	(3.50)	(3.18)	(1.89)	(1.81)

Table 2. The Cumulative Effects of Contractionary (neg) Demand Shocks on Economic Variables (Concluded)

Country	Dependent Variable	The Cum. Effect of $\sum_{i=0}^{x} neg_{t-i}$						
		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Sweden	Dp_t	-0.28	0.06	0.097**	0.10	0.015	-0.35	-0.40
		(-0.97)	(1.45)	(1.81)	(0.69)	(0.08)	(-1.28)	(-1.05)
	Dw_t	0.10	0.27*	0.64*	1.021*	0.60	0.23	-0.93
		(1.13)	(1.99)	(4.11)	(2.57)	(1.45)	(0.32)	(-0.99)
	Drw_t	0.12	0.19	0.50*	0.79**	0.55	0.56	-0.65
		(1.38)	(1.36)	(3.35)	(1.85)	(1.00)	(0.69)	(-0.62)
	Dy_t	-0.0045	-0.096	-0.15	-0.13	-0.25	0.42	2.17
		(-0.06)	(-0.78)	(-0.96)	(-0.26)	(-0.37)	(0.39)	(1.29)
United Kingdom	Dp_t	-0.43**	0.13	0.19	0.33	0.21	0.43	0.24
		(-1.74)	(0.43)	(0.50)	(0.76)	(0.38)	(0.86)	(0.43)
	Dw_t	-0.18	0.064	0.14	-0.051	-0.04	-0.48	-0.27
		(-0.84)	(0.21)	(0.39)	(-0.12)	(-0.087)	(-1.01)	(-0.64)
	Drw_t	0.24	-0.07	-0.013	-0.38	-0.22	-0.91	-0.47
		(0.88)	(-0.17)	(-0.026)	(-0.68)	(-0.35)	(-1.32)	(-0.58)
	Dy_t	0.64*	0.18	0.28	-0.37	-0.0066	0.02	0.11
		(3.22)	((0.80)	(1.02)	(-1.23)	(-0.021)	(0.057)	(0.27)
United States	Dp_t	-0.054	-0.11	-0.53*	-0.60*	-0.48	0.31	0.25
		(-0.30)	(-0.48)	(-2.21)	(-2.46)	(-1.54)	(1.06)	(0.68)
	Dw_t	-0.04	-0.16	-0.42**	-0.52*	-0.57*	-0.30	0.21
		(-0.26)	(-0.75)	(-1.71)	(-2.05)	(-2.11)	(-0.90)	(0.53)
	Drw_t	0.013	-0.052	0.11	0.08	-0.19	-0.61	-0.045
		(0.07)	(-0.21)	(0.37)	(0.24)	(-0.52)	(-1.41)	(-0.088)
	Dy_t	1.11*	1.22*	1.58*	1.70*	1.65*	1.42*	1.09*
		(7.89)	(6.34)	(7.51)	(7.98)	(7.39)	(5.50)	(3.29)

Notes:

$$Dp_t = a_0 + \sum_{i=0}^{x} a_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} a_{2pi} pos_{t-i} + \sum_{i=0}^{x} a_{2ni} neg_{t-i} + \sum_{i=0}^{x} a_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} a_{4i} Dqs_{t-i} + \eta_{pt}$$

$$Dw_t = b_0 + \sum_{i=0}^{x} b_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} b_{2pi} pos_{t-i} + \sum_{i=0}^{x} b_{2ni} neg_{t-i} + \sum_{i=0}^{x} b_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} b_{4i} Dqs_{t-i} + \eta_{wt}$$

$$Drw_t = c_0 + \sum_{i=0}^{x} c_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} c_{2pi} pos_{t-i} + \sum_{i=0}^{x} c_{2ni} neg_{t-i} + \sum_{i=0}^{x} c_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} c_{4i} Dqs_{t-i} + \eta_{rwt}$$

$$Dy_t = d_0 + \sum_{i=0}^{x} d_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} d_{2pi} pos_{t-i} + \sum_{i=0}^{x} d_{2ni} neg_{t-i} + \sum_{i=0}^{x} d_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} d_{4i} Dqs_{t-i} + \eta_{yt}$$

- Coefficients measure the cumulative response of variables to expansionary and contractionary demand shocks at various lag lengths, x.
- t-ratios are in parentheses.
- * and ** denote statistical significance at the 5 and 10 percent levels, respectively.

Table 3. Asymmetry in Real Wage and Output Adjustments to Expansionary and Contractionary Demand Shocks

