Unemployment in Britain: Some more Questions

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Recent time series evidence favouring a supply-side interpretation of long-run unemployment in the UK is based on the finding of cointegration between unemployment and wage pressure variables. We show that this is necessary but not sufficient. The key assumptions in recent work, that a single relation exists between unemployment and wage pressure variables and that the causality is from these variables to unemployment, both appear to be invalid. In the light of this, and evidence of its serious parameter instability, this model of long-run UK unemployment seems flawed.

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"Yet in practice, there seems to be no problem in finding wage pressure variables which explain long-run movements in log u, at least for Britain"

(Nickell (1998)).

1. Introduction.

Many recent time time-series empirical tests of the view that labour supply factors play a crucial role in determining long-term unemployment have used reduced- form unemployment equations. A clear and representative example is found in Nickell (1998) and is shown as equation (1).

$$\ln u = \alpha_0 + \alpha_1 TT + \alpha_2 Skill + \alpha_3 T + \alpha_4 RR + \alpha_5 UP + \alpha_6 IT + \alpha_7 r \qquad (1)$$

Here ln u is the natural logarithm of the unemployment rate, TT a terms of trade variable, *Skill* is a measure of skill shortage, T is the tax wedge, RR the replacement ratio, UP a measure of union power, IT is an index of industrial turbulence, and r is the real interest rate. Fuller definitions of these are given in an Appendix A. Equation (1) is a reduced form of a simple macroeconomic model of the labour market, versions of which date back to Layard, Nickell and Jackman (1991). Following the notation and definitions in the most recent version (Nickell, 1998) the basic equations are a price equation based on mark-up pricing,

$$p - w = z_p - \beta_2 (p - p^e) \qquad (2)$$

and a wage equation derived from union-firm bargaining,

$$w = \gamma_2 p^e + (1 - \gamma_2) p - \gamma_1 \ln u - \gamma_{11} \Delta \ln u + z_w \qquad (3)$$

Solving these two equations for ln u, and ignoring the price surprise terms gives a lagged equation in ln u dependant on exogenous wage and price pressure variables (z_p, z_w)[1],

[1] See Nickell (1998) for reasons for using unemployment in log form.

$$\ln u = \frac{\gamma_{11}}{\gamma} \ln u_{-1} + \frac{z_p + z_w}{\gamma} \tag{4}$$

It is the long-run part of this equation, especially that between ln *u* and z_w, which concerns us in the rest of this note. Thus, equation (1) is the implied long-run relationship between *ln u* and a particular set of z_w variables, and it is this which matters from here on.

2. The Background.

2.1. The Econometric Debate.

Equation (1) includes the complete set of possible unemployment determinants used in reduced-form long-run unemployment models to date, and the version of this reported in Nickell (1998) estimated over 1964Q4-1992Q4, uses an Auto-Regressive Distributed Lag (ARDL) equation, the long-run version of which is shown for reference in Table 1 below.[2] Although not all variables in the equation appear significant, it nonetheless is taken by the author as giving a ”comfortable” explanation of the fourfold rise in unemployment from the early/mid 1960s to the late 1980s/early 1990s.(see Nickell op.cit p 814). The background to this is that a number of commentators have argued that wage-push variables do not appear the account for the movements in unemployment over long periods of time in a satisfactory way (A small sample of dissenting voices includes Madsen (1998), and Henry and Snower (1996), Oswald (1997) and Henry and Nixon (2000)). Nickell (1998) partly acknowledges some of his critic’s claims when he notes that finding a set of wage-pressure variables which accounts for long-run movements in unemployment is likely to be difficult since these variables were no worse in the mid 1980s than in the 1960s, yet unemployment rose. But the long-run equation quoted above which appears to explain the fourfold rise in unemployment

[2] Although not specified in Nickell (1998), the lag length of a comparable ARDL in Nickell and Bell (1995) is preset at 5.

from the early /mid 1960s to the late 1980s/early 1990s using these wage pressure factors, seems to settle the issue. The rest of this note considers whether the result quoted above does settle this controversy in favour of the supply-side view[3].

