A Cross-Country Investigation of Macroeconomic Asymmetries

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Abstract

Using a recently introduced nonparametric test, I investigate two important and distinct asymmetries in cross-country quarterly macroeconomic time series. Asymmetries are suggested by many theories (old and new), and those discovered aid in the selection of the appropriate nonlinear time series representation (useful, for example, in both forecasting and policy guidance). Further, asymmetries can help determine underlying economic mechanisms. The key findings: positive growth rate asymmetry is nearly ubiquitous in price level data (but is not caused by money growth asymmetry); and the pattern of asymmetries varies dramatically across countries (making widespread reliance on US data to study fluctuations worrisome).

Triples test; nonlinear time series; inflation; business cycles.

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1. INTRODUCTION

For most of this century, aggregate fluctuations were chiefly regarded, and analyzed, as inherently asymmetric phenomena: business cycles. Over the last two decades, however, economists have largely begun to think formally about them as the sample paths of (inherently symmetric) linear stochastic processes with constant coefficients. To what extent has this substantial shift in analysis been warranted? Do the data lead us to this conclusion? Is modeling economic time series as linear stochastic processes (LSP's) merely a simplifying assumption, or does it mislead us in important ways?

Despite the fact that the presence of asymmetry would call into question the appropriateness of such analyses, almost no systematic investigation of cyclical asymmetries was attempted until DeLong and Summers (1986), who searched for (one form of) asymmetry in six OECD economies, but failed to detect it in 17 of the 18 series investigated. They concluded, "asymmetry is probably not a phenomenon of first-order importance in understanding business cycles," a conclusion more or less supported by most economists. However, the main empirical finding on which this conclusion is based is now in question. Significant asymmetry has been detected in numerous US economic time series (see Sichel 1993, Ramsey and Rothman 1996, and Verbrugge 1997a) and in a handful of economic time series of other countries (see, e.g., Sensier 1996 and Razzak 1998). Surprisingly, almost no effort has been exerted in attempting to discover the extent to which cyclical asymmetries vary across countries. Those studies which do exist are far from comprehensive, and almost all are parametric (i.e., are linearity tests with specified alternative nonlinear models). Thus, they suffer from pre-imposing strong assumptions on the data, limiting their use for establishing stylized facts and making them unfit for use as a criterion for ruling *out* particular nonlinear models. Two non-parametric studies study a handful of cross-country series (Ramsey and Rothman 1996 and Hinich and Rothman 1997), but both of these suffer from an embarassment of riches: it is unclear which particular forms of asymmetries these tests are discovering. Hence, the following is still an open questions: Are there characteristic asymmetries, a common set of stylized macroeconomic facts, indicating a large degree of commonality across economies? Or is the U.S. pattern of asymmetries atypical?

Should we care? The existence of asymmetries is of fundamental importance for economic theory, empirical work, and policy analysis. Standard linear stochastic processes, a fundamental building block in theoretical and applied macroeconomic analyses, cannot generate asymmetric sample paths; hence, such theoretical models fail to explain important characteristics of the data. Further, linear empirical analyses suffer from probable misspecification, which may be quite serious. Why? Under standard assumptions, linear processes cannot generate the asymmetries that are robust features of the data. Hence imposing linearity on the data ignores nonlinear aspects of the data which should be useful in correctly interpreting the effects of policy, in forecasting (e.g., Potter 1995), and in estimation. Regarding forecasting, correctly modeling the nonlinearity may be especially important in turning point prediction; see Filardo and Gordon (1995) for evidence that nonlinear models can outperform linear models around business cycle turning points. As Neftçi (1984) points out, the issue is also important in empirical work on rational expectations models: if the true data generating process is nonlinear, yet is treated mistakenly as a linear one, then the estimate of the ‘unpredictable components’ of a time series would contain too much information. Regarding policy, the Reserve Bank of New Zeeland, the Bank of Canada, and the Swedish Riksbank all have begun to use calibrated models with asymmetrical transmission mechanisms for policy analysis; John Taylor's policy rule implicitly assumes symmetric cyclical movements. Regarding estimation, estimators will be inefficient and perhaps inconsistent if the parametric model is misspecified.

