

ON THE NORMALITY OF RELATIVE PRICE CHANGES

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The purpose of this paper is to present evidence on the non-normality of relative price changes in West Germany based on annual data for forty industries [Krengel et al. (n.d.)]. The question of normality is examined only for Germany.

1. Introduction

As a direct result of the empirical observation by Vining and Elwertowski (V-E) (1976) that there appears to be a relationship between the price level and price variability there have been several sophisticated models of this relationship. Most notable are Parks (1978), Bordo (1980) and Hercowitz (1981). These studies ignore one of the fundamental warnings of V-E, that the distribution of relative price changes is not normal, usually not symmetric and often has fat tails. There have also been several strictly empirical investigations of relative price changes [Clements and Nguyen (1981), Balk (1978), Ashley (1981)] which, with the exception of Balk, have also ignored the question of non-normality.

2. The distribution of relative price changes

V-E conclude on the basis of their reported first four moments for the distribution of price changes that the assumption of normality, or even

Table 1
Empirical Shapiro-Wilk statistics for distribution of unweighted rates of price change.^a

Year	All industry <i>n</i> = 40	Mining <i>n</i> = 5	Production goods <i>n</i> = 10	Investment goods <i>n</i> = 8	Consumption goods <i>n</i> = 12	Food & luxuries <i>n</i> = 5
1952	0.92443	0.95648	0.93923	0.82876	0.88662	0.70149 <i>r</i>
1953	0.93602	0.89658	0.86079	0.85469	0.86390	0.73029 <i>r</i>
1954	0.78273 <i>r</i>	0.90343	0.83955 <i>r</i>	0.68980 <i>r</i>	0.61210 <i>r</i>	0.48152 <i>r</i>
1955	0.36697 <i>r</i>	0.96238	0.70189 <i>r</i>	0.50722 <i>r</i>	0.90038	0.84988
1956	0.30951 <i>r</i>	0.88952	0.94992	0.41953 <i>r</i>	0.48971 <i>r</i>	0.42118 <i>r</i>
1957	0.75560 <i>r</i>	0.91462	0.79266 <i>r</i>	0.49990 <i>r</i>	0.39466 <i>r</i>	0.58756 <i>r</i>
1958	0.84223 <i>r</i>	0.91939	0.85366	0.85245	0.76219 <i>r</i>	0.51681 <i>r</i>
1959	0.94283	0.88100	0.89626	0.61867 <i>r</i>	0.89830	0.44366 <i>r</i>
1960	0.97059	0.98564	0.92250	0.86763	0.80227 <i>r</i>	0.68113 <i>r</i>
1961	0.93070	0.97824	0.92887	0.55997 <i>r</i>	0.59445 <i>r</i>	0.48938 <i>r</i>
1962	0.95714	0.88572	0.88950	0.64136 <i>r</i>	0.79811 <i>r</i>	0.41458 <i>r</i>
1963	0.60276 <i>r</i>	0.83227	0.93678	0.74925 <i>r</i>	0.73769 <i>r</i>	0.59137 <i>r</i>

1964	0.47533 <i>r</i>	0.79655	0.88156	0.89594	0.54115 <i>r</i>	0.49865 <i>r</i>
1965	0.73809 <i>r</i>	0.93653	0.75769	0.82703	0.34725 <i>r</i>	0.47915 <i>r</i>
1966	0.81859 <i>r</i>	0.95061	0.80908 <i>r</i>	0.30227 <i>r</i>	0.48950 <i>r</i>	0.64595 <i>r</i>
1967	0.97711	0.96272	0.81325 <i>r</i>	0.88316	0.73894 <i>r</i>	0.94698
1968	0.63610 <i>r</i>	0.76741	0.86661	0.59769 <i>r</i>	0.46176 <i>r</i>	0.83406
1969	0.91615 <i>r</i>	0.89650	0.80572 <i>r</i>	0.55213 <i>r</i>	0.49168 <i>r</i>	0.67760 <i>r</i>
1970	0.94560	0.99845	0.75424 <i>r</i>	0.47134 <i>r</i>	0.41372 <i>r</i>	0.54219 <i>r</i>
1971	0.96834	0.87907	0.95816	0.31376 <i>r</i>	0.44761 <i>r</i>	0.95418
1972	0.94692	0.95648	0.94172	0.10168 <i>r</i>	0.49202 <i>r</i>	0.61158 <i>r</i>
1973	0.94343	0.82544	0.72307 <i>r</i>	0.56528 <i>r</i>	0.49838 <i>r</i>	0.47164 <i>r</i>
1974	0.93773 <i>r</i>	0.95376	0.62811 <i>r</i>	0.12905 <i>r</i>	0.46987 <i>r</i>	0.41265 <i>r</i>
1975	0.98490	0.96386	0.92699	0.38894 <i>r</i>	0.68173 <i>r</i>	0.69469 <i>r</i>
1976	0.96970	0.89154	0.96695	0.64712 <i>r</i>	0.76858 <i>r</i>	0.84892
1977	0.98382	0.90298	0.98366	0.71652 <i>r</i>	0.61866 <i>r</i>	0.82974
<i>Critical point</i>						
10% level	0.949	0.806	0.869	0.851	0.883	0.806
5% level	0.940	0.762	0.842	0.818	0.859	0.762

