International Finance Discussion Papers

Number 231

October 1983

A QUANTITATIVE REASSESSMENT OF THE PURCHASING POWER PARITY HYPOTHESIS: EVIDENCE FROM NORWAY AND THE UNITED KINGDOM

by

Hali J. Edison and Jan Tore Klovland

Hali J. Edison and Jan Tore Klovland August 1983

A Quantitative Reassessment of the Purchasing Power Parity Hypothesis: Evidence from Norway and the United Kingdom

> Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate.
> Dornbusch and Krugman (1976)

I. Introduction

The reemergence of empirical research on the purchasing power parity hypothesis (henceforth PPP) in the 1970's does not seem to have led to any consensus as to its general empirical validity. On the one hand, Gailliot (1970), Myhrman (1976), Officer (1976a, 1980) and Friedman (1980) have presented historical evidence for many countries and over many time periods which supports the basic PPP hypothesis, i.e., that trends in relative price levels between two countries are offset by movements in the exchange rate in the long run. This conclusion stands out most clearly during time periods dominated by monetary disturbances.[1/] On the other hand, these findings contrast sharply with the experience of the 1970's where the evidence suggest persistent divergences of exchange rates from PPP.[2/]

Nevertheless, some form of the PPP relationship remains a basic ingredient in many empirical models of exchange rate determination.[3/] The purpose of this paper is to analyse what direction the PPP theory can be amended so that it can be retained as a useful empirical relationship. We focus on amending the simple theoretical version of PPP in a way consistent with Cassel's original arguments[4/] and how to empirically test the PPP proposition.

In this study annual data for Norway and the United Kingdom covering more than a century are used to reassess the empirical performance of the PPP theory. Using data over such a long time period provides a firm basis for evaluating the extent to which the simple PPP model is affected by structural changes in the real economy. The choice of Norway, the home country, and the United Kingdom, representing the world,[5/] should highlight the problems involved in applying the PPP relationship in models of small, open economies.

This paper is organised as follows. In section II the PPP theory is restated. In section III four different and more complex models - a simple, a real, a monetary and a synthesis - are described. All of these models are used to test PPP. In the section following the general method of empirically implementing these models is discussed. In section V the empirical results are reported. The final section contains some concluding remarks.

II. Purchasing Power Parity Theory

The PPP hypothesis is stated as

$$(1) \qquad E = K \cdot P/P^*$$

where E, P, P^* are the exchange rate (domestic currency value of foreign currency), index of domestic prices, index of foreign prices and K a constant (however K may be a function of variables), respectively. There are several distinct theoretical interpretations of the PPP relationship.[6/] We, however, consider the PPP proposition as an equilibrium relationship between the exchange rate and the relative price level, rather than an arbitrage condition.[7/] The basic justification for equation (1) is then to be sought in the principle of long run neutrality of money.[8/]

Since our underlying notion of PPP is a long-run equilibrium relationship care is exercised in transforming (1) into an empirically testable form. Three conditions are considered important in testing PPP. They are: (i) symmetry between the domestic and foreign country, (ii) proportionality between relative prices and the exchange rate, (iii) the requirement that K is a constant (but not necessarily unity) or the exclusiveness condition. In this paper, we focus mainly on the proportionality and exclusiveness conditions.

III. The Four Different Models

Our view of the PPP doctrine leaves the door open to the influence of real factors on the equilibrium relationship between exchange rates and relative national price levels. That is, in equation (1) K may be a function of productivity growth and/or other variables which alter the relative prices of goods. Furthermore, in the case of monetary disturbances both real and monetary factors may have an important role in explaining short run deviations for PPP. Both of these extensions to the traditional or "naive" version of PPP are described below as well as a synthesis model.

Since over much of the time period we consider the exchange rate is fixed, it is most natural to use the domestic price as the dependent variable. Equation (1) is rewritten here as

$$(2) \qquad P = K \cdot E \cdot P^*$$

The Simple Version of PPP

The simple version of the PPP, dubbed as such because it is limited to prices and the exchange rate, is stated as follows:

$$(3) \qquad \bar{p} = k + \bar{p}^* + \bar{e}$$

where lower case letters denote logarithmic values and bars over the variables are used to denote long-run values of variables defined in (2). In section IV the econometric specification of (3) is described.

The Real Model (of PPP)

The distinction between traded and non-traded goods, together with the existence of differential rates of productivity growth are reasons often cited for the failure of the PPP hypothesis.[9/]

In his empirical specification of the productivity bias hypothesis Balassa (1964) suggested to test for a positive relationship between the real exchange rate and per capita GNP which was implied by the theoretical relationship between the relative price of nontraded goods and the level of productivity. In this paper a different measure of real income from Balassa is employed taking into account both productivity growth and changes in international purchasing power of domestic output. Real income (YD) is defined as

$$(4) \qquad YD = Q \cdot P_Q/P_E$$

where Q is an index of output per worker, P_Q is a price index of domestic output and P_E is a price index of domestic expenditure. Using logarithmic values of price indices of domestic goods, P_D, of exports, P_x, and of imports, P_m, and assuming balanced trade ($\beta_x = \beta_m = \beta_T$) we decompose the price indices used in equation (4) to be:

$$(5) \qquad p_E = \beta_D p_D + \beta_T p_m$$

$$(6) \qquad \begin{aligned} p_Q &= \beta_D p_D + \beta_T p_x \\ &= p_E + \beta_T (p_x - p_m) \end{aligned}$$

Given (6), real income (4) can be rewritten as

$$(7) \qquad YD = Q \cdot (p_x/p_m)^{\beta_T}$$

Thus real income growth corresponds to productivity growth plus a fraction β_T, the foreign trade share of GDP, times the relative change in terms of trade.

In terms of the PPP proposition, K is modified and considered as a function of productivity and terms of trade. The effect of productivity growth and terms-of-trade changes on the real exchange rate via real income growth is a long-run process that is primarily reflected in secular trends. The impact effect of changes in YD are therefore expected to be small, although the long-run effect should be significant. Since price deflators for output are being used rather than price deflators for domestic expenditure in our empirical analysis there is some reason to argue that there is a more direct effect of terms-of-trade changes on the price level in the short run. Consider a sudden increase in the world price of one of the items of which the home country is a large net exporter, like shipping services as in the case of Norway. The dominant impact effect will be an increase in the computed GDP deflator which is proportional to the output share of the exportables in question. Subsequently, however, domestic income and substitution effects as well as a reversal of world market conditions might work towards a gradual restoration of the old relative price structure.[10/]

These considerations lead to amending the simple PPP hypothesis (3) to include the effect of productivity, Q, and the terms of trade, B. In logarithmic terms, we then have

$$(8) \qquad \bar{p} = k' + \bar{p}^* + \bar{e} + \pi_1 q - \pi_1^* q^* + \pi_2 b - \pi_2^* b^*$$

where it is assumed that all coefficients are positive.

The Monetary Model (of PPP)

We now consider testing PPP theory within a framework that accounts for differential adjustment speeds of commodity prices and exchange rate along the lines of Dornbusch (1976). The model consists of the simple PPP relationship (like equation (1) but written in logs), a conventional demand for money equation (10), a short run price equation (11) and a demand function for output (12). Letting $x^{+} = x - x^{*}$, a bar over variables ($\bar{x}$) denoting long-run equilibrium values, and assuming that all coefficients are positive[11/] the model can be written as

(9) $$\bar{e} = k + \bar{p}^{+}$$

(10) $$m^{+} = \mu_0 + p^{+} + \mu_1 y^{+} - \mu_2 r^{+}$$

(11) $$p^{+} = \phi_0 + \bar{p}^{+} + \phi_1 (d^{+} - y^{+})$$

(12) $$d^{+} = \delta_0 + \delta_1(e - p^{+}) + \delta_2 y^{+} - \delta_3 r^{+} + \delta_4 f^{+}$$

The variables are all in logarithms (except for interest rates) where m, y, r, d, and f are nominal money stock, real output, interest rate, expenditure on domestic goods, and a fiscal policy measure, respectively. The price equation (11) says that the deviation of actual from long run prices is proportional to excess demand for output, while equation (12) relates the expenditure on domestic goods to the real exchange rate, output, the interest rate and fiscal policy. The simple four-equation model can be used to determine the four endogenous variables, p^{+}, $\bar{p}^{+}$, r^{+}

and d^+. It should be pointed out that our purpose with this model is merely to use it as a framework for testing the PPP doctrine. It is noted that existence of capital controls, capital market imperfections and slow speeds of adjustment might be sufficient reasons for considering the money stock as exogenous in the short run even in a predominantly fixed exchange rate world.[12/]

The reduced form solution of the model for p^+, neglecting all constant terms, is

$$(13) \qquad p^+ = [1 + \phi_1\delta_1 + \frac{\phi_1\delta_3}{\mu_2}]^{-1} \cdot [\bar{e} + \phi_1\delta_1 e + \frac{\phi_1\delta_3}{\mu_2} m^+ + (\phi_1(\delta_2 - 1) - \frac{\phi_1\delta_3\mu_1}{\mu_2})y^+ + \phi_1\delta_4 f^+]$$

We note that the steady-state version of (13), assuming $r^+ = 0$, $\delta_2 = 1$, $f^+ = 0$ and $e = \bar{e}$ ensures homogeneity of nominal variables, i.e., purchasing power parity, $\bar{p}^+ = k' + \bar{e}$.

The implication of (13) leads to a model corresponding to (2) in logarithm and enlarged with the other exogenous variables appearing in (13).

$$(14) \quad \bar{p} = \tilde{k} + \bar{p}^* + \bar{e} + x_t'$$

where $x_t' = (m_t, ,m_t^*, y_t, y_t^*, f_t, f_t^*)$. According to this model monetary and real disturbances as represented by x_t' should contribute significantly in explaining short-term movements in p but not its long term level.

The Synthesis Model - Real and Monetary Effects Combined

The last model considered is a synthesis of both the extended PPP relationships, i.e., the real model equation (8) and the "monetary" model given by equations (9) - (12). This leads to a final equation similar to (14) except that the vector x now consists of the variables m, m^*, y, y^*, f, f^*, q, q^*, and b and b^*. According to the theory we would expect that the steady-state value of domestic prices is positively related to q and b and negatively related to q^* and b^*. The theory outlined thus far gives no reason for m and y and their foreign counterparts to affect the long-run value of p beyond the influences already embedded in the equilibrium values of e and p^*. Our choice of empirical counterparts of theoretical variables y and q, real GDP per capita and per employed worker, however, makes these two variables highly positively correlated. Therefore, only the y-variables are used in accounting for short-run effects and the q-variables are used to capture the long run structural effects, in accordance with the theory, outlined above.

