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Economic Uncertainty and Fertility

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Abstract

In this paper, we conduct an empirical study of the effect of uncertainty on fertility. The precautionary motive for saving predicts that an increase in uncertainty increases saving by reducing both consumption and fertility. We use a new measure of uncertainty, the World Uncertainty Index, and focus on data from 126 countries for the period from 1996 to 2017. The empirical findings indicate that uncertainty shocks decrease the fertility rate. This evidence is robust to different model specifications and econometric techniques as well as to the inclusion of various controls.

Keywords: Fertility; Uncertainty; WUI Index; Precautionary Saving; Business Cycle; Panel Data Estimation Techniques

JEL Codes: J13; D81; D14; E32; C33

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1. Introduction

Research over the last 50 years has established that fertility is affected by several economic factors. The main focus of this research is explaining the long downward trend in fertility over the course of economic development—a key component of the *demographic transition*. The slowdown in population growth during the demographic transition, in turn, has dramatic economic consequences on per capita economic growth, aging of the population, and the viability of large social transfer programs built on pay-as-you-go government financing schemes.

Less well known is the connection between fertility and the business cycle. The connection is so strong that fertility has recently been labeled "a leading economic indicator" (Buckles et al., 2018). One explanation for this surprising relationship is that household sense economic uncertainty from news reports, the stock market, and other sources. Concerns over future wages cause them to lose "consumer confidence," reduce current consumption and engage in "precautionary saving." This logic can be extended to fertility because precautionary saving can be built up by both reducing consumptions and postponing childbearing (Ranjan, 1999; Sommer, 2016).

However, empirical work on the importance of the precautionary motive for fertility has thus far been mixed. We attempt to contribute to the literature searching for a link between labor market uncertainty and fertility. To identify the precautionary motive for procyclical fertility variations, we look at a particular measure of after-tax wage uncertainty—the World Uncertainty Index (WUI) created by the IMF (Ahir et al., 2018). The measure is based on country reports formed by analysts working for a private intelligence company. The reports focus on economic policy and politics to gauge the level of uncertainty in economic conditions of the country. Uncertainty over fiscal, regulatory, and other policy changes creates uncertainty over future after-tax wages similar to business cycle fluctuations or longer-term sources of uncertainty and should have similar effects on fertility if the uncertainty mechanism is generally valid. Furthermore, policy uncertainty is likely to be exogenous; i.e., it is not expected to be affected by the feedback from fertility to wage volatility (De la Croix and Pommeret, 2018).

Section 2 offers an organizing theoretical framework that includes the precautionary effect of uncertainty on fertility and allows us to review previous papers on the topic. Section 3 develops the empirical model and reports on the data used. Section 4 presents our empirical findings, and Section 5 offers a brief conclusion.

2. A Theory of Fertility: The Role of Uncertainty and Literature Review

This section presents a simple model that identifies some of the important economic forces affecting fertility. We also discuss the related empirical work and highlight how our study fits into the literature. A challenge to fertility theory is to simultaneously explain why income and fertility are *negatively* correlated in the long-run (fertility eventually falls over the course of economic development) but are often found to be *positively* correlated in the medium or short-run (e.g., as mentioned, fertility is a leading, pro-cyclical variable).[1] Of particular interest for our study is the effect of uncertainty on

[1] On the demographic transition and the long-run causes of fertility trends see Galor (2011, Chapter 2) and Greenwood et al. (2017). For the behavior of fertility across the business cycle and during economic upheavals, see Buckles et al. (2018) and Chatterjee and Vogel (2018).

fertility—a connection that could explain the pro-cyclical nature of fertility or why events that raise the uncertainty for as much as a decade tend to lower fertility.[2]

Several of the key determinants of fertility that are stressed in the economics literature, including economic uncertainty, can be highlighted using the following simple model. Imagine households that live for three periods. The three periods correspond to one period of childhood and two periods of adulthood. Households value their consumption over the two periods of adulthood (c_{1t}, c_{2t+1}). From the perspective of period t, future labor income, and therefore, future consumption, is uncertain. Random variables are denoted with a "~" so when making choices in period t, second-period consumption is written as $\tilde{c}_{2t+1}$.

