Mismatching Measures of Output and Prices: Implications for Measuring the Comovement of Prices and Output

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The correlation between prices and output provides evidence on the source of macroeconomic shocks. For example, Den Haan (2001) finds positive correlations at short forecast horizons and negative correlations at longer forecast horizons for the consumer price index (CPI) and the index of industrial production (IP). He interprets these results to mean that demand shocks dominate in the short run while supply shocks dominate in the long run. Several other papers confirm the positive correlation between the CPI and IP at short forecast horizons. On the other hand, some of these same authors have found a negative correlation between real GDP and the GDP deflator at short forecast horizons.[1] This difference is disappointing since the results provide conflicting evidence on the nature of shocks at short horizons and surprising since the CPI and the deflator are positively correlated as are GDP and IP.

An important distinction between pairing GDP with the deflator and pairing IP with the CPI is the extent to which products in the output index are matched to products in the price index. GDP and the GDP deflator are based on the same set of goods and services. On the other hand, IP contains products, such as mining, whose prices are not included in the CPI, and the CPI includes products, such as housing services, that are not included in industrial production. In this paper, we argue that the correlation between mismatched price and output indexes can be, and often is, misleading and we find that correlations between matched price and output indexes are negative or very small even at short forecast horizons.

It is important to match an output index with a price index that includes the same products. The reasoning is quite simple. Suppose you are interested in the correlation between the price and quantity of apples. If instead you compute the correlation between the price of

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[1] For reasons discussed in section 2, we consider only correlations between forecast errors, or shocks, to price and output. Papers that examine this correlation include Rotemberg (1996), Den Haan (2000), Den Haan and Sumner (2001), Davis and Kanago (2002), Cover and Hueng (2003), Davis and Kanago (2004). The results of these papers are described in section 2.

oranges and the quantity of apples, the correlation is correct only if the relative price of oranges to apples does not vary with the quantity of apples. If the relative price varies, then the mismatched correlation may have the opposite sign of the matched one. We examine the correlations of several matched price and output indexes and find that the correlation is almost always negative.[2] In contrast, the correlations between mismatched measures are sometimes positive. For example, investment and the investment deflator are negatively correlated, while investment and the consumption deflator are positively correlated. These two correlations imply that the relative price of consumption to investment may be positively correlated with investment, and we find this and similar relationships in the data.

There is no matched price index for industrial production, so correlations with industrial production and a price index are silent on the price-output relationship over the business cycle. However, correlations across matched and mismatched price and output indexes suggest that it is at least plausible, and perhaps likely, that the correlation between IP and an appropriately matched price index would be negative, and that the positive correlations found in the data between IP and the CPI are the result of relative price movements over the business cycle.

We first review the recent literature on the computation and sign and size of the price-output correlation. We then discuss the consequences of mismatching a price and output index. Results are presented in section 3 for correlations between both matched and mismatched price and output indexes. In section 4, we examine the correlation of various relative prices with output. We then conclude.

Review of the Issues

[2] For convenience, unless otherwise noted, correlations refer to correlations between forecast errors.

For most of the twentieth century, economists believed prices were clearly procyclical. This was often interpreted as evidence for the importance of demand shocks. Kydland and Prescott (1990) and Cooley and Ohanian (1991) challenged this long-held belief. They showed that prices were countercyclical in the post-Korean War era and argued that this correlation would be difficult to reconcile with a model driven by demand shocks.[3] Subsequently, Hall (1995) and Judd and Trehan (1995) argued that the long-run adjustment of price and output masks the nature of shocks to the economy.[4] In short, not all price changes reflect price shocks. The dynamic adjustment to long-run equilibrium can create a negative correlation between prices and output, even if most shocks are from the demand side. These authors constructed model economies where the price-output correlation is negative even if there are only demand shocks.

To address the issues raised by dynamic adjustment of price and output, Rotemberg (1996) examined the correlation between unexpected movements in the two. He constructed forecast errors using a VAR model and found a positive contemporaneous correlation between price and output.[5] He concluded that the positive correlation was most naturally explained by a sticky price model driven primarily by monetary shocks. Den Haan (2001) and Den Haan and Sumner (2002) extended this analysis by examining the correlation of price and output forecast errors from a VAR at different forecast horizons. They generally find negative correlations at longer horizons, and argue that this finding is difficult to explain with a model driven only by demand shocks.

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[3] See Davis and Kanago (2003) for further details.

[4] Friedman and Schwartz (1982, pp. 402-403) anticipate this argument.

[5] His VAR model includes two lags of value added in the private sector, the corresponding deflator, man hours, the consumption-output ratio, and alternative measures of monetary variables or the share of labor compensation in the value added of the corporate business sector. He only reports contemporaneous correlations which range from .058 when M2 is the fifth variable to .150 when share of labor compensation is the fifth variable. The sample is 1960:1-1993:1.

The negative correlation at longer horizons is robust to different measures of price and output and across countries; the correlations at short horizons are not. Den Haan and Sumner (2001) find that the correlation of short horizon forecast errors in the U.S. are negative or small when real GDP and the GDP deflator measure price and output. Davis and Kanago (2002) also find a negative contemporaneous correlation between real GDP and the deflator for the U.S., U.K., and Canada when using forecast equations for price and output. Using an alternative methodology, Cover and Hueng also find a negative correlation between real GDP and the deflator since 1964.[6]

On the other hand, Den Hann (2000) reports positive correlations between the CPI and IP at short-forecast horizons. Den Haan and Sumner (2001) also find positive correlations at short horizons between the CPI and IP for the U.S., France, Italy, and Japan. Using survey data for the U.S., Davis and Kanago (2004) find a negative correlation for real GDP and the deflator; but, like Den Haan, they find a positive correlation between the CPI and IP. To summarize, short-horizon correlations between real GDP and the deflator are usually negative, but short horizon correlations for shocks to IP and the CPI are usually positive.

The Consequences of Mismatching Indexes

The evidence in support of a positive correlation for the price-output correlation over the past forty years or so comes mostly from forecast errors in IP and the CPI. The CPI and IP contain dissimilar products and relative price variations over the business cycle make this evidence suspect at best. To see the potential problems with using mismatched price and output measures, suppose we are interested in the correlation between the goods and services in the

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[6] Cover and Hueng use a two-variable VAR with GARCH errors to compute a contemporaneous correlation that varies across time.

output index, X, and an index of the prices of these goods and services, P^X. However, because the data is not available or the indexes are very costly to construct, we use the price index P^Y instead. The goods and services whose prices are inputs in the index P^Y are not identical to those in P^X, though they could overlap. Define the relative price q = P^Y/P^X. The forecast error for the log of the price index P^Y in time t, e_t^{PY}, is related to the logs of the shocks to the relative price q and the price index P^X by

$$e_t^{P^Y} = e_t^{P^X} + e_t^q$$

and so the covariance between the forecast errors to the log of X and the log of P^Y, $\sigma_{P^Y X}$, is

$$\sigma_{P^Y X} = \sigma_{P^X X} + \sigma_{qX} \qquad (1)$$

The interest is in the correlation between the index X and the index P^X, the sign of which is determined by the covariance $\sigma_{P^X X}$. If the relative price q is constant or independent of variations in X (or in practice the correlation between q and X is very small); then the covariance $\sigma_{P^Y X}$ will serve well as a measure of the covariance of interest. On the other hand, if the covariance between shocks to q and X is large, the covariance $\sigma_{P^Y X}$ will be a poor proxy for the covariance $\sigma_{P^X X}$ and perhaps even have the opposite sign.