IV. Modelling Strategy

In our attempt to assess PPP we suggest a way of transforming (1), an equilibrium relationship, into a testable form. The overall strategy is to (i) transform economic theory into an econometric specification (ii) select a parsimonious representation of the data generating process (iii) test the prior restrictions suggested by theory against the data and (iv) analyse the long-run properties of the final econometric specification comparing it to the theory it was originally derived from. Note that a by product of this procedure is that the results of previous researchers can be explained as well since the general model will encompass these earlier models.

The general specification we propose (step i) takes the form of an Autoregressive Distributed lag model and is referred to as an AD(p, q_i) model where p and q_i are the length of lag of the dependent and independent variables respectively. The choice of p and q_i depends on a priori information and/or data constraints. The model takes the form where the error term (u_t) is white noise without extractable innovations.

$$(15) \qquad e_t = \alpha_0 + \sum_{j=0}^{n} (\alpha_{1j} p_{t-j} + \alpha_{2j} p^*_{t-j} + \beta_j e_{t-j-1}) + u_t$$

where lower case letters indicate log level and $u_t \sim N(0, \sigma^2)$. Given (15) further restricted specifications are considered (step (ii)). The objective is to find the appropriate lag length (order of dynamics) and then to test the restrictions on the coefficients as suggested by prior theory [Mizon (1977)].

Once the final specification has been chosen (step (iii)), the long-run assumption of purchasing power parity can be analysed from it (Step (iv)). Setting $\bar{e} = e_{t-g}$ and $\bar{z}_i = z_{i\ t-g}$ for all g and for z_i = (p, p') and solving for $\bar{e}$ the econometric results can be compared to the original theory. For the symmetry condition mentioned above to hold, the restriction on the independent variables' coefficients are $\alpha_{1g} = \alpha_{2g}$ for all g. For the proportionality condition to hold, the symmetry condition and the restriction $\frac{\Sigma\alpha_g}{1-\Sigma b_g} = 1$ must hold.

A particular type of model, an error correction mechanism (ECM), is considered which facilitates testing the proportionality assumption. The underlying economic concept of the ECM model when applied to PPP is: when PPP does not hold at a particular moment (assuming that the ECM model representation is valid) signifying a situation of "disequilibrium", the exchange rate will adjust to eliminate the discrepancy (error) that exists. What makes the ECM model different from other models is that the steady state solution (e.g., PPP) is incorporated within the model. Furthermore, this restriction is easily testable.13/

An example of an ECM type specification is considered in (16). For simplification of exposition we drop the lag terms present in (15) and we assume symmetry, $p^{+} = p - p^{*}$

(16) $$\Delta e_t = \alpha_0 + \alpha_1 \Delta p_t^{+} + (1 - \beta_1)(p^{+} - e)_{t-1} + u_t$$

Thus when $\Delta p_t^{+} = \Delta e_t = u_t = 0$ (16) ensures $e = p^{+} + k$. The term $(p^{+} - e)_{t-1}$ measures the deviations from PPP in the previous period. The exchange rate adjusts to remove this disequilibrium. If our estimates support the formulation of equation (16) this then implies that the PPP hypothesis is not rejected on the grounds of symmetry or proportionality. Note that α_1 represents the impact or short-run reactions of the exchange rate to changes in relative prices, it is not necessary for PPP that $\alpha_1 = 1$ since the solution $\bar{e} = \bar{p}^{+}$ will occur even when $\alpha_1 \neq 1$ in (16).

V. Empirical Results

This study covers the period from 1876 to 1980. In figure 1 the annual average value of the nominal exchange rate index, with the pre-World War I mint parity of 18.16 kroner per pound equal to 100, and the real exchange rate index are plotted.[14/] There is considerable year to year variation in the real exchange rate over the time span considered. Moreover, it exhibits persistent deviations from its mean.

The simple PPP relationship appears to perform poorly in the short run, however its predictive performance is quite impressive over the long run. Over the period of 105 years between 1876 and 1980 the U.K. price level grew by 337.8 per cent and the domestic price level by 289.3 per cent.[15/] This differential of 48.5 per cent was offset by an appreciation of the exchange rate by 45.4 per cent, implying a real exchange rate depreciation of only 3.1 per cent.

The empirical counterpart to equation (3) is the general econometric specification which follows the strategy outlined in section IV.

$$(17) \qquad \Delta p_t = a + \sum_{i=1}^{A} a_i \, \Delta p_{t-i} + \sum_{i=0}^{B} b_i \Delta p^*_{t-i} + \sum_{i=0}^{C} c_i \, \Delta e_{t-i} + \alpha p_{t-1} + \beta p^*_{t-1} + \gamma e_{t-1} + u_t$$

Table one sets out the results from estimating the simple version of the PPP relationship over one hundred years, 1876 to 1975, using implicit deflators for gross domestic product at market prices and average annual krone-pound exchange rate quoted on the Oslo stock exchange.[16/] Regression 1A, equation 17, is the general model with A, B, C, preset at 3. Regressions 1B and 1C are restricted versions of 1A.

An F-test, denoted by Z_6, is used to test the joint restrictions of 1B against 1A.[17] The seven restrictions are not rejected using this criteria. Using regression 1c we test for the validity of the proportionality assumption crucial to the PPP theory. This restriction is rejected since Z_6 is 4.71 which exceeds the critical value at the 5% significance level.[18]

The long-run or steady-state relationship that emerges from 1B, found by setting $\bar{p}=p_{t-i}$, $\bar{p}^* = p^*_{t-i}$, $\bar{e} = e_{t-i}$ for all i is

$$\bar{p} = k + .91\bar{p}^* + 52\bar{e}$$

This result clearly shows that the proportionality assumption is far from being consistent with the data, in particular, the coefficient on the exchange rate is well below unity.[19,20]

A general empirical representation of the real model, equation (8), is given in Table 2. With the exception of the foreign productivity variable, q^*_{t-1}, all of the "real" or "structural" variables appear to have a significant influence on the steady state domestic price level. There is also a significant impact effect of terms of trade changes which is in accordance with the theory discussed above. The strong and highly significant effect of contemporaneous productivity growth in the opposite direction of that predicted for the steady-state relationship is, on the other hand, clearly at variance with this version of the Balassa-Samuelson model.[21]

As before, a comparision of models 2C and 2B provides a test of the proportionality assumption of the PPP theory. This hypothesis is now decisively rejected, which one would suspect from the pattern of estimated coefficients on p_{t-1}, p^*_{t-1} and e_{t-1} of model 2B. Furthermore, the additional factors included in the real model are significant. Accordingly, both the proportionality and the exclusiveness assumptions are rejected. Although the estimation of this model has given some indication that real factors may be of some importance in explaining long-run price behaviour, the model is clearly not satisfactory on the whole. Therefore, we proceed to the evaluation of the PPP theory in light of a monetary model.

The econometric specification of the final monetary model of PPP (14) is

$$(18)\qquad \Delta p_t = a_0 + \sum_{i=1}^{A} a_i \Delta p_{t-i} + \sum_{i=0}^{B} b_i \Delta p^*_{t-i} + \sum_{i=0}^{C} c_i \Delta e_{t-i} + \sum_{i=0}^{H} h_i \Delta x'_{t-i} + \alpha p_{t-1} + \beta p^*_{t-1} + \gamma e_{t-1} + \eta x'_{t-1}$$

where $x'_t = (m_t, m^*_t, y_t, y^*_t, f_t, f^*_t)$ and h and η are coefficient vectors. According to this model short run monetary and real disturbances, $\Delta x'_t$, are anticipated to explain short run fluctuation of domestic prices, Δp_t, but these variables are not anticipated to affect the steady-state values of p. This implies that the vector of coefficients η should be insignificant.

The estimation results are reported in table 3.[22/] Broad versions of the money stock, on a per capita basis, are used for both countries. Output is measured by GDP per capita at constant market prices. The results show a relatively strong effect of domestic money and foreign income growth. In addition, the steady-state solution of model 3B depends on the output differential, since the coefficients of y_{t-1} and y^*_{t-1} are significantly different from zero. Once again the proportionality hypothesis, $\alpha = -\beta = \gamma$, is firmly rejected. The exclusiveness assumption in the long run is also violated which may be indicative of the productivity bias effect which was considered in the real model.

The estimation results of the synthesis model are set out in table 4. In contrast to the previous results, nearly all the pieces of the puzzle now fit together. The coefficient estimates of α, β and γ are very close in absolute value, and the proportionality assumption cannot be rejected with a F statistic of .55 (against the critical value of 3.11). The short-run effects of money, income and terms-of-trade changes are pervasive and in the hypothesised direction, with the exception of Δm^*_t. Moreover, the long-run price level differential is significantly related to both components of the relative income level, productivity and term-of-trade, in accordance with our interpretation of the Balassa-Samuelson theory. One feature of model 4C that requires some investigation is the significant influence of the levels of the money stock on the steady-state value of the domestic price level, which is discussed below.[23/] The long-run solution of model 4C is given by

$$\bar{p} = k + \bar{p}^* + \bar{e}\ .82q - 1.28q^* + .54(b-b^*) + .15m - .30m^*$$

As noted above, the influence of the real factors on the long-run value of the price level is consistent with the theoretical arguments put forward by Balassa (1964) and Samuelson (1964). Thus, although it implies a rejection of the simple version of PPP, it is consistent with a more elaborate version of the PPP doctrine. Since the Balassa/Samuelson argument has been accepted in theory by most writers and the empirical evidence has been somewhat ambiguous, this result may be of some importance.

A theoretical justification is needed for the significant influence of the levels of the money stock on the long-run price level.[24/] Two lines of investigation were pursued. First, it was investigated whether the result was due to a misspecification of the demand-for-money equation. Bordo and Jonung (1981) and Klovland (1983) have shown that it might be important to take into account the influence on long-run velocity behavior of structural factors like financial sophistication and the development of a modern banking system. This applies particularly to Norway, where the velocity of money fell from 3.3 in 1870 to slightly above 1 in the interwar years.[25/] When the variable, a three year moving average of the deposit-currency ratio, was included in the model, the main results were, however, left essentially unchanged.[26/] The new variable did not contribute significantly to the explanatory power and the influence of m and m^* did not vanish.

Secondly, it was investigated whether the effect of real factors on the relative price of non-traded goods was due to disturbances of monetary origin; an argument first described by Niehans (1981). The underlying idea is that[27/] "the larger the imports which can be financed by the net receipts from foreign assets, the larger is the fraction of resources allocated to the production of non-traded goods and the higher is their relative price". Thus, in the case where the international reserve component of the monetary base is a major source of money creation purchases of foreign exchange by the central bank may, at least in the short run, add to the money stock. If the hypothesis put forth by Niehans is valid, money creation through foreign-exchange purchases is consistent with an appreciation of the real exchange rate. If it is assumed that the course of the money stock reflects movements in foreign asset holdings, this argument is also consistent with a positive coefficient on the money stock differential, $m-m^*$ in equation (17).

