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The Easterlin hypothesis in the recent experience of higher-income OECD countries: A panel-data approach

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Abstract. The Easterlin hypothesis emphasizes the effect of relative cohort size on fertility. Models based on the Easterlin hypothesis have performed well in explaining time series fertility data, although these results have been for long historical time series and have typically been restricted to single country studies. These models are not adequate to determine if the hypothesis still holds and if the success of the Easterlin hypothesis is an artifact of the time period chosen. We use panel data analysis and temporal causality tests to see of the Easterlin hypothesis holds for higher-income OECD countries. The results support the Easterlin hypothesis.

JEL classification: J1, C23

Key words: Cohort, fertility, panel

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1. Introduction

A basic building block in the Easterlin hypothesis is the assumption that a change in the age structure of the population will influence fertility through its impact on the income and labor market experiences of young adults relative to these experiences of others, particularly of their parents. For example, Easterlin contends that the baby boom following World War II was temporarily brought about by several factors that increased the

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earnings of young adults beyond what they had learned to expect when they were adolescents. One factor that increased the income of these young adults relative to their parents was the low ratio of young adults to the remaining (older) labor force. A lower ratio of young to older workers was thought to lead to favorable labor market conditions for young workers looking for entry-level employment. The subsequent baby bust, in this theory, is assumed to be largely caused by the resulting high ratio of young workers to the labor force fifteen to twenty years later.

In testing the Easterlin hypothesis, many studies have focused on relative cohort size. Tests of the Easterlin hypothesis have consisted of case studies, which examine the experience of individual countries by using aggregate time-series data for many years. Some of the methods, including time series methods such as causality tests or cointegration models, require a large sample. Consequently, these methods cannot adequately address the question of whether or not the evident impact of relative cohort size was largely an artifact of the baby boom and baby bust.

Four basic types of models have been used in the existing literature. These models are reduced form models, simultaneous equation models, causality models, and cointegration models. As an alternative to numerous case studies, we will use a panel data model to examine the impact of relative cohort size on fertility.[1] Temporal causality tests for the panel are also performed. Since there already exist several reviews of the Easterlin hypothesis and of the empirical literature that it has generated, including Pampel and Peters (1995) and Macunovich (1998), we will not attempt to survey this large literature but will merely provide a few examples of different empirical techniques. These examples will be provided in the next section of this paper. Section 3 will provide a brief description of the economic model to be tested and the data to be analyzed. Section 4 discusses empirical models of the panel data analysis as well as of the panel causality test, and their results. Section 5 consists of a few brief conclusions.

2. The Easterlin hypothesis with experiences of higher income countries

The Easterlin model attempts to explain the baby boom that followed World War II and the decline in U.S. fertility that began in 1967. This model also predicts swings in fertility due to the relationship between age structure and fertility. Although Easterlin's hypothesis is relatively successful in explaining the U.S. experience, the recent rise in fertility is much smaller than earlier studies predicted.[2] Furthermore, its empirical validity in other industrialized nations has been limited, although they have experienced similar fertility patterns over time.[3] Wright (1989), for example, performs Granger-causality tests on the time series data of relative cohort size and fertility in each of 16 Western European countries separately.[4] The Easterlin hypothesis implies that if relative cohort size Granger-causes fertility, then fertility can be predicted more accurately by using past values of relative cohort size. But even if the Easterlin hypothesis is valid, fertility is not expected to Granger-cause relative cohort size. Wright (1989) concludes that there is no strong statistical support on the Easterlin hypothesis for European countries in general, based on country-level case study.[5]

Lenehan (1996) reports a post-war baby boom in Australia, with a mild decline in births since 1962 even after counting for a dramatic increase in immigrants since World War II. The Australian fertility rate rose from 2.5 in 1945 to 3.4 in 1956, and then dropped to 1.9 by 1986, shown in Lenehan (1996, page 156) with the confirmation of Easterlin's relative cohort size theory in the case of Australia since the early 1960s. Robertson and Roy (1982) find, with Canadian annual data for 1954–1977, that the post-war baby boom had the effect of increasing labor force participation rates of young adults, which resulted from pressures upon married females to supplement family income, and discouraging fertility. Ermisch (1979, 1980) finds little empirical support in Great Britain and Germany for the Easterlin hypothesis.

