Fertility and women’s employment reconsidered: a macro-level time series analysis for developed countries, 1960-2000

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Abstract

This paper examines causality and parameter instability in the long-run relationship between fertility and women's employment. This is done by a cross-national comparison of macro-level time series data from 1960–2000 for France, West Germany, Italy, Sweden, the UK, and the USA. By applying vector error correction models (a combination of Granger-causality tests with recent econometric time series techniques) we find causality in both directions. This finding is consistent with simultaneous movements of both variables brought about by common exogenous factors such as social norms, social institutions, financial incentives, and the availability and acceptability of contraception. We find a negative and significant correlation until about the mid–1970s and an insignificant or weaker negative correlation afterwards. This result is consistent with a recent hypothesis in the demographic literature according to which changes in the institutional context, such as childcare availability and attitudes towards working mothers, might have reduced the incompatibility between child-rearing and the employment of women.

Keywords: fertility, female employment, Granger causality, time series analysis, vector error correction models.

Introduction

The relationship between fertility and female labour force participation is a long-standing question in demography. One has generally argued that a negative association between these two variables is evidence for the incompatibility of rearing children and staying in the workforce in today's society, where the place of work and home are normally separated spatially. Decreasing fertility is thus associated with increasing female employment, and rising female employment is associated with falling fertility. It remains unclear whether these mutual relations are causal in one direction or the other.

The question 'What causes what?' has received renewed attention in the demographic literature in recent years. This interest resulted from recent studies, which have shown that a simple cross-country correlation coefficient between total fertility and the female labour force participation switched from a negative value before the 1980s to a positive value thereafter. The question then arises as to whether there is any causal relationship at all.

Several studies go beyond calculating the correlation and explicitly attempt to test for the existence and direction of causality between fertility and female employment. Due to substantive and methodical shortcomings, these studies have found conflicting results. Our paper aims to clarify the relationship between fertility and female employment in three specific ways. First, we apply methods that are designed to avoid the problem referred to as 'spurious regression' in the time series literature. Spurious regression refers to a situation in which the t-statistic indicates a significant relation between variables that are actually unrelated. This problem frequently plagues the analysis of variables with stochastic or deterministic trends, and it arguably afflicts existing efforts to estimate the causal relation between female labour force participation and fertility. Second, we estimate what are called 'vector error correction models', which are the appropriate models to test for causality between stochastic trending time series. These models distinguish between long-run and short-run causality. From a substantial point of view, one can interpret long-run causality as the macro-level effect from intended behaviour and short-run causality as the instantaneous effect from unintended behaviour. Third, we explicitly test for 'parameter instability', i.e., the possibility that the causal relation between total fertility and the female labour force participation has changed over time.

The structure of our paper is as follows. We first discuss the possible relationships between fertility and female employment from a micro-theoretical point of view. Then we discuss the gap in the existing macro-level time series literature that we aim to close with our paper. After a description of the data and an explanation of the applied econometric method we present the results, and conclude with a discussion.

Theoretical and methodical considerations

Micro explanations

At the individual level, numerous studies have shown a negative association between fertility and female labour force participation (e.g., Lehrer and Nerlove 1986; Brewster and Rindfuss 2000). On average, women in gainful employment tend to have fewer children, and women with children spend less time in the labour market. Weller (1977, pp.43) lists four possible explanations for this negative association:

1. women's fertility affect their labour force participation;
2. women's labour force participation affect their fertility;
3. both women's fertility and their labour force participation affect each other; and
4. the observed negative relationship is spurious and is caused by common antecedents of both variables.

According to the above mentioned role incompatibility hypothesis, both women's fertility and their labour force participation affect each other reciprocally because of the strain between the roles of mother and employee. Nothing in this hypothesis suggests causality in one direction rather than the other (Lehrer and Nerlove 1986).

Following Becker (1960), economic theory views fertility and female employment to be simultaneously determined by the same basic economic variables (Engelhardt and Prskawetz 2002). This view corresponds to explanation 4 in the above list. More specifically, female labour market participation and fertility are both choice variables, which households choose simultaneously, given their exogenous constraints. If both variables fluctuate to some extent synchronously, then – according to the logic of economic theory – this must be caused *entirely* by external variables that determine both variables exogenously. Examples of such external variables are the real wage of women, unemployment and – according to recent work by some economists – social norms (Palivos 2001, Ishida 2003), but also the availability and acceptability of contraception (Murphy 1993).

Many researchers would not go as far as economic theory and would argue that at least part of the correlation between fertility and female employment is not determined by external variables. Some of these researchers view fertility and female employment as the result of a sequential decision process rather than of a simultaneous decision problem. If these variables are indeed the result of the former, then it is quite possible that one variable exogenously causes the other. The hypothesis of a sequential decision process corresponds to hypothesis 1 and 2 in the above list.

Macro studies

Given the explanations of the fertility/employment nexus on the micro level mentioned above, it is no wonder that previous empirical research has concentrated mainly on micro-level data (for an extensive review of the micro literature, see Cramer 1980; Lehrer and Nerlove 1986; Spitze 1988). However, work intentions may cause actual fertility behaviour and fertility intentions may cause actual work behaviour. That is, intended events in the future may cause present behaviour (Bernhardt 1993; Ní Bhrolcháin 1993). Macro-level studies – and especially cross-national comparisons – are an alternative way to answer the fertility/employment question because they do not require detailed individual-level data (see Rindfuss and Brewster 1996, p.262, who also stress the value of a cross-national assessment). However, relationships at the individual and the aggregate level may be different (cf. Ní Bhrolcháin 1993). For example, Smith-Lovin and Tickamyer (1981) find in individual data of married women in the US evidence for two types of women. One type are career-oriented women, who leave the labour market for only a very short time in order to bear children, and another type are family-oriented women, who leave the labour market for a very long time after first birth. If such heterogeneity exists, then on the one hand one cannot draw conclusions about individual behaviour from macro-level data. On the other hand, if in addition the composition of career-oriented women and family-oriented women in all women changes over time, then one can also not draw conclusions regarding the macro-level time series relation between fertility and female employment from individual data (see also Kohler and Kohler 2002; Ryder 1980).

