International Trade and the Connection Between Excess Demand and Inflation

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Abstract

This paper demonstrates that globalization, taking the form of a higher import component of consumption and a larger export component of GDP, is the cause of the apparent breakdown in the relationship between excess demand and inflation. Within a parsimonious empirical framework, we show that increasing openness of the U.S. economy is all that is needed to reestablish the relationship between inflation and capacity utilization. We also show that international trade has a significant separate influence on inflation, and is important for identifying a Phillips curve relationship between unemployment and inflation.

I. Introduction

In a closed economic environment it is generally believed that inflationary pressures increase as excess demand builds in the economy. For example, Robert Gordon (1989a) has shown that in the United States capacity utilization within the economy was been a good, positive predictor of inflation from the mid-1950s to the late 1980s. However, as Kenneth Emery and Chih-Ping Chang (1997) have shown, the inflation-capacity link that existed before the early 1980s has broken down. Several hypotheses for this breakdown have been put forward. These include productivity advances due to technological change, a general shift from goods to relatively sticky-priced services, energy price variations which have added noise, changes in money growth, and increases in international trade (Carol Corrado and Joe Mattey, 1997; Mary Finn, 1996).

In this paper, we focus on the effects of international trade on the relationship between excess demand pressures and inflation. The possibility that international trade is responsible for the apparent breakdown of the relationship between excess demand and inflation is suggested in the analyses of Phillips curve relationships studied by Robert Gordon (1998) and Robert Rich and Donald Rissmiller (2000). For example, in a study of supply shocks and inflation, Gordon found import prices relative to overall prices are an important part of the explanation of the "Goldilocks" economy of the 1990s – that is, an economy with simultaneously low inflation and low unemployment. Similarly, using the difference between the percentage change in import prices and the percentage change in core CPI, Rich and Rissmiller concluded that import prices are a key influence on the recent behavior of inflation. In addition Geoffrey Tootell (1998) finds that large increases in non-oil import price inflation have had a significant affect on overall US inflation, although decreases do not.

We take a broader view of international trade that considers the role of the quantities of both imports and exports rather than just the price of imports: *ceteris paribus*, greater availability of goods through trade subdues inflation. Our approach also allows for the

indirect impact of competition from imported goods on the prices of domestically produced goods, as well as the direct impact through inclusion in the CPI. By including the real import share of consumption and real export share of production, we explain the apparent recent absence of a link between excess demand pressures and inflation. We find that accounting for international trade re-establishes the historically strong relationship between capacity utilization and inflation. Furthermore, accounting for international trade strengthens the Phillips curve relationship between unemployment and inflation. In addition, we show that trade volumes themselves are a significant influence on inflation, in addition to the excess demand pressures from capacity or unemployment. These results are robust to different measures of trade.

II. Openness, Trade and Inflation

The relationship between domestic market pressure and inflation depends on openness to international trade. Specifically, the availability of imports can affect domestic inflation directly via the prices of these imports included in the price index, and indirectly through competition with domestic goods and services. Exports affect supplies of products available to domestic consumers, and hence prices. That is, international trade serves like an "open door", such that pressures within the economy are mitigated by the flows of products into and out of that door. Consideration of openness suggests that just as the effects of efforts to change pressure in a room will be mitigated by an open door, so too are effects of domestic capacity or unemployment pressures on inflation.

The potential relevance of openness is suggested by the shift in quantities of imports and exports in the early 1980s that coincides with the time when the link between inflation and capacity utilization breaks down (Emery and Chang, 1997): the door opened wider in the early 1980s. For example, from 1967 through 1981 imports only grew from 9% to 11% of personal consumption expenditures, whereas from 1982 through the first quarter of 1999 imports more than doubled, expanding from 11% to 24% of consumption.

Growth in exports was more similar in the two sub-periods, growing from 4% of GDP in 1967 to 7% by the end of 1981, and then to 13% of GDP by the first quarter of 1999. The more recent period, that which begins in the early 1980's, has shown a shift in the US from a more isolated, independent economy to an increasingly open one.

Accounting for international trade may also be an element of the difficulty finding a stable Phillips curve relationship (Robert Gordon, 1989b). Because inflation is influenced by trade as well as by unemployment, a failure to allow for the importance of trade for inflation may confound the measured Phillips curve relationship.