As an example of the above, consider the covariance between IP and the CPI. The covariance between shocks to IP and the CPI equals the sum of two other covariances. The first is the covariance between IP and a price index for IP. The second is the covariance between IP and the CPI relative to the price index for IP. The covariance between IP and the CPI could be positive if the covariance between IP and a price index for IP were negative, but offset by a positive covariance between the CPI relative to the price index for IP and IP itself. Since there is no price index for industrial production, it is impossible to compute either of these covariances. Since the correlation between the CPI and IP is positive, one, but not necessarily both, of the covariances that sum to the covariance between the CPI and IP must be positive. Consequently, there is no way to determine the cyclical nature of prices associated with the index of industrial production.

Nevertheless, if components of GDP and their matched price indexes are negatively correlated, it would seem less likely that the first component of the CPI-IP correlation is positive. Further, if components of GDP that have negative correlations when paired with matched price indexes, tend to have positive correlations when mismatched with consumer prices, or if there is direct evidence that consumer prices relative to other prices tend to be procyclical, then it seems more likely that the second component of the correlation is positive.

Matched vs. Mismatched Correlation

We now examine the evidence on alternative measures of price and output looking first at matched pairs and then at mismatched pairs. We then compare the two sets of results to see to how much mismatches matter. For example, we compute the correlation between the goods component of real GDP and the matching GDP goods deflator.[7] Then we compute the correlation between real goods and a mismatched price index, such as the CPI. If the matched correlation is close to the mismatched correlations this suggests that, for that particular case, the mismatch is of little importance; presumably because shocks to the relative price of the matched to the mismatched price index vary little with shocks to production. If the correlations differ

[7] We examine correlations rather than covariances. As for the covariance, the sign of mismatched correlations still depend on the sign of the matched correlation and the correlation between the relative price of the mismatched to matched price index and the output measure.

considerably, then the mismatch matters indicating that shocks to relative prices vary with production.

We compute forecasts by employing the same VAR model Den Haan uses. In particular, we estimate a VAR with the logs of a price index, an output index, and reserves, the ratio of non-borrowed reserves to total reserves and the level of the effective federal funds rate. Our sample is 1959:1 to 2002:4, and sources of and details concerning the data appear in Appendix A. The estimated VAR model is used to compute dynamic forecasts of the logs of price and output at various forecast horizons. That is, the forecasts use forecasts of lagged values when necessary. The forecasted values are then subtracted from the corresponding actual values to compute forecast errors. Finally, the correlations between price and output forecast errors are computed at each forecast horizon. To determine the appropriate lag length and whether or not trend and trend squared should be included, we use the Akaike Information Criterion. We consider up to eight lags, narrowing the sample to 1961:2 to 2002:4 to ensure that the span of the dependent variables is the same no matter how many lags are included.[8]

Data revisions and our extended sample could cause our results to differ from those of Den Haan. In Appendix B, we plot the correlations using both Den Haan's data and his specifications. We also plot two other sets of correlations based on our updated data. The first of these retains Den Haan's sample period and his specification but uses our revised data. The second of these uses our entire sample and the specifications suggested by the Akaike Information Criteria for our data. Although there are some differences in magnitudes at the longer forecast horizons, the additional data and change in specification do not substantively change Den Haan's results. This is particularly clear at the short forecast horizons that are

[8] We use 1961:2 so that when we do the correlations with unit roots, there are eight lagged growth rates. Results on correlations with unit roots appear in Appendix C.

relevant to the issues here. At the short forecast horizons, we continue to find small or negative correlations for the GDP and the GDP deflator and positive correlations for IP and the CPI.

Correlations for the matched pairs are reported in Table 1. The correlations are negative or near zero at all forecast horizons.[9] The correlations vary in magnitude across output measures with consumption and investment being the largest. Except for non-durables, correlations at

Table 1: Matched correlations:

		forecast horizon in quarters							
price	L	1	2	3	4	5	6	7	8
gdp	7	-0.06	-0.02	-0.04	-0.09	-0.13	-0.21	-0.28	-0.33
con	2	-0.16	-0.27	-0.33	-0.41	-0.52	-0.59	-0.63	-0.67
inv	2	-0.24	-0.18	-0.18	-0.22	-0.27	-0.31	-0.34	-0.36
goods	2	-0.11	-0.05	-0.04	-0.02	-0.03	-0.09	-0.16	-0.20
dur	2	-0.09	-0.04	-0.13	-0.16	-0.21	-0.25	-0.28	-0.32
non	2	-0.09	-0.09	-0.10	-0.07	0.00	-0.01	-0.10	-0.12
serv	7	-0.10	-0.13	-0.15	-0.20	-0.30	-0.40	-0.46	-0.50

Notes: The numbers are correlation coefficients between forecast errors from a VAR at different horizons. All regressions include a constant, time, and time squared. The letter L denotes the number of lags which is common for all regressors. The specification does not impose a unit root. Imposition of a unit root does not substantively change our results. Analogous results with unit roots imposed may be found in Appendix C.

longer horizons are of greater magnitude; Den Haan also finds this to be true for GDP and the GDP deflator and for the IP and the CPI.

Before we discuss the results for mismatched pairs, we discuss a bit further the nature of the bias in the correlation between mismatched pairs. In general, the mismatched covariance may understate or overstate the covariance between matched pairs. The sign and size of the bias depends on the sign and size of the covariance σ_{qX}. However, in our setting there are some

[9] Balke and Nath (2003) find mostly negative unconditional correlations between changes in prices and output growth from 1947 to 1987 for annual observations of 35 industries that roughly parallel the SIC two digit codes.

potentially interesting relationships. Consider two measures X and Y. Recall that the relationship in equation 1 for the covariance between P^Y and X is

$$\sigma_{P^Y X} = \sigma_{P^X X} + \sigma_{qX} \; .$$

For the covariance between P^X and Y we have

$$\sigma_{P^X Y} = \sigma_{P^Y Y} + \sigma_{(1/q)Y}.$$

If X and Y move closely together, as is probable in our application, then it is likely that the covariance between Y and P^X/P^Y, $\sigma_{(1/q)Y}$, will have the opposite sign of the covariance between X and P^Y/P^X, σ_{qX}. Now, suppose that the covariance between X and P^Y/P^X is positive. Then the covariance between X and P^Y will be larger than the covariance between X and P^X and could be positive even if the covariance between X and P^X is negative. In turn, if the covariance between Y and P^Y is negative, then the covariance between Y and P^X will be negative but will have a larger magnitude than the covariance between Y and P^Y.

