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# THE FERTILITY REBOUND AND ECONOMIC GROWTH. NEW EVIDENCE FOR 18 COUNTRIES OVER THE PERIOD 1970-2011.

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**GUT Faculty of Management and Economics**

**Working Paper Series A (Economics, Management, Statistics)**

**No.5/2014 (23)**

**May 2014**



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# The fertility rebound and economic growth.

## New evidence for 18 countries over the period 1970-2011.

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**Abstract**

The long-run impact of economic growth on total fertility trends is ambiguous and sensitive for in-time variations. Over last decades, economic growth has led in many countries to significant falls in total fertility rates. However, in recent years, in high-income economies a kind of “fertility rebound” is revealed (Goldstein 2009; Luci and Thevenon, 2010; Day 2012). The concept of fertility rebound supports the hypothesis that reversal trends in total fertility rates are mainly attributed to economic growth. The paper unveils the relationship between total fertility rate changes and economic growth in 18 selected countries with fertility rebound observed, over the period 1970-2011. We anticipate uncovering U-shaped impact of economic growth on total fertility rate. To report on the relationship we deploy longitudinal data analysis assuming non-linearity between examined variables. Data applied are exclusive derived from World Development Indicators 2013. Our main findings support the hypothesis on U-shaped relationship between total fertility rate and economic growth in analyzed countries in 1970-2011. Along with the previous we project the threshold level of GDP *per capita* when the fertility rebound takes place.

**Keywords:** fertility rate, fertility rebound, economic growth, panel data analysis.

**JEL classification:** J11, O10, C23.

## 1. Introduction

Hirschman (1994) concluded that the picture emerging from empirical evidence on changing fertility (by convention measured as period total fertility rate – TFR) was ambiguous and did not provide a clear explanation of its determinants. After twenty years of continuous studies, our knowledge about the factors influencing fertility is much broader; however, we still lack an overarching theory in this field.

Although the relationship between changing fertility rates and economic development is affected by a multitude of quantifiable and unquantifiable factors, the negative relationship between fertility and socio-economic development is recognized in the literature as one of the best-established and consolidated regularities. This has been empirically confirmed in prominent works by, *inter alias*, Becker (1960), Heer (1966), Easterline (1975), Van de Kaa (1987), Witte and Wagner (1995), Becker et al. (1999), Lee (2003), Myrskylä et al. (2009), Luci and Thévenon (2011) and Bacci (2013). The economic reasoning behind the negative relationship between fertility and economic development is the following. As mortality and fertility rates decline[4], there are reductions in the amounts of energy and resources necessary for childbearing (Kalemli-Ozcan et al. 2000, Orsal and Goldstein 2011, Livi-Bacci 2012, 2013), resulting in a higher level of engagement of women in market activities instead, which potentially generates shifts in total productivity. On the other hand, as Weil (2013) claims, as countries get richer, an 'income effect' and 'substitution effect' emerge, which explain why people tend to have fewer children as their income grows. Usually, people value children as 'normal goods' that they need to spend money on. As people earn more, the demand for children should rise. However, this is usually not true, as the relative *price* of raising children also rises. Childbearing requires time, which is perceived as the equivalent of an opportunity cost of lost earnings from regular work; hence, the 'substitution effect' emerges. If the 'substitution effect' is stronger than the 'income effect' then the country`s fertility rate falls. Weil (2013) additionally explains that reductions in fertility may be determined by an emerging 'quality-quantity trade-off' effect. In highly-developed countries, children need to get a good education, which is costly. Thus, people decide to have fewer – but better educated – children, hoping for payoffs in the future and on the children`s support as they age. Alternatively, people decide to have more children, but at the cost of them receiving worse education. Whether the first or the second occurs depends predominantly on how societies value children, on what the well-established social norms and attitudes are, or on individual preferences.

Although the negative association between fertility and economic growth seems to have been well established somewhat regularly, recent estimates provide solid grounds for claiming a reversal of the negative relationship between the TFR and economic growth (i.e. Gubhaju and Moriki-Durand

[4] Note that from a demographic perspective, reductions in fertility rates are a consequence of both declines in mortality and increases in life expectancy.

2003, Bongaarts and Sobotka 2012). In Europe, the period 1998-2008 was marked by significant changes in total fertility rates (Bongaarts and Sobotka 2012, Sobotka 2012). In fact, in many European countries the TFR began to grow, after having fallen to unprecedentedly low levels in the early 2000s (in 19 European countries the TFR fell below 2.0). Evidence for an attempt to escape the 'low fertility trap[5]' in Europe is reported in works by, *inter alias*, Prioux (2007), Goldstein et al. (2009) and Bongaarts and Sobotka (2012). Furthermore, over the period 2000-2011, similar reverse trends in total fertility rates were observable in more than 60 highly-developed and economically backward countries (see World Development Indicators 2013), while each of these experienced continuous economic growth. Thus, increases in fertility rates occurred simultaneously with growth in national output. This may suggest the emergence of new positively correlated regularities between TFR and economic growth (Myrskylä et al. 2009, Day 2012 and 2013, Varvarigos 2013). In the literature (Luci-Greulich and Thévenon 2013), this reversal of the downward trend in total fertility rates has been dubbed the 'fertility rebound', and it usually coincides with economic growth.