The argument we give in section 3 is that this most recent evidence does not favour the interpretation the authors wish to place on it, since that interpretation is based on an overly simple view of what cointegration *per-se* actually shows. To develop our case we review the econometric basis of the model. The model itself has used a set of wage pressure variables which has been augmented over time, so there is already some suggestion that it may not be parameter stable. In an early version, Nickell (1988), for example, uses only five variables; *IT*, real benefits (not the replacement ratio (*RR*)), import prices (not the Terms of Trade), *UP* and employer' taxes. Later, in Nickell and Bell (1995), six of the variables described in (1) with the exception of the real interest rate (*r*) are used, and it is only in Nickell (1998) that the results of using the full set of seven variables are reported. This is the equation quoted above. It is these latter two versions that we conduct some tests on in section 3. To anticipate the findings of these tests, we report that there are important shortcomings to these results; important enough to undermine their interpretation as "explaining" trends in unemployment. Although this note is thus largely negative, we suggest its essential message is to emphasise the need for a radical alternative to the model of long-run unemployment just outlined.

[3] In what follows we refer to the unemployment model in (1) as a "supply-side" view for expositional convenience. Supply-side models (such as Fitoussi *et al*. (2000) for example) embrace a much wider class of behaviour than this, but our focus will be on the wage pressure version only in the rest of this paper.

2.2 The Evidence for Cointegration and its Interpretation.

Nickell and Bell (op.cit), in describing their results on the long-run equation conclude that it shows "unemployment can be explained by supply-side variables only" (p. 58). Nickell (1998) reviewing the results of his long-run equation which now includes all the variables in equation (1) states "there seems no problem in finding wage pressure variables which explain long-run movements in $\ln u$". We show in section 3 that these judgements are incorrect as they are based on untested – and we will show, invalid - assumptions about the implications of the tests used, including the uniqueness of the quoted cointegrating relation, the exogeneity of the variables in the model, their causality structure and the parameter stability of the quoted equation.

The evidence presented in the two papers already quoted is of two types; long run equations which are solutions of ARDL equations (Nickell, 1998), and direct estimates of a cointegrating equation using Johanson's M-L method (Nickell and Bell, 1995). Our reasons for not accepting that either of these "explain long-run trends in unemployment in Britain using wage pressure variables" as Nickell (1998) claims, are that the use of the ARDL method requires that the right-hand-side variables are weakly exogenous for *ln* u, and this is clearly not supported by tests we perform on the model. Also, estimating a long-run cointegrating equation using the ARDL approach requires that the right-hand-side variables do *not* themselves cointegrate. Our results show that they do[4]. Finally, the ARDL estimates of the long-run equation are parameter unstable. These problems are not resolved by simply using the Johansen M-L method to estimate a cointegrating vector. It is worth recalling that the Full Information dynamic model underlying (1) above is a Vector Error Correction

[4] Using the Johansen procedure would require essentially the same thing, if it was believed that there was a single equation linking unemployment to supply side variables and the causality ran from them to unemployment.

Model (VECM), with an unrestricted form comprising 8 equations with potentially over 40 parameters to estimate in each equation[5] We explore the implications of this more fully below and argue it undermines the assertion that the cointegration results in Nickell and Bell (1995) for example, "explain" long run unemployment.

While it makes intuitive sense that a long-run equilibrium equation should have a stationary error[6], it does not follow that finding an equation has a stationary error means it is a long-run equilibrium equation. Where there are a substantial number of I(1) variables at the disposal of the researcher, as in the present case, it would be surprising that they did not cointegrate. Davidson's important contribution in this area is directed at precisely making headway with this issue, and he defines the key concept of an irreducible cointegrating (IC) relation as a more appropriate finding favouring a structural interpretation, where the IC is one where no variable can be omitted without losing the property of cointegration. (Davidson (1998)). In section 3 we show this property does not hold for the empirical estimates of (1). Moreover, the fact that there appears to be a cointegrating vector between the variables in (1), when only this equation is estimated, does not inform us about which variable is causing which other(s) in this set.

The case we make is the now standard econometric analysis of the joint determination of a set of economic variables which contain a set of cointegrating vectors. (See, inter alia, Banerjee *et. al*. (1993), Hendry (1995), Davidson (1998) and Pesaran *et al*. (2001)). To begin we start with a VECM written as,

[5] Thus with 5 lags on each variable and, as we show later, probably 4 cointegrating vectors in each equation, there are 43 regressors per equation if each cointegrating vector is treated as a single variable.
[6] Even this need not hold in all circumstances. There are many examples of arbitrage equations which although implied by asymptotic equilibrium theory may not exhibit stationary errors. The failure of PPP to hold even in very long samples is perhaps the best known example.

