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31 October 2011

Breaks in the Breaks:

An Analysis of Divorce Rates in Europe

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Abstract:

This paper explores the frequency of permanent shocks in divorce rates for 16 European countries during the period 1930 to 2006. We examine whether the divorce rate is a stationary series, exhibits a unit root, or is stationary around a process subject to structural breaks. A clear finding from this analysis is that not all shocks have transitory effects on the divorce rate. Our results provide evidence of both stationarity around occasional shocks that have permanent effects, and of a unit root, where all shocks have a permanent effect on the divorce rate. All of the permanent shocks are positive, and most are grouped in the 1970s. These shocks can be related to major events that occurred throughout Europe at that time: the divorce law reforms, suggesting that those policies play an important role in the movement of European divorce rates.

Keywords: Divorce rate, unit root, structural break.

JEL: C12, C22, J12, J18, K36

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1. Introduction

This paper aims to provide empirical evidence of the frequency of persistent shocks in European divorce rates, defined as the number of annual divorces per 1000 inhabitants. We consider three possible situations. First, shocks may have transitory effects on divorce rates. In this situation, the divorce rate is mainly steady; after a shock, such as divorce law reform, temporary movements of the divorce rate would be detected, but in the long-run, the divorce rate should go back to its equilibrium level. This would indicate that the divorce rate is stationary. In the second situation, sporadic shocks may cause permanent changes in the equilibrium rate itself, but most shocks would cause only short-run effects on the divorce rate around the equilibrium level. We should expect that the divorce rate would be stationary around a process that is subject to structural breaks. The third situation consists of all shocks having permanent effects on the level of divorce. The divorce rate would be expected to exhibit a unit root, since fluctuations are not transitory.

There is a substantial literature studying the effects of divorce on the socio-economic outcomes of women and children. The possibility of divorce may increase female labour force participation (Michael, 1985; Johnson and Skinner 1986; Peters, 1986; Parkman, 1992), but it can also affect the economic status of women and children (Jarvis and Jenkins, 1999; Bedard and Deschênes, 2005). At the same time, divorce may also have long-term negative effects on children (Seltzer, 1994; Amato, 2000; Gruber, 2004). These findings suggest that it is crucial to carefully consider the frequency of persistent shocks in divorce rates, since divorce can permanently impact on large sectors of the population.

This paper contributes to a growing literature that evaluates whether shocks have permanent effects on social and economic variables. Using statistical techniques developed by Dickey and Fuller (1979), Nelson and Plosser (1982) argue that shocks have a permanent effect on the long-run level of most macroeconomic and financial aggregates, such as, real gross national product (GNP), nominal GNP, real per capita GNP, industrial production, employment, the unemployment rate, the GNP deflator, consumer prices, wages, and real wages. Perron (1989) carried out tests of the unit-root hypothesis against the alternative hypothesis of trend stationarity, with breaks in the trend at the Great Crash of 1929 and at the 1973 oil-price shock. He used data from the Nelson-Plosser macroeconomic data series, as well as a post-war quarterly real GNP series. Zivot and Andrews (1992) used the same data, but considered an endogenous breaking point. Ben-David and Papell (1997) examined the structure of post-war trade, testing for structural change in the import-GDP and export-GDP ratios for 48 countries, attempting to determine whether the evolution of trade shares had followed a stable process during the post-war period or, alternatively, whether and when the process had changed. In the field of international economics, there is an extended literature on purchasing power parity

(PPP) using unit root tests and considering structural changes (Papell, 1997; O'Connell, 1998; Murray and Papell, 2002; Papell, 2002). Recently, Davis and Weinstein (2002) examined the evolution of city growth in Japan by testing for the presence of a unit root while considering the Allied bombing of Japanese cities in WWII as a shock to relative city sizes. In the same way, Bosker et al. (2008) used unit root tests to analyze the evolution of the individual cities that make up the West-German city size distribution in the period 1925-1999. We add to this work by presenting evidence of the frequency of persistent shocks in European divorce rates.

In our empirical analysis, we first apply standard unit root methods to the divorce rate for 16 European countries, from 1930 to 2006. When using Augmented Dickey-Fuller (ADF) tests, the null hypothesis of a unit root in the divorce rate can be rejected for five of the sixteen countries. Thus, the unit root scenario seems to better describe the experience of the European countries. For eleven of sixteen countries, these results suggest that any sudden shock has permanent effects. For the remaining countries, there is a tendency to return to a stable value; fluctuations are transitory (mean reversion).

Despite being widely used, the ADF tests suffer from an important drawback. It has been documented that the usual tests for a unit root are biased towards non-rejection of the null hypothesis of a unit root, due to a mis-specification of the deterministic trend (Perron, 1989). Thus, stationary fluctuations with a mean that exhibit a one-time permanent change in level may previously have been identified as a unit-root process (Perron, 1990). To examine this issue, we use Perron and Vogelsang's (1992) methodology for non-trending data to test for a unit root in a divorce rate series, while allowing for a structural break in the mean level occurring at an unknown date. These tests provide evidence in favour of stationarity of divorce rates around a process that is subject to a structural break for seven of the sixteen countries. For those seven countries, only these one-time shocks appear to have any permanent effects.

We further explore the existence of multiple structural changes in non-trending, stationary time series using the methodology developed by Bai and Perron (1998, 2003). These tests are applied to those countries for which the one-break unit root tests provide evidence of stationarity. Structural breaks are also assumed to occur at unknown dates. Our findings suggest that divorce rates may be characterized as being stationary around occasional shocks that have permanent effects. Our results show that five of the countries with stationary mean have more than one break, while the rest of the countries have one break. Additionally, there is some clustering of the break dates; most of the breaks occurred during the 1970s. The magnitude of the impact of those breaks achieves a peak in the 1970s, but is lower in previous and subsequent decades.

Finally, we present a possible explanation for the apparent permanent changes in European divorce rates, related to major events that are known to have occurred across Europe, and which may have caused the structural change in the behaviour of the divorce rate series. We

focus on divorce-law reforms, since the dates of those reforms seem to coincide with the break dates. There is extensive literature examining changes in the divorce rates that focuses on the effects of changes in divorce laws. Jacob (1988) explains that divorce-law reforms in the U.S. made no difference to divorce rates. Peters (1986, 1992) uses cross-sectional data and finds that changes in divorce laws do not affect marital stability; more recently, a similar finding appears in a study by Gray (1998). These results are rebutted first by Allen (1992), who finds a causal relation between the legal regime and divorce rates, and another rebuttal is provided by Friedberg (1998), who presents a state-based panel analysis. She finds that divorce-law reforms, which occurred from the 1970s onward, accounted for about one-sixth of the rise in the divorce rate during the 1970s and 1980s.[1] More recently, the issue is not whether divorce law reforms have an impact on the divorce rate, but whether or not this effect is lasting (Smith, 2002). Wolfers (2006) replicates Friedberg's work with a longer panel using data from the 1950s to the 1990s, investigating whether the unilateral reforms that occurred from the 1970s in the US had permanent or transitory effects on the divorce rate by accounting for the dynamic effects of changes in divorce laws. He finds that the unilateral system had a transitory effect on divorce rates that persisted 15 years after the reform took place. Some years later, González and Viitanen (2009) extended Wolfers' analysis using European data, by including the analysis of no-fault and unilateral reforms that occurred from the 1970s. They also find a transitory response to unilateral reforms that lasted between 5 and 8 years after the reform, as well as a permanent effect of no-fault reforms on divorce rates. Based on this analysis, the reforms account for an increase of about 0.6 divorces per 1,000 inhabitants, from 1950 to 2003.

Our analysis is more interpretive; in the case of stationary divorce rate series to determine whether a divorce law reform has had a permanent impact, we simply compare the timing of the reforms with the year in which a break is located. Results show that the two dates coincide in most countries. Thus, we may conclude that occasional shocks may actually be policy shocks that had a permanent effect on the divorce rate. For those non-stationary divorce rate series, fluctuations that could produce a shock, such as divorce law reform, are also not transitory. This evidence is consistent with the literature that reports a significant impact of divorce law reforms on the evolution of divorce rates.

The remainder of the paper is organized as follows. Section 2 presents a description of the data used. Section 3 shows the econometric specifications and our main results. Section 4

[1] In the area of sociology (see Nakonezny et al., 1995; and Rodgers et al., 1999) and law and economics literature (see Brinig and Buckley, 1998 and Ellman and Lohr, 1998) mixed results have also been found. It has been asserted for some decades that easier divorce laws have only a small effect on the divorce rates. An exception is Brinig and Buckley (1998) who provide the strongest evidence to date that no-fault divorce laws are associated with higher divorce levels.

gives a possible explanation for the shifts in divorce rate series, and the final section offers concluding remarks about the findings.

