

## Good Deflation/Bad Deflation and Japanese Economic Recovery

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Teach a parrot the terms “supply and demand’ and you’ve got an economist

Thomas Carlyle (1795-1881)  
Scottish historian and essayist

### I. The Classical Identification Problem: How to Account for Price Change: Demand and/or Supply Shocks

It is conventional to think of deflation as intimately associated with inferior economic performance. Of course, this need not be the case. For example, in late nineteenth century United States new technological and policy innovations permitted a vast expansion in the exploitation of America’s abundant natural resources leading to both falling prices and rapid economic growth (Bordo et al, 2004). This is good deflation!

That deflation can be brought about by a positive supply shock as well as by negative demand shock calls to mind that the best-known identification problem in econometrics is the disentangling of demand and supply curve shifts to determine the sources of a price change (Klein, 1962, pp. 8-92). Consider the world-wide inflation of the mid-1970s. This is variously seen as the result of the negative supply shock brought on by Middle Eastern producers in 1973 and thereafter (Hamilton, 1994, pp. 307-308), or alternatively as the by-product of loose monetary policies earlier in the 1970s (Barsky and Killian, 2001). Thirty years after the event it remains a debate whether expansionary or restrictive macroeconomic policies should have been used to cope with the economic distortions of the mid-1970s. With oil prices rising again today this old controversy has emerged anew.

## II. Price Deflation in Japan at the Turn of the Twenty-First Century

The deflation Japan has experienced over the past ten years has led to renewed debate about the determinants of price changes. While there is a vast literature suggesting that Japanese disinflation is associated with negative demand shocks (see the summary in Saxonhouse and Stern, 2003), other voices pointing to the late nineteenth century experience not only of the United States, but also that of Germany and the United Kingdom have suggested positive supply shocks might instead be at work. In particular former Bank of Japan Governor Masaru Hayami argued

.... there is yet another major factor behind worldwide disinflation ... a new industrial revolution, and the resulting improvement of productivity. To find answers to what is price stability and an appropriate monetary policy in the face of rapid disinflation due to higher productivity are difficult but positive challenges (Hayami, 2001)

By arguing that Japan may be facing persistent good deflation of uncertain duration Governor Hayami was suggesting that conventional price level targets or inflation rate targets might not necessarily be the appropriate policy framework for the Bank of Japan. This position put the Bank of Japan at odds not only with a large number of academic economists and with many other government agencies within Japan, but also attracted criticism from economists and government officials throughout the world (Svensson, 2003).<sup>1</sup>

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<sup>1</sup> Hayami has never gone so far as to say that all deflation is supply side in origin. In addition to supply-side shocks, he has also allowed that there is a "lack of demand" (*Mainichi Shimbun*, January 27, 2003) and that related to this "problems in the banking sector have impaired Japan's credit creation mechanism" (*Jiji Shimbun*, November 23, 2002).

### III. Sources of Good Deflation

If Japan is experiencing at least some good deflation, what might be its sources. Four obvious candidates include 1) positive technological shocks at home; 2) positive technological shocks abroad; 3) less concentrated market power in Japan as a result of deregulation in the home market and at the border, and 4) reallocation of resources from declining sectors into increasing returns to scale industries.

Among these four candidates (2) seems the least controversial. For example, it now seems well established that a marked acceleration in the rate of technological progress commenced in the United States, Japan's leading trading partner, around 1995 (Oliner and Sichel, 2003; Basu, Fernald and Shapiro, 2001).

In contrast, that the rate of technological progress may have accelerated during the 1990s and in the early years of twenty-first century in Japan seems the most controversial. Conventional estimates of Japan's multifactor productivity suggest it hardly increased at all between 1992 and 2001 (*OECD*, 2004) and a leading explanation of Japan's almost decade and one-half turn-down after 1990 stresses the critical role by an inexplicable halt in Japan's technological progress (Hayashi and Prescott, 2002). More recent work on Japan's technological progress, however, which allows for increasing returns to scale, imperfect competition, cyclical utilization of capital and labor and reallocation effects finds no such turndown occurred between 1990 and 1998 and the possibility of an increase in the rate of progress after 1998 cannot be ruled out (Kawamoto, 2004). This result rests in part on a sectoral reallocation of resources during 1990s. As suggested above in (4), during downturns in the 1990s the importance of increasing returns to scale industries grew relative to those characterized by decreasing returns.

#### IV. Central Banks and Good Deflation

To the extent that prices are falling as a result of technological progress, to that extent a central bank response may not be required. In light of this, and given that central banks typically have a mandate to maintain stability, there is a very clear interest in having a measure of price change that exclude supply shocks.

If supply shocks are more likely to change the price of goods relative to one another, and demand shocks are more likely to change the price of all goods relative to money, but not to each other, defining a core price change statistic is useful for better appreciating the imperatives imposed on a central bank (Ball and Mankiw, 1995). Statistical agencies in many countries produce such a statistic by taking the CPI and excluding from it the foodstuffs, energy and/or few other volatile components.

Since many other items besides foodstuffs and energy experience, at any given time, extreme changes in price relative to other goods choosing *ex ante* which goods and services to exclude may be a very imperfect way to remove the influence of supply shocks from the CPI. One way to allow for this is to trim the tails (by 15%, 25% or 35%) of a cross-sectional distribution of the changes in the components of the national consumer price index. The time series of the resulting trimmed index is thought to provide a good measure of demand-side inflation (Bryan and Cecchetti, 1994).

Trimming symmetrically the two tails of a price change distribution will not yield a different price change time series from the conventional CPI if the distribution is normal. For the trimmed index to provide new insight the cross-sectional price change distribution has to be skewed with right skewness signaling inflation in an untrimmed CPI series while left skewness signals deflation. Other higher order moments are also relevant for the

impact of trimming. The sign of the coefficient of excess kurtosis will measure the extent, to which the tails of the distribution are large or smaller than would be the case if the distribution were normal. A positive coefficient of excess kurtosis means the distribution is sharper peaked and fatter tailed than the normal distribution. A negative coefficient may mean a flatter and thin-tailed distribution. An asymmetric, fat-tailed distribution means that the changes in the mean of the distribution may be dominated by shocks to other items. Changes in the prices of goods and services relative to one another, rather than changes in the price of goods and services relative to money may dominate such a series.

