CAPACITY UTILIZATION-INFLATION LINKAGES: A CROSS-COUNTRY ANALYSIS

by
Gabriel S. P de Kock and Tania Nadal-Vicens

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ABSTRACT

This paper analyzes whether capacity utilization in manufacturing is a reliable inflation indicator over and above economy-wide indicators of inflationary pressure and examines different theories on the propagation of inflation by testing their implications for the relationship between capacity utilization and inflation. Three mechanisms whereby shocks to manufacturing can impact on inflation are explored: First, direct pressure on producer prices in manufacturing arising from bottlenecks and a slowdown in productivity growth at high operating rates, second, spill-overs of manufacturing-sector wage increases into inflationary wage growth in the service sector, and finally, investment in manufacturing capacity that stimulates expansion, capacity pressures, and inflation on an economy-wide basis.

We find that manufacturing capacity utilization has marginal predictive power for inflation in seven out of 15 major OECD economies and that the inflationary impact of an increase in manufacturing operating rates tends to be sizable. The links between capacity utilization and inflation that we uncover suggest that the mechanisms that propagate inflationary impulses differ widely among nations. In the U.S. there is strong evidence that changes in manufacturing activity impact on inflation through unit labor costs and finished goods producer prices. By contrast, wage contagion appears to be a crucial element of the inflation process in Japan. It also plays a role in Europe, particularly in Germany. Finally, only in Germany of the major capital-goods producing economies, does capital goods prices unambiguously play a role in transmitting manufacturing-sector shocks to economy-wide price indices.

JEL Classification: E31, E37, F41, F47, J30

Capacity Utilization-Inflation Linkages: A Cross-Country Analysis

I. Introduction

The 1994-95 recovery in continental Europe posed interesting questions about the origins and propagation of inflation in industrial economies. The expansion was lopsided, with industrial output buoyant but overall economic growth sluggish by past standards. As a result, near-peak manufacturing capacity utilization rates coincided with unusually high unemployment. In fact, capacity pressures in Europe were so acute that manufacturing operating rates for the Western industrial world as a whole were high by past standards.

The unusual juxtaposition of capacity pressures in industry and under-used resources on an economy-wide basis made predicting inflation particularly difficult at a stage of the business cycle when inflation prospects were of special concern to policy makers. On the one hand, economy-wide inflation indicators such as the GDP gap and the unemployment rate suggested that the recovery was somewhat weaker than usual, and that inflation was likely to remain subdued. On the other hand, there was a danger that higher than usual capacity utilization could spark inflation at an earlier stage in the cycle.

The objectives of this paper is two-fold. It, first, analyzes the inflation implications of high levels of capacity utilization. Data from 15 OECD economies is used to test whether capacity utilization in manufacturing is a reliable inflation indicator over and above economy-wide indicators of inflationary pressure. Then it proceeds to examine different theories on the propagation of inflation by testing their implications for the relationship between capacity utilization and inflation. Three mechanisms whereby shocks to manufacturing can impact on inflation are explored: (i) direct pressure on producer prices in manufacturing arising from bottlenecks and a slowdown in productivity growth at high operating rates, (ii) spill-overs of manufacturing-sector wage increases into inflationary wage growth in the service sector, and (iii) investment in manufacturing capacity that stimulates expansion, capacity pressures, and inflation on an economy-wide basis.

We find that manufacturing capacity utilization has marginal predictive power for inflation in seven out of 15 major OECD economies and that the inflationary impact of an increases in manufacturing operating rates tends to be sizable. Furthermore, in about one-half of the countries in our sample shocks to capacity utilization account for more than one-tenth of the variation in inflation rates.

The links between capacity utilization and inflation that we uncover suggest that the mechanisms that propagate inflationary impulses differ widely among nations. In the U.S there is strong evidence that changes in manufacturing activity impact on inflation through unit labor costs and finished goods producer prices, but no sign that wage contagion plays a role. By contrast, wage contagion appears to be a crucial element of the inflation process in Japan. It also plays a role in Europe, particularly in Germany. Finally, only in Germany of the major capital-goods producing economies, does capital goods prices unambiguously play a role in transmitting manufacturing-sector shocks to economy-wide price indices.

The plan of the paper is as follows: We start with a brief comparison of capacity utilization and output growth in the current and earlier recoveries, followed by a discussion of the linkages between manufacturing operating rates and inflation associated with different inflation propagation mechanisms. The subsequent empirical sections first establish that capacity utilization predicts inflation, but not everywhere, and then evaluate evidence in favor of each of the potential links in turn. The conclusion summarizes the results and suggests avenues for further research.

II. Capacity Pressures in the Current Recovery

European industry has operated at rates of capacity utilization well above the historical norm throughout the current recovery. This can be seen in Chart 1, which shows a GDP-weighted aggregate of capacity utilization in continental European OECD member countries. Capacity pressures emerged early for two main reasons. First, the upturn has followed a relatively short recession and years of unusually low rates of manufacturing fixed investment. European firms have invested little in new plant and equipment in recent years and have scrapped existing equipment at an unusually high pace in aggressive efforts to downsize their operations.[1]

Second, and more important, the expansion has been biased towards the industrial sector as a result of strong export growth and weak domestic demand. Export growth has led the current European recovery because of the desynchronization of the current global business cycle. Europe had barely slipped into recession when demand in the English-speaking countries, East Asia and Latin America started picking up momentum. Robust foreign demand, coupled with currency devaluations in the wake of the 1992 ERM crisis, stimulated European exports. At the same time, domestic demand, which falls more heavily on the service sector, stagnated as slow wage growth and government fiscal consolidation weighed on private budgets. As a result, service-sector output stagnated, leading to sluggish GDP growth and unusually high and persistent unemployment (Charts 2 and 3).