The aim of this paper is to provide new evidence on the relationship between total fertility rates and economic growth in a long-term perspective. We re-examine the hypothesis of a U-shaped relationship between TFR and GDP per capita for 18 high-income countries over the period 1970-2011. Our study consists of six parts. Section 2 explains the theoretical background and reviews the literature. Section 3 presents the data employed. Section 4 sets the main goals of the paper and outlines the empirical strategy. Subsequently, section 5 analyses the results, and the final part concludes.

## 2. Conceptual background.

Recent empirical studies (see, e.g., the works by Goldstein et al. 2009, Bongaarst and Sobotka 2012, Luci-Greulich and Thevenon 2013, and Day 2013) provide well-documented evidence on the relationship between TFR and GDP per capita or – alternatively – socio-economic development, approximated by the Human Development Index. Although the evidence is relatively broad, the

[5] The concept of 'low fertility' is somewhat ambiguous. As Bacci (2013) argues, in its simplest form, low fertility occurs when it falls below 1 (and thus is "below replacement' or a 'net reproduction rate'), depending only on mortality. The previous definition is far from satisfactory. However, in modern societies, where life expectancy is high and mortality in reproductive years is close to zero, the replacement of populations is strictly dependent on total fertility. Societies where the total fertility rates oscillate around two children per woman in her reproductive life cycle are labeled low fertility societies (Bacci 2012, 2013). If total fertility declines to around 1 or fewer children *per* woman, this is named 'ultra-low fertility' or 'lowest-low fertility'. Low fertility can also be perceived subjectively. Locally, fertility rates depend on individual expectations or preferences, social norms or ideals, religious attitudes, or finally on state strategic targets. In such cases, a rigid notion of low fertility remains fuzzy and undefined. In general, from a purely demographic perspective, the concept of low fertility relates exclusively to population replacement, while incorporating the low fertility notion into its social or economic background allows it to be perceived in the context of meeting broadly agreed social, economic or political targets (as, for example, in the case of China's 'one child' policy).

main conclusions reached vary significantly, showing the complexity of the problem and the multitude of factors which potentially affect the two-way relationship between fertility and economic growth and development.

In both theoretical and empirical works where the main emphasis is put on the relationship between fertility trends and economic development[6], three seminal research streams are easily distinguishable, since each one offers a different perspective for its analysis. The first stream combines issues of changing fertility with economic development (a rather long-run perspective), the second relates changing fertility trends exclusively with economic growth (a rather long-run perspective), while the third compares changing fertility trends with business cycles (both long- and short-run perspectives).

In one prominent work, Myrskylä et al. (2009) employ panel data for 37 highly developed countries over the period 1975 to 2005 to examine the relationship between the Human Development Index (HDI) and total fertility rates. They suggest that the HDI-TFR relationship tends to reverse from negative to positive as countries pass a critical level of HDI. Their findings show that at low and medium levels of human development index (HDI), decreases in the fertility rate coincide with continuously progressing economic growth. The situation changes diametrically at higher HDI levels. Beyond a particular threshold, further development may lead to a reversal in the declining fertility trend. The level of HDI which turns the correlation between human development and fertility from negative to positive is about 0.9. Following from this, they predict that in a long-run perspective advances in human development should positively impact fertility rates; however, changes in fertility are not exclusively attributed to economic effects.

Luci and Thévenon (2010) also report a U-shaped relationship between TFR and GDP per capita. Unlike Myrskylä et al. (2009), they analyse the impact of GDP per capita on fertility rates to isolate the pure economic impact on total fertility rates. To test the hypothesis of a convex impact of GDP per capita on TFR, Luci and Thévenon (2010) use a panel data set of 30 OECD countries over the timespan 1960-2007. Applying a step estimator, they identify the turning point in the relationship between economic growth and fertility beyond which further growth may lead to a reversal of the declining fertility trend. The minimum of the curve is located at a specific GDP per capita that corresponds to approximately $32,600 (in constant 2005 US$) and a total fertility rate of 1.51 children per woman. They separately identify country-specific factors, which they expect to explain why countries at comparable levels of GDP per capita experience different fertility rates. A general conclusion of the study is that economic development is likely to induce the fertility rebound; however, the evidence is not robust and case-sensitive.

[6] Along with the growing literature on the relationships between total fertility rates and economic development, there is broad empirical evidence providing demographic explanations for the reversal in fertility trends. Such evidence can be traced in work by, *inter alias*, Bongaarts and Sobotka (2012), Bongarts and Feeney (1998), Bongaarts (2002), Sobotka (2004), Goldstein et al. (2009), Frejka (2010), Sobotka et al. (2011), and Neels and de Wachter (2010a, 2010b).