Economic theory argues that under certain conditions the aggregate of choices of individuals can be summarized by that of a ‘representative agent’ (Lewbel 1989). In this case it is straightforward to conclude from macro-level results to individual behaviour. If the assumption of a representative agent is very unrealistic, then different individual behaviour can lead to the same macro-level result and empirical micro-level analysis is important for an understanding of individual behaviour.

There is a substantial literature that tests for evidence of economic theories of fertility behaviour in post-war time series data. For example, Butz and Ward (1979) apply a model of the 'new home economics' to US data, while Easterlin (1968) suggest and tests with US data a theory which implies an effect from a families relative economic status on fertility. Ermisch (1979) tests the relevance of the models of Butz and Ward, and Easterlin for data of Great Britain. Cooman et al. (1987) investigate the effect of labour market developments on fluctuations in births in England and Wales separately for the first four parities proceeding to another birth. Murphy (1992) critically assesses the relevance of economic models for British data.

Existing macro studies on the relation between total fertility and female employment can be divided into studies that analyse macro-level data on a cross-country basis and studies that apply the methods of time series analysis. Various authors (Ahn and Mira 2002; Brewster and Rindfuss 2000; Esping-Andersen 1999; Rindfuss et al. 2003) challenge conventional wisdom. They find that in OECD countries, the cross-country correlation between total fertility (TFR) (the sum of age specific fertility rates) and female labour market participation (FLP) turned from a negative value before the 1980s to a positive value thereafter. The countries that now have the lowest levels of fertility are those with relatively low levels of female labour force participation, and the countries with higher fertility levels tend to have relatively high female labour force participation. Following the graphical presentation in the literature (e.g., Ahn and Mira 2002; Rindfuss et al. 2003), Figure 1 illustrates this change for 21 OECD countries.

Insert Figure 1 about here

Several recent papers have suggested that the link between fertility and female employment weakens due to greater availability of child care services, family policies (such as state mandated maternity leave) and changing attitudes towards working mothers (Brewster and Rindfuss 2000; Rindfuss et al. 2003; Rindfuss and Brewster 1996). For that reason, they argue that changes in the institutional context at the macro-level must have enabled women in some countries to combine work and child rearing more successfully.

The cross-sectional studies do not, however, explicitly address the causality question. This is done in studies that apply formal Granger causality tests to aggregate time series in different countries (Cheng 1996; Klijzing et al. 1988; Michael 1985; Zimmermann 1985). The standard Granger causality test is typically based on the estimation of a dynamic model with variables in levels or in first differences:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m_Y} \alpha_{Y,i} \Delta Y_{t-i} + \sum_{j=1}^{n_Y} \beta_{Y,j} \Delta X_{t-j} + u_t \,, \ (1)$$

where $\Delta Z_t = Z_t - Z_{t-1}$, for all Z = Y, X. The αs and βs are constants, m and n are the optimal numbers of lags of the series ΔY and ΔX and u_t are the residuals. For given values of the lag lengths m and n it can be tested whether X Granger-causes Y by testing in (1) the hypothesis H_0: $\beta_{Y,1} = \beta_{Y,2} = ... = \beta_{Y,nY} = 0$ against the alternative H_a: not H_0. If X represents TFR (FLP) and Y represents the FLP (TFR), then H_a (H_a') corresponds to the hypothesis that the macro relation between TFR and FLP results from the sequential decision problem listed as micro explanation 1 (2) above. If we can accept H_a and H_a' as well, this corresponds to the hypothesis that the macro relation between TFR and FLP results from micro explanation 3 or 4. Whether it is the result of micro explanation 3 or 4 cannot be established with Granger-causality tests and therefore lies outside the scope of this paper.

Insert Table 1 about here

Table 1 provides a summary of the empirical results of macro studies with time series data that apply the Granger causality test methodology. Analysing German time series from 1960-1979, Zimmermann (1985) concludes from a modified Granger-causality test applied to first differences of all variables that increasing female employment does not cause decreasing fertility; rather, the reduction in births causes the increase in female labour force participation. Applying standard Granger-causality tests to the levels of U.S. time series data from 1948-1980, Michael (1985) finds that female labour force participation positively causes fertility and not the other way around. However, this result seems to be sensitive to the definition of fertility. With age-specific fertility rates, Michael finds that fertility negatively affects female labour force participation and not the other way around. Klijzing et al. (1988) use monthly individual data from a Dutch survey for a seven-year period (1977-1984). In a first step, they calculate for each month the average number of children of all women in this survey and the percentage of all women in this survey that participates in the labour market. In a second step, they apply Sims' indirect Granger-causality test to the first differences of these data. They find that labour force participation has no influence on subsequent fertility decision-making and that fertility decisions do have an impact on female labour force participation. However, when using standard Granger tests, they find causality in both directions. Cheng (1996) applies a modified version of the Granger-causality method to first differences of aggregate U.S. data for 1948-1993. He finds unidirectional negative causality running from fertility to female employment.

Obviously, the time series literature has neither come to an agreement on the presence nor on the direction of causality between fertility and female employment. In our view, this might be due to two issues that have not yet been addressed in the literature. First, the literature has not yet taken into consideration several important recent developments in the econometric time series literature. In particular, Michael (1985) fails to consider non-stationarity of the time series in his analysis, that is, whether the mean and/or the variance of the time series change over time. This is problematic because, if the time series are non-stationary, then there is the possibility of 'spurious' causality results. Cheng (1996), Klijzing et al. (1988), and Zimmermann (1985) take into account non-stationarity in their works. However, in applying only Granger-causality tests to first differences, they do not use valuable information about a possible long-run relationship between the variables. As a consequence, the results in these studies might be wrong.

Our paper contains two advances over these earlier attempts to determine causality. First, we use more recent data, which is important because the relationship between TFR and FLP may have shifted in recent years. Second, we employ more sophisticated econometric methods to overcome deficiencies in earlier efforts. Apart from the methodical issues related to the stationarity assumption of the time series, we allow for a further methodical correction. We consider the possibility of parameter instability in the long-run relation between fertility and female employment (as suggested by Figure 1) and structural breaks in the trend of the variables. Clearly, it would be desirable to include in the regressions socio-demographic variables that caused this change in behaviour. However, this would be too complex – if not impossible – and, for that reason, we approximate this change in behaviour with the inclusion of dummy variables.