As in Becker (1960 and 1981) and Becker and Lewis (1973), households also value the *quantity* (n_{t+1}) and *quality* of their children—measured by the child's adult earnings ($w_{t+1}h_{t+1}$). The child's adult earnings are the product of the after-tax market rental rate for skills (w_{t+1}) and embodied skills or human capital (h_{t+1}) accumulated. Parents directly choose n_{t+1}. They affect their child's adult productivity and earnings by selecting the time the child spends in school, e_t. The adult human capital of the child is given by $h_{t+1} = e_t^{\theta}$, where $0 < \theta < 1$ is a parameter that captures the effect of schooling on human capital accumulation. The fertility and schooling decisions are made in period t, at which time future wages are uncertain and are denoted by $\tilde{w}_{t+1}h_{t+1}$.

Adults inelastically supply one unit of labor in each period. Children have an endowment of $T < 1$ units of time that they can use to attend school (e_t) or work ($T - e_t$). Children have less than one unit of time to spend producing because early in childhood they are too young to either attend a school or to work, and in the middle years of childhood they do not possess an adult's mental or physical endurance to learn or work.

We think of the children as being too young to work over the early part of their lives or that a minimum amount of schooling is needed for the child to be productive. Under either interpretation, each child invests at least $\bar{e}$ units of time into learning during the first portion of their childhood. This investment gives older child $\gamma\bar{h}_t = \gamma\bar{e}^{\theta}$ units of human capital that can be used in production during the later years of childhood, where $0 < \gamma < 1$ reflects the fact that even older children lack the relative physical strength or experience in applying knowledge to production compared to an adult. Thus, per hour of work, a person is more productive in adulthood than in childhood because of greater strength and experience ($1 > \gamma$) and possibly additional schooling received later in childhood ($e_t \geq \bar{e}$).

While children may work as they become older, providing income to the family, they are also expensive to care for and feed. To raise each child requires a loss of adult consumption equal to a fixed fraction η of the adult's first period wages. One can interpret the cost of raising a child as (i) the parent's forgone salaries associated with the time away from work needed watch over and informally educate a young child or (ii) the loss in adult consumption associated with providing consumer goods to

[2] For example, the collapse of the communist system in Eastern Europe and Russia was associated with heightened uncertainty in labor markets and a decline in fertility. See, for example, Kohler and Kohler (2002) and Kregenfeld (2005).

children. Putting these elements together, we have the following interrelated cost concepts associated with the decision to (i) have a child and (ii) send the child to school:

(i) the *net cost of raising a child, forgone adult consumption minus child income* expressed as $\eta w_t h_t - w_t \gamma \bar{h} \left(T - e_t \right)$

(ii) *cost of time spent in school* expressed as *forgone child wages* $w_t \gamma \bar{h}$.

Note that as schooling increases, it raises the net cost of children in two ways. First, an increase in parents' human capital increases the opportunity cost of raising children. Second, greater schooling means less work and less income generated by older children.

The preferences of parents are given by as follows:

$$U_t = \ln c_{1t} + \beta E_t \left\{ \ln \tilde{c}_{2t+1} \right\} + \psi E_t \left\{ \ln \left(n_{t+1} \tilde{w}_{t+1} h_{t+1} \right) \right\} \tag{1}$$

where $0 < \beta < 1$ and $\psi > 0$ are preference parameters, and where the expectation operator (E_t) captures household beliefs about the future distribution of after-tax human capital rental rates. The choices of the quantity and quality of children and the associated costs are included in the family's two single-period budget constraints:

$$c_{1t} + n_{t+1} \eta w_t h_t + s_t = w_t h_t + n_{t+1} w_t \gamma \bar{h} \left(T - e_t \right) \tag{2a}$$

$$\tilde{c}_{2t+1} = \tilde{w}_{t+1} h_t + R_t s_t \,, \tag{2b}$$

where s_t is household saving and R_t is the associated interest factor (one plus the interest rate).

Parents choose consumption, saving, the number of children, and the schooling/work of each child to maximize (1) subject to (2). The first-order conditions are used to obtain the following equations determining schooling, first-period consumption, and fertility (the two budget constraints allow one to solve for saving and second-period consumption):

$$e_t = \frac{\theta \left(\frac{\eta}{\gamma} \left(e_{t-1} / \bar{e} \right)^{\theta} - T \right)}{\left(1 - \theta \right)} \tag{3a}$$

$$\frac{1}{c_{1t}} = \beta R_t E_t \left\{ \frac{1}{\tilde{c}_{t+1}} \right\} \tag{3b}$$

$$n_{t+1} = \frac{\psi c_{1t}}{\left(1 + \beta + \psi \right) \left(\eta w_t h_t - w_t \gamma \bar{h} \left(T - e_t \right) \right)} \quad . \tag{3c}$$

The evolution of schooling across generations is given in (3a). As long as parent's education is sufficiently high and the relative productivity of older children is sufficiently low, schooling will rise across generations, approaching a steady state where schooling becomes constant.