The unusual recovery in continental Europe promptly raised capacity utilization rates while GDP growth fell short of historical norms and unemployment remained stubbornly high. Reflecting trends in Europe, manufacturing capacity utilization for the Western industrial (OECD) countries as a whole (on a GDP-weighted basis) is also rapidly approaching past cyclical peaks (Chart 4). The prospect of the Western industrial world running into manufacturing capacity constraints in the near future has led some observers to argue that the best news on inflation is over, and that a turnaround in price trends is in the offing.[2] We now turn to the rationale for this point of view.

III. Manufacturing Capacity Utilization and Inflation: Theory

Standard macroeconomic models explain short-run changes in the inflation rate in terms of a Keynesian Phillips Curve, that is by deviations of aggregate output from its potential (the GDP gap) or deviations of unemployment from the natural rate, or NAIRU. Why, then, should a high rate of capacity utilization in manufacturing, that is, a high utilization rate of existing plant and equipment, ignite inflation, especially if there are ample under-utilized resources in the economy as a whole? Proponents of a link between capacity utilization and inflation offer three main explanations that, in effect, emphasize different ways in which inflationary impulses spread through the economy.[3] The first and most direct, claims that high levels of capacity utilization are associated with slow productivity growth, rising unit labor costs, and associated price pressures. The second, which we can call the "wage-contagion hypothesis", argues that rapid expansion and high utilization rates in industry engender rapid manufacturing-sector wage rises that spill over into inflationary wage growth in the government and service sectors. According to the third, capacity pressures in industry lead firms to invest in new plant and equipment, thereby stimulating economic expansion and capacity pressures, and, hence, inflation on an economy-wide basis.

There are, in fact, three mechanisms that create a direct link between manufacturing capacity utilization to prices.[4] The first is the association of high operating rates, at least after some point, with slow productivity growth, rising unit labor costs and direct pressure on manufactured goods prices. The second is cost-increasing bottlenecks that typically arise when utilization rates are high. Finally, producers tend to have more pricing power when supply is scarce relative to demand, which allows them to increase profit margins and to pass cost increases on to buyers more readily.[5] These mechanisms apply only to manufacturing goods prices, but will be important for broader price indices if the cyclical variation in inflation rates is dominated by movements in goods prices.

The wage-contagion hypothesis has its origins in the so-called Scandinavian model of inflation [Aukrust (1977), Aukrust *et al* (1967)].[6] It applies most forcefully to countries with strong trade unions, highly centralized wage bargaining and egalitarian political traditions. In these circumstances, manufacturing wage settlements set the tone for other sectors because unions try to maintain their members' real wages relative to those in manufacturing. Unions in the government and private service sectors are able to negotiate wage settlements that are closely tied to those in manufacturing because these sectors are sheltered from foreign competition. Thus, high levels of manufacturing capacity utilization that are typically associated with high profits and rapidly rising wages in manufacturing spill over into rapid wage increases throughout the economy. Rapid wage growth in manufacturing, as such, need not be inflationary, since it is often accompanied by rapid productivity growth. Generous wage settlements outside manufacturing tend to be inflationary, however, because they are not typically accompanied by large productivity gains. Inflationary pressures are subsequently spread further as price increases spill over into indexed wage contracts and social benefits payments.[7] For wage contagion to occur in the face of high unemployment, however, it is necessary that unemployed workers have little impact on the wage claims of employed workers. Such a division of workers into insiders and outsiders is especially characteristic of European labor markets.[8]

The third, and most indirect, hypothesis links manufacturing capacity pressures to future inflation through investment spending. It starts with the intuitively plausible supposition that firms faced with capacity constraints will try to expand their productive capacity by investing in new plant and equipment. Moreover, since high utilization rates are typically associated with healthy profits, they will have the means to do so. High investment spending leads to output and income growth in the capital goods and construction industries. Increased demand by the recipients of the higher incomes in these industries put further inflationary pressure on the productive capacity of the manufacturing sector and eventually on the economy as a whole.

It is to be expected that capacity pressures will take much longer to impact inflation through the investment channel than directly through producer prices or through wage contagion, simply because there are long delays in the planning and execution of investment projects. In addition, the investment link is likely to be stronger in countries that are important capital goods producers because the domestically produced component of business fixed investment is likely to be large in such countries.[9] If, by contrast, a country imports much of its capital goods, some of the investment spending engendered by high utilization rates is likely to spill over to foreign capital goods producing countries.

IV. Does Capacity Utilization Predict Inflation?

We start our empirical analysis of the links between manufacturing capacity utilization and inflation by asking whether there is a reliable predictive relationship between manufacturing capacity utilization and general inflation. To evaluate whether there is such a relationship, we pose a conceptually simple question: "Does manufacturing-sector capacity utilization provide a signal about future inflation beyond the information provided by economy-wide measures of inflationary pressure?" Posing the question in terms of marginal predictive power is not only standard practice. It is also particularly informative at a time when capacity utilization and economy-wide indicators of inflation give potentially conflicting signals. We do not attempt to test, at this point, whether such a signal is associated with any particular link between operating rates and inflation discussed above. That topic is taken up in the next section.

IV.1 A Note on Methodology

To test whether capacity utilization predicts inflation, or whether a particular link is responsible for its predictive power, we rely on variants of Granger-causality tests based on estimated vector-autoregession models. Such tests are clearly indicated when we want to determine whether an variable has marginal predictive content for another economic variable of interest.

Are variants of Granger-causality tests appropriate, however, when we want to draw inferences about the validity of different theories about inflation? This question arises because it is well-known that tests that associate causality with temporal precedence cannot be used to draw inferences about the structure of the economy [Cooley and Leroy (1985)]. However, we look at different theories of inflation from the point of view of their implications for how inflationary impulses in the manufacturing sector spread through the economy over time. Because the implications of different theories are stated in terms of the dynamic relationships among macroeconomic variables, they invariably embody elements of temporal precedence. (For example, the wage spill-overs that the "Scandinavian model" identify as a crucial element of the inflation process imply that wage changes in industry predict wage changes in the service sector.) For this reason, Grange-Sims "causality" tests are well suited to shed light on the validity of different inflation theories.