Data and methods

We assembled annual time series of TFR and FLP from 1960-2000 for four OECD countries (France, Italy, Sweden, and the UK) and for 1960-1999 for two further OECD countries (West-Germany and the USA). For the FLP, we followed the literature in utilising the female labour force of women of all ages (including unemployed women) divided by the female population aged 15 to 64 (note that in Western-Europe women above age 64 are rarely employed). For the USA, we were able to utilize for the FLP the more appropriate measure of the female labour force of women aged 15 to 64 (again, including unemployed women) divided by the female population aged 15 to 64.

The selection of countries was based on maximising the variety of different institutional settings and gender regimes that may influence the fertility/employment relation. We have opted to include Italy and Sweden in our set of countries since each of them represents an extreme position in the spectrum of family policies and gender relations. The exceptional behaviour of Italian fertility and female employment is often explained with traditional norms and a view of the family as a private domain in which the government does not intervene with many state services. Sweden is clearly on the other extreme regarding family policy and gender regime. The policies in the 'nation of individuals' (Chesnais 1996; Hantrais 1997) tend to be both supportive of women's desires and concerned with children's care. France and the United Kingdom provide a somewhat weaker illustration of the 'nations of individuals' concept. West-Germany as a 'nation of families' shares a strong commitment toward families, backed by monetary allowances for housing, child benefit packages, and well-paid maternal leave.

In Figure 2 and Figure 3, we plot the time series of TFR and FLP for each country for 1960-2000 (resp. 1999). Overall, the graphs seem to reveal a negative relation between TFR and FLP, but this paper goes more into detail on this relation.

Insert Figure 2 and Figure 3 about here

As is well known, the time series of TFR show for most developed countries a kink in the 1960s. Some researchers argue that this kink represents the diffusion of the use of the contraceptive pill (e.g. Ermisch 1990, Goldin and Katz 2002, and Murphy 1993). Other researchers argue that the kink is the result of changing social norms. One can see that Italy is an exceptional case since its fertility decline was very slow in comparison to most countries in the developed world. The Swedish TFR shows a small hill around 1990. The demographic literature offers some explanation for this hill, which is, however, outside the scope of our paper (see, e.g., Andersson 1999, and Hoem 1990, who explain the increase of Swedish total fertility at the end of the 1980s with newly enacted leave and wage compensation policies).

As is also well known, the time series of FLP show a clear upward trend in most developed countries. Italy is again an exception. There, the rise of female employment is rather modest. However, the high level of education of younger Italian women (not shown) seems to indicate a future change in FLP even in Italy. Their relatively higher levels distinguish the FLP of Sweden and the USA over most of the time period from 1960 to 2000.

There are some possible measurement problems with our data. Our measure of FLP includes women aged 15 to 64. It would be more convincing to exclude women aged above, say, 44, since their fertility is almost zero. However, for most countries, age-specific data of FLP are only available since the mid-1970s, which would lead to time series that are too short. For the USA, it was possible to calculate the FLP of women aged 20-44 since the 1960s. (This variable was calculated as the FLP of women of age 20-24, 25-34, and 35-44 weighted by the share of the female population of age 20-24, 25-34, and 35-44 in the female population of age 20-44). In the next section, we show that the results for the USA are qualitatively the same no matter whether the FLP of women aged 15-64 or the FLP of women aged 20-44 is utilized.

Further, TFR constitutes an age-standardised measure, while the measure of FLP that we applied does not. However, due to data limitation it was not possible to construct an age-standardised measure of FLP. Nevertheless, we doubt that the results would be qualitatively different with such a measure.

In addition, for the time period of our investigation the TFR contains tempo effects from postponement of childbearing. Maybe the postponement of childbearing and the increase of FLP – at least to some extent – are due to common external factors, such as the increasing career orientation of women. In this case, it seems appropriate to utilize the TFR in the regressions. Alternatively, the postponement of childbearing might be caused by external factors that have no impact on FLP. In this case, one would ideally like to include them into the regressions. However, we do not know these external factors. For this reason, a simpler alternative is to apply a recent Bongaarts and Feeney method (1998) that yields a tempo-adjusted TFR (henceforth adjusted TFR). One could replace in the regressions the unadjusted TFR with the adjusted TFR. Due to data limitations, it is only possible to calculate the adjusted TFR for a few countries, e.g. for the USA from 1960 to 1989 (as provided by Boongarts and Feeney). We show in the next section that in the USA the results are qualitatively the same no matter whether the adjusted TFR or the unadjusted TFR is applied. This might be due to the fact that the time series movements of the adjusted TFR and the unadjusted TFR viewed on a long-term basis are very similar (see Figure 3 in Bongaarts and Feeney 1998).

Finally, our measure of FLP does not account for time series changes and cross-country differences in average hours worked per women. Instead, every women working above a certain minimum level is counted as employed, no matter whether she has a part-time or a full-time job. Accounting for average hours worked per women or accounting for part-time employment is, if at all, only possible for recent years. Using these data would lead to time series that are too short. Therefore, we leave this issue to future work when longer samples sizes are available.

When estimating the relation between two trending time series – as in the case of TFR and FLP – one often gets 'spurious regression' results, that is, a seemingly significant effect even though the variables are actually unrelated in a statistical sense. Detrending (that is, including a trend as a further regressor) often helps to eliminate spurious regression results. But as a recent econometric literature (started by Granger and Newbold 1974) shows, detrending does not help in case the variables are difference-stationary (a series is difference-stationary if its mean and its variance are constant over time after first differencing, but not in levels). Cointegration tests can be applied to test whether there exists a long-run relation between two difference-stationary variables. These tests aim to detect synchronous movements in deviations from the trends of both variables. Further, Engle and Granger (1987) have shown that the standard Granger-causality test can be seriously wrong if the time-series are difference-stationary and cointegrated.