Determining the pattern of asymmetries in a particular country is an appropriate first step in the selection of an appropriate time series representation of a given series. A model selection procedure that begins with nonparametric tests like the triples test, which narrow down the list of appropriate alternatives by noting the major forms of nonlinearity that characterize the series in question *without* imposing a model or numerous assumptions a priori, is likely to be less laborious, and perhaps less judgmental, than performing a battery of parametric linearity tests (e.g., Rothman 1996). This general point has been previously made by Granger and Teräsvirta (1993) and by Teräsvirta (1996), who notes: "...it seems to me that an important precondition for a successful model selection technique is that the set of alternative models from which to choose be sufficiently restricted."

Further, detected asymmetries provide clues about the economic mechanisms which underlie these series; knowing what the data are telling us is the first step in figuring out what economic processes are at work. Many theories suggest the existence of asymmetries in aggregate data. Models which feature asymmetric price adjustment to positive and negative disturbances are likely to feature level asymmetry (i.e., the distribution of (detrended) output is likely to be skewed to the left); examples include: the standard Keynesian convex aggregate supply curve; unexplained downward price rigidity (e.g., Tobin 1972); and some menu cost models (e.g., Kuran 1983 and Ball and Mankiw 1994). A number of studies (e.g., Caballero and Engel 1993) locate evidence for such asymmetric behavior. Asymmetric price and output behavior is also likely to arise in models with capacity constraints (such as Hicks' (1950) model of trade cycles, DeLong and Summer's (1988) 'output gaps' view, or Friedman's (1993) plucking theory), and might arise in some sS models or models with various other nonconvexities facing economic agents. Sectoral shifts models (e.g. Lilien 1982) and investment-uncertainty models (e.g. Bernanke 1983) imply that "expansionary" shocks will have contractionary effects (their effects will be partially or wholly mitigated) while "contractionary" shocks will be exacerbated. Financial accelerator theories are also likely to feature asymmetric responses to positive and negative shocks.

Skewness in the distribution of growth rates or first-differences is liable to arise under many circumstances as well. Models with asymmetric adjustment costs (e.g., hiring new workers being more costly than firing existing workers, or job creation being more costly or time-consuming than job destruction) or in which there are costs to moving or to finding a new job, will tend to generate asymmetry in labor market variables such as hours worked, employment, net labor reallocation, and unemployment. Models in which exit from an industry is less costly than entry (e.g., Chetty and Heckman 1986 and Baldwin and Krugman 1989) will also be inclined to generate output and employment asymmetry. Strategic complementarities in investment (e.g., Gale 1996) or intertemporal increasing returns (e.g., Acemoglu and Scott 1997) can give rise to difference asymmetry. In general, if the series only gradually returns to a "normal" state, this will generally give rise to difference asymmetry.

Thus, asymmetries may provide a means of differentiating among competing theories. Though stylized facts such as those uncovered here can rule out models whose equilibria generate linear stochastic processes, they can not *immediately* discriminate among all *possible* models that are able to generate asymmetries. In that sense, work of this nature is but the first step in moving towards a more complete and accurate picture of the economy. However, see Hooker (1997) for an example of a reduced form parametric study utilizing asymmetries in the data to discriminate between different theories by exploiting their distinct asymmetry predictions

Asymmetries may have vital economic consequences. For example, knowledge of the full predictive density those stochastic processes which are exogenous to the decision-maker (rather than, say, simply the first two moments) is crucial in intertemporal problems. Estimation of an appropriate nonlinear model is the proper first step in answering questions both regarding the economic significance of the particular asymmetry, and how bad a linear approximation is (see Potter 1994, 1995). A thorough answer to these questions requires the full solution of the nonlinear theoretical economic model, although one can imagine contexts in which knowledge of the loss function would suffice. In some cases (particularly if the loss function depends only upon the first and second moments of the series), these asymmetries might not be important. (Note that the asymmetries might *still* be of crucial significance in this case, if they aid in prediction, if they are informative about underlying economic mechanisms, and/or if policy does or does not take them into account). On the other hand, particularly if the loss function is asymmetric (that is, below-mean realizations have a greater impact on utility than do equivalent above-mean realizations), these asymmetries might be very significant indeed.