#### V. What Does the Cross-sectional Distribution of Japan's CPI Look Like?

Using measures, such as those listed in Table 1, scholars have attempted to characterize Japan's price distribution (Shiratsuka, 1997). This work using Japan's CPI disaggregated

Table 1

$$\text{Standard Deviation} = \sigma = \sqrt{\sum_{i=1}^n w_i (x_i - \mu)^2}$$

$$\text{Coefficient of Skewness} = \sum_{i=1}^n w_i \frac{(x_i - \mu)^3}{\sigma^3}$$

$$\text{Coefficient of Excess Kurtosis} = \sum_{i=1}^n w_i \frac{(x_i - \mu)^4}{\sigma^4} - 3$$

$w_i \equiv$  weight of item in the CPI

to 88 components on a monthly basis for the years 1970-1997 finds Japan's price change distribution mostly skewed in a rightward direction. The price change distribution appears to be almost always leptokurtic (fat-tailed), and often dramatically so. There does appear to be a positive association between skewness and the rate of CPI change. Of particular interest, in 1995, 1996 and 1997, mild deflation is associated with a left-ward skewness of price change distribution (Mio and Hiyo, 1999). A strong positive relationship is also found

for those years between inflation and the standard deviation of price change. If supply shocks were temporary *and* prices flexible, the latter correlation should not be found.

#### VI. Further Disaggregation of Japan's CPI

The 88 components in Japan's price distribution can be further disaggregated. In 1970 there were 329 sub-components of Japan's CPI. Over time the number of sub-components has grown and changed with items dropped and added. The total number of subcomponents in the CPI is now 613. Table 2 provides information on when new items have been added to the CPI. The two most recent items added (in 2002) were interconnection

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Table 2

#### Introduction of New Items to the Japanese CPI by Year

1970: 329	1985: 45
1972: 2	1990: 31
1975: 63	1995: 36
1980: 45	2000: 55
1981: 4	2002: 2

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charges for the internet and PC printers. Significantly, PC printers are estimated to have fallen in price in Japan by two-thirds since 2000. Table 3 provides an example of how much extra detail the disaggregation of one of the 88 components provides.

Of the 329 subcomponents in the index in 1970, 285 are still in the index. Using these 285 series for 1970 through February 2000 an attempt will be made to assess whether and how relative price shocks played a role in the movements in Japan's CPI over this period.

The results of the first part of this analysis are presented in Figures 1, 2 and 3. Figures 1

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Table 3

## An Example of the Disaggregation of the CPI

School fees (one of the 88 sub-groups of the CPI)
School fees disaggregated
PTA (primary school) membership fees (since 1970)
PTA (junior high school) membership fees (since 1970)
Junior high school fees, private (since 1970)
High school fees, public (since 1970)
High school fees, private (since 1970)
College & university fees, national (since 1970)
College & university fees, private (since 1970)
Junior college fees, private (since 1995)
Kindergarten fees, public (since 1970)
Kindergarten fees, private (since 1970)

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and 2 show there is a strong positive correlation between the change in the overall CPI series and the changes in the standard deviation of its components, and a positive correlation between changes in the overall CPI series and changes in the coefficient of skewness. In Figure 3 the relationship between CPI change and the coefficient of excess kurtosis is either non-existent or negative depending on which method of seasonal adjustment is used.<sup>2</sup>

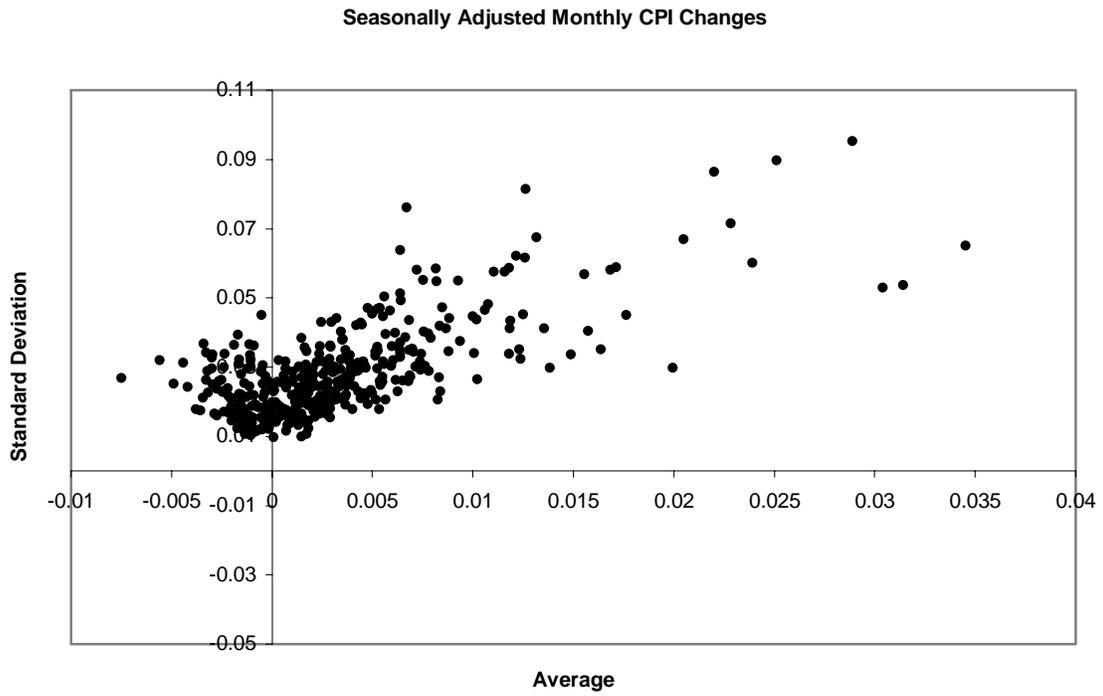
These findings are consistent with the view that supply shocks play a role in driving changes in Japan's CPI. The skewness results allow the easiest interpretation. Positive extreme results are helping to cause inflation; negative extreme shocks are helping to cause deflation. The interpretation of the relationships between average price change and some of the other moments of the price distribution is more complicated. The positive correlation between CPI change and the standard deviation seems to indicate a decline in

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<sup>2</sup> Seasonal effects have been muted by used two alternative methods: 1) X-12-ARIMA with constant and level effects and 2) year-over-year monthly changes.