One approach to explaining inflation in an open economy is to use *foreign* excess demand pressures as a predictor of inflation in the prices of US imports, and then include import inflation in the prediction of US inflation. However, as Carol Corrado and Joe Mattey (1997) and Tootell (1998) show, there is little evidence that foreign capacity utilization influences US inflation. Consequently, if it is to play a role, the effect of US import price inflation must come at least in part through the effects of increased supply and consequent downward price pressure on domestic goods. Similarly, if exports are to play a role, it is through reduced supply to domestic buyers, and hence in the increased competition for that supply. In what follows, we consider this possible impact of openness using relative trade volume measures, both for the capacity-inflation relationship and for the Phillips curve.

The structural advantage of basing inflation on the available quantities of traded goods and services rather than on values or prices is twofold. First, we avoid having prices on both sides of the estimation equation. Second, while higher import prices raise inflation, higher import quantities reduce inflation. As a result, using values of imports involves two offsetting influences. In addition, while a higher quantity of exports could increase inflation through lower domestic availability, there is no impact of export prices on the country's CPI.

III. Data Description

In our analysis, we measure inflation as the difference of the logarithms of the CPI from the quarterly levels of the CPI for 1967:1 to 1999:1. The CPI, as with all the data used, is seasonally adjusted and obtained from the Federal Reserve Economic Database (FRED), available from the Federal Reserve Bank of St. Louis. Some of the work on the link between excess demand pressures and inflation has focused on other measures of inflation. For example, Corrado and Mattey (1997) use core CPI measured in terms of accelerations, Rich and Rissmiller (2000) use core CPI inflation, and Gordon (1998) uses the GDP and personal consumption expenditure (PCE) deflators. However, the primary difficulty has been in explaining inflation in the CPI, which is the focus of this study.

We measure excess demand pressures two ways. First, capacity utilization is measured by the Federal Reserve Board's total capacity utilization rate. Our quarterly measure is that of the last month of each quarter, matching the quarter-end to quarter-end CPI inflation. Second, unemployment is measured as deviations in the civilian unemployment rate from a 16-quarter moving average. This allows the "normal" unemployment rate – our 16-quarter moving average – to be time-varying. Our quarterly measure for the civilian unemployment rate is the average over the three months of each calendar quarter.

To allow for the importance of availability of imports for the relationship between excess demand and inflation we take the ratio of real imports to real personal consumption expenditures. To allow for the impact of exports we take the ratio of real exports to real GDP. Both of these ratios have been increasing over time, and more importantly, capture both the direct and indirect effects of trade on inflation: we expect a negative inflationary impact of import growth and a positive impact of export growth.

Available data from the Bureau of Economic Analysis, Department of Commerce, for real imports and exports are in chained 1992 dollars, as are real personal consumption

expenditures and real GDP. As has been indicated by Whelan (2000), the use of chain-aggregated data can significantly influence empirical relationships. The problem is particularly acute for capital goods for which relative prices have declined over time.[1] Therefore, we also report results for real export and import ratios of non-durable goods and services where the problem should be less severe. We include a supply shock as does Gordon (1998) and Rich and Rissmiller (2000). This is measured as the ratio of the price of energy from the energy component of the CPI relative to the overall CPI. All data is seasonally adjusted.

IV. The Capacity Utilization – Inflation Relationship

In order to evaluate the role of international trade we first measure the impact of total capacity utilization on inflation, without allowing for the effects of trade. We then add the trade variables to see whether these help unravel the effects of capacity utilization on inflation and to see whether these variables themselves are significant. The benchmark against which international trade effects are measured includes, in addition to total capacity utilization, the lagged inflation rate – from differences in logarithms – and our energy supply shock variable. This makes equation (1) below essentially the same as the one used by Gordon (1998) and Rich and Rissmiller (2000). That is, we first estimate

$$d\ln P_t = \beta_0 + \beta_1\, d\ln P_{t-1} + \beta_2\, d\ln\left(\frac{P_t^e}{P_t}\right) + \beta_3\, \ln D_{t-1} + \varepsilon_t\,, \qquad (1)$$

and then we estimate

$$d\ln P_t = \beta_0 + \beta_1\, d\ln P_{t-1} + \beta_2\, d\ln\left(\frac{P_t^e}{P_t}\right) + \beta_3\, \ln D_{t-1} + \beta_4\, \ln\frac{M_t}{C_t} + \beta_5\, \ln\frac{X_t}{G_t} + \varepsilon_t \qquad (2)$$

where

[1] We thank one of the referees for bringing this to our attention.