Pampel (1993) estimates reduced-form models of fertility with pooled data from 1951 to 1986 for 18 high-income nations, and the models include other explanatory variables such as a one-year lag of the female labor force participation rate, a one-year lag of social security spending, a one-year lag of gross domestic product per capita, and a collectivism scale. Pampel shows that the two-year lagged relative cohort size (the ratio of the number of persons ages 30 to 64 to the number of persons ages 15 to 29) has a positive and significant effect on fertility.[6]

Macunovich (2000) uses United Nations' quinquennial observations for the total fertility rate and the relative cohort size (the ratio of 15–24 years old to that of 25–59 years old), covering 184 countries from the year 1950 to 1995, although the data involves considerable interpolation (p. 242). Macunovich adopts ordinary least squares regression with the first difference of the *five-year-interval* total fertility rate as the dependent variable. Relative cohort size has a significant negative effect on the total fertility rate as expected.[7]

3. The population model and data to be analyzed

It is important for any model of the Easterlin hypothesis to be reasonably well specified due to the high degree of potential endogeneity. There is a belief in the literature that it is important to use explanatory variables that are exogenous to relative cohort size, and that relative cohort size is treated as being exogenous.[8] In order to capture the cyclical impact of relative cohort size on fertility, it is important to control for factors such as the level of economic growth, urbanization, infant mortality and the labor market opportunities for women that possibly capture differences in underlying fertility trends.

The model to be estimated has the total fertility rate as the dependent variable and involves five explanatory variables in order to capture cultural differences, by country and year, affecting fertility. These variables are relative cohort size, the proportion of the labor force that is female, linear and quadratic terms of real purchasing power parity per capita income, the infant mortality rate, and the percentage of the population that is urban.[9] These independent variables have been thought to be key to the demographic transition and their separate impacts on fertility have long been dominant themes in population analysis (Shields and Tracy 1986). Relative cohort size, which is named the age-structure variable in this paper, is defined as the ratio of the size of the younger generation (of ages 15–29) over the size of the older generation (of 30–65). Relative cohort size is a cyclical variable representing systematic changes from an underlying trend.

The data are obtained from the World Banks' *2001 World Development Indicators*. This paper considers 23 high-income OECD countries over the periods 1975–1999. As shown in Table 1, the average total fertility rate, defined as births per woman, among those countries is 1.75. Germany has experienced the lowest fertility rate of 1.37 and Ireland has the highest rate of 2.51 among high-income countries.[10] The average ratio of relative cohort size is 0.533, which indicates that roughly one third of the working population is from the younger generation and two thirds belong to the older generation group. Unsurprisingly, Ireland has highest younger generation portion (0.815) because it has had the highest fertility rate. Interestingly, Luxembourg has the largest portion of older to the younger adults, with the ratio of five older working adults to two younger adults. Higher income OECD countries have an average percent of the labor force that is female of 39.4%, with the highest percentage of 46.9% in Finland and the lowest of 30.5% in Ireland. In addition, they show quite high urbanization patterns with the average percentage of 75.1%. Particularly, Belgium has a very high urbanization ratio of 0.961, while Portugal (0.392) is the least urbanized high-income OECD country. Portugal and Greece suffer from high infant mortality rates, but Finland and Sweden have managed a low infant mortality rate. The

Table 1. Summary statistics by country: average values over 1975–1999

Country name	Total fertility rate	Age structure	Female labor force	PPP GDP per capita	Urban population	Infant mortality rate
Australia	1.90	0.502	39.54	14901	85.30	12.43
Austria	1.51	0.485	40.32	15875	64.68	16.95
Belgium	1.61	0.485	37.17	16390	96.15	15.01
Canada	1.69	0.523	42.01	16970	76.32	13.49
Denmark	1.63	0.486	44.81	22204	84.22	10.77
Finland	1.72	0.514	46.91	14148	61.46	8.30
France	1.80	0.519	42.10	14953	73.95	12.90
Germany	1.37	0.437	41.06	21578	84.42	12.47
Greece	1.73	0.503	32.57	9755	58.26	20.40
Iceland	2.22	0.720	43.13	17646	89.77	9.27
Ireland	2.51	0.815	30.55	11187	56.43	14.56
Italy	1.48	0.507	35.18	14404	66.57	19.42
Japan	1.64	0.474	39.40	16078	77.07	10.33
Luxembourg	1.56	0.392	34.36	19011	83.60	14.39
Netherlands	1.57	0.523	35.75	14929	88.68	9.94
New Zealand	2.06	0.666	39.41	15861	84.20	13.61
Norway	1.81	0.525	42.65	17191	71.72	10.17
Portugal	1.80	0.673	40.47	9332	42.42	33.47
Spain	1.72	0.592	32.21	10747	74.34	18.97
Sweden	1.76	0.430	45.63	14971	83.07	8.58
Switzerland	1.53	0.441	38.18	19521	60.64	11.09
United Kingdom	1.78	0.514	41.03	18434	89.00	13.37
United States	1.92	0.542	42.95	19828	74.92	14.79