By applying so-called Augmented Dickey-Fuller tests, we found difference-stationarity of both TFR and FLP (test results not shown) and therefore ruled out the use of the standard Granger-causality test. Instead, we applied vector error correction models (VECMs), which are the appropriate models for difference-stationary series that are cointegrated. (Alternatively, one could use the residual based approach suggested by Engle and Granger 1987. However, the literature has shown VECMs to be more powerful). The VECM is defined as follows:

$$\begin{aligned}
\Delta TFR_t &= \mu_1 + \delta_1(\mathrm{TFR}_{\mathrm{t\text{-}1}} - \beta\,\mathrm{FLP}_{\mathrm{t\text{-}1}}) + \tau_1 t + \sum_{i=1}^{m_1}\gamma_{11,i}\Delta TFR_{t-i} + \sum_{j=1}^{n_1}\gamma_{12,j}\Delta FLP_{t-j} + \varepsilon_{1,t}\,, \\
\Delta FLP_t &= \mu_2 + \delta_2(\mathrm{TFR}_{\mathrm{t\text{-}1}} - \beta\,\mathrm{FLP}_{\mathrm{t\text{-}1}}) + \tau_2 t + \sum_{k=1}^{q_1}\gamma_{21,i}\Delta TFR_{t-i} + \sum_{l=1}^{p_1}\gamma_{22,j}\Delta FLP_{t-j} + \varepsilon_{2,t}\,,
\end{aligned} \tag{2}$$

where TFR and FLP are measured in logs, Δ denotes the first difference, μs are constants, the δs, βs, τs and γs denote constant parameters and the εs represent errors, which are assumed to be normally distributed with mean zero. The variable t denotes a trend term, which is a smooth function of calendar time. The δs represent adjustment parameters to a long-run equilibrium. The expression ($TFR_{t-1} - \beta FLP_{t-1}$) represents the long-run relation between TFR and FLP and β represents the 'long-run elasticity' of TFR with respect to

FLP. The γs denote 'short-run elasticities' and m, n, q and p are the optimal numbers of lags of ΔTFR and ΔFLP.

One might argue that couples make fertility decisions at the outset of marriage and that the natural formulation would be to align conceptions to FLP, and not births. We estimated (2) also with total fertility lagged one year. This implies, among other changes, that TFR_{t-2} (instead of TFR_{t-1}) enters the long-run relation in (2). The qualitative results were almost unaffected. Nevertheless, we show only the results with TFR_{t-1} in the long-run relation. In our view a long-run relation between TFR and FLP represents the consequences of incompatibility between child-rearing and female employment, and not pregnancy.

According to Horvath and Watson (1995) one should estimate (2) simultaneously. This approach allows the TFR and the FLP to be both endogenous variables. (Note, that if the TFR and the FLP are difference-stationary and cointegrated, then the estimates of (2) are consistent even if the TFR and the FLP are both endogenous variables). In this paper we estimated (2) with the 'seemingly unrelated regression' method to allow for correlation between $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$.

First, one has to test for cointegration, that is, whether there exists a long-run relation between TFR and FLP. Horvath and Watson (1995) show that one can test in (2) for cointegration between TFR and FLP with a joint Wald test of the hypothesis H_0: $\delta_1 = \delta_2 = 0$. In this test one needs to compare the χ^2-statistic that results from a test of H_0 with the critical values tabulated in Table 1 in Horvath and Watson. Cointegration cannot be rejected if the χ^2-statistic is larger than the relevant critical value. (As an alternative to the Horvath and Watson method (1995), one could test for cointegration with the Johansen procedure (Johansen 1988 and 1991), which is more often applied in the literature. However, later we will show that there is instability in the long-run relation between TFR and FLP. With the Horvath and Watson method it is much easier to handle this instability than with the Johansen procedure).

If one finds cointegration, then one can test for the direction of long-run causality upon use of a VECM. In this case, there is long-run causality from FLP to TFR, if we can reject in (2) the hypothesis H_0: $\delta_1 = 0$ against H_a: $\delta_1 < 0$ upon use of the t-statistic. Analogously, there is long-run causality from TFR to FLP, if we can reject the hypothesis H_0': $\delta_2 = 0$ against H_a': $\delta_2 < 0$ (again upon use of the t-statistic). Intuitively, long-run causality implies that a deviation in the long-run relation between TFR and FLP, that is, $TFR_{t-1} - \beta FLP_{t-1} \neq 0$ for some t, will impact on the value of ΔTFR_t and/or ΔFLP_t.

If δ_1 as well as δ_2 are negative and significant, then FLP long-run causes TFR and TFR long-run causes FLP. In this case we can clearly reject the view that a sequential decision process at the micro-level gives rise to a long-run relation between TFR and FLP at the macro-level. In contrast, this result is consistent with the view that TFR and FLP influence each other in both directions or that there exists a *Z* vector containing exogenous variables that cause the long-run relation between TFR and FLP. With the Granger-causality framework, it is not possible to distinguish between these two possible interpretations and such a task lies outside of the scope of this paper.

Empirical application

We estimated system (2) simultaneously. We found for each country in the long-run relation, that is, in ($TFR_{t-1} - \beta FLP_{t-1}$), a structural break in the slope of FLP_{t-1}. To make the model not too complicated, we limited the number of breaks in the slope of FLP_{t-1} to one. Further, we found for each country a significant trend in both equations of (2) when we allowed for structural breaks in the trend. We chose the exact dates of the breaks in the slope and in the trends, the number of breaks in the trends, and the order of the lags of ΔTFR and ΔFLP endogenously. We chose them such that the Schwarz criterion of system (2) was minimised (see Kim 1997, and Maddala and Kim 1998).

The second column 2 in Table 2 summarises the dates of breaks in the slope in the long-run relation (all breaks were significant at the 5 per cent level according to the t-statistic). In our view, the important issue here is not the exact timing of the break (we do not actually believe that the break occurred at a single distinct point in history) but that the long-run relation between TFR and FLP has changed in recent history at least for some of the countries under analysis.

Insert Table 2 about here

The results in the last row of Table 2 and all following tables show the US results for the adjusted TFR (adjusted according to the aforementioned Bongaarts and Feeney method 1998) and the FLP of women aged 20-44. The results for the USA are always qualitatively the same no matter whether the unadjusted TFR and the FLP of women aged 15-64 or the adjusted TFR and the FLP of women aged 20-44 are utilized.

Next, we tested for cointegration between TFR and FLP with a joint Wald test of the hypothesis H_0: $\delta_1 = \delta_2 = 0$ in (2). The third column in Table 2 summarises the cointegration test results. The column shows cointegration between TFR and FLP for all countries (mostly at the 1 per cent significance level).