There are several reasons why one would be inclined not to attach too much confidence in this explanation, however. The correlation between foreign exchange reserves and the money stock may be rather weak because it depends on the degree of sterilization and other policy measures taken by domestic monetary authorities. Moreover, it is not actually official foreign exchange holdings but rather the international purchasing power of the return from the total of foreign interesting-bearing assets held by all domestic sectors that affects the relative price of non-traded goods in the model analyzed by Niehans (1981).

This suggests that a more direct test of the Niehans argument could be provided by testing the influence of the flow of coupon payments on foreign assets within our model. Assuming for simplicity that all foreign assets and liabilities were denominated in U.S. dollars, such a variable was constructed by deflating the domestic currency value of net property income from abroad by the implicit price deflator for the United States GNP and converting it to U.S. dollars at the annual average of the exchange rate of the domestic currency against dollars. The (preliminary) results obtained with this variable were negative, however. The coefficient estimates were not significantly different from zero, while both money stock variables retained their significance. While the data quality of the foreign asset returns is known to be poor, at least for Norway in the first half of the sample, our preliminary investigations do not give much support to the empirical significance of the Niehans argument in this case.

V. Conclusion

The main conclusion that follows from our quantitative reassessment of the PPP doctrine is that a simple version of the PPP relationship, comprising only the exchange rate and relative price levels, does not adequately represent the data generation process. Two sets of factors were found to be important in amending the simple model which embodied the theoretically appealing proportionality proposition between the exchange rate and relative price levels. One set of factors originates from the effect of real income growth on the relative price of non-traded goods, well known from the articles by Balassa (1964) and Samuelson (1964), but not always found to be significant in empirical work on PPP. The other extension that seems to be fruitful is the explicit modelling of other real and monetary factors that affect the dynamic adjustment to long-run equilibrium. Although these amendments to the simple PPP model may go some way in improving the empirical performance of PPP models, our investigations have also shown that even the extended version of the PPP relationship has its shortcomings.

TABLE 1: Test of the PPP Hypothesis, Norway - U.K. 1876-1975.

The Simple Model

	1A	1B	1C
Δp_{t-1}	.641 (.114)	.585 (.099) R1	.627 (.097) R1
Δp_{t-2}	-.170 (.116)	-.250 (.064) R2	-.253 (.066) R2
Δp_{t-3}	.170 (.108)	.250 (.064) R2	.253 (.066) R2
Δp^*_t	1.262 (.147)	1.264 (.129)	1.157 (.104)
Δp^*_{t-1}	-.751 (.201)	-.585 (.099) R1	-.627 (.097) R1
Δp^*_{t-2}	-.052 (.202)		
Δp^*_{t-3}	.301 (.194)		
Δe_t	-.072 (.115)		
Δe_{t-1}	.270 (.134)	.283 (.083) R3	.258 (.084) R3
Δe_{t-2}	-.366 (.136)	-.283 (.083) R3	-.258 (.084) R3
Δe_{t-3}	.288 (.114)	.283 (.083) R3	.258 (.084) R3
p_{t-1}	-.173 (.053)	-.160 (.038)	-.108 (.035) R4
p^*_{t-1}	.153 (.049)	.145 (.036)	.108 (.035) R4
e_{t-1}	.108 (.076)	.083 (.053)	.108 (.035) R4
constant	-.422 (.332)	-.332 (.235)	-.514 (.168)
T-K	85	92	94
R^2	.7724	.7625	.7382
SEE	.0425	.0417	.0433
$Z_3(4)$	2.29/9.49*	3.39/9.49*	5.37/9.49*
$Z_4(5)$	8.28/11.07*	5.87/11.07*	6.16/11.07*
$Z_5(5,T-K)$	1.04/2.32*	0.97/2.31*	0.93/2.31*
$Z_6(n,T-K)$		0.53/2.11*	4.71/3.10*

Notes: Dependent variable is Δp_t. The upper half of the table shows ordinary least squares estimates of coefficients with standard errors in parentheses.

T-K	-number of observations minus the number of regressors (including the constant term)
R^2	-multiple correlation coefficient
SEE	-standard error of regression
$Z_3(\ell)$	-Lagrange Multiplier test for ℓth-order residual autocorrelation, distrubuted as χ^2_1 in large sample
$Z_4(m)$	-chi square test of the accuracy of post-sample prediction relative to the within-sample fit, distributed as χ^2_m in large samples (m is the number of observations predicted.)
$Z_5(m, T-K)$	-Chow test for parameter stability between the estimated sample of T observations and the subsequent m observations, asymptotically distributed as $F_{m, T-K}$
$Z_6(n, T-K)$	-F-test of the validity the n exclusions or additional restrictions imposed compared to the previous model
*	-donotes the critical value at the 5 per cent significance level
Restrictions:	-(coefficients of variables within the parentheses are restricted to be the same) R1 $(\Delta p - \Delta p^*)_{t-1}$, R2 $(\Delta p_{t-2} - \Delta p_{t-3})$, R3 $(\Delta e_{t-1} - \Delta e_{t-2} + \Delta e_{t-3})$, R4 $(p - p^* - e)_{t-1}$

TABLE 2. Test of the PPP-hypothesis, Norway - U.K., 1876-1975. The Real Model.

	2A	2B	2C
Δp_{t-1}	.165 (.098)	.172 (.064) R1	.247 (.070) R1
Δp_{t-2}	.015 (.085)		
Δp_{t-3}	.018 (.076)		
Δp^*_t	1.534 (.121)	1.551 (.094)	1.711 (.099)
Δp^*_{t-1}	-.168 (.160)	-.172 (.064) R1	-.247 (.070) R1
Δp^*_{t-2}	-.081 (.141)		
Δp^*_{t-3}	.186 (.133)	.172 (.064) R1	.247 (.070) R1
Δe_t	.346 (.091)	.363 (.061)	.267 (.067)
Δe_{t-1}	.090 (.099)		
Δe_{t-2}	-.073 (.099)		
Δe_{t-3}	.040 (.087)		
Δb_t	.215 (.046)	.245 (.037)	.267 (.042)
Δb^*_t	-.576 (.104)	-.559 (.082)	-.444 (.090)
Δq_t	-.397 (.132)	-.422 (.102)	-.480 (.112)
Δq^*_t	.814 (.164)	.846 (.145)	.907 (.166)
p_{t-1}	-.078 (.061)	-.101 (.036)	-.221 (.032) R3
p^*_{t-1}	-.045 (.081)	-.011 (.051)	.221 (.032) R3
e_{t-1}	.187 (.080)	.191 (.037)	.221 (.032) R3
b_{t-1}	.022 (.036)	.054 (.021) R2	.032 (.024) R2
b^*_{t-1}	-.090 (.050)	-.054 (.021) R2	-.032 (.024) R2
q_{t-1}	.123 (.066)	.118 (.028)	-.029 (.011)
q^*_{t-1}	.024 (.089)		
constant	-.640 (.561)	-.890 (.175)	-.924 (.156)
T-K	77	87	89
R^2	.9089	.9052	.8713
SEE	.0283	.0271	.0312
$Z_3(4)$	5.28/9.49*	4.83/9.49*	15.11/9.49*
$Z_4(5)$	41.63/11.07*	34.37/11.07*	13.53/11.07*
$Z_5(5,T\text{-}K)$	2.27/2.34*	2.24/2.32*	2.10/2.32*
$Z_6(n,T\text{-}K)$		0.31/1.96*	15.57/3.10*

See general notes to TABLE 1.

<u>Restrictions</u>: R1 $(\Delta p_{t-1} - \Delta p^*_{t-1} + \Delta p^*_{t-3})$, R2 $(b - b^*)_{t-1}$,
R3 $(p - p^* - e)_{t-1}$.

TABLE 3. Test of the PPP-hypothesis, Norway - U.K., 1876-1975.
The Monetary Model.

	3A	3B	3C
Δp_{t-1}	-.008 (.130)		
Δp_{t-2}	-.372 (.104)	-.299 (.061)	-.249 (.063)
Δp^*_t	1.118 (.140)	1.086 (.093)	1.152 (.096)
Δp^*_{t-1}	-.246 (.163)	-.232 (.075) R1	-.222 (.082) R1
Δp^*_{t-2}	-.178 (.144)	-.201 (.060) R2	-.272 (.062) R2
Δe_t	.112 (.093)	.156 (.035) R3	.162 (.036) R3
Δe_{t-1}	.212 (.110)	.156 (.035) R3	.162 (.036) R3
Δe_{t-2}	.006 (.089)		
Δm_t	.511 (.102)	.524 (.041) R4	.499 (.044) R4
Δm_{t-1}	.077 (.126)		
Δm_{t-2}	.521 (.109)	.524 (.041) R4	.499 (.044) R4
Δm^*_t	-.067 (.170)		
Δm^*_{t-1}	.169 (.221)		
Δm^*_{t-2}	-.323 (.182)	-.201 (.060) R2	-.272 (.062) R2
Δy_t	.037 (.069)		
Δy_{t-1}	-.101 (.081)		
Δy^*_t	.463 (.143)	.524 (.041) R4	.499 (.044) R4
Δy^*_{t-1}	.202 (.140)	.232 (.075) R1	.222 (.082) R1
p_{t-1}	-.036 (.098)	-.066 (.042)	-.132 (.042) R6
p^*_{t-1}	-.043 (.146)	.010 (.048)	.132 (.042) R6
e_{t-1}	.092 (.092)	.095 (.051)	.132 (.042) R6
m_{t-1}	-.011 (.025)		
m^*_{t-1}	.019 (.043)		
y_{t-1}	.172 (.073)	.125 (.033) R5	.001 (.015) R5
y^*_{t-1}	-.170 (.065)	-.125 (.033) R5	-.001 (.015) R5
constant	-.361 (.571)	-.424 (.229)	-.656 (.186)
T-K	74	89	91
R^2	.9023	.8981	.8773
SEE	.0298	.0278	.0302
$Z_3(4)$	2.84/9.49*	3.39/9.49*	5.59/9.49*
$Z_4(5)$	22.20/11.07*	17.71/11.07*	17.24/11.07*
$Z_5(5,T-K)$	2.03/2.34*	2.46/2.32*	2.65/2.31*
$Z_6(n,T-K)$		0.22/1.81*	9.09/3.10*

See general notes to TABLE 1.

<u>Restrictions</u>: R1 $(\Delta y^* - \Delta p^*)_{t-1}$, R2$(\Delta m^* + \Delta p^*)_{t-2}$, R3$(\Delta e_t + \Delta e_{t-1})$, R4$(\Delta m_t + \Delta m_{t-2} + \Delta y^*_t)$, R5$(y - y^*)_{t-1}$, R6$(p - p^* - e)_{t-1}$.

