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THE RELATIONSHIP BETWEEN FEMALE LABOUR FORCE PARTICIPATION AND FERTILITY IN G7 COUNTRIES: EVIDENCE FROM PANEL COINTEGRATION AND GRANGER CAUSALITY

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ABSTRACT

This paper examines the relationship between the female labour force participation rate and total fertility rate for the G7 countries over the period 1960 to 2004 using panel unit root, panel cointegration, Granger causality and long-run structural estimation. The paper's main findings are that the female labour force participation rate and total fertility rate are cointegrated for the panel of G7 countries; that long-run Granger causality runs from the total fertility rate to the female labour force participation rate and that a 1-per cent increase in the total fertility rate results in a 0.4 per cent decrease in the female labour force participation rate for the G7 countries.

Keywords: fertility, female labour force participation, panel unit roots, panel cointegration, G7 countries.

JEL Classification: C22, C52, J13

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THE RELATIONSHIP BETWEEN FEMALE LABOUR FORCE PARTICIPATION AND FERTILITY IN G7 COUNTRIES: EVIDENCE FROM PANEL COINTEGRATION AND GRANGER CAUSALITY

1. INTRODUCTION

The relationship between the female labour force participation rate (FLFP) and the total fertility rate (TFR) has been much studied in the demography and economics literature. Until relatively recently most studies that have examined the relationship between FLFP and TFR have employed correlation-based methods that do not address the issue of causation. As Granger (1980) noted, it is conceivable that two variables could be highly correlated, but not be causally linked. A related problem is that correlation-based models assume a one period comparative static framework, while the effect of TFR and FLFP on each other is unlikely to be instantaneous. This fact has led to calls for the FLFP and TFR to be modelled not only in a dynamic manner, but also as an autoregressive process (Cheng, 1996a; Narayan and Smyth, 2006). As a result, the question "what causes what?" has received renewed attention in the demographic and economic literatures in recent times (Engelhardt *et al.,* 2004).

The renewed interest in the causal relationship between FLFP and TFR partly reflects an attempt to address the limitations of correlation-based methods. However, in addition, correlation-based studies have shown that the simple cross-country correlation coefficient between FLFP and TFR switched from a negative value before the 1980s to a positive value thereafter. This change posed the question whether there was any causal relationship at all (Engelhardt *et al,* 2004). Some studies have explicitly tested whether there is a causal relationship between FLFP and TFR. The results of the studies published in the 1980s and 1990s are of questionable or limited value because they did not test for stationarity and/or cointegration between FLFP and TFR (see Michael, 1985; Klijzing *et al.,* 1988; Zimmerman, 1985; Cheng, 1996a, 1996b). More recent studies have tested for stationarity and cointegration before proceeding to implementing Granger causality tests within a cointegration and vector error-correction framework, but have still used individual cointegration tests, whose power to reject the null is impaired in small samples (Engelhardt *et al,* 2004; Narayan and Smyth, 2003, 2006). Because of these limitations, existing studies have reached conflicting results about the causal relationship between FLFP and TFR.

The objective of the present study is to examine the causal relationship between FLFP and TFR for a panel of G7 countries over the period 1960 to 2004. The study extends the existing literature in three directions. First, the study uses panel unit root, panel cointegration and panel Granger causality testing to avoid power distortions inherent in small samples. Second, the long-run relationship between FLFP and TFR is estimated using fully-modified ordinary least squares (FMOLS). Third, we use more recent data than existing studies, which is important given it may co-vary with an increase in child care places that allow for greater FLFP or co-vary with economic restraints that increase the opportunity cost of children and decrease TFR by choice.

The remainder of the paper is organized as follows. Section 2 discusses the reasons for expecting causality to run from FLFP to TFR and vice-versa. Section 3 provides an overview of the existing literature including an examination of the limitations of existing studies explicitly testing the causal relationship between FLFP and TFR. The data are discussed in Section 4. The econometric methodology and empirical results are presented in Section 5. Foreshadowing the main results, the study finds that there is long-run panel Granger causality running from TFR to FLFP and that for the panel a 1-per cent increase in TFR results in a 0.4-per cent decrease in FLFP. The final section concludes with a discussion of the results and suggestions for future research.

2. CONCEPTUAL PERSPECTIVES ON FERTILITY AND FEMALE LABOUR FORCE PARTICIPATION

Bowen and Finegan (1969) argued that an increase in TFR can have two opposite effects on FLFP. On one hand, the presence of small children can increase the amount of work in the home, which serves to reduce the desire of the mother to seek market work. Sociologists have also emphasised the emotional attachment between mother and small child that make the mother reluctant to leave her child to enter or re-enter the workforce (Lehrer and Nerlove, 1986). This outcome is consistent with the role-incompatibility hypothesis that states there is a negative relationship between TFR and FLFP because of the strain of performing the role of employee and mother. On the other hand, the presence of small children increases the household's need for more income, which may increase the necessity for women to seek outside employment.