Finally, determining the pattern of macroeconomic asymmetries across countries is a first step in determining the extent to which various economies differ from one another. This is of interest for many reasons, one of which is that it is one of the key criterion used in determining an "optimal currency area."

The particular asymmetry test used in this paper is one that Verbrugge (1997b) introduced to the economics literature: the triples test of Randles, Flinger, Policello, and Wolfe (1980). Verbrugge (1997a) demonstrates that this test has considerably more power than popular tests based upon the coefficient of skewness; thus, it allows us to address the issue of the existence of asymmetry across countries in a new way, with the potential of overturning previous studies and providing some new and interesting results. The triples test has a significant advantage over moment-based tests like the skewness test: as it is not a moment-based test, it cannot be dominated by outliers, so is not subject to the kind of small-sample bias highlighted by Bryan and Cecchetti (1996). Time reversibility tests (Ramsey and Rothman 1996 and Hinich and Rothman 1997) are a complement, not a substitute, to the triples test, since they have trouble distinguishing between different forms of longitudinal, or of transversal, asymmetry. Indeed, the ability of these testing methodologies to detect difference asymmetry is in doubt; the author, P. Rothman, and J. Ramsey are currently engaged in discussion about this point.

2. METHODOLOGY AND RESULTS

2.1 Methodology

A trendless time series possesses difference or growth rate asymmetry if the distribution of first-differences is asymmetric (loosely, if its contractions are 'steeper' than its expansions, or vice versa). A trendless time series possesses level asymmetry if the distribution of levels is asymmetric (loosely, if its troughs are deeper than its peaks are tall, or vice versa). (Sichel (1993) termed difference asymmetry 'steepness', and level asymmetry 'deepness'; Ramsey and Rothman (1996) note that depth is a form of longitudinal asymmetry, that steepness is a form of transversal asymmetry, and that other forms of longitudinal and transversal symmetry are possible.) These two types of asymmetries are illustrated in Figure 1 for a trendless time series.

The asymmetry test utilized is the nonparametric triples test of Randles et al. (1980); this test is highly regarded in the statistics literature for its power properties (see Eubank, LaRiccia, and Rosenstein 1992) and is described formally in Appendix A. Its intuitive basis is the following: Take all possible triples from the sample of size N (i.e., $\binom{N}{3}$ combinations). If 'most' of these triplets are right-skewed, infer that this is true of the underlying distribution. While this test does not correct for serial correlation, results in Verbrugge (1997a,b) indicate that serial correlation is generally not a problem in practice, at least for quarterly series of reasonable length. Further, one can control for serial correlation using a Monte Carlo procedure; this procedure, describe briefly in Appendix A, is utilized here on selected series.

Since this test applies only to stationary series, nonstationary series must be rendered stationary by filtering. Interestingly, the appropriate test procedure is *not* to test the residuals from an (appropriate) ARMA regression. Why? It frequently turns out that the fitted series closely mimics the original series, *including its asymmetry*, leaving the residuals insignificantly asymmetric and leading to type II error, as the Monte-Carlo procedure in Verbrugge (1997a,b) makes clear. (Clark 1987 and Westlund and Öhlén 1991 offer a similar criticism: when detrending, the flexibility of ARMA representations can yield a trend fit that is too successful (high R^2), leaving the residual cycle noisy and insignificant. Failure to detect much asymmetry in residuals has been noted previously, e.g. Potter 1994). The filter used must extract the component appropriate for the particular asymmetry being tested for. First-differencing is the obvious filter to use in testing for difference asymmetry, since it arguably induces stationarity in all of the economic time series investigated here, and asymmetry in first-differences is precisely the definition of difference asymmetry. However, to test for level asymmetry, series that are trending or otherwise nonstationary must be detrended by some means. As Westlund and Öhlén (1991) point out, trend elimination is always at least partly judgmental, and trend elimination may remove part of the asymmetry dimension of the series. Any detrending procedure must satisfy two criteria: First, it must succeed in rendering the series stationary; and second, it must be a linear filter, otherwise the filter itself may induce asymmetry in the original series. Here, I utilize Hodrick-Prescott (HP) filtering; this filter is appropriate to use in all cases, as it is a linear filter (hence cannot induce any form of nonlinearity in the series) and as it will render stationary any time series that is integrated of order four or less. This filter is of interest if for no other reason than that it is widely applied in the macro literature, and its properties have been extensively studied; see, for example, Harvey and Jaeger (1993), King and Rebelo (1993), and Cogley and Nason (1995). Applied to quarterly data with the standard parameter setting, the filter's properties mimic that of a band-pass filter that retains those components of the data with periodicity between six and thirty-two quarters. Most importantly, the HP filter is linear, hence cannot induce asymmetry into the data. Verbrugge (1997a) demonstrates that results are rather insensitive to the value of the smoothing parameter lambda; here, I use the standard setting of 1600. For unemployment rates, linear detrending (LD) is also utilized, as these series are arguably stationary once detrended.

