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EUROSYSTEM

Working Paper

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APRIL 2009

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www.bankofgreece.gr

Printed in Athens, Greece
at the Bank of Greece Printing Works.

ISSN 1109-6691

FERTILITY DETERMINANTS AND ECONOMIC UNCERTAINTY: AN ASSESSMENT USING EUROPEAN PANEL DATA

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ABSTRACT

This paper examines the determinants of fertility, using panel data for twenty-seven European countries. We employ panel co-integration to estimate fertility as function of demographic and economic variables. We show that low fertility in most industrialized countries in Europe is due to low infant mortality rates, high female employment, low nuptiality rate and high opportunity cost of having children. Using two measures of economic uncertainty, which are associated with labor market decisions - a production (an output) volatility measure and the unemployment rate - we examine to what extent economic insecurities affect fertility decisions. The empirical results show that both measures of economic uncertainty have a significant negative impact on fertility implying that labor market insecurities might be a significant factor affecting fertility decisions.

Keywords: Fertility Choice; Panel Estimation,
JEL clasification: J13, C22, 040, 057

Acknowledgements: I wish to acknowledge useful discussions and suggestions with Stephen Hall and Heather Gibson. The views expressed in this paper are those of the author and not those of the Bank of Greece. All errors and deficiencies are the responsibility of the author.

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1. Introduction

Most countries industrialized or not, experience important demographic changes, one of the most important of which is the "demographic transition" which is based on the uniform observation that each country passes through three different demographic phases. During the first phase each country experiences high fertility and high mortality resulting in a fairly stable or very slowly growing population. In the second phase, mortality declines substantially causing population size to increase, and in the last phase with some time lag, the reduction in mortality triggers a steady and continuous decline in fertility resulting in a pattern of steady or slowly decline population growth – this phase characterizes industrialized countries at the present time. Changes in world population size show the growing importance of the "demographic transition" (Lee 2003).

The infant mortality rate is expected to decrease further due to increased industrialization, the diffusion of medical technology and an overall improvement in economic activity, which has contributed to increase living standards. The declining fertility in accordance with the drop in infant mortality and rising life expectancy are leading to a substantial increase of the elderly fraction of the population and a relative decrease of the young population. Today, these effects of both processes are known as "double aging process".

On top of these developments most of the industrialized countries witness an increase in female labor force participation with a simultaneous decrease in the nuptiality rate which in accordance with the rise in income per capita results in an increase in the opportunity cost of children at least in those countries that have succeeded in minimizing the incurred costs of childbearing and work. Moreover, when women are provided with opportunities nearly equivalent to those of men, such as in market employment and in education, but these opportunities are severely curtailed by having children, then, on average, women will restrict the number of children that they have to an extent which leaves fertility at a precariously low, long-term level.

Finally, on the one hand, productivity risk is associated with high economic performance in most of the industrialized countries, which are more integrated in the global economy with high per capita income. On the other hand, volatility of growth is associated with deterioration in economic performance in countries with low per capita income, immature financial and labor markets and limited trade openness (Kose et al. 2005). High productivity risk implies economic uncertainty since it alters saving behavior, affects portfolio decisions between alternative capital investments and hence changes household fertility decisions. These uncertainties are associated with labor market uncertainties and are considered as a major characteristic of modern societies, which have been brought about by internationalization and globalization. The main argument is that responsible parents will decide to have children when they are able to support them not only in the current economic situation but in the future. What maters for fertility is not only the current income position but also expectations about future family income. Therefore, changes in labor market conditions, such as higher unemployment or lower job security, create uncertainties about present and future earnings. Hence, any type of uncertainty in the labor market or in the overall economic performance of the economy will prevent child bearing since economic uncertainties induce doubts about households' future economic position.

Since the 1960s many economists, mainly on a theoretical basis, have explored the factors determining the fertility decisions of households. Becker (1960, 1973) supports the notion that fertility is an endogenous variable to the economic system and develops a theoretical framework to model household fertility decisions. In particular, his theoretical results indicate that fertility depends on a number of socioeconomic factors, such as the incentive for having children, the "quality of children", labor decision of the female, the efficiency of private capital markets and the intergenerational transfers within the family. He emphasizes the relationship between household income and the number of children and he concludes that this relationship is ambiguous depending on the magnitude of offsetting income and substitution effects. Therefore, according to Becker, declining fertility rates can be explained by a negative effect of a higher price of having children, due to increasing wages for women, outperforming the positive effect of a higher income on the demand for children.

The modern economic theory of population emphasizes the interdependence between infant mortality and fertility in the context of economic theories of behavior (Sah 1991; Cigno 1998; Becker et al. 1999; Whittington et al. 1990). In Cigno's model an exogenous reduction in child mortality may either raise or lower fertility. When the level of child mortality is high, reductions in it are likely to raise both fertility and survival-enhancing expenditures on children, because it lowers the price of a surviving child. When fertility is low, further reductions in it are likely to reduce fertility and survival-enhancing expenditures on children. Sah (1991) finds that when parents have a target fertility level and are sufficiently risk averse, then better survival opportunities for their children tend to reduce fertility.

Furthermore, a number of researchers such as Becker (1988, 1992), Becker and Barro (1988), Barro and Becker (1989), Ehrlich (1990), Ehrlich and Lui (1991) and Wang et al. (1994), based on microfoundations of economic theory, treat both population and income growth as endogenous variables in an effort to develop a coherent model of economic growth and explain the process of dynamic economic growth. Along these lines Becker et al. (1990) provide a model that explains how certain economies can have high fertility and low human capital investments while other countries could reach a path of low fertility, high investment in human capital and high economic growth. Becker et al. (1999) support the proposition that population growth may produce positive and negative effects on productivity and hence per capita income. They argue that in countries with limited human capital and rudimentary technology, population may reduce productivity because of diminishing returns from more intensive use of land and other resources. However, in modern economies a larger population encourages greater labor specialization and increased investments in knowledge that raise per capita income. Pommeret and Smith (2005) use the framework of the neoclassical model to argue that growth rates are correlated with production risk and jointly determine household fertility decisions in a risky economic environment.

This paper extends previous theoretical work of Becker (1960, 1981, 1992) and Becker and Lewis (1973), Sah (1991), Cigno (1998), Pommeret and Smith (2005) to examine empirically how family fertility decisions are determined by changes in economic and demographic variables taking into account the presence of economic uncertainties, employing, for first time to our knowledge, unbalanced aggregate panel data for 27 European countries during the period 1960-2005[1]. Over the last two decades, most of the work on the population and output has been theoretical. Several empirical studies have examined the interaction between economic growth and fertility such as Simon (1989), Rostow (1990), Ehrlich and Lui (1991), Winegarden and Wheeler, (1992), Brander and Dowrick (1994), Wang et al. (1994), Guest and McDonald (2001), Poot and Siegers (2001) and Hondroyiannis

[1] Data for the years after 2005 for many countries either are not available or are on provisional status.

and Papapetrou (2002a, 2002b, 2004, 2005).[2] Most of them have employed time series data for industrialized countries except Hondroyiannis and Papapetrou (2002b, and 2005) who employed aggregate panel data for a few European Countries. However, clear empirical evidence on the relationship among fertility and output has been hard to obtain and the impact of economic uncertainties has not been adequately explained.

Given the limited amount of empirical research on this issue and the wide range of empirical results, it appears that no clear consensus has emerged from research on this issue. Methodologically, the statistical inference of this research work relies on univariate time series data on panel country data over a prolonged period of time. Panel studies offer a number of advantages over time series and cross section analysis. Having multiple years of data increases the sample size and may lead to more reliable estimates. Also, having multiple observations for each country enables researchers to include country-specific fixed effects, by controlling for a wide range of time-invariant country characteristics whose omission might otherwise bias the estimated relationship between demographic changes and economic growth.

This paper's contribution to the existing literature is as follows. First, the purpose of the analysis is to extend our understanding of the potential determinants, demographic and economic, of fertility choice by examining empirically the validity of the proposition that fertility is a function of economic and demographic variables. Second, using panel modeling for 27 European countries for the period 1960-2005, we show that a long-run relationship exists between fertility, economic and demographic variables, such as mortality rate, nuptiality rate, female employment, real wage and real per capita output. Third, the model is re-estimated employing two measures of economic uncertainty, the unemployment rate following other authors such as Mocan (1990) and Huang (2003), Huang et al. (2006) and a production volatility measure, as independent variables to show how uncertainties affect the decision to have children. Our results are consistent with the theoretical findings of Whittington et al. (1990), Cigno (1998), Sah (1991), Becker et al. (1999) and Pommeret and Smith (2005) and we show that in modern economies, where the level of infant mortality is already low, female employment is high, the nuptiality rate is low, income per capita and real

[2] There are several empirical studies on household fertility decisions over the last years for industrialized and developing countries employing cross section data (e.g. Carliner et al. 1980 for Canada; Nguyen-Dinh 1997 for Vietnam; Wang and Famoye 1997, Weagley et al. (2007) and Herbst and Barnow 2008 for USA; Colombino 2000 for Italy; Kalwij 2000 for Netherlands; Melkersson and Rooth 2000 for Sweden; Hondroyiannis 2004 for Greece; Klasen and Launov 2006 for Check Republic).

wages are high and hence the opportunity cost of having children is high, further reductions in fertility are likely to occur. In addition, we reveal that in most industrialized economies with mature markets and high per capita income a further increase in output volatility, which increases growth, is associated with low rates of fertility. In relatively less mature economies with low per capita income a less volatile economic activity, which is associated with higher growth rates is likely to reduce fertility rate. Finally, the empirical findings support the proposition that high unemployment is associated with low fertility rate since the negative effects of labor insecurity dominate the positive effect of partnership and parenthood.