Figure 1

Standard Deviation and Average Price Change (both weighted)



Standard Deviation and Average Price Change(both weighted)

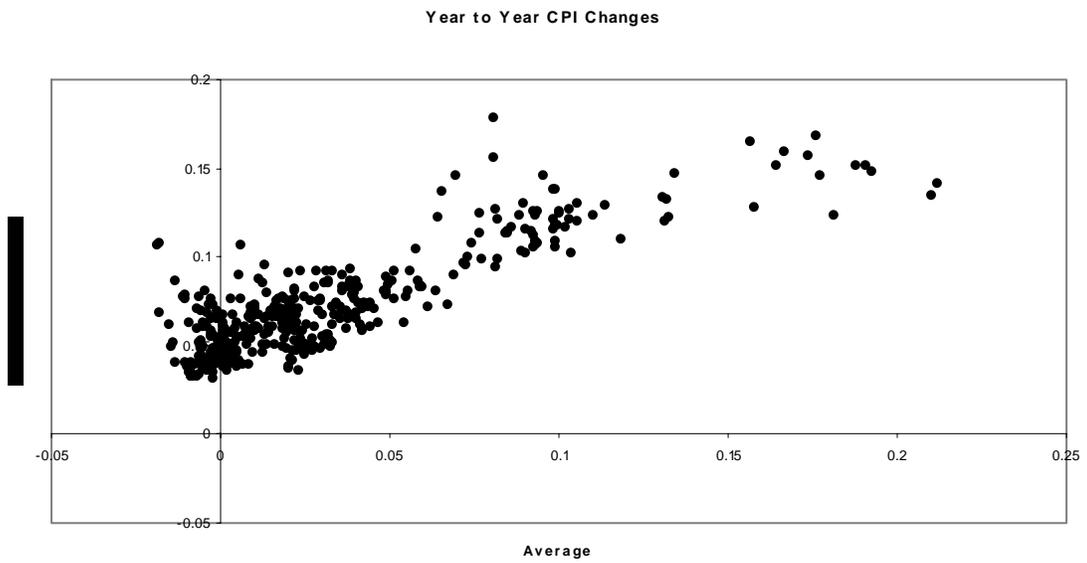
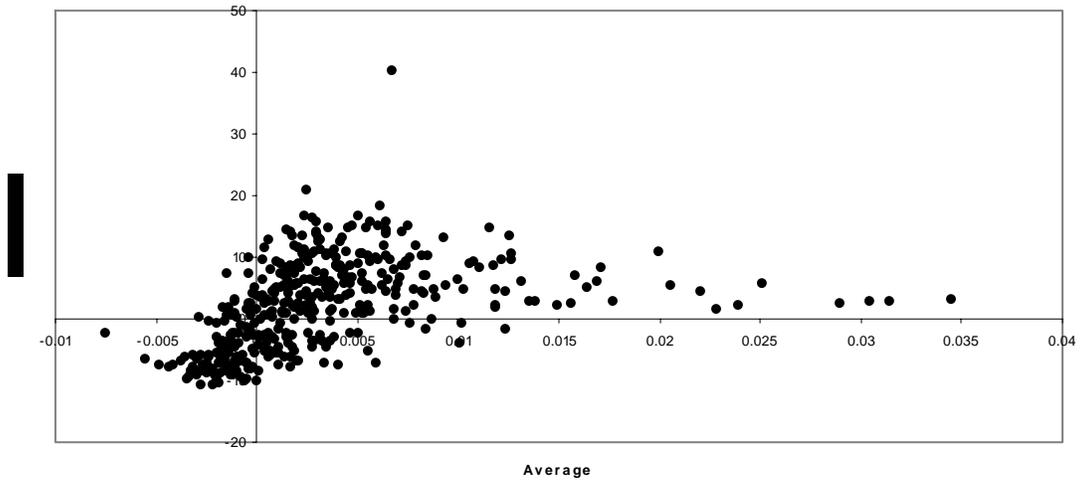


Figure 2

Coefficient of Skewness and Average Price Change (both weighted)

Seasonally Adjusted Monthly CPI Changes



Coefficient of Skewness and Average Price Change (both weighted)

Year to Year CPI Changes

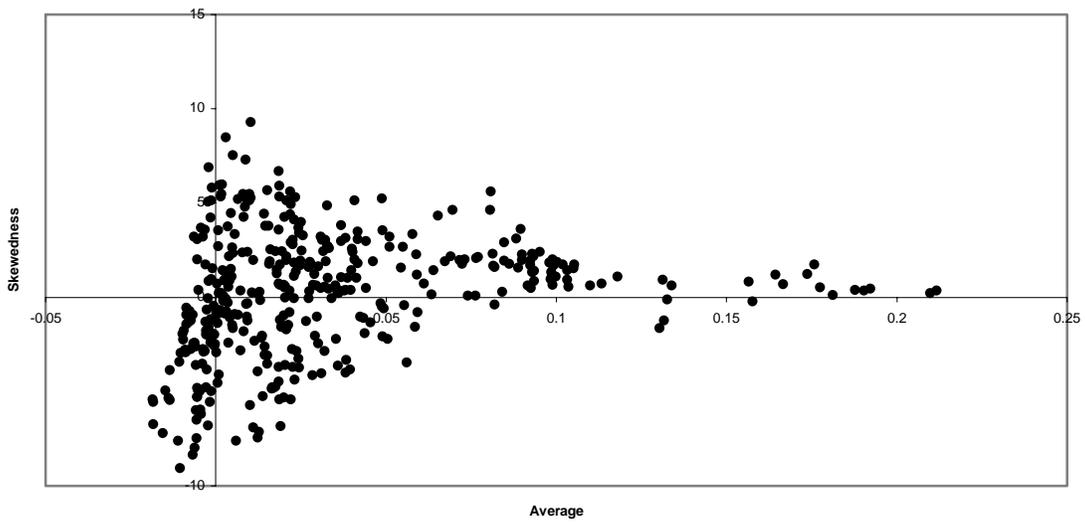
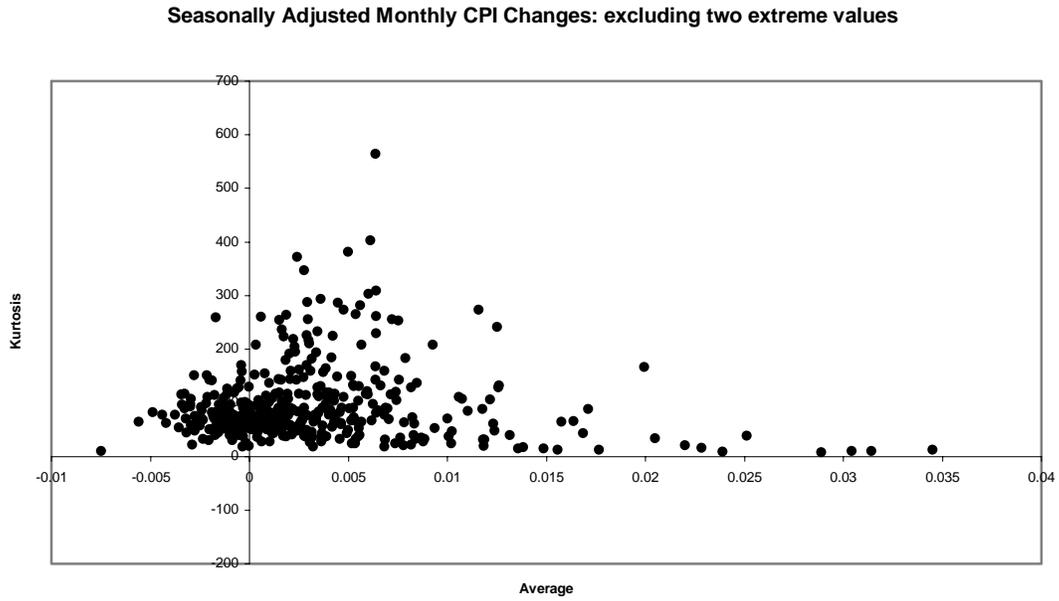
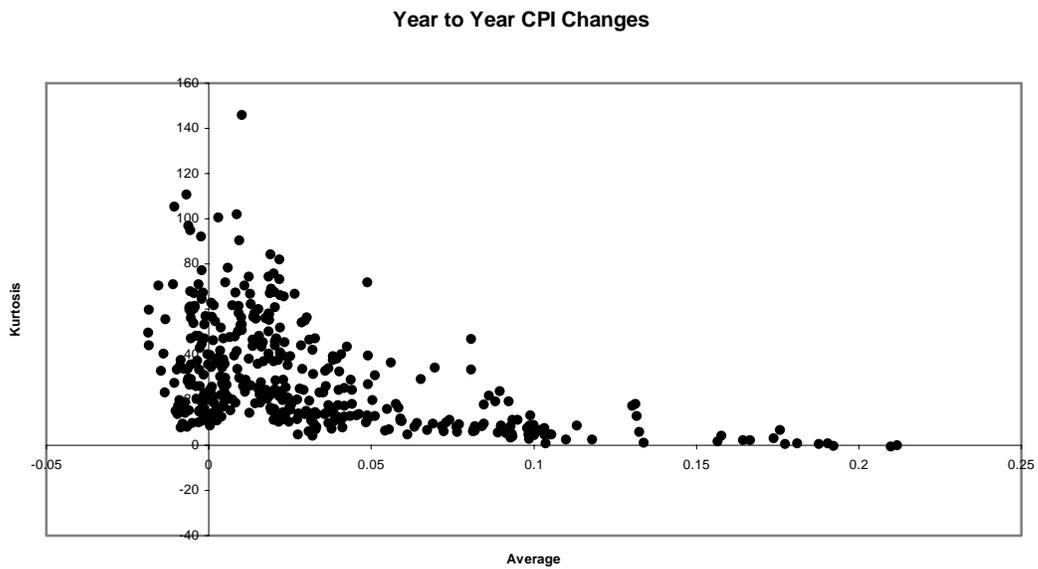