Economic uncertainty, the primary focus of our study, affects household behavior, as indicated in (3b). Utility functions with a convex marginal utility of consumption, or a positive third derivative concerning consumption, yield "precautionary" saving behavior (Leland (1968) and Sandmo (1970)). The log utility function assumed here, as well as many others, have this property. A convex marginal utility of consumption implies that increased uncertainty, a larger spread of possible values for $\tilde{c}_{2t+1}$, raises the expected value $E_t\left\{\frac{1}{\tilde{c}_{t+1}}\right\}$ on the right-hand-side of (3b), causing a decrease in c_{1t}.

Optimal fertility choice is related to human capital and uncertainty in (3c). Human capital can affect fertility in two ways. First, as emphasized above, increased education makes the net cost of children higher (raising the term in the denominator on the right-hand side), creating a force that lowers fertility. This mechanism helps to explain the *long-run negative correlation between income and fertility*.[3] Empirical support for schooling as an essential long-run determinant of fertility can be found in both calibration and econometric studies. The calibration studies show that a robust causal link from rising schooling to falling fertility is consistent with other features of economic growth and development (e.g., Das et al., 2018: Chapter 9) and Lord and Rangazas, 2006). Econometric studies finding a significant negative impact of schooling on fertility include Aaronson et al. (2014), Amin and Behrman (2014), Murtin (2013), and Osili and Long (2008).

There is a second connection between human capital and fertility that works through family consumption (note the presence of c_{1t} in the numerator on the right-hand-side of (3c)). As greater education raises family income, it can raise the ratio $c_{1t} / w_t h_t$ and fertility. An increase in $c_{1t} / w_t h_t$ could happen in several ways that go beyond the simple model. For example, education could be increasing for both the mother and the father of the household. If the mother is predominately responsible for the care of the children, then it is only the rise in mother's education that raises the net cost of children in the denominator of (3c). However, the increase in *both* parents' education can cause family income to rise more than the opportunity cost of raising children, which would raise consumption more than the net cost of children and fertility could then rise (the value of c_{1t} rises more than the denominator in (3c)).

Another reason that consumption could rise faster than the cost of children results from the fact that higher education steepens the life-cycle wage profiles of workers (Lagakos et al., 2018)). A steeper life-cycle wage profile will raise fertility because higher wages in the middle of life do not raise the opportunity cost of childbearing when young but do increase lifetime earnings and c_{1t}. This type of

[3] See Das et al. (2018, Chapter 4) and Galor (2011) for more discussion. Other features have been offered for the decline of fertility with economic development. One of these is the structural transformation away from agriculture and family-based production towards manufacturing and service production in firms (Das et al., 2018: Chapters 7 and 9; Greenwood and Seshadri, 2002; Lord and Rangazas, 2006). Another is a decline in infant and child mortality. For the theory, see Barro and Becker (1989), Boldrin and Jones (2002), Kalemli-Ozcan (2003) and Sah (1991). For the empirical support, see Bar and Leukhina (2010), Doepke (2005), and Eckstein et al. (1999).

effect can be seen even in the simple model if we assume away uncertainty about future wages, allowing us to explicitly solve for fertility in terms of exogenous variables,

$$n_{t+1} = \frac{\psi\left[1+\frac{w_{t+1}}{w_t}\right]}{\left(1+\beta+\psi\right)(\eta-\gamma(\overline{h}/h_t)(T-e_t))} \quad . \tag{4}$$

An increase in the market valuation of human capital over the life-cycle, raising future wages above current wages, will raise fertility. Thus, there are ways that an increase in education can create wealth effects that increase fertility, working against the negative effect of a higher net cost of children from greater parental education.

As mentioned, equation (3b) connects future wage uncertainty to current consumption and saving. However, wage uncertainty not only raises precautionary saving by lowering consumption but, as indicated in (3c), also by reducing fertility. The precautionary motive was extended to include the fertility choice by Ranjan (1999) and Sommer (2016). This condition offers a possible explanation for the pro-cyclical nature of fertility. Households sensing an increase in uncertainty about the economy's future path, experience a drop in "consumer confidence" and postpone fertility before a recession or during a period of economic upheaval.