Note that this test cannot distinguish between an (asymmetric) nonlinear data generating process and a linear process with asymmetric disturbances. Thus, once asymmetry is identified, a natural next step in the model selection process is to apply a general test of nonlinearity. This task is not attempted here; it is left for future work.

2.2 Data and Results

The economic time series investigated here are real GDP, the CPI, industrial production, a measure of industrial employment (which varies from country to country), and the unemployment rate, for 22 countries, chosen primarily on the basis of availability of data. Data are taken from the IMF *International Financial Statistics*, except for unemployment data, which are from OECD *Main Economic Indicators*. Data typically run from 1957 through 1996; however, actual dates are listed in the Appendix B. All data are obtained as seasonally adjusted, or are linearly seasonally detrended. (In some cases, data were not obtained as seasonally adjusted, and the seasonal pattern varied so dramatically over time that linear seasonal detrending did not appear to be justified; these series were omitted from the analysis.)

Results are in Tables 1 and 2; alongside each triples statistic is reported its associated (standard normal, two sided) p-value; these p-values are asymptotically valid. For those series where significant asymmetry is indicated by these p-values, the Monte Carlo procedure described in Appendix A, which corrects for serial correlation, is conducted, and these p-values are reported underneath the test statistic. Results with (Monte-Carlo) p-values of 0.15 or under are in bold.

2.3 Synopsis

Three features of the data are particularly striking. First, significant level- and difference-asymmetry is located in numerous economic time series across countries (decisively overturning the well-known results of DeLong and Summers 1986 regarding difference asymmetry); second, positive asymmetry in price level growth rates is all but ubiquitous; and third, aside from some other general patterns mentioned below, there is tremendous heterogeneity across countries. The U.S. pattern of asymmetry is not totally typical. Despite an inclination to expect both negative level asymmetry and negative difference asymmetry in real GDP across countries (reflecting, in the latter case, sharp or rapid declines in GDP associated with recessions, and in the former case, rapid rebounds from larger recessions), in fact some countries actually feature significant *positive* asymmetry in levels or differences. Some general patterns are discernible. First, there is some indication that positive difference asymmetry in the unemployment rate is a typical feature across countries, as one might expect (this would indicate a tendency for the unemployment rate to rise sharply, but then decline only gradually over time), but this is statistically significant in under one-half of the countries. Second, negative asymmetry in industrial production growth rates is relatively common, occurring in over one quarter of the countries, while negative asymmetry in industrial production levels is only slightly less common. Finally, though there are significant exceptions, negative asymmetry in GDP levels is fairly common.

An interesting and puzzling feature of the data is the following: asymmetries detected in a country's industrial production series are not always shared by its employment series, nor vice versa. This suggests nonlinearity or asymmetric utilization of other factors of production. (Altug, Ashley and Patterson 1997 make a related suggestion about the US economy.)

While the purpose of this paper is not to determine the *causes* of particular asymmetries, two additional comments that are worth making regarding the asymmetry in inflation growth rates. First, for the seven countries he investigates, Razzak (1998) locates this positive asymmetry in growth rates mainly during the Post-Bretton Woods era. Second, the source of this asymmetry is *not* asymmetric money growth: Table 3 shows that asymmetric money growth is rather uncommon. (Verbrugge 1998 confirms this finding for US data; none of the six monetary aggregates studied displays positive growth rate asymmetry.) As GDP growth is generally not asymmetric either, this is a puzzling empirical regularity that awaits explanation.