An increase in FLFP can have a negative effect on TFR, which also reflects the role incompatibility hypothesis. As Lehrer and Nerlove (1986) noted, while the role incompatibility hypothesis suggests a negative relationship between TFR and FLFP, nothing in this hypothesis suggests causation in one direction rather than the other. An increase in FLFP will have a negative effect on TFR if females who are in the workforce put off having children because of the opportunity cost. The opportunity cost may take the form of income foregone from giving up paid employment if the female needs to leave the workforce to look after the children or switch from full-time to part-time employment. The opportunity cost of having children could also take the form of an interruption to the female's career path, manifest in the loss of a higher potential future income stream and non-pecuniary benefits including recognition and status associated with a more senior position in her chosen profession. In this respect, economic theory suggests that for those females with higher human capital, the opportunity cost associated with having children is higher. Another source of opportunity cost of having children could be the loss of companionship and social networks in the workplace that serve as a point of release outside the home. As Blake (1970, p. 342) described it, “employment will often entail satisfactions alternative to children (companionship, recreation, stimulation and creative activity)” that may be curtailed if the female leaves work to look after her children in the home.

3. OVERVIEW OF THE EXISTING LITERATURE

Using micro-level data several studies have found a negative association between FLFP and TFR (see Cramer, 1980; Lehrer and Nerlove, 1986; Spitze, 1988 for reviews). These findings are consistent with the role incompatibility hypothesis, although from the results of correlation studies, the direction of causation is unclear. However, various authors find that in OECD countries the cross-country correlation between FLFP and TFR changes from a negative to a positive value in the 1980s (see eg. Ahn and Mira, 2002; Brewster and Rindfuss, 2000; Esping-Anderson, 1999). These studies have found that countries which have the lowest level of fertility also have the lowest level of female labour force participation and vice-versa.

The finding that the correlation between FLFP and TFR changed from negative to positive in the 1980s has given rise to the ‘societal response’ hypothesis that posits societal level responses such as changing attitudes towards working mothers, increased availability of childcare and state-mandated paid maternity have eased the incompatibility between having children and remaining in paid employment in most developed countries. Using pooled cross-sectional data for OECD countries Kogel (2004) challenged the conclusions of studies that have found support for the societal response hypothesis. Kogel (2004) found that (a) unmeasured country-specific factors and (b) country-heterogeneity in the magnitude of the negative time-series association accounted for the reversal of the signs in the cross-country correlation coefficient.

Studies which have employed correlation-based methods do not explicitly address the issue of causation. Compared with the voluminous literature that has tested for correlation between FLFP and TFR, there are relatively few studies that have explicitly examined the issue of causation between FLFP and TFR. Zimmerman (1985), using German time series data from 1960-1979; Cheng (1996b) using United States time series data from 1948 to 1993 and Cheng *et al.* (1997) employing Japanese time series data from 1950 to 1993 within a bivariate Granger causality framework found short run unidirectional Granger causality running from TFR to FLFP. Cheng (1996a) examined causation between fertility and labour force participation for African-American females. He found unidirectional Granger causality running from FLFP to TFR. Michael (1985), using United States time series data from 1948 to 1980 and Klijzing *et al.* (1988) using Dutch survey data for 1977 to 1988 found short-run bi-directional Granger causality between FLFP and TFR.

Narayan and Smyth (2003) applied Granger causality tests within an error-correction framework to analyse the relationship between FLFP and TFR in six South Asian countries. Of the six countries, they only found evidence of a cointegrating relationship between FLFP and TFR for the Maldives, where in the long run FLFP Granger causes TFR. Engelhardt *et al.* (2004) examined the long-run relationship between FLFP and TFR within a cointegration and Granger causality framework for France, Italy, Sweden, West Germany and the United Kingdom over the period 1960 to 1994. These authors found long run bi-directional Granger causality for all countries except Sweden. McNown and Ridao-Cano (2005) considered the relationship between age-specific fertility rates, age-specific female labour force participation rates and men's and women's wages for the United Kingdom within a cointegration and Granger causality framework and found evidence of extensive feedback among these variables. Narayan and Smyth (2006) examined the relationship between fertility rates, female labour force participation and infant mortality rates in Australia over the period 1960 to 2000 and found that in the long run both the fertility rate and infant mortality rate Granger cause female labour force participation. In a related study Chevalier and Viitanen (2002) examined the relationship between childcare provision and female labour force participation using quarterly UK data for the period 1992:1 to 1999:4 within a cointegration and Granger causality framework. These authors found unidirectional Granger causality running from the provision of childcare services to female labour force participation.