The evidence provided by Myrskylä et al. (2009) clearly supports the claim that advances along the development path are in some cases accompanied by reverses of the declining fertility rate, but Furuoka (2009), in contrast, question this conclusion. Furuoka applies a threshold regression to examine the existence of the U-shaped fertility-development curve proposed by Myrskylä et al. (2009). He uses an HDI threshold (of 0.777) to divide the sample into two subsamples: countries with HDI levels at or below the threshold value and those above. The negative relationship between HDI and the fertility rate was identified in both groups of countries, although the negative relationship between the covariates was relatively weak in the countries with high HDI. This supports the supposition that countries located in the earlier phases of economic development are more likely to experience declining fertility rates while in highly developed countries it is the opposite. The aforementioned evidence provided by Myrskylä et al. (2009) is additionally supported by Goldstein et al. (2010). They verify the importance of economic conditions for fertility trends by using data on unemployment rates and GDP growth in 27 OECD countries (regardless of their total fertility rate levels) over the period 1995 to 2008. They do not claim a direct influence of unemployment on fertility, but rather emphasise the importance of current economic conditions on individual childbearing decisions. They find both unemployment and economic growth rates to be statistically significant predictors of future TFR.

Another stream of research, both theoretical and empirical, highlights the importance of distinguishing between short and long-run perspectives when analyzing the TFR and GDP per capita relationship. Long-term analysis mainly focuses on macro-factors (at an aggregate level) that determine observed changes in fertility, and this approach was employed in the aforementioned studies. Short-term analysis, however, concentrates on examining the impact of business cycles (especially recession) on the period TFR, and refers to individual decisions that may influence changes in TFR (Sobotka et al., 2011).

The majority of short-term analyses show a pro-cyclical relationship between fertility and GDP per capita. During recessions (approximated by declines in GDP per capita, growth in unemployment rates etc.), fertility tends to decrease. Evidence for this is presented in works by Lee (1990), Bengtsson et al. (2004), Martin (2004) and Adsera and Menendez (2009). Sobotka, et al. (2011) confirm the pro-cyclical relationship between GDP per capita and fertility. They use changes in GDP per capita as a proxy for recession and the period TFR as an indicator of fertility (imposing a 1-year lag on the impact of GDP per capita on TFR changes). The study covers 26 low-fertility developed countries over the period 1980-2008, and the results obtained seem to support the hypothesis that fertility and economic growth are positively correlated along business cycles, as had already been concluded in previous works (see, e.g., Lee, 1990; Bengtsson et al. 2004). However, huge uncertainties emerge in detecting rigid regularities in the behaviour of TFR relative to GDP per capita if business cycles are considered, which makes the relationship even fuzzier.

This is strongly underlined in works by, for example, Kohler et al. (2002a, 2002b), Santow and Bracher (2001), Mills and Blossfeld (2005), Kreynfeld (2010), Neels (2010) and Sobotka (2010).
The circumstances under which today`s recessions (e.g. the one which started in 2008) take place, differ significantly from those in the past. This is mainly due to huge increases in the active participation of women in the labour market, which is partly determined by their increasing access to education, contraceptives, and changing social norms. These changes may effectively precondition the strength of the influence of short-term recessions on changing fertility trends.

The counter-cyclical relationship has only been mentioned in a few studies, such as Butz and Ward (1979a, 1979b) and Macukovich (1996). Recessions in recent decades have been relatively short and thus their real impact on fertility has been temporary. The falls in fertility during recessions have been followed by a rise (or slower decline) during recoveries.
When analyzing trends in fertility in a short time perspective, some difficulties might arise in clearly distinguishing between fertility changes and fertility timing (postponement of childbearing). An attempt to tackle this problem can only be observed in a few studies. Formal analysis trying to combine short- and long-run perspectives in detecting relationships between economic development and fertility can be found in works by, e.g., Ogawa (2003) and Rindfuss et al. (1988). Empirical evidence linking fertility changes with GDP per capita is even rarer.

## 3. Data

We intentionally exclusively consider just two variables: the total fertility rate ($TFR_{it}$), which refers to the number of children that a woman gives birth to, in accordance with current age-specific fertility rates; and gross domestic product per capita ($GDPpc_{it}$) (in constant 2005 US$). All the data are derived from the World Development Indicators database 2013. To complete our empirical analysis we construct a long strongly-balanced cross-country panel covering 18 high-income economies that satisfy two prerequisites: in the period 1970-2011 they experienced drops in total fertility rates below 2.1 (replacement rate) followed by a "fertility rebound"; and they are classified[7] as high-income countries. The result is that the sample covers Australia, Belgium, Barbados, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Japan, Italy, the Netherlands, Norway, Sweden and the United States.