$$\Delta z_t = \sum_{j=1}^{p-1} \Gamma_j \Delta z_{t-j} + \gamma \alpha' z_{t-1} + \varepsilon_t \tag{5}$$

Here z is a vector of n variables, $(z = (y, x))$, where y are endogenous and x weakly exogenous, and each x and y can be a mixture of I(1) and I(0) variables. Γ is a matrix of suitably dimensioned parameters, γ, α' are the loading weights and cointegrating vectors respectively, and are dimensioned as *nxr* to reflect the reduced rank of the system (we are implicitly assuming there are *r* cointegrating vectors), and ε is a vector of white noise error terms, with $\varepsilon_t = N(0, \Sigma)$. As written, equation (5) is what can be thought of as the general or Full- Information model underlying the long-run equation reported in the two cited papers, with *z* (*n* = 8) being the set of variables defined beneath equation (1) and *(p-1)* = 5 being the maximum lag on each of the variables in the ARDL. Interest centres on the long-run part of (5), and what can be inferred about the determinants of long-run unemployment from estimates of it. By construction, (5) is written as having *y* endogenous and *x* weakly exogenous variables. The obvious question is, how do we decide on the dimensions of these?

Assuming the system is of reduced rank, if the 8 variables are non-stationary, there are potentially up to 7 cointegrating vectors in the model $(r \le 7)$. In both their ARDL and M-L results, the authors assume that there is only one cointegrating vector. Crucially they also assert that this vector can be read as one determining ln *u* in terms of all the other seven variables. In the terminology of the VECM above, they are assuming that the vector of weakly exogenous variables (*x*) has the dimension (7×1) and includes all the variables except ln *u*. Sufficient conditions for this interpretation to hold is that there is only one variable in the *y* vector of endogenous variables (i.e. ln *u*), that there is a single cointegrating vector between all the variables (including ln *u*) and that this single cointegrating vector only enters into the dynamic ln *u* equation in the full set of eight dynamic equations given by (5) and in no other. In what follows, we scrutinise these assumptions and test whether they are borne out by the evidence.

For this we use standard definitions of exogeneity concepts, starting with weak and ending with super exogeneity set out by Hendry and his associates. (see Hendry (1995) for an overview). These include Weak exogeneity which determines conditions under which it is statistically possible to treat some variables as given in a model when making inferences about the others and it is this idea that we focus here. The test employed is a Wald test on the parameters of the loading matrix as described in Hall and Wickens (1993).

As well as the cointegrating equation estimated by the Johansen M-L method, Nickell and Bell (1995) and Nickell (1998) also use the ARDL approach to cointegration. The problems about weak exogeneity and causality structure of the model just noted remain central to this procedure, although they are implicit rather than explicit. In practice a single dynamic equation is used with a single left-hand variable assumed to be endogenous and dependant on variables which are assumed to be weakly exogenous *a-priori* from the outset. Furthermore, these dependant variables are assumed to be I(1) and cointegration between them is ruled out The ARDL is estimated by OLS and model selection – the time-form of the *y* and *x* variables, given the maximum lag preset by the researcher - can be decided by using one of a variety of information criteria[7].

[7] These are AIC, SBC or HQ. (See Pesaran and Pesaran, 1997).

3. Econometric Results

In this section we show that the issues of parameter stability, weak exogeneity and causality in cointegrated systems just reviewed are of profound significance, so much so that, based on this analysis, we argue that the empirical results reported in Nickell and Bell (1995) and Nickell (1998) above are very limited in what they can tell us about the long-run behaviour of (log) unemployment in Britain. In the next two subsections we use both ARDL estimates and the Johansen M-L procedure to show this. The data used is the same as used in the original papers, the sample period is 1964Q4-1992Q4, and full definitions are found in Nickell and Bell (1995) and Nickell (1998). They are also described in Appendix A.

Before reporting on these, note that the standard tests of orders of integration for each of the variables in equation (1) are shown in an Appendix B. These show that the variables concerned are I(1) except industrial turbulence (*IT*) and the Skill shortage variable (*Skills*), where the ADF statistic rejects a unit root in the levels of the variables at the 95% level. The order of integration of the *Skill* variable is ambiguous however, since with the ADF(4) employed in the table, there is evidence of considerable non-normality in the residuals. An ADF(5) seems preferable on these grounds, and this suggests non-stationarity (ADF(5)= 2.3). We comment on the ramifications of this as we go along. (See Appendix B, Table B1, for details of the standard Dickey-Fuller tests).