From this short description of existing studies, it is clear that there is no consensus on the direction of causality between FLFP and TFR. The lack of consensus may reflect three problems with the extant literature which tests for causality. First, Michael (1985) did not examine the stationarity properties of the data at all, potentially resulting in spurious findings. Second, Zimmerman (1985) and Klijzing *et al,* (1988) corrected for non-stationarity through applying Granger causality tests to first differences. But, in applying Granger causality tests to first differences they forgo valuable information about a possible long-run relationship between the variables. Cheng (1996a, 1996b) and Cheng *et al.* (1997) applied a unit root test to the ordinary least squares (OLS) residuals and found no cointegration, but this approach has very low power to reject the null of no cointegration. It is only the most recent studies that have applied more powerful individual cointegration tests, such as the Johansen (1988) method or the bounds test proposed by Pesaran *et al.* (2001) (Engelhardt, 2004; McNown and Ridao-Cano, 2005; Narayan and Smyth, 2003, 2006). However, the problem is that even these more powerful individual cointegration tests, and certainly the popular Johansen (1988) approach, have low power to reject the null of no cointegration with sample sizes of less than 50 observations. In recognition of this fact, recently a large number of studies have begun testing long-standing hypotheses using panel cointegration tests. To this point, however, there are no such studies applying a panel cointegration and Granger causality framework to examine the relationship between FLFP and TFR which is the purpose of the present study.

4. DATA

The data are annual time series of FLFP and TFR from 1960 to 2004 for Canada, France, Germany, Italy, Japan, United Kingdom and the United States. The TFR is defined as the sum of age specific fertility rates and is defined the same as in Engelhardt *et al.* (2004) and Narayan and Smyth (2006). FLFP is defined as the percentage of the adult female population aged 15 to 65 in the labour force. In defining the FLFP in this manner, the present study uses the same definition as previous studies (Cheng, 1996a, 1996b; Cheng *et al.,* 1997; Engelhardt *et al.,* 2004; Narayan and Smyth, 2006). While it would be better to exclude women aged above their mid-forties since their fertility rates are close to zero, time series data are not available for specific age categories for panels of countries. The United States is one country that has time series data on labour force participation rates for women aged 20 to 44 since the 1960s. Engelhardt *et al.* (2004) found that their substantive findings for the United States were the same whether the labour force participation on women aged 15 to 65 or 20-44 is used. All data are from the World Tables of the World Bank and were converted to logarithms prior to analysis. The timeframe from 1960 to 2004 is dictated by the data available in the World Bank, World Tables.

Insert Figures 1 and 2

Figures 1 and 2 plot the time series of FLFP and TFR for each country over the period 1960 to 2004. The figures appear to suggest a negative relationship between FLFP and TFR. The time series for TFR contains a kink in the 1960s reflecting the widespread diffusion of contraceptive pills and changing social attitudes towards having large families (Engelhardt *et al.,* 2004). TFR in Italy was higher than the other G7 countries in the 1970s, but declined rapidly throughout the 1980s and 1990s and is now the lowest among the G7. Demographic studies have pointed out that over the last two decades in developed countries, there is an inverse relationship between fertility rates and the proportion of people aged 20 to 30 living in the parental home (Della Zuanna, 2000). Between the mid-1980s and mid-1990s Italy had the highest proportion of people aged 20-30 living with their parents in Europe and this figure was increasing in Italy while it was falling in most other countries (Del Boca, 2002a).

FLFP generally shows an upward trend, although Italy stands out as having lower rates of FLFP than the other G7 countries. Del Boca (2002a) has argued that the modest growth in FLFP in Italy reflects the characteristics of the Italian institutional environment; namely pervasive imperfections and rigidities in the labour market and peculiar features of the publicly-funded child care system. An important reason for the low participation rates of married women, particularly those with children in Italy is that part-time employment is extremely rare. While the quality of publicly-funded childcare is very high, there are few places and the hours for which childcare is available are not conducive to entering part-time employment (Del Boca, 2002a).

5. ECONOMETRIC METHODOLOGY AND RESULTS

Panel Unit Root Results

We started through testing for the presence of a unit root in FLFP and TFR using the Lagrange Multiplier (LM) panel unit root test without a structural break and with one structural break proposed by Im *et al.* (2005). Consider a model of the form: $y_{it} = \delta_i^{'} X_{it} + e_{it}$, $e_{it} = \beta_i e_{i,t-1} + \varepsilon_{it}$ where y_{it} is FLFP or TFR, *i* represents the cross-section of G7 countries(*i* = *1, . . . ,N*), *t* represents the time period (*t* = *1, . . . , T*) and e_{it} is the error term. The test for the null hypothesis of a unit root in FLFP or TFR is based on the parameter β_i while ε_{it} is a zero mean error term that allows for heterogeneous variance structure across cross-sectional units but assumes no cross-correlations. The parameter β_i allows for heterogeneous measures of persistence. A structural break in the model is incorporated by specifying X_{it} as $\left[1, t, D_{it}, T_{it}\right]^{'}$, where D_{it} is a dummy variable that denotes a mean shift while T_{it} denotes a trend shift. If a structural break for country *i* occurs at time TB_i , the dummy variable D_{it} = 1 if $t > TB_i$, zero otherwise, and $T_{it} = t - TB$ if $t > TB_i$, zero otherwise.