We use a generalization of a standard Granger-causality test to determine whether capacity utilization predicts inflation. It is designed to test whether capacity utilization predicts inflation either directly, or indirectly by predicting economy-wide inflation indicators. The test can be explained as follows: Consider a vector of variables y_t that includes capacity utilization, a number of economy-wide inflation indicators (such as the unemployment rate) and an inflation rate. Let the autoregressive representation of the data be given by

(4.1) $[I-A_1(L)]y_t = u_t,$

and the contemporaneous correlations (ordering) by

(4.2) $[I-A_0]u_t = \upsilon_t,$

where υ_t are the orthogonalized innovations to the system. The moving-average representation of the model is

(4.3) $y_t = [I-A_1(L)]^{-1}[I-A_0]^{-1}\upsilon_t = B(L)[I-A_0]^{-1}\upsilon_t\,.$

Let capacity utilization be the first variable in the vector y_t, $y_{1,t}$. Denote the vector of economy-wide inflation indicators by $y_{2,t}$ and let the inflation rate be the last element of y_t, $y_{3,t}$. The null hypothesis y_1 has no indirect or direct predictive value for y_3 can be stated in terms of the moving-average representation of the model, that is, $B_{3,1}(L) = 0$. By stating the hypothesis in this way, we preclude theoretically-derived restrictions on A_0 from influencing our inferences. The restriction that $B_{3,1}(L) = 0$ is equivalent to

(4.4) $A_{1,3,1}(L) + A_{1,3,2}(L)[I-A_{1,2,2}(L)]^{-1}A_{1,2,1} = 0,$

where the submatrices $A_{1,3,1}(L)$ etc. reflect a partitioning of $A_1(L)$ conformable with the partitioning of y_t. Testing the necessary and sufficient condition, eq.(4.4), is possible in principle, but difficult in practice. Therefore we test a weak sufficient condition:

(4.5) $\{(A_{1,3,1}(L)=0 \text{ and } A_{1,3,2}(L)=0) \text{ or } (A_{1,3,1}(L)=0 \text{ and } A_{1,2,1}=0)\}$

for which we can easily calculate a critical value.

IV.2 Data

Our empirical analysis of whether capacity utilization predicts inflation covers 15 major industrialized economies, chosen on the basis of data availability.[10] For each country, we used at least one inflation rate, two economy-wide measures of inflationary pressure and a measure of manufacturing capacity utilization. Two price indices are used to calculate the inflation rate: the consumer price index excluding food and energy prices (or "core" CPI), and the GDP deflator. The CPI is the most widely available measure of general price movements. We follow standard practice in excluding food and energy prices from the index because they are heavily influenced by weather conditions and energy price disturbances that are exogenous to the domestic inflation process. It is nevertheless sensitive to import price movements (and some policy changes) that may to a greater or lesser extent be independent of wage and cost movements. The GDP deflator is the most comprehensive measure of domestic price and cost movements -- that is, it does not reflect import prices. In addition, it is not unduly sensitive to energy prices because most industrialized countries are not self-sufficient in energy production.

We use two indicators of economy-wide capacity pressures, the deviation of GDP from its long-term trend (or GDP gap) and the deviation of the unemployment rate from its long-term trend.[11] In principle, the unemployment rate is an economy-wide measure of excess capacity. We use the deviation from its long-term trend because unemployment rates in industrialized economies have exhibited a pronounced upward trend over the past two decades. Thus, we allow for the possibility that the long-term increase is permanent and does not reflect a cyclical change in economy-wide resource utilization. We measure the GDP gaps as deviations from a Hodrick-Prescott (H-P) filter trend. We chose deviations from an H-P filter trend, rather than OECD data for the GDP gaps, for three reasons. First, we want to be sure that the gap is not influenced by subsequent inflation developments. Second, we wanted a method that could easily be applied to a number of countries. Third, we do not profess to know when changes in trend growth occur -- thus we use a method that only imposes the prior that changes in trend growth occur smoothly. Recent OECD comparisons of potential GDP series calculated using the H-P filter and using more sophisticated techniques reveal strong similarities. For these reasons, we also use the H-P filter to calculate trend unemployment.

To measure capacity pressures in industry, we use the standard manufacturing capacity utilization rate, where available. Capacity utilization figures are usually based on firm-level surveys aimed at determining the degree to which plant and equipment is utilized.[12] However, not all the countries in our sample publish official capacity utilization data. For those that do not, we use the deviation of industrial production from its long-term trend as a proxy. We also use the H-P filter to calculate our proxy for capacity utilization in these cases (for the second and third of the above reasons). The proxy may not capture all the information contained in the official capacity utilization figures. To see whether it does, we experimented with this proxy and the official capacity utilization data for the countries that do publish capacity utilization data. Typically, the proxy is significant in predicting inflation when the official capacity utilization series is. Nevertheless, the proxy and the official figure are not perfect substitutes -- sometimes both were significant in the same regression.[13] Finally, to determine whether our capacity utilization proxy captures information that is not contained in the deviation of GDP from its trend, we regressed each country's capacity utilization measure (official or our proxy) on the contemporaneous deviation of GDP from its trend. The percentage of capacity utilization variance that is explained by GDP movements varied widely among countries, from a high of 80 in the case of U.S. to a low of 4 for Norway. Strikingly however, there appears to be little relationship between the closeness of the fit and whether the capacity utilization measure was from official sources or our proxy.[14]

IV.2 Results

For each country, we estimate at least one four-lag VAR that includes an inflation rate, two economy-wide measures of inflationary pressure and a measure of manufacturing capacity utilization.[15] The specification of the VAR models is based on prior exploration of the time-series properties of the data, including unit root tests. Accordingly, the VARs were estimated on inflation rates (log differences), the rate of capacity utilization in percent, the unemployment rate deviation from trend in percentage points, the GDP gap (in percent of trend GDP), and in the cases where we proxied capacity utilization, the percentage points deviation of industrial production from its trend.