Figure 3

Kurtosis and Average Price Change (both weighted): excluding two extreme values



Kurtosis and Average Price Change (both weighted)



extreme relative price changes has helped to drive down Japan's inflation rate. Inspection of Figure 1 also indicates that the standard deviation continues to fall as inflation turns to deflation and gets still smaller as deflation gets larger. If supply shocks play an important role in driving price change, the scatter of points in Figure 1 might more likely be v-shaped centered around the y-axis. It is possible, however, that if Japan had experienced deflation more comparable in absolute size to the inflation it had experienced, the expected patterned might have been observed

As noted, when examining the relationship between the coefficient of excess kurtosis and price change the method used to remove seasonal effects makes considerable difference. The price change distribution is leptokutopic throughout each month of the entire sample. When the relatively simple method of year-over-year monthly changes is used to take out seasonal effects, there is a negative relationship between price change and the coefficient of excess kurtosis<sup>3</sup>. As seen in the bottom panel of Figure 3, this negative relationship is greatly strengthened by a small number of outlier observations. Even in the absence of these observations the negative correlation does persist and therefore continues to suggest that with less inflation and more deflation, the price change distribution will be sharper and flatter-tailed. In contrast, the results obtained when X-12-ARIMA is used to remove seasonal effects suggests no relationship at all between price change and the coefficient of excess kurtosis.

Table 4 presents the correlation coefficients for the relationships just discussed broken down by time period. The results in Table 4 show some change in Japan's price change distribution over the past dozen years with a much stronger relationship between price

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<sup>3</sup> Seasonal adjustment of the sub-components of Japan's CPI is necessary because, unlike the US CPI, seasonal adjustment is done by Japan's statistical agencies only at the most aggregate level.

change and the coefficient of skewness even while there is a substantially weaker, but still

Table 4

Correlations between the Moments of the Japan's Price Change Distribution

Correlation Coefficients with Seasonal Effects Removed by X-12-ARIMA

with AVE	STD DEV	SKEW	KURT
1970-1992	0.703*	0.3641*	-0.0395
1993-2004	0.4655*	0.6763*	0.2975*
1970-2004	0.7224*	0.4224*	-0.4596

Correlation Coefficients for Year-over-Year Monthly Changes

with AVE	STD DEV	SKEW	KURT
1970-1992	0.8374*	0.1872*	-0.553*
1993-2004	0.2738*	0.4843*	-0.0654
1970-2004	0.8526*	0.2252*	-0.4596*

\* ≡ correlation coefficient is significant at 95% or higher confidence interval

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statistically significant relationship between price change and the and the standard deviation. Given that most of the observations to the left of the y-axis in Figures 1,2 and 3 date from the past dozen years these results are no surprise.

The results on the correlation between price change and the coefficient of excess kurtosis suggest a somewhat more dramatic break from the past during the past dozen years. The year-over-year monthly price changes have a negative correlation with the coefficient of excess kurtosis prior to 1992. After 1992, the correlation becomes statistically insignificant. The tails of the Japanese price change distribution no longer become fatter as

deflation emerges. When X-12-ARIMA is used to remove seasonal effects in the price change data, the price change – coefficient of excess kurtosis correlation goes from being statistically insignificant to being positive and statistically significant for the period after 1992. By this account, less inflation and more deflation go hand in hand with thinner tails for Japan's price change distribution.