For this purpose the panel dynamic ordinary least squared (DOLS) estimator proposed by Kao and Chiang (1999) is employed. The DOLS panel estimator can produce asymptotically efficient estimates of the co-integrating vector and account for the endogeneity of all explanatory variables. Hence, this estimation technique is superior compared to other techniques for dealing with the inherent problem of predetermined and endogenous variables as well as the potential autocorrelation and heteroskedasticity within panels. Thus, in the empirical estimation the possible endogeneity of female employment (Pampel, 1993), the nuptiality rate, the uncertainty variables and the opportunity cost variables (Hondroyiannis and Papapetrou 2002a, 2004) are taken into account. That is, the fertility rate may be affected by the demographic and economic variables and vice versa.

The remainder of the paper is organized as follows. Section 2 discusses the recent demographic developments in Europe and relates the stylized facts with the recent theoretical developments in this area. Section 3 presents the data and describes briefly the methodology. Section 4 presents the empirical results. Section 5 concludes.

2. Demographic developments in Europe

In Europe the average total fertility rate decreased from 2.7 births per woman in the early 1960s to 1.4 in 2005, a figure far below the replacement rate of 2.1 births per woman.[3] The average infant mortality rate dropped from 37 children aged under one year per 1000 in 1960 to 4.0 in 2005 (Figure 1). As we can see from Figure 1, the declining trend in infant mortality started before the decline in fertility and it was initially accompanied by a steady

[3] The analysis refers to the sample of twenty-seven European countries. For more details see section 3.1 “Data description”.

fertility rate until 1965. Initially, the rise in real per capita income might increase the desirable number of surviving children and hence, despite the decline in mortality rate, the fertility rate remained constant. In the following years, the declining fertility rates can be explained by the negative effect of a higher price of having children, due to increasing wages, outperforming the positive effect of a higher income on the demand for children. Hence, the continuous increase in real per capita income and real wage decreased fertility since the opportunity cost of children increased and the substitution effect was greater than the income effect (Figure 2). The increase in the female labor force participation rate from 33.3% in 1960 to 44.6% in 2005 and the simultaneous decrease in the nuptiality rate from 8 marriages per 1000 inhabitants in 1960 to about 5 marriages in 2005 reinforced the previous developments, (Figure 3). To sum up, during the last forty years, rapid economic developments have increased the opportunity cost of children and the opportunity cost of women bearing children.

Furthermore, the youth dependency ratio decreased from 58% in 1960 to 48% in 2005 while due to the increase of life expectancy the old-age dependency ratio increased from 15% in 1960 to 26% in 2005. These developments show, that population growth in Europe is decreasing while the long-term ageing trends are positive resulting in an ageing population. In the coming decades, as the working age population is projected to decline substantially, there will be many fewer people working and paying taxes to support a growing number of people in receipt of government pensions and health care. It appears reasonable to expect that this decrease in fertility will put significant pressure on living standards as the number of the workforce will decrease relative to the number of people demanding consumption goods and services.

The present demographic problem, that is declining fertility rates and the aging population known as "double aging process", is expected to affect further the macro-economy in the near future (Figure 4). It is expected that due to the "double aging process" there will be a slowdown in the growth rates of the economy since ageing might lead to a fall of average productivity (e.g. Boucekkine et al. 2002). The aging population is expected to put additional pressure on the social security system as an upsurge in health costs is expected, while a reduction in revenues is also possible. Declining savings ratios, as the aging population might save less, might cause a period of slowdown until a new steady state is reached, since a decrease in the rate of savings will reduce the stock of capital and the level of output (Modigliani 1966, 1970).[4]

These stylized facts, for the European countries, are in line with the neoclassical theory of "allocation of time" and "household production function". The theory of the allocation of time in Becker (1965) implies the importance of labor supply and fertility decisions. In his framework the fertility decision is viewed as an economic one, and one of the costs of having a child is the forgone earnings of the person caring for the child at home, in most cases the mother. Willis (1973) formally modeled this joint fertility - labor supply decision. In the model of household behavior, the family is maximizing utility defined over market goods, leisure and child services. In the household, the wife's time and market goods are used as inputs to produce child services. So the participation and procreation decisions are mutually exclusive. If the woman devotes most of her time to market work, then she should decrease her leisure time and /or the number of children. This implication is especially important, as we need to explain the trends in fertility and female labor supply over the last thirty years.

3. Data and methodology

3. 1 Data description

The empirical analysis has been carried out using annual data for the period 1960 to 2005[5] for twenty-seven European countries.[6] The dependent variable is the fertility choice variable (FERT) that is the total fertility rate (i.e. the number of children which a woman would bear if she followed throughout her life the current age specific birthrates). The explanatory variables are: the infant mortality rate (MORT), defined as the number of children aged under one year old who die per 1000; the female employment rate, defined as the

[4] Recent theoretical studies, such as Chakraborty (2004), argued that a longer life is a good thing since it promotes savings. Many empirical studies employing different panels of European countries suggest that an upward shock in old dependency ratio will increase private saving a result which is against the life cycle hypothesis. The various authors argued that in most of the European countries the established social security systems are under financial pressure. The level of reimbursement from the existing social security systems does not satisfy the individuals that they realize the need for more own provision by private saving, (e.g. Haque et al. 1999; Attanasio et al. 2000; Sarantis and Stewart 2001; Hondroyiannis 2006).

[5] Initially data were collected until the year 2007. However, it was decided to use data until the year 2005 since data for the years 2006 and 2007 were provisional.

[6] The twenty-seven European countries are: Austria, Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Finland, Sweden, United Kingdom, Norway, Czech Republic, Cyprus, Latvia, Lithuania, Hungary, Iceland, Malta, Poland, Slovakia, Bulgaria, Romania.

proportion of female in the labor force (FEM); the nuptiality rate (MAR), defined as the number of marriages per 1000 inhabitants; the old age dependency ratio (ODEP), defined as the ratio of people older than 64 to the working population (people between 15 to 64); the real wage, defined as the real compensation per employee (RWAGE); the income variable, defined as the real per capita GDP in US dollars (PPGDP); the unemployment rate variable (UNEMP), defined as the number of unemployed persons divided by the labor force, where the labor force is the number of unemployed persons plus the number of employed persons. In addition, real GDP (RGDP) is employed to estimate production volatility (VOL)[7]. All the demographic variables, except the nuptiality rate and the real per capita GDP in US dollars, are extracted from the World Bank Gender Stats. The nuptiality rate and the real GDP data are obtained from Eurostat and the wage variable from AMECO database. All variables are expressed in logarithmic form (LFERT, LMORT, LFEM, LMAR, LODEP, LPPGDP, LRWAGE, LRGDP, LUNEMP).

Summary statistics of the data (mean and standard deviation) are presented in Table 1. The average fertility rate is equal to 2.00; however, this rate varies from 1.66 in Germany (lowest) to 2.87 (highest) in Ireland. The average infant mortality rate is equal to 15.52. Sweden, Iceland and Norway have the lowest average infant mortality, while Portugal and Romania have the highest. Average female labor force participation is 38.32%. Mediterranean countries such as Malta, Greece, Spain have the lowest female participation. Typically, north European countries such as Latvia, Lithuania, The Czech Republic, Sweden and Norway have the highest. The average nuptiality rate is 6.79. The highest value appears in Cyprus and the lowest in north European countries such as Sweden and Norway. Finally, the average per capita income is US$14,019.14. The poorest country is Romania and the richest is Luxemburg. The average unemployment rate is 5.83%, while the highest unemployment appears in Slovak Republic, Poland and Bulgaria and the lowest in Iceland and Luxemburg.

3.2 Methodology

Following the theoretical work of Becker (1960, 1981, 1992) and Becker and Lewis (1973), Sah (1991), Cigno (1998) it is possible to derive an equation for fertility

LFERT = f(LMORT, LFEM, LMAR, LODEP, LPPGDP,

[7] For more details for the estimation of production volatility see section 3.2 “Methodology”.