The estimated VAR models describe the data well. The adjusted R^2s for the consumer price inflation equations exceed 0.9 for all but two countries, the U.S. (0.72) and Sweden (0.84). The adjusted R^2s for the deflator inflation equations are somewhat lower -- between 0.52 and 0.82 in all but one case.[16] There is no evidence that the VAR models are misspecified: Diagnostic statistics, shown in Appendix Table 1 for the inflation equations, reveal little evidence that the residuals of the individual equations are serially correlated (a sign of possible parameter instability).[17] Finally, impulse responses were in line with our expectations and gave no hint of model instability.

The results in Table 1 indicate whether manufacturing-sector capacity pressures provide a signal about future inflation. The test results show that manufacturing capacity utilization (or our proxy for it) provides a signal about future inflation in seven out of the 15 countries in our sample (if we take significance at the 5% level for at least one price index as our criterion). Capacity utilization has somewhat stronger predictive power for the GDP deflator than for consumer prices: its marginal contribution in predicting inflation, as measured by the GDP deflator, is statistically significant at the 2% level in six of those seven countries: the U.S., Japan, Germany, Italy, Sweden and Austria. When inflation is gauged by the consumer price index, capacity pressures are significant at the 5% level in the U.S., Japan, Germany and Canada. Overall, these results are fairly supportive of a link between capacity utilization and inflation. A link is evident in nearly one-half of the countries in the sample (two-thirds if we are willing to accept significance at the 10% level as sufficient evidence). In addition, these countries account for the bulk of the output of the industrial world. It is striking that capacity utilization does not predict inflation (at the 5% level) in any of the countries for which we had to use our proxy for capacity utilization. This fact suggests that the proxy may not capture the same information as official capacity utilization data, but it may also reflect that the countries for which we had to proxy for capacity utilization are somewhat less industrial than the countries where capacity utilization turned out to be significant.

To judge whether our results may have been unduly influenced by our decision to measure some variables as deviations from their H-P filter trends, we also estimated our VARs with all variables in levels. The test results summarized in Table 1 were affected in only relatively minor details.[18] As a result, for the remainder of the results reported in this paper, we use variables measured in deviations form trend where standard theory suggests such use.

At this point, it is natural to ask whether the impact of manufacturing capacity pressures on inflation is large enough to be economically as well as statistically significant. To begin, Table 2, which summarizes an impulse response analysis, sheds some light on this question. It presents the impact on CPI and deflator inflation of a one-time one percentage point increase in capacity utilization and indicates the time it takes for the impact to be felt. The results show that the price effect is generally sizable but subject to substantial time delays. The figures in the left half of the table were derived by allowing GDP and inflation to rise (and unemployment to fall) immediately in response to an increase in capacity utilization. These figures are broadly representative of the increases in capacity utilization in the late s and late s, which were accompanied by rapid GDP growth and large declines in unemployment. They show a sizable acceleration in inflation -- about 0.5 percentage points for the U.S., Japan, Canada and Germany

-- after 2-2 1/2 years. The pick-up in inflation takes somewhat longer in Germany, where less than one-quarter of the full impact is felt within a year.

The right-hand side of Table 2 reports the results of an experiment aimed at mimicking the most recent increases in capacity utilization (which coincided with slow GDP growth). In this case we restricted GDP, inflation and unemployment to respond to capacity utilization with a one-quarter time delay. The overall price impact is generally no smaller, but it takes about a year longer to develop, as confirmed by a generally smaller impact over a one-year horizon. In Italy, however, an increase in capacity utilization that is not accompanied by an immediate increase in GDP actually lowers deflator inflation. This unexpected effect presumably reflects inflation-reducing productivity gains associated with increased operating rates in the early stages of a cyclical upswing. Similarly, in Germany an increase in capacity utilization actually lowers consumer prices initially. The consumer price impulse responses corroborate the general character of the capacity-inflation relationships obtained with the GDP deflator. However, the impact of capacity pressures on inflation as measured by the CPI, take longer to develop, suggesting that it may be the goods prices that react to capacity pressures, at least initially.

Table 3 shows an alternative yardstick of the economic significance of the impact of manufacturing capacity pressures on inflation. It shows the contribution of capacity utilization shocks to the variances of the GDP deflator and the consumer price inflation rates derived from a variance decomposition analysis of the vector autoregressions underlying the results in Table 1. They capture the contribution to inflation variability from fluctuations in capacity utilization that cannot be accounted for by movements in the GDP gap and the unemployment rate.[19] By contrast with Table 2, which showed a fairly consistent impact of capacity utilization on inflation, Table 3 breaks our countries into two clearly delimited groups. Changes in capacity utilization are responsible for a sizable portion of inflation variability in Japan, Italy, Canada, Austria, Switzerland, Spain and Finland, and typically for much less in the remaining countries. Together, the very similar impulse response in Table 2 and the divergent variance decompositions in Table 3 suggest that the manufacturing sectors of the countries named here are subject to more idiosyncratic industrial disturbances than the others and that these disturbances tend to feed through to inflation.

V. A Closer Look at the Linkages

Having established that the data is fairly supportive of a link between capacity utilization and inflation, we now investigate which of the hypothesized linkages are responsible for the relationship. Our strategy is to identify and test necessary conditions for the different channels to operate. Overall, the test results suggest that a direct link between capacity utilization and prices is crucial to the relationship between capacity utilization and inflation in the U.S. In Japan and Europe, by contrast, there is evidence of wage contagion. The investment link, by contrast, gets very little support in the data.

V.1 Capacity Utilization, Productivity and Prices

For capacity utilization to explain general price inflation via movements in labor productivity and unit labor cost, at least two crucial conditions must be met: First, changes in capacity utilization must have marginal predictive power for producer prices over and above lagged producer prices and aggregate indicators of inflationary pressure. Second, producer prices must account for a significant portion of the movement in consumer price (or GDP deflator) inflation.