3.1. ARDL Results

This section discusses two aspects of the ARDL estimates of the long-run equation (1); their use of a relatively large set of variables (a concern which Nickell (1998) also notes), and the related issue of the parameter stability of the estimated equations.

First we test for the likely lag length of the model. Results are given in Appendix B (Table B2). Briefly the results of the table are ambiguous with the Akaike Information Criteria (AIC) indicating a lag length of 6 (although there is evidence on this criteria that this could be 2) and both the Schwarz Bayesian Criteria (SBC) and adjusted Likelihood Ratio (LR) indicating two lags are needed. As a compromise, and to give some comparability with the assumptions used in the cited papers, we use a lag length of four in what follows.

Next we show the result of re-estimating over subsets of the full sample in Table 2 by assuming, as do the authors, that these are all I(1). So these equations use the full set of eight variables listed immediately following equation (1), ln *u*, *TT*, *Skill*, *T*, *RR*, *UP*, *IT* and *r*. The first two rows repeat the result from Nickell (1998) which estimates the model for the period 1964Q4-1992Q4. The third and fourth rows show our re-estimate using L=4 for the full sample. Next, the fifth and sixth rows show an estimate over the period 1964Q4-1989Q4. The last result shown in the final two rows is the equation when estimated for the period 1964Q4-1984Q4.

These estimates reveal substantial variation in the estimated parameters of the equation and in crucial cases a complete turnaround in the significance of the estimate. Take the key supply side variables *UP* and *RR* for example. Union power (*UP*) appears correctly signed and significant in both the full sample and the short sample (ending in 1984) but is negative and insignificant in the middle sample (ending in 1989). The significance and magnitude of the effect of the replacement ratio (*RR*) is very sensitive to the specification and time period[8]. Other variables show substantial change; the terms of trade (*TT*) actually changing sign in the short sample though is numerically large and significant at the 10 per cent level. Given this it is hard to see that this sort of equation "comfortably explains" the large rise in unemployment over this full period as Nickell claims (Nickell, 1998).

Table 1. ARDL estimates of long-run unemployment equations.

Const	IT	RR*	TT	Skill	UP	T	R
-35.5	0.11	0.049	9.99	0.09	1.90	0.035	0.021
**	(0.6)	(1.4)	(2.2)	(3.0)	(2.0)	(2.7)	(2.1)
Lag of 4, 1964Q4-1992Q4							
-45.5	0.17	2.19	11.2	0.06	1.9	0.039	0.01
(4.0)	(1.2)	(1.5)	(2.89)	(2.1)	(1.82)	(2.7)	(1.5)
Lag of 4, 1964Q4-1989Q4							
-71.9	0.34	2.5	6.9	0.05	-0.6	0.067	0.01
(4.5)	(2.4)	(1.87)	(1.6)	(2.2)	(0.5)	(3.55)	(1.2)
Lag of 4, 1964Q4-1984Q4							
-65.1	0.14	0.4	-13.1	0.08	2.0	0.069	0.02
(5.6)	(1.6)	(0.4)	(1.8)	(2.6)	(2.2)	(4.5)	(2.6)

Notes: In all but the first example, these equations are estimated using the ARDL procedure in Microfit 4.1. Each uses a maximum lag of 4 on each variable.
*Nickell and Bell (1995) give this as 8.95 and 4.88 for the ARDL and Johansen estimate respectively and these appear to use the log of the replacement ratio. The estimate above from Nickell (1998) is apparently its level. We use the former throughout.
** No *t-statistic* is given in the original.

Applying ARDL assumes that the right-hand-side variables do not themselves cointegrate. Tests for cointegration using the variables on the right-hand of equation (1) show they clearly are cointegrated. The Trace statistic indicates that there are probably two cointegrating vectors in this set (i.e. all the variables in equation (1) excluding ln *u*), with the test statistic for 2 cointegrating vectors being 109.3 (95.9) (95 per cent critical value in

[8] Nickell (1998) results show that *RR* is insignificant in the full sample in his equation..

brackets). Apart from the issues of inconsistency this introduces, the finding undermines the assertion that a long-run equation such as (1) estimated via an ARDL "explains" long-run movements in unemployment because this cannot be true if – as we know - the variables *excluding unemployment* are themselves an equilibrium set in this sense.