LRWAGE, UNCERTAINTY) (1)

where fertility (LFERT) is a function of demographic and economic variables. Equation (1) can be considered as demand for children equation. In the microeconomic framework the demand for children is considered as depending on the household's subjective preferences for goods and children externally determined by constraints of prices and income in a way that the household maximizes satisfaction. Changes in basic preferences, prices and income will alter fertility decisions. Other factors being constant, the number of children will vary directly with changes in medical technology, literacy, standard of living, urbanization, religious beliefs (e.g. Ireland), superstitin (e.g. Greece)[8], male and female income, unemployment, labor market decisions of the household, educational level of the population and overall economic performance of the economy. In addition, other public policy variables such as child benefits (e.g. France), parental holidays, educational cost, wage taxation, development of public day nurseries complemented by institutional variables such as the importance of part-time work, home working possibilities etc. may affect fertility decisions.[9] Furthermore, other public policy variables, such as unemployment benefits and total family allowances, might determine crucially fertility decisions. These two variables have been used in the literature to examine the determinants of declining fertility rates when the focus of the analysis is on the structural factors that have contributed to the decline in fertility, with special emphasis to those that reduce the costs of children borne by families (D' Addio and Mira d'Ecole, 2005). These variables are omitted from the present empirical analysis since first they are highly correlated with other variables and could bias the results and second there is a lack of consistent data for many European countries.

Medical technology might influence fertility negatively since a household is primarily interested in growing up a desirable number of children and not in the number of births. Thus, infant mortality (LMORT) is expected to have positive sign. The predicted positive sign is in accordance with some of the theoretical explanations provided by Whittington et al. (1990), Sah (1991) and Cigno (1998). Whittington et al. (1990) and Sah (1991) showed that when the probability that a child survives to adulthood decreases, the parents may wish to replace them in their fecund period. Thus, when child survival is more likely fertility will not be higher.

[8] In Greece couples do not prefer to get married during leap years because they believe that leap years bring misfortune to their married life.
[9] Variables such as cohort size and urbanization are available on aggregate level and are employed in the initial estimation. The estimated coefficients of these variables are not statistically significant and these variables were not included in our preferred specification. The results are available upon request.

However, a cost may be incurred by a birth, regardless of whether or not the child survives. In such a case, when the probability that a child survives increases the effective price of a surviving birth decreases and therefore higher fertility is encouraged. When the parents are risk averse or have a target fertility level, the first effect, the "hoarding effect", dominates the second effect, the "cost effect", so better survival chances for children tend to reduce fertility. In addition, Cigno (1998) argues that when the level of child mortality is already low, as it is in many European countries (Figure 1), then a further reduction in it may well decrease both fertility and survival-enhancing expenditures on children.

Literacy, standard of living and life expectancy have been assumed implicitly to affect positively family size since they increase quality of life and hence the number and "quality" of children. Thus, the old-age dependency ratio (LODEP), which is considered as a proxy for the previous variables since for most of them there is no data available for all the countries in the sample during the estimation period, is expected to have a positive sign. Female participation in the labor market and child rearing are competing claims on scarce time. If the woman devotes most of her time to market work, then she will decrease the time devoted to children since the opportunity cost of children increases. Hence, the increase in female participation in the labor market (LFEM) will decrease fertility decisions.[10]

Labor market decisions are often related to marriage decisions. In addition, the educational level of women might play an important role in female labor market decisions since it affects directly marriage and fertility decisions. When a woman increases her educational level, she will feel more independent and she will postpone or delay marriage and fertility decisions. Marriage agreements are based on anticipated gains from cooperation between individuals. The gains from marriage are positively related to fertility, since children offer benefits to the household, and negatively related to income from labor. Hence, the nuptiality rate (LMAR) variable is expected to have positive sign.[11]

According to Becker (1981) household fertility decisions are closely related to the opportunity cost of children and income. The basic idea behind this neoclassical microeconomic theory is that there are investment and consumption aspects to having

[10] For recent empirical investigations on this issue see e.g. Campione (2008), Murasko (2008), Pagani and Marenzi (2008) and Mammen et al. (2008).

[11] In the present study due to lack of data we are not able to capture directly the effect of women educational level on fertility.

children. Therefore, declining fertility can be explained by the positive effect of a higher income on the demand for children being outweighed by the negative effect of a higher price of having children. Thus, if we assume that children are normal goods overall household income has two effects on fertility, the income effect and substitution effect. The overall sign of the income variable depends on which effect dominates the other. In the present analysis we approximate the income effect using the real per capita income variable (LPPGDP) and the substitution effect using the real wage. Hence, the expected sign for the income variable (LPPGDP) is positive and the expected sign for the real wage variable (RWAGE) is negative.[12]

In the empirical analysis we estimate equation (1) without the uncertainty variable to examine the macroeconomic determinants of fertility employing panel data for 27 European countries for the period 1960-2005. In particular, we employ panel estimation techniques to estimate equation (1) and investigate if all the demographic and economic variables are statistically significant determinants of fertility.

Next equation (1) is estimated including the uncertainty variable to examine how insecurities might affect fertility decisions. The first measure of uncertainty used in the empirical analysis is the unemployment rate (LUNEMP). High unemployment rate creates uncertainties for present and future income since it creates term-limited contacts and unstable employment situations which are the main forces behind the postponement of childbearing. Responsible parents will have children only when they are able to financially support a family. Since children are long-term commitments parents take into account not only their present financial situation but also their future situation. The second measure of uncertainly used in the estimation of the fertility equation is production volatility (VOL). Productivity risk is a measure of uncertainty, which may affect fertility choices. Production volatility is important in the overall performance of the economy since in the long run it may alter saving behavior, portfolio choices between alternative investments and hence fertility choices. This measure is associated with labor market insecurities since it is a major characteristic of modern societies, which are characterized by internationalization and globalization. Responsible parents will decide to have children when they are able to support them not only in the current economic situation but in the future. Hence changes in saving behavior and

[12] For a recent empirical investigation see e.g. Yilmazer (2008).

portfolio choices associated with production volatility might affect future earnings and postpone fertility decisions.

3.3 Unit root tests

In the empirical analysis, first we verify the order of integration of the variables of the individual country since the long-run relationship is valid only if the variables have the same order of integration. Standard tests for the presence of a unit root based on the work of Dickey and Fuller (1979, 1981), Perron (1988), Phillips (1987) and Phillips and Perron (1988)[13] and Kwiatkowski et al. (1992)[14] were used to investigate the degree of integration of the variables for each country used in the empirical analysis.

In addition, panel unit root tests were employed to examine the order of integration of the variables in the panel data setting. Different unit root tests according to Madala and Wu (1999) and Choi (2001), Levin et al. (2002), Breitung (2002), Im et al. (2003) were estimated to test the hypothesis that each panel data series has a common unit root process. In addition, the Hadri (2000) test for the presence of a unit root in a heterogeneous panel was employed. In contrast to the previous tests, this test examines the null hypothesis of stationarity against the alternative hypothesis of unit roots in panel data with independent errors over t to the case of heterogeneous and serially correlated errors over t. Two specifications were estimated for all tests: the first was with a constant without a trend and the second included a deterministic trend.

3. 4 Panel co-integration

Before estimating equation (1) panel co-integration tests were employed to test the hypothesis that a long-run relationship exists among the variables. Kao (1999), Madala and Wu (1999) and Pedroni (1999, 2004) developed several tests to examine the existence of co-integration in a multivariate framework. The proposed statistics test the null hypothesis of no co-integration versus the alternative of co-integration. Pedroni (1999, 2000) developed several tests to test for no co-integration in a dynamic panel allowing for heterogeneity

[13] This version of the test is an extension of the Dickey-Fuller test, which makes a semi-parametric correction for autocorrelation and is more robust in the case of weakly autocorrelated and heteroskedastic regression residuals.

[14] The KPSS procedure assumes the univariate series can be decomposed into the sum of a deterministic trend, random walk and stationary I(0) disturbance and is based on a Lagrange Multiplier score testing principle. This test reverses the null and the alternative hypothesis. A finding favorable to a unit root in this case requires strong evidence against the null hypothesis of stationarity.

among the individual countries.[15] The estimated tests permit heterogeneity in co-integrating vectors and the dynamics of the underlying error process across the cross-sectional units and are estimated as residuals tests. Seven tests were estimated to examine whether the error process of the estimated equation is stationary, (Table 3). The first four statistics were based on pooling along within-dimension. The null hypothesis associated with the first four statistics is that $\rho_i = 1$ against the alternative that $\rho_i \langle 1$ for all cross-sectional units (homogeneous panel).[16] Specifically, the four statistics tested the null hypothesis of no co-integration for all cross-sectional units versus the alternative hypothesis of the existence of co-integration for all cross-sectional units. The next three statistics were based on pooling along between-dimension. The null hypothesis tested was the same as in the previous case while the alternative is equal to $\rho_i \langle 1$ for all i (existence of co-integration) so it permits distinct slope values, (heterogeneous panel). The Kao test follows the same basic approach as the Pedroni test, while the Fisher test is derived as a combined Johansen test. Madala and Wu (1999) proposed an approach to test for co-integration in panel data, based on Fisher's derived test, combining tests from individual cross-section to obtain a test statistic for the whole panel. Hence, evidence of co-integration rules out the possibility that the estimated relationship is spurious[17] and since the variables have a common trend, causality must exist in at least one direction and information for the endogeneity of the variables is revealed.