		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Australia	Drw_t	0.53*	0.89*	0.07	-0.05	-0.31	-0.64	-0.16
		(2.69)	(3.014)	(0.20)	(-0.13)	(-0.69)	(-1.22)	(-0.24)
	Dy_t	0.17	0.21	-0.73	-0.12	0.73	0.46	-0.10
		(0.52)	(0.42)	(-1.23)	(-0.17)	(1.028)	(0.60)	(-0.12)
Austria	Drw_t	-0.14**	-0.14	-0.25**	-0.22	-0.11	-0.21	-0.16
		(-1.71)	(-1.18)	(-1.73)	(-1.32)	(-0.58)	(-0.91)	(-0.59)
	Dy_t	0.23*	0.47*	0.57*	0.57*	0.80*	1.12*	1.15*
		(3.28)	(4.68)	(4.56)	(3.96)	(5.06)	(6.10)	(13.61)
Canada	Drw_t	-0.028	-0.46	-0.67**	0.07	0.53	-0.15	-0.35
		(-0.13)	(-1.39)	(-1.65)	(0.15)	(1.06)	(-0.27)	(-0.58)
	Dy_t	-0.12	-0.18	-0.68*	-0.42	-0.21	0.03	0.56
		(-0.69)	(-0.77)	(-2.49)	(-1.40)	(-0.85)	(0.084)	(1.40)
Finland	Drw_t	0.37*	-0.31*	-0.02	-0.08	-0.22	-0.15	-0.29
		(2.62)	(-1.85)	(-0.097)	(-0.24)	(-0.55)	(-0.28)	(-0.36)
	Dy_t	0.60*	1.01*	0.85*	0.40	0.58	0.56	0.14
		(3.99)	(4.82)	(3.27)	(1.00)	(1.25)	(0.98)	(0.17)
France	Drw_t	0.42*	0.33*	0.13	0.13	0.01	0.30	0.21
		(3.82)	(2.077)	(0.71)	(0.66)	(0.046)	(1.095)	(0.65)
	Dy_t	-0.01	0.23	0.46	0.50	0.46	0.05	0.59
		(-0.05)	(0.91)	(1.66)	(1.59)	(1.28)	(0.11)	(1.11)
Germany	Drw_t	-0.22	0.46	0.77*	0.97*	0.59	0.69	1.13
		(-0.89)	(1.41)	(2.67)	(2.25)	(1.27)	(1.17)	(0.68)
	Dy_t	-0.10	-0.13	0.02	0.19	0.41*	0.13	0.78*
		(-1.02)	(-0.99)	(0.13)	(1.24)	(2.46)	(0.60)	(2.97)
Italy	Drw_t	0.09	-0.11	0.12	0.48	0.36	0.83	-0.40
		(0.39)	(-0.33)	(0.26)	(0.91)	(0.82)	(1.55)	(-0.31)
	Dy_t	-0.27*	-0.06	-0.13	-0.014	-0.026	-0.07	0.19
		(-2.95)	(-0.46)	(-0.81)	(-0.074)	(-0.12)	(-0.27)	(0.52)

Table 3 (concluded). Asymmetry in Real Wage and Output Adjustments to Expansionary and Contractionary Demand Shocks

		x=0	x=1	x=2	x=3	x=4	x=6	x=8
Japan	Drw_t	-0.35	-0.41	0.66	0.65	0.43	1.95*	2.16*
		(-1.18)	(-1.15)	(1.46)	(1.17)	(0.68)	(4.37)	(2.98)
	Dy_t	0.71*	0.61*	0.67*	1.25*	1.61*	2.33*	2.79*
		(4.25)	(2.69)	(2.23)	(3.43)	(4.85)	(4.53)	(4.63)
Netherlands	Drw_t	-0.38*	0.031	-0.33	-0.02	-0.38	-0.46	-0.49
		(-2.37)	(0.14)	(-1.24)	(-0.066)	(-0.95)	(-1.53)	(-1.36)
	Dy_t	-0.09	0.03	0.07	0.31	0.36	0.14	0.35
		(-0.96)	(0.23)	(0.42)	(1.56)	(1.49)	(0.27)	(0.64)
Sweden	Drw_t	-0.16*	-0.06	-0.10	-0.17	-0.12	-0.12	0.08
		(-2.08)	(-0.52)	(-0.76)	(-0.45)	(-0.25)	(-0.18)	(0.08)
	Dy_t	0.032	0.052	0.03	0.13	0.07	-0.02	-0.10
		(0.49)	(0.51)	(0.22)	(0.33)	(0.14)	(-0.02)	(-0.066)
United Kingdom	Drw_t	-0.39*	0.036	-0.21	0.05	-0.25	1.19*	0.29
		(-2.16)	(0.14)	(-0.65)	(0.14)	(-0.59)	(2.08)	(0.40)
	Dy_t	0.14	0.42*	0.20	0.90*	0.51*	0.75*	0.53
		(1.07)	(2.86)	(1.13)	(4.67)	(2.32)	(2.51)	(1.51)
United States	Drw_t	0.18	0.23	0.44	0.85*	1.34*	2.11*	1.26*
		(1.25)	(1.096)	(1.59)	(2.43)	(3.23)	(4.43)	(2.24)
	Dy_t	-0.55*	-0.76*	-1.33*	-1.46*	-1.43*	-0.84*	-0.41
		(-4.86)	(-4.71)	(-6.76)	(-4.99)	(-5.98)	(-2.82)	(-1.07)

Notes:

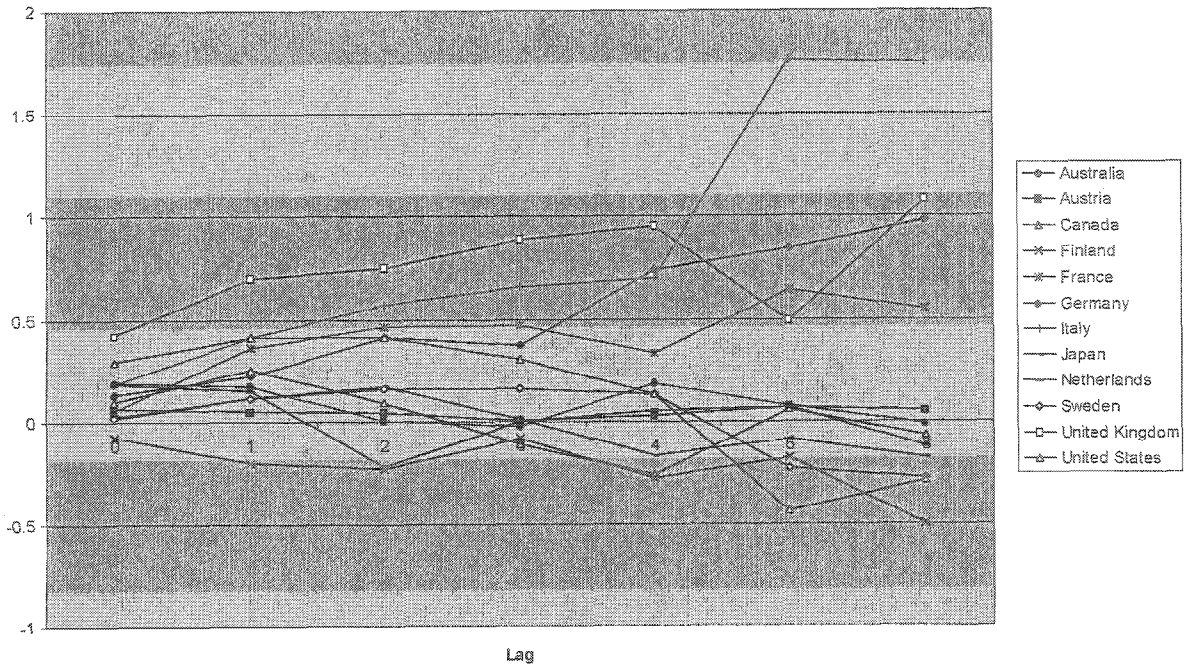
$$Drw_t = c_0 + \sum_{i=0}^{x} c_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} c_{2pi} pos_{t-i} + \sum_{i=0}^{x} c_{2ni} neg_{t-i} + \sum_{i=0}^{x} c_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} c_{4i} Dqs_{t-i} + \eta_{rwt}$$

$$Dy_t = d_0 + \sum_{i=0}^{x} d_{1i} E_{t-i-1} Dn_{t-i} + \sum_{i=0}^{x} d_{2pi} pos_{t-i} + \sum_{i=0}^{x} d_{2ni} neg_{t-i} + \sum_{i=0}^{x} d_{3i} E_{t-i-1} Dq_{t-i} + \sum_{i-0}^{x} d_{4i} Dqs_{t-i} + \eta_{yt}$$

- Coefficients indicate the difference in the cumulative response of real wage growth, $\sum_{i=0}^{x}(c_{2pi} - c_{2ni})$, or output growth, $\sum_{i=0}^{x}(d_{2pi} - d_{2ni})$, to expansionary and contractionary demand shocks at various lag length x.
- t-ratios are in parentheses.
- *and ** denote statistical significance at the 5 and 10, percent levels respectively.