Note: Total fertility rate (births per woman), infant mortality rate (per 1,000 live births), female labor force (% of total labor force), PPP GDP per capita (current international $), and urban population (% of total population).

relationship between the fertility rate and age structure will be examined later in the framework of panel data analysis.

Table 2 illustrates that the total fertility rate has been decreasing across years 1975–1999, averaged over OECD countries. Although the rate leveled off at about 1.70 during the late 1980s and the early 1990s, it began to decline again in 1997. Currently it has fallen to about 1.6. Also, the age-structure variable has decreased consistently during the last 25 years, starting from 0.607 to 0.421. Note that these numbers do not consider the panel structure of the data set, which means that the data set does not count the unobserved effect in each country. The percentage of the labor force that is female has steadily increased, reaching 42.4% in 1999. Since the year 1975, Purchasing Power Parity GDP per capita (PPPGDP) has been dramatically increasing and the portion of urban population also has been increasing but at a mild rate. However, the infant mortality rate has been decreasing consistently.

One can see in Fig. 1, there is no clear relationship between age structure and total fertility, especially for values below the range of 0.6 in the age structure variable, which corresponds to the range of below 2.5 in the variable of total fertility rate. For higher values than 0.6 in the variable of age structure, there is a contemporaneous upward trend and the age structure seems to be positively related to the total fertility rate instead of the negative relationship predicted by the Easterlin hypothesis. One caveat is that it is an unconditional

Table 2. Summary statistics by year: average values over 23 OECD countries

Year	Total fertility rate	Age structure	Female labor force	PPP GDP per capita	Urban population	Infant mortality rate
1975	2.04	0.607	34.77	6226	72.34	15.84
1976	2.01	0.600	35.26	6495	72.58	14.54
1977	1.93	0.598	35.75	6870	72.82	13.35
1978	1.89	0.595	36.24	7638	73.05	12.75
1979	1.88	0.593	36.73	8824	73.29	12.17
1980	1.87	0.589	37.22	10009	73.53	11.43
1981	1.83	0.583	37.61	10625	73.73	10.87
1982	1.81	0.577	38.00	10721	73.94	10.35
1983	1.75	0.570	38.39	10887	74.14	10.00
1984	1.72	0.565	38.78	11724	74.35	9.77
1985	1.69	0.560	39.17	12574	74.55	9.20
1986	1.69	0.553	39.56	13805	74.77	8.86
1987	1.68	0.547	39.95	15341	74.98	8.73
1988	1.70	0.541	40.34	16941	75.20	8.38
1989	1.70	0.535	40.73	17467	75.41	7.99
1990	1.73	0.529	41.12	17845	75.63	7.51
1991	1.71	0.516	41.27	18244	75.92	7.36
1992	1.71	0.502	41.42	19083	76.21	6.71
1993	1.68	0.489	41.57	19595	76.50	6.31
1994	1.66	0.477	41.72	20493	76.79	5.91
1995	1.63	0.465	41.87	21549	77.08	5.67
1996	1.63	0.453	42.01	22299	77.31	5.30
1997	1.62	0.442	42.14	22981	77.53	5.33
1998	1.66	0.430	42.28	23386	77.76	5.17
1999	1.62	0.421	42.41	24593	77.98	4.90

Note: See Table 1.

