Structural Change in Fiscal Policy and The Permanence of Fiscal Contractions - The Case of Denmark and Ireland

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Abstract

Instead of relying on descriptive statistics to evaluate the permanence of a fiscal contraction, this paper suggests that this issue should be studied using tests for structural breaks in cointegrating relationships between taxes and spending. We label a fiscal contraction as 'permanent' if a structural break is detected during the contraction period. Applying Gregory and Hansen's (1996) test on Danish and Irish data and find that the fiscal contraction in Ireland (1987-1989) induced a structural change in fiscal policy while the results from the Danish data do not imply such a regime shift. We discuss possible explanations for this finding.

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1 Introduction

What is a 'successful' fiscal contraction? Since the seminal work by Giavazzi and Pagano (1990) concerning the fiscal contractions in Denmark and Ireland in the 1980s researchers have defined success or failure in terms of: (i) macroeconomic outcome and, (ii) permanent reduction in the debt ratio[1].

This paper focus on the second line of research and previously the literature have used descriptive statistics in order to determine the permanence of fiscal contractions. For example, in the pioneering work by Alesina and Perotti (1995, p.17) they state that: "...we want to isolate episodes of very tight fiscal policy which have led to 'long run' consolidation of the budget...". They then carry on and define a successful (or permanent) fiscal adjustment: "A *successful adjustment* in year t is defined as a 'very tight' fiscal stance in year t such that the gross debt/GDP ratio in year $t+3$ is at least 5 percentage points of GDP lower than in year t."[2] Instead of relying on descriptive measures like the one described here (which is arbitrarily both in terms of length and size), we believe that a more rigorous econometric framework is needed in order to explore this issue.

In this paper, we propose the use of fairly new econometric methods to determine the permanence of fiscal contractions. More specifically, we argue that the permanence of fiscal actions should be gauged using test for breaks in cointegrating relationships between taxes and government expenditure. By definition, cointegrating relationships are long run phenomena which depends on the structure of fiscal policy. There are, arguably, reasons to believe that such structures can change. The circumstance most likely to trigger a fiscal contraction is the gradual build up of public debt in relation to GDP and in the most famous cases from the fiscal contraction literature (Denmark 1982-1986 and Ireland 1987-1989), the debt ratio rose from 44 to 66 percent (Denmark) and from 105 to 118 percent (Ireland) the last two years before the contraction[3]. Although these contractions generally are considered as successful[4], we investigate whether these consolidations induced long run effects on the relationship between taxes and spending. That is, if a structural break in the cointegrating relationship occurred during the contraction period. To our knowledge relatively little work has been carried out on structural change in fiscal policy in the framework of cointegration analysis, see Quintos (1995) and Papadopoulos and

[1] Note that in the fiscal contraction literature the terms 'permanent' and 'succesful' are often used synonymously.

[2] Similar definitions have been applied by, among others, Alesina and Ardagna, 1998, and Zaghini, 2001.

[3] OECD Fiscal positions and business cycles 1998.

[4] See case studies by, among others, Andersen (1994), Bergman and Hutchison, (1996, 1999), Giavazzi and Pagano (1990), and Lambertini and Tavares (2000) for the Danish contraction in the beginning of the 1980's and Bradley and Whelan (1997), Dornbusch (1989), and Lambertini and Tavares (2000) for the two Irish contractions in the 1980s. However, see Barry (1991) for a critical assessment of the Irish experience.

Sidiropoulos (1999) for two such studies. However, none of these consider aspects of fiscal contractions.

The rest of the paper is structured as follows. Section 2 introduces the econometric methodology used in the paper. In section 3, we examine the presence of structural breaks in fiscal policy in Denmark and Ireland. Interestingly, we find that only Ireland has a significant structural break in the relationship between taxes and government expenditure. Reassuringly this break (or, equally, new fiscal policy regime) coincides with their fiscal contraction period 1987-1989. This is contrary to the Danish case where no evidence of cointegration is found with or without the inclusion of a structural break. In Section 4 we conclude our findings and discuss possible causes of the discrepancies in the result between the two countries.