Finally, the important approach to structural cointegrating relations advanced by Davidson by finding an Irreducible Cointegrating (IC) equation is relevant here (Davidson, 1998). In the present case of equation (1), it is easy to find smaller sets of variables which cointegrate with ln *u*, including ones which drop the primary supply-side variables *UP* and *RR* altogether. Without these variables tests of cointegration give a Trace test result of 115.9 (95.9) for the hypothesis of a single cointegrating vector.

3.2. Maximum Likelihood Results

Finally, we assess whether the model fares better when treated as system by using the Johansen Maximum Likelihood (ML) approach, as in Nickell and Bell (1995). Using ML seems a more natural treatment than the ARDL one, apart from anything else because of the data used. Thus, one regressor variable (*UP*) is derived from a previous regression (see Appendix A) while others, such at *TT* and *IT* almost certainly depend on macro developments in the economy especially the real exchange rate[9]. The possible implications of the complete eight variable set as a full information system of equations is then the next issue to be addressed. Two cases are again used, one where all the eight variables are treated

[9] We do not follow this up fully in what follows, simply in order not to further complicate the exposition. Strictly, it would mean extending the sample to include all the other variables-both those used as regressors in the *UP* equation, and the putative determinants of *TT* and IT.

as I(1) as apparently Nickell and Bell (1995) do in their Johansen estimates, and the other where account is taken of the one clearly I(0) variable (industrial turbulence (*IT*)) .

Case 1. All variables I (1)

In the first case, the Johansen results show that there is strong evidence that ln *u* and supply-side variables cointegrate. However, in line with our earlier review of the problems with using this large set of “explanatory” variables, there is evidence that there is more than one cointegrating vector in the data set. According to the Trace test for example, there appears to be as many as four (4) cointegrating vectors in this data set. (For $r \leq 4$, Trace =69.0 (68.5)). Next we apply standard analysis of weak exogeneity and causality to each model. The second column of Table B3 in Appendix B gives the relevant Wald tests for this case.

In summary, in this version of the model where all 8 variables are assumed I(1), the results in Table B3 show that only one variable - the tax wedge (*T*) – appears to be weakly exogenous and to weakly cause the other variables in the set. All the others - industrial turbulence (*IT*), the replacement ratio (*RR*), the measure of the terms of trade (*TT*), the skill mismatch (*Skill*), the union markup (*UP*) and the real interest rate (*r*) - and not just unemployment, are jointly determined in a conditional model like equation (5) above, and this conditional model contains four cointegrating vectors. To just identify this model requires the application of r^2 restrictions, where *r* is the number of cointegrating vectors. Thus 16 restrictions just identify the version of the model as implicitly used by the authors. Even with these the just-identified model is still very different from equation (1), and to arrive at something like it, the general dynamic model would need to satisfy considerable further restrictions. One necessary requirement, for example, would be that none of the cointegrating vectors be significant in the dynamic equations for any of the variables in the conditional model apart from ln *u* (i.e. *IT, RR, TT, Skill, UP* and *r*), which is contradicted by the findings in Table B3.

Case 2. Seven variables I(1) one I(0)

This subsection follows that of the previous one, so only the most salient points are noted. Treating *IT* as I(0), there are probably 3 cointegrating vectors ($r \leq 3$, Tr =75.2 (75.9)), but the asymptotic LR test gives 84.2(76.1)). Tests of Weak Causality are shown in the third column of Table B3 in Appendix B show that the terms of trade (*TT*) and, again, the tax wedge (*T*) are weakly exogenous. So where the first stage results on orders of integration are taken seriously the implied model is a six equation conditional model plus a two-equation marginal model for *TT* and *T*. It might be thought that, because this version of the model is of smaller dimensionality than the previous case, it would be easier to satisfy sufficient over-identifying restrictions to end up with a long-run equation of the form given by equation (1). Deriving a model which conforms to equation (1) from this is not any more likely however. The three cointegrating vectors would need to be restricted so they do not affect any of the other variables in the conditional model except ln *u*, and this contradicts the results on Weak causality given in Table B3. Second if, in spite of the evidence to the contrary, the first restriction were upheld, the individual parameter estimates of the three cointegrating vectors in combination would need to satisfy the parameter restrictions given by the first quoted result in Table 1.