Table 3 shows the results of tests for long-run causality. The second column shows the test results of H_0: $\delta_1 = 0$ against H_a: $\delta_1 < 0$ in (2), that is, whether FLP long-run causes TFR. The third column shows the test results of H_0': $\delta_2 = 0$ against H_a': $\delta_2 < 0$ in (2), that is, whether TFR long-run causes FLP. The results indicate strong evidence for bi-directional long-run causality for all countries (always at the 1 per cent significance level). In our view, Table 3 is consistent with the view that simultaneous movements of both variables are brought about by common exogenous third variables. These variables are possibly social norms and social institutions, which help to combine work and family, financial incentives, and the availability and acceptability of contraception. Alternatively, TFR and FLP could affect each other in both directions.

Insert Table 3 about here

Table 4 shows estimates of the slope of FLP in the long-run relation in (2) prior and after its break. Our estimation results show for all countries a negative and significant relation between TFR and FLP prior to the break in the slope and that this relation is weaker after the break. For most countries, the relation is still negative and significant. However, for Sweden and the USA, it is even insignificant after the break. This finding is consistent with the view in Rindfuss and Brewster (1996), Rindfuss et al. (2003), and Brewster and Rindfuss (2000) that changes in child-care availability and attitudes towards working mothers might have reduced the incompatibility between child-rearing and female employment. On the other hand, for Italy the negative relation between TFR and FLP weakened only mildly after the break. This finding also supports the argument in Rindfuss et al., and Brewster and Rindfuss, according to which we are only likely to see increasing female employment not leading to a decrease in fertility in countries that have succeeded in minimising the incompatibility between child-rearing and female work. This was not the case in Mediterranean countries. More detailed results of estimation of (2) can be found in the Appendix.

Insert Table 4 about here

The cross-country differences in the magnitudes of the slopes are counterintuitive. This might be due to the fact that the paper does not use cross-country information (because this would make the econometric method more complicate than necessary for the research question of this paper). Kögel (2003) examines cross-country differences in the effect of FLP on TFR with pooled cross-country and time series data of 21 OECD countries. He finds intuitively more plausible differences (that is, he finds a weak negative effect for Scandinavian countries and a strong negative effect for Mediterranean countries). However, the cross-country differences in the changes of the slope *over time* in Table 4 are intuitively plausible and are compatible with the results of earlier demographic literature.

Discussion

In this study, we applied recent econometric time series techniques to test for long-run causality between fertility and female employment with macro-level time series data from six developed countries. Compared to previous research, we introduced three new methodical elements: (i) we applied methods that are designed to avoid the 'spurious regression-problem', (ii) we used a vector error correction model to distinguish between long-run and short-run causality, and (iii) we allowed for parameter instability.

The existing literature mostly found unidirectional causation and conflicting results on the direction of causality between fertility and female employment. In light of our empirical results – which show causality in both directions – we suggest that previous research tended to reject causality too often. The failure to account for parameter instability (either in the long-run relation between fertility and female employment and/or the trend of each time series) may partly explain why this was the case (see Table 1). Moreover, most previous research either ignored difference-stationarity or applied Granger-causality tests to the first differences of the time series without testing for cointegration.

Our result of bi-directional causality implies rejecting the view that a sequential decision problem (hypothesis 1 or 2 of the list of micro explanations) underlies the macro relation between TFR and FLP. Moreover, we argued that it cannot be established with the Granger-causality test framework, whether the macro relation between TFR and FLP results from micro explanation 3 (bi-directional causality) or from micro explanation 4 (spurious causality) in the aforementioned list. If micro explanation 4 underlies the relation between TFR and FLP, then this relation is a 'spurious correlation' and one might argue that an interpretation of parameter instability in this relation is not useful. Instead, the researcher should regress TFR and FLP on its external determinants in separate equations and test for parameter instability in that framework. This is certainly a desirable task for future work. However, we are sceptical, whether such a task is feasible. We believe that social norms and institutions are the most important external determinants of TFR and FLP. Appropriate time series data of these variables seem not to be available. For this reason, an interpretation of parameter instability in the relation between TFR and FLP might be the only feasible option. Moreover, as mentioned before, our result is also consistent with the view that micro explanation 3 underlies the relation between TFR and FLP. In this later case TFR and FLP influence each other in both directions and in this case an interpretation of parameter instability is quite possible and very useful.

The aforementioned studies that found a changing sign in the association between TFR and FLP in OECD countries, as well as our study, do not distinguish between full and part-time employment. The availability of part-time employment is clearly a further element of societal level responses, which might also have reduced the incompatibility between child rearing and female labour market participation. Since more data about the availability of part-time employment will become accessible in the future, we suggest for future work that one should examine the contribution of availability of part-time employment to the weakening association between fertility and female employment.