Mismatched pairs are reported in Tables 2A-2H. At long forecast horizons the correlations are negative, but there is some variation in magnitude. However, our emphasis is on the short forecast horizons. There is, as we would expect, much variation in both the signs and magnitudes of correlations across output measures. The correlations for GDP, IP, and goods are mixed. The correlations for consumption, non-durables, and services are predominantly negative. On the other hand, the correlations for investment and durable goods are predominantly positive. It is noteworthy that the correlations that are predominantly negative are measures that are dominated by non-durable goods or services, while the correlations that are predominantly positive are dominated by durable goods.

To organize our discussion, we may think of two types of output; output that is mostly durables, call it X, and output that is mostly non-durables and services, call it Y. Category X includes investment and durable goods. Category Y includes consumption, services, and

Table 2A: Mismatched correlations: Output = Real GDP

		forecast horizon in quarters							
price	L	1	2	3	4	5	6	7	8
con	2	0.01	0.03	-0.03	-0.09	-0.19	-0.30	-0.37	-0.42
inv	2	-0.30	-0.28	-0.29	-0.33	-0.39	-0.43	-0.47	-0.51
goods	2	-0.13	-0.13	-0.17	-0.20	-0.26	-0.36	-0.45	-0.51
dur	2	-0.22	-0.23	-0.33	-0.36	-0.41	-0.47	-0.53	-0.57
non	2	0.13	0.15	0.09	0.02	-0.04	-0.14	-0.24	-0.30
serv	8	-0.03	-0.05	-0.12	-0.21	-0.25	-0.29	-0.33	-0.35
cpi	2	0.07	0.10	0.00	-0.06	-0.16	-0.26	-0.35	-0.41

Notes: The numbers are correlation coefficients between forecast errors from a VAR at different horizons. All regressions include a constant, time, and time squared. The letter L denotes the number of lags which is common for all regressors. The specification does not impose a unit root. Imposition of a unit root does not substantively change our results. Analogous results with unit roots imposed may be found in Appendix C.

Table 2B: Mismatched correlations: Output = Real Consumption

		forecast horizon in quarters							
price	L	1	2	3	4	5	6	7	8
gdp	2	-0.16	-0.25	-0.38	-0.46	-0.54	-0.62	-0.67	-0.70
inv	2	-0.17	-0.23	-0.38	-0.44	-0.49	-0.54	-0.57	-0.58
goods	2	-0.17	-0.28	-0.37	-0.44	-0.52	-0.59	-0.65	-0.68
dur	2	-0.18	-0.33	-0.43	-0.50	-0.55	-0.60	-0.65	-0.68
non	2	-0.09	-0.14	-0.19	-0.29	-0.37	-0.45	-0.51	-0.55
serv	8	0.03	-0.10	-0.28	-0.39	-0.48	-0.55	-0.59	-0.61
cpi	2	-0.16	-0.28	-0.37	-0.43	-0.53	-0.59	-0.64	-0.68

Notes: See Table 2A.

Table 2C: Mismatched correlations: Output = Real Investment

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	3	0.03	0.11	0.09	0.00	-0.09	-0.16	-0.22	-0.25
con	2	0.05	0.11	0.06	0.00	-0.08	-0.20	-0.26	-0.28
goods	2	-0.05	-0.02	-0.08	-0.14	-0.21	-0.28	-0.35	-0.39
dur	2	-0.14	-0.09	-0.20	-0.24	-0.29	-0.34	-0.37	-0.40
non	2	0.15	0.15	0.06	-0.02	-0.08	-0.16	-0.25	-0.30
serv	8	0.02	0.06	0.05	-0.03	-0.03	-0.03	-0.04	-0.04
cpi	2	0.15	0.22	0.14	0.06	-0.03	-0.15	-0.23	-0.26

Notes: See Table 2A.

Table 2D Mismatched correlations: Output = Goods

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	2	-0.12	-0.01	-0.01	-0.01	-0.03	-0.08	-0.15	-0.18
con	2	0.00	0.06	0.06	0.06	0.03	-0.04	-0.09	-0.12
inv	2	-0.23	-0.15	-0.13	-0.14	-0.17	-0.17	-0.20	-0.22
dur	2	-0.17	-0.11	-0.20	-0.20	-0.22	-0.26	-0.29	-0.32
non	2	0.10	0.16	0.16	0.17	0.16	0.10	0.03	-0.02
serv	8	-0.01	0.04	0.05	0.02	0.03	0.01	0.00	-0.01
cpi	2	0.11	0.20	0.13	0.13	0.09	0.01	-0.05	-0.11

Notes: See Table 2A.

Table 2E: Mismatched correlations: Output = Durable Goods

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	2	-0.02	0.10	0.09	0.05	-0.03	-0.09	-0.14	-0.17
con	2	0.05	0.10	0.10	0.10	0.03	-0.04	-0.06	-0.09
inv	2	-0.18	-0.09	-0.09	-0.13	-0.17	-0.18	-0.20	-0.20
goods	2	0.02	0.09	0.08	0.04	-0.01	-0.07	-0.13	-0.18
non	2	0.18	0.26	0.27	0.24	0.19	0.11	0.06	0.01
serv	8	0.00	0.02	0.09	0.04	0.03	0.01	0.00	-0.04
cpi	2	0.17	0.21	0.16	0.12	0.05	-0.03	-0.08	-0.13

Notes: See Table 2A.

Table 2F: Mismatched correlations: Output = Non-durable Goods

		forecast horizon in quarters

price	L								
		1	2	3	4	5	6	7	8
gdp	4	-0.17	-0.15	-0.14	-0.10	-0.04	-0.10	-0.17	-0.14
con	4	-0.06	-0.02	-0.02	-0.06	-0.04	-0.13	-0.20	-0.17
inv	2	-0.20	-0.22	-0.21	-0.17	-0.17	-0.19	-0.20	-0.21
goods	4	-0.27	-0.28	-0.25	-0.15	-0.07	-0.12	-0.20	-0.17
dur	8	-0.25	-0.30	-0.35	-0.30	-0.27	-0.31	-0.29	-0.25
serv	8	-0.08	-0.02	-0.05	-0.06	-0.03	-0.07	-0.08	-0.03
cpi	4	-0.07	0.07	0.04	0.06	0.07	-0.01	-0.07	-0.06
Notes: See Table 2A.									