2. Divorce Rate

The longitudinal data on divorce rates covers 16 European countries for the period 1930 to 2006. The data for the divorce rate is publicly available from United Nations Demographic Yearbooks.[2] These yearbooks contain regular data series of a comprehensive collection of international demographic statistics, comparable within and among themselves, prepared by the Statistical Office of the United Nations. We incorporate data for our sample from successive issues on Marriage and Divorce Statistics (1958, 1968, 1976, 1982, 1990), and from each Demographic Yearbook from 1990 to 2006.[3] We have also used divorce rate data from Eurostat to complete our dataset, which is also publicly available.[4]

The UN Demographic Yearbooks define divorce as the final legal dissolution of marriage, conferring on both parties involved the right to remarry as defined by the laws of each country. The divorce rate is measured as the absolute number of divorces reported to have occurred in the time period and within contemporary geographic boundaries, per 1000 persons estimated to be present in the area at the mid-point of the year in question, that is, the annual number of divorces per 1000 mid-year population. The divorce rate does provide a simple measure of the level of, and changes in, divorce. However, the rates might be affected by the marital status structure of the populations to which they relate. Divorce rates may be low either because marriage rates are low, or because marriages are less likely to end in divorce. To examine this issue, we could have utilised another measure of divorce rates, defined as annual number of divorces per 1000 married population, but this analysis would have been less reliable due to the scarcity of data on the total number of marriages, which is only available when each census is collected by country, normally every 10 years (see Furtado et al., 2011). Thus, we

[2] For Italy, Spain and Ireland, divorce was banned until 1970, 1981, and 1996, respectively. We do not include Spain and Ireland in our analysis since we do not have enough data to implement our methodology and results could be less reliable.

[3] After a careful examination of all the UN Demographic Yearbooks mentioned above, there are not remarkable differences within each country in the way data is collected during all the period analysed. Since the period of the World War II is a little problematic because of the changes in the territory of some countries, we have also repeated the analysis without the data on divorce prior the end of the World War II. Results do not change, see a more detailed discussion below.

[4] To fill in the few gaps in the divorce rate series, we impute divorce rate using the available data points, plus a linear, a quadratic trend, and a mid-point. Results are quite robust.

favour the use of the divorce rate with a longer series, 77 observations available in almost all countries (see Table 1), which also facilitates comparison with earlier studies on divorce rates. [5]

Figure 1 shows the temporal evolution of the divorce rate by country. Our sample begins in a transitional period in the history of divorce between both World Wars, characterised by a relative stability in divorce rates. Overall, this stable divorce rate was interrupted by an acceleration of divorces during and after World War II. After that, the stable decade of the 1950s was characterised by a level of divorce rates slightly greater than that of the pre-war period. That was followed by the most rapid sustained growth in the divorce rate across Europe, in the 1970s. In subsequent decades, the divorce rate stabilized. However, it is important to note that not all individual countries conform to the same pattern.

This quick glance at the divorce rate series seems to reveal the presence of at least a sudden change in the mean level of the series. That change occurs in the 1970s, and it is so large and sudden, compared to the variability exhibited over the rest of the sample period, that we would expect the divorce rate to be stationary around that occasional highly persistent structural change. Nevertheless, this is not a conclusive analysis. In the subsequent sections, we provide evidence of the frequency of persistent shocks in divorce rates.

3. Methodology and Results

3.1. Unit Roots in Divorce

We first test for unit roots without accounting for structural changes. Formally, consider the following expression:

$$DR_t = \alpha + \rho DR_{t-1} + \varepsilon_t, \qquad (1)$$

where DR_t is the divorce rate, α and ρ are parameters and ε_t is the perturbation term. When $-1 < \rho < 1$, the divorce rate will be a stationary time series and any shock will dissipate over time.[6] Fluctuations are transitory. However, if $\rho = 1$, the divorce rate will be a non-stationary time series, and the stochastic process modelled by equation (1) will be a random walk with drift (Brockwell and Davis, 1991), referred to as a unit root process (see Banerjee et al., 1993;

[5] Much recent literature uses divorces per thousand as the main dependent variable in their studies; see Friedberg (1998), Wolfers (2006) and González and Viitanen (2009).

[6] A stochastic process is said to be stationary if its mean and variance are time-independent and if the covariance between any two periods depends only on the lag and not on the actual time at which the covariance is calculated.

Hamilton, 1994; and Gujarati, 1995). In this case, any sudden shock would have permanent effects on the long-run level of the divorce rate.

To test for the presence of unit roots, where $\rho = 1$, we apply the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981). The ADF test for non-trending data is carried out by running the following regression:

$$\Delta DR_t = \alpha + \gamma DR_{t-1} + \sum_{i=1}^{k} \left(c_i \Delta DR_{t-1} \right) + \varepsilon_t , \qquad (2)$$

where $\Delta DR_t = DR_t - DR_{t-1}$, $\gamma = (\rho - 1)$, and k is the number of lags added to ensure that the residuals, ε_t, are Gaussian White Noises.[7] Following Ng and Perron (1995), we choose the optimal k using a 'general-to-specific procedure' based on the t-statistic. The null and alternative hypotheses are, respectively, $H_0 : \gamma = 0$, $H_A : \gamma < 0$. If γ is found to be equal to 0, then the divorce rate series follows a random walk. If, on the other hand, γ is found to be significantly smaller than 0, the divorce rate is stationary around α.

Table 2 reports a summary of the results of the individual country unit root tests. We find that the null hypothesis of a unit root in the divorce rate is not rejected for most of the countries in the sample. In particular, for eleven of the sixteen countries, or 68.75%, unit root is not rejected at the 10% level. Our estimates indicate that the unit root scenario seems to better describe the experience of the European countries.[8] However, there is another possible perspective since the non-rejection of the unit root hypothesis may be because the standard ADF tests are biased (Perron, 1989). It is possible that what we identified as a unit root process could be better modelled as a stationary process around highly permanent shocks. We revisit this issue in subsection 3.2.

3.1.1. Robustness Checks: Panel Unit Root Test

For completeness, we also test for a unit root in a balanced panel (excluding Germany, Greece and Italy) and in an unbalanced panel that includes all countries. We first use the test created by Levin et al. (2002) on the balanced panel. The null hypothesis that all series have a unit root, versus the alternative of all series are stationary, is tested using the same autoregressive parameter. We then run a less restrictive test developed by Im et al. (2003). This also allows us to test the null of a unit root in all series, versus the alternative that some of the series are stationary, with a potentially varying autoregressive parameter. We also use a generalization of

[7] This means that ε_t has a zero mean and a constant variance that is uncorrelated with ε_s for $t \neq s$.

[8] We also ran ADF tests incorporating a trend and results are quite consistent.

the Pesaran CADF test (Pesaran, 2007), which allows us to test for unit roots in heterogenous panels with cross-section dependence. Pesaran's CADF eliminates the cross-dependence by augmenting the standard DF (or ADF) regressions with the cross section averages of lagged levels, and with first-differences of the individual series. Like the test done by Im et al. (2003), Pesaran's CADF test is consistent under the alternative that only a fraction of the series is stationary.

Panel B of Table 2 shows the results of applying the above-described panel unit root tests. Regarding the balanced panel, using the Levin–Lin–Chu test, we find that the null hypothesis of a unit root is not rejected, even at the 10% level. In contrast, the Im–Pesaran–Shin test rejects the unit root null at the 5% level, and Pesaran's test shows that, when controlling for cross-sectional dependence, the null hypothesis is not rejected at the 5% level. Thus, not all countries conform to the same pattern, since these tests provide weaker evidence in favour of a unit root for all countries. The same fragility is observed when we test for unit root in an unbalanced panel; the null hypothesis is not rejected at the 1% level with Pesaran's test.

3.2. Unit Roots in the Presence of a One-time Structural Break

A visual inspection of Figure 1, which presents the temporal evolution of the divorce rate by country, appears to indicate a permanent change in the mean level of the series around the 1970s. This is problematic, since it is possible that the unit root tests are not able to reject the unit root null hypothesis in the presence of a structural break in our finite divorce rate series. As mentioned above, in the presence of a structural break, the standard ADF tests are biased towards the non-rejection of the null hypothesis (Perron, 1989). The estimator of the autoregressive parameter goes asymptotically to values close to 1 when the variable is generated by a regime-wise stationary process, in which the effect of a structural break is present. In order to avoid this type of problem, we apply a unit root test suggested by Perron and Vogelsang (1992) that works correctly in a structural break framework, and is appropriate for non-trending data.[9]

We estimate additive outlier (AO) models, allowing for a sudden change in mean (crash model). The AO model is appropriate when the change is assumed to take effect instantaneously which seems to be the case for the divorce rate.[10] This model is estimated by way of a two-step

[9] See others papers such as Banerjee et al. (1992) and Zivot and Andrews (1992) in which the breakpoint selection is also endogenized.

[10] It is conceivable that shocks have very different short-run and long-run effects, which may induce a gradual change in the divorce rates. To tackle this, and at least from a robustness perspective, we also estimated innovational outlier (IO) models where the structural change occurs gradually. Our results are

procedure. The first step removes the deterministic part of the series by estimating the regression

$$DR_t = \mu + \delta DU_t + \eta_t \,, \qquad (3)$$

where $DU_t = 0$ if $t \leq TB$ (the break date), and is *1* otherwise. The resulting residuals are then tested for the presence of a unit root by estimating

$$\eta_t = \sum_{i=0}^{k} \omega_i DTB_{t-i} + \rho \eta_{t-1} + \sum_{i=0}^{k} c_i \Delta \eta_{t-i} + \varepsilon_t \,, \quad (4)$$

where η_t is the estimated residual from equation (3), *TB* is the break date, $DTB_t = 1$ if $t = TB + 1$, and is *0* otherwise. Both equations are estimated by OLS for each break year $TB = k + 2,...,T - 1$, with T being the number of observations and k the truncation lag parameter. The null-hypothesis of a unit root is rejected if the t-statistic on ρ is significantly different from zero. In this case, the divorce rate will be a stationary time series around a structural break. All but one shock (the break) would cause temporary movements of the divorce rate. By contrast, if the t-statistic on ρ is not significantly different from zero, the divorce rate will be a non-stationary time series and any sudden shock would have permanent effects on the long-run level of the divorce rate.