Empirical work on the importance of the precautionary motive for fertility has been mixed. Hondroyiannis (2010) and Hanappi et al. (2017) support a negative link between greater uncertainty and lower fertility. Chabe-Ferret and Gobbi (2018) also support a negative connection in the first half of the 20th century but one that disappears after WWII. Kohler and Kohler (2002) and Kreyenfeld (2005) find no link between fertility and the rising labor market uncertainty associated with the collapse of communism in Eastern Europe and Russia.

A paper by De la Croix and Pommeret (2018) suggests why it may be challenging to establish a clear negative association between wage uncertainty and fertility. They emphasize that the decision to have children *creates* labor market uncertainty for the woman in a variety of ways. This positive reverse causation running from fertility to uncertain labor market outcomes hampers the ability to identify the fertility effect of an *exogenous* change in labor market uncertainty.

We attempt to contribute to the empirical literature searching for a link between labor market uncertainty and fertility. To identify the precautionary motive for pro-cyclical fertility variations, we look at a particular cause of after-tax wage uncertainty. Uncertainty over fiscal, regulatory, and other policy changes creates uncertainty over future after-tax wages similar to business cycle fluctuations or longer-term sources of uncertainty and should have similar effects on fertility if the uncertainty mechanism is generally valid. Furthermore, policy uncertainty is exogenous to fertility, eliminating the feedback identified by De la Croix and Pommeret (2018).

3. Empirical Strategy

3.1 The Baseline Empirical Model

Motivated by the theory discussed in the previous section, we form a parsimonious baseline econometric specification that includes human capital, a measure of country-level economic uncertainty, per capita income, and lagged fertility. We include per capita income to capture the

various aspect of economic development on fertility such as the degree of urbanization and child mortality, as suggested in Footnote 3, as well as public health conditions, nutrition of the parents, availability of and subsidies for contraceptives, and delivery assistance. We estimate the following equations:

$$Fertility_{i,t} = \gamma_0 + \gamma_1\, Fertility_{i,t-1} + \gamma_2\, Uncertainty_{i,t-k} + \gamma_3\, X_{i,t-1} + \vartheta_t + \vartheta_i + \varepsilon_{i,t} \qquad (5)$$

$$\Delta Fertility_{i,t} = \beta_0 + \beta_1\ Uncertainty_{i,t-k} + \beta_2\, X_{i,t-1} + \vartheta_t + \vartheta_i + \varepsilon_{i,t} \qquad (6)$$

In Eq. (5) moreover, Eq. (6), $Fertility_{i,t}$, $Fertility_{i,t-1}$, and $\Delta Fertility_{i,t}$ are the current, the lagged, and the change of the fertility rates in country *i*. $Uncertainty_{i,t-k}$ is the measure of economic uncertainty in country *i* at time *t-k* (k is zero or one). $X_{i,t-1}$ indicates the vector of controls, which is the baseline model includes only human capital and per capita income. Finally, ϑ_t, ϑ_t, and $\varepsilon_{i,t}$ denote the "year fixed-effects," "country fixed-effects," and the "error term," respectively. The annual dataset[4] covers the data for the period from 1996 to 2017 from 126 countries. We provide a list of the included countries in the dataset in Appendix I.

The dependent variables in the estimations are the fertility rate and the change of the fertility rates, which are obtained from the World Development Indicators (WDI) dataset of the World Bank (2019). To capture omitted cultural and religious factors that may affect the average level of fertility in a country, we include lagged fertility. Alternatively, we also form a baseline model where the dependent variable is the change in fertility from one period to the next. Given the lag between birth and the fertility decision, especially relevant for births occurring early in the year, we consider specifications where all regressors are lagged. Furthermore, economic uncertainty, unlike the uncertainty caused by business cycle fluctuations, could affect fertility over shorter or longer term horizons—so we try different model specifications.

The uncertainty measure is the World Uncertainty Index (WUI) created by Ahir et al. (2018). The measure is based on country reports formed by analysts working for a private intelligence company. The reports focus on economic policy and politics to gauge the level of uncertainty in economic conditions of the country. This measure is available for a broad set of countries regularly. The precautionary effect of uncertainty on fertility suggests there should be a significant negative correlation between the WUI and fertility. We use both the current and the lagged WUI. We consider a lagged WUI for the theoretical issues, and this also helps us to avoid a potential reverse causality. It is unclear whether the WUI is based on actual policy changes or perceived/anticipated policy changes. If it is based on actual changes, then the expectations affecting fertility decisions are likely to be based on past actual policy changes. If instead, it is a direct measure of expectations, then the WUI can be included as a contemporaneous measure.