TABLE 4. Test of the PPP-hypothesis, Norway - U.K., 1876-1975.
Synthesis Model.

	4A	4B	4C
Δp_{t-1}	-.020 (.090)		
Δp_{t-2}	-.030 (.070)		
Δp^*_t	1.252 (.100)	1.237 (.078)	1.260 (.064)
Δp^*_{t-1}	-.252 (.120)	-.262 (.042) R1	-.256 (.042) R1
Δp^*_{t-2}	-.281 (.101)	-.262 (.042) R1	-.256 (.042) R1
Δe_t	.342 (.073)	.384 (.051)	.390 (.050)
Δe_{t-1}	.141 (.078)	.093 (.044) R2	.093 (.043) R2
Δe_{t-2}	-.086 (.065)	-.093 (.044) R2	-.093 (.043) R2
Δm_t	.491 (.070)	.503 (.041) R4	.499 (.040) R4
Δm_{t-1}	.094 (.089)		
Δm_{t-2}	.208 (.079)	.205 (.055)	.203 (.055) R2
Δm^*_t	.158 (.123)	.195 (.053) R3	.192 (.053) R4
Δm^*_{t-1}	.009 (.155)		
Δm^*_{t-2}	-.038 (.129)		
Δy_t	-.184 (.050)	-.185 (.033) R5	-.178 (.032) R5
Δy_{t-1}	-.156 (.058)	-.185 (.033) R5	-.178 (.032) R5
Δy^*_t	.331 (.099)	.312 (.078)	.312 (.077)
Δy^*_{t-1}	.240 (.095)	.195 (.053) R3	.192 (.053) R3
Δb_t	.199 (.035)	.201 (.029)	.202 (.029)
Δb^*_t	-.480 (.081)	-.503 (.041) R4	-.499 (.040) R4
p_{t-1}	-.289 (.076)	-.279 (.050)	-.268 (.037) R7
p^*_{t-1}	.285 (.104)	.269 (.067)	.268 (.037) R7
e_{t-1}	.233 (.074)	.250 (.041)	.268 (.037) R7
m_{t-1}	.053 (.019)	.047 (.012)	.040 (.007)
m^*_{t-1}	-.079 (.032)	-.076 (.024)	-.081 (.013)
b_{t-1}	.146 (.032)	.153 (.021) R6	.145 (.019) R6
b^*_{t-1}	-.150 (.047)	-.153(.021) R6	-.145 (.019)R6
q_{t-1}	.207 (.054)	.218 (.038)	.220 (.036)
q^*_{t-1}	-.367 (.068)	-.355 (.059)	-.342 (.056)
constant	-.451 (.461)	-.602 (.285)	-.784 (.222)
T-K	70	81	83
R^2	.9579	.9563	.9557
SEE	.0201	.0191	.0190
$Z_3(4)$	6.38/9.49*	7.14/9.49*	6.42/9.49*
$Z_4(5)$	47.52/11.07*	60.63/11.07*	73.54/11.07*
$Z_5(5,T-K)$	4.71/2.35*	6.52/2.33*	8.05/2.33*
$Z_6(n,T-K)$		0.26/1.93*	0.55/3.11*

See general notes to TABLE 1.

Restrictions: R1($\Delta p^*_{t-1} + \Delta p^*_{t-2}$), R2($\Delta e_{t-1} - \Delta e_{t-2}$),
R3($\Delta m^*_t + \Delta y^*_{t-1}$), R4($\Delta m_t - \Delta b^*_t$), R5($\Delta y_t + \Delta y_{t-1}$),
R6$(b - b^*)_{t-1}$, R7$(p - p^* - e)_{t-1}$.

REFERENCES

Balassa, Bela (1964), The purchasing-power parity doctrine: A reappraisal, Journal of Political Economy 72, 584-596.

Black, Stanley W. (1981), The analysis of floating exchange rates and the choice between crawl and float, in John Williamson (ed.), Exchange rate rules: The theory, performance and prospects of the crawling peg (Macmillan, London).

Branson, William H. (1981) "Comment: The collapse of purchasing power parity during the 1970's," European Economic Review, 16, 167 - 171.

Cassel, Gustav (1922), Money and foreign exchange after 1914, Constable & Co., Ltd., New York.

Bordo, Michael and Lars Jonung (1981), The long run behavior of the income velocity of money in five advanced countries, 1870-1975: An institutional approach, Economic Inquiry 19, 96-116.

Davidson, James E.H., David F. Hendry, Frank Srba and Stephen Yeo (1978), Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom, Economic Journal 88, 661-692.

Desai, Meghnad (1981), Testing monetarism (Frances Pinter, London).

Dornbusch, Rudiger (1976), Expectations and exchange rate dynamics, Journal of Political Economy 84, 1161-1176.

Dornbusch, Rudiger (1978), Monetary policy under exchange-rate flexibility, in Managed exchange-rate flexibility: The recent experience, Federal Reserve Bank of Boston Conference Series no. 20.

Dornbusch, Rudiger and Paul Krugman (1976), Flexible exchange rates in the short run, Brookings Paper on Economic Activity, 537-575.

Edison, Hali J. (1981) Short-run dynamics and long-run equilibrium behaviour in purchasing power parity: A quantitative reassessment, unpublished L.S.E. Ph.D dissertation.

Edison, Hali J. (1981a), Purchasing power parity: A quantitative reassessment of the 1920's experience, International Centre for Economics and Related Disciplines Discussion Paper 81/31.

Edison, Hali J. (1981b), The dollar/pound exchange rate over the century (1890-1978), International Centre for Economics and Related Disciplines Discussion Paper 81/32.

Frenkel, Jacob A. (1976), A monetary approach to the exchange rate: Doctrinal aspects and empirical evidence, Scandinavian Journal of Economics 78, 200-224.

Frenkel, Jacob A. (1978), Purchasing power parity: Doctrinal perspective and evidence from the 1920's, Journal of International Economies, 8, 169 - 191.

Frenkel, Jacob A. (1981) The Collapse of purchasing power parities during the 1970's. European Economic Review, 16, 145-165.

Friedman, Milton (1980), Prices of money and goods across frontiers: the £ and $ over a century, The World Economy 2, 497-511.

Gailliot, Henry J. (1970), Purchasing power parity as an explanation of long-term changes in exchange rates, Journal of Money, Credit, and Banking 2, 348-357.

Genberg, Hans (1978), Purchasing power parity under fixed and flexible exchange rates, Journal of International Economics 8, 247-276.

Hacche, Graham and John Townend (1981), Exchange rates and monetary policy: modelling sterling's effective exchange rate, 1972-80, Oxford Economic Papers 33 (Supplement), 201-247.

Hendry, David F. (1980), Predictive failure and econometric modelling in macroeconomics: The transactions demand for money, in Paul Ormerod (ed.) Economic modelling: Current issues and problems in macroeconomic modelling in the UK and the US (Heinemann, London).

Hsieh, David A. (1982), The determination of the real exchange rate: The productivity approach, Journal of International Economics 12, 355-362.

Katseli-Papaefstratiou, Louka (1979), The re-emergence of the PPP doctrine in the 1970's, Special Papers in International Economics no. 13, International Finance Section, Princeton University.

Keynes, John M. (1930), A treatise on money (Macmillan, London).

Klovland, Jan T. (1983), The demand for money in secular perspective: The case of Norway 1867-1980, European Economic Review, 22, 193-218.

Kravis, Irving B. and Robert E. Lipsey (1978), Price behavior in the light of balance of payments theories, Journal of International Economics 8, 193-246.

Krugman, Paul R. (1978), Purchasing power parity and exchange rates: Another look at the evidence, Journal of International Economics 8, 397-407.

Mizon, Graham E (1977) Model selection procedures in Studies in modern economic analysis edited by Artis, M.J. and A.R. Nobay, (Basil Blackwell, Oxford).

Myhrman, Johan (1976), Experiences of flexible exchange rates in earlier periods: Theories, evidence and a new view, Scandanavian Journal of Economics 78, 169-196.

Niehans, Jürg (1981), Static deviations from purchasing-power parity, Journal of Monetary Economics 7, 57-68.

Officer, Lawrence H. (1976a), The purchasing-power parity theory of exchange rates: A review articale, IMF Staff Papers 23, 1-60.

Officer, Lawrence H. (1976b), The productivity bias in purchasing power parity: An econometric investigation, IMF Staff Papers 23, 545-579.

Officer, Lawrence H. (1980), Effective exchange rates and price ratios over the long run: A test of the purchasing-power-parity theory, Canadian Journal of Economics 13, 206-230.

Samuelson, Paul A. (1964), Theoretical notes on trade problems, Review of Economics and Statistics 46 145-154.

Samuelson, Paul A. (1974), Analytical notes on international real-income measures, Economic Journal 84, 595 - 608.

Tryon, Ralph W. (1978) The French franc in the 1920's, MIT Ph.D., Unpublished.

Footnotes

*The first author is an economist in the International Finance Division of the Board of Governors of the Federal Reserve System and the second author is an associate professor at the Norwegian School of Economic and Business Administration, Bergen Norway. Work on this project was done by the first author while employed at the Centre for Applied Research at the Norwegian School of Economics and Business Administration. We would like to thank Victor D. Norman for his helpful comments. This paper represents the views of the authors and should not be interpreted as representing the views of the Board of Governors of the Federal Reserve System.

1. An outstanding example of this is provided by Frenkel (1976) in his study covering the German hyperinflation. Frenkel (1978) presents further evidence that PPP theory works well in non-hyperinflationery countries during the 1920's. It has been shown, however, that the strict version of PPP does not hold during this time by Krugman (1978) and Edison (1981a), Tryon (1978).

2. See for example Genberg (1978), Dornbusch (1978), Frenkel (1981), Branson (1981) and Desai (1981).

3. Obvious examples are the monetary approach to balance of payments and to the exchange rate.

4. In Edison (1981) Chapter One there is a review of the development of PPP. Cassel (1922) outlined in his Chapter "Deviations from PPP" factors that we associate with k.

5. Over the past century as a whole the United Kingdom has unambiguously been Norway's most important single trading partner, although with a diminishing relative share in the past twenty years.

6. Extensive reviews of the PPP theory from a doctrinal perspective are given by Officer (1976a), Frenkel (1978) and Katseli-Papaefstratiou (1979).

7. This is consistent with all of Cassel's writings.

8. This view is clearly stated in Samuelson (1974, p. 602): "What Gustav Cassel, and Ricardo before him, had in mind in connection with the doctrine of purchasing power parity was something more than the above trivial doctrine of arbitrage among near-transport-free staple commodities. In any case, what they should have had primarily in mind was the homogeneity fact lying at the root of the classical Quantity Theory of Money: namely that a scale change in the nominal prices...would ultimately have no substantive effects on any of the real magnitudes...in a classical determinate system".