3. CONCLUSION

This paper has presented a new set of stylized facts which business cycle models must account for. Asymmetries are a feature of many macroeconomic variables across countries; economists can no longer argue that asymmetry is economically insignificant on the basis of its statistical insignificance. Further, the existence of such asymmetry calls into question the widespread use of linear stochastic processes to model aggregate phenomena, since such processes, under standard assumptions, cannot generate asymmetric sample paths. A related point: the prevalence of asymmetries suggests that we need to refocus our attention on the notion of a business cycle, that it is inappropriate to think of recessions as being the mirror images of expansions. The pattern of asymmetries detected may furnish clues about the underlying economic mechanisms at work, and may help one distinguish between various models (see, e.g., Hooker 1997). Results here indicate that, in many countries, there is a nonlinear relationship between employment and production which must be explained. Moreover, as the pattern of asymmetries is not uniform across countries, the widespread reliance on US data to study business cycles (and to test models) is somewhat worrisome. (Of course, this is largely necessitated by data availability …)

The underlying cause of positive steepness in price levels (and particularly its relationship to *average* inflation) has received renewed attention recently (see, e.g., Caballero and Engel 1993, Ball and Mankiw 1995, Balke and Wynne 1996, 1998, Bryan and Cecchetti 1996, and Verbrugge 1998.) This paper has documented that this feature is common across both low- and high-inflation economies, and shown that money growth does *not* display a similar asymmetry. As GDP is generally not asymmetric either, this is an important puzzle that remains to be explained.

Clearly, much work remains to be done. Identifying asymmetries is a first step toward the selection of an appropriate nonlinear time series model to capture the dynamics in the particular series, and a step in the direction of selecting appropriate theoretical frameworks within which to conduct policy analysis. It remains to be established whether the asymmetry detected reflects asymmetric (exogenous) shocks, or nonlinearity in the economy. Though of *statistical* significance, this paper is silent on the *economic* significance of these asymmetries; this is best answered in the context of an appropriate nonlinear time series model, with a well-specified economic environment that has an associated loss function.

APPENDIX A: DESCRIPTION OF TRIPLES TEST

A.1 Triples Test

A triple of observations $\left(X_i, X_j, X_k\right)$ is a *right triple* (is skewed to the right) if the middle observation is closer to the smaller observation than it is to the larger. An example of a right triple:

—XX———X—

Let

$$f'\left(X_i, X_j, X_k\right) := \frac{1}{3}\left[\begin{array}{r} sign\left(X_i + X_j - 2X_k\right) + sign\left(X_j + X_k - 2X_i\right) + \\ sign\left(X_i + X_k - 2X_j\right) \end{array}\right] \qquad (1)$$

The range of this function is $\left\{-\frac{1}{3}, 0, \frac{1}{3}\right\}$; a right triple is a triple which maps into $\frac{1}{3}$, and a left triple is defined analogously. The triples test statistic is given by

$$\frac{\hat{h} - h}{\sqrt{\hat{s}^{\,2}_{\hat{h}} / N}} \qquad (2)$$

where

$$\hat{h} := \frac{1}{\binom{N}{3}} \sum_{i<j<k} f^{*}\left(X_i, X_j, X_k\right) \qquad (3)$$

and

$$\hat{s}^{\,2}_{\hat{h}} / N := \frac{1}{\binom{N}{3}} \sum_{c=1}^{3} \binom{3}{c}\binom{N-3}{3-c} \hat{v}_c \qquad (4)$$

where

$$\hat{v}_1 := \frac{1}{N} \sum_{i=1}^{N} \left(f_1^{*}(X_i) - \hat{h}\right)^2 \text{ with } f_1^{*}(X_i) := \frac{1}{\binom{N-1}{2}} \sum_{\substack{j<k \\ i\neq j, i\neq k}}\sum f^{*}\left(X_i, X_j, X_k\right) \qquad (5)$$

$$\hat{v}_2 := \frac{1}{\binom{N}{2}} \sum_{j<k}\sum [f_2^{*}\left(X_j, X_k\right) - \hat{h}]^2 \text{ with } f_2^{*}(X_i, X_k) := \frac{1}{N-2} \sum_{\substack{i=1 \\ i\neq j\neq k}}\sum f^{*}\left(X_i, X_j, X_k\right) \qquad (6)$$

and

$$\hat{v}_3 := \frac{1}{9} - \hat{h}^2 \qquad (7)$$

$h = 0$ is the null hypothesis. The asymptotic distribution of the test statistic is standard normal, so conventional critical values may be used.