The results of applying the AO-model to test for a unit root in divorce rates in the European countries under the null of unit root versus stationary around a possibly shifting mean under the alternative are also summarized in Table 2. Results do not substantially vary. At the 10% level, the unit root null hypothesis cannot be rejected in favour of a stationary divorce rate with a one-time break for 56.25% of the countries in our sample, or nine of sixteen countries.

Table 3 displays the results by country. The null hypothesis of a unit root is rejected for France and Germany at the 1% level, and for Denmark, Iceland, the Netherlands, Sweden and the United Kingdom at the 5% level. Results show that the structural breaks are all positive, which reflects the rise in the mean of the divorce rate among the European countries in the period considered. It is also observed that the timing of the breaks for those stationary series spans from the late 1960s to the late 1970s.

Results suggest that not all shocks have temporary effects on divorce, even though there is no single scenario for all countries. Our results do provide evidence in favour of both unit root processes and stationary processes subject to a structural break. For stationary countries, most

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quite consistent, although some of the structural breaks are detected some years later than those determined by using the AO model.

shocks cause temporary movements of the divorce rate around the equilibrium level, but occasionally, shocks cause permanent changes in the equilibrium rate. It is important to note that by *permanent* what should be understood is that the change is still in effect given a sample of data, but not that the change will last forever. For non-stationary countries, there is no tendency to return to a stable value, since all shocks have permanent effects on the level of divorce.

3.2.1. Robustness Checks: Unit Roots in the Presence of Double Structural Break

The previous analysis only captures the single most significant break in each divorce rate series. However, since variables rarely show just one break (rather, it is common for them to exhibit the presence of more than one break; Clemente et al., 1998), and given that by simply plotting the divorce rate it is observed that the stable divorce rate may be interrupted by another change in the mean during the 1940s, we also attempt to determine whether divorce rate series show double change in the mean.

For the non-trending case, we use the test developed by Clemente et al. (1998), who base their approach on Perron and Vogelsang (1992), but who allow for two breaks.[11] Formally, (3) and (4) change to:

$$DR_t = \mu + \delta_1 DU_{1t} + \delta_2 DU_{2t} + \eta_t, \qquad (5)$$

and

$$\eta_t = \sum_{i=0}^{k} \omega_{1i} DTB_{1t-i} + \sum_{i=0}^{k} \omega_{2i} DTB_{2t-i} + \rho\eta_{t-1} + \sum_{i=0}^{k} c_i \Delta\eta_{t-i} + \varepsilon_t, \qquad (6)$$

where $DU_{jt} = 1$ if $t > TB_j$ $(j = 1,2)$ and *0* otherwise. DTB_{jt} sets equal 1 if $t = TB_j + 1$, *0* otherwise, $(j = 1,2)$. TB_1 and TB_2 are the time periods when the mean is being modified. As Clemente et al. (1998), we suppose that $TB_j = \lambda_j T$ $(j = 1,2)$, with $0 < \lambda_j < 1$ which implies that the test is not defined at the limits of the sample, and also that $\lambda_2 > \lambda_1$, which eliminates those cases where breaks occur in consecutive periods. To test for the unit root null hypothesis, equation (5) is first estimated by OLS to remove the deterministic part of the variable, and then the test is carried out by searching for the minimal pseudo t-ratio for the $\rho = 1$ hypothesis in equation (6) for all the break time combinations. The null-hypothesis of a unit root is rejected if the t-statistic on ρ is significantly different from zero. In this case, the divorce rate will be a stationary time series around two structural breaks. Most shocks would cause temporary

[11] A similar extension is also provided by Lumsdaine and Papell (1997) for the case of trending series.

movements of the divorce rate, but two shocks (the breaks) would cause permanent effects. Unlike if the t-statistic on ρ is not significantly different from zero, the divorce rate will be a non-stationary time series and any sudden shock would have permanent effects on the long-run level of the divorce rate.

We would expect that allowing for the possibility of two endogenous break points would provide further evidence against the unit root hypothesis (Lumsdaine and Papell, 1997; Ben-David et al., 2003; Maddala and Kim,2003). However, the percentage of unit root rejected at the 10% is lower than for the one break test (see Table 2). For ten of the sixteen countries, results suggest that any sudden shock has permanent effects. Table 4 reports results for each individual country. The structural breaks are all positive and significant. For Denmark, France, Sweden and the United Kingdom, results indicate that divorce may be characterized as being stationary around a mean, which changes in the 1940s and in the 1970s. For two countries, Belgium and Switzerland, evidence suggests that introducing the possibility of two structural breaks results in the divorce rate series being identified as stationary around two breaks in the mean level, in the 1970s and again in the late 1980s. Intriguingly, in the case of Iceland, Germany and the Netherlands, we conclude that these series are not stationary when allowing for double structural break, but the unit root null hypothesis can be rejected in favour of a stationary divorce rate with just one-time break. All in all, these findings seem to confirm that there is no single scenario for all divorce rate series.

3.3. Multiple Structural Changes

Admittedly, there is no economic reason for restricting the analysis to one or two breaks. Using the methodology developed by Bai and Perron (1998, 2003) enables us to test for and estimate multiple structural changes once stationarity has been established for the case, with no trending regressors. Following the Bai and Perron sequential procedure, we first estimate the linear regression with only a constant as regressor:

$$DR_t = \mu + \delta DU_t + \eta_t , \qquad (7)$$

where DR_t is the divorce rate, the observed independent variable, *TB* is the break date and $DU_t = 1$ if $t > TB$, and 0 otherwise. Again, the break dates are explicitly treated as unknown. The method of estimation considered is based on the least-squares principle. The sup-F statistic is obtained by maximizing the difference between the restricted (without DU_t) and unrestricted sums of squared residuals, over all potential break dates. When a break point is identified, the full sample is divided into two sub-samples at the break point, and subsequently the test is carried out on each of the sub-samples. This subdivision process continues until the test fails to

reject the null hypothesis of no additional structural changes, or until the sub-samples become too small. To determine the final breaks, we utilize the repartition method described in Bai (1997), estimating breaks one at a time.[12] We also allow for heterogeneity and autocorrelation in the residuals. The method used is Andrews (1991) automatic bandwidth with AR(1) approximation and the quadratic kernel. We impose a trimming of 15%, hence each segment has at least 15 observations, and allows up to five breaks (Bai and Perron, 1998, 2003).

Table 5 shows the significant break dates, at the 5% level, from the Bai and Perron tests for multiple structural changes. This Table also reports the mean divorce rates before the first break and after each posterior break. In the case of those countries in which the one-break unit root tests provide evidence of stationarity, we observe that four of the seven countries (Denmark, France, Germany and the Netherlands) have one significant break at the 5% level; one country, Sweden, has one break; and two countries, Iceland and the United Kingdom have three breaks.

The Netherlands and Germany are special cases, since the unit root null is not rejected by the double-break tests, but is rejected by the single-break tests. For the purpose of considering structural change, using Bai and Perron multiple structural tests, the number of breaks selected is only one, which coincides with the single-break test. We therefore will treat both Netherlands and Germany as stationary. Iceland will also be treated as stationary, while recognizing that the unit root null is not rejected by the double-break tests and that there are differences in the breaks chosen. After repartition, the first break selected is 1945, which does not coincide with that chosen by the unit root tests in the presence of one structural break in 1966. Rather, it is close to that determined by the unit root in the presence of a double-structural break at 1943. The second break is not captured as the most significant break in any of the unit root tests used, but after the repartition procedure, the third break is chosen one year later than that detected by the unit root double-structural break test. Two other countries, Switzerland and Belgium, will also be treated as stationary, since these countries can be identified as stationary around two breaks, and the Bai and Perron method also determines two breaks.

[12] For the countries in which the sequential procedure found no break, since the $supF_T(1)$ test is not significant, we use the LWZ method which is a modified Schwarz criterion proposed by Liu et al. (1997) to determine the number of breaks (see Bai and Perron, 1998, 2003). For Portugal and the United Kingdom, the number of breaks determined following the LWZ coincides with those determined using the Bayesian Information Criterion (BIC) (Yao, 1988). In the case of Greece, Italy and Switzerland, both the LWZ method and the $supF_T(l+1|l)$ with $l \geq 1$ allow us to select for the same number of breaks, but the BIC criterion determines more than 2 breaks. The number of breaks selected by the LWZ does not coincide with those determined by the BIC and the $supF_T(l+1|l)$ in the cases of Austria (BIC and $supF_T(l+1|l)$: 3 breaks) and Sweden (BIC: 4 breaks and $supF_T(l+1|l)$: 0 breaks).

There are several remarkable aspects of these results. For all of the countries, we have identified at least one significant break. This determination provides strong evidence against the scenario in which all shocks have temporary effects on divorce. Our findings suggest that divorce may be characterized as being stationary around occasional persistent shocks. These occasional shocks cause persistent changes in the equilibrium rate itself, although most shocks cause temporary movements of divorce around the equilibrium level.

We observe no negative structural breaks, reflecting the rise in divorce in the period under consideration. Another interesting result is that most of the break dates are grouped. Nine of fifteen breaks are chosen during the 1970s, and three breaks occur in 1944 and 1945. This can be associated with major events that are known to have occurred, such as a particular government policy, a divorce law reform, an economic crisis, a war, a regime shift, or other factors. We revisit this issue in the subsequent section.