P_t = Overall CPI
P_t^e = Energy price component of the CPI
D_t = Total industry percent capacity utilization
M_t = Real imports of goods and services
C_t = Real consumption expenditures
X_t = Real exports of goods and services
G_t = Real GDP, chained 1992 dollars[2]

Inflation is taken as the first difference in the log of the CPI, and put into percentages by multiplying by 100. The supply shock is measured as the rate of change of the relative price of energy to the overall CPI, that is, the first difference of the log of the ratio of the energy component of the CPI to the overall CPI. The trade variables are logs of the ratios of real imports to real personal consumption and of real exports to real GDP. The excess demand variable is the log of total capacity utilization, lagged one period. The Augmented Dickey-Fuller unit root test rejects the presence of a unit root on all relevant right hand variables – that is, those variables not differenced already. The presence of a unit root is rejected at the 1% level for our capacity utilization and exports variable, and at the 5% level for our imports variable.

Both equations (1) and (2) are estimated over the two sub-periods, 1967:1-1981:4, and 1982:1-1999:1, as well as over the entire sample period.[3] Our principal purpose is to see whether capacity utilization has a more significant impact after allowing for international trade, especially since the early 1980's. In addition, we expect $\beta_4 < 0$ on the grounds that more imports reduce inflationary pressures: it is as if US capacity becomes less relevant when the door is open wider. We also expect $\beta_5 > 0$, reflecting the added inflationary impact of exported goods and services not being available for US consumers to buy.

(Table 1 about here)

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[2] As mentioned earlier, real imports and exports are also measured without including durables to mitigate the problem of using chain-aggregated data.
[3] The structural break at the end of 1981, mentioned in the literature cited earlier, is confirmed by the Chow Breakpoint Test. The null hypothesis of no breakpoint is rejected at the 0.0001 level of significance for capacity utilization, and at the 0.000001 level for unemployment.

Results for the entire sample period are summarized in Table 1. Comparison of the first column of Table 1 with the second column shows the effect of including international trade when accounting for inflation. Specifically, the inclusion of trade increases the size and significance of capacity utilization. The supply shock is marginally significant when trade is included. Both trade variables are significant and carry the expected sign. We find that increasing real imports is, *ceteris paribus*, associated with lower inflation – significant at the 1% level. Also as expected, increasing real exports, which means *ceteris paribus* fewer goods and services available for Americans to buy, has a positive impact on inflation. This is also significant at the 1% level. Even though both trade variables have an upward trend, we find one with a negative impact and the other with a positive impact, indicating the effects are not statistical artifacts. As well as being significant themselves and contributing to the significance of capacity utilization, the trade variables improve the overall explanation of inflation as measured by the adjusted R^2. The third column of Table 1 shows that capacity utilization remains significant when durable goods imports and exports, for which chain-aggregation may be more problematic, are excluded. However, while imports remain significant when durable goods are excluded, exports are no longer significant.

The first two columns of Table 2 show the insignificance of the impact of capacity utilization that has been observed for the period since the early 1980's as compared to the earlier period. We also see from the R^2 for column 2 that inflation is poorly explained even when this explanation includes the inertia from lagged inflation and the supply shock from the relative increases in prices of energy. Indeed, the only significant variable in column 2 is the supply shock. Comparison of the third and fourth columns of Table 2 with the first and second columns shows the importance of including the trade variables for both sub-periods, where trade measures are based on chain-aggregated data. Capacity utilization is significant at the 1% level in both sub-periods. The supply shock is significant at the 1% level for the latter period – relatively higher energy prices contribute to inflation. Exports have a significant positive relationship with inflation in the earlier

period, and imports have a significant negative relationship with inflation in the latter period. While not statistically significant, imports in the first period and exports in the second period also have the expected signs. Comparing the adjusted R^{2}'s in the second and fourth columns versus the first and second columns shows that inclusion of the trade variables is particularly important in the latter sub-period. The final two columns of Table 2 show that excluding durable imports and exports does not change the influence of capacity utilization: it remains significant at the one-percent level in both sub-periods. Comparing the remaining parts of the final column with column four shows that any problems introduced by chain-aggregation in the durable goods have not substantially influenced the results.