It is straightforward to test whether capacity utilization predicts producer prices at the margin -- we performed standard Granger-causality tests with the GDP gap and the unemployment rate playing the role of aggregate indicators of inflationary pressure. In accounting for the contribution of producer prices of manufactures to overall price inflation, it is necessary to eliminate the components of producer price fluctuations that are attributable to shocks that are common to both producer prices and overall price inflation, for example wage changes that affect both consumer and producer prices. To do so we ran two VAR systems. The first accounts for the behavior of producer price inflation, consumer price inflation and inflation in prices of consumer services and the second for producer price inflation, GDP deflator inflation and inflation in prices of consumer services. In these set-ups the prices of consumer services are used as an indicator of common shocks to producer and consumer prices and to producer prices and the GDP deflator. We do not try to use our standard indicators of aggregate inflationary pressure to pick up these common price shocks because they would not account for wage-contagion effects. To evaluate the contribution of producer prices to consumer price (GDP deflator) inflation, we calculated a variance decompositions with services price inflation ordered first, producer price inflation ordered second and consumer price (GDP deflator) inflation ordered last. Intuitively, this procedure filters shocks that are common to producer price inflation and service price inflation (for example, wage changes in manufacturing that spill over to the services sector) before evaluating the contribution of producer prices to CPI (deflator) inflation.

Table 4 shows the test results for the hypothesis that there is a "direct" link from capacity utilization to producer prices and hence to the GDP deflator and consumer prices. The first column shows the P-value for the hypothesis that capacity utilization does not predict producer price inflation at the margin, the second column shows the contribution of PPI inflation shocks to GDP deflator inflation over an eight-quarter horizon, and the third column shows the contribution of PPI inflation shocks to consumer price inflation over the same horizon. Overall, the results confirm that producer prices account for a significant fraction of the variation in inflation, whether gauged by the consumer price index or the GDP deflator. However, capacity utilization predicts producer price inflation in only the U.S. Strikingly, capacity utilization does not have much predictive power for producer prices in Europe and in two countries, Italy and France, the impact of capacity utilization on producer prices has the "wrong" sign.[20] As a result, the direct link appears to account for the relationship between capacity utilization and inflation in the U.S., but nowhere else.

V.2 Wage Contagion

Our evaluation of the wage-contagion link between capacity utilization and inflation follows the same broad outlines as that of the direct link. We first test whether capacity utilization predicts average hourly earnings in manufacturing and then we evaluate the contribution of manufacturing wages to the variation of wages in other sectors, once common sources of fluctuation have been accounted for. In this case we use our economy-wide indicators or inflationary pressure to filter common shocks from average hourly earnings in manufacturing and non-manufacturing earnings.

Data on non-manufacturing earnings are not commonly available. For this reason we limited the variance decomposition test to those countries where manufacturing capacity utilization proved significant, at the margin, in predicting average hourly earnings in manufacturing. For those countries we backed out an estimate of quarterly earnings per person employed outside manufacturing from national accounts labor compensation data, figures on employment in- and outside manufacturing, and earnings and average working hours in manufacturing.

The results of the two tests of the wage contagion hypothesis are shown in Table 5. The first column shows P-value for the hypothesis that lagged values of manufacturing capacity utilization does not predict average hourly earnings in manufacturing, once lagged values of earnings and the deviation of unemployment form its long-run trend have been taken into account. From it we deduce that an increase in capacity utilization increases manufacturing earnings in Japan, Germany, France, and Sweden. In Austria an increase in capacity utilization tends to lower wages in manufacturing. The second column shows P-values for the null hypothesis that manufacturing earnings do not predict earnings outside of manufacturing. Strikingly, we get significant results in Japan, Germany, France (at the 1% level), and Austria (at the 10% level) -- all the countries (of those where capacity utilization predicts manufacturing earnings) for which we could derive series for non-manufacturing earnings. In Japan manufacturing wages account for well more than one-quarter of wage fluctuations outside manufacturing -- a result that must be considered strongly supportive of the wage contagion story. The results for the other countries are not unambiguously supportive of the wage-contagion hypothesis, though -- manufacturing wages do not account for much more than 10% of the variation in non-manufacturing wages in Germany and for as little as 3.7% in France. Moreover, in Austria the negative impact of capacity utilization on manufacturing wages clearly undermines the wage contagion model.[21] Overall however, it is not surprising that we find evidence of wage contagion in continental Europe and Japan. Unions remain powerful in these countries and their wage negotiations tend to be highly centralized.

V.3 The Investment Link

A link from capacity utilization to investment and hence to inflation requires that at least two conditions be met: First, high levels of capacity utilization must lead to an increase in investment spending and, second, a pick-up of investment must lead to an acceleration of inflation. But, because a sizable portion of machinery and equipment investment in the smaller economies is likely to spill over to the major capital-goods producing countries, the inflationary impact of increased investment spending may not be felt in the countries where the spending occurs.

For our first test of the capacity-investment-inflation link, we ask whether capacity utilization has marginal predictive power for the growth rate of business fixed investment spending, once lagged investment growth and lagged GDP gaps have been taken into account.[22] The results are shown in the first column of Table 6a, which indicates that the first element of an investment link holds in the U.S. and Canada (at the 5% level of significance) and in France and the Netherlands at the 10% level.[23] In Italy, by contrast an increase in capacity utilization leads to a statistically significant decline in investment growth. In none of these countries however, does investment actually predict either consumer price inflation or deflator inflation. Thus, there is no evidence of a link between capacity utilization and inflation through domestic investment spending. For this reason we now look at the market for newly-produced capital goods on a world-wide basis.

Our third test determines whether capacity utilization predicts producer prices of capital goods. It takes into account that capital goods are internationally traded, first, by aggregating capacity utilization for the OECD as a whole[24] and for the countries where capacity utilization predicts investment at the margin and, second, by testing whether these aggregates predict capital goods prices in the major capital goods-producing nations, the U.S., Japan, and Germany. For each of the capital goods producing countries the left-hand side variable in these prediction tests is the capital goods price inflation rate and the right-hand side variables are four lags of each of the capital goods price inflation rate, the country's GDP gap (to capture economy-wide inflationary pressures), the country's capacity utilization rate (to capture "direct" pressures on prices) and the relevant aggregate capacity utilization rate. The results are shown in the two left columns of Table 6b. They reveal that the aggregate investment link is highly significant in Germany (for both international aggregates). For the U.S. only capacity utilization in the nations where high capacity utilization rates spark investment is significant at the 5% level. In Japan, by contrast, neither aggregate plays a role in predicting capital goods price inflation.