In a final analysis, we applied the Bai and Perron procedure to the other seven countries for which the unit root hypothesis is not rejected, in either the single-break tests or the double-break tests. Although the assumptions for the Bai and Perron methodology are not satisfied, and we cannot strictly speak of a change in the mean due to a structural break, we consider the results exemplary of the behaviour of divorce rates in those countries. As in the previous case, all breaks are positive and most are grouped around the 1970s. None of them has a large number of breaks, but our results do not provide evidence against unit root for them.

4. Explanation of Shifts in Divorce

Up to this point, we have focused on testing shock frequency for statistical reasons. However, since the previous analysis allows us to identify the times when possible structural breaks occur, we have meaningful information for exploring whether a structural break in a certain year can be related to a particular event. In this section, we present potential explanations for the permanent changes in the divorce rate series discussed in Section 3.

Researchers have looked at several determinants of divorce behaviour mainly using US data: the divorce law reforms (Friedberg, 1998; Wolfers, 2006; González and Viitanen, 2009; González-Val and Marcén, 2011), the effect of major wars (South, 1985; Anderson and Little, 1999), economic changes (Nunley, 2009), variations in female economic empowerment and in female labour force participation (Bremmer and Kesselring, 2004; Nunley and Kietz, 2009), unemployment (Jensen and Smith, 1990), public transfers, tax laws and welfare reforms (Bitler et al., 2004; Tjøtta and Vaage, 2008), property distribution within marriage (Gray, 1998), child support enforcement (Nixon, 1997; Heim, 2003), child custody (Halla, 2011), fertility behaviour (Svarer and Verner, 2008), legal access to the pill (Goldin and Katz, 2002; Nunley and Kietz,

2009), religiosity (Vaaler et al., 2009), television (Chong and La Ferrara, 2009) and even culture (Furtado et al., 2011).

Among all these possible factors that may influence the behaviour of divorce, the most likely explanation for the permanent changes in divorce rates in Europe is the liberalization of divorce laws that swept Europe. First, policy reforms and the introduction of new laws can be considered major events that may cause structural breaks (see, for instance, the Boston Gun Project, Piehl et al. 2003, Public Interest Litigation in India, Rathinam and Raja, 2008, the California Under-age Drunk Driving Laws, Kuo, 2011, and even the divorce laws and the laws that regulate the aftermath of divorce in the US, González-Val and Marcén, 2011). Variations in other socio-economic determinants of divorce, such as the increase in female labour force participation, the decline in the fertility rate, variations in religiosity or culture, among others, are less feasible as major events that caused the sudden changes in the European divorce rates described above, because these factors are certainly slower to change (they are changing over long periods) and so we would not expect a sharp response of divorce to fluctuations in those factors. Second, the timing of the reforms is quite close to, or even coincides with, the dates on which structural breaks are detected (detailed comparison of the timing of the reforms and the years in which a break is located for stationary series is carried out in subsection 4.2). The implementation of other policies, such as those allowing access to the pill in Europe, precedes by several years the exact dates on which structural breaks are located, and thus it is less probable that those reforms generated those abrupt changes in divorce rate series (legal access to the pill in Europe is studied by Bellido and Marcén, 2011). Third, from a theoretical point of view, the liberalization of divorce laws may cause a permanent change in the divorce rate. As mentioned in Matouscheck and Rasul (2008), the liberalization of divorce laws generated a one-off and permanent reduction in the costs of divorce. There is a consensus about this permanent reduction in the costs of exiting a marriage in the law and economics literature, and in the opinions of legal practitioners. Thus, under the new legal regime, divorce is less costly and consequently more probable, which can lead to higher divorce rates. Additionally, the change from mutual consent divorce to unilateral divorce may change the way in which spouses bargain to prevent a divorce. In Coasian terms, under mutual consent divorce, the party who wants to divorce has to compensate the spouse who wishes to continue married, in such a way that mutual consent gives considerable power to spouses who do not want a divorce (Becker, 1981). However, the change to a unilateral system transfers the right of divorce to the spouse most wanting a divorce. Under unilateral divorce, it is the party who wants to continue being married who has to compensate the spouse who wishes to leave (Becker, 1981). As Allen and Gallagher (2007) explain, the outcome under each regime is highly unlikely to be the same. If, for example, transaction costs are quite high, the spouse who wishes to continue married may be

unable to compensate the partner, and hence, a higher divorce rate may be observed under unilateral divorce (Allen, 2002).

To check this further, we simply compare the timing of the reforms with the year in which a break is located for stationary series, in order to observe whether they coincide. This is quite common in the literature; González-Val and Marcén (2011) carry out the same exercise using US divorce rate data. Of course, we acknowledge that such an explanation is interpretive in nature and we cannot strictly speak about a causal relationship between divorce law reforms and divorce rates using this methodology as, for instance, Wolfers (2006) and González and Viitanen (2009) do. In the next subsection, we briefly review divorce law reforms that were passed in the period under consideration, throughout Europe, to make the comparison easier.

4.1 A Brief Review of Divorce Law Reforms

We can distinguish two main periods of divorce law reforms since 1930 (see Table 6). The first occurred in the inter-war period, and mainly consisted in added fault grounds or added egregious behaviours that were acceptable reasons for requesting a divorce.[13] In England, in the year 1937, the grounds for divorce were explicitly extended beyond adultery, but this law also incorporated a restriction in order to prevent hasty divorces. [14] In 1938, there was also a divorce reform in Scotland but, as in England, it was limited to extending fault grounds (Doroghi, 1955). The law adopted in Germany and Austria in 1938 was more liberal (Phillips, 1991), adopting irretrievable breakdown as a no-fault ground.

The second wave of reforms swept Europe since the 1970s. The timing of the main reforms is summarized in Table 6. [15] Divorce laws were passed for three different systems: no-fault, unilateral, and separation (non-explicit unilateral divorce). Under no-fault laws, a couple could divorce for any reason, normally the "irretrievable" breakdown of the marriage or "irreconcilable differences". This law did not attribute blame to either party, but mutual consent was usually necessary. Under the unilateral system, divorce required the consent of only one person, and did not specify a period of living apart; a divorce could be instigated without the consent of the spouse. In the separation system, evidence that the couple had lived apart for a

[13] Faults mostly consisted of adultery, desertion, or cruelty.

[14] The Matrimonial Causes Act of 1937 included the grounds of cruelty, desertion in excess of three years and incurable insanity. The last of these grounds constituted the first example of 'no fault' divorce known to English law (Lowe, 2002). To avoid hasty divorces, no petition of divorce could be presented during the first three years of marriage (Lowe, 2002). This bar was later reduced in 1984 (see Table 6).

[15] This information comes from the Commission on European Family Law, http://www.ceflonline.net, González and Viitanen (2009), Dutoit et al. (2000), and National Legislations.

specified period was needed as a requisite for divorce, at the request of either of spouse. Italy represented a special case, since divorce was actually banned until 1970.

Beginning in the late 1960s and continuing in the 1980s, 7 countries passed no-fault divorce laws; 11 permitted divorce when a couple had lived apart for a specified period, allowing unilateral divorce, where separation was considered to be proof of the irretrievable breakdown of the marriage. Additionally, one country (Norway) allowed this ground in the 1990s and another (Switzerland) in 2000. Only two countries (Finland and Sweden) recognized unilateral divorce, the right to divorce at the request of either spouse without a separation requirement. [16]

4.2 Structural Breaks and Divorce Law Reforms

To explain the apparent permanent shifts in the divorce rate series, we focus on comparing the timing of divorce laws and the timing of structural breaks, which are determined by using the Bai and Perron test, as González-Val and Marcén (2011) do with US divorce rate series. For illustrative purposes, Figure 2 plots the divorce rates, along with the permanent breaks in their means (dashed lines) and the divorce law reforms (vertical lines), for the sixteen countries.

We first focus on the nine countries for which the Bai and Perron test is applicable, that is, those countries for which the unit root null can be rejected in favour of a stationary process around occasional breaks. As can be seen in Figure 2, all no-fault reforms implemented in these countries can be associated with structural breaks. For France, the Netherlands, and the United Kingdom, structural breaks are located close to the passing of the laws. Although the year in which those breaks are located does not coincide with the exact date on which the laws were passed, these reforms are also likely to generate those permanent changes in the divorce rates since; as explained by Kuo (2011), there are often lags due to information acquisition and the costs of adjustment in the impact of law reforms. [17]

In the case of the separation system (non-explicit unilateral divorce) all the reforms that were passed from the late 1960s until the late 1970s can also be associated with the structural breaks found in that period. As previously seen, we observe lags in the Denmark and Germany series but not in Belgium. A special case is Iceland, since the break is found two years before the reform, although the year of the reform, 1972, is included in the confidence interval of the

[16] Later reforms, such as those introduced in France in 2005, were not included in Table 6 since changes in the divorce rates cannot be detected with this methodology due to the proximity of the end of the sample.