Figure 1. Graphs for Price Inflation

The Cumulative Effects of Expansionary Demand Shocks on Price Inflation



The Cumulative Effects of Contractionary Demand Shocks on Price Inflation

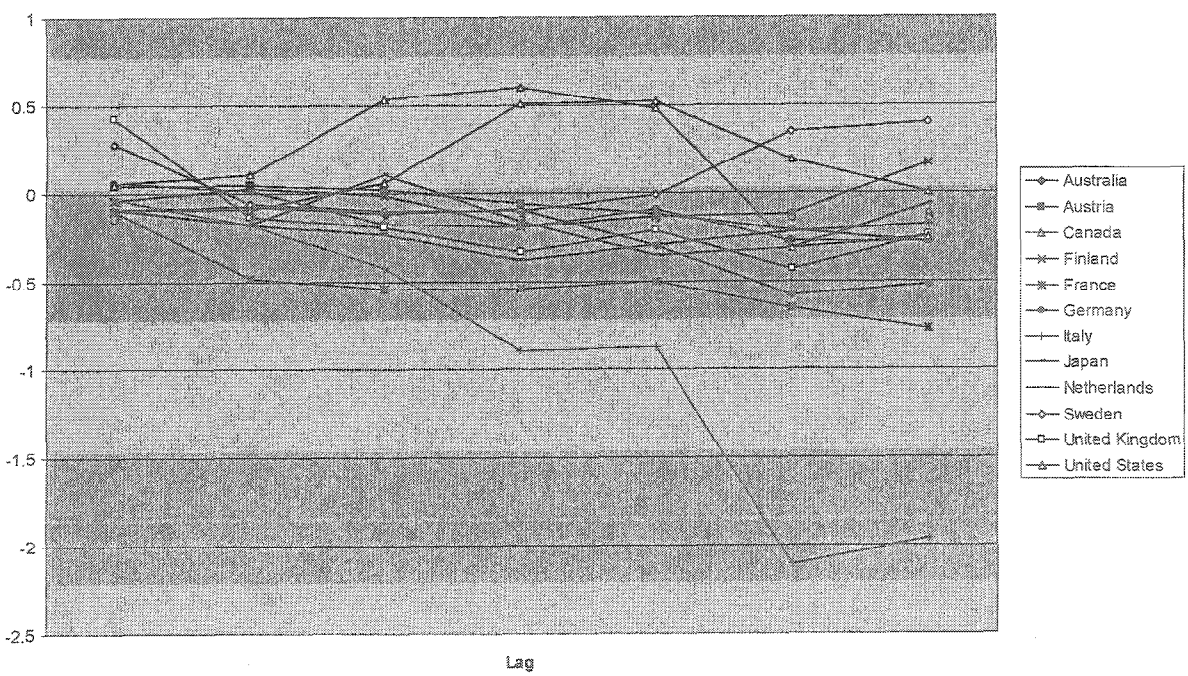
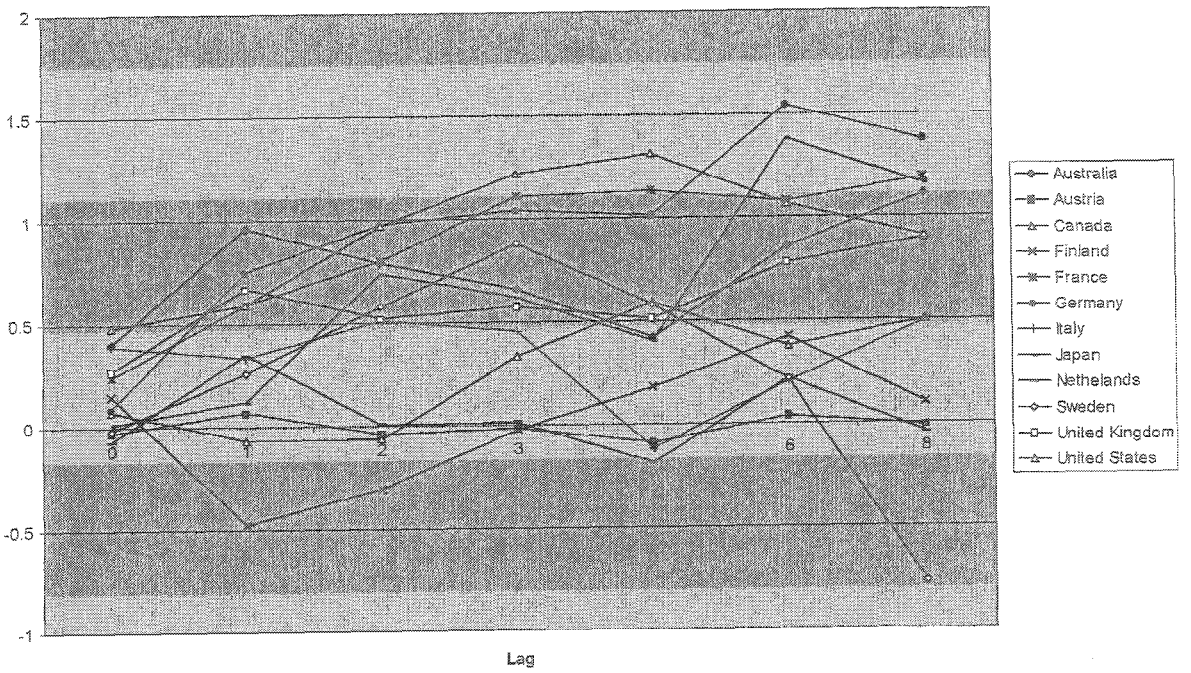