9. This argument has been discussed by many writers, including Keynes (1930), but was more fully developed by Balassa (1964) and Samuelson (1964) and recently referred to by Officer (1976b) and Hsieh (1982).

Balassa assumed that prices of traded goods were equalised across countries but that this did not apply to prices of non-traded goods. On the further assumptions of wages in the traded goods sector being linked to productivity and of an equilisation of wages across all industries within a country the price of nontraded relative to traded goods increases more over time in a country with high productivity growth than in a country with low productivity growth. Thus when using general price indices which cover both traded and non traded goods, like the GDP deflator, a productivity bias emerges in PPP comparisons, showing a real exchange rate appreciation for fast growing countries.

10. Between 1913 and 1916 Norway's terms of trade improved by 48 per cent, following a rise in the export price index to 296 (1913 = 100) and a rise in the import price index to 199. A major contributing factor to the rise in export prices was the huge increase in shipping freights, which increased by 390 per cent. By contrast, price indexes of domestic goods, P_D, rose only by 25 per cent to 125, which resulted in an output price index, P_Q, of 188 in 1916. Since the UK price index was 129 and the exchange rate appreciated 8 per cent this led to a sharp real exchange rate appreciation of 37 per cent over these three years. As an empirical matter it appears to be important to allow for such large terms-of-trade changes in the empirical PPP relationship. Note again that this argument crucially depends on our use of an output price deflator as the empirical price measure.

11. If the demand for domestic goods depends positively on both domestic and foreign output, the sign of δ_2 may be ambiguous.

12. Alternatively, we might have split the money stock into an endogenous foreign source component and an exogenous domestic source component and otherwise made the model more similar to, for example, the pegged exchange rate model analyzed by Black (1981). This line was not pursued, partly because of data limitations and partly because of the desire to keep the model simple. A further extension might be to allow for short run adjustments in output in response to changes in aggregate demand along the lines analysed by Dornbusch (1976).

13. In Davidson, et. al. (1978) there is a discussion of ECM models and their properties.

14. Figure 1 may serve as a background for a brief discussion of the history of exchange rate regimes in Norway, which also has implications for which variable is selected as the dependent variable in the regressions. There have been long time periods where the exchange rate between Norway and the UK have been fixed. In particular, during the gold standard, 1873 to 1914, the exchange rate never deviated more than one per cent from mint parity. From the outbreak of World War I to the restoration of the gold standard in May 1928 the exchange rate fluctuated widely. From the final collapse of the gold exchange standard in September 1931 the Norwegian kroner was pegged to the pound sterling or U.S. dollar for forty years with significant adjustments occuring in 1940, 1945 and 1967. Since 1971 the kroner-pound rate has been highly variable partly due to Norway's participation in the snake or currency basket and partly due to the general state of floating exchange rates.

15. Computed on a continuous time basis, i.e., as logarithmic first differences.

16. For Norway, an implicit deflator for GDP at market prices is used since it was the only one available. The use of price deflators for GDP at factor costs might be preferable in the simple PPP model, however, preliminary analysis of the effects of indirect taxes less subsidies showed little influence of this variable.

17. In the process of going from the general model 1A to the more restricted model 1B each individual restriction is tested separately, adjusting the significance level so as not to alter the power of the overall joint test.

18. The various models were also estimated by instrumental variable methods, but the coefficient estimates were little affected, so that only the ordinary least squares estimates are reported here.

19. The direct OLS estimates of the simple static model is P_t = const + $.999p_t^* + .237e_t$. Not surprisingly, however, the Durbin-Watson statistic is 0.17 and $Z_3(4) = 88.4$ indicating that there is a high degree of serial correlation and some type of misspecification.

20. Proponents of the PPP doctrine might argue that our 100 year sample covering two world wars, subperiods of price controls, and restrictions on trade and payments not to mention different exchange rate regimes has too many structural changes to provide a testing ground for PPP. Our main purpose in this paper however, is to model structural factors explicitly rather than attempt to make the PPP relationship well. However, we did test PPP using the simple model over the gold standard era, 1876 to 1913. Since the exchange rate was virtually fixed over this period equation (3) reduced to $\bar{p} = k + \bar{p}^*$. The results showed that the proportionality assumption could not be rejected by the data during this subperiod. There was some evidence using a Chow Test of parameter instability so the evidence is not unambiguous.

21. Models 2A - 2C were also estimated by instrumental variables, treating Δe_t and Δb_t as endogenous variables. Additional instruments were one period lagged growth rates of money, income, interest rate and terms of trade in both countries. Again the qualitative results were the same as OLS estimates.

22. The fiscal policy variables, empirically represented by central government surplus as a percentage of GDP, did not contribute significantly to the explanatory power in some preliminary regressions, and were consequently omitted from the regressions reported here. Thus x_t refers to thhe set of variables $x_t = (m_t, m_t^*, y_t, y_t^*)$.

23. Another disturbing feature of model 4C is the breakdown in the model's predictive ability beyond the estimation conveyed by the high values of Z_4 and Z_5. The source of the collapse in predictive ability is a sizeable underprediction of the domestic inflator in years 1976-1978.

This is a period of excessive exchange rate volatility for the pound sterling as described in Hacche and Townend (1981). We attach some but not too much importance to this finding.

24. A similar result was obtained by Edison (1981b) in testing the PPP relationship between the United Kingdom and the United States over the period 1890-1972 within a monetary model of the exchange rate. The final equation emerging from that study was $\bar{e} = k + \bar{p} - \bar{p}^* - .30(m-m^*)$, which is quite similar to (17) above, apart from the real factors.

25. The United Kingdom was already relatively financially sophisticated at the beginning of the gold standard era, which may be a major explanatory factor of the relative constancy of the velocity of money in the UK over the same period.

26. This is the same variable used in Klovland (1983) to pick up the effects of structural change in the long-run demand for money.

27. Niehans (1981 p. 67).

DATA APPENDIX

to

A QUANTITATIVE REASSESSMENT OF THE PURCHASING POWER PARITY HYPOTHESIS: EVIDENCE FROM NORWAY AND THE UNITED KINGDOM

by

Hali J. Edison

and

Jan Tore Klovland

1. General notes and sources

(a) Norway

The primary sources of data are the various National Accounts (NA) issues published by the Central Bureau of Statistics (CBS) of Norway. Data for all years, except 1940-1945, are derived from the following NA sources: NA 1865-1960, NA 1900-1929, NA 1949-1962 (revised version), NA 1962-1978, NA 1969-1980 and SØS 16 (Trends in Norwegian Economy 1865-1960, Central Bureau of Statistics, Oslo, 1966). Data compiled according to new System of National Accounts are available beginning 1949; data prior to 1949 are spliced with the new series by means of the simple ratio method, i.e., by multiplying the old series by the ratio of new figures to old figures in 1949. Other sources of data than the ones referred to above are listed explictly.

(b) United Kingdom

The national accounts data up to about 1948 are taken from C.H. Feinstein, National Income, Expenditure and Output of the United Kingdom 1855-1965, Cambridge, 1972, and spliced with the corresponding series of Economic Trends, Annual Supplement 1982, which cover most of the post-World War II period. These sources are referred to as Feinstein (table, column). Whenever there is a break in the level of the series, for example because of the inclusion of Southern Ireland in the data prior to 1920, the two series are spliced by the simple ratio method.

2. Notes and sources to data listed in table A1, by column

(1) P(NOR) = implicit deflator for gross domestic product at market prices, 1913 = 100.

From the NA sources listed above. Figures for 1940 to 1945 were interpolated by means of the cost-of-living index and the wholesale price index, each with weight one-half, taken from NOS Historical Statistics 1948.

(2) P(UK) = implicit deflator for gross domestic product at market prices, 1913 = 100

Feinstein (3,5).

(3) E(NOM) = nominal exchange rate, NOK per GBP
1870-1872: Mint parity, 18.15952, assumed. 1873-1877: Averages of buying and selling rates of sterling as quoted by Norges Bank, published in the Annual Reports of the Board of Directors of Norges Bank. 1878-1980: annual averages of quotations at the Oslo Stock Exchange, published in various issues of Statistical Yearbook of Norway for the years up to 1913, thereafter the figures are taken from Historical Statistics 1948 and 1978 and from Penger og Kreditt.

(4) E(REAL) = real exchange rate, NOK against GBP
Computed as E(NOM)*P(UK)/P(NOR) on the basis of data listed in cols. (1) to (3).

(5) M(NOR) = money stock per capita
The money stock consists of currency, demand deposits and time deposits (including savings deposits) at commercial banks, savings banks, the Postal Savings Bank and the Postal Giro System held by the non-bank public. Blocked deposits and deposits in foreign currency are excluded. Annual averages of end-of-month data; prior to 1919 primary sources of deposit figures are on a quarterly or annual basis. Further details are given in J.T. Klovland, Quantitative Studies in the Monetary History of Norway, part I and Appendix A, mimeo Norwegian School of Economics and Business Administration, 1979. The series is converted to per capita figures by division by an index of total mid-year population, 1913 = 100, complied from various issues of Historical Statistics and Statistical Yearbook.

(6) M(UK) = money stock per capita
1870-1897: M_2 series in Michael D. Bordo, The U.K. Money Supply. 1870-1914, in Research in Economic History, vol. 6, plus an estimate of private deposits at Bank of England, from David K. Sheppard, The growth and role of U.K. financial institutions 1880-1962, London, 1971, table A3.3, col. 3 (figures for 1870-1879 assumed to be equal to the 1880 figure). 1898-1965: net money supply series from Sheppard, op. cit., table A3.3, col. 6. 1966-1980: M3, unadjusted figures from various issues of Financial Statistics.

Annual averages of the end-of-year figures compiled from these sources, after adjusting for the level shift in 1920, were then divided by an index of mid-year home population, 1913 = 100, derived from Feinstein (55.1) for the years up to 1950, thereafter from Annual Abstracts of Statistics, 1982. The population data 1940-1950 are net of armed forces abroad, which were interpolated along a straight line between 1939 and 1950.

(7) Y(NOR) = per capita gross domestic product at constant market prices
Gross domestic product at constant (1975) market prices, divided by the index of total mid-year population as in col. 5. Estimates of nominal GDP for 1940 to 1944 were based on data in O. Aukrust and P.J. Bjerve, Hva krigen kostet Norge, Oslo, 1945; the estimate for 1945 is taken from SØS 12, The Norwegian post-war economy, Oslo, 1965, p. 304. These estimates for the years 1940-1945, which are likely to be subject to substantial errors, were than deflated by the price index described in col. 2 and chained with the official national accounts series.

(8) Y(UK) = per capita gross domestic product at constant market prices
Gross domestic product at constant (1975) market prices, from Feinstein (5,8) and Economic Trends, 1982, divided by the index of mid-year population as described in col. 6.