2 Cointegration and structural breaks

It is known that standard tests for cointegration are biased towards non-rejection of no cointegration if the data is subjected to a structural break. Hence a researcher relying on standard cointegration tools may erroneously fail to reject the null of no cointegration if the presence of a structural break is not accounted for. In a response to this problem there has in recent years emerged a number of tests that deal with structural breaks in the cointegrating relations, see e.g. Quintos (1995), Gregory and Hansen (1996), Seo (1998), Hansen (2000) and Lütkepohl et al. (2001). From an applied economist's point of view the most important difference between the tests involves the nature of the null hypothesis that the tests operate under. We favor the test by Gregory and Hansen (1996) as it has the null hypothesis of no cointegration. The likelihood based tests by Quintos (1995), Seo (1998) and Hansen (2000) consider the null of cointegration against the alternative of cointegration with a structural break or (in the case of Quintos, 1995) time-varying rank. Yet, little appears to be written on the performance of these tests if the data is *not* cointegrated, i.e. the data generating process (DGP) is neither the null nor the alternative. When analyzing fiscal policy the presence of cointegration is by no means guaranteed for the sample at hand and it is in fact one of the hypotheses that we want to test. For this reason we will rely on Gregory and Hansen's (1996) methodology that explicitly considers the possibility of no cointegration. They consider four cointegration models:

Model 1: Standard cointegration (see Engle and Granger, 1987)

$$y_{1t} = \mu + a y_{2t} + e_t \qquad t = 1, ..., n \tag{1}$$

where y_{1t} and y_{2t} are $I(1)$, μ and a are the cointegrating parameters and $e_t \sim I(0)$.

Model 2: Level shift (C)

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + a y_{2t} + e_t \qquad t = 1, ..., n \tag{2}$$

In Models 2 through 4 the structural break is modelled using the dummy variable, $\varphi_{t\tau}$:

$$\varphi_{t\tau} = \begin{cases} 0 \text{ if } t \leq int(n\lambda) \\ 1 \text{ if } t > int(n\lambda) \end{cases}$$

where the unknown parameter $\lambda \in (0,1)$ denotes the relative timing of the break point, and *int* denotes the integer part. Hence in Model C we allow for a shift in the constant in the long run relationship.

Model 3: Level shift with trend (C/T)

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \delta t + ay_{2t} + e_t \qquad t = 1, ..., n \tag{3}$$

In effect Model C/T is identical to Model C apart from the inclusion of a linear trend in the cointegrating equation.

Model 4: Regime shift (C/S)

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + a_1y_{2t} + a_2y_{2t}\varphi_{t\tau} + e_t \qquad t = 1, ..., n \tag{4}$$

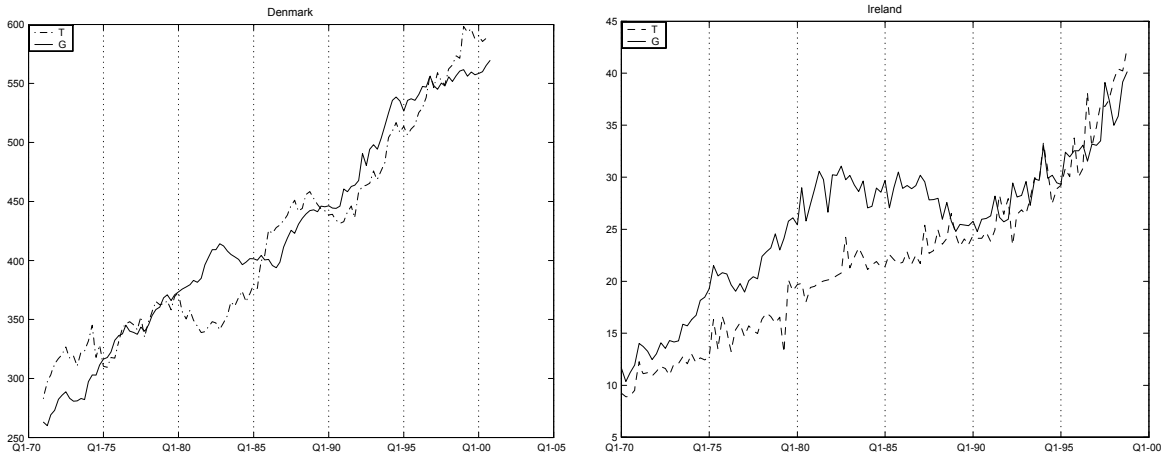
In Model C/S we let the long run relationship rotate (that is, a shift in a) together with a level shift in μ.