Table 2G: Mismatched correlations: Output = Services

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.18	-0.24	-0.24	-0.27	-0.34	-0.41	-0.46	-0.50
con	2	-0.09	-0.15	-0.18	-0.20	-0.25	-0.30	-0.35	-0.39
inv	2	-0.11	-0.24	-0.24	-0.28	-0.34	-0.40	-0.43	-0.47
goods	2	-0.18	-0.18	-0.20	-0.24	-0.31	-0.37	-0.41	-0.45
dur	3	-0.21	-0.15	-0.14	-0.18	-0.27	-0.33	-0.39	-0.45
non	2	-0.01	-0.03	-0.07	-0.10	-0.16	-0.21	-0.26	-0.28
cpi	2	-0.18	-0.24	-0.25	-0.28	-0.32	-0.36	-0.40	-0.43
Notes: See Table 2A.									

Table 2H: Mismatched correlations: Output = Industrial Production

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	0.14	0.12	0.08	0.02	-0.03	-0.08	-0.13	-0.17
con	3	-0.09	-0.18	-0.20	-0.21	-0.22	-0.24	-0.25	-0.24
inv	2	0.01	-0.09	-0.11	-0.11	-0.12	-0.15	-0.20	-0.24
goods	2	0.08	0.01	-0.06	-0.10	-0.14	-0.20	-0.26	-0.30
dur	6	-0.01	-0.15	-0.22	-0.25	-0.28	-0.31	-0.35	-0.41
non	2	0.12	0.17	0.12	0.07	0.04	-0.02	-0.08	-0.13
serv	8	0.17	0.17	0.17	0.11	0.11	0.10	0.06	0.02
cpi	2	0.17	0.20	0.16	0.10	0.02	-0.06	-0.12	-0.16
Notes: See Table 2A.									

nondurables, and we include the CPI as an additional price measure of mostly Y-type products. This breakdown gives four categories: both price and output measures are mostly durables, both price and output measures are mostly non-durables, price measures are mostly nondurables while output measures are mostly durables, and price measures are mostly durables while output measures are mostly nondurables.

The results for these categories are summarized in Table 3 where we report the average correlation for the first four forecast horizons from Tables 2. The correlations for the Y-type outputs (consumption, nondurable goods, and services) are nearly always negative regardless of the price index with which they are paired. The only exception is when nondurables is paired with the CPI. The Y-type output correlations are generally of greater magnitude when paired with price indexes that contain mostly durables than when paired with price indexes that contain mostly prices of nondurables. So, for output measures containing mostly non-durables, the

Table 3: Average of the First Four Correlations- GDP Components or Sectors

output		price					
		X		Y			
	output	inv	dur	con	ser	non	cpi
X	inv	-0.20	-0.16	0.06	0.02	0.09	0.14
	dur	-0.12	-0.11	0.09	0.03	0.23	0.16
Y	con	-0.30	-0.36	-0.29	-0.18	-0.18	-0.31
	ser	-0.22	-0.17	-0.15	-0.14	-0.05	-0.24
	non	-0.20	-0.30	-0.04	-0.05	-0.09	0.03

notes: Analogous results for the specification that imposes a unit root may be found in Appendix C.

correlations tend to be negative; mismatching them with price indexes based mostly on durables tends to make them more so.

Investment and durable goods have negative correlations when paired with the price indexes for either investment or durable goods. However, when investment and durable goods are paired with price indexes that contain mostly Y-type products, the correlations are positive, although sometimes small in magnitude. Mismatching durable output measures with nondurable price measures, moves correlations from negative to positive. This consequence of mismatching contrasts sharply with the effect of mismatching nondurable outputs with durables price measures. Given our earlier discussion, this strongly suggests that the price of X-type goods relative to the price of Y-type goods is procyclical and nontrivial in magnitude. We return to this issue below.

When output measures contain significant portions of both durables and nondurables, such as industrial production, real GDP, and aggregate goods production, the statistical issues are a bit more involved because of multiple relative prices. However, the results for the aggregates are most similar to those for durables. These results are summarized in Table 4. When the aggregates are matched with prices that have mostly X-type products, the correlations are mostly negative. When the aggregates are matched with price indexes based mostly on Y-type products, the correlations tend to be positive, although the results are a bit more mixed for real GDP.

Table 4: Average of the First Four Correlations - Aggregates

	price						
output	inv	goods	dur	cpi	con	ser	non
goods	-0.16	-0.05	-0.17	0.14	0.05	0.02	0.15
ip	-0.17	-0.02	-0.16	0.16	0.15	0.15	0.12
real gdp	-0.30	-0.16	-0.29	0.03	-0.02	-0.10	0.10

The correlations between IP and prices behave more like the correlations between durable goods and prices than the correlations between goods, non-durable goods, and prices. Table 4 shows that the IP -price correlation is positive only when the price index is one with mostly Y-type products. This suggests that the source of the increase in the correlation that occurs when a mostly durable output is matched with a mostly non-durable price index may also be responsible for the positive correlation between IP and a mostly non-durable price index namely, procyclical movements in the relative price of durable-type outputs.

The correlations above were computed using levels of the variables in the VARs. We consider two alternative specifications to check the sensitivity of our results. First, following Den Haan, we difference the variables, except the ratio of nonborrowed reserves and the federal funds rate; this is done to address the possible presence of unit roots. The results appear in Appendix C. Second, it is possible that forecasts of disaggregated prices and output, and the other variables used to forecast them, also depend on aggregate output and prices; therefore in the levels regressions we include GDP and the GDP deflator in those VARs where they are not otherwise included. The results appear in Appendix D.

At long horizons, the results from the various specifications are essentially the same. At short horizons, the correlations for the alternative VARs differ somewhat in their details, but our general conclusions hold. In particular, matched measures of prices and output have mostly negative correlations and are never large positive numbers. Correlations from mismatched pairs are positive when outputs that are mostly durables are paired with price indexes based mostly on nondurables, otherwise the mismatched pairs are mostly negative. Thus, our general results are robust to these specification changes.

Implications for the Movements of Relative Prices

The source of the difference between correlations for matched and mismatched pairs reflects the correlation between the matched measure of production and the mismatched price index relative to the matched price index. Mismatching nondurable output measures with measures of durable prices makes the correlations for nondurables larger negative numbers. This suggests that the correlation between nondurable output and durable price indexes relative to non-durable price indexes may be negative. Mismatching durable output measures with nondurable price measures makes the correlations small or positive, whereas matched pairs are negatively correlated. This implies that the correlation between durable output measures and the relative price of nondurables to durables is positive. So, at the risk of overgeneralizing, the implication of the correlations above is that the relative price of durables to nondurables tends to be negatively correlated with nondurables, while the relative price of nondurables to durables tends to be positively correlated with output of durables. To the extent that the output of nondurables and durables move with GDP, this can be summarized by saying that the relative price of nondurables to durables is procyclical.