The human capital measure is a stock measure of the average years of schooling in the adult workforce introduced by the Penn World Table (PWT) (version 9.1).[5] Not being able to distinguish between human capital of the mother and father means it is difficult to expect a positive effect (dominant wealth effect) or negative effect (dominant cost-of-children effect), but either way theory indicates

[4] We do not purify the business cycles and use annual data, instead of four-year or five-year average data.
[5] For details of measuring human capital in the PWT dataset, refer to Feenstra et al. (2015) and the references therein.

that human capital is expected to play an important role. The per capita income measure comes from the World Bank Development Indicators.

3.2 Extended Models and Robustness Checks

In the robustness checks, we include other controls related to macroeconomic stance, demographics, the role of government, institutional quality, labor market regulations, globalization and income inequality (a complete list is provided in Table 1). For the macroeconomic stance, we include the economic growth rate, female labor participation, and the unemployment rate. For demographics, we include the total population, age-dependency ratio, the urban population share, and life expectancy at birth. These indicators are obtained from World Bank (2019).

We consider the Gini market index of the income inequality and related data from the Standardized World Income Inequality Database (SWIID) (version 8.0) of Solt (2019). Our government controls include transfer and subsidies, government consumption, income payroll tax rate (top marginal). Similarly, we include the index of labor market regulations since it can directly or indirectly affect fertility decisions. These data are obtained from the Economic Freedom Dataset of Gwartney et al. (2018).

Furthermore, fertility decisions may be affected through channels of economic globalization, including globalization shocks that contribute to uncertainty (Potrafke, 2015). We include the revised version of the KOF indexes of globalization (the index of economic globalization and overall globalization) constructed by Gygli et al. (2019).[6]

Finally, we control for the level of institutional quality and the conflicts. Following the spirit of Acemoglu et al. (2019), we include the level of institutionalized democracy (index from 0 to 10) in the regressions. Other institutional quality measures included are the concept of the executive constraint (index from 1 to 7) and the Polity2 (index from -10 to +10). All of these data are obtained from the Polity IV Annual Time Series proposed Marshall et al. (2018). We also include conflicts (index from 0 to 10), which are obtained from the Major Episodes of Political Violence dataset of Marshall (2017). In so doing, we test whether the results are robust to the inclusion of the measures of institutional quality and conflicts since formal institutions and conflicts via the uncertainty channel. Details of all variables and a summary of the descriptive statistics can be found in Table 1.

[Insert Table 1 around here]

3.3. Estimation Procedures

We estimate the benchmark regressions in Eq. (5) and Eq. (6) using the fixed-effects estimations, which is the standard estimation technique in the literature. Also, we estimate the regression in Eq. (5) by the System Generalized Method of Moments (GMM) technique, which can solve possible problems due to autocorrelation and the presence of different orders of integration (Arellano and Bover, 1995; Blundell and Bond, 1998). We also utilize the two-stage estimation procedure to avoid possible multicollinearity among the right-side variables. We collapse the instruments following the

[6] For the details of the original KOF indexes of globalization, refer to Dreher (2006) and Gozgor (2018). For the revised version of the index, refer to Gygli et al. (2019).

suggestions of Roodman (2009).[7] In so doing, we address a solution to the possible endogeneity problem between economic uncertainty and the fertility rate by instrumenting them with the suitable lagged variables. To obtain efficient findings in the System GMM estimations, we need evidence for the validity of the first-order autocorrelation in the residuals, but second-order autocorrelation must be rejected.[8] We run the Sargan test to avoid possible over-identification problem. Finally, we include country fixed-effects and year fixed-effects since there could be unobserved heterogeneities affecting the fertility rates.

4. Empirical Findings

4.1 Baseline Findings

In Table 2, we report the findings of the baseline lagged models in Eq. (5) (Model I) and in Eq. (6) (Model II) for the total fertility rate for the period from 1996 to 2017. We provide the findings of the fixed-effects estimations.[9]

[Insert Table 2 around here]

The results for all (126) countries are reported in Columns (I) and (II). The coefficients of WUI are found around –0.4[10], and they are statistically significant at the 1% level. The results for 93 non-OECD countries are reported in Columns (III) and (IV) while the findings for 33 OECD countries are provided in Columns (V) and (VI). The effects of uncertainty on the fertility rates are negative, and the coefficients are statistically significant at 5% level and lower.