Figure 2. Graphs for Wage Inflation

The Cumulative Effects of Expansionary Demand Shocks on Wage Inflation



The Cumulative Effects of Contractionary Demand Shocks on Wage Inflation

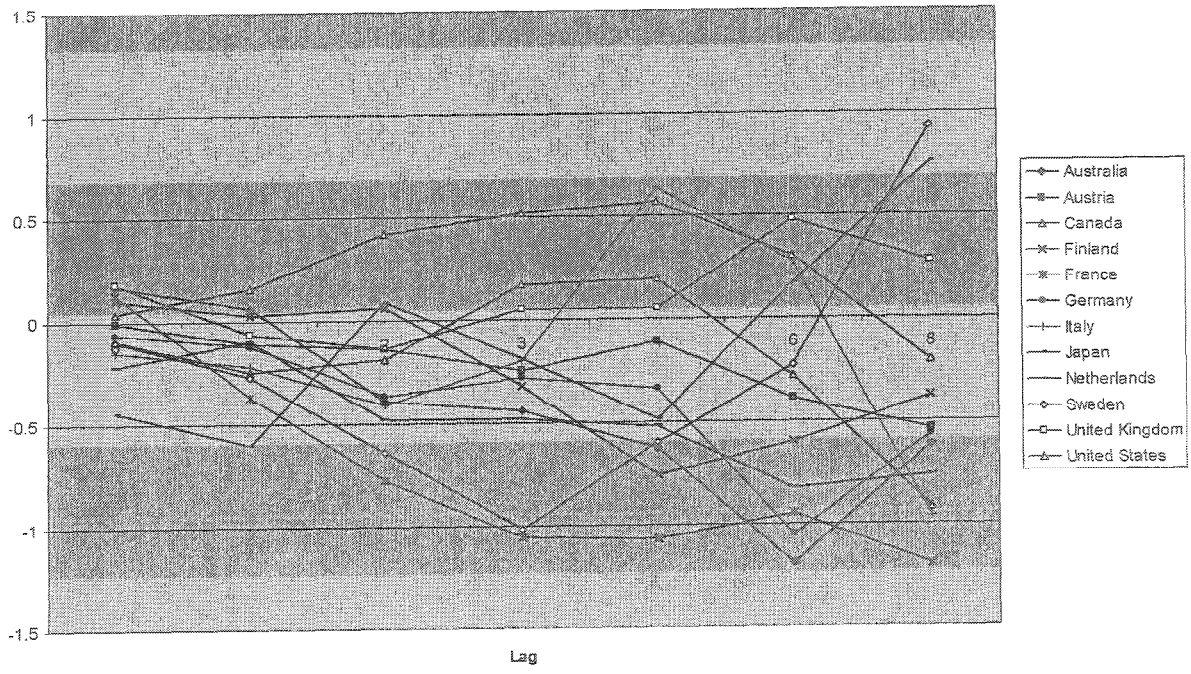
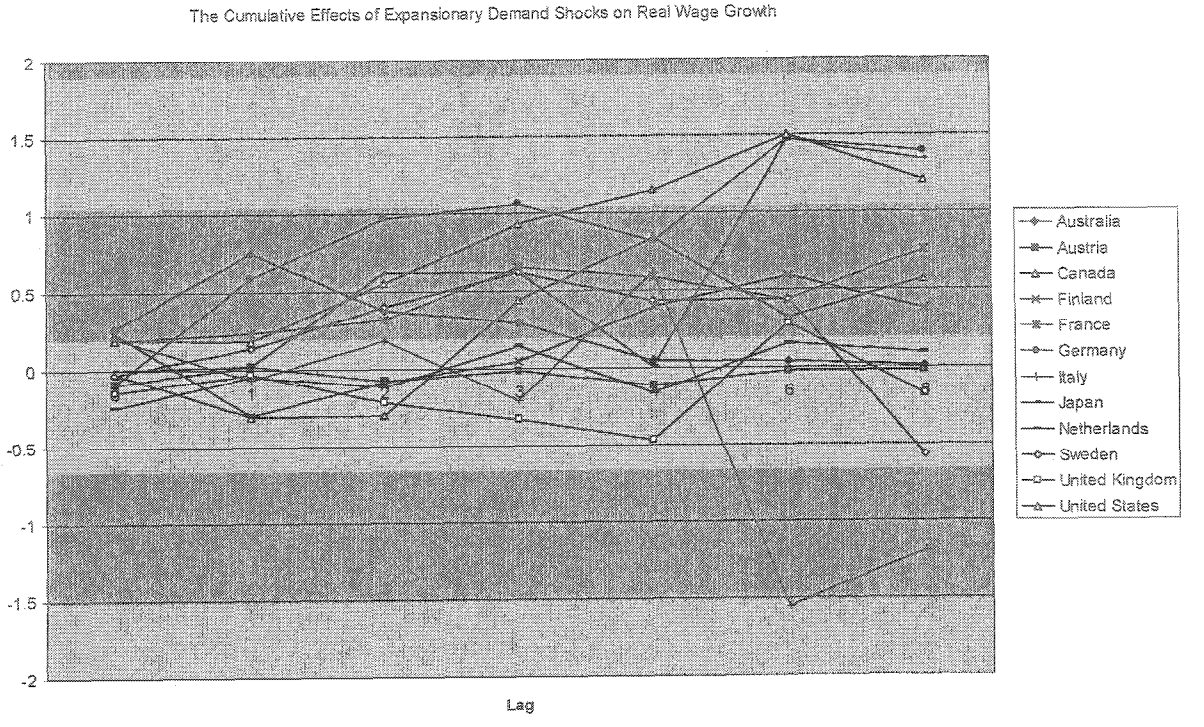