## 4. Empirical targets and methodological approach

The objectives of this paper are twofold. Using panel data for 18 countries over the period 1970-2011 we aim to confirm the hypothesis of a U-shaped relationship between the total fertility rate and economic growth approximated by GDP per capita. Following on from this, we estimate the

[7] According to the formal World Bank country classification (see: http://data.worldbank.org/about/country-classifications, acceded: Feb 2014)

threshold level of GDP per capita at which the fertility rebound effect potentially occurs. First, we confirm the U-shaped relationship between the variables: the response variable, total fertility rate ($TFR_{it}$); and the explanatory variable, economic growth ($LnGDPpc_{it}$). To do this, we adopt pooled OLS and compare the linear model with 2nd order polynomial (quadratic) and 3rd order polynomial (cubic) models. Hence, we specify:

$$TFR_{it} = \beta_0 + \beta_1 lnGDP_{pc_{it}} + \varepsilon_{it} \quad (1)$$

$$TFR_{it} = \beta_0 + \beta_1 lnGDP_{pc_{it}} + \beta_2 (lnGDP_{pc_{it}})^2 + \varepsilon_{it} \quad (2)$$

$$TFR_{it} = \beta_0 + \beta_1 lnGDP_{pc_{it}} + \beta_2 (lnGDP_{pc_{it}})^2 + \beta_3 (lnGDP_{pc_{it}})^3 + \varepsilon_{it} \quad (3)$$

where *i* denotes country, *t* the period (year), and $\varepsilon_{it}$ is an error term.

If a U-shaped relationship between $TFR_{it}$ and $LnGDPpc_{it}$ is confirmed, we exclusively adopt quadratic longitudinal models, and using yearly observations we test for a convex shape of the curve explaining the cross-country relationship between $TFR_i$ and $LnGDPpc_{it}$ and its square term. To capture time-invariant country-specific effects, we employ a country-fixed effects regression:

$$TFR_{it} = \alpha_i + \delta_1 lnGDP_{pc_{it}} + \delta_2 (lnGDP_{pc_{it}})^2 + \varepsilon_{it}$$

(4)

which can be rewritten (with country dummies included) as:

$$TFR_{it} = \delta_0 + \delta_1 lnGDP_{pc_{it}} + \delta_2 (lnGDP_{pc_{it}})^2 + \gamma_2 C_2 + \cdots + \gamma_n C_n + \varepsilon_{it} \quad (5).$$

In Eq.(4) and Eq.(5), $\alpha_i$ denotes an unobserved and time-invariant fixed effect, $\gamma_2$ is the coefficient for binary country regressors, C is a country dummy, and n is the number of countries in the sample. To satisfy the exogeneity assumption, in these two equations we assume that $E(\varepsilon_{it}/X_i, \alpha_i) = 0$, if $X_i$ represents $LnGDPpc_{it}$. In the specified models, the $TFR_{it}$ concisely expresses the vector of a country`s individual results determined by changes in per capita income across all periods.

To examine time-fixed effects we additionally estimate:

$$TFR_{it} = \delta_0 + \delta_1 lnGDP_{pc_{it}} + \delta_2 (lnGDP_{pc_{it}})^2 + \gamma_2 C_2 + \cdots + \gamma_n C_n + \lambda_2 Y_2 + \cdots + \lambda_t Y_t + \varepsilon_{it} \quad (6)$$

where *Y* is a year dummy and $\lambda$ stands for its coefficient. Hence, Eq.(6) is estimated for $(n-1)$ countries and $(t-1)$ years. In Eq.(6) we relax the assumption on unobserved effects which vary across countries but are constant over time, and we control for time effects, supposing that unexpected variations potentially influence the explanatory variable.

To confirm the results generated from Eq.(5) and Eq.(6), we additionally introduce an instrumental variables (IV) estimator, which cuts out any potential correlation between the error term and the explanatory variables. Assume that $y_i = \beta x_i + \varepsilon_i$, but $E(x_i, \varepsilon_i) \neq 0$, despite the exogeneity assumption, requires $E(x_i, \varepsilon_i) = 0$. Hence, to “omit” the endogeneity, we define $z_i$ as an instrument which satisfies both $E(z_i, \varepsilon_i) \neq 0$ and $E(z_i, \varepsilon_i) = 0$. To obtain an unbiased $\beta$, we adopt the 2SLS method, where $y_i = \beta x_i + \varepsilon_i$, and $x_i = \varphi z_i + \mu_i$, if $\varphi \neq 0$ $(\leftrightarrow E[z_i, x_i] \neq 0)$. In our case we employ lagged $LnGDPpc_{it}$ and $LnGDPpc_{it}^2$ ($LnGDPpc_{it}$ – 1-year lag; $LnGDPpc_{it}^2$ – 1-year lag) as instruments, which are sufficiently correlated with $LnGDPpc_{it}$ and $LnGDPpc_{it}^2$ respectively, but uncorrelated with $\varepsilon_{it}$. This allows the production of unbiased $\delta_1$ and $\delta_2$.

To remove unobserved heterogeneity from models, first differences estimators (FDE) are often applied. However, we decide not to follow this approach. First differencing of data implies that all estimates are generated for relative changes instead of levels, which brings a risk of obtaining misleading results due to any convergence process that characterizes the countries analyzed. If this is true, results for the role of economic growth in fertility in-time variability might be confusing and inconclusive. Luci and Thévenon (2011) also refer to this problem and indicate that using an FD estimator in this case might not allow for a clear statement about the "role of economic development for the fertility rebound in highly developed countries" (see Luci and Thévenon, 2011).