We first check this assertion by examining unconditional correlations. In Table 5 we present the correlation between detrended log levels of real GDP and a detrended log of relative price. We detrend by first-differencing and by applying the Hodrick-Prescott filter. In the six

Table 5: Correlation of Relative Prices with Real GDP

relative price	hodrick-prescott	first differences
con/inv	0.22	0.22
ser/dur	0.49	0.21
non/dur	0.36	0.25

notes: The sample runs from 1961.2 to 2002.4

cases we present, all the correlations are positive and relatively large. Thus, the correlations indicate the relative prices of consumption to investment, services to durable, and nondurables to durables are all procyclical.

To further examine the cyclical nature of relative price shocks, we build VARs like the ones above, but include multiple output and price indexes.[10] We then compute shocks to the relative prices and correlate them with shocks to production. The results are presented in Table 6. Except for the price of services relative to durables correlated with output of durables and at some lags with real GDP, the table shows that shocks to the price index for a mostly nondurable good relative to a price index for a mostly durable good are positively correlated with shocks to output.[11] This is particularly so when output is measured by GDP and is consistent with the impressions left by Table 5.

Table 6: Relative Price Correlations

price	L	output	forecast horizon in quarters							
			1	2	3	4	5	6	7	8
con/inv	2	rgdp	0.30	0.34	0.36	0.35	0.35	0.36	0.35	0.33
ser/dur	2	rgdp	0.18	0.15	0.13	-0.01	-0.06	0.00	0.13	0.23
non/dur	2	rgdp	0.24	0.24	0.23	0.12	0.05	0.02	0..03	0.09
con/inv	2	inv	0.22	0.24	0.26	0.25	0.26	0.27	0.27	0.26
ser/dur	2	dur	0.00	0.01	0.08	-0.02	-0.02	0.03	0.13	0.22
non/dur	2	dur	0.15	0.25	0.31	0.26	0.22	0.18	0.20	0.24

notes: The sample runs from 1961.2 to 2002.4

Conclusion

The price-output correlation is important to understanding the nature of shocks to the economy. Evidence of a positive correlation comes mostly from correlations between industrial

[10]For the relative price of consumption to investment, price and output measures are included for consumption, investment, and GDP. For the other relative prices, price and output measures are included for durable goods, nondurable goods, services, and real GDP. Because of the larger number of variables in these vars, lag lengths were restricted to four or less.

[11]When we used the deflator for services and services as reported in table 2, the lag length was longer. In this table we only considered lag lengths of four or less, because the number of variables in the VAR's quickly reduces degrees of freedom as lags are added. However, if the VAR is run with 8 lags, then the first four correlations for the correlation between the price of services relative to durables and services are .07, .10, .12, and .10.

production and the consumer price index. We show that the correlation between industrial production and the consumer price index cannot be taken at face value. When an output index and price index are mismatched, the correlation depends on two components: the matched price-output correlation and the correlation between a relative price and output. Since relative prices may vary systematically over the business cycle, the second component in the correlation vitiates the mismatched correlation as a measure of the price-output relationship.

This problem is not just a curiosity. We show that matched price-output correlations are mostly negative even at short forecast horizons. We also show that the price of non-durable-type goods relative to the price of durable-type goods is procyclical. This positive correlation imparts a positive bias to the correlation of a mostly nondurable goods price index, such as the CPI, to a mostly durable goods output index, such as investment. So, the correlation between the CPI and investment is positive even though the correlations between investment and the investment deflator and between consumption and the CPI are both negative. There is no price index that matches with IP. Nevertheless, we conjecture that were one to exist or if one is created, the correlation between this price index and industrial production would be negative even at short forecast horizons.

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Appendix A

Data Definitions and Sources

Prices:

Consumption Deflator:	Implicit Price Deflator Personal Consumption Expenditures, Table 1.1.9. BEA website.
Consumer Price Index:	Consumer Price Index -- All Urban Consumers, Seasonally Adjusted, Series CUSR0000SA0 BLS website
Durables Price Index:	Price Index for Durable Goods, Table 1.2.4. BEA webite.
GDP Deflator:	Implicit Price Deflator GDP, Table 1.1.9. BEA website.
Goods Deflator:	Implicit Price Deflator Goods, computed as the ratio of nominal goods from Table 1.2.5 divided by Chained Real Goods from Table 1.2.6. BEA website.
Investment Deflator:	Implicit Price Deflator Gross Private Domestic Investment, Table 1.1.9. BEA website.
Nondurables Price Index:	Price Index for Nondurable Goods, Table 1.2.4. BEA webite.
Services Deflator:	Implicit Price Deflator Services, computed as the ratio of nominal goods from Table 1.2.5 divided by Chained Real Services from Table 1.2.6. BEA website.

Output:

Consumption:	Chained Real Personal Consumption Expenditures, Table 1.1.6. BEA website
Durables:	Real Quantity Index, Durable Goods, Table 1.2.3. BEA website.
GDP:	Chained Real Gross Domestic Product, Table 1.1.6. BEA website
Goods:	Chained Real Goods, Table 1.2.6. BEA website.
Investment:	Chained Real Gross Private Domestic Investment, Table 1.1.6 BEA website
Industrial Production:	Index of Industrial Production, Seasonally Adjusted, Federal Reserve Bank of St. Louis

Nondurables:	Real Quantity Index, Nondurable Goods, Table 1.2.3. BEA website.
Services:	Chained Real Goods, from Table 1.2.6. BEA website.

Financial Variables:

Federal Funds Rate:	Federal Funds Effective Rate, Release H:15 BOG website.
Nonborrowed Reserves:	Nonborrowed Reserves Plus Extended Credit, Seasonally Adjusted, Adjusted for Changes in Reserve Requirements, Release H:3 BOG website
Reserves:	Total Reserves, Seasonally Adjusted, Adjusted for Changes in Reserve Requirements, Release H:3 BOG website.

Appendix B

In this appendix we compare our correlations for GDP and the GDP deflator and for IP and the CPI to those reported in Den Haan (2000). Each figure below plots the correlation of price and output errors for forecast horizons from 1 to 28. There are three plots in each graph. One is numbers we generated using Den Haan's data. Our graphs for the cases with unit roots imposed are identical to his. However, we were unable to replicate his graphs for the cases where no unit roots are imposed for the multivariate cases shown below, even though we were able to replicate his results for the bivariate VARS with no unit roots imposed. The second graph uses our data but the same sample and specifications as Den Haan used.[12] The third graph uses our data, our extended sample, and the lag length we found for each case with the new data.

Figure B.1. GDP and the GDP Deflator without Unit Roots Imposed.