Although the cointegration tests (2) through (4) allow for a more flexible DGP than the original Engle-Granger test, there is a slight snag since they all have power against the same alternative hypothesis, i.e. that of cointegration. To deal with this problem Gregory and Hansen (1996) suggest that testing for cointegration with a structural break should be carried out in two steps. First the researcher tests for cointegration using (1). If the null of no cointegration is not rejected one proceeds with testing for cointegration using (2)-(4). If the null of no cointegration is now rejected we may conclude that a structural break is likely to have occurred. The Gregory and Hansen (1996) test is then carried out as follows. Estimate any of the Models 2 through 4 for each break point in the interval $(int(0.15n), int(0.85n))$ and perform an Augmented Dickey-Fuller (ADF) test on each of the associated residual series. Pick the smallest of the ADF-statistics (labelled ADF*) and use this as test statistic and compare it with the critical value. If we reject the null of no cointegration using (2)-(4) but not (1) then this may be interpreted as evidence in favour of a structural break.

The main limitation of the test is that it can only be applied if there is a single break in the data, hence multiple breaks are not allowed. Thus the method would be unsuitable if a country has performed multiple permanent contractions. Yet, in practice this may not be that much of a drawback since the idea of multiple permanent fiscal contractions is something of a misnomer - if a fiscal contraction is permanent there will be no need for a follow-up[5].

[5]Infact, Ireland carried out two fiscal contractions in the 1980s. The first one, implemented 1982-1984, was a failure by any standards (see e.g Dornbusch, 1989) and will therefore not pose any problems for our test.

Figure 1: Government expenditure (G) and revenue (T) in Denmark and Ireland



3 Empirical analysis

3.1 The data

The Danish data is obtained from the Danish Central Bank and consists of seasonally adjusted quarterly observations on total government revenue, T, and expenditure, G, from 1971:1 to 2000:4 in fixed prices[6]. As can be seen from the left hand panel of Figure 1 government expenditure is considerably higher than taxes in the early 1980s which prompted the fiscal contraction of 1982-1986 and brought down the deficit. The Irish data set, also quarterly, is culled from International Financial Statistics and spans the period 1970:1 to 1998:4[7]. The Irish data is in fixed prices and seasonally adjusted using the X-11 filter in Eviews 3.1. The right hand panel of Figure 1 shows that government expenditure consistently exceeds revenue up to the late 1980s. All variables are used in levels, not logs.

3.2 Stationarity issues

The residual based tests for cointegration used in this paper necessitate that the individual series are stochastically non-stationary, i.e. $\{G, T\} \sim I(1)$. To formally test this we perform standard ADF tests on the series and the results from these tests are reported in Table 1. As can be seen from Table 1 all the variables under consideration are deemed to

[6]The authors thank Dan Knudsen, Danmarks Nationalbank, for providing the data. The data concerns general government, i.e. including local government. To our knowledge, it is not possible to net out local government from general government with the data available on a quarterly basis.

[7]This measure of expenditure and revenue includes central government only. Data on local government is not to the authors' knowledge available on a quarterly basis.

Table 1: ADF tests for stationarity

Series	τ_τ	p[LM_1]	p[LM_4]
T_{DK}	-1.55	0.84	0.49
G_{DK}	-2.08	0.89	0.34
T_{IR}	-0.59	0.96	0.53
G_{IR}	-1.92	0.57	0.43

Notes: 'τ_τ' denotes the result from the ADF tests including intercept and linear trend, critical value at the 5% level, -3.43. The number of lagged observations in the ADF equations were set to the lowest number that yielded non-correlated residuals. The last two columns denote the p-values for LM tests for residual autocorrelation (1 and 4 lags).

Table 2: Cointegration tests, Denmark

Model	$ADF^{(*)}$	p[LM_4]	p[$ARCH_4$]	p[JB]	Date
Engle-Granger	-1.88	0.52	0.94	0.96	n.a
C	-2.34	0.79	0.98	<0.01	1980:1
C/T	-4.08	0.22	0.14	<0.01	1993:3
C/S	-2.28	0.52	0.02	<0.01	1981:2

Notes: The first column reports the ADF statistic from the Engle-Granger test and the tests in Gregory and Hansen (1996). The next two columns report p-values from LM tests (4 lags) for autocorrelation and ARCH effects for the residuals from the test equations. The second last column reports the p-value from the Jarque-Berra test for normality. The last column reports the date that minimized the ADF^* statistics of the Gregory-Hansen tests. Critical values, at 5 percent level: ADF=-3.17, ADF^*_C =-4.61, $ADF^*_{C/T}$ =-4.99 and $ADF^*_{C/S}$ =-4.95.

be unit-root processes and hence we may continue with the cointegration analysis.