To accomplish the second goal of the paper, we calculate the minimum (turning point) of the parabola defined as in Eq.(2) which corresponds to the averaged level of GDP per capita at which the fertility rebound occurs. Assuming that Eq.(2) follows the 2nd order polynomial, then its general form is:

$$f(x) = ax^2 + bx + c, \tag{7}$$

where $x \in (-\infty; +\infty)$, and at least $a \neq 0$. Thus the minimum (turning point) of Eq.(7) is defined as:

$$\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right). \tag{8}$$

Alternatively, (8) can be calculated by use of the first derivative of Eq.(7):

$$f`(x) = 2ax + b, \tag{9}$$

and by solving the equation:

$$f`(x) = 2ax + b = 0. \tag{10}$$

The solution of Eq.(10) returns estimates of the level of GDP per capita corresponding to the threshold at which the relationship between TFR and GDPpc turns from negative to positive.

## 5. Results

The essence of the empirical analysis is to detect direct relationships between TFR and GDPpc in developed countries where the fertility rebound phenomenon occurred in the period 1970-2011. The country set covers 18 high-income economies that experienced TFR falls below 2.1, but the periods of low fertility were followed by TFR upswings. TFR in the 41 periods analyzed did not follow a smooth trend, but the upward trends were occasionally disrupted by "ups" and "downs". Despite this, a positive upward trend in TFR was maintained.

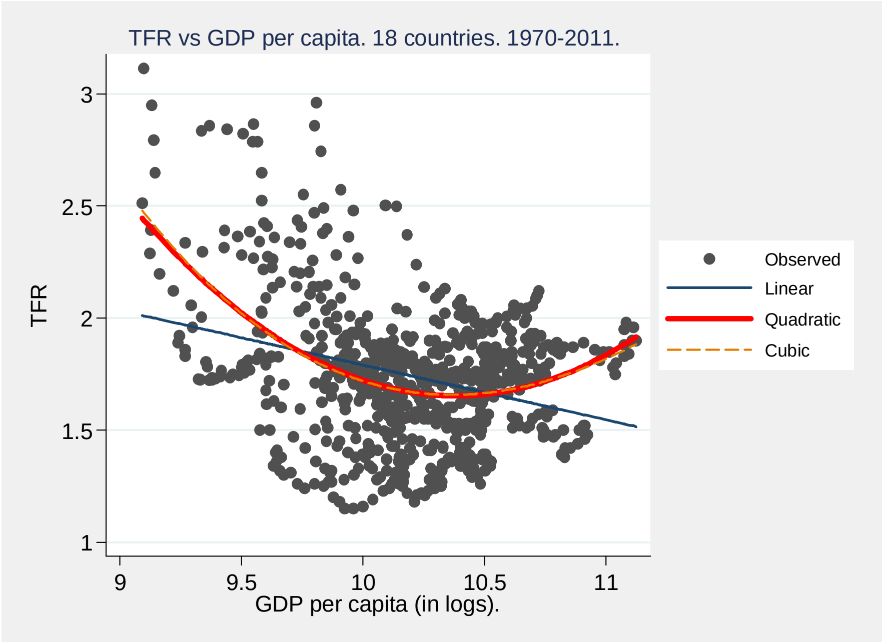
Looking backwards, in the 18 countries selected the reversal trends in TFR were preceded by permanent and substantial falls. In 1970, the average TFR was approximately 2.36[8]; in 1980 it was 1.77; in 1990, 1.69; in 2000, 1.60 (the low point); and finally in 2011 it recovered to 1.70. Hence,

[8] Own estimates for the 18 selected countries.

the absolute fall in average TFR over the period 1970-2000 reached 0.76. The sharpest decline in total fertility rates is seen in the decade 1970-1980, as TFR fell below the threshold (2.1) recognized as the replacement rate. Countries that experienced the most significant declines in TFR over the period 1970-1980 were Barbados (-1.1), the Netherlands (-0.98), Australia (-0.96), Italy and Norway (-0.78 for both). Conversely, we note that in 2011 the average TFR was slightly higher compared to 2000 (+0.1) and thus in the period 2000-2011 the fertility rebound occurred. The countries with the highest intensity of increasing TFR over the period 2000-2011 were Sweden (+0.36), the United Kingdom (+0.34), Belgium and Greece (+0.13 for both) and Italy (+0.15). It is possible that these observed positive changes in fertility rates are becoming a permanent feature rather than mere cyclical changes.

First, we plot our panel for a visual inspection of the nature of the relationship examined. Figure 1 confirms that the TFR – $GDPpc_{it}$ relationship followed a U-shaped pattern over the period 1970-2011. Initially, as the $GDPpc_{it}$ is relatively low, the $TFR_{it}$ is high; however, as the GDPpc grows the TFR steadily declines, finally reaching the low point of the U-shaped curve. Once passed the minimum, moderate increases in $TFR_{it}$ are revealed and the parabola opens upward. This offers support for the idea that the fertility rebound can be attributed to a certain threshold of $GDPpc_{it}$.