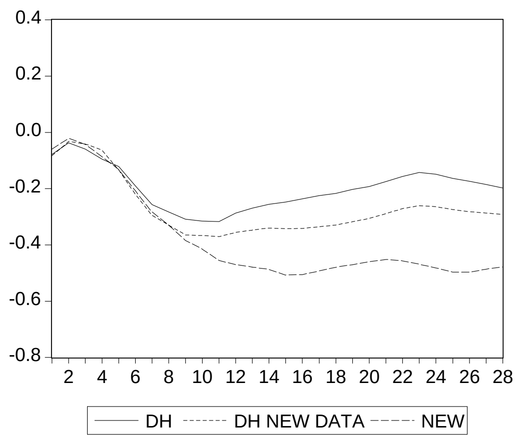
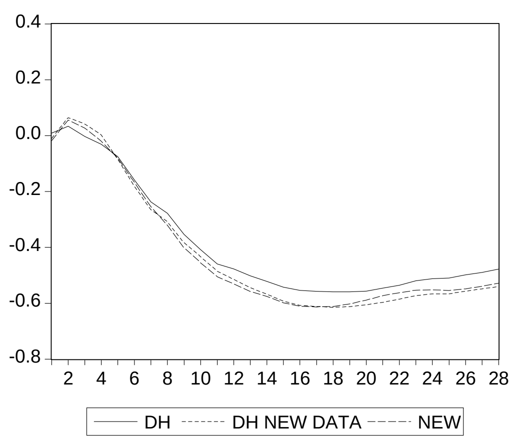


Figure B.2. GDP and the GDP Deflator without Unit Roots Imposed



[12]For the CPI and IP correlations we use Den Haan's monthly data for the first graph. For his sample with our data, we use quarterly averages and use quarterly lags that include at least as many months as his specification.

Figure B.3. IP and the CPI without Unit Roots Imposed

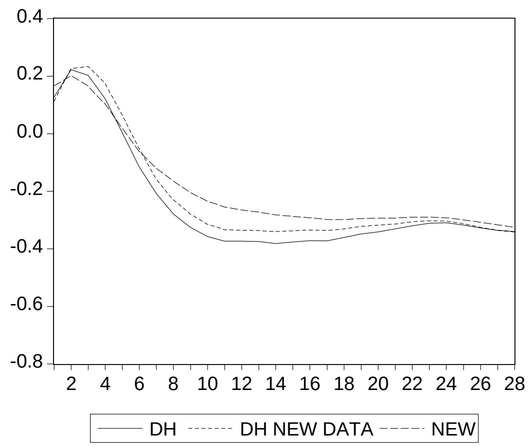
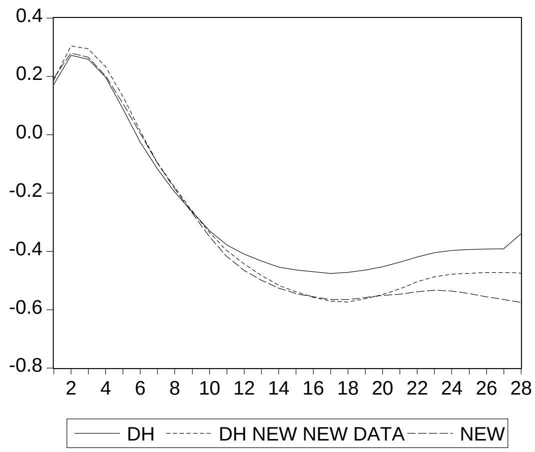


Figure B.4. IP and CPI with Unit Roots Imposed



Appendix C

The specification used to generate the results below imposes a unit root assumption on the data. The tables below present results analogous to those found in the text in tables 1 - 3.

Table C-1: Matched correlations:

		forecast horizon in quarters							
price	L	1	2	3	4	5	6	7	8
gdp	4	-0.02	0.06	0.03	-0.02	-0.08	-0.17	-0.25	-0.32
con	2	-0.12	-0.20	-0.24	-0.31	-0.40	-0.46	-0.49	-0.53
inv	2	-0.16	-0.05	0.01	0.00	-0.05	-0.08	-0.13	-0.17
goods	2	-0.08	-0.01	0.00	0.04	0.04	-0.02	-0.10	-0.14
dur	2	-0.05	-0.01	-0.06	-0.09	-0.15	-0.18	-0.22	-0.28
non	2	-0.06	-0.09	-0.11	-0.06	0.02	0.01	-0.08	-0.09
serv	2	-0.16	-0.19	-0.20	-0.22	-0.29	-0.35	-0.39	-0.43

Notes: The numbers are correlation coefficients between forecast errors from a VAR at different horizons. All regressions include a constant and time. The letter L denotes the number of lags which is common for all regressors. The specification imposes a unit root.

Table C-2A: Mismatched correlations: Output = Real GDP

		forecast horizon in quarters							
price	L	1	2	3	4	5	6	7	8
con	7	0.05	0.13	0.12	0.07	0.00	-0.10	-0.18	-0.25
inv	2	-0.25	-0.19	-0.13	-0.13	-0.17	-0.20	-0.25	-0.29
goods	2	-0.07	-0.06	-0.06	-0.06	-0.09	-0.19	-0.28	-0.35
dur	2	-0.17	-0.16	-0.23	-0.21	-0.25	-0.31	-0.37	-0.43
non	2	0.17	0.18	0.11	0.03	-0.02	-0.11	-0.21	-0.28
serv	2	0.02	0.05	0.02	-0.09	-0.17	-0.25	-0.30	-0.35
cpi	2	0.14	0.19	0.12	0.09	0.02	-0.08	-0.15	-0.20

Notes: See Table C-1.

Table C-2B: Mismatched correlations: Output = Real Consumption

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.07	-0.10	-0.21	-0.28	-0.36	-0.44	-0.50	-0.54
inv	2	-0.03	-0.05	-0.17	-0.22	-0.28	-0.35	-0.40	-0.43
goods	2	-0.10	-0.15	-0.21	-0.27	-0.34	-0.43	-0.50	-0.55
dur	2	-0.10	-0.18	-0.27	-0.31	-0.38	-0.45	-0.52	-0.58
non	2	-0.07	-0.11	-0.17	-0.26	-0.33	-0.42	-0.47	-0.52
serv	2	0.00	-0.03	-0.16	-0.27	-0.36	-0.44	-0.49	-0.54
cpi	2	-0.11	-0.19	-0.25	-0.28	-0.36	-0.40	-0.43	-0.47

Notes: See Table C-1.

Table C-2C: Mismatched correlations: Output = Real Investment

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	0.07	0.16	0.11	0.03	-0.07	-0.15	-0.24	-0.30
con	2	0.11	0.19	0.15	0.07	-0.03	-0.14	-0.22	-0.26
goods	2	0.03	0.07	0.03	-0.01	-0.07	-0.14	-0.23	-0.29
dur	2	-0.06	-0.02	-0.09	-0.11	-0.17	-0.21	-0.26	-0.30
non	2	0.21	0.22	0.13	0.04	-0.01	-0.09	-0.19	-0.25
serv	2	0.08	0.14	0.13	0.01	-0.07	-0.14	-0.20	-0.23
cpi	2	0.21	0.29	0.22	0.14	0.05	-0.07	-0.16	-0.21

Notes: See Table C-1.