Notes

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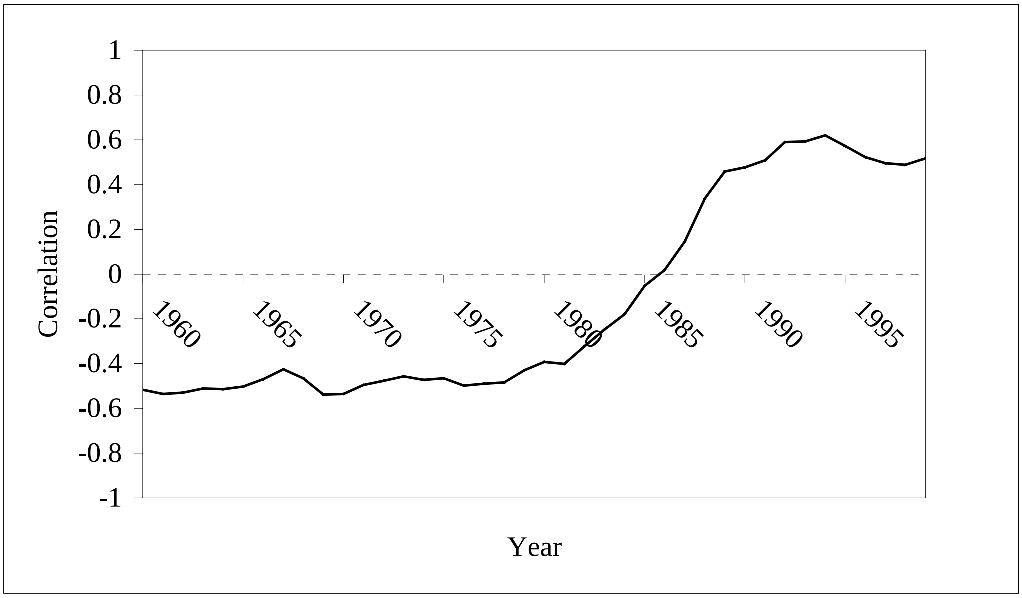
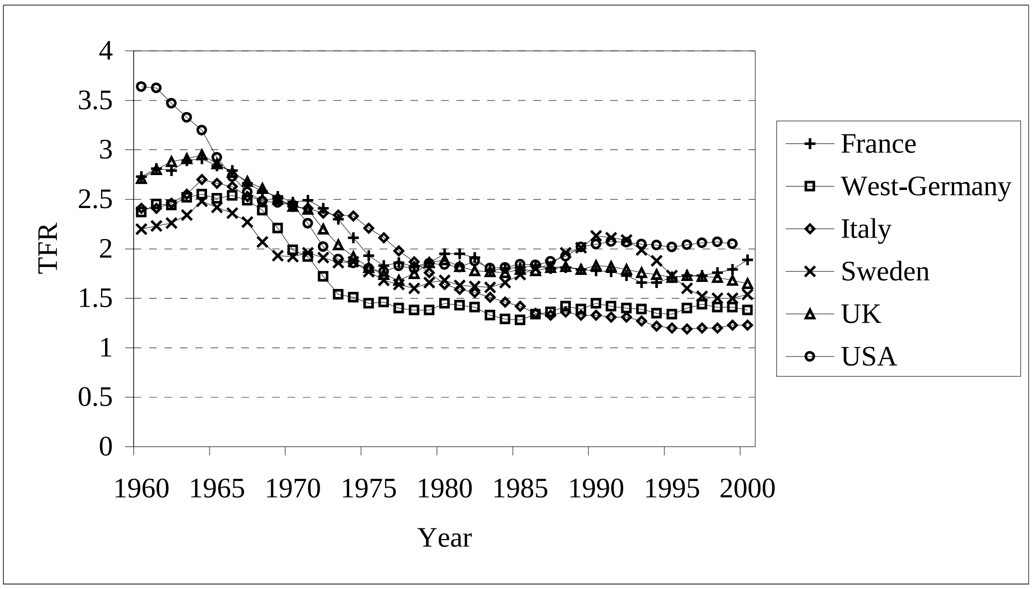
Figure 1: Correlation between the total fertility rate and female labour force participation rate for 21 OECD countries, 1960-1999



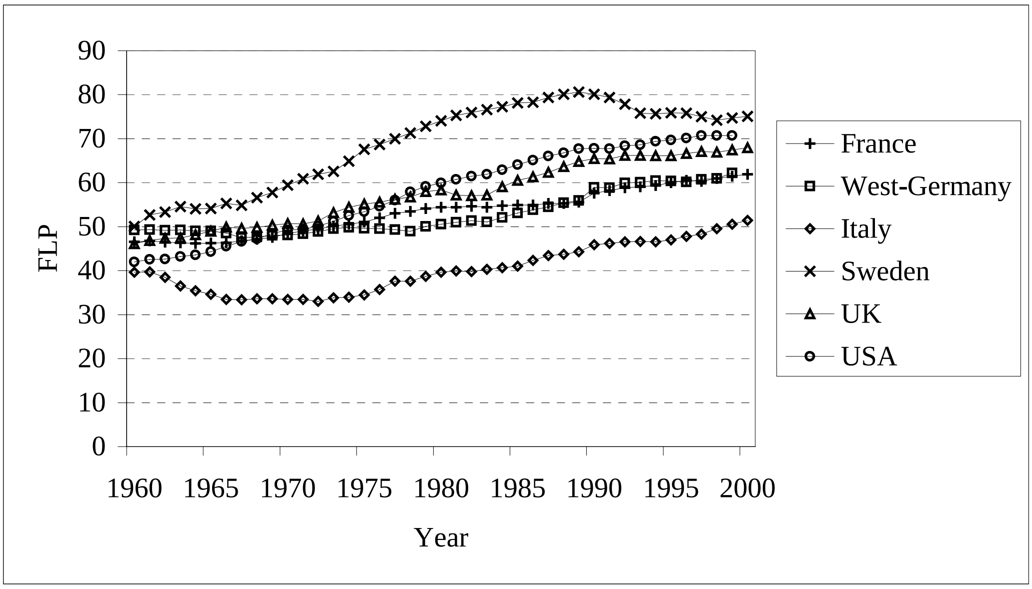
Notes: The countries included are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States, and West-Germany.
Data sources: TFR: For the European countries: ‘Recent demographic developments in Europe 2001’, Council of Europe. For the all other countries: for 1960-1995 ‘UN Demographic Yearbook 1948-97’, cd-rom (for Australia also for 1996) and for 1996-1999 for the USA and Japan ‘New Cronos 2001’ (Eurostat Database), cd-rom. FLP: ‘Comparative welfare states’ at http://www.lis.ceps.lu/ and ‘OECD Labour Force Statistics’ (1997, 1998 and 2001); West-Germany after 1989: German Federal Statistical Office, microcensus.

Figure 2: Time-series of total fertility for six countries, 1960-2000



Data sources: As for Figure 1.

Figure 3: Time-series of the female labour force participation for six countries, 1960-2000



Data sources: As for Figure 1, except for FLP in the USA, where the data source is US Bureau of Labor Statistics http://stats.bls.gov/).

Table 1: Summary of macro-level time- series studies

Author	Method	Data	Results
Zimmermann (1985)	modified Granger / first differences	German time series 1960-79	TFR → FLP
Michael (1985)	standard Granger / Levels	US time series 1948-80	TFR ← FLP FER → FLP
Klijzing et al. (1988)	indirect (standard) Granger / first diff.	Dutch survey data 1977-84	BIRTHS → LFP (BIRTHS ← LFP)
Cheng (1996)	modified Granger / first differences	US time series 1948-93	TFR → FLP

Notes: TFR – total fertility; FLP – female labour force participation rate; FER – age-specific fertility rate; BIRTHS – lagged (by 10 months) number of children born (per month); LFP – percentage of women participating in the labour market (per month) An arrow indicates the direction of causality.