3.5 Panel estimation

Panel data estimation was used in the empirical analysis to estimate equation (1). Panel data have the advantage that they increase the sample size, are better suited to examine the dynamics of change and estimate complicated behavioral models. However, panel data estimation faces several estimation and inference problems since the estimation method used should combine cross section and time series dimensions. In our analysis three panel data

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[15] Pooling time series has resulted in a substantial sacrifice in terms of the permissible heterogeneity of the individual time series. It is important in the process of polling time series to permit as much heterogeneity as possible among individual time series. Testing for co-integration among the variables should permit for as much heterogeneity as possible among the individual countries of the panel. If pooled results rely on homogeneous panel co-integration theory then common slope coefficients are imposed. Pesaran and Smith (1995) show that if a common estimator is used when there are differences among the individual countries then the variables are not co-integrated.

[16] The following equation was estimated: $u_{it}=\rho u_{i(t-1)}+e_{it}$ where u_{it} are the estimated residuals.

[17] When the regression analysis reveals the existence of a relationship, otherwise not expected, then such regression is called spurious.

estimation methods were employed, that is the “fixed effects", the “random effects" and “dynamic OLS” estimations. Specifically, equation (1) can be written as follows

$$LFERT_{it} = \beta_0 + \beta^{'} X_{it} + \mu_i + \lambda_t + v_{it} \quad (2)$$

where X_{it} is a vector of explanatory variables used in the regression estimation and v_{it} is the error term. The *fixed effects* model takes into account that certain unobserved country-specific variables, that are constant over time *t*, may influence the fertility and are correlated with the explanatory variables in the equation. Under this assumption, a country-specific constant term, μ_i, is added to the right-hand side of equation (2) to allow the equation to contain the country-specific variables. In addition another term, λ_t, which is individual-invariant but changes over time is added in equation (2) to capture time specific effects. Thus using the fixed effect model including country specific and time specific effects to estimate equation (2) might produce unbiased and consistent estimates of the coefficients.

The second estimation method is the *random effects* model. This estimation method, instead of treating the constant term in equation (2) as fixed, assumes that all individual specific constant terms are randomly distributed across-sectional units. Therefore, the error term consists of two components, which are: the country specific and the combined time series and country specific. However, when there is correlation between the explanatory variables and the error term the random effects estimator is inconsistent. To test for the validity of the random effects estimator, the Hausman test was used. A significant value of the test implies that the random effects estimator is inconsistent and fixed effects estimates are more appropriate.

However, the estimation of the fertility equation raises several issues. First, endogeneity is likely to be present in equation (2). The endogeneity problem can arise because of the reverse causality. Several of the explanatory variables, such as female employment, infant mortality, nuptiality rate, real wage, uncertainty measures and real per capita GDP, may be jointly determined with fertility decisions. This means that the error term of equation (2) in period t is correlated with the explanatory variables and earlier shocks, but uncorrelated with the error term in period t+1 and subsequent shocks. Second, some independent variables may be predetermined in the sense that they are uncorrelated with the error term in period t but correlated with the error term in period t-1. Finally, unobserved heterogeneity may arise across countries.

To address successfully all the above issues in the estimation of equation (2), the *dynamic ordinary least squared* (DOLS) estimator was used which tackles successfully all the above problems obtaining asymptotically efficient and consistent estimators. Kao and Chiang (1999) have shown that DOLS estimators are asymptotically standard normal in a co-integrating regression and produce asymptotically efficient estimates of the long-run vector. This method of estimation outperforms both bias-corrected OLS and fully modified OLS eliminating the second order bias caused by the fact that the independent variables are endogenous. DOLS estimator is generated from equation (2) when symmetrical lead and lag dynamic terms of the explanatory variables are included.

3. 6 Production volatility estimation

Following several authors we attempt to capture the volatility dynamics of the real gross domestic product (GDP) by using the conditional second moment to proxy such volatility. The underlying idea is that part of the volatility can be predicted based on past values of the economic growth and volatility is time varying.

We constructed a measure of uncertainty (volatility) that captures this phenomenon. Generalized autoregressive conditional heteroskedasticity (GARCH) models have been used to capture volatility. In the present analysis, initially, we employed the conditional time-variant variance of economic growth as obtained by GARCH regressions as measure of production volatility. The estimated conditional variance obtained by the GARCH models for each European country is the one-period ahead forecast variance based on past information and serves as a reasonable representation of economic agents expectations about future uncertainty. Using the conditional variance as derived by the following GARCH model we captured the fact that volatility is changing over time and this is a better measure of uncertainty perceived by the households compared to the simple variance of growth rate. The simple variance has a major drawback, as it is an average estimate during the estimation period which is not capable of taking into account regime changes and could be misleading.

We construct a GARCH measure of volatility as follows:

Mean equation: $$y_{i,t} = \alpha_0 + \alpha_1 y_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

Variance equation: $$\sigma^2_{i,t} = \beta_0 + \beta_1 \varepsilon^2_{i,t-1} + \beta_2 \sigma^2_{i,t-1} \quad (4)$$

where the growth rate of country i is expressed as the first difference of the natural log of the annual real GDP and $\varepsilon_{i,t}$ is a random error for country i. The conditional variance equation in (3) is a function of three terms: (i) the mean, β_0; (ii) news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, $\varepsilon^2_{i,t-1}$ (the ARCH term); and (iii) the last period's forecast error variance, $\sigma^2_{i,t-1}$(the GARCH term). We estimated a number of versions of GARCH models. For equation (3), lags of up to two periods are used, depending upon whether the lags are significant. In most of the cases a GARCH (1,1) specification generated superior results.

Since the GARCH (1,1) model was not capable of capturing asymmetries, an exponential GARCH (EGARCH) model, as developed by Nelson (1991), was estimated for several countries. The advantage of EGARCH (1,1) model compared to the standard GARCH (1,1) is that, first, it does not place any restriction on the estimated coefficients of equation (3), second, the estimated coefficient β_2 of equation (3) can be either positive or negative permitting a certain degree of oscillatory behavior in the conditional variance and, third, the presence of asymmetric volatility is captured by the estimated parameter of an extra term $\frac{\varepsilon_{i,t-1}}{\sigma_{i,t-1}}$ added in the variance equation (equation 4). When the estimated coefficient of the extra term is negative and significant asymmetry exists and implies that negative shocks to GDP growth rate induce greater volatility than positive shocks of the same magnitude. In addition, the higher in absolute terms the magnitude of the extra term is the more vulnerable to GDP shocks is the economy. Several diagnostic tests such as the serial correlation test, the ARCH LM test and the Ljung-Box Q test were used to assess model adequacy. Finally, the estimated volatility (VOL) was added in equation (2) as an extra explanatory variable to capture how changes in the production risk may alter the family decision to have children.

4. Empirical results

4. 1 Unit root tests

All country data series in levels and first differences are tested for stationarity employing the ADF, PP and KPSS tests. The combined results from all the tests (ADF, PP, KPSS) suggests that all the individual country series except real GDP growth rate and volatility appear to be I(1) processes.[18]

Table 2 presents the results of panel unit roots employing the Im, Pesaran and Shin test and the Hadri test. The Hadri (2000) Z-test and the Im et al. (2003) W-test for each variable in levels and first differences are estimated. The first test does not reject the null hypothesis of unit root for all variables except for the real GDP growth rate and the estimated production volatility. On the contrary, the test rejects the null hypothesis for the first differences. According to the second test the null hypothesis of stationarity is rejected at 1% level of significance for all variables in levels except for the real GDP growth rate and production volatility. Therefore, the results from the tests suggest that all the series except real GDP growth rate and volatility appear to be non-stationary in the panel data set.

[INSERT Table 2]

4. 2 Estimation of Production Volatility

Since the GDP growth rate series are stationary a GARCH (1,1) model is estimated for all countries. For equation (3), lags of up to two periods were used, depending upon whether the lags were significant. A GARCH (1,1) specification generates superior results. To help select a parsimonious model the Schwartz Bayesian Criterion is used. To test for the existence of asymmetric conditional volatility an EGARCH (1,1) model is estimated. When the estimated value for the asymmetry term is statistically significant then the EGARCH(1,1) specification is preferred to GARCH(1,1). For all models the ARCH LM test is employed to test the null hypothesis of no autoregressive heteroskedasticity in the standardized residuals.

[INSERT Figure 5]

Figure 5 presents average GDP growth and the estimated volatility over time for all countries in the sample. As depicted from Figure 5, volatility increases around 1975 and 1992, two periods of low growth rate or economic downturn. Hence, the estimated results suggest that the highest volatility is concentrated around periods with low GDP growth implying that economic downturns are periods of high uncertainty and volatility. These results are in accordance with the theoretical explanation provided by French and Sichel (1993).

[18] The results for the unit root tests for the individual data are available upon request.