Finally, we consider whether inflation in capital good prices sparks inflation on a broader basis. The rightmost two columns of Table 6b show that it does in all three the major capital goods producing nations. Nevertheless, we have to conclude that the evidence for an investment channel linking capacity utilization and inflation is weak. Only in the case of Germany are our results strongly supportive of an investment link, while in the U.S there is weak support.

VI. Conclusion

In early 1995, the manufacturing sector of the western industrialized nations appeared to be heading for capacity constraints at an unusually early stage of the business cycle recovery.

Some observers interpreted this trend as portending a more rapid pick-up in inflation than aggregate measures of capacity utilization would have suggested. They pointed out that capacity pressures may feed into inflation by stimulating inflationary cost increases in industry, rapid increases in manufacturing-sector wages that spill over to the government and service sectors, and by spurring capacity-constrained firms to invest in plant and equipment.

Our statistical analysis shows that an increase in manufacturing capacity pressures are associated with a sizable acceleration of inflation in seven out of fifteen major OECD countries -- clear evidence of a capacity-inflation link. High utilization rates take up to three years to affect consumer prices, but their impact on the GDP deflator is typically felt within two years. Nevertheless, movements in capacity that occur independently of changes in GDP or unemployment only account for a large proportion of the variation in inflation rates in a small group of countries, most notably in Japan, Canada, Italy and Spain.

The linkages from capacity utilization to inflation differ markedly among countries, suggesting that there are significant cross-country differences in the ways in which inflationary shocks spread through the economy. Only in the U.S. is there a consistent direct link from manufacturing operating rates to producer prices and broader price indices. Wage contagion plays a major role in transmitting movements in capacity utilization to inflation in Japan, and a statistically significant but economically less important role in continental Europe. There is little evidence that an investment channel links capacity utilization and inflation -- only in the case of Germany did we find support for this line of reasoning. Finally, we found no evidence in favor of any particular link for the observed relationship between capacity utilization and inflation in Canada and Italy and some indications of a perverse relationship in Italy and in Austria. These are clearly puzzles that deserve further exploration.

Endnotes

1. A GDP-weighted aggregate business sector capital stock for continental Europe expanded at an average rate of 2.8% per year from 1982 to 1994, compared to an average growth rate of 4.4% from 1970 to 1981. Even during the Europhoria years (1987-1991) it grew only 3.3% per year. For further discussion and evidence of unusually slow growth in European manufacturing sector productive capacity in recent years, see Kasman (1994).

2. See Kasman (1995) for a good exposition of this line of reasoning.

3. Kasman (1995) applies all three explanations to the current situation in Europe.

4. This formulation relies very heavily on the exposition of an anonymous referee.

5. For further analysis of the impact of capacity utilization on mark-ups along these lines, also see McElhattan (1985).

6. An extensive exposition of the Scandinavian model can be found in Frisch (1984) and a useful recent assessment in Bartoli. For a recent empirical application of the Scandinavian model to the Norwegian economy see R. Nymoen (1991). For an application to Japanese data, see Jagdish Handa and Yukio Okiyama (1985).

7. In some countries the link between wages and social benefits payments is even more direct. In Germany for example, some social benefits payments are determined as a percentage of average wages.

8. See, Lindbeck and Snower (1988) for a discussion of insider-outsider models of the labor market. The unemployed will also have little impact on the compensation of employed workers if legislation or collective bargaining agreements automatically extend existing wage agreements to new hires, if high unemployment benefits discourage the unemployed form actively competing on wages, and if generous replacement rates lower the expected cost of becoming unemployed.

9. Most notably, it applies to countries irrespective of their labor-market institutions.

10. The sample is determined by the availability of data at a quarterly or higher frequency from 1970 onwards. To be included a country had to have quarterly data on at least consumer prices or the GDP deflator and the unemployment rate or GDP and manufacturing capacity utilization or industrial production.

11. The unemployment rate was not included in the regressions for Switzerland because of data limitations.

12. In some cases, Italy is an example, it measures actual industrial output relative to a statistically-derived measure of potential output in manufacturing.

13. It should be noted that our results may be biased by the use of detrended variables as regressors. The use of regressors generated as "residuals" from a fitted trend implies that the standard errors produced by regression packages are inappropriate if lagged values are used as explanatory variables -- a fact that we did not take into account in the test results reported below [Pagan (1984)]. This problem arises irrespective of whether the trend was obtained by using the H-P filter or some other method of de-trending.

14. For example, the highest R^2 for a regression of our capacity utilization proxy on GDP is 0.64 (for Switzerland and Finland) and the lowest is 0.04 (Norway). The R^2s for a regression of official capacity utilization on GDP range from 0.8 (U.S.) to 0.09 (Sweden). Detailed results can be obtained from the authors.

15. Eight-lag VARs gave essentially the same results.

16. In the case of Norway the adjusted R^2 is an anomalously low 0.04.

17. In the cases where there is evidence of serial correlation, respecification to eliminate the remaining serial correlation did not change the test results reported below. It is usually quite easy to get "clean" residuals, as judged by the Breusch-Godfrey Lagrange multiplier statistic -- one simply has to add lags of the dependent variable to the regressor list (or eliminate some lags). The result, however is a motley assortment of equations with widely varying lag structures. Since our results were not affected by such housecleaning activities, we report the test statistics obtained from industry-standard four-lag VARs. The results for the tests for the "cleaner" equations are available upon request.

18. Capacity utilization remains useful in predicting inflation at the 10% level in 9 out the fifteen countries. Of the major countries, capacity utilization lost its significance in Canada, but became significant in France. In addition Norway and Spain traded places with Sweden and Finland.