The panel LM test statistic is obtained by averaging the optimal univariate LM unit root t-test statistic estimated for each country. This is denoted as LM_i^{τ} :

$$LM_{barNT} = \frac{1}{N}\sum_{i=1}^{N} LM_i^{\tau} \qquad (1)$$

Im *et al*. (2005) constructed a standardized panel LM unit root test statistic by letting *E(L_T)* and *V(L_T)* denote the expected value and variance of LM_i^{τ} respectively under the null hypothesis. Im *et al.* (2005) then compute the following expression:

$$\psi_{LM} = \frac{\sqrt{N}\left[LM_{barNT} - E\left(L_T\right)\right]}{\sqrt{V\left(L_T\right)}} \qquad (2)$$

The numerical values for *E(L_T)* and *V(L_T)* are in Im *et al*. (2005). The asymptotic distribution is unaffected by the presence of structural breaks and is standard normal.

Insert Table 1

The results of the panel LM unit root test are reported in Table 1. For both the panel LM unit root test without a structural break and panel LM unit root test with one structural break the null hypothesis of a unit root in the levels of FLFP and TFR cannot be rejected. When the panel LM unit root test is applied to first differences TFR is stationary in first differences in the no-break and one-break case at the 1-per cent level. FLFP is non-stationary in first differences in the no-break case, but stationary in first differences in the one-break case at the 10-per cent level. Thus, on balance, it is reasonable to conclude that both series are integrated of order one (I(1)).

Panel Cointegration Results

On the basis of the panel unit root test results we proceed to testing for cointegration using the panel cointegration test suggested by Westerlund (2006). The cointegration test proposed by Westerlund (2006) can accommodate multiple structural breaks.

Consider the following FLFP-TFR long-run model:

$$FLFP_{it} = \lambda_{ij} + \beta_i TFR_{it} + e_{it}, \qquad (3)$$

$$e_{it} = r_{it} + \mu_{it},$$

$$r_{it} = r_{it-1} + \phi_i \mu_{it},$$

The index $j = 1,...,M_i + 1$ denotes structural breaks. One can allow for at most M_i breaks or $M_i + 1$ regimes that are located at dates $T_{i1},...,T_{iM_i}$, where $T_{i0} = 1$ and $T_{iM_i+1} = T$. The location of the breaks are specified as a fixed fraction $\lambda_{ij} \in (0,1)$ of T such that $T_{ij} = \lfloor \lambda_{ij} T \rfloor$ and $\lambda_{ij-1} < \lambda_{ij}$ for $j = 1,...,M_i$. Westerlund (2006) determines the structural breaks endogenously using the Bai and Perron (2003) technique, which globally minimizes the sum of squared residuals to obtain the location of breaks:

$$\hat{T}_i = \arg\min_{T_i} \sum_{j=1}^{M_i+1} \sum_{t=T_{ij-1}+1}^{T_{ij}} \left(y_{it} - z'_{it}\hat{\gamma}_{ij} - x'_{it}\hat{\beta}_i\right)^2 \quad (4)$$

where $\hat{T}_i = \left(\hat{T}_{i1},...,\hat{T}_{iMi}\right)'$ is a vector of estimate break points, $\hat{\gamma}_{ij}$ and $\hat{\beta}_i$ are the estimates of the cointegration parameters based on the partition $T_i = \left(T_{i1},...,T_{iMi}\right)'$ and τ is the trimming parameter such that $\lambda_{ij} - \lambda_{ij-1} > \tau$. To ensure that the break date estimator works properly we set the minimum length of each sample segment equal to 0.15*T* and follow the advice of Bai and Perron (2003) and use the Schwartz Bayesian Criterion. The maximum number of allowable breaks is set equal to three.

The null hypothesis for all countries of the panel is:

$H_0 : \phi_i = 0$ for all $i = 1,..., N,$

versus

$H_1 : \phi_i \neq 0$ for $i = 1,..., N_1$ and $\phi_i = 0$ for $i = N_1 + 1,..., N$

The alternative hypothesis allows ϕ_i to differ across the cross-sectional units.

The panel LM test statistic is defined as follows:

$$Z(M) \equiv \sum_{i=1}^{N} \sum_{j=1}^{M_i+1} \sum_{t=T_{ij-1}+1}^{T_{ij}} \left(T_{ij} - T_{ij-1}\right)^{-2} \hat{\omega}_{i1.2}^{-2} S_{it}^2 \quad (5)$$

where $\hat{\omega}_{i1.2}^{-2} = \hat{\omega}'_{i1.1} - \hat{\omega}'_{i21}\hat{\Omega}_{i22}^{-1}\hat{\omega}_{i21}$ and $S_{it} = \sum_{k=T_{ij-1}+1}^{t} \hat{e}_{ik}^{*}$, where $\hat{e}_{it}^{*}$ is any efficient estimate of e_{it}. We use the FMOLS estimator suggested by Phillips and Hansen (1990) to estimate e_{it}, where the test statistic is written as a function of breaks.