#### VII. Do Relative Price Changes Reflect Long-Term Technological Change?

The price change distribution can be skewed and leptokurtopic and its mean can vary with its standard deviation and yet the consequences of any shock might be short lived (Ball and Mankiw, 1995 and Parsley, 1996). The price changes observed for Japan and the particular shape of its price change may reflect nothing more than short-term frictions, misperceptions about the current state of the economy, and the possibility that whatever supply shock occurs often reverses itself relatively quickly. If this is the case, the findings on the price change distribution that have just been presented might not bear on Governor Hayami's analysis of Japan's deflation problem or the implications of that analysis for central bank policy (Romer, 2001, pp. 304-312). If, however, many of the shocks that generate the special shape of Japan's relative price distribution are real in origin and reflect technological change then the contemporaneous correlation found between the mean and the standard deviation, the coefficient of skewness, and the coefficient of excess kurtosis might be expected to persist in the long-run (Balke and Wynne, 2000)

### VIII. Searching for Long-Term Impact

Using a VAR model the short-term and long-term relationship between the mean and the standard deviation, the coefficient of skewness and the coefficient of excess kurtosis will be explored.<sup>4</sup> These relationships will be examined using the correlation coefficients of VAR forecasts errors over different time horizons. If the series being examined are stationary then the correlation coefficient of the forecast errors will converge to the unconditional correlation coefficient of the series as the forecast horizon goes to infinity. If some of the series used in the VAR are not stationary the estimates of the correlation coefficient might not converge but can still be estimated consistently for a fixed forecast period (den Haan, 2000).

Monthly observations on 285 CPI sub-components available from January 1970 through February 2004 will be used for this empirical work. The VAR is given by

$$Z_t = D + Pt + Ft^2 + \sum_{k=1}^n J_k Z_{t-k} + \varepsilon_t$$

$Z \equiv$  q-vector containing selected moments and other variables characterizing the price change distribution

$D, P$  and  $F \equiv$  q-vectors of constants

$J \equiv$  qxq matrix of autoregressive constants at lag k

$\varepsilon \equiv$  qx1 vector of innovations assumed to be serially

The M-period ahead forecast errors for selected statistics is characterizing the price change distribution is given by

$$e_{t+m,t} = \psi_{t+m} - E\psi_{t+m}$$

where  $\psi \equiv$  a selected statistic characterizing the price change distribution

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<sup>4</sup> The methods used here follow closely the approach used in den Haan (2000)

In order to examine long-term relationships the correlation between the mean and the standard deviation, the coefficient of skewness, and the coefficient of excess kurtosis of the Japanese price change distribution are calculated using this model over various forecast horizons using the VAR model.

The VAR model just outlined is estimated (1) with and without linear and quadratic terms, (2) without the unit root imposed and (3) with lag lengths that vary from 1 to 19 months.<sup>5</sup> Lag lengths and whether to include linear and quadratic terms are based on the Akaike Information Criterion.<sup>6</sup> Bootstrap methods are used to construct 90% confidence intervals around the estimates of the correlation of the forecast errors. Table 5 explains the characteristics of the estimated VARs. The results of this empirical work are presented in Figures 4, 5, 6, and 7.

Table 5

## Characteristics of Estimated VARs

Data	Pair with Mean	Lag #	Trend	Figure
Monthly from 1970 adjusted by X-12- ARIMA	Standard Deviation	2	linear, quadratic	4
	Coefficient of Skewness	3	linear, quadratic	4
	Coefficient of Excess Kurtosis	17	linear, quadratic	4
Monthly from 1986 adjusted by X-12- ARIMA	Standard Deviation	1	linear	5
	Coefficient of Skewness	3	linear	5
	Coefficient of Excess	1	linear, quadratic	5

<sup>5</sup> Unit roots have been tested for using Augmented Dickey-Fuller and Ng-Perron. These tests reject the null unit root hypothesis for all variables used in this analysis except average price change.

<sup>6</sup> The analysis here has also been conducted with lag lengths and the inclusion or exclusion of linear and quadratic terms based on the Schwarz Information Criterion. While many of the details of the analysis change dramatically (in some cases the length of the lags), the conclusion of the analysis is in no significant way different from what is found when the Akaike Information Criterion is used.

Kurtosis				
Year-over-Year Monthly Change from 1970	Standard Deviation	13	linear, quadratic	6
	Coefficient of Skewness	14	linear, quadratic	6
	Coefficient of Excess Kurtosis	17	linear, quadratic	6
Year-over-Year Monthly Change from 1986	Standard Deviation	13	linear	7
	Coefficient of Skewness	14	linear	7
	Coefficient of Excess Kurtosis	18	linear	7

In each of the three panels in Figures 4, 5, 6, and 7 there are three lines. The middle line connects each of the estimated correlation coefficients at each forecast horizon. The lines above and below it define the 90% confidence interval for these estimates. Notwithstanding that two time periods are examined, and notwithstanding that two alternative methods are being used for removing seasonal effects, overall, there is strong evidence for a positive correlation between average price change and the standard deviation, and average price change and the coefficient of skewness that is not temporary, but that holds in the long run.

When the monthly data that has been adjusted by X-12-ARIMA is examined for the entire sample period since 1970, the upper two panels of Figure 4 suggest that there is a very rapid convergence to a constant positive correlation between price change and the standard deviation and between price change and the coefficient of skewness. As seen in the upper two panels of Figure 5 the same results are found when VARs are estimated with data from 1986 onwards.

Convergence takes much longer for the correlation coefficients of VAR forecast errors between price change and the standard deviation and between price change the coefficient