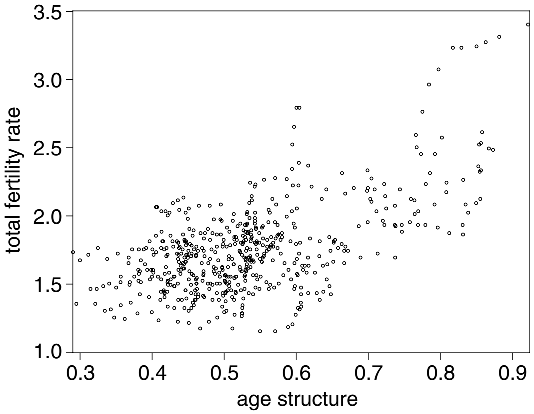

Fig. 1. The relationship between the total fertility rate and age structure

relationship; that is, the other unobserved country-specific variables have not been controlled for, unlike the panel analysis such as in Tables 3 and 4.

4. Empirical panel data analysis

As Easterlin (1987, p. 161) and Pampel (1993, pp. 497–498) point out, each country has different national environments in its labor market, in its social security net, and in economic policies, so a mere replication of the U.S. experience for European countries may not be expected. Further, the relationship between relative cohort size and fertility has been problematic ever since 1980, although its statistical relationship was stable in past periods. The Easterlin effect of cyclical changes in birth rates and cohort size has at best weak support after 1980 in the United States and is only confirmed for a few countries such as Canada, Australia and New Zealand.[11] The Easterlin effect is tested for higher income OECD countries, extended from Easterlin's experiments on the United States, with an updated data up to year 1999. This paper attempts to incorporate this unobserved information through a panel data analysis.

The standard method in empirical cross-country studies estimates regression equations with ordinary least squares (OLS), which assumes that the omitted variables are independent of the regressors and are independently, identically distributed. Such estimation, however, can create problems of interpretation if country-specific characteristics, such as income level and other characteristics of population, which affect the fertility rate are not properly considered. If those omitted country-specific variables (both observed and unobserved) correlate with the explanatory variables, then OLS produces biased and inconsistent coefficient estimates (see Hsiao 1986). Using a panel data analysis, however, the fixed-effect model produces unbiased and consistent estimates of the coefficients.[12]

Another popular method is the random-effects model, which assumes that individual specific constant terms are randomly distributed across cross-sectional units. Thus, it treats unobserved individual effects as uncorrelated with the other explanatory variables,[13] but there seems to be weaker justification

Table 3. Panel data analysis: fixed effects model

	Model 1 with female labor	Model 2 without female labor	Model 3 with female labor	Model 4 without female labor
Age structure	−0.917 (−5.26) [−4.56]	−0.894 (−5.12) [−4.37]	−1.393 (−7.10) [−5.48]	−1.432 (−7.33) [−5.64]
Female labor participation	−0.015 (−2.29) [−2.15]		−0.012 (−1.65) [−1.63]	
Linear term of pppgdp	−0.023 (−2.94) [−2.17]	−0.033 (−5.16) [−3.61]	−0.015 (−0.88) [−0.49]	−0.012 (−0.70) [−0.39]
Square term of pppgdp	0.001 (4.88) [3.64]	0.001 (6.62) [4.68]	0.001 (3.18) [1.70]	0.001 (3.08) [1.63]
Urban population	0.006 (1.72) [1.85]	0.006 (1.80) [1.85]	0.006 (1.81) [1.74]	0.006 (1.79) [1.67]
Infant Mortality rate	0.057 (12.48) [9.11]	0.059 (13.55) [9.52]	0.054 (11.45) [9.43]	0.055 (11.68) [9.71]
Country fixed effects?	Yes	Yes	Yes	Yes
Time effects?	No	No	Yes	Yes
Adjusted R^2	0.7899	0.788	0.8043	0.8035

Note: The dependent variable is total fertility rate (births per woman). Of the independent variables, *flabor* indicates female labor force (% of total labor force), *pppgdp* for PPP 1000 GDP per capita, *pppgdp2* for square term of PPP 1000 GDP per capita and *urban* for urban population (% of total). The values in the parentheses are t-statistics and those in the brackets are Huber/White/Sandwich robust t-statistics. Also note that Hausman test favors Fixed Effects models over Random Effects models (not shown).

for it. This model may suffer from inconsistency caused by omitted variables. Hausman (1978) tested for orthogonality of the random effects and the regressors, suggesting that generalized least squares estimation is consistent under the hypothesis of no correlation, but OLS is not efficient. Therefore, the Hausman test can be run on the difference of the two estimates, random-effects and fixed-effects, with a hypothesis that the covariance of an efficient estimator with its difference from an inefficient estimator is zero. If the hypothesis of no correlation between the individual effects and other regressors is rejected, then one can conclude that, of the two alternatives considered, the fixed effects model is the better option. Under our two specifications (with and without female labor force participation) in Table 3, our initial hypothesis that the unobserved individual-level effects are modeled by random-effects estimation is rejected.[14] Therefore, we choose the fixed-effects model specification.