[17] Lags are also observed in the case of US divorce law reforms (González-Val and Marcén, 2011).

break date at the 95% level, suggesting that this permanent change in the divorce rate series can be due to the divorce law reform. With respect to the reforms introduced later, but also classified as separation system, it is possible to relate the structural break detected in the Belgian divorce rate series in 1991 to the reforms that occurred in Belgium in the 1980s. [18] However, none of the breaks can be related to the divorce law reform that was approved in 2000 in Belgium. It is possible to argue that our analysis is unable to detect breaks in this series due to the proximity of the end of the sample, as in other cases that we mention below, but it could also be that subsequent reforms that only introduced minor changes in the area of the separation system, as those passed in Belgium, are less likely to be major events causing a structural change in the divorce rate series. [19] Similarly, the reforms that were enacted in Iceland in 1993 and Denmark in 1989, are also less likely to permanently change the divorce rate, since there were major reforms under the same regime some years before. [20] The last stationary series subject to structural breaks, that also passed a non-explicit unilateral divorce reform in 2000, is the Swiss series. In this case, we detect no structural break close to that year. As explained above, due to the proximity of the end of the sample, the methodology applied here is less likely to detect breaks in those years. The separation period also complicates the detection of the break, since 4 years were required to get a divorce at that time in Switzerland, which could have delayed the impact of the law through the end of our series.

Just one of the series for which the Bai and Perron test is applicable introduced explicitly unilateral divorce, Sweden. As in the case of Iceland, the structural break in the Swedish divorce rate series was found 2 years before the divorce law reform, but the year of the reform, 1974, is also included in the confidence interval of the break date at the 95% level, again pointing to a relationship between this permanent change in the divorce rate series and the divorce law reform.

For the remaining seven countries, as explained above, we cannot strictly speak of a change in the mean due to a structural break, but it is comforting that the structural breaks are located close to the divorce law reforms. Specifically, all no-fault reforms can be related to permanent changes in the divorce rate series. These reforms were enacted in Austria, Greece, Italy, Luxembourg, and two in Portugal. Also, in the case of the Austrian divorce rate series, a second permanent change, located in 1979, may be associated with a divorce law reform

[18] The separation period was considerably reduced from 10 to 5 years in Belgium, which also simplified the divorce procedure in the 1990s, in a year close to that break (see Table 6). This clearly made divorce easier in Belgium.

[19] The separation period was reduced to 3 years.

[20] The separation period fell to just one year in both countries.

introduced under the separation system regime in 1978. The separation system enacted in Greece, Luxembourg and Portugal, does not seem to be related to any of the detected structural breaks, but the absence of structural breaks can be justified by the proximity of previous reforms. As can be seen in Table 6, previous reforms were passed with a difference of only 2 to 4 years (4 years for Greece, 3 years for Luxembourg and 2 years for Portugal). Thus, even considerably reducing the trimming of the Bai and Perron test, it is hard to find two permanent changes so close to each other. The last permanent change found in the Norwegian divorce rate series can also be related to the separation system approved in Norway, since, as in the case of Sweden and Iceland, the year of the adoption of that law is included in the confidence interval of the break date at the 95% level. However, it is worth noting that this permanent change could be due to other reforms introduced in Norway (we analyse this issue more closely below). Finally, the only country in this group that enacted a unilateral divorce reform was Finland, which can clearly be connected to the permanent change found in the year of the reform, suggesting a permanent impact of unilateral divorce on the divorce rate.

To sum up, we observe that all the no-fault and unilateral reforms can be associated with permanent changes in the divorce rate series, since the years of the reforms are quite close to, or even coincide with, the years in which structural breaks are located. Most of the separation system reforms can also be related to structural breaks. The lack of detection of permanent changes close to some of the separation system reforms, as explained above, is mainly due to the closeness of the end of the sample, or to the proximity of these reforms to other major law changes, but this only occurs in a few cases. To provide additional evidence of the relationship between the divorce law reforms and permanent changes in the divorce rate series, we also calculate the Pearson correlation between the year of the reforms and the timing of the closest structural breaks. If we consider all the breaks, correlation is 0.6. However, a few breaks are clearly far from the year of the reforms; when we consider only the breaks detected within a range of 20 years from or until the year of the reform (87.10% of the breaks) correlation increases to 0.82. Moreover, if we set the maximum range between the timing of the breaks and the year of the reforms to 15 years (this is the case in 77.42% of the breaks) our results show a high level of correlation, 0.91. These findings suggest that the permanent changes detected in the time-series analysis appear to be due to changes in the divorce law. [21]

Although, throughout this section, particular emphasis is placed on convincing readers that permanent changes in divorce rate series are driven by divorce law reforms, there is also

[21] We acknowledge that, strictly speaking, we cannot say that there is a causal link between the reforms and the permanent changes using this methodology. However, it is worth noting that the analysis developed here also presents some advantages that we discuss below.

another potential explanation for some of the permanent changes observed in the 1940s. These abrupt changes can be associated, not only with the first wave of divorce law reforms, but also with World War II.[22] It is not clear whether the divorce law reforms caused those breaks, since major wars have also been suggested as causing permanent changes in the divorce rate series.[23] In order to avoid this conflict period, we have re-run all the analysis with shorter series using information on the divorce rate from 1945 to 2006 and also from 1950 to 2006. Our results do not change substantially, again providing evidence in favour of a potential association between divorce law reforms and permanent changes in divorce rates.[24]

In this analysis, we have also left out some structural breaks, since they cannot be associated with reforms that regulate the grounds of divorce. For instance, in the case of the Swiss and the Nordic divorce rate series, some of the permanent changes were found in the 1970s but they cannot be related to divorce law reforms because those laws were passed more than 20 years later.[25] Then, there may be other factors that can be associated with all the breaks located in the 1970s, invalidating the divorce law hypothesis. However, there is also another possible explanation for those permanent changes that are not likely to be driven by divorce law reforms governing the grounds of divorce.

As González-Val and Marcén (2011) explain, the adoption of other laws that affect divorce decisions can also generate permanent changes in the divorce rate series. In addition to those laws that regulate the grounds for divorce, there were also reforms in the area of post-divorce property division and parental responsibilities in Europe that are likely to be related to permanent changes in the divorce rate series.[26] In Switzerland, two main reforms were enacted in the 1970s, revising child laws to improve the mother's position by the abolition of the father's right to make final decisions in disputes (Hausheer et al., 2005), and in the late 1980s regulating property division in order to achieve gender equality by increasing the protection of housewives and the autonomy of the spouses to contractually vary the property regime (Schwenzer and Bock, 2008). Both reforms can be associated with permanent changes in the

[22] Philips (1988) enumerates the main factors that could have produced the rise in the divorce rate in the 1940s, such as the weakening of marriages under wartime conditions, the increase in war marriages, the separation imposed by the war, and wartime adultery.

[23] In the US, González-Val and Marcén (2011) find a wave of positive breaks in divorce rates at the time of the Vietnam War, in almost all states.

[24] This additional empirical evidence is available upon request.

[25] They are not highly correlated. Also, note that some of those permanent breaks are found in non-stationary series, so that, as mentioned above, we cannot strictly speak of changes in the mean.

[26] We recognize that some of these reforms were passed at the same time as those laws regulating the grounds for divorce, making it difficult to separate the impact of both reforms.

Swiss divorce rate series located in 1975 and 1991. Nordic countries also passed laws governing the aftermath of divorce that can be related to the unexplained permanent changes found in the period analysed. In Finland, law reforms related to child support enforcement, adopted in the 1970s, are likely to be associated with the permanent changes detected in that period (Kurki-Suonio, 2005). In the case of Norway, reforms in the area of property division enacted in the 1970s (Sverdrup, 2008), and in the area of parental responsibilities in the 1980s (Lødrup ad Sverdrup, 2005), are likely to explain the permanent changes located in the 1970s and 1980s in the Norwegian divorce rate series. [27] Thus, this analysis also provides support to the divorce law hypothesis, since other reforms are likely to explain the unexplained permanent changes that are found in the 1970s and in the following decades.[28]

Finally, in order to analyse whether a pattern in the evolution of divorce rate series exists across Europe, we also look at the distribution of all structural breaks. Results indicate that the major events that could have caused the structural breaks in the divorce rate series do have similar effects on divorce rates within specific periods, but that those effects vary over time. In Figure 3, we plot the change in each country's mean divorce rate, after the estimation of the structural breaks obtained by the Bai and Perron procedure. We observe that persistent changes have an inverted U-shape; the size of the effect is lower in the 1940s, increases in the late 1960s, achieves a peak in the 1970s, and then decreases in the 1980s and 1990s.

5. Conclusions

The purpose of this paper is to provide evidence regarding the frequency of permanent shocks in the divorce rates of sixteen European countries. In the majority of these countries, the evolution of the divorce rate has provoked much concern among researchers and policy makers because of the high and persistent divorce rate that is observed from the 1970s, and its effects on women and children. The main advantage of the methodology utilized in this paper is that it lets data "speak for themselves" (Piehl et al., 2003; Kuo, 2011; González-Val and Marcén, 2011),

[27] Other reforms that may also cause the rest of the posterior unexplained permanent changes are those reducing the costs of divorce by facilitating divorce procedure, in Luxembourg in the mid-1990s (Table 6), and the reduction in the number of years of marriage required to divorce in the United Kingdom in 1984. Quite close to those reforms, we have also detected permanent changes in the divorce rate series. Subsequent reforms in Italy and Greece can also explain the unexplained permanent breaks located in the 1990s, in both series.