3.3 Cointegration tests

To investigate the cointegrating properties of the series we perform the testing procedure suggested by Gregory and Hansen (1996), see Section 2. First, we apply the standard Engle-Granger test. Second, if the null of no cointegration is not rejected, we test for cointegration using (2)-(4).

Denmark

For the Danish data we do not reject the null of no cointegration using neither the Engle-Granger test nor any of the specifications suggested by Gregory and Hansen (1996), see ADF and ADF^* in Table 2 and the left hand side panels of Figure 2. Hence we find

Table 3: Cointegration tests, Ireland

Model	ADF$^{(*)}$	p[LM$_4$]	p[ARCH$_4$]	p[JB]	Date
Engle-Granger	-1.20	0.86	0.67	<0.01	n.a.
C	-6.39	<0.01	0.52	<0.01	1988:4
C/T	-5.92	0.38	0.29	<0.01	1988:2
C/S	-9.30	0.14	0.85	0.10	1987:4

Notes: See Table 2.

no evidence of any long run ties between government expenditure and revenue during the sample considered[8]. By inspecting Figure 1 it is not surprising that the Danish data is not cointegrated around a structural break as the relationship between taxes and spending *before* and *after* the fiscal contraction period appears to be similar.

Suppose that the Danish data was not cointegrated up to the fiscal contraction in 1982-1986, but cointegrated with a sustainable vector after that period. This would make us consider the Danish contraction successful, yet it would also present us with a problem as Gregory and Hansen's (1996) methodology is not designed to deal with time-varying rank properties[9]. To investigate the possibility that the contraction in 1982-1986 in fact was successful in the sense that government expenditure and revenue went from not being cointegrated to being cointegrated with a sustainable vector we calculate the Trace test (Johansen, 1995) for two subsamples beginning in either 1982 or 1986. Yet in no case are we able to reject the null of no cointegration, not shown.

Ireland

For the Irish data the null of no cointegration is not rejected using the standard Engle-Granger test but when applying (2), (3) and (4) the same null is soundly rejected, see Table 3. The minimum ADF statistic of the three tests can be pinpointed to around 1987-1988. Interestingly enough these years coincide with the fiscal restructuring undertaken in Ireland between 1987 and 1989[10]. This is also evident in the right hand panels of Figure 2. Taken together we interpret this as strong evidence that the fiscal consolidation of 1987-1989 marked a turning point in the way fiscal policy was conducted in Ireland.

Can we from Table 3 infer what kind of break that took place in the Irish data, i.e. which (2), (3) and (4) that is the correct specification? Unfortunately the critical

[8]It is of course very likely that Danish taxes and spending are cointegrated in the sense that they are tied together in the really long run. In our sample, however, we are not able to reject the null of no cointegration with or without a structural break.

[9]In fact, Quintos' (1995) test is designed to deal with such a situation.

[10]It is well known that residual based tests for cointegration can be sensitive to the ordering of the variables. Hence we have run a parallell set of regressions for both countries where the ordering of G and T are reversed. This did not produce any noteworthy alterations in the results.

values tabulated in Gregory and Hansen (1996) are only valid when testing the null of no cointegration against either (2), (3) or (4) and can not be used to test the different models against each other[11]. As a solution to this problem we estimate bivariate vector error correction (VEC) models on two subsamples of the Irish data, using 1987:4 as a break point:

$$\Delta x_{kt} = \delta_k + \sum_{i=1}^{p-1} \Gamma_{ki} \Delta x_{kt-i} + \alpha_k \beta_k' x_{kt-1} + e_{kt} \quad (5)$$

$$k = \begin{cases} 1 \text{ if } t \leq 1987{:}4 \\ 2 \text{ if } t > 1988{:}1 \end{cases} \quad (6)$$