A panel regression equation is estimated to explore the relationship between economic growth rate and volatility. In the regression equation economic growth is the dependent variable and volatility the explanatory. The panel equation is estimated using the fixed and random effects estimation methods. In the estimation fixed country and time specific effects are estimated and it is assumed that the explanatory variable was predetermined. All the diagnostic tests are in favor of the fixed effects model with country and time effects.[19] In addition, the regression is estimated employing the GMM method using as instrumental variables several lags of growth rate. The estimated results qualitatively are the same and there is no autocorrelation in the estimation. The estimated coefficient for volatility is negative and statistically significant indicating the negative relationship between economic growth rate and volatility. Next, the same regression is estimated for two sub-samples. The first sub-sample contains all the cases with income per capita greater or equal to the average income per capita in the sample ($14,019) and the other all the cases with in per capital income less than the average. Following the same methodology the empirical results suggested that for both samples the estimated coefficient is statistically significant. For the first sample the relationship between economic growth and volatility is positive (0.66) and for the second is negative (-17.80). These empirical findings imply that in economies with low income macroeconomic volatility and economic growth are negatively related and these results are in accordance with recent empirical studies of Hnatkovska and Loayza (2004) and Kose et al. (2005).

4. 3 Panel co-integration tests

Table 3 summarizes the results of panel co-integration analysis among the variables using the Pedroni and Kao statistics. Five out of seven Pedroni tests reject the null hypothesis of no co-integration using both the panel and group versions of the Phillips-Perron and ADF tests. In addition, the Kao test rejects the null hypothesis of no co-integration. Thus, the estimated statistics provide evidence of co-integration to support the existence of fertility function in the panel. In particular, panel co-integration test results suggest that there is a co-integrating relationship among the variables in the sample of 27 European countries. Therefore we conclude that equation (1) finds statistical support in the panel.

[INSERT Table 3]

[19] For more details for the estimated diagnostic tests see below in the panel estimation of fertility.

4.4 Panel estimation

Next, equation (2) was estimated employing unbalanced panel data and using the fixed and random effects estimation methods (Table 4). In the estimation fixed country and time specific effects are estimated and it is assumed that all the explanatory variables are predetermined. The Wald test suggests that the null hypothesis that country effects, time effects and jointly country and time effects was rejected at 1% level of significance. In addition, the estimated statistic for the Hausman test, which tests the null hypothesis of no correlation between individual effects and other regressors, is high enough to reject the null hypothesis at 1% level of significance. Hence, we can conclude that the fixed effects model is more appropriate to estimate equation (2).

Table 4 shows that all the variables, except the income and the real wage, are statistically significant and have the right sign. These results imply that income and opportunity cost of children do not affect fertility in this panel of European countries (model 1). Next two variables to measure production volatility were added to the regression equation that is volatility (VOL) and volatility squared (VOL^2). In Table 4 model (2) shows that when fixed method estimation is used only volatility is statistically significant while the volatility squared variable has the right sign but it is not statistically significant. Finally, instead of the production volatility variables unemployment is used as explanatory variable in the estimation of fertility equation. Model (3), last two columns in Table 4, shows that unemployment variable has the right sign and is significant at 10% level of significance. These results might imply that uncertainties do not influence fertility and hence the growing insecurities of modern economies are not responsible for the reduction of fertility rate. However, the fixed effects model does not take into account the endogeneity of the regressors. Many of the regressors used in our empirical analysis such as infant mortality, real per capita income, real wage, nuptiality rate, female labor force participation and uncertainty measures influence fertility and vice versa. The modern economic theory of population which emphasizes the interdependence between economic and demographic variables and fertility in the context of economic theories of behavior (Whittington et al. 1990; Sah 1991; Cigno 1998; Becker et al. 1999; Cigno 1998) suggests that when the level of child mortality is high, reductions in it are likely to raise both fertility and survival-enhancing expenditures on children, because it lowers the price of a surviving child. When fertility is low, further reductions in it are likely to reduce fertility and survival-enhancing expenditures on children.

Sah (1991) finds that when parents have a target fertility level and are sufficiently risk averse, then better survival opportunities for their children tend to reduce fertility.

In the analysis by Becker et al. (1999) parents choose their number of children and investment in the human capital of each child to maximize their dynastic utility. In their model, birth rates are lower in the modern world with growing human capital than in agricultural economies partly because adult and child mortality are much lower. High female labor force participation and high real wage may reduce fertility since the opportunity cost of children is high. Many researchers have estimated simultaneous models of fertility, labor supply and child care and have shown the interdependency over the life cycle of fertility and female employment rates (e.g. Cain and Dooley 1976; Fleisher and Rhodes 1976; Moffit 1984; Hotz and Miller 1988; Mahdavi 1990; Cigno 1991; Kalwij 2000; Papapetrou 2004; Stanfors 2006; Huang 2007; Weagley et al. 2007; Craig 2007; Herbst and Barnow 2008).

Nuptiality, fertility, real wage and real income should be viewed as jointly determined, each being a product of decisions based on a set of preferences and constraints. Marriage agreements are based on anticipated gains from cooperation between individuals. The gains from marriage are positively related to fertility, since children offer benefits to the household, and negatively related to real wage and real income and female decision to participate in the labor market since higher real wage and real income for each individual reduces the gains from marriage (Becker, 1973).

At the same time declining fertility rates matched with an aging population (Figure 4) are partially responsible for changes in unemployment and output movements, indicating that a slower population growth is responsible for slower economic performance growth in the long-run period, putting further burden to future generations. Given that the "double aging process" is partially responsible for the deterioration in economic developments, future unfavorable demographic developments will exercise further pressure on the economy leading to a lower economic performance growth in the long-run period. On the contrary, a longer life might promote savings and investment in human capital leading to an increase of average productivity.

One way to solve the theoretical problem of endogeneity, the existence of interrelationships among the variables, is to estimate equation (2) using DOLS estimation.

Hence, equation (2) is estimated using one lead and one lag of all the independent variables. The results are reported in Table 5.

Initially equation (2) is estimated without the uncertainty variables. The empirical results imply that a downward shock to infant mortality, due for example, to medical advances, leads to lower fertility. This result is consistent with the recent theoretical explanations provided by Whittington et al. (1990), Sah (1991) and Cigno (1998). An increase in female labor force participation leads to lower fertility. This implies that the opportunity cost of time devoted to childcare has increased and consequently fertility has declined. This result is consistent with the theoretical explanations provided by Becker and Lewis (1973). At the same time an increase in the real per capita income increases fertility (income elasticity=0.199) but an increase in real wage, which is a proxy for the opportunity cost of children decreases fertility (wage elasticity=-0.267). This result is consistent with the theoretical explanations suggesting that both the number of children and spending on children are decision variables. Therefore, an upward shock in real GDP per capita, due for example to an improvement in the terms of trade, leads to higher fertility. This implies a positive income effect on the demand for children while the negative sign in real wage and female labor force participation rate imply a negative substitution effect. Finally, the other two demographic variables used in the estimation, mainly to control for other demographic changes, are positive and statistically significant. The estimated coefficients are in accordance with the previous theoretical explanations. For example, an increase in the nuptiality rate is expected to increase further fertility since one of the gains of marriage is the accomplishment of the desire to have children. This result is consistent with the results of Bailey and Chambers (1998) and Hondroyiannis and Papapetrou (2004).

Finally, the uncertainty variables are added to the fertility equation. First, the production volatility measures, volatility (VOL) and volatility squared (VOL^2) were added to the fertility equation, (equation 1). Table 5, second column, presents the empirical results. The addition of the two extra variables did not change significantly the previous empirical results. In addition, the standard error of regression is reduced. The estimated sign for the volatility variable is positive while for the volatility squared is negative and both have statistically significant coefficients. A turning point is calculated as 0.0041 (34.914/2*4208.5). The turning point is higher than the average volatility (average volatility=0.00056) and lower than the maximum (maximum volatility=0.024). This result implies that higher volatility, which is related with higher risk, increases fertility up to a level and after this point a further increase in volatility leads to lower fertility. Next the second measure of uncertainty, unemployment rate was added in the fertility equation (Table 5, third column). All the estimated coefficients have the right sign and are statistically significant. The unemployment rate variable has a negative sign and the estimated coefficient is statistically significant. This result implies that an increase in unemployment increases insecurities about present and future income resulting to a decline of fertility.

Hence, the above empirical results imply that in countries with high real income per capita where there is a positive relationship between economic growth and volatility a further increase in volatility and hence of economic growth will initially increase fertility up to a point. After this point a further increase in volatility and hence of economic growth will reduce fertility. Contrary to that, in countries with lower income per capital where volatility is negatively related with economic growth, high volatility is associated with low economic growth. The last empirical finding implies that in European countries with low per capita income in periods of economic downturn, which are related with low economic growth rate and high volatility, a reduction in volatility will reduce fertility rate. Therefore, from the empirical results we can conclude that European economies that have a relatively lower level of income per capita, less institutionally developed and less mature markets appear to face a reduction in fertility when economic growth is catching up after a recessionary period. In addition, the results imply that labor market uncertainties might dominate adults' decisions for partnership and parenthood since responsible couples will decide to have children when they manage to secure their present and future income. The above results may imply that in the presence of insecurities couples may postpone fertility plans and as long as these types of insecurities grow in the modern industrialized societies fertility will continue to decrease.