A.2 Monte Carlo Procedure

First, note that in this context the null hypothesis of the triples test is: the data generating process is a linear ARMA process with well-behaved iid symmetric errors. Given this null, a conservative Monte Carlo procedure may be performed to estimate the finite sample p-values of the test statistic on each individual series. One begins by selecting and estimating an appropriate ARMA model for the series, then performing 500 replications of the estimated process by drawing with replacement from a symmetrized distribution of the estimated residuals, and finally calculating the test statistic for each replication. (A symmetrized distribution of the residuals is composed of the estimated residuals *and their additive inverses*.)

APPENDIX B: TIME SPAN OF EACH SERIES

Country	Real GDP	Consumer Price Level	Industrial Production	Employ-ment series	Un. rate	Money
Argentina	68:1-96:4	84:4-96:4 (57:1-96:4 ΔCPI)	-	-	-	
Australia	59:3-96:3	57:1-96:4	57:3-96:3	76:3-96:4	72:4-97:1	57:1-96:3
Brazil		57:1-96:4				
Canada	57:1-96:3	57:1-96:4	57:1-96:3	61:1-96:3	66:2-97:1	57:1-96:3
Chile	-	57:1-96:4	-	-	-	78:4-96:4
Denmark	87:1-96:3	57:1-96:4	68:1-93:4	72:1-93:4	-	57:1-96:4
Finland	70:1-96:2	57:1-96:4	57:1-96:3	76:1-95:4	67:3-97:1	57:1-96:3
France	70:1-96:3	57:1-96:4	57:1-96:3	80:1-96:3	66:2-97:1	57:1-96:2
Germany	78:3-96:3	57:1-96:4	57:1-96:4	57:1-94:4	72:1-97:1	57:1-96:4
Italy	60:1-93:3	57:1-96:4	57:1-93:4	59:1-96:3		57:1-96:3
Japan	57:1-96:3	57:1-96:4	57:1-96:3	57:1-96:2	72:1-97:3	57:1-96:2
Korea	60:1-96:3	70:1-96:4	57:1-96:3	67:1-96:3	-	57:1-96:3
Mexico	80:1-96:3	58:1-96:4 (57:1-96:4 ΔCPI)	57:1-95:4	-	-	58:1-96:3
Netherlands	77:1-96:3	57:1-96:4	57:1-96:3	57:1-96:3	79:1-96:4	57:1-96:4
Norway	66:1-96:3	57:1-96:4	60:1-96:3	60:1-95:4	-	57:1-96:3
New Zealand	-	57:1-96:4	77:2-95:4	71:1-96:3	-	57:1-96:3
Peru	79:1-96:3	57:1-96:4	79:1-96:4	80:1-96:4	-	
South Africa	60:1-96:3	57:1-96:4	61:1-96:3	61:1-96:3	-	66:1-96:2
Spain	70:1-96:2	57:1-96:4	61:1-96:3	64:1-96:2	75:2-97:1	57:1-96:4
Sweden	69:1-95:3	57:1-96:3	57:1-96:2	57:1-95:4	72:1-97:1	65:1-96:4
UK	57:1-96:3	57:1-96:4	57:1-96:3	59:2-96:1	72:1-97:1	57:1-96:4
USA	57:1-96:3	57:1-96:4	57:1-96:4	57:1-96:4	48:1-95:4	57:1-96:1

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Table 1. Level Asymmetry of Quarterly Series