^a *n* denotes the number of branches in the industry for which price changes were calculable. The distribution of price changes is examined with respect to the mean change in that industry. *r* denotes rejection of the null hypothesis of normality at the 5% level. Price changes enter the calculation of the Shapiro–Wilk statistic with equal weights.

symmetry, is unwarranted. In a similar vein, Balk finds that price changes in The Netherlands are not drawn from a single family of distributions. Rana (1981) in a study of changes in exchange rates finds that changes in the prices of foreign exchange for Asian countries are not normally distributed.

The hypothesis of normality was tested for price changes in Germany using the Shapiro–Wilk (1965) test statistic (W). Pearson, D’Agostino and Bowman (1977) conclude in their Monte Carlo study that the Shapiro–Wilk statistic is the most powerful small sample, omnibus test for normality.

For the computation of W , the already ordered price changes were weighted by their Divisia Index expenditure shares. The resounding conclusion was that price changes, as weighted in the calculation of an inflation rate, are not normally distributed.

In order to make the test less stringent, and more consistent with the assumptions made by, for example Lucas (1973), the distribution of unweighted price changes around its arithmetic mean was investigated. The Shapiro–Wilk statistics for the forty industry sample are reported in the first column of table 1. A very conservative statistician might reject even fewer of the normality hypotheses than those indicated in the table by a small r .

Following the results of the first column, the sample was divided into five groups of industries: mining, production goods, investment goods, consumption goods, food and luxuries. The Shapiro–Wilk statistics were calculated from price changes in each group and are reported in table 1. An immediately striking fact is that the number of rejections increases as one moves from raw materials to finished goods. This result might have been predicted from the work of Cairnes (1873), Bordo (1980) or Taylor (1981), Ashley (1981). The first two authors discuss at length the mechanism of transmitting monetary shocks through the various sectors, predicting that prices in manufacturing rise the least uniformly of all sectors due to the timing of processing and production as well as the existence of long-term contracts. Taylor (1981) and Ashley (1981) warn that any empirical study of relative price changes must sort out the effect of one industry in the sample buying inputs from another in the sample. In particular, Taylor notes that most of the variability of relative price changes in the U.S. during ’73 and ’74 can be attributed to the oil price shock which is only slowly passed through to other more highly processed goods. This is clearly a problem in the German data.

The extreme disparity in results for weighted and unweighted price

changes and examination of the moments of the two distributions (available from the authors) leads to the conclusion that price changes which fall into the tails of the unweighted distribution get enormous weights in an expenditure share weighted distribution of price changes, thus fattening the tails and changing the skewness of the distribution of price changes while making it less leptokurtic in almost all years for which normality is not rejected. As Ashley suggests and our results seem to demonstrate, careful thought should be given to the choice of representative distribution to be incorporated into empirical work.

3. Conclusions

Evidence is presented which shows that relative price changes in Germany are not normally distributed. This has been previously shown to be the case for The Netherlands. Such evidence is in contradistinction to the assumption of normality in many macro-models. It may also explain the instability of the relation between the variance of price changes on the one hand and either the rate of inflation or variability of inflation on the other [see Buck and Gahlen (1982)].

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