**Figure 1. Total Fertility Rate against GDP per capita. 18 countries. Period 1970-2011.**




Source: own elaboration based on data derived from World Development Indicators 2013. Note: solid line represents the quadratic prediction for $GDPpc_{it}$ against $TFR_{it}$. X axis: logs of $GDPpc_{it}$ in constant 2005 US$; Y axis: Total Fertility Rate absolute values.

Relying on pooled OLS, we detect the best-fit curve demonstrating how $TFR_{it}$ is related to $GDPpc_{it}$. Table 1 presents the results of linear, quadratic and cubic predictions for the relationship between $TFR_{it}$ and $GDPpc_{it}$. It emerges that the quadratic specification shows the best fit to the empirical data, as $R^2$=0.196 and all the coefficients are statistically significant. Thus, the quadratic model provides better predictions compared to the linear or cubic ones of the relationship between $TFR_{it}$ and $LnGDPpc_{it}$.

**Table 1. Total Fertility Rate against GDP per capita. Linear, quadratic and cubic specifications. 18 countries. Period 1970-2011.**

| | Linear | Quadratic | Cubic |
|---|---|---|---|
| | Pooled OLS | | |
| $LnGDPpc_{it}$ | -.25<br>(-8.85) | -10.09<br>(-9.87) | -18.33<br>(-.66) |
| $(LnGDPpc_{it})^2$ | | 0.48<br>(9.65) | 1.30<br>(.47) |
| $(LnGDPpc_{it})^3$ | | | -.02<br>(-.30) |
| _cons | 4.2<br>(14.88) | 54.06<br>(10.47) | 81.79<br>(.87) |
| $R^2$ of the model<br>adjusted – $R^2$ | .095<br>.094 | .196<br>.193 | .196<br>.192 |
| # of countries<br># of observations | 18<br>746 | 18<br>746 | 18<br>746 |

Source: own estimates based on data derived from World Development Indicators 2013. Note: in parenthesis t-statistics at 5% significance level.

Table 2 summarizes the regression results for the OLS and fixed-effects models. The OLS regression explains only 19.6% of the overall variation (25.9% if the lagged GDP variable is included); the FE specification produces a goodness of fit varying between 46.6% and 59.0%.

**Table 2. Total Fertility Rate against GDP per capita. Quadratic estimates. 18 countries. Period 1970-2011.**

| | **Pooled OLS** | | **FE (I)** | | **FE (II)** | | **FE (III)** | **FE (IV)** |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $LnGDPpc_{it}$ | -10.09 (1.01) | -9.19 (.88) | -21.54 (5.15) | -18.30 (5.26) | -14.56 (5.79) | -14.61 (5.88) | -21.48 (6.02)[(a)] | -14.65 (7.09)[(a)] |
| $(LnGDPpc_{it})^2$ | 0.48 (.049) | .422 (.044) | 1.02 (.25) | .862 (.26) | .724 (.28) | .721 (.28) | 1.02 (.29)[(a)] | .727 (.35)[(a)] |
| $LnGDPpc_{it}$ - 2-year lag | | .434 (.061) | | .267 (.09) | | .064 (.13) | | |
| _cons | 54.06 (5.1) | 46.99 (4.6) | 114.22 (26.1) | 95.78 (27.3) | 75.46 (29.9) | 75.49 (30.6) | 113.87 (30.55)[(a)] | 75.9 (35.9)[(a)] |
| $R^2$ of the model | .196 | .259 | .466 (within) | .487 (within) | .590 (within) | .582 (within) | .466 (within) | .586 (within) |
| Year-fixed<br>Country-fixed<br>Instruments | No<br>No<br>No | No<br>No<br>No | No<br>Yes<br>No | No<br>Yes<br>No | Yes<br>Yes<br>No | Yes<br>Yes<br>No | No<br>Yes<br>Yes | Yes<br>Yes<br>Yes |
| # of countries<br># of observation | 18<br>746 | 18<br>744 | 18<br>746 | 18<br>744 | 18<br>746 | 18<br>744 | 18<br>744 | 18<br>744 |

Source: own estimates based on data derived from World Development Indicators 2013. Note: in parenthesis - robust SE. Also tested for ($LnGDPpc_{it}$, 1-year lag) – results less significant than for ($LnGDPpc_{it}$, 2-year lag). All estimates for significance level at 5%. [(a)] bootstrap SE (1000 replications). Lagged explanatory variable used as instrument: (I) country-fixed effect; (II) time-fixed effects; (III) instrumented country-fixed effects regression; (IV) instrumented time-fixed effects regression.