Country	Real GDP	Consumer Price Level	Industrial Production	Employment series	Un. rate (HP)	Un. rate (LD)
Argentina	+.023 (0.31)	+.015 (0.53)				
Australia	**-.029 (0.03) (<.01)**	+.017 (0.21)	+.005 (0.75)	+.012[1] (0.51)	+.004 (0.81)	-.018 (0.24)
Canada	**-.030 (0.02) (0.08)**	**+.038 (<.01) (0.04)**	-.010 (0.52)	+.007[1] (0.60)	-.006 (0.75)	**+.044 (0.01) (0.16)**
Chile		-.020 (0.52)				
Denmark	+.001 (0.99)	+.022 (0.10) (0.16)	-.004 (0.82)	+.023[1] (0.17) (0.18)		
Finland	+.018 (0.20)	-.0054 (0.66)	**-.024 (0.10) (0.10)**	+.019[2] (0.40)	-.011 (0.56)	+.013 (0.37)
France	-.012 (0.44)	-.005 (0.74)	-.013 (0.42)	+.004[3] (0.82)	-.014 (0.53)	-.031 (0.22)
Germany	-.023 (0.11) (0.16)	+.002 (0.86)	**-.042 (<.01) (0.02)**	**-.026[2] (0.06) (0.13)**	+.018 (0.20)	+.025 (0.10) (0.25)
Italy	**-.031 (0.06) (0.13)**	-.024 (0.04) (0.16)	-.0021 (0.40)	**-.029[2] (0.08) (0.09)**	+.0014 (0.94)	-.020 (0.37)
Japan	+.025 (0.06) (0.20)	-.018 (0.26)	-.018 (0.18) (0.20)	-.017[1] (0.23)	**+.033 (0.11) (0.08)**	**-.055 (<.01) (0.07)**
Korea		+.012 (0.50)	+.017 (0.30)	-.002[1] (0.90)		
Mexico	-.020 (0.33)	+.003 (0.86)	-.017 (0.16)			
Netherlands	+.001 (0.99)	+.011 (0.45)	**-.025 (0.06) (0.08)**	**-.026[2] (0.06) (0.10)**	**+.067 (<.01) (0.01)**	+.042 (0.03) (0.22)
Norway	+.022 (0.22)	**-.033 (0.01) (0.07)**	-.017 (0.36)	+.008[2] (0.57)		
New Zealand		+.013 (0.42)	-.001[4] (0.96)	-.018[1] (0.26)		
Peru	-.006 (0.72)		+.009[4] (0.67)	-.013[2] (0.51)		
South Africa	+.006 (0.70)	-.011 (0.40)	+.006[4] (0.70)	**+.033[1] (0.01) (.08)**		
Spain	+.007 (0.66)	+.013 (0.28)	-.003 (0.83)	-.025[3] (0.11) (.19)	+.010 (0.55)	+.045 (0.03) (0.22)
Sweden		-.007 (0.59)	-.016 (0.23)	+.010[2] (0.52)	+.021 (0.32)	+.002 (0.87)
UK	**+.027 (0.03) (0.09)**	+.012 (0.35)	-.013 (0.36)	**+.024[3] (0.05) (0.12)**	**-.069 (<.01) (0.03)**	**+.084 (<.01) (0.02)**
USA	**-.023 (0.08) (0.14)**	+.003 (0.84)	**-.037 (0.01) (0.09)**	**-.025[5] (0.05) (0.12)**	**+.049 (<.01) (0.01)**	**+.032 (0.01) (0.04)**

1. Manufacturing employment
2. Industrial employment
3. Total employment
4. Manufacturing production
5. Total non-agricultural employment