In (5) $x_{kt}=\left[\begin{array}{cc} T_{kt} & G_{kt} \end{array}\right]'$, α_k is the error-correction term, β_k is the cointegrating vector and $e_{kt} \sim N(0, \Omega_k)$. As the two subsamples are separately estimated we allow the parameters of the VEC model to differ between the two samples. This is the equivalent of Model C/S as it allows for a rotating equilibrium relationship (i.e. a shift in β in terms of (5)). We then test whether the estimated βs are significantly different from each other. If we can reject that the beta vectors are proportional to each other we can exclude that (2) or (3) is the correct specification since neither of these models allow for a rotating shift in the long run equilibrium across regimes. The VEC estimates are summarized in Table 4. The estimated βs give a clear indication that Irish fiscal policy has swung from producing budget deficits in the first part of the sample to producing budget surpluses in the later half. We also test whether the change in fiscal policy is significant in the sense that the vectors of the two samples are different from that of a long run balanced budget, i.e. $[1 - 1]$. As can be seen from Table 4 the null of a balanced budget vector is rejected for both samples. Moreover, since we can reject that the two vectors are proportional to $[1 - 1]$ we can automatically reject that they are equal for the two subsamples and hence we argue that (4) is likely to be the correct specification.

4 Conclusions

Unlike previous work on fiscal contractions, we adopt a more strict definition of the permanence of a fiscal contraction. Instead on relying on arbitrary descriptive statistics that monitors the outcome for an equally arbitrary number of years after the event, we apply formal tests for structural change in fiscal policy. Using data on taxes and government expenditures of two famous case studies often referred to in the literature,

[11] Graphical inspection of the right hand panel of Figure 1 does however suggest that the cointegrating vector is not the same before and after the fiscal restructuring. This is view is supported by the fact that the C/S model produces a ADF* statistic far below those of the other models, see Table 3. Moreover, the C/S model is the only model that does not return non-normal errors. Taken together this implies that the C/S model is the most likely model to correctly represent the DGP.