Figure 4

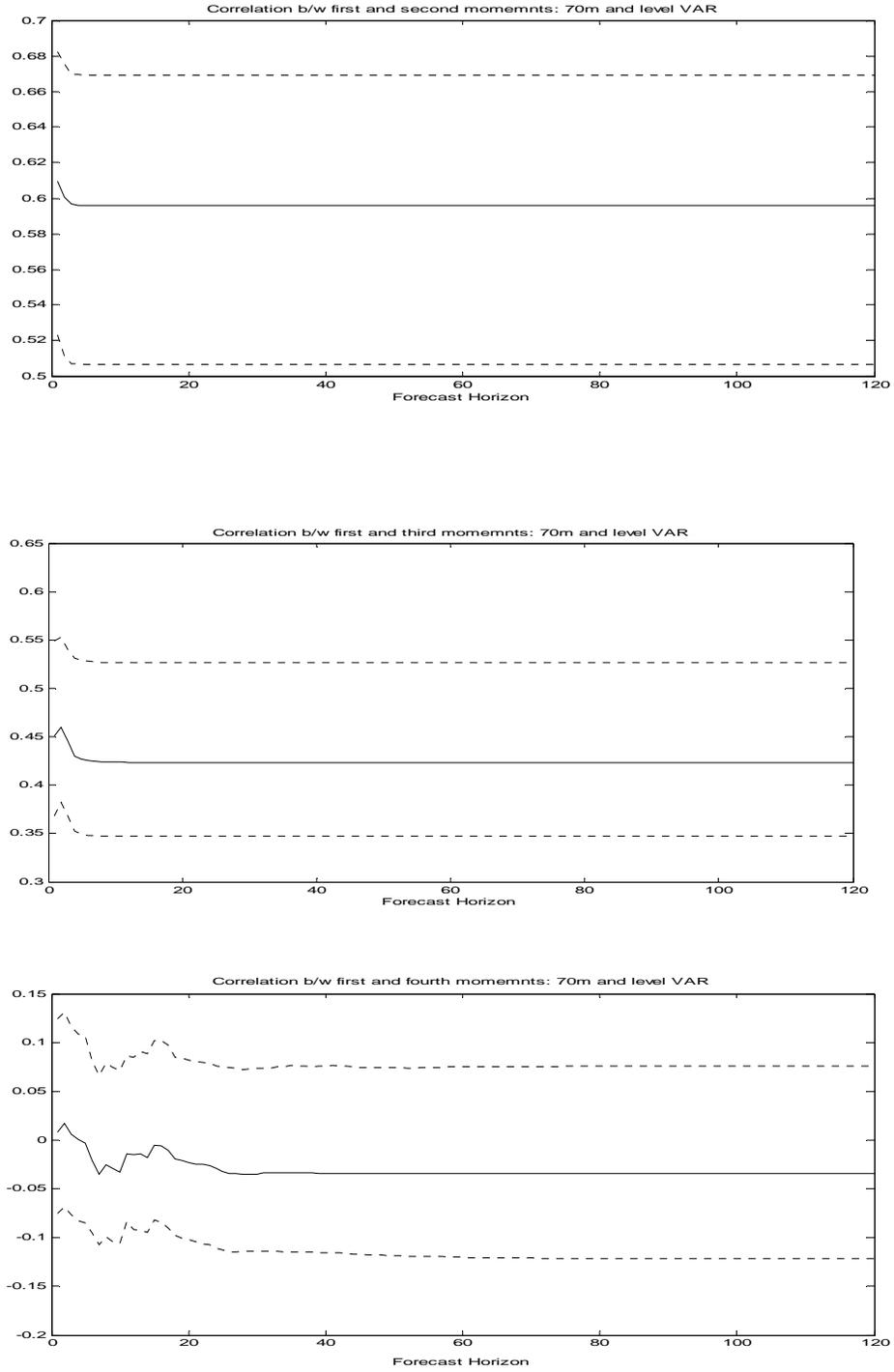


Figure 5

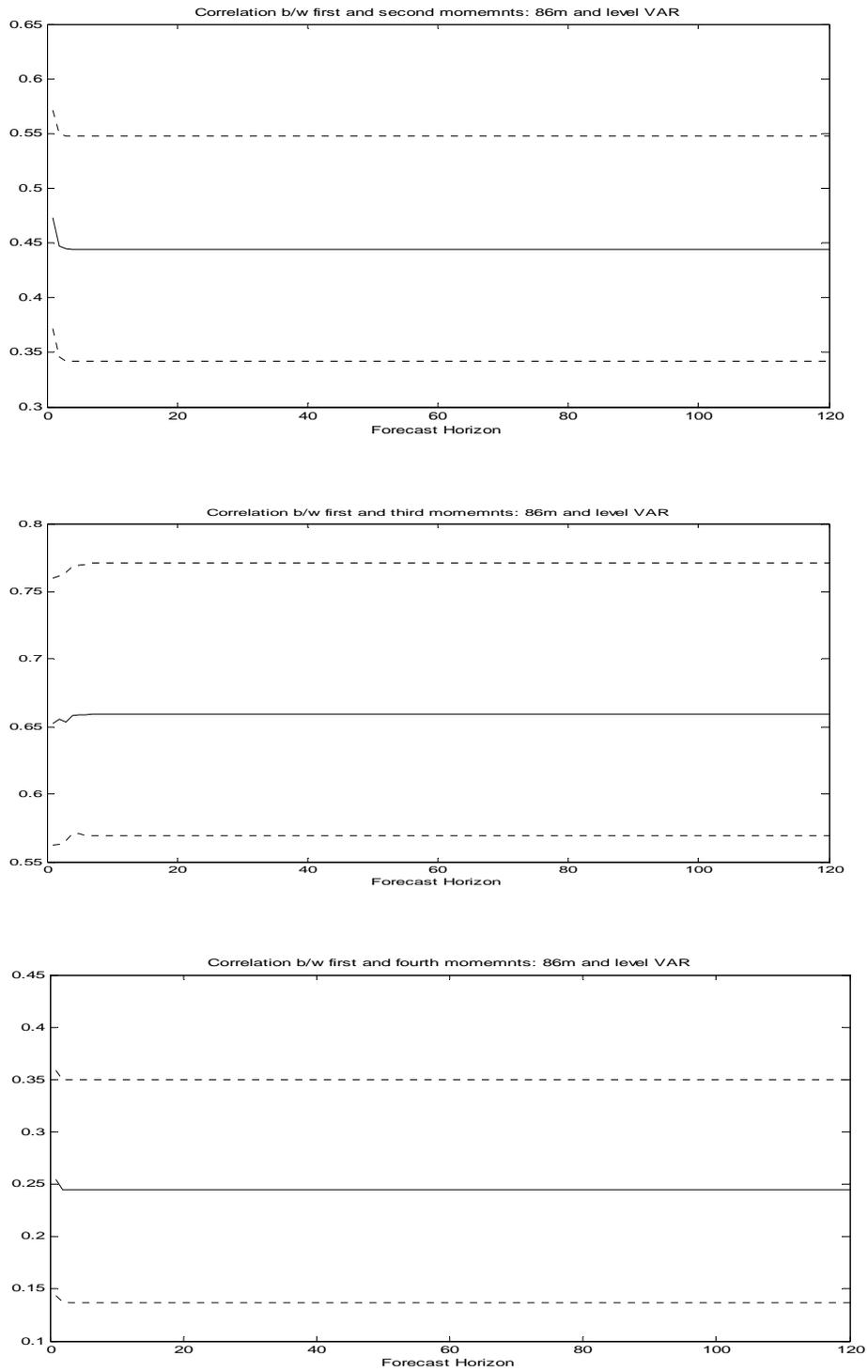