Table C-2D Mismatched correlations: Output = Goods

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	-0.06	0.05	0.05	0.04	0.00	-0.05	-0.12	-0.16
con	7	0.00	0.11	0.13	0.12	0.10	0.04	-0.02	-0.06
inv	2	-0.18	-0.07	-0.01	-0.02	-0.05	-0.05	-0.09	-0.11
dur	2	-0.13	-0.08	-0.13	-0.11	-0.13	-0.18	-0.22	-0.26
non	2	0.13	0.18	0.15	0.13	0.12	0.07	-0.02	-0.07
serv	2	0.00	0.06	0.07	0.00	-0.04	-0.09	-0.14	-0.18
cpi	2	0.16	0.23	0.19	0.19	0.15	0.08	0.02	-0.02

Notes: See Table C-1.

Table C-2E: Mismatched correlations: Output = Durable Goods

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	2	0.04	0.17	0.18	0.13	0.04	-0.01	-0.07	-0.12
con	3	0.07	0.15	0.14	0.11	0.03	-0.03	-0.08	-0.13
inv	3	-0.10	0.06	0.08	0.05	0.00	0.00	-0.06	-0.09
goods	2	0.06	0.16	0.17	0.13	0.13	0.03	-0.05	-0.11
non	2	0.18	0.27	0.26	0.22	0.16	0.09	0.02	-0.05
serv	2	0.01	0.04	0.08	0.00	-0.08	-0.13	-0.16	-0.21
cpi	2	0.20	0.25	0.24	0.21	0.14	0.09	0.04	-0.01

Notes: See Table C-1.

Table C-2F: Mismatched correlations: Output = Non-durable Goods

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	3	-0.19	-0.13	-0.11	-0.07	0.00	-0.05	-0.11	-0.10
con	4	-0.04	0.00	0.01	-0.01	0.01	-0.08	-0.15	-0.14
inv	2	-0.14	-0.12	-0.07	-0.02	0.00	-0.02	-0.03	-0.05
goods	2	-0.24	-0.26	-0.25	-0.13	-0.03	-0.08	-0.16	-0.13
dur	2	-0.18	-0.15	-0.20	-0.10	-0.04	-0.09	-0.11	-0.07
serv	2	-0.04	0.02	0.00	0.03	0.07	0.02	-0.04	-0.01
cpi	2	-0.03	0.07	0.01	0.07	0.12	0.03	-0.05	-0.04

Notes: See Table C-1.

Table C-2G: Mismatched correlations: Output = Services

price	L	forecast horizon in quarters 1	2	3	4	5	6	7	8
gdp	2	-0.16	-0.19	-0.16	-0.15	-0.20	-0.24	-0.28	-0.32
con	2	-0.06	-0.09	-0.11	-0.11	-0.14	-0.17	-0.22	-0.27
inv	2	-0.12	-0.24	-0.22	-0.22	-0.26	-0.31	-0.34	-0.38
goods	2	-0.15	-0.13	-0.12	-0.14	-0.20	-0.27	-0.31	-0.36
dur	2	-0.19	-0.18	-0.18	-0.21	-0.28	-0.34	-0.39	-0.45
non	2	-0.03	-0.07	-0.10	-0.13	-0.19	-0.24	-0.29	-0.32
cpi	2	-0.15	-0.19	-0.19	-0.20	-0.22	-0.24	-0.28	-0.32

Notes: See Table C-1.

Table C-2H: Mismatched correlations: Output = Industrial Production

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	0.19	0.20	0.16	0.10	0.03	-0.04	-0.12	-0.20
con	2	0.14	0.24	0.25	0.18	0.08	-0.02	-0.11	-0.19
inv	2	0.00	-0.03	0.00	0.00	-0.02	-0.07	-0.12	-0.18
goods	2	0.15	0.11	0.06	0.02	-0.02	-0.10	-0.19	-0.27
dur	2	0.03	-0.04	-0.10	-0.13	-0.17	-0.22	-0.27	-0.34
non	2	0.16	0.22	0.17	0.11	0.06	-0.02	-0.12	-0.21
serv	2	0.15	0.18	0.18	0.12	0.05	-0.01	-0.08	-0.15
cpi	2	0.19	0.28	0.27	0.20	0.11	0.00	-0.10	-0.19
Notes: See Table C-1.									

Table C-3: Average of the First Four Correlations- GDP Components or Sectors

		price						
		X			Y			
		output	inv	dur	con	ser	non	cpi
output	X	inv	-0.05	-0.07	0.13	0.09	0.15	0.22
		dur	0.02	-0.05	0.12	0.03	0.24	0.23
	Y	con	-0.12	-0.22	-0.22	-0.11	-0.15	-0.21
		ser	-0.20	-0.19	-0.09	-0.19	-0.08	-0.18
		non	-0.09	-0.16	-0.01	0.00	-0.08	0.03

Appendix D

The specification used to generate the results below includes real GDP and the GDP deflator as additional explanatory variables. Because of the addition variables the lag length was restricted to be 4 periods or less. The tables below present results analogous to those found in the text in tables 1 - 3.

Table D-1 Matched Correlations

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
con	2	-0.17	-0.29	-0.34	-0.42	-0.53	-0.60	-0.66	-0.70
inv	3	-0.18	-0.14	-0.12	-0.18	-0.30	-0.39	-0.45	-0.48
goods	2	-0.07	0.01	0.01	0.03	-0.01	-0.09	-0.18	-0.23
dur	2	-0.10	-0.07	-0.15	-0.17	-0.23	-0.28	-0.32	-0.34
non	3	-0.13	-0.13	-0.13	-0.117	-0.07	-0.10	-0.19	-0.21
serv	4	-0.08	-0.13	-0.20	-0.29	-0.43	-0.55	-0.63	-0.68

Notes: The numbers are correlation coefficients between forecast errors from a VAR at different horizons. All regressions include a constant, time, time squared, real GDP, and the GDP deflator. The letter L denotes the number of lags which is common for all regressors. No unit roots are imposed.

Table D-2A Mismatched Correlations Output = GDP

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
con	2	0.00	0.04	0.01	-0.04	-0.13	-0.24	-0.34	-0.40
inv	3	-0.28	-0.24	-0.22	-0.24	-0.30	-0.36	-0.41	-0.42
goods	2	-0.12	-0.09	-0.10	-0.13	-0.21	-0.32	-0.41	-0.47
dur	2	-0.20	-0.17	-0.21	-0.19	-0.22	-0.27	-0.34	-0.39
non	3	0.15	0.19	0.16	0.09	0.00	-0.11	-0.22	-0.29
serv	4	0.01	0.01	-0.05	-0.15	-0.25	-0.36	-0.46	-0.54
cpi	2	0.05	0.11	0.03	-0.01	-0.10	-0.22	-0.33	-0.41

Notes: See Table D-1.