Insert Table 2

The result of the FMOLS based test, denoted as $Z_{FM}(M)$ is reported in Table 2 together with the structural breaks for each of the countries. As Westerlund (2006) noted the results for the Z(M) test statistic are sensitive to cross-sectional correlation. To ensure the results in this study are robust to cross-sectional correlation we used bootstrapped critical values based on 5000 bootstrap replications. The 5-per cent critical value obtained from the bootstrap distribution for the FMOLS-based test is 2.155. Given that the Z_{FM}(M) statistic is 2.015, we are unable to reject the null hypothesis that FLFP and TFR are cointegrated around a broken intercept.

For three countries (Canada, Italy and the United Kingdom) the first break occurs in the mid-1960s. For three countries (France, Germany and the United States) the first break occurs in the late 1970s and for two further countries (Canada and the United Kingdom) the second break occurs in the late 1970s. In Japan's case the first break occurs in 1974. For all countries except Italy, the second or third break occurs in the mid-1980s. In Italy, the second break occurs in the late 1990s, while in France and the United States the third break occurs in the late 1990s. The break in the 1960s is likely to be associated with the increased use of contraception. The breaks in many countries in the late 1970s and mid-1980s may reflect periods of economic downturn associated with the first and second oil price shocks that impacted on both FLFP and TFR. The first break for Japan is likely due to the recession following the first oil price shock coupled with delayed timing of marriage that has been a principal factor contributing to the decline in TFR and increase in FLFP in Japan since the mid-1970s (Ogawa and Retherford, 1993). Economic downturn may also explain the third break in Japan in the early 1990s that coincided with the beginning of the Japanese recession. Hobcraft (1996) and Witte and Wagner (1995) concluded that occupational insecurity and child-care are responsible for the breaks in FLFP and TFR in the United Kingdom and Germany respectively. In the early 1980s France, Germany, Japan and the United Kingdom experienced prolonged recessions of three or four years, while Canada and the United States experienced two shorter recessions in the same period. Increased job insecurity was also associated with a weakening of welfare programs including a decline in the real value of pro-natalist programs in countries such as France and Italy.

Panel Granger Causality

Next we examine the direction of causality between the variables in a panel context. Engle and Granger (1987) show that if two nonstationary variables are cointegrated, a vector autoregression (VAR) in first differences will be mis-specified. Given that we found a long-run equilibrium relationship between FLFP and TFR, when testing for Granger causality, we specify a model with a dynamic error correction representation. This means that the traditional VAR model is augmented with a one-period lagged error correction term that is obtained from the cointegrated model.

The Granger causality test is based on the following regressions:

$$\Delta TFR_{it} = \theta_{1i} + \sum_{p} \theta_{11ip} \Delta TFR_{it-p} + \sum_{p} \theta_{12ip} \Delta FLFP_{it-p} + \psi_{1i} ECT_{t-1} \quad (6)$$

$$\Delta FLFP_{it} = \theta_{2i} + \sum_{p} \theta_{21ip} \Delta FLFP_{it-p} + \sum_{p} \theta_{22ip} \Delta TFR_{it-p} + \psi_{2i} ECT_{t-1} \quad (7)$$

Here FLFP and TFR are as previously defined, Δ denotes the first difference of the variable, ECT is the error-correction term, and p denotes the lag length. The lag length in both cases was selected using the two-stage procedure suggested in Abdalla and Murinde (1997). Following the approach in Abdalla and Murinde (1997) the optimal lag length was selected through maximizing the value of the R^2. The long-run panel causality results are reported in Table 3. The null hypothesis that TFR does not cause FLFP is rejected at the 5-per cent level, while the null hypothesis that FLFP does not cause TFR cannot be rejected. These findings suggest that there is a unidirectional long-run Granger causality relationship running from TFR to FLFP.

Insert Table 3

Panel long-run estimates

Having established cointegration as well as the direction of causality in the long-run we proceed to estimation of the long-run structural coefficients using the method of FMOLS. FMOLS addresses the problem of non-stationary regressors as well as the problem of simultaneity biases. For the FMOLS estimator, consider a cointegrated system for a panel of $i = 1,2,...,N$ countries over time $t = 1,2,...,M$:

$$Y_{it} = \alpha_{it} + \beta X_{it} + \varepsilon_{it} \tag{8}$$

$$X_{it} = X_{it-1} + \varepsilon_{it}$$

$Z_{it} = (Y_{it}, X_{it})' \sim I(1)$ and $\varpi_{it} = (\varepsilon_{it}, \mu_{it})' \sim I(0)$ with covariance matrix $\boldsymbol{\Omega}_i = L_i L_i'$, where L_i is the lower triangular decomposition of $\boldsymbol{\Omega}_i$ which can also be decomposed as $\boldsymbol{\Omega}_i = \boldsymbol{\Omega}_i^0 + \boldsymbol{\Gamma}_i + \boldsymbol{\Gamma}_i'$, where $\boldsymbol{\Omega}_i^0$ is the contemporaneous covariance and Γ_i is a weighted sum of autocovariances. The panel FMOLS estimator for coefficient β is:

$$\beta_{NT}^* = N^{-1} \sum_{i=1}^{N} \left(\sum_{i=1}^{T} \left(X_{it} - \overline{X}_i \right)^2 \right)^{-1} \left(\sum_{i=1}^{T} \left(X_{it} - \overline{X}_i \right) Y_{it}^* - T\hat{\tau}_i \right) \tag{9}$$

where

$$Y_{it}^* = \left(Y_{it} - \overline{Y}_i \right) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta X_{it}, \quad \hat{\tau}_i \equiv \hat{\boldsymbol{\Gamma}}_{21i} + \hat{\boldsymbol{\Omega}}_{21i}^0 - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \left(\hat{\boldsymbol{\Gamma}}_{22i} + \hat{\boldsymbol{\Omega}}_{22i}^0 \right)$$

The results for the panel long-run estimators using panel FMOLS which are reported in Table 4 are consistent with the incompatibility hypothesis. For each of the countries and for the panel as a whole TFR has a statistically significant negative effect on FLFP. The effect of TFR on FLFP is the largest in Canada where a 1-per cent increase in the TFR reduces FLFP by 0.6 per cent. The effect of TFR on FLFP is similar in Italy, the United Kingdom, France and the United States where a 1-per cent increase in the TFR reduces FLFP by 0.3 to 0.5 per cent. The effect of TFR on FLFP is smallest in Germany and Japan where a 1-per cent increase in the TFR reduces FLFP by 0.1 to 0.2 per cent. The panel long-run elasticities reported in the last row of Table 4 suggest that a 1-per cent increase in the TFR reduces FLFP by around 0.4 per cent.

6. DISCUSSION AND CONCLUSION

The relationship between FLFP and TFR is controversial with extant studies reaching conflicting results. This study represents the first attempt to address the direction of causality between FLFP and TFR for the G7 countries using a panel unit root, panel cointegration and Granger causality approach. The panel-based approach has the advantage that it avoids the power distortions of individual cointegration tests in sample sizes with less than 50 observations, the use of which has been the norm in the existing literature. The FMOLS technique that corrects for biases inherent with endogenous regressors is used to ascertain whether there is a negative or positive relationship between FLFP and TFR. Thus, the study has been able to examine both the direction of Granger causality between the variables and the role incompatibility versus societal response hypotheses. If causation runs from TFR to FLFP and TFR has a negative effect on FLFP this would support the role incompatibility hypothesis. If causation runs from FLFP to TFR and FLFP has a negative effect on TFR this would also support the role incompatibility hypothesis. If causation runs from TFR to FLFP and TFR has a positive effect on FLFP this would be consistent with the societal response hypothesis where changing social attitudes towards mothers in the workplace would make it easier for females to re-enter the workforce.

This study has found that in the long run causation runs from TFR to FLFP in the G7 countries and that there is an inverse relationship between FLFP and TFR consistent with the role incompatibility hypothesis. The negative effect of an increase in TFR on FLFP varies across the G7 countries from Germany and Japan at one end of the spectrum to Canada at the other. The result for the panel as a whole that a 1-per cent increase in TFR reduces FLFP by 0.37 per cent is in the mid-range for the G7 countries. There are several policies that may be responsible for the finding that there is a negative equilibrium relationship between FLFP and TFR. One set of policies that acts as a disincentive for women with small children to re-enter the workforce is the lack of effective access to childcare. A number of studies have found that the cost of childcare is a substantial barrier to mothers returning to the workforce (see eg. Garfinkel *et al.,* 1990; Cattan, 1991; Liebowitz *et al.,* 1991). The results from these studies suggest that childcare subsidies can be effective in encouraging mothers with small children to re-enter the workforce, particularly when targeted at low income households through means testing., In their study examining Granger causality between female labour force participation of women with young children and the supply of childcare in the United Kingdom, Chevalier and Viitanen (2002) found that a lack of childcare facilities limits FLFP and yet increases in demand for childcare only serve to increase costs or queues rather than have an effect on the supply. Chevalier and Viitanen (2002) concluded that in the United Kingdom if governments aim to increase the labour force supply through an increase in mother's participation rates, policy reform in the childcare market is required, either through creating new facilities, facilitating increased entries or lowering the costs of childcare. As Del Boca (2002b) noted, similar childcare reforms are required in Italy, where increased access to affordable childcare is required (Del Boca, 2002b). Similar studies in Canada (Cleveland *et al.,* 1996) and Germany (Kreyenfeld and Hank, 2000) have suggested analogous findings; women's participation in the labour force is affected by childcare supply. In order to attract women with small children to the workforce, government policies and interventions must address and tailor childcare services to their users' needs and provide quality, affordable, accessible childcare services.