Figure 3. Graphs for Real Wage Growth



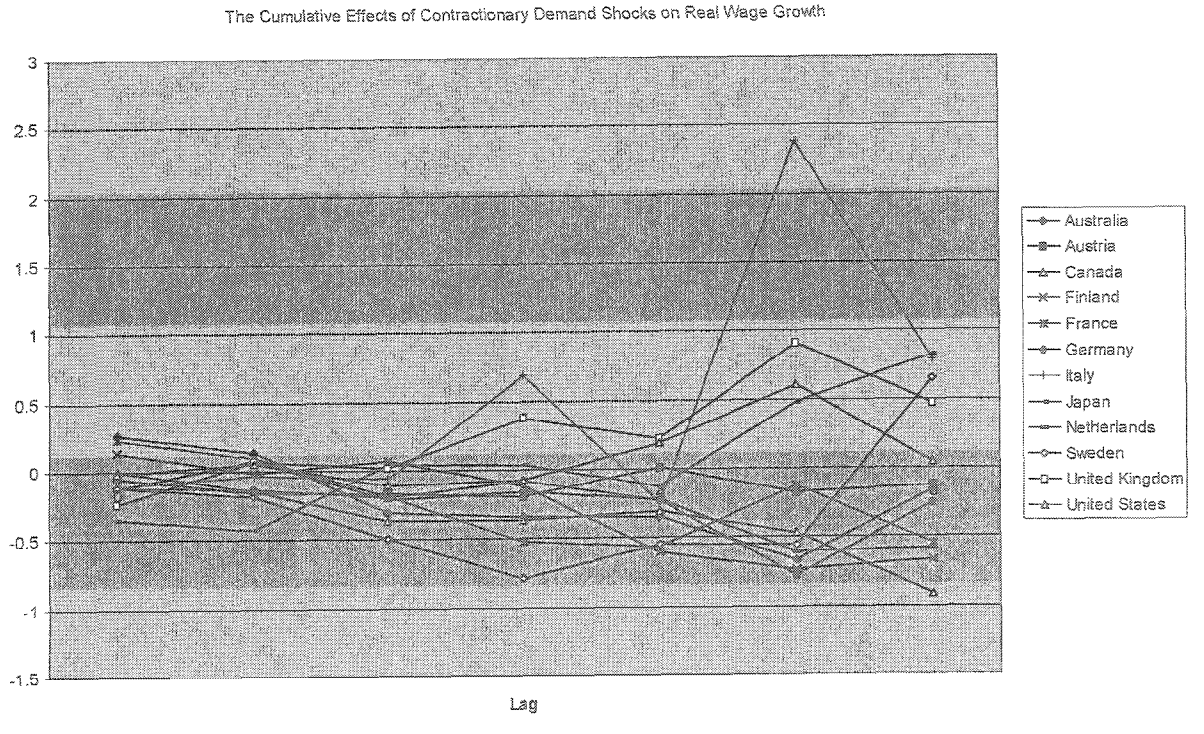
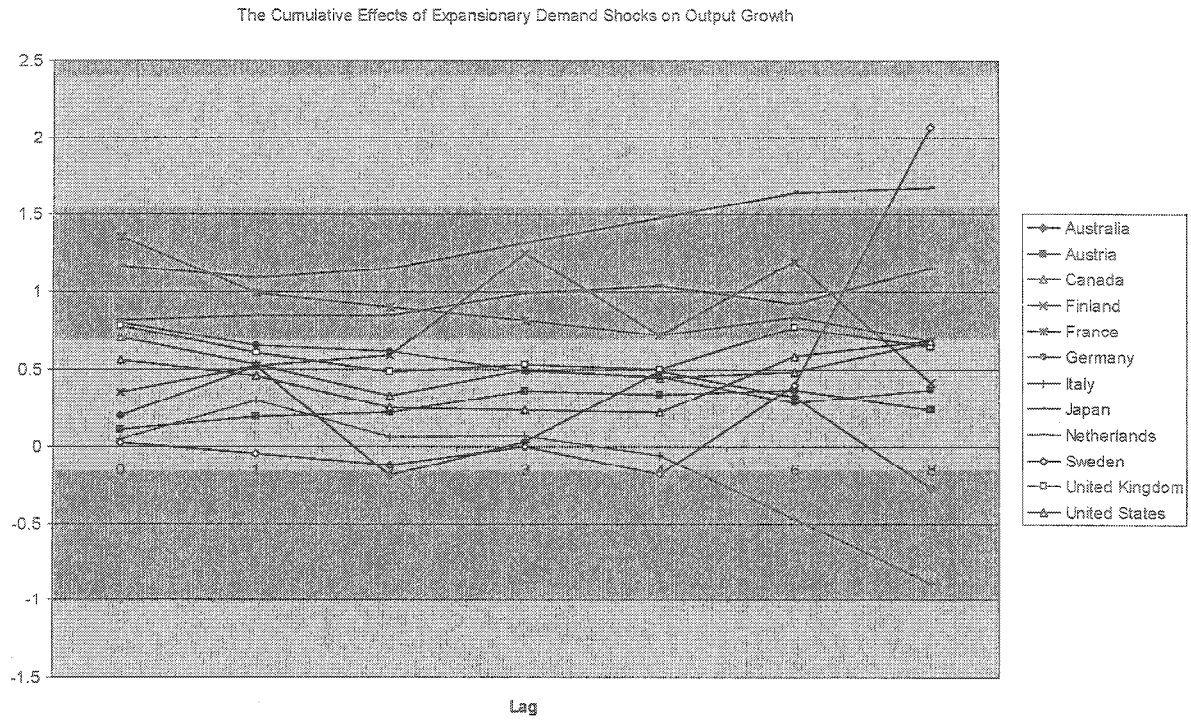