To analyze the magnitudes of the effect, we find that one standard deviation (0.836 points) increase in the WUI leads to a 0.332-point decrease (0.2 standard deviations) in the fertility rate. Looking at the controls, the per capita GDP is positively related to the fertility rate in all groups of countries. The index of human capital is positively associated with the fertility rate in the sample with all countries, but it is negatively associated with the fertility rate in a narrower sample of OECD countries. The lagged coefficients of fertility rate in Model I are also found to be statistically significant.

In Table 3, we provide the fixed effects estimates when the regressors are not lagged in Eq. (5) (Model I) and in Eq. (6) (Model II) for the total fertility rate for the period from 1996 to 2017.

[Insert Table 3 around here]

The results for all countries, provided in Columns (I) and (II), are very similar to the case with lagged variables. The coefficients of WUI are found around –0.42, and they are statistically significant at the 1% level. The results for 93 non-OECD countries are reported in Columns (III) and (IV) while the findings for 33 OECD countries are provided in Columns (V) and (VI). Again, we find that the impact of uncertainty on fertility rate is negative, and the coefficients are statistically significant at 5% level at least. Similarly, to investigate the magnitude of the effect, we find that one standard deviation (0.836 points) increase in the WUI leads to a 0.353-point reduce (almost 0.2 standard deviations) in the

[7] We run the xtabond2 Stata Package written by Roodman (2009).

[8] This evidence is due to the assumptions that the instruments must be uncorrelated with the error terms, but the instruments must be correlated with the instrumented variables in the system GMM estimations.

[9] Note that the results of the cluster-robust Hausman test indicate that the fixed-effects estimations are consistent.

[10] We report the coefficients of WUI multiply by 100 to improve understanding of the findings.

fertility rate. In terms of controls, the per capita GDP is positively related to the fertility rate in all groups of countries. Besides, the index of human capital is positively associated with the fertility rate in all countries, but it is negatively related to the fertility rate in OECD countries. Finally, the lagged coefficients of fertility rate in Model I are also found to be statistically significant.

Interestingly, the adverse effects of uncertainty on the fertility rate are much stronger in the OECD countries than in the non-OECD countries. This evidence could be because of the non-OECD countries have lower parental human capital than the more prosperous OECD economies. In theory, wages are the product of the after-tax market rental rate and the stock of human capital. Policy shocks that change the rental rate will cause larger swings in wages, and the greater is the stock of human capital.

According to the precautionary theory of saving, greater uncertainty, from any source, lowers fertility. If uncertainty increases (decreases) before recessions (expansions), then it may be one explanation of why fertility is pro-cyclical. According to our empirical findings, greater uncertainty does cause a lower fertility rate. This evidence explains why fertility is a leading pro-cyclical variable.

4.2. Findings of the System GMM Estimations

In Tables 4 and 5, we report the results of the system GMM estimations for the baseline models in Eq. (5) (Model I) for the total fertility rate for the period from 1996 to 2017.
[Insert Table 4 around here]

[Insert Table 5 around here]

These regressions address a potential endogeneity bias.[11] System-GMM estimations can solve this potential problem. The findings of the Sargan test indicate that there is no over-identification problem. The results of the Arellano-Bond autocorrelation test for AR(1) and AR(2) illustrate that the first-order autocorrelation is statistically significant, but the second-order autocorrelation is not statistically significant. The findings also show that there is a significant and very high-level persistence in the fertility rates. We find that a higher level of (both lagged and current) WUI yield to lower fertility rates, which are in line with the baseline fixed-effects estimations. The next section provides a battery of robustness exercises

5. Robustness Checks

5.1. Robustness to the Inclusion of Other Controls

In Table 6, we report the findings of robustness checks for the baseline lagged models in Eq. (5) (Model I) moreover, in Eq. (6) (Model II) for the fertility rates for the period from 1996 to 2017.

[Insert Table 6 around here]

Each additional control discussed in section 3,2 is added individually to the regressions. The findings are in line with the baseline evidence and are robust to the inclusion of these controls. In all cases, the negative impact of uncertainty on fertility rate remains statistically significant.

[11] Note that the findings of the Panel Granger causality tests indicate that lagged fertility rates do not significantly affect the level of WUI.