Similarly, it has been suggested that workplace policies affect the labour force participation rates of women after childbirth. In spite of changing societal attitudes, the general absence of family-friendly policies in many workplaces may explain why women with small children can be reluctant to re-enter the workforce. In their study of maternity leave policies and women's employment in the Unites States, Britain and Japan, Waldfogel *et al.* (1998) found that in all three countries, and in particular Japan, maternity leave coverage increased the likelihood that women would return to their employer after childbirth. These findings are consistent with other studies and reviews in the area (Ahn and Mira, 2002; Asdera, 2004; Berger and Waldfogel, 2004; Brewster and Rindfuss, 2000; Dex and Joshi, 1999; Joesch, 1997) which found that the provision of maternity and parental leave policies, the rate of leave, job security and flexible family friendly policies influence women's fertility rates, their decisions to re-enter the workforce and the rate at which they return to work.

In a study that examined how different labour market arrangements shape fertility rates and FLFP across 23 OECD countries, Adsera (2004, p.38) found that the key to explaining the relationship between fertility and FLFP is "the flexibility of the market to accommodate women's exit and entry decisions and the penalty that particular market arrangements impose on truncated careers - through forgone experience, delayed wage growth and increased risk of unemployment…". High unemployment and unstable contracts depressed fertility, particularly in younger women who delay or forsake having children due to the impact it has on their lifetime earning capacity and increased employment uncertainty (Adsera, 2004). However, in countries where a higher proportion of females worked in the public sector, fertility rates of women in their mid- to late twenties and early thirties were higher reflecting the public sector's stable employment opportunities and liberal maternity benefits (Adsera, 2004).

It is evident that structural constraints, including access to child care and workplace policies, not only impact on fertility but also on the paid employment experiences of women. Crompton and Harris (1998) argued that these constraints have resulted from the 'male breadwinner model' of division of labour which has not only shaped major institutions such as the education and welfare systems, which are slow to change, but has informed our views of what are appropriate gender roles for men and women. In a recent Australian study examining attitudes to working mothers, data from the International Social Survey Project showed that whilst social attitude to working mothers has been progressive, the speed of change is slower than might be expected (Blunsdon and Reed, 2005). Albrecht *et al.* (2000), in their cross country comparison of attitudes about working mothers in seven European countries and the United States, found that considerable variation still exists across countries in terms of both attitudes to working mothers and the actual behaviour of mothers. Respondents in Germany are most in favour of mothers staying at home with young children, reinforced by the number of mothers actually staying at home, but attitudes to working mothers in the United States represented the extreme opposite, reflecting the relatively little support there is for mothers staying at home with their children.

Having considered some policy barriers that help to explain our major findings, the article concludes with suggestions for future research. One way forward is to extend the application of the panel approach to examining causality between FLFP and TFR from the bivariate context as in this study to a multivariate setting. In addition to FLFP and TFR other variables that could be usefully considered are factors that influence the opportunity cost of having children such as female education, male income and male unemployment. Another avenue for future research could be to apply panel unit root, panel cointegration and long-run panel estimation using FMOLS or some other long-run estimator to examine the determinants of fertility. Several recent studies have examined the determinants of the fertility rate for individual countries using a cointegration and vector-error correction framework (see eg. Masih and Masih, 1999; Narayan and Peng, 2006, 2006a). An extension of these studies would be to employ panels of either developing or developed countries.

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Table 1: Results of the panel LM Unit root test

Variable	No structural break		One structural break	
	Levels	First Differences	Levels	First Differences
TFR	-0.515	-8.003*	-0.440	-8.414*
FLFP	0.755	0.057	1.803	-1.447***

Notes: The 1%, 5% and 10% critical values for the panel LM unit root tests are -2.326, -1.645 and -1.282 respectively. *(***) denotes statistical significance at 1%(5%).

Table 2: Results of the Westerlund (2006) panel cointegration test

$Z_{FM}(M) = 2.015$			
	Location of Structural Breaks		
Country	Break 1	Break 2	Break 3
Canada	1965	1977	1986
France	1979	1985	1997
Germany	1979	1985	1996
Italy	1965	1998	-
Japan	1974	1985	1993
UK	1965	1978	1986
USA	1978	1987	1997

Notes: The null hypothesis is cointegration. The lag length was chosen so that the largest integer was less than $4(T/100)^{2/9}$. The bootstrapped critical value at 5 per cent is 2.155.

Table 3: Long-run panel causality tests

Null Hypothesis	F- Statistic	p-value	Optimal lag length
TFR does not cause FLFP	2.9169	0.0139	FLFP =2, TFR = 5
FLFP does not cause TFR	1.9950	0.3103	FLFP=3, TFR=3

Notes*:* The optimal lag length was selected by a two stage procedure similar to Abdalla and Murinde (1997). The lag selection chosen using the R^2 criterion.