Overall, the empirical findings suggest that: first, in countries with low per capita income and a low growth rate which is associated with high uncertainty, a reduction in output volatility will lead to a decline in fertility and second, in economies with high per capita income, institutionally developed with mature financial markets and high economic performance a further increase in output volatility will reduce fertility.

5. Conclusions

This paper provides an empirical model to explain the changes in fertility choice in Europe employing panel data. The statistical relationship among fertility economic and demographic variables is estimated for twenty-seven European countries employing unbalanced panel data for the period 1960-2005.

The study examines the stationary properties of the data, employing individual along with panel unit root tests. The relationship is estimated employing three different estimation procedures: the fixed, the random effects and the DOLS estimation for heterogeneous unbalanced panel. However, because of data limitations some important policy variables, such as unemployment benefits and family allowances, which are typically included in this type of studies were omitted from the empirical analysis and might influence the empirical results of our analysis. We believe that the inclusion of these variables in our analysis will not alter our empirical findings since other variables, such as real income per capita, real wage, female employment and unemployment rate, which are highly correlated with these public policy variables were already incorporated in the analysis. However, this omission is one limitation of our study and a potential topic for further research in this area of empirical analysis.

The analysis supports the view that fertility variations in Europe are explained by changes in infant mortality, female employment, nuptiality, old age dependency ratio, real income per capita, real wage and output volatility. Two measures, production volatility and unemployment rate are used as proxies to measure uncertainty and insecurities in the modern economies. The empirical results for the panel data indicate that a downward shock to infant mortality, due for example to medical advances, leads to lower fertility. An upward shock in real GDP per capita, due for example to an improvement in the terms of trade, leads an increase of fertility. This implies a positive income effect on the demand for children. However an increase in real wage which is a proxy for the opportunity cost of children will decrease fertility. This implies a negative substitution effect which is reinforced by the increase in female employment. Hence the opportunity cost of time devoted to childcare has increased as a result of increasing real wage and female labour force participation and consequently fertility has declined. At the same time, an increase in nuptiality leads to higher fertility since children is one of the most important gains of the marriage.

Finally, the empirical results support the proposition that economic uncertainty might be an important determinant of fertility decision, explaining the decline in fertility in Europe. The empirical findings suggest that in economies with high per capita income an increase in output volatility that is associated with low economic performance leads to lower fertility. Contrary to that, in economies with low income per capita an increase in output volatility which is associated with a downturn of the economic activity an increase in real economic activity associated with reduction in volatility will result in a decline of fertility. Likewise, high unemployment increases labor market insecurities. Since children are long-term commitments labor market uncertainties might domain adults' decisions for partnership and parenthood since responsible couples will decide to have children when they are able to secure their present and future income.

The empirical results have important implications for the sample European countries, with declining fertility and aging population. Fertility is found to be related to demographic and economic factors, such as infant mortality, nuptiality rate, female employment, real per capita output, real wage and uncertainty, so that movements in fertility rates observed over the last three decades can be accounted by changes in these economic variables. Therefore, the declining fertility rates in the European countries can be explained by the positive effect of lower infant mortality rate, the negative effect of a higher price of having children, due to increasing female employment, outperforming the positive effect of a higher income on the demand for children. Finally, the declining fertility rates may be attributed to the growing uncertainties related to labor market insecurities which are a major characteristic of modern European societies which are characterized by internationalization and globalization.

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Table 1								
Summary Statistics by country: Average values and Standard Deviation values								
Country	Fertility	Infant mortality	Female labor force participation rate	Nuptiality rate	Old dependency ratio	Real wage	GDP per capita	Unemployment rate
Austria	1.82 (0.51)	15.32 (10.01)	40.70 (1.93)	6.26 (1.30)	22.22 (1.44)	4.28 (0.34)	16639.97 (5566.35)	2.80 (1.16)
Belgium	1.87 (0.39)	12.99 (7.71)	35.97 (5.52)	6.12 (1.17)	22.03 (2.05)	4.27 (0.37)	16028.23 (4971.65)	6.25 (3.26)
Bulgaria	1.85 (0.41)	21.37 (8.30)	45.76 (1.61)	6.77 (1.81)	19.23 (4.50)	4.51 (0.12)	1628.37 (235.52)	13.92 (3.27)
Cyprus	2.41 (0.56)	17.01 (10.19)	36.70 (3.72)	9.58 (2.46)	17.01 (0.45)	4.70 (0.06)	9568.85 (3006.64)	3.95 (0.77)
Czech Republic	1.87 (0.34)	13.74 (6.43)	45.42 (1.44)	7.50 (1.60)	18.43 (2.02)	4.77 (0.10)	5501.69 (674.30)	7.36 (1.03)
Denmark	1.87 (0.37)	9.96 (5.17)	42.07 (5.22)	6.66 (1.00)	20.97 (2.21)	4.45 (0.21)	22183.66 (5501.12)	4.51 (2.68)
Finland	1.87 (0.35)	8.78 (5.36)	45.75 (2.28)	6.24 (1.38)	17.41 (3.71)	4.30 (0.34)	16221.13 (5442.58)	6.13 (4.24)
France	2.08 (0.41	11.81 (7.30)	40.57 (4.15)	5.87 (1.23)	21.45 (1.87)	4.35 (0.31)	16225.95 (4798.71)	6.62 (3.63)
Germany	1.66 (0.44)	13.69 (8.93)	40.65 (2.17)	6.46 (1.32)	21.96 (2.12)	4.36 (0.27)	18498.97 (3785.61)	8.36 (1.35)
Greece	1.86 (0.48)	18.35 (11.81)	32.02 (5.88)	6.73 (1.46)	19.38 (3.86)	4.50 (0.29)	8115.55 (2488.72)	6.30 (2.98)
Hungary	1.78 (0.29)	23.34 (12.56)	42.18 (2.84)	7.07 (1.94)	19.98 (2.13)	4.67 (0.07)	3572.02 (1174.18)	8.04 (1.97)

Table 1								
Summary Statistics by country: Average values and Standard Deviation values								
Country	Fertility	Infant mortality	Female labor force participation rate	Nuptiality rate	Old dependency ratio	Real wage	GDP per capita	Unemployment rate
Iceland	2.57 (0.66)	8.23 (4.84)	40.93 (6.64)	6.37 (1.39)	15.99 (1.18)	4.51 (0.22)	22065.07 (7266.71)	1.47 (1.41)
Ireland	2.87 (0.85)	13.41 (7.96)	32.01 (6.09)	5.67 (0.87)	18.33 (0.92)	4.24 (0.38)	13228.68 (7686.27)	8.97 (4.35)
Italy	1.78 (0.55)	17.25 (12.34)	33.49 (4.46)	6.01 (1.21)	20.28 (4.19)	4.37 (0.30)	13513.24 (4415.08)	7.51 (2.18)
Latvia	1.74 (0.33)	16.09 (4.30)	49.74 (0.96)	8.10 (2.46)	19.84 (2.02)	4.72 (0.23)	3064.503 (933.67)	11.11 (5.77)
Lithuania	1.99 (0.41)	16.61 (7.89)	48.64 (0.78)	8.14 (1.83)	18.05 (2.23)	4.83 (0.23)	3558.98 (841.37)	8.40 (5.37)
Luxembourg	1.75 (0.32)	13.18 (8.25)	33.26 (5.09)	5.77 (0.81)	19.63 (1.24)	4.33 (0.28)	27776.92 (12328.48)	1.68 (1.50)
Malta	2.12 (0.45)	16.17 (9.95)	23.71 (4.16)	7.34 (1.45)	17.88 (0.83)	4.69 (0.15)	5023.37 (3094.08)	6.25 (1.16)
Netherlands	1.97 (0.60)	9.17 (3.68)	34.25 (7.64)	6.66 (1.50)	17.57 (1.70)	4.39 (0.29)	17171.99 (4807.32)	4.40 (2.81)
Norway	2.10 (0.46)	8.37 (3.76)	38.74 (8.35)	5.82 (1.01)	22.41 (2.42)	4.31 (0.31)	24306.82 (9351.06)	3.38 (1.39)
Poland	2.08 (0.46)	24.72 (13.65)	45.22 (0.66)	7.19 (1.55)	15.58 (2.12)	4.74 (0.20)	4029.51 (852.28)	15.05 (3.16)
Portugal	2.14 (0.67)	29.67 (25.13)	36.39 (9.47)	7.58 (1.54)	18.18 (3.80)	4.13 (0.51)	6888.46 (2817.50)	5.16 (2.32)
Romania	2.08 (0.63)	33.03 (14.93)	44.97 (0.74)	7.71 (1.15)	17.77 (1.99)	4.78 (0.24)	1899.99 (242.28)	6.55 (1.36)