5.2. Robustness to the Outliers

In Table 6, we also report the findings of robustness checks by excluding outliers from the dataset. The results are based on the baseline lagged models in Eq. (5) (Model I) and Eq. (6) (Model II) for the fertility rates for the period from 1996 to 2017.

First, we exclude the extreme observations for the measures of the fertility rates and the WUI. Following Gozgor and Ranjan (2017), we define the "extreme observations" as those who are more than two standard deviations away from the mean. The findings are robust to excluding these observations from the panel dataset. Second, we separately exclude the observations of the Latin American and the Caribbean as well as East Asia and Pacific countries. We find that the results are robust to the exclusion of each region; that is, observations from these regions do not determine the benchmark findings.

In short, a battery of robustness analysis shows that policy uncertainty lowers fertility as we have observed in Table 3.

6. Conclusion

This paper contributes to the literature searching for a link between economic uncertainty and fertility. We used a particular measure of economic uncertainty—the World Uncertainty Index (WUI) created by Ahir et al. (2018). The measure is based on reports focusing on economic policy and politics to gauge the level of uncertainty in economic conditions of the country. Uncertainty over economic, regulatory, and other policy changes creates uncertainty over future after-tax wages similar to business cycle fluctuations. Besides, policy uncertainty is likely to be exogenous to the fertility choice. We found robust evidence that increases in the WUI reduce fertility, helping to explain why fertility is a leading pro-cyclical indicator of the business cycle.

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Table 1
Summary of Descriptive Statistics

Variables	Definition	Data Source	Mean	Standard. Deviation	Minimum	Maximum	Observation
Total Fertility Rate	Births per Woman	World Bank, World Development Indicators	3.139	1.686	0.901	7.716	2,982
World Uncertainty Index	Index in Logarithmic Form	International Monetary Fund: Ahir et al. (2018)	–2.078	0.836	–4.422	0.232	2,780
Per Capita GDP (Constant 2010 US$)	Logarithmic Form	World Bank, World Development Indicators	8.280	1.576	5.229	11.42	2,958
Economic Growth Rate	% (Δ Log Per Capita GDP)	World Bank, World Development Indicators	0.023	0.051	–0.973	0.801	2,816
Human Capital	Index	PWT 9.1: Feenstra et al. (2015)	2.387	0.710	1.053	3.734	2,394
Female Labor Force Participation Rate	% of Female Population Ages 15+	World Bank, World Development Indicators	56.91	17.45	6.349	88.84	2,982
Total Population	Logarithmic Form	World Bank, World Development Indicators	16.42	1.348	13.16	21.04	2,977
Total Unemployment Rate	% of Total Labor Force	World Bank, World Development Indicators	8.269	6.186	0.140	44.15	2,982
Age Dependency Ratio	% of Working-age Population	World Bank, World Development Indicators	64.01	19.70	16.45	113.2	2,977
Urban Population	% of Total	World Bank, World Development Indicators	55.84	22.96	7.412	100.0	2,977
Life Expectancy At Birth	Total (Years)	World Bank, World Development Indicators	68.17	9.965	35.92	84.27	2,977
Market Gini	Index	SWIID 8.0: Solt (2019)	0.441	0.067	0.214	0.687	2,527
Transfers and Subsidies	Share of GDP	Economic Freedom Dataset: Gwartney et al. (2018)	9.157	7.875	0.000	30.08	1,977
Government Consumption	Share of Total Consumption	Economic Freedom Dataset: Gwartney et al. (2018)	19.89	8.065	4.100	59.01	2,137
Top Marginal Income Payroll Tax Rate	Percentage	Economic Freedom Dataset: Gwartney et al. (2018)	41.38	13.20	0.000	71.90	1,799
Labor Market Regulation	Index from 0 to 10	Economic Freedom Dataset: Gwartney et al. (2018)	6.154	1.448	2.100	9.730	2,089
Overall Globalization	Index from 0 to 100	KOF: Dreher (2006) & Gygli et al. (2019)	59.20	16.11	22.59	91.16	2,982
Economic Globalization	Index from 0 to 100	KOF: Dreher (2006) & Gygli et al. (2019)	55.53	16.21	17.44	95.43	2,982
Executive Constraints Concept	Index from 1 to 7	Polity IV Annual Time Series: Marshall et al. (2018)	4.970	1.996	1.000	7.000	2,835
Level of Institutionalized Democracy	Index from 0 to 10	Polity IV Annual Time Series: Marshall et al. (2018)	5.558	3.810	0.000	10.00	2,835
Polity2	Index from –10 to 10	Polity IV Annual Time Series: Marshall et al. (2018)	3.647	6.257	–10.00	10.00	2,911
Conflicts	Index from 0 to 10	Major Episodes of Political Violence: Marshall (2017)	0.600	1.499	0.000	9.000	2,961