Figure 2: The ADF statistics from the tests for structural change

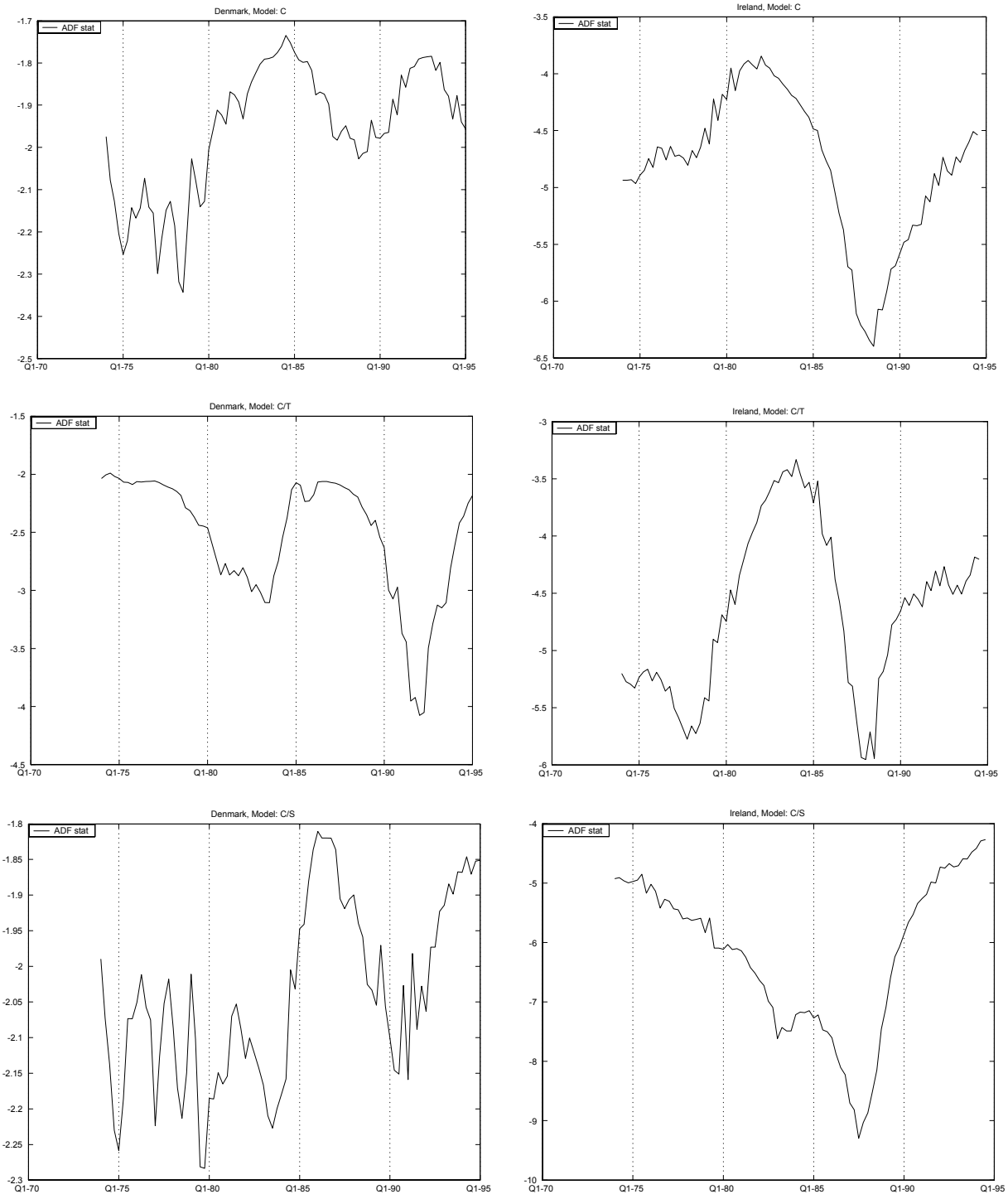


Table 4: VEC estimtes on the subsamples

Sample	rank	$\hat{\beta}_k$	p[$\hat{\beta}_k \propto (1-1)$]	nlag	p[LM_4]	p[DH]
1970:1-1987:4	1	(1, -0.67)	0.02	2	0.05	0.07
1988:1-1998:4	1	(1, -1.33)	<0.01	2	0.32	0.19

Notes: 'Sample' denotes the sample period. 'rank' reports the number of cointegrating vectors significant at the 5 percent level using small sample corrected critical values, Cheung and Lai (1993). '$\hat{\beta}_k$' reports the estimated cointegrating vector. The next column reports the p-values from a bootstrapped likelihood ratio test (5000 replications) whether the estimated β_k from each subsample is proportional to [1 -1]. 'nlag' denotes the number of lags in the VAR model and the last two columns report the p-values from a multivariate LM test for autocorrelation and a test for multivariate normality, due to Doornik and Hansen (1994).

we find that the fiscal restructuring in Ireland 1987-1989 was successful in the sense that it permanently (i.e. within the sample) changed the long run relationship between government expenditure and revenue. In contrast with the policies pursued up to the late 1980s the current Irish fiscal regime is aimed at producing solid budget surpluses. The estimated break occurred in 1987:4[12]. In the Danish case we found no evidence of cointegration with or without a structural break.

A follow-up question is why the consolidation in the two countries generated such different long run effects on the budget balance. We believe that an important contribution to Ireland's successful structural fiscal shift is the political environment that has prevailed since 1987 in Ireland. The reforms in Ireland during the late 1980s were carried out by the government in close cooperation with the labour market organizations. This arrangement is called 'Social Partnership' and an important ingredient includes tax cuts in exchange for moderated wage increases[13]. This in itself lowers the wage pressure in the public sector making it easier to obtain a balanced budget. Hence the economic boom during and after the contraction did not spill over into inflationary pressure and an economic downturn. As this partnership is still operational after 15 years we believe that there has been a long lasting change in the politic-economic climate, appearing as a structural break in the relationship between taxes and spending. The Danish consolidation also resulted in an economic expansion, but perhaps due to the lack of a 'Social Partnership' along Irish lines, the boom followed the standard 'boom-bust' procedure as described by the standard textbook (see Andersen, 1994, for a detailed exposition of the Danish experience). Of course the Danish government has contacts with the labor market organizations but it is far from as extensive as in Ireland.

[12] Using our preferred model, C/S.

[13] See Dept. of Finance, National development plan, 2000-2006.

Another related issue could be the fact that when the fiscal contraction was implemented in Ireland the debt to GDP ratio amounted to a staggering 118 percent of GDP. The corresponding figure for the Danish contraction was 66 percent. Hence there was a much stronger incentive for Irish policymakers to make the fiscal reforms lasting.

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