Figure 6

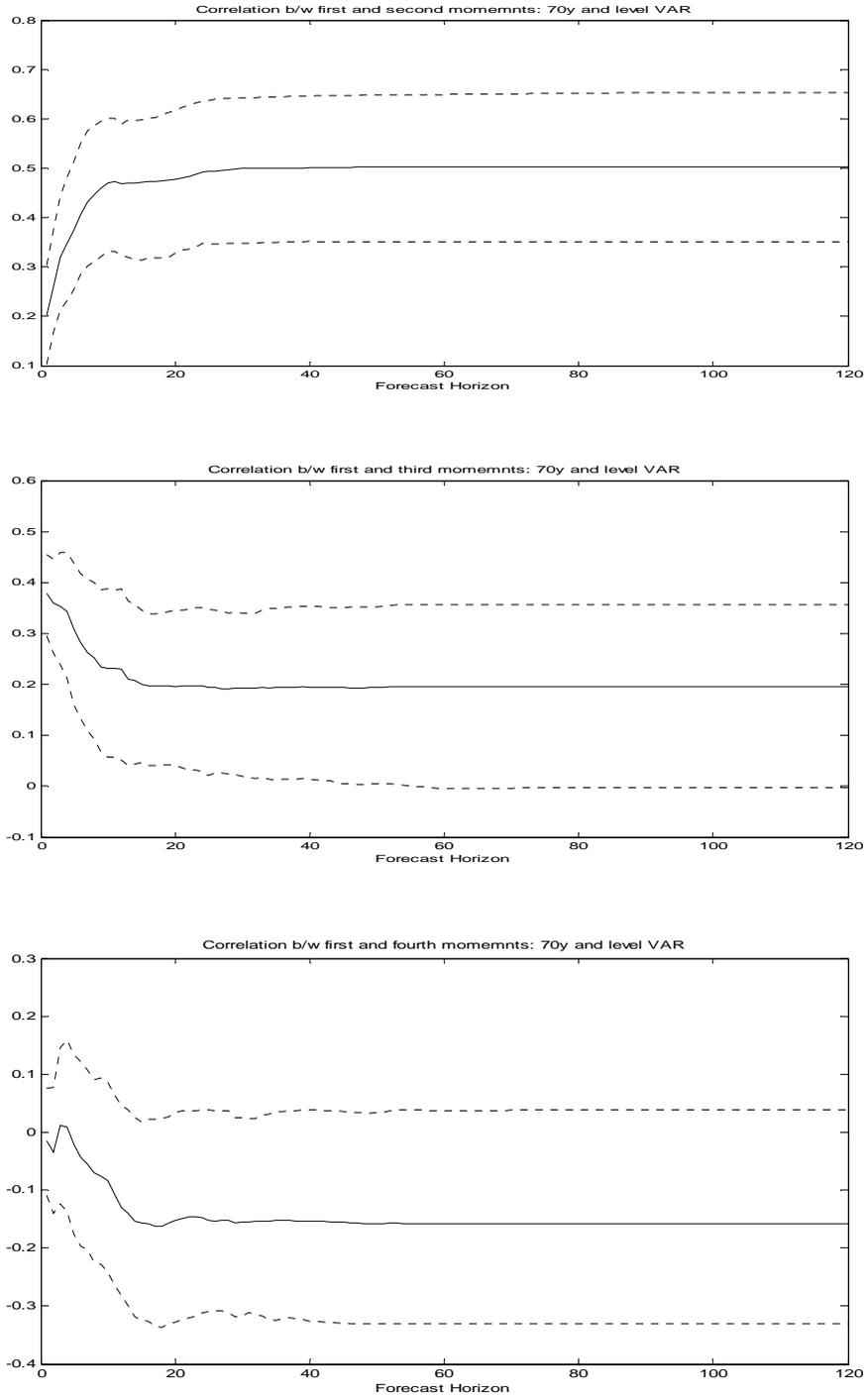
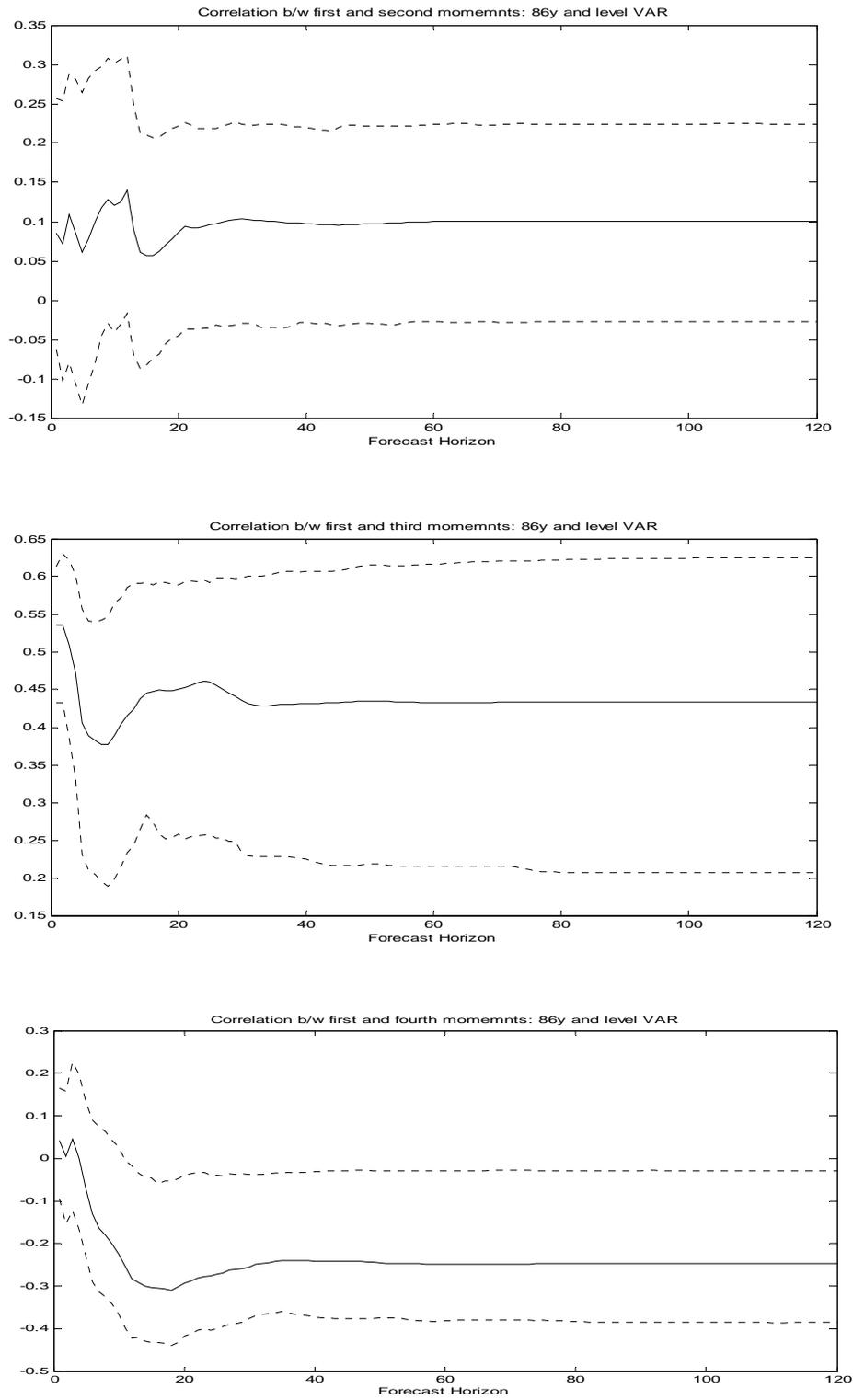