The estimates obtained from the quadratic panel regressions of the total fertility rates against economic growth show that the regressor ($LnGDPpc_{it}$) always has a negative sign and ($LnGDPpc_{it}^2$) is positive, thus generating the U-shaped trajectory. The outcomes displayed suggest that $TRF_{it}$ and $GDPpc_{it}$ are negatively correlated for lower per capita income (before the minimum of the curve), and the relationship turns positive for higher $GDPpc_{it}$.

In all cases, the estimated coefficients are statistically significant at the 5% level. In columns (1) and (2) the results for simple OLS are reported. The model with $LnGDPpc_{it}$ - 2-year lag variable added shows a slightly higher $R^2$, which might suggest that the level of the total fertility rate in period (t) is to some extent pre-conditioned by GDP per capita in period (t-2). Estimates were also performed with $LnGDPpc_{it}$ - 1-year lag included. These were significantly weaker than for the 2-year lag. This also supports the hypothesis that positive effects of economic growth on total fertility rates are realised with significant time lags. The estimates of the coefficients $\delta_1$ and $\delta_2$ from the within-estimator (FE(I)) model, explaining the mediated effects of $LnGDPpc_{it}$ on $TFR_{it}$ due to cross-country differences, are statistically significant. However, in each case $\delta_1$ tends to be higher than $\delta_2$. This suggests that over the period 1970-2011 the "negative" relationship between $TFR_{it}$ and $GDPpc_{it}$ was strongly dominant. As in the case of the OLS estimates, inclusion of lagged $GDPpc_{it}$

results in a slightly higher $R^2$ for the model (0.487), which again confirms a lagged impact of economic growth on changes in total fertility rates.

In analyzing the relationship between the total fertility rate and economic growth, we suppose that the impact of $GDPpc_{it}$ on $TFR_{it}$ may be additionally determined by factors varying across time. Hence, to check for unexpected in-time variation which potentially affects the influence of GDP per capita on ($TFR_{it}$), we control for time-fixed effects. The results obtained from FE(II) suggest that, after "absorbing" the unobserved effects that vary across time and potentially determine the impact of $GDPpc_{it}$ on $TFR_{it}$, the strength and direction of the relationship remains at a comparable level to the estimates generated by the FE(I) model. The (internal) $R^2$ of the model FE(II) is 0.59, and thus we may conclude that the FE(II) regression – with time-fixed effects included – explains the relationship between the total fertility rate and economic growth relatively better than the FE(I) model. For FE(II) with lagged $GDPpc_{it}$ included, the estimated coefficients also confirm the previous results and prove that the relationship between total fertility changes and economic growth in the panel examined is not specifically determined by country- and/or time-fixed effects, but rather is inter-temporal in its nature. However, to confirm this, we additionally run a random-effects regression (results not reported in Table 2) and perform a Hausman test, which yields the result Prob>$chi^2$=0.000. However, the V_b-V_B matrix is not positive definite. This suggests that the relationship between the total fertility rate and economic growth might to some extent be additionally affected by omitted variables which are relatively constant over time but vary across countries, and by some other variable which is relatively constant (fixed) for countries but varies over time.

To control for potential endogeneity in the models, in columns (7) and (8) we present the results of an instrumental variables estimator. All the coefficients are reported under the assumption that lagged $LnGDPpc_{it}$ and $LnGDPpc_{it}^2$ are treated as instruments, and the IV-regression was performed using 2SLS. The outcomes obtained are remarkably similar to those resulting from the estimates with no instruments used, and thus do not require particular discussion.

The presence of time-invariant country-specific effects, such as culture or institutions, surely influences the relationship between $TFR_{it}$ and economic growth, but their impact is not strong enough to eliminate the average response of $TFR_{it}$ to GDP per capita changes in the countries analyzed over the period 1970-2011. Hence, the "panel effect" is not interrupted by occasional incidents.

However, to some extent our results seem to be additionally conditioned by unobserved effects that tend to vary in time (but not only across countries). This explains why variations in GDP per capita influence the total fertility rate (determined by people`s behaviour) differently at different points in time, and explains the changes in the patterns of the total fertility rate over the period 1970-2011, with significant falls being followed by moderate increases. Similar conclusions are presented in works by Luci and Thévenon (2011), Myrskylä et al. (2009) and Furuoka (2009).

As Figure 1 demonstrates, the relationship between the total fertility rate and economic growth follows a U-shaped pattern which is well described by quadratic models (as confirmed by the results presented in Table 2 above). The U-shaped pattern approximated by a quadratic function yields the existence of the specific minimum (convex of the parabola), which represents the threshold level of GDP per capita at which the total fertility rate starts to rise and the downward trend is halted. Following the previous estimates, the low peak of the curve (using OLS) corresponds to approximately $LnGDPpc_{it}$=10.38, which is equivalent to $32,208 GDP per capita (in 2005 constant US$). Thus, the reversal in fertility trends hypothetically occurs once a country achieves this threshold level.

The effects of economic growth on changing total fertility rates examined explain the averaged response of falling/rising TFR as GDPpc grows in a hypothetical country. This shows that economic growth might be one of the channels inducing increases in total fertility rates. However, it should be borne in mind that our study predominantly unveils purely statistical relationships between TFR and GDP per capita.