[28] It is worth noting that, in contrast to the findings of González-Val and Marcén (2011) when using US data, here all shocks have a positive impact on divorce. This could be due to the fact that policy reforms in the US mainly affect the non-custodial parent, normally men, but in Europe, these changes in the law aimed to increase the power of women. In this paper, we do not attempt to analyse the gender nature of these changes.

allowings us to test whether there have been permanent changes in divorce rates, and when those permanent changes took place, without imposing any a priori timing (such as the years of the law changes). A further attractive feature of our approach is that it provides valuable information for determining whether a structural break in a divorce rate can be associated with a special event.

The clear result of this analysis is that not all shocks have transitory effects on European divorce rate series. This result is robust to a range of alternative tests that are presented. We observe that there is no single scenario to identify the behaviour of the European divorce rate series. We find evidence of stationarity around a process that is subject to structural breaks and of unit root. In the first case, only a few occasional shocks have permanent effects, and in the second, all shocks have permanent effects on the divorce rate.

These findings can also be related to the literature evaluating the effects of divorce laws on divorce rates. Unlike some papers that find a transitory impact of divorce law reforms (mainly unilateral divorce reforms) as Wolfers (2006) for the US and González and Viitanen (2009) for Europe, providing support to the Coasian assumption of efficient bargaining, in our case, the finding that the permanent changes in European divorce rates can be associated with the major changes in divorce laws enacted in several European countries calls into question the applicability of the Coase theorem to marital dissolution.[29] We view our results as adding support to the research that suggests a positive and permanent impact of divorce law reforms on the evolution of divorce rates, in line with recent works such as González-Val and Marcén (2011).

Acknowledgements

Rafael González-Val acknowledges financial support from the Spanish Ministerio de Educación y Ciencia (ECO2009-09332 and ECO2010-16934 projects), the DGA (ADETRE research group), and FEDER. Miriam Marcén acknowledges financial support from the Spanish Ministerio de Educación y Ciencia (ECO2008-01297 project). We benefited from the helpful comments of Olivier Donni, Adriaan Kalwij, Victor Montuenga, Almudena Sevilla-Sanz, and Arantza Ugidos. Comments from anonymous reviewers have also improved the version originally submitted. We thank Marcos Sanso-Navarro for suggesting the title. Earlier versions of this paper were presented at the 64th European Meeting of the Econometric Society (Barcelona, 2009) and at the XXXIV Symposium of Economic Analysis (Valencia, 2009), with all the comments made by participants being highly appreciated. All remaining errors are ours.

[29] In Coasian terms, a change in divorce law only generates a redistribution of the property rights between spouses, thus divorce reforms are not expected to affect the divorce rate (Becker 1981). Wolfers (2006) suggests that a transitory and small impact of divorce law reforms on divorce rates can also be considered as being consistent with the Coase theorem, since this may indicate that couples are able to bargain efficiently under the new legal regime.

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Tables

Table 1. Descriptive statistics of the sample

Country	Mean	Stand. Dev.	Max.	Min.	Period	Years
Austria	1.47	0.68	2.56	0.09	1930-2006	77
Belgium	1.23	0.95	3.45	0.22	1930-2006	77
Denmark	1.95	0.74	2.95	0.65	1930-2006	77
Finland	1.51	0.83	2.89	0.31	1930-2006	77
France	1.17	0.63	2.50	0.28	1930-2006	77
Germany[1]	1.54	0.62	2.60	0.61	1947-2006	60
Greece	0.57	0.30	1.30	0.17	1958-2006	49
Iceland	1.22	0.64	2.18	0.24	1930-2006	77
Italy	0.45	0.20	0.80	0.19	1971-2006	36
Luxembourg	1.02	0.80	2.50	0.03	1930-2006	77
The Netherlands	1.17	0.74	2.36	0.33	1930-2006	77
Norway	1.22	0.77	2.54	0.29	1930-2006	77
Portugal	0.56	0.66	2.30	0.04	1930-2006	77
Sweden	1.62	0.79	3.33	0.36	1930-2006	77
Switzerland	1.35	0.64	2.91	0.67	1930-2006	77
United Kingdom	1.51	1.15	3.08	0.08	1930-2006	77

Source: UN Demographic Yearbooks and Eurostat.

Note: [1]Germany includes the German Democratic Republic

Table 2. Results of unit root tests on divorce rates

A: Country specific tests	% Unit root rejected		
Significance level	Trend stationarity	Trend stationarity with one break	Trend stationarity with two breaks
1%	0.00%	12.50%	12.50%
5%	12.50%	43.75%	18.75%
10%	31.25%	43.75%	37.50%

B: Panel tests (p = 1)	Test-statistic (p-value)	
Statistic Type	Balanced panel[1]	Unbalanced panel[2]
Levin–Lin–Chu (2002)	-0.947 (0.172)	
Im–Pesaran–Shin (2003)	-1.988 (0.023)	-4.073 (0.000)
Pesaran (2007)	-1.329 (0.092)	-1.861 (0.031)

Notes: The null hypothesis is the existence of a unit root in divorce rate in all cases. We choose the optimal number of lagged growth rates to be included in the regression to control for autocorrelation using a 'general-to-specific procedure' based on the t-statistic, see Ng and Perron (1995). The maximum lag length to begin this procedure is set at 11. The panel test statistics are the t^*, the $W[\bar{t}]$, and the $Z[\bar{t}]$-statistic in case of the Levin–Lin–Chu, Im–Pesaran–Shin, and Pesaran test respectively.

[1] Excluding Germany, Greece and Italy.

[2] Including all countries.

Table 3. Results of unit root tests on divorce rates with one structural break test

Country	δ	$(\hat{\rho}-1)$	Structural Break Year
Austria	1.04865***	-0.167	1979
Belgium	1.80242***	-0.077	1996
Denmark	1.30622***	-0.283**	1972
Finland	1.47677***	-0.151	1975
France	1.17906***	-0.340***	1978
Germany	0.83457***	-0.333***	1976
Greece	0.51521***	-0.239	1996
Iceland	1.16039***	-0.333**	1966
Italy	0.32726***	-0.332	1993
Luxembourg	1.55066***	-0.252	1979
The Netherlands	1.41294***	-0.328**	1974
Norway	1.47264***	-0.173	1982
Portugal	1.47106***	-0.134	1993
Sweden	1.42242***	-0.287**	1969
Switzerland	1.1428***	-0.291	1973
United Kingdom	2.16492***	-0.287**	1973

Notes: One-break test of Perron and Vogelsang (1992), AO model.
Structural break year dummy variable coefficient δ:
Significant at the *** 1% level; ** 5% level, * 10% level
$(\hat{\rho}-1)$: H_0: Unit root rejected at *** 1% level, ** 5% level, * 10% level

Table 4. Results of unit root tests on divorce rates, double structural break test

Country	δ_1	δ_2	$(\hat{\rho}-1)$	Year of 1st Break	Year of 2nd Break
Austria	1.03855***	0.82017***	-0.495	1940	1979
Belgium	1.14391***	1.06912***	-0.497*	1975	1989
Denmark	0.72623***	1.06978***	-0.559**	1943	1972
Finland	1.24115***	0.59594***	-0.274	1968	1990
France	0.35489***	1.0849***	-0.446*	1942	1978
Germany	0.47493***	0.47045***	-0.349	1969	1976
Greece	0.33292***	0.31033***	-0.564	1981	1996
Iceland	0.41527***	1.03548***	-0.620	1943	1969
Italy	0.1922***	0.25034***	-0.648	1984	1997
Luxembourg	1.41351***	0.46289***	-0.308	1979	1998
The Netherlands	0.745***	0.78332***	-0.418	1969	1977
Norway	0.85443***	0.81167***	-0.307	1970	1982
Portugal	0.72414***	0.91664***	-0.407	1978	1993
Sweden	0.66193***	1.16103***	-0.715***	1946	1971
Switzerland	0.82341***	0.62***	-0.745***	1973	1989
United Kingdom	0.53848***	1.93239***	-0.501*	1948	1973

Notes: Two-break test of Clemente-Montañés-Reyes (1998), AO model.
Structural break year dummy variables coefficients δ_i:
Significant at: *** 1% level, ** 5% level, * 10% level
$(\hat{\rho}-1)$: H_0: Unit root, rejected at: *** 1% level, ** 5% level, * 10% level

Table 5. The multiple break model

Country	Mean Divorce Rate Before Break	Mean Divorce Rate *Year*		
		TB_1	TB_2	TB_3
Austria[1]	0.29	1.33	2.15	
		1940	*1979*	
Belgium	0.52	1.69	2.83	
		1974	*1991*	
Denmark	1.31	2.67		
		1970		
Finland	0.80	1.99	2.62	
		1970	*1987*	
France	0.72	1.89		
		1976		
Germany	1.28	2.20		
		1979		
Greece[1]	0.39	0.68	1.03	
		1979	*1994*	
Iceland	0.40	0.72	0.95	1.85
		1945	*1957*	*1970*
Italy[1]	0.27	0.51	0.74	
		1986	*1999*	
Luxembourg	0.43	1.74	2.33	
		1976	*1995*	
The Netherlands	0.54	1.96		
		1972		
Norway	0.37	0.72	1.65	2.29
		1944	*1973*	*1986*
Portugal[1]	0.11	0.88	1.88	
		1975	*1995*	
Sweden[1]	0.52	1.22	2.40	
		1944	*1971*	
Switzerland[1]	0.87	1.77	2.34	
		1975	*1991*	
United Kingdom[1]	0.15	0.73	2.43	2.84
		1945	*1971*	*1982*

Note: The entries in columns 3 to 5 are the mean divorce rates following the break, with the break date reported in italics.