(9) Q(NOR) = index of output per worker, 1913 = 100
Real GDP, as in col. 7, divided by estimates of total employment. The figures for 1940-1945 are set equal to the 1939 figure since no estimates are available. Estimates of employment are derived as follows: 1870-1899: Data on total labour force for every fifth year from SØS 16, interpolated by means of annual figures on population of working age (18-64 years) from NOS Folkemengdens bevegelse 1911-1920. 1900-1929: Estimates of total employment in man-years from Aukrust and J. Bjerke, Real capital and economic growth, ART 4, Central Bureau of Statistics, 1958. 1930-1939 and 1946-1980: Employment in full-time equivalent man-years from NOS National Accounts.

(10) Q(UK) = index of output per worker, 1913 = 100
Output per worker as calculated in Feinstein (20.5) up to 1960; thereafter output per person employed from Economic Trends, 1982.

(11) B(NOR) = terms of trade, 1913 = 100
Ratio of implicit deflator for total exports to implicit deflator for total imports from NOS National Accounts. Figures for 1940-1945 were derived from export and import price indexes given in NOS Economic Surveys.

(12) B(UK) = terms of trade, 1913 = 100
1870-1965: Ratio of implicit deflator for exports of goods and services, Feinstein (61, 4), to implicit deflator for imports of goods and services, Feinstein (61,6); thereafter corresponding series from Economic Trends 1982.

(13) R(NOR) = long-term bond yield
Yield to average life (15 years or more) on long-term state bank bonds (Kongeriget Norges Hypotebank) 1870-1946 and on government bonds 1947-1980. A detailed account of the construction of the series is given in J.T. Klovland, Quantitative Studies in the Monetary History of Norway, part II and Appendix B, mimeo, Norwegian School of Economics and Business Administration, 1980. Data for 1979 and 1980 are taken from International Financial Statistics.

(14) R(UK) = long-term bond yield
Consol yield. 1870-1872: Sheppard, op. cit., table A3.7 col. II. 1873-1913: C. Knick Harley, The interest rate and prices in Britain, 1873-1913: A study of the Gibson Paradox, Explorations in Economic History 14 (1977), pp. 69-89. 1914-1975: S. Homer, A history of interest rates, New Brunswick, 1977, table 57. 1976-1980: Financial Statistics.

(15) V(NOR)= indirect taxes less price subsidies as a percentage of GDP
(a) Indirect taxes and customs duty. 1865-1900: SØS 16. 1901-1939 and 1946-1966: NA 1900-1929, NA 1865-1960 and NA 1953-1969. 1940-1945: Interpolated by figures on taxes paid to central government on trade and production, from *Historical Statistics* 1968. 1967-1980: Indirect taxes less (i) tax on production of crude petroleum and natural gas, (ii) surplus of Norwegian Pools Limited and (iii) taxes not levied on commodities, from NA 1962-1978 and NA 1970-1981.
(b) Price subsidies. 1870-1912: Assumed to be nil. 1913-1929: Government expenses on cost-of-living allowances, from NOS *Den norske statskasses finanser* 1905-1933. 1930-1939 and 1946-1960: Price subsidies paid by central government, from NA 1865-1960. 1940-1945: Government expenses on price regulation and supply & commodities, from NOS *Economic Survey* 1967. 1967-1980: Subsidies related to commodities including price subsidies on milk, grain and flour, refunds of customs duties to shipyards and subsidies from the funds of customs duties to shipyards and subsidies from the funds of the Price Control Directorate, from NA 1962-1978 and NA 1970-1981.
(c) Gross domestic product. See notes to cols. 1 and 7.

(16) V(UK) = (logarithm of) the ratio of implicit deflators for GDP at market prices to GDP at factor cost with 1975 as base year
(a) Implicit deflator for GDP at market prices. See notes to col 2.
(b) Implicit deflator for GDP at factor cost. Derived from Feinstein (3,9) and (5,12) and *Economic Trends* 1982.

(17) F(NOR) = government surplus as a percentage of GDP
Current surplus of central government and social security exclusive of (i) transfers to and from abroad, (ii) taxes on petroleum and natural gas production. This series was then related to GDP exclusive of crude petroleum and natural gas production and oil well drilling. From NA sources, data for (1940-1945 estimated on basis of figures on government current account in *Historical Statistics* 1968.

(18) F(UK) = government surplus as a percentage of GDP
Current surplus of central government and National Insurance Fund exclusive of current grants to/from abroad. 1870-1899: Approximated by figures on gross public income and gross public expenditure in B.R. Mitchell and P. Deane, *Abstract of British Historical Statistics*, Cambridge, 1962, pp. 394-398. 1900-1965: Feinstein (12, 16), (12, 6) and (12, 14). 1966-1980: *Financial Statistics.*

(19) A(NOR) = net income from foreign investments in constant U.S. dollars
Computed as NIA/(EXNOKUSD x PUS).
(a) NIA = net income from foreign investments. NA sources, figures for 1940-1945 interpolated along a straight line.
(b) EXNOKUSD = exchange rate, NOK per USD. 1870-1914: Estimated as EXNOKGBP/EXUSDGBP. See notes to cols. 3 and 20. 1915-1980: Market rates at Oslo Stock Exchange from *Historical Statistics* 1948 and 1978 and various issues of *Historical Statistics* 1948 and 1978 and various isssues of *Penger og kreditt*.
(c) PUS = implicit deflator for U.S. net national product, 1920 = 100, as

computed by M. Friedman and A.J. Schwartz, Monetary trends in the United States and the United Kingdom, Chicago, 1982, table 4,8, for the years 1870-1975; thereafter from Economic Report of the President, Washington, 1982.

(20) A(UK) = net property income from abroad in constant U.S. dollars
Computed as (NIA x EXUSDGBP)/PUS.
(a) NIA = net property income from abroad 1870-1945: Feinstein (1,10); thereafter from Economic Trends 1982.
(b) EXUSDGBP = exchange rate, USD per GBP. Same sources as col. 19, item c.
(c) PUS see col. 19, item c.

TABLE A1. ANNUAL DATA. NORWAY AND UNITED KINGDOM. 1870-1917

DATE	P NOR *(1)*	P UK *(2)*	E NOM *(3)*	E REAL *(4)*	M NOR *(5)*	M UK *(6)*	Y NOR *(7)*	Y UK *(8)*	Q NOR *(9)*	Q UK *(10)*
1870	74.06	95.06	18.16	23.31	2.09		10.12	238.48	55.78	67.40
1871	75.47	97.45	18.16	23.45	2.28	7.54	10.24	250.87	56.23	69.00
1872	80.69	102.88	18.16	23.15	2.47	8.32	10.84	246.45	59.25	68.30
1873	89.78	106.18	18.12	21.43	2.76	8.75	11.03	243.06	59.85	69.50
1874	93.78	103.03	18.12	19.90	3.08	8.90	11.34	254.66	61.06	70.50
1875	89.00	99.11	18.18	20.25	3.04	9.02	11.53	255.15	61.78	72.10
1876	89.59	97.07	18.13	19.64	3.04	8.91	11.70	255.24	62.65	73.30
1877	88.69	94.54	18.16	19.36	3.12	8.69	11.65	255.02	62.04	74.20
1878	81.42	93.26	18.21	20.86	3.00	8.30	11.09	253.54	58.87	75.40
1879	75.68	89.07	18.17	21.39	2.95	7.97	11.04	245.64	58.68	78.90
1880	79.73	92.48	18.13	21.03	3.14	8.02	11.29	262.63	60.43	76.00
1881	81.08	90.82	18.19	20.37	3.30	8.11	11.37	259.69	61.21	77.50
1882	83.55	92.18	18.19	20.07	3.50	8.23	11.37	261.56	61.44	78.00
1883	82.74	91.26	18.17	20.05	3.68	8.31	11.33	271.07	61.25	77.90
1884	78.15	88.80	18.17	20.65	3.77	8.31	11.48	266.34	62.12	81.90
1885	72.92	86.60	18.19	21.61	3.75	8.23	11.49	262.49	62.62	81.60
1886	71.26	85.42	18.14	21.75	3.72	8.00	11.47	262.02	62.74	82.90
1887	69.51	85.77	18.14	22.39	3.74	7.78	11.55	271.86	63.67	83.00
1888	71.55	85.55	18.15	21.70	3.87	7.80	12.05	274.02	66.84	83.50
1889	74.71	86.77	18.17	21.10	4.13	7.92	12.46	276.96	69.14	84.60
1890	73.67	88.45	18.18	21.83	4.29	8.05	12.72	277.77	70.66	84.20
1891	75.03	87.94	18.15	21.28	4.27	8.25	12.74	285.52	70.99	84.50
1892	73.35	87.90	18.14	21.74	4.27	8.36	12.90	277.68	71.97	83.90
1893	72.35	87.47	18.16	21.95	4.40	8.30	13.17	273.35	73.54	84.00
1894	72.54	86.33	18.13	21.58	4.51	8.52	13.13	285.27	72.86	88.10
1895	73.07	85.52	18.16	21.26	4.74	8.87	13.12	290.96	72.56	88.80
1896	74.72	85.30	18.16	20.73	4.92	9.12	13.31	301.75	73.40	89.20
1897	74.53	86.25	18.14	20.99	5.25	9.30	13.82	299.51	75.84	89.30
1898	80.27	86.59	18.19	19.63	5.69	9.41	13.73	313.60	75.22	92.10
1899	83.10	88.04	18.22	19.31	5.95	9.55	13.95	327.76	76.15	94.10
1900	85.91	93.79	18.24	19.91	6.36	9.76	13.96	319.59	76.62	92.80
1901	82.78	93.40	18.17	20.50	6.86	9.79	14.15	329.10	77.73	92.50
1902	80.56	92.22	18.19	20.82	7.06	9.69	14.24	327.60	78.44	94.60
1903	80.55	92.03	18.20	20.79	7.27	9.60	14.08	324.87	77.72	93.50
1904	80.40	92.25	18.18	20.86	7.50	9.48	14.04	324.17	77.63	94.50
1905	81.57	92.74	18.18	20.67	7.62	9.51	14.08	326.75	77.99	95.50
1906	84.13	93.14	18.21	20.17	8.13	9.63	14.60	331.10	80.98	96.40
1907	85.91	94.83	18.27	20.16	8.79	9.75	15.17	328.88	84.24	97.40
1908	85.51	94.73	18.21	20.17	9.18	9.79	15.54	314.58	86.50	96.80
1909	84.78	94.55	18.20	20.30	9.68	9.85	15.73	322.03	87.52	98.00
1910	88.80	95.23	18.21	19.53	10.22	10.04	16.27	330.24	90.76	97.20
1911	91.12	96.51	18.20	19.28	10.82	10.36	16.78	335.33	93.04	97.40
1912	95.37	99.41	18.23	19.00	11.48	10.69	17.44	333.04	96.31	98.40
1913	100.00	100.00	18.24	18.24	12.37	11.05	18.21	348.77	100.00	100.00
1914	101.25	100.67	18.47	18.36	13.44	11.80	18.39	348.38	100.29	101.30
1915	131.09	112.46	18.42	15.80	15.36	13.01	19.01	380.98	103.10	106.00
1916	188.35	128.71	16.78	11.47	21.95	14.57	19.55	379.04	105.47	106.80
1917	240.31	161.97	15.79	10.64	30.70	17.07	17.57	380.09	94.35	107.00