Figure 7



of skewness when year-over-year monthly change data incorporating the full sample are used. Inspection of the top panel of Figure 6 indicates it might be as long as six years before there is complete convergence of the estimates of the correlation coefficient between price change and the standard deviation. Somewhat similar and as seen in the middle panel of Figure 6, the correlation coefficient between price change and the coefficient of skewness converges permanently to 0.2 when the forecast horizon is somewhere four and five years. Note, however, 0.2, the long-run value of this correlation coefficient is only borderline statistically significantly different from zero.

Unlike the X-12-ARIMA data, the results from monthly sub-sample comprising only the 1986 onwards using year-over-year monthly change data are somewhat different from the results gathered from the full sample. As before, convergence takes a long time but in this case the correlation coefficient between price change and the standard deviation converges to a statistically insignificant value in the long run. In contrast, in the long run the correlation coefficient between price change and the coefficient of skewness is clearly statistically significant.

In the short run results presented earlier the findings on the sign and significance of the correlation between price change and the coefficient of excess kurtosis varied substantially depending on the method used to remove seasonal effects and on the time period examined. Much the same is true when the long-run correlation between them is estimated. With the monthly data when X-12-ARIMA has been used to remove seasonal effects there is no statistically significant relationship between price change and the coefficient of excess kurtosis (bottom panels of Figures 4 and 5). This is also the finding on the long-run correlation when the full sample of year-over-year monthly change data is used (bottom panel of Figure 6). When only the 1986 and later data are used in the estimation of

the long-run correlation, there is a statistically significant negative correlation between price change and the coefficient of excess kurtosis (bottom panel of Figure 7).

### VIII. Finale

The correlation coefficients of VAR forecast errors at different forecast horizons, as presented in Figures 4 through 15, provide strong, though not unanimous, evidence that the positive short-run relationships between price change and the standard deviation and the coefficient of skewness persist in the long run. To the extent that these relationships persist in the long run this suggests that the shocks responsible for short-run price change are often real in origin and reflect technological change.

To the extent that no effort has yet been made to show the full extent to which technological improvements are driving short-run relative price changes in Japan and the full extent to which relative price changes are driving aggregate price change, the policy implications of this paper are unclear. What is clear is that it is a mistake to dismiss out of hand the possibility that technological shocks are playing an important role among other forces in Japan's current deflation.

### Bibliography

- Balke, N.S. and M. A. Wynne, 2000. An Equilibrium Analysis of Relative Price Changes and Aggregate Inflation, *JOURNAL of MONETARY ECONOMICS* 45, 269-292.
- Ball, L. and N.G. Mankiw, 1995. Relative-Price Changes as Aggregate Supply Shocks, *QUARTERLY JOURNAL of ECONOMICS* 110, 161-193.
- Barsky, R. and L. Killian, 2001. Do We Really Know that Oil Caused the Great Stagflation? A Monetary Alternative, NBER Working Paper No. 8389

- Basu, S., Fernald, J. and M. Shapiro, 2001. Productivity Growth in the 1990s: Technology Utilization or Adjustment? CARNEGIE-ROCESTER SERIES on PUBLIC POLICY 55, 117-165.
- Bordo, M. D., J. L. Lane and A. Redish, 2004. Good Versus Bad Inflation: Lessons from the Gold Standard Era, NBER Working Paper No. 10329
- Bryan, M. and S. Cecchetti, 1994. Measuring Core Inflation, in N. G. Mankiw (ed.) Monetary Policy, Chicago: University of Chicago Press
- den Haan, W. , 2000. The Co-movement between Output and Prices, JOURNAL of MONETARY ECONOMICS 46, 3-30.
- Hamilton, J. D., 1994. Times Series Analysis. Princeton, N.J.: Princeton University Press
- Hayami, M. 2001. Opening Speech, MONETARY and ECONOMIC STUDIES 19, 9-11
- Hayashi, F. and E.C. Prescott, 2002. The 1990s in Japan: A Lost Decade, REVIEW of ECONOMIC DYNAMICS 5, 206-235
- Kawamoto, T., 2004. What Do the Purified Solow Residuals Tell Us about Japan's Lost Decade? Institute of Monetary and Economic Studies Discussion Paper 2004-E-5
- Klein, L. R., 1962. An Introduction to Econometrics, Englewood Cliffs, N.J.: Prentice-Hall
- Mio, H. and M. Higo, 1999. Underlying Inflation and the Distribution of Price Change: Evidence from Japan's Trimmed-Mean CPI, MONETARY and ECONOMIC STUDIES 17 103-132
- Oliner, S. and D. Sichel, 2003. Where Are We Now and Where Are We Going? JOURNAL of POLICY MODELING 26, 477-503
- Organization for Economic Co-operation and Development, 2004. Economic Surveys: Japan Paris: OECD
- Parsley, D., 1996 Inflation and Relative Price Variability in the Short- and Long-Run: New Evidence from the United States, JOURNAL of MONEY, BANKING and CREDIT 28, 323-341
- Romer, D., 2001. Advanced Macroeconomics (2<sup>nd</sup> Ed.), Boston: McGraw-Hill
- Saxonhouse G. and R. M. Stern, 2003. The Bubble and the Lost Decade, WORLD ECONOMY 26, 267-282

Shiratsuka, S., 1997. Inflation Measures for Monetary Policy: Measuring the Underlying Inflation Trend and Its Implications for Monetary Policy Implementation, *MONETARY and ECONOMIC STUDIES* 15, 1-26

Svensson, L., 2003. Escaping from the Liquidity Trap and Deflation: The Foolproof Way and Others, *JOURNAL of ECONOMIC PERSPECTIVES* 17, 145-166