Table 1

Summary Statistics by country: Average values and Standard Deviation values

Country	Fertility	Infant mortality	Female labor force participation rate	Nuptiality rate	Old dependency ratio	Real wage	GDP per capita	Unemployment rate
Slovak Republic	2.15 (0.54)	17.68 (7.29)	43.44 (2.97)	6.98 (1.47)	15.08 (1.57)	4.77 (0.14)	3730.44 (549.44)	15.51 (2.87)
Spain	2.04 (0.74)	14.05 (9.76)	30.49 (6.91)	6.15 (1.10)	18.40 (3.79)	4.28 (0.38)	9705.03 (3396.27)	9.67 (6.01)
Sweden	1.87 (0.27)	7.90 (3.99)	42.46 (6.36)	5.26 (1.62)	24.24 (3.43)	4.46 (0.22)	20416.90 (5139.16)	3.77 (2.66)
United Kingdom	2.03 (0.44)	12.71 (6.07)	40.31 (4.68)	7.02 (1.24)	22.22 (2.24)	4.37 (0.26)	17442.89 (5009.08)	5.54 (3.24)
European Average	*2.00* *(0.56)*	*15.52* *(11.42)*	*39.32* *(7.66)*	*6.79* *(1.71)*	*19.54* *(3.49)*	*4.32* *(0.32)*	*14019.14* *(9400.14)*	*5.83* *(4.38)*

Notes: Standard deviations are in parenthesis. Total fertility rate is measured as the number of children which a woman would bear if she followed throughout her life the current age specific birth rates. Infant mortality rate is measured as the number of children aged under one year old who die per 1000. Female participation is measured as the proportion of female in the labor force. The nuptiality rate is measured as the number of marriages per 1000 inhabitants. The old age dependency ratio is measured as the ratio of people older than 64 to working population (people between 15 to 64). Real wage is the log of real compensation per employee. Real income per capita is the real per capita GDP in US dollars and unemployment rate is measured as the percentage of unemployed workers. The unemployment rate is measured as the number of unemployed persons divided by the labor force.

Table 2

Panel Unit Root Tests

Variable	Level		First Difference	
	Hadri Z-test	Im, Pesaran and Shin W-test	Hadri Z-test	Im, Pesaran and Shin W-test
LFERT	19.25***	1.29	1.59	-9.04***
LIMORT	24.24***	8.17	0.25	-23.24***
LFEM	23.44***	-1.69	1.56	-3.05**
LMAR	18.14***	5.63	1.09	-21.80***
LODEP	22.83***	0.64	1.24	-7.39***
LPPGDP	23.41***	-1.19	1.55	-12.34***
LRWAGE	16.90***	0.03	1.22	-10.18***
DLRGDP	1.11	-10.80***		
VOL	1.33	-7.10***		
LUNEMP	11.81***	-0.77	1.55	-10.19***

Notes: ***, ** indicate rejection of the null hypothesis at 0.1% and 1% level of significance respectively.

Table 3	
Panel Co-integration Tests for Heterogeneous Panel	
Co-integration Statistics	Value
Pedroni Co-integration tests	
Panel ν-Statistic	-0.416
Panel ρ-Statistic	9.186***
Panel t-statistic: (non-parametric)	1.285
Panel t-statistic: (parametric)	2.031*
Group ρ-Statistic	11.085***
Group t-statistic: (non-parametric)	-4.339**
Group t-statistic: (parametric)	-1.275
Kao Co-integration test	-1.20†
Fisher Co-integration test for one vector	458.8***
Notes: ***, **, *, † indicate rejection of the null hypothesis of no co-integration at 0.1%, 1%, 5% and 10% level of significance.	

Table 4						
Fixed and random effects and specification tests **Dependent Variable: Fertility choice**						
Variables	Fixed effects estimation Model (1)	Random effects estimation Model (1)	Fixed effects estimation Model (2)	Random effects estimation Model (2)	Fixed effects estimation Model (3)	Random effects estimation Model (3)
Constant	0.658 [1.14]	1.744** [5.79]	0.550 [0.93]	2.00** [5.97]	1.457* [2.19]	2.161** [6.64]
LMORT	0.287** [13.50]	0.106** [5.61]	0.320** [15.95]	0.100** [4.88]	0.258** [9.56]	0.047* [2.24]
LFEM	-0.476** [-7.11]	-0.495** [-10.13]	-0.572** [-7.85]	-0.580** [-10.89]	-0.444** [-4.30]	-0.483** [-8.76]
LMAR	0.186** [5.15]	0.161** [4.97]	0.154** [4.45]	0.138** [4.17]	0.179** [4.85]	0.143** [4.31]
LODEP	0.161** [3.98]	0.053 [1.11]	0.214** [4.86]	0.071 [1.38]	0.382** [7.33]	0.243** [4.97]
LPPGDP	0.014 [0.34]	0.124** [5.21]	0.016 [0.37]	0.131** [5.46]	-0.089† [-1.90]	0.087** [3.49]
LRWAGE	0.016 [0.28]	-0.276** [-8.13]	0.076 [1.37]	-0.279** [-7.48]	-0.096 [-1.29]	-0.391** [-10.61]
VOL	-	-	20.084** [3.34]	16.205* [2.33]	-	-
VOL^2	-	-	-266.34 [-1.00]	-537.66 [-1.44]	-	-
LUNEMP	-	-	-	-	-0.018† [-1.94]	-0.011 [-1.28]
Fixed effects (country specific)	46.95**		46.08**		55.29**	
Fixed effects (time specific)	5.05**		5.66**		5.64**	
Fixed effects (country and time specific)	19.47**		18.95**		22.19**	
Hausman test for country effects	13.62*		18.13*		17.75**	
Hausman test for time effects	39.26**		29.44**		20.89**	
Adjusted R-squared	0.87	0.74	0.87	0.73	0.91	0.70
S. E. of regression	0.108	0.112	0.098	0.111	0.084	0.098
Notes: Figures in brackets are t-statistics. **,* and † indicate significance at 1%, 5% and 10% level respectively.						

Table 5			
Panel estimation using Dynamic OLS Dependent Variable: Fertility choice			
Variables	Model (1)	Model (2)	Model (3)
Constant	1.366** [4.52]	1.017** [3.19]	1.910** [6.58]
LMORT	0.118** [6.46]	0.137** [6.65]	0.015 [0.77]
LFEM	-0.739** [-9.78]	-0.699** [-10.94]	-0.828** [-9.65]
LMAR	0.221** [6.10]	0.220* [6.37]	0.188** [6.34]
LODEP	0.191** [5.16]	0.253** [6.92]	0.474** [8.44]
LPPGDP	0.199** [5.58]	0.186** [5.37]	0.233** [5.90]
LRWAGE	-0.267** [-6.41]	-0.248** [-6.28]	-0.512** [14.36]
VOL	-	34.914** [4.24]	-
VOL^2	-	-4208.500** [-5.06]	-
LUNEMP	-	-	-0.017** [-3.63]
Wald joint test for excluding uncertainty		13.34**	13.20**
S. E. of regression	0.106	0.105	0.087
Notes: Figures in brackets are t-statistics. ** and * indicate significance at 1% and 5% level respectively.			