Table 3 examines two possible candidates for the fixed-effects model in order to consider endogeneity of the variable, Female Labor Force. The endogeneity issue has been discussed in the literature, for example, Pampel (1993, Footnote 14). That is, the fertility rate is influenced by female labor

Table 4. Temporal causality test

	Short-run temporal causality F(5, 418)	Long-run temporal causality F(1, 418)
Bivariate temporal causality tests		
(1a) Age structure does not temporally lead (cause) fertility	8.44 (0.000)	27.30 (0.000)
(1b) Fertility does not temporally lead (cause) relative cohort size	2.62 (0.024)	5.59 (0.019)
Temporal causality tests after controlling for other explanatory variables		
(2a) Age structure ⇒ fertility	9.05 (0.000)	31.07 (0.000)
(2b) Female labor participation ⇒ fertility	4.96 (0.000)	4.97 (0.026)
(2c) PPPGDP (linear, quadratic) ⇒ fertility	3.43 (0.000)	0.21 (0.647)
(2d) Urban ⇒ fertility	3.00 (0.012)	12.20 (0.000)
(2e) Infant mortality ⇒ fertility	38.66 (0.000)	138.95 (0.000)

Note: The values in the parentheses are *p*-values.

force participation, and vice versa. Pampel (1993, p 511) suggests that the high female labor force participation rates depresses the effect of relative cohort size on fertility, which partially explains the declining association between relative cohort size and fertility over time. One way to solve the endogeneity problem is to find suitable instrumental variables.[15] However, it is in practice difficult to find any instrumental variables for labor force participation due to data limitations.[16] Therefore, our discussion may need some caution to interpret. Alternatively, the two different model specifications, with and without Female Labor Force, are compared. Since the impact of the Easterlin effect is strongly confirmed in both specifications, regardless of this endogeneity problem, our final specification is the one with Female Labor Force included in the model.[17]

The results of our panel data analysis, shown in Table 3, indicate that relative cohort size has a significantly negative influence on fertility.[18] Hence, the results support the Easterlin hypothesis for OECD countries after controlling for other socio-economic factors and demographic profiles. These results hold both when there are fixed effects by country and when fixed time effects are added to the model.

The final specification includes the income variable as well as three demographic trend variables such as women's labor force participation rate, the infant mortality rate and the urban percentage of the population. The income variables are a linear term of PPP GDP per capita (PPPGDP, \$1000) and a quadratic PPPGDP.[19] The latter has significant positive coefficients while the first has a significant negative influence on fertility. Therefore, a turning point can be calculated as $0.002294/(2*0.0008588) = 13.356$ (that is \$13,356). The fertility rate decreases until PPPGDP per capita reaches \$13,356 while it starts to increase after passing this dollar value. The turning point slightly rises to \$15,899 when female labor force participation is omitted. These results are consistent with the usual proposition that both the number of children and expenditures per child are decision variables. We hesitate to emphasize any specific story when dealing with macro data, in part because the income variables become insignificant when fixed time effects are considered.[20] All the demographic trend variables have the expected signs and are significant. Women's labor force participation rate is negative, indicating that increases in the status of women employment may reduce fertility. Finally, higher rates of infant mortality also increase the fertility rate as suggested by the theory of the demographic transition, while urbanization does not have a significant effect on the fertility rate.