Table 2. Difference Asymmetry of Quarterly Series

Country	Real GDP	Consumer Price Level[1]	Industrial Production	Employment series	Un. rate
Argentina	-.004 (0.85)	**+.183 (<.01)** **(<.01)**			
Australia	**-.025 (0.05)** **(<.01)**	**+.064 (<.01)** **(0.02)**	**-.035 (0.03)** **(0.02)**	-.027[2] (0.18)	**+.048 (0.01)** **(<.01)**
Brazil		**+.207 (<.01)** **(<.01)**			
Canada	+.012 (0.37)	**+.079 (<.01)** **(<.01)**	**-.021 (0.15)** **(0.06)**	+.003[2] (0.83)	**+.024 (0.18)** **(0.15)**
Chile		**+.118 (<.01)** **(0.05)**			
Denmark	-.012 (0.63)	**+.065 (<.01)** **(0.08)**	**-.030 (0.04)** **(0.03)**	+.009[2] (0.68)	
Finland	-.001 (0.98)	**+.064 (<.01)** **(<.01)**	-.006 (0.70)	-.015[3] (0.40)	**+.037 (0.02)** **(0.01)**
France	**-.026 (0.10)** **(0.12)**	**+.086 (<.01)** **(0.08)**	+.010 (0.54)	+.008[4] (0.79)	+.013 (0.60)
Germany	-.001 (0.97)	**+.045 (<.01)** **(0.02)**	+.013 (0.36)	-.016[3] (0.20)	-.006 (0.77)
Italy	+.009 (0.60)	**+.086 (<.01)** **(<.01)**	-.006 (0.74)	+.014[3] (0.35)	+.019 (0.36)
Japan	**+.044 (<.01)** **(<.01)**	**+.072 (<.01)** **(<.01)**	-.001 (0.94)	**+.051[2] (<.01)** **(0.07)**	-.009 (0.65)
Korea		**+.101 (<.01)** **(<.01)**	-.002 (0.93)	+.020[2] (0.29)	
Mexico	+.022 (0.37)	**+.146 (<.01)** **(<.01)**	+.015 (0.29)		
Netherlands	-.020 (0.37)	**+.027 (0.03)** **(.20)**	**-.024 (0.08)** **(0.03)**	-.014[3] (0.33)	+.017 (0.51)
Norway	+.008 (0.60)	**+.042 (<.01)** **(0.01)**	+.015 (0.37)	+.015[3] (0.28)	
New Zealand		**+.080 (<.01)** **(<.01)**	+.011[5] (0.62)	+.017[2] (0.26)	
Peru	**+.065 (<.01)** **(.05)**	**+.185 (<.01)** **(<.01)**	**-.036 (0.12)** **(<.01)**	-.011[3] (0.58)	
South Africa	-.013 (0.37)	-.012 (0.50)	-.014 (0.31)	+.010[2] (0.56)	
Spain	+.024 (0.10) (.31)	**+.064 (<.01)** **(0.06)**	-.008 (0.59)	-.005[4] (0.80)	-.004 (0.83)
Sweden		**+.039 (<.01)** **(0.10)**	-.005 (0.74)	-.084[3] (0.35)	+.025 (0.22)
UK	+.0058 (0.71)	**+.109 (<.01)** **(<.01)**	+.004 (0.83)	**-.028[4] (0.15)** **(<.01)**	**+.041 (0.03)** **(0.07)**
USA	-.011 (0.46)	**+.088 (<.01)** **(<.01)**	**-.030 (0.04)** **(<.01)**	**-.055[6] (<.01)** **(0.02)**	**+.047 (<.01)** **(<.01)**

1. This series is the IFS series “Changes in consumer prices;” hence it is not log-first-differenced.
2. Manufacturing employment
3. Industrial employment
4. Total employment
5. Manufacturing production
6. Total non-agricultural employment

Table 3. Money Growth Rate Asymmetry

Country	Money asymmetry	Country	Money asymmetry
Australia	+.013 (0.34)	Mexico	+.067 (<.01)
Canada	+.022 (0.13)	Netherlands	+.010 (0.43)
Chile	+.010 (0.60)	Norway	-.021 (0.22)
Denmark	+.006 (0.62)	New Zealand	+.041 (<.01)
Finland	+.003 (0.82)	South Africa	+.016 (0.31)
France	-.033 (0.01)	Spain	-.030 (0.04)
Germany	+.004 (0.82)	Sweden	-.024 (0.25)
Italy	+.005 (0.80)	UK	-.009 (0.54)
Japan	-.019 (0.20)	USA	+.011 (0.43)
Korea	-.013 (0.38)		

Note: tests are conducted on log-first-differences of the seasonally adjusted sequence labeled "Money" in the IFS data. This series did not appear for Argentina, Brazil, and Peru.

Figure 1. Level and Difference Asymmetry of Trendless Time Series