Table D-2B Mismatched Correlations Output = Consumption									
price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.16	-0.25	-0.38	-0.46	-0.54	-0.62	-0.67	-0.70
inv	2	-0.11	-0.17	-0.27	-0.30	-0.35	-0.39	-0.42	-0.42
goods	2	-0.13	-0.20	-0.28	-0.35	-0.44	-0.53	-0.60	-0.64
dur	2	-0.13	-0.22	-0.30	-0.35	-0.42	-0.48	-0.55	-0.60
non	2	-0.07	-0.09	-0.14	-0.24	-0.35	-0.45	-0.51	-0.55
serv	3	-0.02	-0.07	-0.20	-0.30	-0.42	-0.52	-0.60	-0.64
cpi	2	-0.18	-0.30	-0.39	-0.44	-0.54	-0.62	-0.68	-0.72
Notes: See Table D-1.									

Table D-2C Mismatched Correlations Output = Investment									
price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.03	0.07	0.04	-0.03	-0.11	-0.18	-0.26	-0.29
con	2	0.10	0.19	0.19	0.17	0.10	-0.01	-0.11	-0.17
goods	2	-0.04	0.02	-0.01	-0.06	-0.15	-0.24	-0.33	-0.38
dur	2	-0.11	-0.02	-0.05	-0.02	-0.04	-0.05	-0.09	-0.11
non	3	0.18	0.25	0.20	0.11	0.03	-0.06	-0.18	-0.25
serv	4	0.06	0.15	0.14	0.03	-0.05	-0.14	-0.26	-0.35
cpi	2	0.19	0.32	0.29	0.24	0.18	0.07	-0.06	-0.13
Notes: See Table D-1.									

Table D-2D Mismatched Correlations Output = Goods									
price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.08	0.03	0.00	0.00	-0.04	-0.10	-0.18	-0.22
con	2	0.04	0.12	0.11	0.12	0.08	-0.01	-0.08	-0.13
inv	2	-0.20	-0.14	-0.15	-0.18	-0.22	-0.25	-0.29	-0.32
dur	2	-0.17	-0.11	-0.15	-0.11	-0.10	-0.14	-0.19	-0.22
non	3	0.14	0.23	0.24	0.23	0.23	0.17	0.09	0.03
serv	3	-0.03	0.01	0.00	-0.03	-0.06	-0.10	-0.17	-0.21
cpi	3	0.10	0.21	0.16	0.17	0.13	0.05	-0.04	-0.10
Notes: See Table D-1.									

Table D-2E Mismatched Correlations Output = Durable Goods

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	0.07	0.19	0.19	0.12	0.03	-0.05	-0.12	-0.18
con	2	0.06	0.14	0.13	0.11	0.02	-0.08	-0.14	-0.20
inv	3	-0.11	-0.02	-0.03	-0.10	-0.18	-0.22	-0.26	-0.25
goods	4	0.14	0.27	0.26	0.19	0.08	-0.02	-0.10	-0.17
non	3	0.25	0.38	0.40	0.37	0.31	0.22	0.13	0.06
serv	4	0.05	0.12	0.15	0.08	0.02	-0.02	-0.10	-0.16
cpi	2	0.15	0.24	0.21	0.17	0.07	-0.01	-0.10	-0.19

Notes: See Table D-1

Table D-2F Mismatched Correlations Output = NonDurable Goods

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	-0.22	-0.23	-0.23	-0.16	-0.11	-0.17	-0.24	-0.21
con	2	-0.09	-0.06	-0.05	-0.05	0.04	-0.04	-0.13	-0.12
inv	3	-0.23	-0.33	-0.31	-0.29	-0.28	-0.32	-0.36	-0.38
goods	3	-0.28	-0.30	-0.27	-0.18	-0.12	-0.19	-0.26	-0.24
dur	2	-0.22	-0.23	-0.27	-0.19	-0.13	-0.15	-0.17	-0.13
serv	3	-0.04	-0.02	-0.06	-0.03	0.00	-0.06	-0.14	-0.16
cpi	3	-0.10	0.09	0.16	0.21	0.14	0.06	0.06	0.04

Notes: See Table D-1.

Table D-2G Mismatched Correlations Output = Services

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	2	-0.20	-0.30	-0.35	-0.42	-0.52	-0.61	-0.67	-0.71
con	2	-0.11	-0.20	-0.26	-0.32	-0.40	-0.48	-0.55	-0.60
inv	2	-0.16	-0.28	-0.28	-0.33	-0.41	-0.49	-0.55	-0.59
goods	2	-0.15	-0.20	-0.25	-0.32	-0.42	-0.51	-0.58	-0.62
dur	2	-0.16	-0.17	-0.20	-0.28	-0.38	-0.46	-0.53	-0.59
non	2	-0.02	-0.08	-0.15	-0.21	-0.30	-0.38	-0.44	-0.46
cpi	2	-0.20	-0.32	-0.37	-0.43	-0.59	-0.57	-0.63	-0.67

Notes: See Table D-1.

Table D-2H Mismatched Correlations Output = IP

price	L	forecast horizon in quarters							
		1	2	3	4	5	6	7	8
gdp	3	0.14	0.12	0.07	-0.01	-0.08	-0.16	-0.24	-0.29
con	2	0.11	0.18	0.19	0.14	0.04	-0.07	-0.14	-0.21
inv	3	-0.02	-0.14	-0.17	-0.22	-0.27	-0.34	-0.37	-0.37
goods	3	0.09	0.06	0.01	-0.05	-0.12	-0.21	-0.29	-0.34
dur	2	0.01	-0.06	-0.08	-0.06	-0.08	-0.11	-0.15	-0.18
non	3	0.13	0.22	0.16	0.08	0.02	-0.07	-0.17	-0.23
serv	4	0.15	0.14	0.10	0.02	-0.07	-0.18	-0.31	-0.42
cpi	2	0.20	0.29	0.27	0.21	0.12	0.01	-0.08	-0.16

Notes: See Table D-1.

Table D-3: Average of the First Four Correlations- GDP Components or Sectors

			price					
			X		Y			
		output	inv	dur	con	ser	non	cpi
output	X	inv	-0.15	-0.05	0.16	0.09	0.18	0.26
output	X	dur	-0.06	-0.12	0.11	0.10	0.37	0.16
output	Y	con	-0.21	-0.25	-0.31	-0.15	-0.14	-0.33
output	Y	ser	-0.26	-0.20	-0.22	-0.17	-0.12	-0.33
output	Y	non	-0.29	-0.23	-0.06	-0.04	-0.12	0.06