Table 2: Endogenous dates of break in slope in long-run relation and test for cointegration between total fertility and female labour force participation in vector-error-correction models for six countries

Country	Date of break in slope	Cointegration
France	1973	yes** (25.89)
West-Germany	1974	yes* (16.79)
Italy	1979	yes** (97.57)
Sweden	1980	yes* (16.74)
UK	1977	yes** (130.95)
USA	1974	yes** (37.16)
USA (adjusted TFR and FLP, 20-44)	1975	yes** (37.16)

Notes: TFR and FLP are in natural logarithms. The sample is 1960-1999 for West-Germany and the USA and 1960-2000 for all other countries. * and ** indicate the 5 per cent and 1 per cent significance level. 'yes' means rejection of H_0: no cointegration. The χ^2-statistics are shown in parenthesis. The critical values for rejection of H_0 are 14.18 (5 per cent level) and 18.13 (1 per cent level). USA (adjusted TFR and FLP, 20-44) contains results with the US total fertility adjusted for tempo effects according to the method of Bongaarts and Feeney (1998) and with the US female labour force participation of women of age 20-44.

Data sources: TFR and FLP: As for Figure 1, except for FLP in the USA, where the data source is as for Figure 3. Adjusted US TFR: Unadjusted total fertility and mean age of childbearing (both at eight birth orders) were made available from Bongaarts and Feeney. US FLP, 20-44: FLP of women of age 20-24, 25-34, and 35-44 was from the US Bureau of Labor Statistics http://stats.bls.gov/. Female population of age 20-24, 25-34, and 35-44 was from the 'UN Demographic Yearbook 1948-97', cd-rom.

Table 3: Testing for long-run causality between total fertility and female labour force participation in vector-error-correction models for six countries

Country	FLP → TFR	TFR → FLP
France	yes** (0.00)	yes* (0.01)
West-Germany	yes* (0.01)	yes** (0.00)
Italy	yes** (0.00)	yes** (0.00)
Sweden	yes** (0.00)	yes** (0.00)
UK	yes** (0.00)	yes** (0.00)
USA	yes**(0.00)	yes**(0.00)
USA (adjusted TFR and FLP, 20-44)	yes**(0.00)	yes**(0.00)

Notes: TFR and FLP are in natural logarithms. The sample is 1960-1999 for West-Germany and the USA and 1960-2000 for all other countries. *, ** denote the 5 per cent and 1 per cent significance level. 'yes' means rejection of H_0: no causality. The p-values are shown in parenthesis. USA (adjusted TFR and FLP, 20-44) contains results with the US total fertility adjusted for tempo effects according to the method of Bongaarts and Feeney (1998) and with the US female labour force participation of women of age 20-44.

Data sources: TFR and FLP: As for Figure 1, except for FLP in the USA, where the data source is as for Figure 3. Adjusted US TFR and US FLP, 20-44: As for Table 2.

Table 4: The slope of female labour force participation prior and after its break in the long-run relation for six countries

Country	Prior to the break		After the break		$R^2_{\Delta TFRt}$	$R^2_{\Delta FLPt}$
France	-1.40**	(0.00)	-1.18**	(0.00)	0.54	0.78
West-Germany	-1.16**	(0.00)	-0.65*	(0.02)	0.46	0.70
Italy	-0.90**	(0.00)	-0.83**	(0.00)	0.60	0.73
Sweden	-1.46**	(0.00)	-0.37	(0.55)	0.79	0.49
UK	-1.07**	(0.00)	-0.77**	(0.00)	0.86	0.45
USA	-0.69**	(0.00)	0.12	(0.29)	0.71	0.63
USA (adjusted TFR and FLP, 20-44)	-0.66**	(0.00)	-0.10	(0.58)	0.60	0.97

Notes: TFR and FLP are in natural logarithms. * and ** refer to 5 per cent and 1 per cent significance level. P-values are in parenthesis. $R^2_{\Delta TFRt}$ ($R^2_{\Delta FLPt}$) is the adjusted R^2 with ΔTFR_t (ΔFLP_t) as dependent variable in (2). The estimation method is 'seemingly unrelated regression'. USA (adjusted TFR and FLP, 20-44) contains results with the US total fertility adusted for tempo effects according to the method of Bongaarts and Feeney (1998) and with the US female labour force participation of women of age 20-44.

Data sources: TFR and FLP*:* As for Figure 1, except for FLP in the USA, where the data source is as for Figure 3. Adjusted US TFR and US FLP, 20-44: As for Table 2.

Appendix

The Appendix shows more detailed results of estimation of (2) than in the main text (cointegration and causality test results are not repeated).

France

ΔTFR_t=0.01-0.42*(TFR_{t-1}-1.40*(dum59-dum73)*FLP_{t-1}-1.18*(dum73-dum2000)*FLP_{t-1})-0.50*(dum61-dum78)*(t/100)-0.16*(dum78-
(-4.73) (-8.04) (-5.51) (-3.97) (-3.86)
dum94)*(t/100)+0.30*Δ TFR_{t-1}+0.58*ΔFLP_{t-1} adj. R^2 =0.54
(2.24) (1.07)
ΔFLP_t=-0.00-0.04*(TFR_{t-1}-1.40*(dum59-dum73)*FLP_{t-1}-1.18*(dum73-dum2000)*FLP_{t-1})+0.06*(dum66-dum79)*(t/100)+0.11*(dum89-
(-2.39) (-8.04) (-5.51) (4.32) (8.58)
dum90)*(t/100)+0.02*(dum90-dum2000)*(t/100)+0.05*ΔFLP_{t-1}-0.03*ΔTFR_{t-1} adj. R^2 =0.72
(3.14) (0.52) (-1.18)

West-Germany

ΔTFR_t=0.01-0.15*(TFR_{t-1}-1.16*(dum59-dum74)*FLP_{t-1}-0.65*(dum74-dum99)*FLP_{t-1})-0.77*(dum66-dum71)*(t/100)-0.98*(dum71-
(-2.48) (-5.48) (-2.49) (-4.45) (-4.99)
dum74)*(t/100)-0.19*(dum74-dum85)*(t/100)+0.04*ΔTFR_{t-1}-0.25*ΔFLP_{t-1} adj. R^2 =0.46
(-3.43) (0.25) (-0.69)
ΔFLP_t=0.01-0.06*(TFR_{t-1}-1.16*(dum59-dum74)*FLP_{t-1}-0.65*(dum74-dum99)*FLP_{t-1})-0.12*(dum63-dum78)*(t/100)-0.09*(dum82-
(-3.66) (-5.48) (-2.49) (-4.54) (-2.79)
dum83)*(t/100)+0.15*(dum89-dum90)*(t/100)-0.16*ΔFLP_{t-1}-0.01*ΔTFR_{t-1} adj. R^2 =0.70
(6.17) (-1.39) (-0.31)