The magnitude of the response of age structure is less than the magnitude found on many single country studies using data from an earlier period. In part, these response differences may represent underlying differences in the economic structure of the economies between time periods. For example, greater employment and income security might reduce the impact of age structure on relative income by shielding young families from the adverse effects of age structure on the earnings of young adults. A change in any factor, such as employment security that enhances the collective responsibility for raising children could reduce the estimated size of the Easterlin effect. It should not be surprising then that the largest observed size of the Easterlin effect was for the United States.[21] Another possible explanation for these differences in the size of the Easterlin effect is that major world events such as the Great Depression, World War II and the post World War II economic expansion colored the results. These important events dramatically reinforced the impact of age structure on relative income and, according to the Easterlin hypothesis, on fertility.

The Granger temporal causality test has commonly been used in time series analysis. Its use, however, is not necessarily constrained to that area only. As panel data sets have recently become popular, a number of papers have applied the concept of causality to panel data structures. For example, two papers by Holtz-Eakin et al. (1988, 1989) provide good theoretical foundations for testing causality with panel data. Also, the more recent empirical literature includes papers, for instance, by Nair-Reichert and Weinhold (2001) and Podrecca and Carmeci (2001) that test for causality using panel data.

We perform temporal causality tests between relative cohort size and the total fertility rate. Table 4 reports the findings of bivariate vector autoregressions with five lags of each independent variable. We perform tests of short-run temporal causality (i.e., the coefficients jointly equal zero) and long-run temporal causality (i.e., the sum of the coefficients equals zero). We find strong evidence at the 1% significance level that the change in relative cohort size leads to a change in the total fertility rate in both specifications of the short as well as of the long run. In addition, we find less evidence that the total fertility rate leads relative cohort size in the short or long run, although it is significant at the 5% level. In sum, the evidence supports the Easterlin hypothesis that increasing cohort size leads to a lower fertility rate.

Such temporal causality tests, however, may reflect spurious correlation due to omitted variables. To test that possibility, Table 4 also reports the findings of temporal causality tests from multivariate fixed-effects estimation that include relative cohort size, female labor force, the linear and quadratic terms of PPPGDP, urban population ratio and infant mortality rate.[22] The basic findings continue to hold. That is, the age structure significantly causes the total fertility rate in the short and long run. Moreover, the infant mortality also significantly causes the fertility rate. Female labor force and the urban population cause the fertility rate, although the evidence for that effect is weaker in the short run than in the long run. Further, PPPGDP significantly causes the fertility rate in the long run, but not in the short. If fertility responds both negatively and positively to income in the short run, then fertility could be pro-cyclical in the short-run for modern economies as suggested by Butz and Ward (1979). However, in the long run, the causal relationship is positive between income and fertility. The results suggest that demographic trend variables like women's labor force participation, urbanization and infant mortality are responsible for the lower fertility of higher income countries.

5. Concluding remarks

There is some evidence to support the proposition that relative cohort size has had a negative impact on population growth, as suggested in the Easterlin hypothesis, for OECD countries in recent years. This negative impact supports the proposition that the Easterlin effect was not just an artifact of the countries and the years chosen. Hence, the Easterlin hypothesis may be a viable explanation of cyclical changes in fertility. The inclusion of relative cohort size as a variable is necessary if we are to understand current trends in fertility. Its effects may not be large enough to generate stable cycles in fertility and the economy, but they may play an important role in explaining economic activity in a wide range of modern economies.

The results suggest that the decline in OECD fertility rates during the 1975–1999 periods do not indicate a failure of the Easterlin hypothesis. Instead, they suggest that fertility fell despite the modest but positive impact that a decline in relative cohort size had on births. A subsequent rise in relative cohort size would not be expected to have a large role in further reducing fertility. However, this possibility is a matter for concern in countries that are already well below the replacement fertility rate of slightly above two births per woman.

Endnotes

[1] Gauthier and Hatzius (1997) and Pampel (2000) use panel data with the purpose of explaining the impact of social-economic institutions on the Easterlin effect.

[2] Lee (1976), for example, predicted a new U.S. baby boom beginning in the late 1980's.

[3] While the self-reinforcing fertility cycles of the Easterlin hypothesis are well applied to an open, competitive labor market (see Samuelson 1976, for example), a labor market of a centrally planned and state guaranteed full employment economy requires closer examination. For example, Carlson (1992, p. 673) observed the hypothesized inverted Kornai-Easterlin adaptation, that is, large generations tend to have high fertility while small generations have smaller one. Thus, the society oscillates between large and small cohorts, which goes against Easterlin's arguments.