19. That is we chose the following ordering for the factorization of contemporaneous correlations of the VAR innovations: GDP gap, unemployment rate deviation from trend, capacity utilization, and inflation rate.

20. That is, an increase in CU tends to lower producer prices, even in the long run.

21. In addition we find evidence of spillovers from non-manufacturing to manufacturing wages in Germany and Austria -- in both these countries, non-manufacturing wages predict wages in the manufacturing sector.

22. Business fixed investment data is not available for all the countries in our sample. If not we used the more widely available machinery and equipment figures, or, failing that total fixed investment

23. It is possible that capacity utilization predicts investment because the official capacity utilization statistics are revised in light of subsequent investment spending.

24. The aggregates are GDP-weighted. The figures for the "OECD as a whole" only includes the OECD members included in our study.

Table 1
Predictive Power of Capacity Utilization on Inflation
(p-values)

Country	GDP Deflator	CPI
United States	0.007	0.000
Japan	0.002	0.001
Germany	0.003	0.017
Italy	0.014	0.204
Canada	0.107	0.013
Sweden	0.020	0.799
Austria	0.014	0.109
France	0.514	0.124
United Kingdom	0.557	0.684
Spain	0.460	0.315
Australia*	0.073	0.126
Netherlands*	0.204	0.582
Switzerland*	0.594	0.577
Finland*	0.642	0.057
Norway*	0.794	0.304

Note: P-values are marginal significance levels for the null hypothesis that capacity utilization does not predict inflation, either directly, or indirectly by predicting the GDP gap or the unemployment rate deviation from trend. Results are based on a 4-lag vector autoregression including the inflation rate, GDP gap, unemployment rate deviation from trend, and a capacity utilization measure.

* Capacity utilization measured as the percentage deviation of industrial production from its Hodrick-Prescott filter trend. For Switzerland the unemployment rate is not included in the regressions.

Table 2
Impact of Capacity Utilization on Inflation

Country	GDP Deflator					
	All variables respond contemporaneously			Other variables do not respond contemporaneously		
	Maximum Effect Amount	Maximum Effect Time Delay (quarters)	Impact After 4 Quarters	Maximum Effect Amount	Maximum Effect Time Delay (quarters)	Impact After 4 Quarters
United Sates	0.4	8	0.3	1.0	13	0.2
Japan	0.8	8	0.4	0.5	9	0.3
Germany	0.5	7	0.4	0.4	7	0.2
Italy	0.2	4	0.2	-0.2	4	-0.2
Sweden	0.1	13	0.0	0.1	12	0.0
Austria	0.0	4	0.0	0.1	4	0.1
	CPI Inflation					
United States	0.7	8	0.5	0.8	12	0.0
Japan	0.6	9	0.3	0.6	14	0.2
Germany	0.5	11	0.1	0.3	13	-0.1
Canada	0.5	10	0.2	0.7	14	0.2

Note: Figures represent impact of a 1% increase in capacity utilization derived from impulse response analyses of four-lag VARs including GDP gap, unemployment rate deviation from trend, capacity utilization measure, and CPI/GDP deflator inflation rate.
* Capacity utilization measured as the percentage deviation of industrial production from its Hodrick-Prescott filter trend.

Table 3
Contribution of Capacity Utilization to Inflation Variance

Country	Percentage of Inflation Variation Accounted for by CU (over 8 quarters)	
	GDP Deflator	CPI
United States	5.5	2.1
Japan	24.0	22.9
Germany	6.6	4.3
Italy	21.3	9.7
Canada	8.3	30.6
Sweden	8.5	1.9
Austria	4.7	12.0
France	2.6	10.3
United Kingdom	8.4	4.4
Spain	10.9	9.0
Australia*	9.1	4.5
Netherlands*	0.9	3.2
Switzerland*	12.8	4.6
Finland*	7.4	10.1
Norway*	1.7	1.0

Note: (1) Variance decompositions are calculated from a four-lag VAR including GDP gap, unemployment rate deviation from trend, capacity utilization measure, and CPI/GDP deflator. Variables ordered as listed.
* Capacity utilization measured as the percentage deviation of industrial production from its Hodrick-Prescott filter trend. For Switzerland unemployment rate is not included in the regressions.

Table 4
Test of Direct Link Between Capacity Utilization and Inflation

Country	Null Hypothesis: CU Does Not Predict Producer Price Inflation (p-values)	Percentage of Inflation Variation Accounted for by PPI (over 8 quarters)	
		GDP Deflator	CPI
United States	0.03	39.2	38.5
Japan	0.33	64.1	83.6
Germany	0.88	15.7	47.8
Italy	0.15**	12.1	37.2
Canada	0.58	35.8	51.0
Sweden	NA	NA	NA
Austria	NA	NA	NA
France	0.34**	4.7	3.6
United Kingdom	NA	NA	NA
Spain	0.21	21.4	14.9
Australia*	0.97	28.1	50.1
Netherlands*	0.55	37.7	19.4
Switzerland*	0.96	44.9	60.3
Finland*	NA	NA	NA
Norway*	0.51	21.1	48.1

Note: (1) P-values are calculated from a regression including four lags of PPI inflation, GDP gap, unemployment rate deviation from trend, and capacity utilization measure.

(2) Variance decompositions are calculated from a four-lag VAR including consumer services price inflation, PPI inflation, GDP deflator/CPI inflation. Variables ordered as listed.

* Capacity utilization measured as the percentage deviation of industrial production from its Hodrick-Prescott filter trend. For Switzerland the unemployment rate is not included in the regressions.