[1]The $supF_T(1)$ test was not significant for any of these countries. Thus, the sequential procedure found no break. However, the BIC and LWZ select more than one break, and the $F_T(2)$ and $F_T(l + 1|l)$ with $l \geq 1$tests were all significant overall, suggesting a model with more than one break. Then, we use the LWZ method to determine the number of breaks.

Table 6. Divorce law reforms from 1930 to 2000

	No-fault	Separation-Unilateral
Country	Year	Year (Separation Period)
Austria	1938[1]	1978 (6)
Belgium[2]	(pre-1930)[3]	1974(10), 1982 (5), 2000 (2)
Denmark	(pre-1930)[4]	1969 (3), 1989 (2)
Finland	(pre-1930)[1,5]	1987 (0)
France	1975	1975 (6)
Germany	1938[1,6]	1976 (3) [7]
Greece	1979	1983 (4)
Iceland[8]	(pre-1930)	1972(3), 1993 (2)
Italy[9]	1987	None
Luxembourg	1975[10]	1978 (3)
The Netherlands	1971	1971 (2)
Norway	(pre-1930)	1991 (1)
Portugal	(pre-1930)[11], 1975, 1995[12]	1977 (3)
Sweden	(pre-1930)	(pre-1930) (3),1973 (0)
Switzerland	(pre-1930)	2000 (4)
United Kingdom	1937[13], 1969[14]	1969 (5)

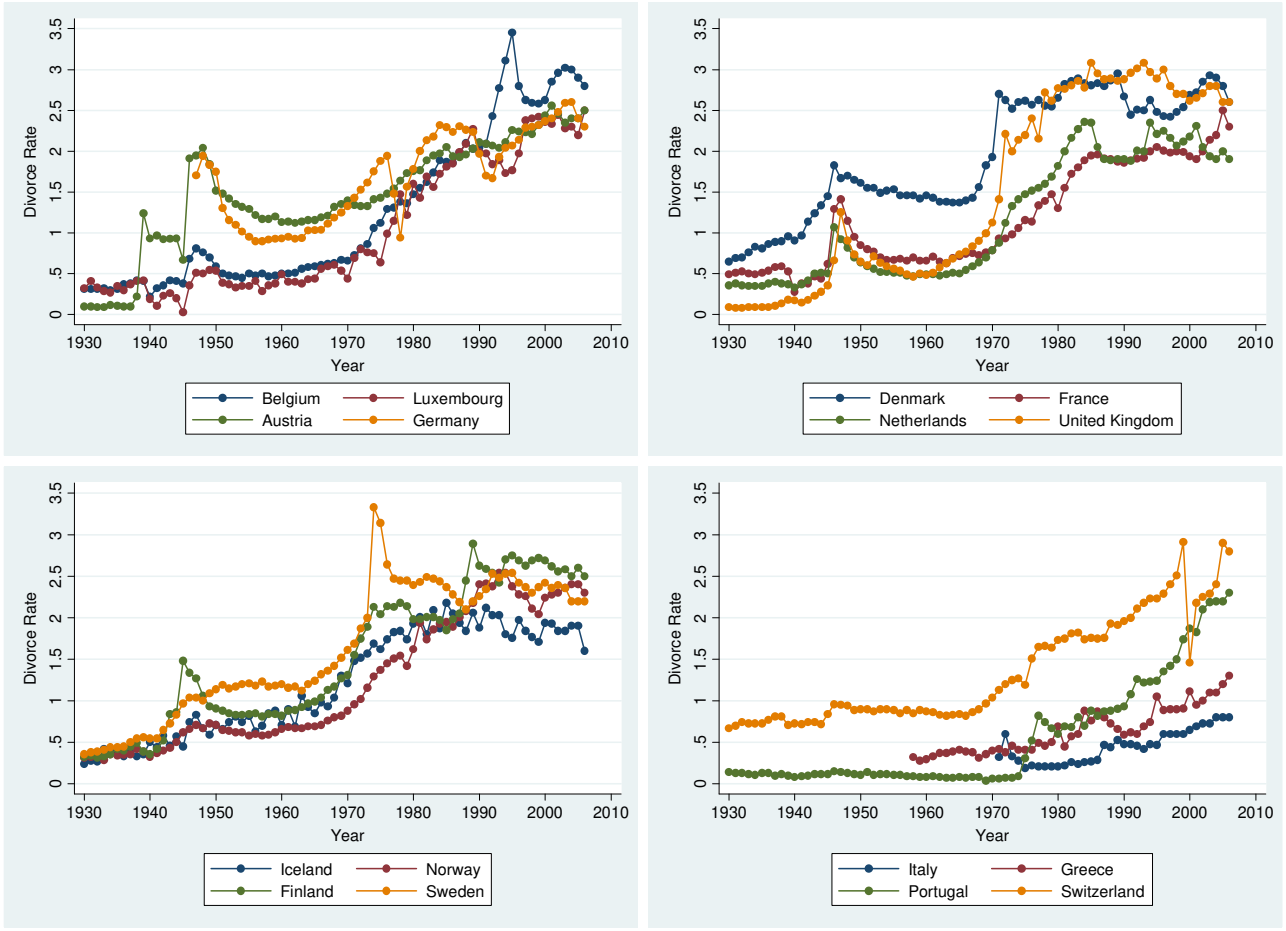
Source: Comission on European Family Law (http://www.ceflonline.net), González and Viitanen (2009), Dutoit et al. (2000) and National Legislations.
Notes: Column 2 shows the year of no-fault grounds for divorce. No-fault grounds for a divorce include irretrievable breakdown, irreconcilable differences and/or incompatibility. Column 3 shows the year when unilateral, or non-explicit unilateral divorce (separation system) was allowed. Unilateral divorce does not require mutual consent and can be granted at the request of either spouse. The dates correspond to the year when a certain reform was enacted. The length of the specified separation period in years in parenthesis indicates that unilateral divorce was not introduced explicitly, but was in fact possible after a certain separation period, which served as proof of irretrievable breakdown of the marriage.

[1]Although it was based on the principle of fault, it also provided the grounds of irretrievable breakdown; see Roth (2002) for Austria, Savolainen (2002) for Finland and Martiny and Schwab (2002) for Germany.
[2] In 1994, a major reform of the divorce procedure in Belgium was introduced to make divorce easier, although the grounds for divorce did not change. The divorce procedure on the grounds of fault, separation, or mutual consent was considerably simplified (Pintens and Torfs, 2002).
[3] It also allowed divorce by mutual consent although it was quite restrictive, Pintens and Torfs, (2002).
[4] It introduced the right to separation in the event of an irretrievable breakdown, and the right to divorce after a certain period of separation (Lund-Andersen and Krabbe, 2002).
[5] Mutual consent was introduced in 1948, Savolainen (2002).
[6] In Western Germany, the 1961 Reform Act attemptied to introduce limits to the right of divorce. In Eastern Germany, irretrievable breakdown of marriage was adopted in 1965 (Martiny and Schwab, 2002).
[7] It was introduced in Eastern Germany after the German Unification in 1990, Martiny and Schwab (2002).
[8] National Legislation.

[9] Divorce was permitted in 1970. The Divorce Law was amended, introducing minor changes for the first time in 1978. The most important was adopted in 1987. This reform introduced divorce by joint petition, for a separation lasting 3 rather than 5 years (Patti et al., 2002).
[10] Mutual consent was adopted in Luxembourg in 1975. In 1997, reforms of the Civil Code of Luxembourg were implemented that affected divorce procedure (Dutoit et al., 2000).
[11] Only civil marriages could obtain a divorce from 1940 to 1975. The Portuguese Civil Code of 1966 did not apply to catholic marriages until 1975 (de Oliveira, 2002).
[12] The second major reform took place in 1995 in Portugal (Coelho and Garoupa, 2006). It provided for the spouses' possibility to request a divorce at the Civil Registry by mutual consent (de Oliveira, 2002).
[13] The grounds for obtaining a divorce were also extended; the Matrimonial Causes Act 1937 added the grounds of cruelty, desertion in excess of three years, and incurable insanity (the last of these grounds being significant in that it constituted the first example of 'no fault' divorce known to English law), Lowe (2002).
[14] The Divorce Act of 1969 was re-enacted by the Matrimonial Causes Act adopted in 1973 (Lowe, 2002). The divorce law for Scotland was passed in 1976 (Meston, 2002). In 1984, an important reform was passed, the Matrimonial and Family Proceedings Act. Under this new reform, a petition of divorce could be presented before the expiration of one year from the date of the marriage, rather than after 3 years (Lowe, 2002).