[4] Calot and Blayo (1982) compare two measures of fertility, (i) the complete fertility of birth cohorts and (ii) the total period fertility ratio for individual calendar years. Both measures are found to display simultaneous turning points for 16 European countries between 1950 and 1981, very similar short term trends and increasingly homogenous fertility, thus coming to the conclusion that the evolution of European fertility is governed by identical factors in all countries, and not specifically national ones.

[5] Only weak and partial evidence from Belgium, England and Wales, France, Finland, and Italy is found in Wright (1989).

[6] Pampel (1993) reports a stronger effect of relative cohort size in the United states, but weaker in most European countries. Pampel (2000) is the most similar to this paper in that it uses some of the same variables. Pampel does not, however, look at causality and does not include some of our variables. Also a different purpose leads him to concentrate on cross products of variables with relative cohort size as explanatory variables.

[7] The regression includes independent variables of (i) relative cohort size (ii) change in relative cohort size, (iii) infant mortality, and (iv) lagged total fertility rate, but without any controlling for the specific information of each country.

[8] Relative cohort size, however, can be partly determined by past values of the other explanatory variables, where the negative influence will be damped or more than offset by the positive impact of fertility on relative cohort size.

[9] In some studies, per capita income is replaced by two or more variables. The female wage rate is thought to capture the price of the child, while male income (male wage earnings plus asset income) is thought to capture the pure income effect. We use per capita income largely because it has been used much more frequently in other studies and is more generally available. This will make our results more comparable with other studies. We use per capita income partly because of the weak results found in the few studies dividing income into a price effect and a pure income effect. For example, Whittington et al. (1990) and Gauthier and Hatzius (1997) find the wife wage rate variable and the husband's income/wage rate variable to be insignificant and typically of the wrong sign. Butz and Ward (1979) and Macunovich (1995) use the log of the female wage rate times the female employment rate as the price variable, the log of male income as the pure income variable and the log of the male wage rate times the female employment rate as an additional income variable. These results are of the correct sign, but difficult to interpret because of the possibility that the female employment rate dominates the results.

[10] As Bhrolchain (1992) shows, period fertility concepts such as the total fertility rate establish the reproduction performance of current population, although period fertility rates fluctuate more than those of cohort indices.

[11] See Macunovich (2000, p. 239). Pampel and Peters (1995) emphasize the reduced role of cohort size for social and demographic behavior in the U.S. since 1980.

[12] Another method of excluding unobserved country-specific variables estimates the first-differenced regression (see Hsiao 1986, and Westbrook and Tybout 1993). Also see Wooldridge (2003, p. 447) for the choice between using fixed-effects and first-differences.

[13] See Greene (2000, Chapt. 14) for details.

[14] The results of the Hausman test are not shown in this paper.

[15] See, for example, Wooldridge (2003, Chapt. 15).

[16] Clearly finding a good instrument for this variable is a challenging future work.

[17] Female Labor Force is used instead of the female labor force participation rate because it filters out changes in over all labor force participation rates resulting from changes in age structure and other factors.

[18] Pampel and Peters (1995, p. 164) argue that the Easterlin effect may be less well applied to recent experiences, due to shifts in gender roles.

[19] Most of literature in cross-sectional studies and in many time series analyses includes only a linear term of income, finding that real income is significantly negative.

[20] The inclusion of a time effect does not change any results except that the linear term of pppgdp becomes statistically insignificant when looking at both t-statistics and robust t-statistics. The quadratic term of pppgdp becomes insignificant under robust t-statistics, while it is also insignificant under t-statistics. In models 3 and 4 of Table 3, both time fixed effects and state fixed effects are considered as well, where the turning points are: $0.01497731/(2*0.0009468) = 7.909$ (that is, \$7,909) for model 3 and for model 4 $0.0118995/(2*0.0009169) = 6.488$ (or \$6,488). These figures are twice as low as those in models 1 and 2 since the time effects are controlled. That is, the turning points are equally explained by the increase in GDP and by the time trend effects.

[21] For more on the reasons behind the decline in magnitude of the Easterlin effect, see Gaunthier and Hatzius (1997) and Pampel (2000, Chpts. 3 and 4).

[22] The relative cohort size is assumed as exogenous, and therefore it is not modeled with other socio-economic and demographic profiles.

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