** Impact does not have the expected sign.

Table 5
Tests of Wage Contagion Hypothesis

Country	Null Hypothesis: CU Does Not Predict Earnings In Manufacturing (p-values) (1)	Null Hypothesis: Manufacturing Earnings Does Not Predict Nonmanufacturing Earnings (p-values) (2)	Percentage of Variation of Nonmanufacturing Earnings Explained by Manufacturing Earnings	
			4 - Quarters	8 - Quarters
United States	0.20	--	--	--
Japan	0.01	0.01	31.1	25.6
Germany	0.06	0.00	10.5	13.1
Italy	0.24	--	--	--
Canada	0.52	--	--	--
Sweden	0.04	--	--	--
Austria	0.00**	0.01	11.9	4.5
France	0.00	0.08	3.7	7.1
United Kingdom	0.28	--	--	--
Spain	0.50	--	--	--
Australia*	0.56	--	--	--
Netherlands*	0.56	--	--	--
Switzerland	NA	--	--	--
Finland*	NA	--	--	--
Norway*	0.76	--	--	--

Notes: (1) P-values are calculated from a regression including four lags of manufacturing earnings, unemployment rate deviation from trend, and CPI inflation.

(2) P-values are calculated from a regression including four lags of nonmanufacturing earnings, manufacturing earnings, GDP gap, unemployment rate deviation from trend, and CPI inflation.

(3) Variance decompositions are calculated from four-lag VARSs including GDP gap, unemployment rate deviation from trend, CPI inflation, manufacturing earnings, and nonmanufacturing earnings . Variables ordered as listed

* Capacity utilization measured as the precentage deviation of industrial production fom its Hodrick-Prescott filter trend. For Switzerland the unemployment rate is not included in the regressions.

** Impact not of the expected sign.

Table 6a
Tests of an Investment Link

Country	Null Hypothesis: Capacity Utilization Does Not Predict Business Fixed Investment (p - values) (1)	Null Hypothesis: Business Fixed Investment Does Not Predict Inflation (p - values)	
		GDP Deflator (2)	CPI (3)
United States	0.00	0.30	0.10
Japan	0.03	0.20	0.61
Germany	0.68**		
Italy	0.01**	0.87	0.28
Canada	0.01	0.44	0.63
Sweden	NA		
Austria	0.26**		
France	0.06	0.79**	0.88
United Kingdom	0.12		
Spain	0.46**		
Australia*	0.68		
Netherlands*	0.09	0.55**	0.31
Switzerland*	0.12		
Finland*	0.44		
Norway*	NA		

Notes: (1) P-values are calculated from regressions including four lags of machinery and equipment investment, GDP gap, and capacity utilization measure.

(2), (3) P-values are calculated from regressions including four lags of the GDP gap, unemployment rate deviation from trend, the growth rate of machinery and equipment investment, and the CPI/GDP deflator inflation rate. For Switzerland the unemployment rate is not included in the regression.

* Capacity utilization measured as the percentage deviation of industrial production from its Hodrick-Prescott filter trend.

** Impact not of the expected sign.

Table 6b
Tests of an Investment Link

Capital Goods Producers	Null Hypothesis: Capacity Utilization Does Not Predict Capital Goods Prices in Capital Goods Producing Countries (p - values)		Null Hypothesis: Capital Goods Prices Do Not Predict Inflation in Capital Goods Producing Countries (p - values)	
	OECD Aggregate CU (1)	Investment-Aggregate CU (2)	Deflator (3)	CPI (3)
US	0.73	0.05	0.00	0.01
Japan	0.15	0.36	0.00	0.02
Germany	0.00	0.00	0.01	0.01

Note: (1) P-values are calculated from a regression including four lags of capital goods PPI, OECD aggregate measure of CU, GDP gap, and country capacity utilization measure.

(2) P-values are calculated from a regression including four lags of capital goods PPI, investment aggregate measure of CU, GDP gap, and country capacity utilization measure. Investment-aggregate CU is calculated by aggregating the capacity utilization measure only for countries where CU has predictive power for investment.

(3) P-values are calculated from a regression including four lags of capital goods PPI, GDP gap, unemploymer rate deviation from trend, and CPI/GDP deflator inflation rate.

** Impact not of the expected sign.

Appendix Table 1
DIAGNOSTIC STATISTICS FOR INFLATION EQUATIONS

Country	Price Index	Adj. R-sq	DW	Q (0-25) p-value	LM (8) pvalue	Modified LM (8) pvalue
U.S.A.	CPI	0.72	2.00	0.64	0.01	0.00
	Deflator	0.74	1.80	0.02	0.05	0.15
Canada	CPI	0.96	1.98	0.94	0.08	0.07
	Deflator	0.67	1.89	0.52	0.30	0.30
United Kingdom	CPI	0.94	2.00	0.64	0.21	0.23
	Deflator	0.53	2.02	0.40	0.02	0.02
Japan	CPI	0.95	1.87	0.02	0.00	0.00
	Deflator	0.96	1.86	0.00	0.03	0.02
Germany	CPI	0.95	2.02	0.95	0.45	0.76
	Deflator	0.52	1.94	0.00	0.01	0.01
France	CPI	0.98	2.02	0.01	0.02	0.01
	Deflator	0.63	2.12	0.10	0.00	0.00
Italy	CPI	0.97	2.06	0.08	0.02	0.00
	Deflator	0.65	1.80	0.23	0.22	0.35
Australia	CPI	0.91	1.91	0.69	0.00	0.00
	Deflator	0.54	2.22	0.99	0.01	0.48
Austria	CPI	0.90	1.96	0.79	0.49	0.32
	Deflator	0.75	2.16	0.18	0.00	0.00
Switzerland	CPI	0.97	2.12	0.07	0.03	0.00
	Deflator	0.75	1.95	0.84	0.00	0.00
Netherlands	CPI	0.95	1.97	0.01	0.14	0.11
	Deflator	0.68	1.86	0.44	0.02	0.02
Norway	CPI	0.93	1.90	0.97	0.44	0.27
	Deflator	0.04	1.97	0.52	0.14	0.03
Sweden	CPI	0.84	1.86	0.59	0.11	0.03
	Deflator	0.72	2.02	0.45	0.00	0.00
Spain	CPI	0.93	2.02	0.00	0.00	0.00
	Deflator	0.83	2.02	0.01	0.01	0.00
Finland	CPI	0.96	1.90	0.92	0.16	0.87
	Deflator	0.84	1.98	0.76	0.05	0.00