The conclusions from this study are intentionally kept at a general level and it thus provides only a partial answer to the question of the determinants of the fertility rebound. To maintain a rigid supposition that the fertility rebound detected was exclusively driven by growth in national output would be based on weak foundations.

The empirically based evidence shows that certain highly developed countries reached a turning point in total fertility (after decreasing below the replacement rate, the TFR then increases), which possibly implies structural shifts in terms of both economic and social conditions (Barlow 1994, Brander and Dorwick 1994, Galor and Zang 1997, Dahan and Tsiddon 1998). However, country-specific effects and patterns explaining the behaviour of the total fertility rate relative to economic growth may differ significantly (Thevenon 2009, Goldstein et al. 2013), as they are likely to be linked by a two-way rather than one-way relationship (see, e.g., Galor and Weil 1996, 1999; Kohler et al. 2002a, 2002b; Deopke 2004, Caldwell and Schindlmayr 2003, Butler 2004, Morgan and Taylor 2006, Klasen and Lamanna 2009, and Mills et al. 2011).

The root causes of the negative relationship between TFR and economic growth may be traced to technological progress and better access of women to mass education (Becker et al. 1994, Frejka 2012, Ní Bhrolcháin and Beaujouan 2012), which allows for an increasing number of people to be engaged in formal market activities and multiplying returns from labour (Bacci 2013). Structural reorientations, such as shifts from an agricultural to an industrial economy, or the emergence of a service-based economy and labour force feminization (Schaller 2012, Lechman and Okonowicz 2013, Lechman 2014), are other recognized determinants of fertility reductions. As the number of women involved in the labour force grows, they are less inclined to bear children. However, the intensity of changes in social attitudes, religion, income inequalities (Repetto 2013) or state policies designed to increase fertility (Alesina and Rodrick 1994, Parr and Guest 2011) may potentially affect social norms or individual fertility choices (Barro and Becker 1989, Wang et al. 1994, Hin et al. 2011, Orsal and Goldstein 2011, Neels et al. 2013a, Neels et al. 2013b) and finally lead to the emergence of a positive relationship between TFR and GDPpc.

The question also arises of whether the observed growth in TFR is permanent or temporary, and there is much uncertainty about this. It is possible that temporary increases in fertility rates are a direct consequence of demographic trends and a new 'fertility transition' might take place. Or, alternatively, modest increases in TFR which are observed in different countries are positive 'responses' to pro-natal state policies which have been broadly adopted in countries affected by low fertility. The answer to this can probably be found in a long-term perspective, as a 'combined response' to demographic and socio-economic changes (Galor and Zang 1997, Schultz 2001, Bloom and Finlay 2009, Cervellati and Sunde 2011).

## 6. Conclusions

This paper was designed to uncover the relationship between changing total fertility rates and economic growth in 18 high-income economies over the period 1970-2011. We have examined the relationship by employing a longitudinal analysis, which has allowed us to obtain the average response of total fertility rates as countries advance in their economic development. It was hypothesized that the U-shaped trajectory observed explains changes in long-run total fertility trends determined by economic growth, and the supposition was confirmed. Our estimates lead to the general conclusion that $TFR_{it}$ and $GDPpc_{it}$ are closely interrelated, and uncover a quantitative relationship that supports the hypothesis of the inter-temporal nature of the links. Hence, the relationship between total fertility rate and economic growth is relatively robust to time- and country-specific effects. We have also discovered that the fertility rebound takes place in particular as countries achieve the threshold level of economic development approximated by $32,208 (in 2005 constant US$) GDP per capita. Identifying the turning point of the U-shaped curve would imply that economic growth up to a certain point constitutes a channel of reversing paths with regard to total fertility rates in high-income countries. This supports the more general idea that countries at higher stages of development tend to experience the fertility rebound as the per capita income becomes sufficient to provide for a decent life and education for more children (Varvarigos, 2013). It may also suggest that some developed countries are now entering a new phase of development significantly marked by demographic changes determined by reversals in fertility rates, which start to recover and grow slightly above the pure replacement rate. Despite discovering such quantitative links between TFR and GDP per capita, we do not claim that achieving the threshold GDP per capita should automatically induce increases in total fertility rates. Certainly, not all countries will follow analogous paths of growing fertility, regardless of whether or not they perform well in terms of economic growth. Additionally, the positive impact of growing income on fertility may eventually turn out to be temporary and short-term. Many developed countries have still not experienced the fertility rebound, which suggests that economic growth does not exclusively drive demographic changes, and fertility rebounds across countries are only partially explained by growth in living standards, with the rest of the explanation able to be largely attributed to the institutional, social and state policy context.

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**Original citation**: Dominiak, P., Lechman, E. and Okonowicz, A. (2014). The fertility rebound and economic growth. New evidence for 18 countries over the period 1970-2011. GUT *FME Working Papers Series A*, No.5/2014(23). Gdansk (Poland): Gdansk University of Technology, Faculty of Management and Economics.



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