Italy

ΔTFR_t=0.05-0.54*(TFR_{t-1}-0.90*(dum59-dum79)*FLP_{t-1}-0.83*(dum79-dum2000)*FLP_{t-1})-1.03*(dum64-dum89)*(t/100)-0.81*(dum89-
(-5.02) (-8.21) (-6.92) (-6.02) (-5.94)
dum98)*(t/100)-0.65*(dum98-dum2000)*(t/100)+0.59*ΔTFR_{t-1}+0.24*ΔFLP_{t-1} adj. R^2 =0.60
(-5.58) (4.33) (1.36)
ΔFLP_t=-0.11-0.18*(TFR_{t-1}-0.90*(dum59-dum79)*FLP_{t-1}-0.83*(dum79-dum2000)*FLP_{t-1})+0.15*(dum75-dum77)*(t/100)-0.07*(dum77-
(-7.89) (-8.21) (-6.92) (3.37) (-3.80)
dum97)*(t/100)-0.09*ΔFLP_{t-1}-0.08*ΔTFR_{t-1} adj. R^2 =0.73
(-2.50) (-1.06)

Sweden

ΔTFR_t=0.03-0.08*(TFR_{t-1}-1.46*(dum59-dum80)*FLP_{t-1}-0.37*(dum80-dum2000)*FLP_{t-1})-1.16*(dum64-dum69)*(t/100)-0.33*(dum69-
(-3.59) (-3.96) (-0.59) (-7.50) (-5.25)
dum78)*(T/100)+0.20*(dum83-dum90)*(t/100)-0.14*(dum92-dum97)*(t/100)+0.08*ΔTFR_{t-1}-0.36*ΔFLP_{t-1} adj. R^2 =0.79
(6.29) (-4.54) (0.78) (-1.59)
ΔFLP_t=0.01-0.04*(TFR_{t-1}-1.46*(dum59-dum80)*FLP_{t-1}-0.37*(dum80-dum2000)*FLP_{t-1})+0.06*(dum67-dum92)*(t/100)
(-3.22) (-3.96) (-0.59) (2.72)
-0.03*ΔFLP_{t-1}-0.04*ΔTFR_{t-1} adj. R^2 =0.49
(-0.22) (-0.87)

United Kingdom

ΔTFR_t=0.12-0.53*(TFR_{t-1}-1.07*(dum59-dum77)*FLP_{t-1}-0.77*(dum77-dum2000)*FLP_{t-1})-0.44*(dum68-dum71)*(t/100)-1.08*(dum71-
(-10.57) (-15.63) (-6.83) (-5.47) (-10.81)
dum77)*(t/100)-0.18*(dum77-dum86)*(t/100)-0.04*(dum96-dum2000)*(t/100)+0.42*ΔTFR_{t-1}+0.42*ΔFLP_{t-1} adj. R^2 =0.86
(-5.12) (-2.54) (5.85) (2.66)
ΔFLP_t=0.03-0.12*(TFR_{t-1}-1.07*(dum59-dum77)*FLP_{t-1}-0.77*(dum77-dum2000)*FLP_{t-1})+0.40*(dum59-dum66)*(t/100)-0.12*(dum73-
(-4.74) (-15.63) (-6.83) (4.14) (-2.98)
dum78)*(t/100)+0.05*(dum85-dum92)*(t/100)+0.36*ΔFLP_{t-1}-0.38*ΔFLP_{t-2}-0.04*ΔTFR_{t-1} adj. R^2 =0.45
(3.82) (3.02) (-2.85) (-0.89)

United States

ΔTFR_t =0.41-0.62*(TFR_{t-1}-0.69*(dum59-dum74)*FLP_{t-1}+0.12*(dum74-dum99)*FLP_{t-1})-1.93*(dum62-dum70)*(t/100)-2.25*(dum70-
(-5.46) (-10.43) (1.07) (-4.91) (-5.80)
DUM74)*(t/100)+0.17*(dum87-dum99)*(T/100)+0.37*ΔTFR_{t-1}+0.03*ΔFLP_{t-1} adj. R^2 =0.71
(3.97) (2.81) (0.06)
ΔFLP_t=0.07-0.09*(TFR_{t-1}-0.69*(dum59-dum74)*FLP_{t-1}+0.12*(dum74-dum99)*FLP_{t-1})-0.26*(dum61-dum74)*(t/100)+0.05*(dum74-
(-3.77) (-10.43) (1.07) (-3.32) (2.75)
dum78)*(t/100)+0.11*ΔFLP_{t-1}-0.07*ΔTFR_{t-1} adj. R^2 =0.63
(0.79) (-1.89)

United States (with adjusted TFR and FLP of women of age 20-44)

ΔTFR_t=0.43-0.58*(TFR_{t-1}-0.66*(dum59-dum75)*FLP_{t-1}-0.10*(dum75-dum88)*FLP_{t-1})-0.73*(dum62-dum70)*(t/100)-0.89*(dum70-
(-5.91) (-3.14) (-0.56) (-5.74) (-6.39)
dUM75)*(t/100)+0.57*ΔTFR_{t-1}-0.45*ΔFLP_{t-1} adj. R^2 =0.60
(4.04) (-0.76)
ΔFLP_t=0.11-0.13*(TFR_{t-1}-0.66*(dum59-dum75)*FLP_{t-1}-0.10*(dum75-dum89)*FLP_{t-1})-0.15*(dum59-dum75)*(t/100)+0.04*(dum75-
(-2.80) (-3.14) (-0.56) (-1.92) (2.03)
dum87)*(t/100)+0.69*ΔFLP_{t-1}-0.02*ΔTFR_{t-1} adj. R^2 =0.97
(4.56) (-0.33)

Notes: t-statistics are shown in parenthesis and dumZ denotes a dummy variable that has the value zero for t=1960,…, Z and one for t=Z+1, …,T, where T denotes the last year in the sample (either 1999 or 2000 depending on country of investigation). Further, adj. R^2 denotes the adjusted R^2.