TABLE A1. ANNUAL DATA. NORWAY AND UNITED KINGDOM. 1870-1917

DATE	I	B NOR *(11)*	B UK *(12)*	R NOR *(13)*	R UK *(14)*	V NOR *(15)*	V UK *(16)*	F NOR *(17)*	F UK *(18)*	A NOR *(19)*	A UK *(20)*
1870	I	87.02	90.50	5.00	3.24	4.23	-6.40	0.40	0.61	-0.02	2.86
1871	I	91.15	95.10	4.87	3.23	4.08	-6.70	0.39	0.03	-0.02	3.06
1872	I	81.15	97.60	4.60	3.24	3.93	-7.10	0.85	0.26	-0.01	3.66
1873	I	90.29	100.40	4.50	3.28	3.60	-7.40	0.90	0.47	-0.01	4.38
1874	I	90.77	97.50	4.50	3.28	3.59	-7.40	0.97	0.07	-0.01	4.79
1875	I	86.15	97.00	4.64	3.24	3.97	-7.20	0.57	0.05	-0.02	5.15
1876	I	93.08	92.70	4.94	3.16	3.83	-7.00	0.55	0.06	-0.02	5.15
1877	I	93.85	88.30	4.98	3.14	4.11	-6.70	0.55	0.09	-0.02	4.82
1878	I	97.60	90.60	5.14	3.15	4.80	-6.50	0.93	-0.15	-0.03	5.01
1879	I	94.04	90.20	4.87	3.08	4.79	-6.40	0.16	-0.14	-0.03	5.23
1880	I	91.64	89.10	4.53	3.05	4.70	-6.70	0.45	-0.64	-0.03	4.90
1881	I	94.23	86.60	4.50	2.90	4.43	-6.40	0.30	0.10	-0.02	5.08
1882	I	101.92	88.90	4.51	2.94	4.74	-6.20	0.43	0.05	-0.02	5.29
1883	I	105.48	87.90	4.50	2.83	4.81	-6.30	0.44	0.02	-0.02	5.41
1884	I	99.81	89.10	4.29	2.72	4.85	-6.10	0.45	0.06	-0.02	5.98
1885	I	96.54	90.50	4.07	2.85	5.31	-5.90	0.48	-0.04	-0.02	6.70
1886	I	94.81	91.90	3.97	2.81	5.24	-5.80	0.16	-0.21	-0.01	7.19
1887	I	95.39	93.60	3.74	2.72	5.30	-5.90	0.00	0.06	-0.01	7.59
1888	I	98.75	90.50	3.65	2.62	4.92	-5.80	0.00	0.23	0.01	7.96
1889	I	100.96	91.30	3.53	2.63	4.82	-5.80	0.28	0.25	0.01	8.39
1890	I	93.75	95.40	3.62	2.67	5.04	-6.00	0.56	0.29	0.01	9.01
1891	I	89.90	94.10	3.88	2.68	4.90	-6.00	0.55	0.21	0.01	9.10
1892	I	89.42	93.70	3.99	2.65	4.92	-6.00	0.41	0.18	0.00	9.59
1893	I	90.48	95.20	4.00	2.60	4.73	-5.90	0.13	0.13	0.00	9.35
1894	I	99.04	96.60	3.74	2.55	4.82	-5.70	0.00	-0.01	-0.01	9.78
1895	I	103.85	96.10	3.62	2.29	4.86	-5.40	-0.39	0.06	-0.02	10.07
1896	I	107.89	96.40	3.65	2.06	5.12	-5.30	-0.87	0.28	-0.03	10.55
1897	I	105.58	95.70	3.73	1.96	5.47	-5.40	-0.36	0.16	-0.05	10.59
1898	I	109.14	95.60	3.80	2.00	5.69	-5.50	0.11	0.23	-0.05	10.68
1899	I	107.50	97.20	4.10	2.18	5.74	-5.50	0.21	0.01	-0.07	10.65
1900	I	107.69	102.50	4.36	2.53	5.39	-5.60	0.00	-3.29	-0.09	10.22
1901	I	100.86	101.40	4.28	2.67	5.56	-5.30	0.20	-3.23	-0.12	10.49
1902	I	96.73	98.90	4.04	2.66	5.62	-4.70	0.30	-1.86	-0.12	10.42
1903	I	100.10	97.40	3.96	2.75	5.56	-4.60	0.40	-0.83	-0.11	10.59
1904	I	99.23	98.00	3.96	2.84	5.36	-4.40	0.30	-0.57	-0.13	10.53
1905	I	99.23	97.90	3.99	2.78	5.24	-4.40	0.39	-0.25	-0.13	11.21
1906	I	98.08	98.70	3.99	2.83	5.34	-4.60	0.92	-0.24	-0.13	11.94
1907	I	94.33	99.30	4.05	2.97	5.35	-4.60	1.21	0.05	-0.12	12.34
1908	I	90.19	99.00	4.18	2.91	5.46	-4.80	1.18	-0.30	-0.12	12.97
1909	I	90.29	95.40	4.13	2.98	5.48	-4.60	1.00	-0.92	-0.11	13.12
1910	I	96.15	94.30	4.16	3.09	5.33	-4.20	0.91	-0.37	-0.08	13.75
1911	I	95.77	97.60	4.22	3.15	5.21	-4.30	1.14	-0.49	-0.10	14.43
1912	I	95.96	97.60	4.40	3.28	5.01	-4.40	0.78	-0.13	-0.09	14.62
1913	I	100.00	100.00	4.59	3.40	4.82	-4.60	0.77	0.00	-0.08	15.56
1914	I	96.44	100.20	4.73	3.46	4.89	-4.60	0.45	-5.11	-0.07	14.75
1915	I	119.33	106.50	5.48	3.82	3.96	-3.80	0.42	-26.48	-0.06	11.98
1916	I	148.46	96.90	5.56	4.31	3.02	-3.50	1.02	-28.05	-0.04	12.88
1917	I	125.96	113.80	5.31	4.58	1.90	-5.70	0.61	-36.11	-0.05	10.16

TABLE A1. ANNUAL DATA. NORWAY AND UNITED KINGDOM. 1918-1965

DATE	P NOR *(1)*	P UK *(2)*	E NOM *(3)*	E REAL *(4)*	M NOR *(5)*	M UK *(6)*	Y NOR *(7)*	Y UK *(8)*	Q NOR *(9)*	Q UK *(10)*
1918	281.52	190.59	15.59	10.55	40.58	20.37	16.67	373.64	89.08	107.00
1919	294.96	222.48	18.12	13.67	45.12	24.09	19.36	341.32	102.84	96.80
1920	335.09	265.93	22.49	17.85	48.68	26.68	20.38	316.49	107.40	91.40
1921	269.54	242.39	26.14	23.51	49.59	27.06	18.18	295.63	105.31	95.10
1922	222.50	208.86	25.40	23.84	48.99	25.82	19.93	303.91	115.06	100.20
1923	217.38	194.04	27.59	24.63	42.80	24.53	20.33	311.69	112.45	102.10
1924	242.67	189.86	31.71	24.81	39.91	23.95	20.20	318.73	110.35	104.80
1925	230.94	190.06	27.46	22.60	37.98	23.69	21.31	333.53	119.94	108.60
1926	187.67	188.65	21.95	22.07	36.13	23.67	21.50	316.87	130.16	104.60
1927	164.17	185.05	18.68	21.06	34.19	23.95	22.22	337.81	135.21	109.80
1928	157.36	183.73	18.23	21.29	31.27	24.37	23.11	342.19	134.42	110.70
1929	147.99	182.14	18.20	22.40	30.68	24.43	25.20	349.54	142.54	112.40
1930	138.64	180.76	18.17	23.69	30.38	24.52	26.98	347.62	153.42	113.70
1931	132.00	177.18	18.10	24.29	29.73	24.05	24.73	328.45	145.30	110.40
1932	126.40	173.28	19.46	26.68	28.00	24.51	25.80	327.55	149.08	110.80
1933	123.44	170.66	19.74	27.30	27.32	25.66	26.29	329.95	151.30	111.80
1934	125.46	169.42	19.90	26.87	26.05	25.69	27.07	351.14	153.58	115.80
1935	128.14	170.82	19.90	26.53	26.29	26.46	28.27	362.74	158.28	118.00
1936	133.46	172.10	19.90	25.66	26.22	27.97	30.03	372.37	164.13	119.60
1937	147.04	178.00	19.90	24.09	26.58	29.08	31.20	386.52	167.26	119.90
1938	150.15	182.09	19.90	24.13	28.24	28.94	31.72	396.30	168.23	120.90
1939	153.72	187.38	19.11	23.29	28.60	29.17	33.04	409.51	172.99	117.40
1940	191.62	206.73	17.41	18.78	30.96	31.78	28.20	466.43	172.99	124.70
1941	230.40	228.93	17.75	17.64	39.33	36.75	29.80	494.80	172.99	130.90
1942	245.18	246.18	17.75	17.82	49.14	41.79	27.84	498.00	172.99	129.80
1943	250.64	257.26	17.75	18.22	58.55	46.58	26.78	503.30	172.99	131.60
1944	255.25	271.17	17.75	18.86	68.51	52.53	25.61	478.46	172.99	128.00
1945	258.57	276.63	19.22	20.56	71.63	57.89	22.53	447.46	172.99	124.80
1946	256.37	281.90	20.03	22.03	69.55	64.34	32.26	444.66	176.60	125.70
1947	265.72	308.92	20.02	23.27	75.53	69.62	36.20	431.43	196.85	123.30
1948	272.30	330.65	20.02	24.31	80.36	70.78	38.28	438.24	208.04	127.50
1949	284.54	339.17	20.02	23.86	81.40	70.84	38.89	448.72	210.06	132.00
1950	298.81	343.64	20.02	23.02	83.35	71.24	40.49	460.61	218.86	135.00
1951	353.54	370.02	20.02	20.95	85.86	71.70	42.21	476.02	230.62	137.40
1952	377.02	402.39	20.02	21.37	93.95	72.26	43.31	473.55	237.55	137.20
1953	365.28	414.29	20.02	22.71	97.78	74.25	44.86	493.76	249.22	141.80
1954	377.58	420.76	20.02	22.31	102.60	76.95	46.62	510.91	258.06	145.30
1955	394.53	436.24	20.02	22.13	103.67	76.99	47.06	528.61	262.26	148.90
1956	424.01	463.88	20.00	21.88	105.88	75.93	49.06	534.97	276.81	149.70
1957	438.89	481.21	20.00	21.92	110.53	77.52	50.02	542.74	284.21	152.40
1958	442.24	500.90	20.01	22.67	112.01	79.87	49.13	540.85	285.71	153.60
1959	445.85	507.30	20.03	22.79	115.89	82.94	51.22	558.94	299.32	158.70
1960	450.28	513.78	20.03	22.86	121.57	85.28	53.73	580.50	314.90	165.00
1961	462.19	531.04	20.02	23.00	127.71	86.18	56.65	594.99	329.48	165.90
1962	484.23	551.53	20.04	22.83	134.87	87.48	57.78	594.79	336.85	167.50
1963	500.65	563.72	20.02	22.55	142.15	89.96	59.51	615.72	344.79	172.80
1964	524.29	584.15	19.99	22.27	152.06	93.62	62.02	644.26	358.61	180.80
1965	549.32	613.46	20.00	22.33	161.98	99.21	64.80	655.44	373.98	184.20