Figures

Figure 1. Divorce rate by country



Source: UN Demographic Yearbooks and Eurostat

Figure 2. Divorce rates and their changing means

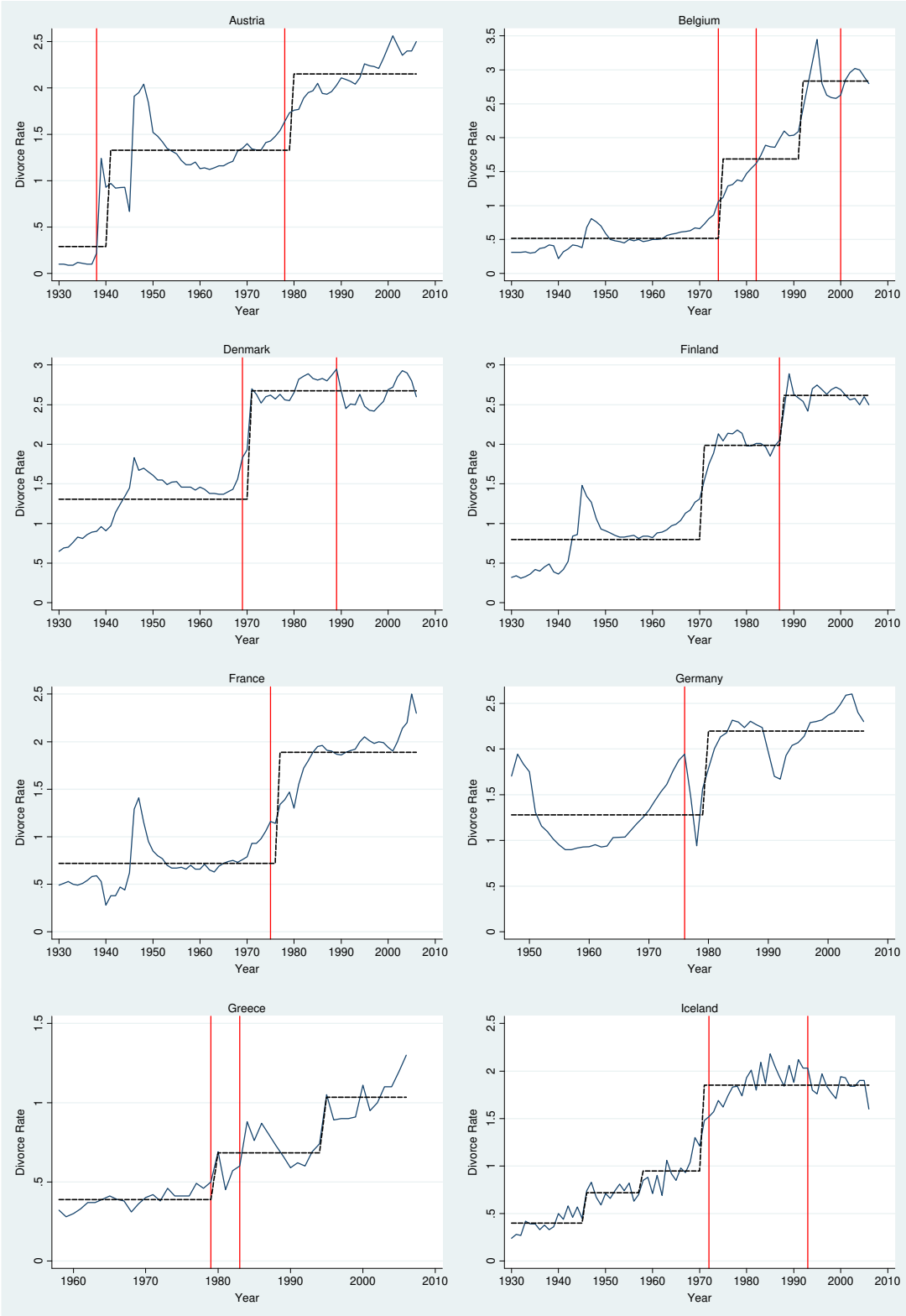
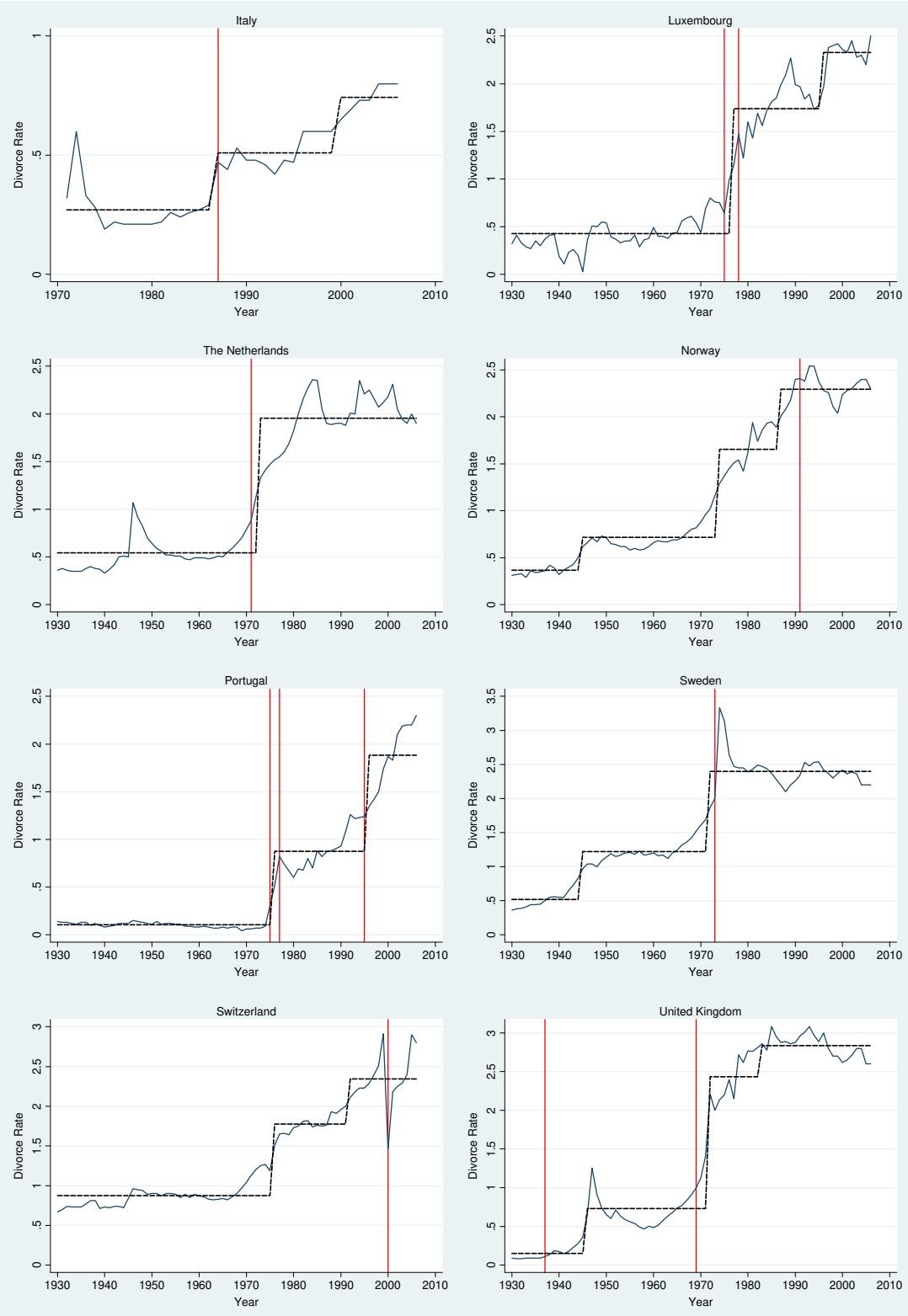
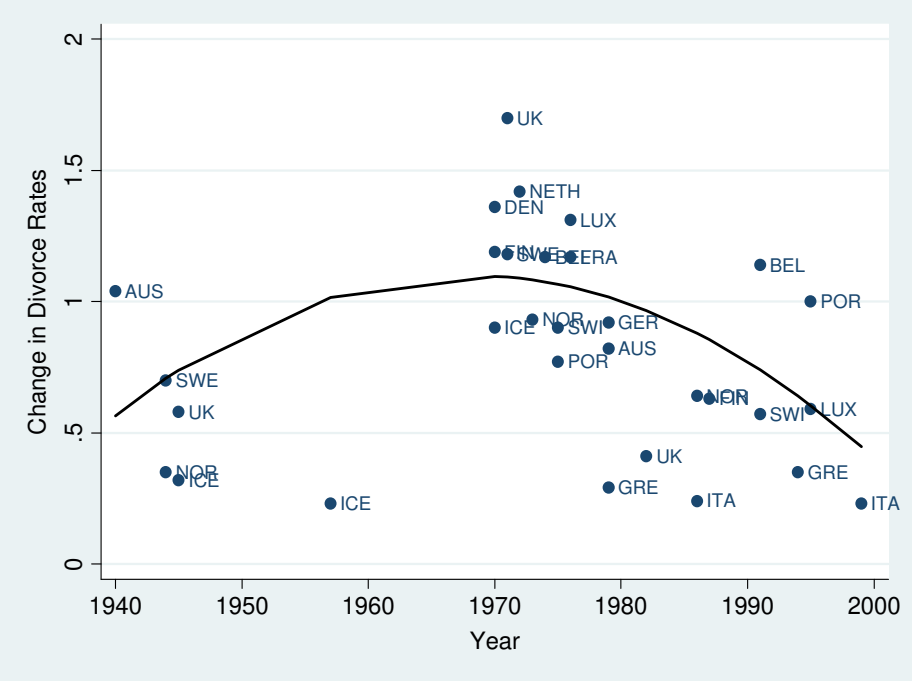


Figure 2. (continued)



Note: Figure 2 plots the divorce rates, along with the permanent breaks in their means (dashed lines) and the divorce law reforms (vertical lines).

Figure 3. Change in the divorce rate (structural breaks) over time



Note: Curve fitted as $y = ax^2 + bx + c$