(Table 2 about here)

V. The Phillips Curve and International Trade

Two excess demand variables have been employed in previous research in this area, such as the work by Gordon (1998) and Rich and Rissmiller (2000), namely capacity utilization as above, and the rate of unemployment. This latter measure, which corresponds more directly to the traditional Phillips curve, means rewriting equations (1) and (2) as:

$$d\ln P_t = \beta_0 + \beta_1 d\ln P_{t-1} + \beta_2 \, d\ln\left(\frac{P_t^e}{P_t}\right) + \beta_3 \ln U_t + \varepsilon_t \,, \qquad (3)$$

and

$$d\ln P_t = \beta_0 + \beta_1 d\ln P_{t-1} + \beta_2 \, d\ln\left(\frac{P_t^e}{P_t}\right) + \beta_3 \, U_t + \beta_4 \ln\frac{M_t}{C_t} + \beta_5 \ln\frac{X_t}{G_t} + \varepsilon_t \qquad (4)$$

where U_t is deviations in the civilian unemployment rate from a 16-quarter moving average. The deviations from the moving average is used to allow for time variation in the "normal" rate of unemployment, and because the unemployment rate has a unit root. The augmented Dickey-Fuller unit root test rejects the presence of a unit root in our chosen unemployment variable at the 1% level.

Table 3 shows the results from estimating equations (3) and (4) for the entire period, 1970.4 to 1999.1, noting that use of the 16-quarter moving average in calculating deviations from the civilian unemployment rate reduced the number of observations relative to our estimations using capacity utilization. The left-hand column shows the Phillips curve without accounting for international trade, and shows that unemployment is insignificant, as is the supply shock. The second column shows that adding the trade variables makes unemployment significant at the 1% level, and the supply shock becomes significant at the 5% level. Most importantly for the arguments made in this paper, the two trade variables are both statistically significant at the 1% level and with the expected signs. Increasing imports keeps inflation down, and increasing exports, by *ceteris paribus* reducing the supplies of goods in the domestic market, raises the rate of inflation. We also note an improvement in the adjusted R^2 from adding the trade variables to the Phillips curve equation.

(Table 3 about here)

Table 4 shows the difference between the earlier and later sub-periods. Comparison of column 1 with column 2 shows that inflation in the latter period is harder to explain, certainly when the trade variables are excluded. We see for example that the R^2 is 0.60 in the first period and 0.13 in the second period. Unemployment is only significant in the first sub-period when we ignore the influence of trade. In the latter period only the supply shock is significant, as we might expect. However, when the trade variables are included we find unemployment significant in both periods: it is significant at the 1% level in the latter period, and at the 5% level in the earlier period. The supply shock is also significant in the latter period, at the 1% level. Furthermore, we find a significant positive effect of exports in both periods and a significant negative effect of imports in the second period: both second-period trade variables are significant at the 1% level. We also note that the overall fit is higher in both sub-periods, with the R^2 for the first period a respectable 0.65. In the second period, the international trade variables raise the fraction of inflation that

can be explained by approximately three times, from 0.13 to 0.37. International trade appears to play an important role in the estimation of the Phillips curve.

(Table 4 about here)

VI. Conclusion

The results we have shown in this short paper provide comfort on at least two fronts. First, the workings of the economy have not changed: inflation still appears to be associated with excess demand pressures, as economists generally believe. Second, the measure of capacity utilization "total industry capacity utilization" remains useful, something that had been in question in light of the poor results of those studying inflation who have not allowed for the presence of international trade (see, for example, Rose McElhattan (1985), Matthew Shapiro (1989), and Stephen Cecchetti (1995)). Third, international trade plays a role in it's own right, playing a significant role itself, as well as helping isolate the underlying relationship between excess demand and inflation. Finally, allowance for the influence of international trade is necessary for the clear and consistent identification of the Philips curve. It would appear that the Phillips curve relationship has been obscured by the changes that have occurred in the openness of the U.S. economy to international trade.

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