To sum up this section. Putting the model in an ML form serves to emphasise the profound difficulties in deriving an equation like (1) from a VECM using the 8 variables from that equation. In our judgement this line of questioning is opened up once it is asserted that equation (1) cointegrates and that it is an equilibrium long-run relationship. Whether all variables are treated as I(1) or not we have indicated that the required restrictions necessary for equation (1) are unlikely to hold.

4. Conclusions

Recent time series research on the effect of supply-side variables on unemployment in the long-run has appeared to concentrate solely on whether it is possible to show that these variables cointegrate with unemployment. That they appear to cointegrate has been taken as confirmation that these variables “explain” unemployment in the long-run. We have argued that this conclusion is based on the “extreme and untested” use of ideas about identification rightly castigated by Sims so long ago (Sims, 1980). In other words, the cointegration evidence makes the extreme assumption that the right-hand variables chosen, *ex-cathedra*, are weakly exogenous so unemployment can be modelled without providing short and long run models for these other variables too. This is almost certainly wrong; not only do these variables appear to affect unemployment in the long-run but they affect each other as well, and unemployment itself appears to affect some of them too. It would appear to be very difficult to determine what all the links between these variables are by applying economically meaningful restrictions to the full information model. All that may be safely concluded is that it has not so been shown yet that the supply-side variables used here explain long-run movements in unemployment in an acceptable way. In our judgement, our results suggest the model outlined in section 1 is far from an adequate explanation of long-run unemployment. The search for a more satisfactory explanation of unemployment trends in the UK needs to be very high on the research agenda.

Appendix A

Apart from unemployment, which is the log of the rate of unemployment for both males and females the remaining variables are as follows.

(1). *TT*. This is a terms of trade variable defined as $s\ln(P_m / P^*)$, where s is the import share in GDP and P_m is the import price index for the UK, and P^* the unit value index of manufacturing exports in sterling[10].

(2). *UP*. The log of the union/non union mark-up, where the mark-up is a derived series as estimated in Layard et al ((1978).

(3). *RR*. The replacement Ratio (percentage) using a weighted average of different family types.

(4). *T*. This is the Tax Wedge defined as the sum of the employment tax on firms, the aggregate direct tax rate and an aggregate indirect tax rate.

(5). *Skill*. This variable is a measure of skill shortages faced by employers, derived from the CBI Industrial Trends Survey. It is the ratio of responses to the questions (i) Limits on output due to skill labour shortage. (ii) Limits on output due to other labour shortage.

(6) *IT*. Industrial Turbulence, defined as the absolute change in the proportion of employees in production industries as a proportion of total employees in employment.

(7) *r*. The Real Interest Rate, defined as the Treasury bill rate minus the rate of inflation in the GDP deflator.

[10] For sources of all the variables see the references to Nickell (1998) below.

Appendix B

Table B1. Orders of integration

Variable	DF	ADF(4)	DF	ADF(4)
ln *u*	-0.71	-1.31	-1.16	-2.58
IT	-3.0	-3.4	-3.19	-3.97
T	-2.34	- 2.3	-1.3	-0.82
TT	-0.96	-0.29	-2.9	-1.74
Skill	-1.49	-3.32	-0.9	-3.92
RR	-0.15	-1.93	-1.3	-2.37
UP	-1.26	-1.48	-1.26	-2.06
R	-2.06	-2.41	- 2.36	-2.72

Note: The first two columns of results refer to tests without a deterministic time trend and the last two are with a trend. The 95% critical values for each are -2.89 and -3.45 respectively.

Table B2. Tests of lag length

Lag	AIC	SBC	Adjusted LR
6	1378	856	
5	1358	923	95.2 (0.007)
4	1345	996	184 (0.001)
3	1354	1093	246 (0.005)
2	1365	1192	306.3 (0.002)
1	1246	1159	516.4 (0.00)

Note: These are the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC), and a small sample adjusted Likelihood Ratio test (LR). Probability levels of the latter are given in brackets.

Table B3. Causality tests, 1964Q4-1992Q4

Variable	Wald Statistic	Wald Statistic
All Variables I(1)		7Variables I(1), 1 I(0)
$\ln u$	16.0	21.9
IT	56.5	--
T	1.3	2.9
TT	25.3	6.44
Skills	22.7	22.2
RR	27.0	19.7
UP	16.1	17.1
R	22.9	22.4

Note: For the second column the relevant test statistic is $\chi^2(4)$ as there are 4 cointegrating vectors in the data. For the fourth with 3 cointegrating vectors it is $\chi^2(3)$.

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