Figure 4. Graphs for Output Growth



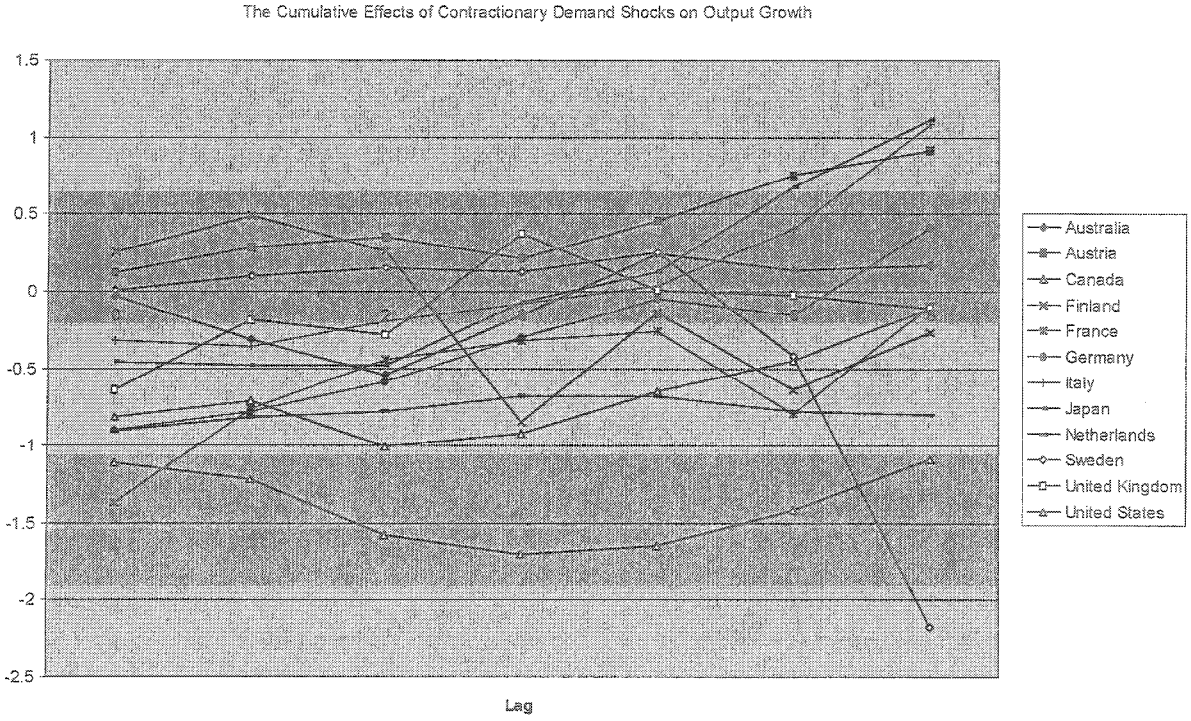
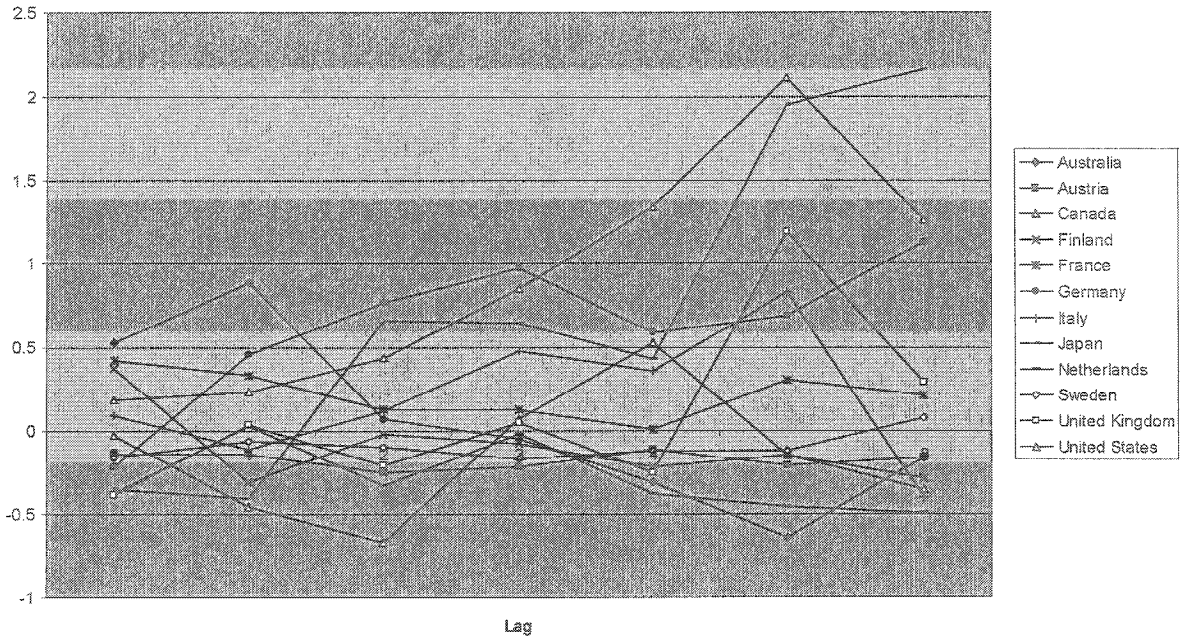
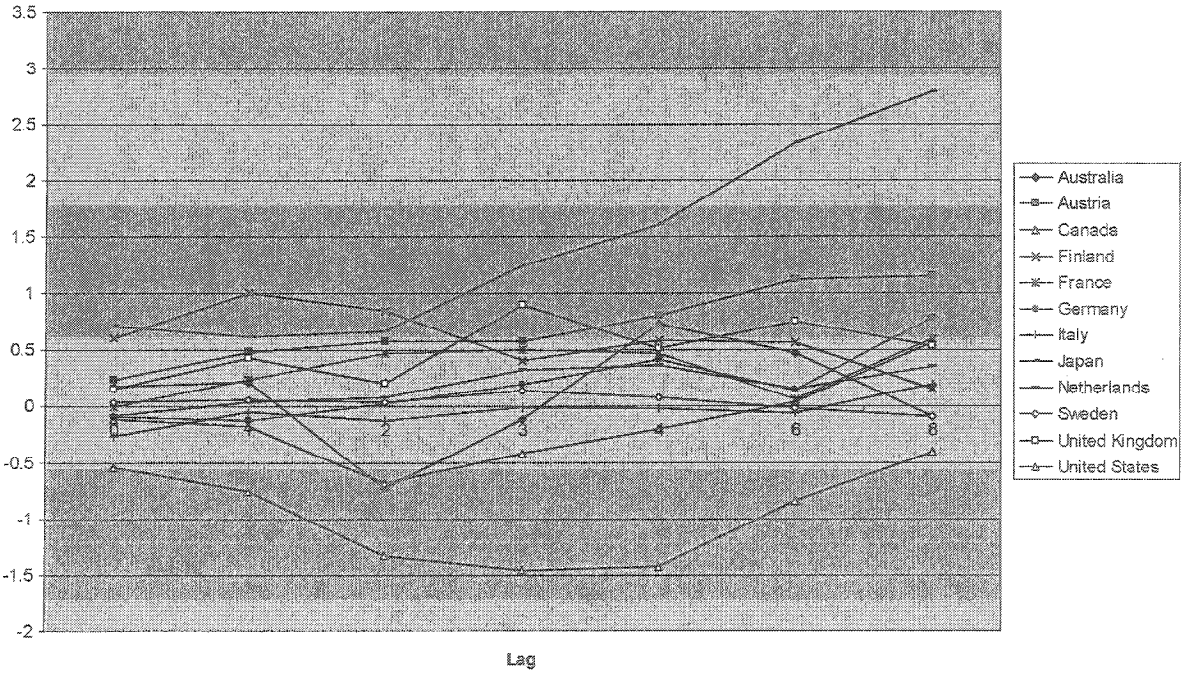