TABLE A1. ANNUAL DATA. NORWAY AND UNITED KINGDOM. 1918-1965

DATE	B NOR *(11)*	B UK *(12)*	R NOR *(13)*	R UK *(14)*	V NOR *(15)*	V UK *(16)*	F NOR *(17)*	F UK *(18)*	A NOR *(19)*	A UK *(20)*
1918	112.50	115.70	5.84	4.40	0.56	-4.80	-0.54	-26.96	-0.06	7.93
1919	132.98	115.60	6.13	4.62	1.43	-5.70	-0.09	-8.14	-0.05	6.84
1920	106.73	126.10	7.29	5.32	0.38	-6.40	-0.41	0.97	-0.03	7.41
1921	79.33	130.20	5.83	5.21	2.21	-4.40	-2.13	-0.54	-0.05	6.61
1922	90.67	123.30	4.79	4.43	3.16	-1.90	-3.33	0.39	-0.08	7.95
1923	93.65	119.50	5.16	4.31	3.82	-0.90	-3.06	0.84	-0.08	7.98
1924	93.65	115.00	5.76	4.39	3.88	-1.60	-1.37	-0.18	-0.09	8.69
1925	91.73	111.60	5.52	4.43	4.09	-1.80	-0.19	-0.56	-0.11	11.03
1926	90.19	116.60	5.26	4.55	4.82	-1.10	0.47	-1.54	-0.11	11.28
1927	88.56	116.40	5.16	4.56	5.49	-0.60	0.67	-0.65	-0.16	11.69
1928	88.27	113.90	5.31	4.47	5.56	-0.30	0.59	-0.49	-0.19	11.67
1929	87.31	113.10	5.33	4.60	5.33	-0.80	0.35	-1.09	-0.18	11.80
1930	85.77	120.70	5.12	4.46	5.89	-1.20	0.55	-1.97	-0.20	10.95
1931	88.56	132.10	4.90	4.53	6.51	-0.70	0.14	-2.24	-0.21	8.80
1932	79.04	133.60	4.98	3.76	6.53	0.70	0.28	-0.58	-0.21	5.99
1933	79.23	135.30	4.65	3.38	6.84	0.50	1.07	-0.54	-0.23	8.90
1934	80.29	133.60	4.59	3.08	6.87	0.60	1.26	-0.20	-0.23	10.77
1935	82.11	132.90	4.26	2.89	7.06	0.40	1.45	-0.91	-0.22	11.51
1936	83.27	130.70	4.61	2.94	7.32	0.70	1.71	-0.89	-0.23	12.07
1937	88.65	131.00	4.43	3.28	7.16	0.40	2.03	-1.13	-0.20	12.51
1938	86.73	134.50	3.67	3.38	7.16	0.00	1.89	-2.59	-0.18	11.65
1939	84.52	134.50	4.39	3.72	6.99	0.40	1.80	-7.65	-0.16	9.15
1940	73.17	121.70	5.39	3.40	8.79	2.00	-0.55	-25.06	-0.15	7.81
1941	62.11	124.20	3.64	3.13	8.79	3.50	-4.56	-26.90	-0.13	6.47
1942	64.61	133.70	3.32	3.03	8.79	3.80	-6.40	-25.89	-0.11	4.09
1943	59.23	132.20	3.19	3.10	8.79	3.80	-6.37	-24.35	-0.09	3.25
1944	62.60	134.10	3.10	3.14	8.79	3.20	-2.42	-23.94	-0.08	2.69
1945	80.67	130.60	3.14	2.92	8.79	2.20	0.24	-18.19	-0.07	2.57
1946	99.33	128.90	2.37	2.60	8.79	2.20	-0.17	-3.29	-0.06	2.71
1947	90.39	122.60	2.48	2.76	8.50	2.80	3.31	1.96	-0.07	4.42
1948	82.40	119.70	2.46	3.21	5.73	2.80	3.60	4.66	-0.09	6.51
1949	80.77	119.30	2.45	3.30	5.98	2.40	2.78	5.08	-0.08	5.62
1950	78.27	110.70	2.66	3.55	7.30	3.00	3.99	5.50	-0.08	7.57
1951	87.50	103.60	3.02	3.79	9.21	3.20	5.44	4.41	-0.09	6.13
1952	84.14	110.70	3.02	4.23	9.89	2.90	4.58	1.85	-0.07	4.45
1953	75.96	115.70	3.01	4.08	9.52	2.90	2.18	0.98	-0.08	4.02
1954	75.00	114.40	3.02	3.76	9.44	2.50	1.82	1.42	-0.10	4.32
1955	79.04	114.10	4.03	4.17	9.51	2.70	2.69	2.75	-0.14	2.92
1956	84.23	118.80	4.53	4.74	9.63	2.80	3.27	2.23	-0.16	3.75
1957	82.31	119.00	4.56	4.98	9.63	2.50	4.50	2.65	-0.17	3.94
1958	75.86	124.00	4.66	4.98	10.50	1.90	4.38	3.04	-0.21	4.60
1959	76.06	124.40	4.58	4.82	10.82	1.50	3.31	2.38	-0.21	4.02
1960	75.48	123.10	4.48	5.40	10.49	1.00	3.05	1.16	-0.24	3.51
1961	75.19	124.70	4.66	6.20	10.83	1.00	3.37	1.78	-0.25	3.78
1962	75.39	126.20	4.66	5.98	11.22	1.50	3.17	2.77	-0.28	4.88
1963	74.61	124.90	4.55	5.58	10.70	1.40	2.67	1.23	-0.33	5.71
1964	77.69	122.20	4.58	6.03	11.41	2.00	2.83	1.99	-0.37	5.54
1965	78.85	123.50	4.75	6.42	11.50	2.90	2.44	3.00	-0.39	5.99

TABLE A1. ANNUAL DATA. NORWAY AND UNITED KINGDOM. 1966-1980

DATE	P NOR *(1)*	P UK *(2)*	E NOM *(3)*	E REAL *(4)*	M NOR *(5)*	M UK *(6)*	Y NOR *(7)*	Y UK *(8)*	Q NOR *(9)*	Q UK *(10)*
1966	571.21	641.35	19.98	22.43	174.62	104.17	66.70	665.52	385.53	186.60
1967	588.12	660.09	19.46	21.84	188.92	111.06	70.27	679.32	404.23	192.40
1968	614.14	686.94	17.11	19.14	203.06	120.39	71.24	704.33	410.63	201.60
1969	639.93	725.28	17.09	19.37	220.93	126.06	73.83	711.67	426.63	205.60
1970	721.93	777.81	17.13	18.45	244.26	133.71	74.79	725.60	429.70	210.00
1971	770.08	849.54	17.17	18.94	279.91	148.38	77.70	742.81	446.35	216.50
1972	808.63	919.39	16.48	18.74	312.92	178.75	81.09	757.34	467.38	222.50
1973	882.87	984.05	14.12	15.73	345.13	227.65	83.84	812.28	484.64	230.60
1974	973.40	1131.39	12.95	15.05	378.78	271.25	87.65	803.98	502.83	225.90
1975	1071.12	1435.86	11.60	15.54	428.42	298.40	90.80	799.91	522.57	223.00
1976	1151.22	1646.12	9.88	14.13	496.17	326.82	96.53	829.31	548.75	228.80
1977	1247.03	1876.57	9.32	14.02	583.03	361.33	99.56	840.35	557.00	234.10
1978	1327.05	2081.28	10.08	15.80	651.53	406.62	103.69	868.47	576.14	240.40
1979	1414.86	2393.98	10.76	18.21	734.10	461.32	108.57	879.89	600.34	244.40
1980	1617.18	2846.16	11.51	20.27	818.14	533.21	112.46	866.98	612.88	242.40

DATE	B NOR *(11)*	B UK *(12)*	R NOR *(13)*	R UK *(14)*	V NOR *(15)*	V UK *(16)*	F NOR *(17)*	F UK *(18)*	A NOR *(19)*	A UK *(20)*
1966	79.33	125.20	4.78	6.80	11.88	3.50	3.43	3.72	-0.42	5.16
1967	81.06	126.70	4.76	6.69	11.97	3.60	3.97	3.06	-0.45	4.81
1968	84.42	123.20	4.74	7.39	11.42	4.70	3.98	4.19	-0.42	3.54
1969	81.92	122.90	5.09	8.88	12.16	6.50	3.92	6.56	-0.33	5.03
1970	85.58	124.90	5.98	9.16	14.21	6.10	3.32	7.55	-0.35	5.32
1971	85.77	126.20	6.10	9.05	14.51	4.70	4.98	5.56	-0.41	4.66
1972	82.11	128.10	6.09	9.11	14.40	2.70	4.82	2.45	-0.56	4.81
1973	84.23	116.50	6.13	10.85	14.08	1.80	6.37	1.92	-0.69	10.31
1974	83.27	102.40	6.95	14.95	13.49	0.20	4.94	0.75	-1.04	10.29
1975	79.14	108.30	7.19	14.66	13.68	0.00	4.34	-1.00	-1.05	4.96
1976	75.19	105.90	7.27	14.25	13.72	0.60	0.57	-1.12	-1.53	1.81
1977	72.89	107.10	7.50	12.32	14.41	2.10	-1.45	0.18	-2.30	0.47
1978	72.21	111.90	8.57	11.92	13.11	1.60	-2.88	-0.65	-3.30	2.74
1979	75.96	117.00	8.43	11.38	13.03	3.10	-3.12	0.21	-4.09	4.00
1980	83.17	121.30	10.23	11.86	12.51	3.80	-3.03	-0.24	-3.96	-0.18