Table 4: Fully modified OLS estimates

Country	FLFP is Dependent Variable	
	Coefficient	t-statistic
Canada	-0.60	-8.98*
France	-0.49	-7.36*
Germany	-0.12	-4.49*
Italy	-0.42	-17.70*
Japan	-0.16	-5.72*
UK	-0.46	-7.41*
USA	-0.34	-2.83*
Panel	-0.37	-20.59*

Notes: * indicates significance at the 1-per cent level

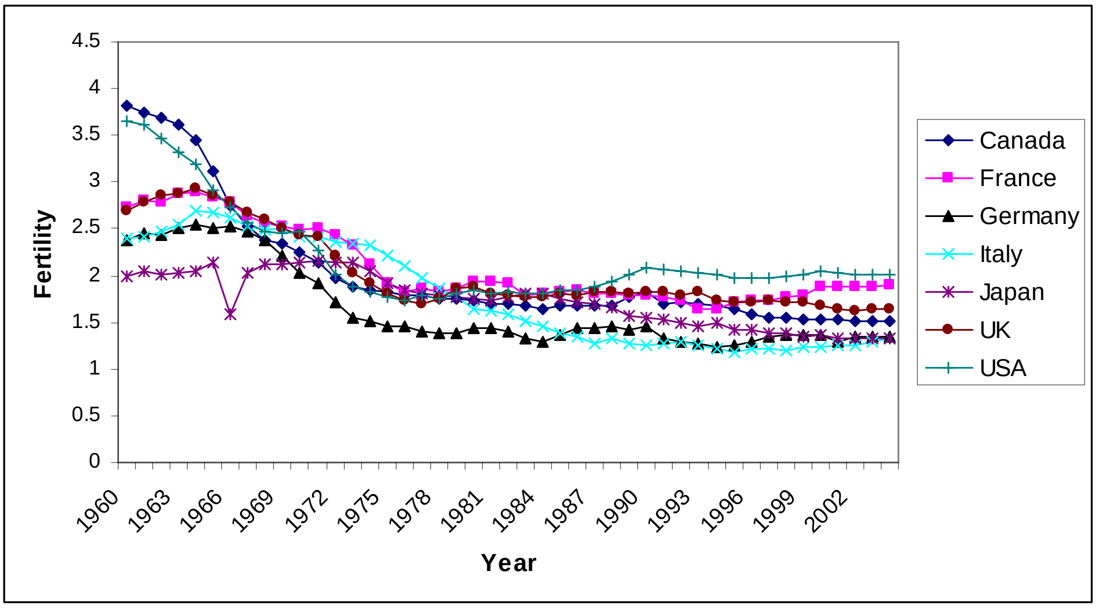

Figure 1: Plot of time series of TFR for the G7 Countries, 1960-2004.

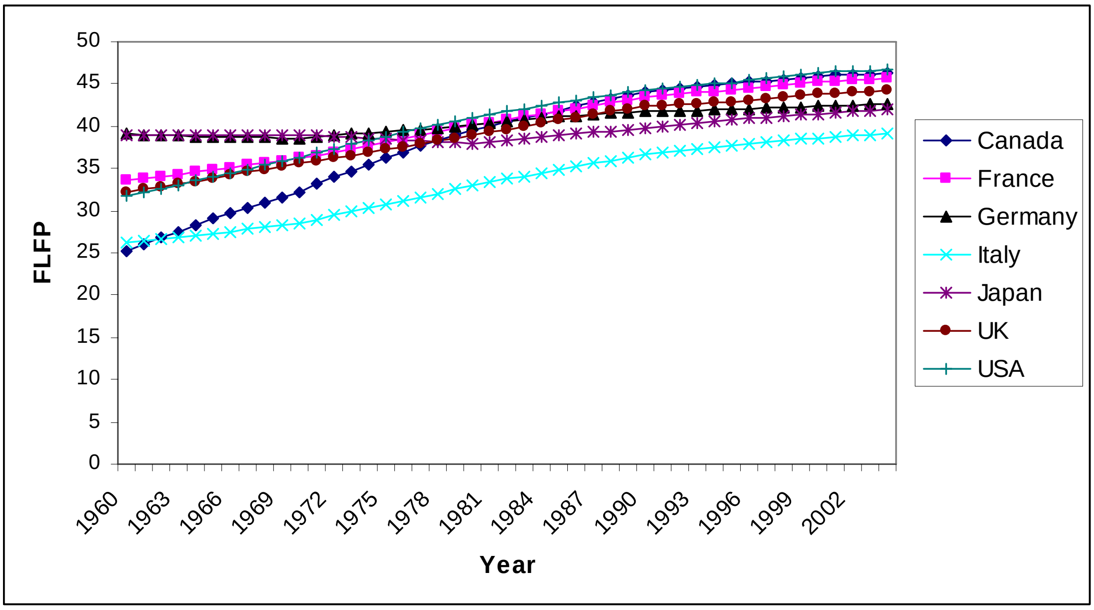

Figure 2: Plot of time series of FLFP for the G7 Countries, 1960-2004.