Figure 5. Asymmetric Effects of Demand Shocks

The Cumulative Difference in the Response of Real Wage Growth to Expansionary and Contractionary Demand Shocks



The Cumulative Difference in the Response of Output Growth to Expansionary and Contractionary Demand Shocks



Appendices

I. Econometric Methodology

The surprise terms that enter models (1) through (4) are unobservable, necessitating the construction of empirical proxies before estimation can take place. Thus, the empirical models include equations describing agents' forecast of aggregate demand growth and the change in energy price. The predictive values from these equations are the proxies for agents' expectations of the change in aggregate demand and the energy price.

Obtaining a proxy for agents' forecast of nominal GDP or GNP growth is complicated by the maintained hypothesis that the level of nominal GDP or GNP is endogenous, which is supported by the results of the test suggested by Engle (1982). Anticipated aggregate demand growth is generated by taking the fitted values of a reduced form equation for the change in the log value of nominal GNP or GDP in which the explanatory variables include lagged values of the change in theoretical determinants of aggregate demand, as follows: four lags of the change in the short-term interest rate and four lags of the change in the log value of real output, the price level, the energy price, government spending, and the money supply. Surprises that enter the empirical models are then formed by subtracting agents' forecasts from the actual growth in nominal GDP or GNP.

The energy price is exogenous according to the results of the test suggested in Engle (1982). Obtaining a proxy for ex-ante forecasts of the energy price is complicated by the assumption that the generating process experienced a structural change between 1973 and 1974. This assumption is supported by the results of a formal test suggested in Dufour (1982). For both the period 1960.I–1973.IV and the period 1974.I–2000.IV, the generating process is modeled as a fourth-order autoregressive process. The proxy for energy price surprises is then formed by subtracting these forecasts from the actual change in the energy price.

Where test results also support structural break in the aggregate demand equation, dummy variables are included in the forecast equations. Upon accounting for these dummy variables, testing for structural break in the estimated empirical models proved insignificant.

Surprises that enter the empirical models are then formed by subtracting agents' forecasts from the actual growth in each variable. Shocks are purely random, i.e., i.i.d., and orthogonal to variables in the information set. These shocks, as well as detailed parameter estimates from the forecast equations, are available upon request.

Given concerns about the "generated regressors" problem and in order to obtain efficient estimates and ensure correct inferences (i.e., to obtain consistent variance estimates), the empirical models are estimated jointly with the equation that determines the proxy variables following the suggestions of Pagan (1984 and 1986). To account for the endogeneity of demand variables, instrumental variables are used in the estimation of the empirical models. The instrument list includes four lags of the change in the interest rate and four lags of the change in the log value of real output, the price level, government spending, and the money supply as well as the change in current and four lags of the log value of the energy price.

To test for the asymmetric effects of positive and negative aggregate demand shocks, the positive and negative components of aggregate demand shocks are defined as follows:

$$neg_t = -\frac{1}{2}\{abs(Dns_t) - Dns_t\}$$

$$pos_t = \frac{1}{2}\{abs(Dns_t) + Dns_t\}$$

abs(.) is the absolute value operator. Dns_t is the shock to the growth of nominal GDP or GNP at time *t*, and neg_t and pos_t are the negative and positive components of the shocks, respectively. The mathematical definitions of these components follow the suggestions of Cover (1992) to facilitate joint estimation.

Following the suggestions of Engle (1982), the results of the test for serial correlation in simultaneous equation models are consistent with the presence of fourth-order autoregressive errors in some models. To maintain comparability (a standard assumption in cross-country investigations), it is assumed in all models that the error term follows an AR(4) process. To filter out serial correlation, the estimated model is transformed through the filter $\left(1-\rho_1 L^1-\rho_2 L^2-\rho_3 L^3-\rho_4 L^4\right)$ where ρ_i are the estimates of the serial correlation parameters and L^i are the lag operators such that $L^i X_t = X_{t-i}$. The estimated residuals from the transformed models have zero means and are serially independent.

The paper's qualitative evidence remains robust in a number of exercises that include varying the lag length and variables in the information and the instruments list, varying the specification of the final models, and using a 2-step estimation procedure. Details of these exercises, as well as all diagnostic tests, are available upon request.

II. Data Sources

1. Real Output: Index of industrial output. Generally, the coverage of this index comprises mining, quarrying, manufacturing, electricity, gas, and water according to the UN International Standard Industrial Classification (ISIC).

2. Price Level: The consumer price index.

3. Nominal Wage: Index of the wage rate per worker employed in the industrial sector per specified time period.

4. Money Stock: The sum of currency outside banks and private sector demand deposits.

5. Short-Term Interest Rate: Representatives of short-term market rates for the various countries, i.e., rates at which short-term borrowing is affected between financial institutions or rates at which short-term government paper is issued or traded in the market.

6. Government Spending: Nominal values of all payments by government.

7. Aggregate Demand: Nominal values of GNP or GDP.

8. The Energy Price: Index of average world crude petroleum price.

Sources: All data are taken from *International Financial Statistics*, available from the International Monetary Fund, Washington, D.C. The qualitative results remain robust in an experiment in which data are adjusted using a seasonality filter.

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