Figure 1
European average of fertility and infant mortality rates

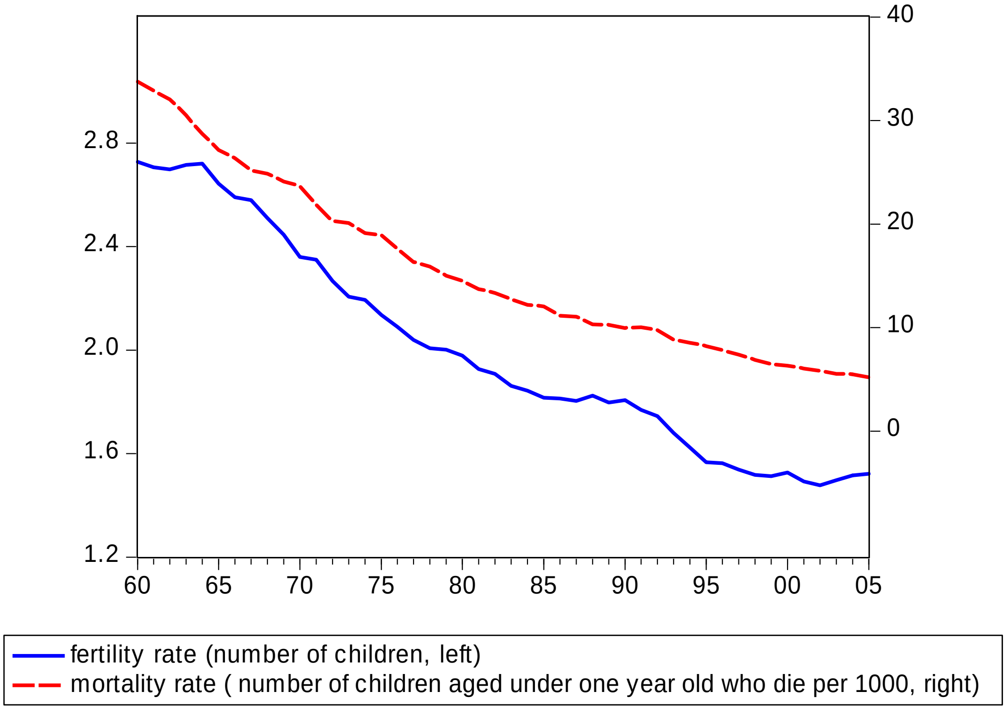


Figure 2
European average of real per capita income and real wage

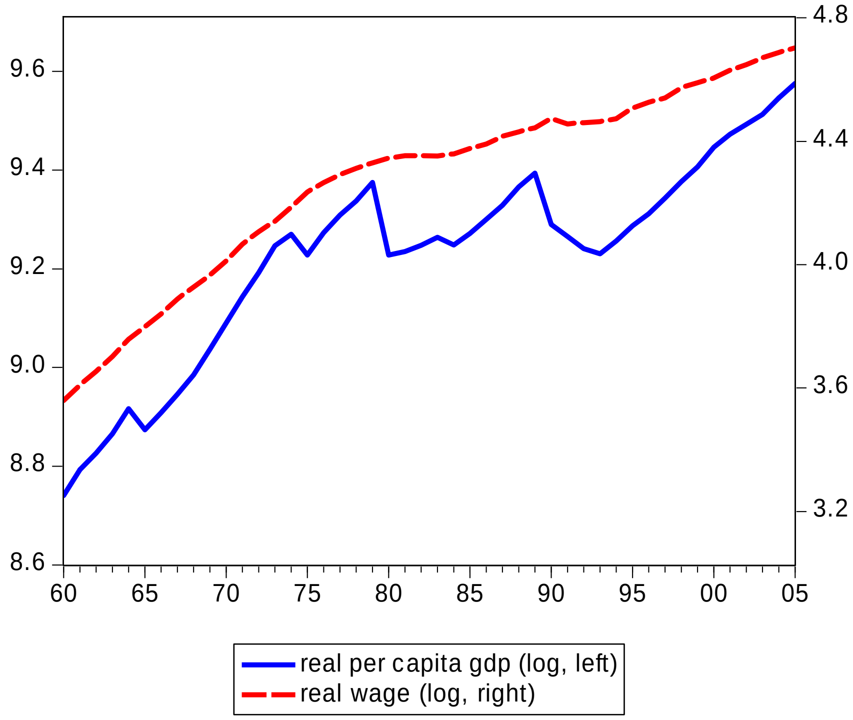


Figure 3
European average of female participation rate and fertility rate

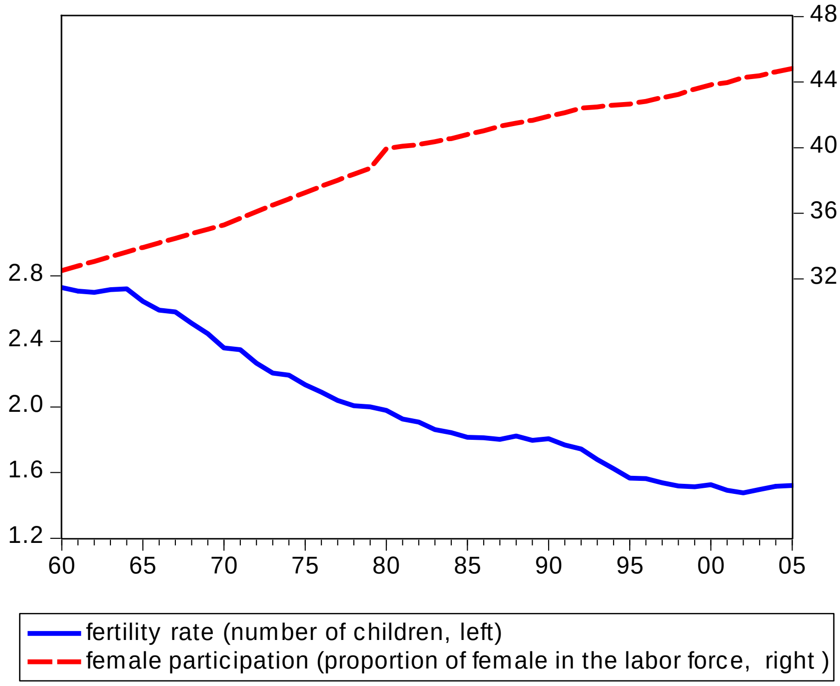


Figure 4
European average of fertility rate and old age dependency ratio

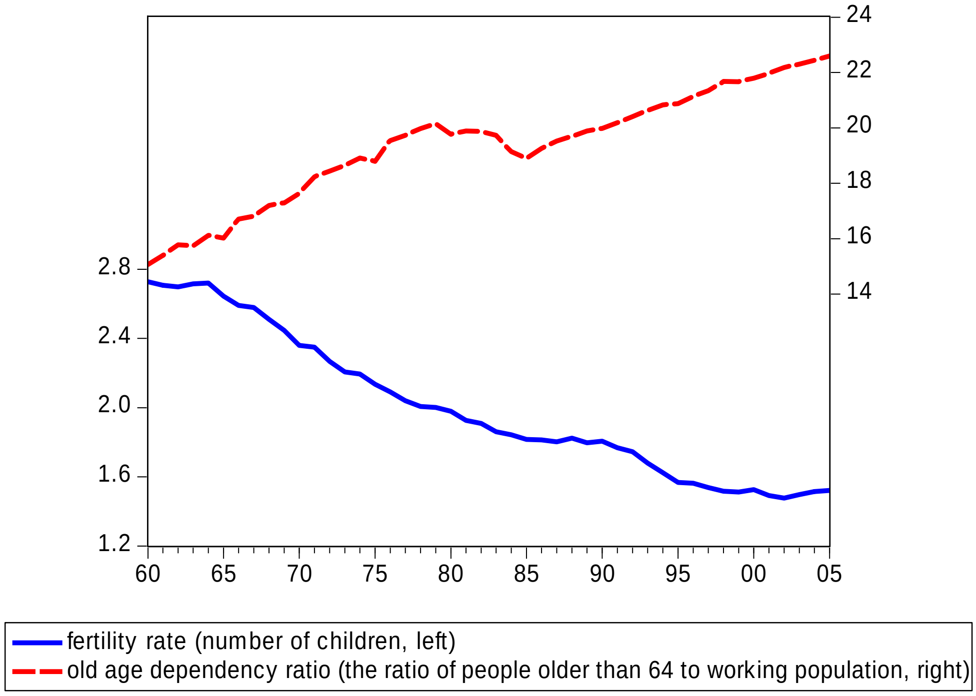
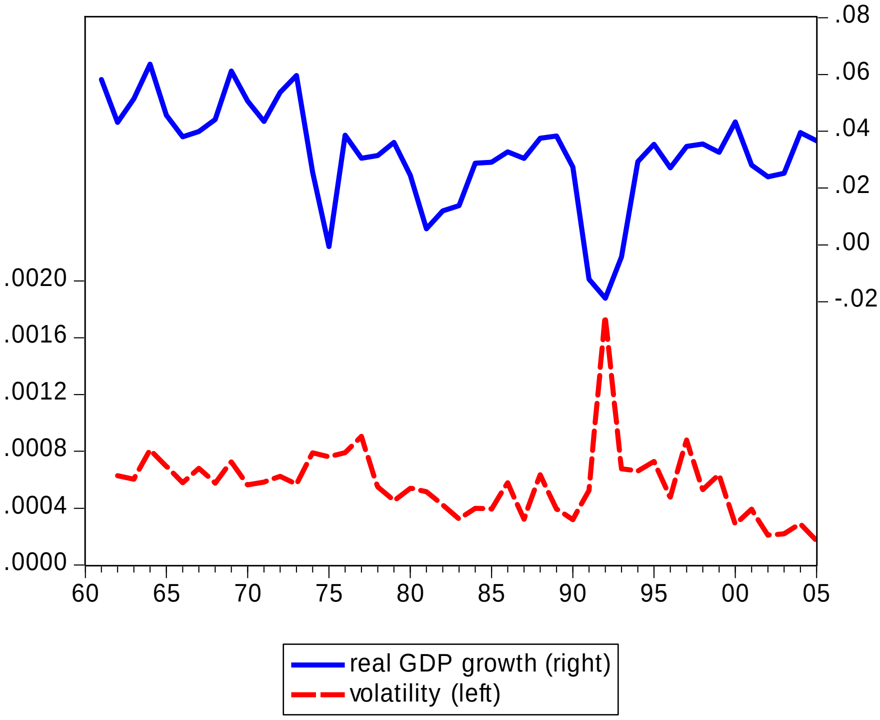


Figure 5
European average of GDP growth and volatility



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