Table 2
Fixed-Effects Estimations (Lagged Model) Total Fertility Rate (1996–2017)

Regressors	All Countries	All Countries	Non-OECD	Non-OECD	OECD	OECD
Regressors	Model (I)	Model (II)	Model (I)	Model (II)	Model (I)	Model (II)
Lagged Total Fertility Rate	0.978*** (0.003)	–	0.983*** (0.003)	–	0.878*** (0.015)	–
Lagged Log Per Capita GDP	0.017*** (0.005)	0.020*** (0.005)	0.008 (0.005)	0.011* (0.005)	0.133*** (0.018)	0.103*** (0.019)
Lagged Human Capital	0.065*** (0.009)	0.091*** (0.008)	0.089*** (0.010)	0.113*** (0.009)	–0.070*** (0.025)	–0.047* (0.026)
Lagged Log World Uncertainty Index	–0.391*** (0.108)	–0.405*** (0.110)	–0.282** (0.119)	–0.283** (0.120)	–0.619*** (0.236)	–0.602** (0.248)
Constant Term	–0.281*** (0.043)	–0.437*** (0.038)	–0.248*** (0.043)	–0.383*** (0.035)	–0.955*** (0.136)	–0.917*** (0.143)
Observations	2,226	2,226	1,617	1,617	609	609
Number of Countries	126	126	93	93	33	33
R-squared (Within)	0.985	0.121	0.989	0.168	0.865	0.074

Notes: The dependent variables are the Total Fertility Rate (Model I) and Δ Total Fertility Rate (Model II). The standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3
Fixed-Effects Estimations (Not Lagged Model) Total Fertility Rate (1996–2017)

Regressors	All Countries	All Countries	Non-OECD	Non-OECD	OECD	OECD
Regressors	Model (I)	Model (II)	Model (I)	Model (II)	Model (I)	Model (II)
Lagged Total Fertility Rate	0.978*** (0.003)	–	0.984*** (0.003)	–	0.880*** (0.015)	–
Log Per Capita GDP	0.026*** (0.006)	0.030*** (0.006)	0.014** (0.006)	0.017*** (0.006)	0.155*** (0.019)	0.139*** (0.020)
Human Capital	0.063*** (0.010)	0.089*** (0.009)	0.093*** (0.010)	0.116*** (0.009)	–0.090*** (0.026)	–0.081*** (0.027)
Log World Uncertainty Index	–0.409*** (0.112)	–0.436*** (0.113)	–0.275** (0.122)	–0.290** (0.123)	–0.605** (0.242)	–0.676*** (0.254)
Constant Term	–0.350*** (0.046)	–0.514*** (0.040)	–0.309*** (0.046)	–0.439*** (0.037)	–1.118*** (0.146)	–1.179*** (0.154)
Observations	2,114	2,114	1,536	1,536	578	578
Number of Countries	126	126	93	93	33	33
R-squared (Within)	0.984	0.130	0.989	0.179	0.864	0.107

Notes: The dependent variables are the Total Fertility Rate (Model I) and Δ Total Fertility Rate (Model II). The standard errors are in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 4
System GMM Estimations for Model I (Lagged Model) Total Fertility Rate (1996–2017)

Regressors	All Countries	Non-OECD Countries	OECD Countries
Lagged Total Fertility Rate	1.007*** (0.003)	1.010*** (0.002)	0.988*** (0.010)
Lagged Log Per Capita GDP	–0.023*** (0.004)	–0.016*** (0.002)	–0.009 (0.008)
Lagged Human Capital	0.117*** (0.010)	0.112*** (0.005)	0.058*** (0.011)
Lagged Log World Uncertainty Index	–0.776*** (0.108)	–0.581*** (0.049)	–1.096*** (0.156)
Constant Term	–0.160*** (0.033)	–0.206*** (0.021)	–0.098* (0.050)
Observations	2,114	1,536	578
Number of Countries	126	93	33
AR (1) Test Statistic and p-value	–3.58 [0.000]	–2.12 [0.034]	–4.14 [0.000]
AR (2) Test Statistic and p-value	1.48 [0.141]	1.45 [0.147]	0.47 [0.638]
Sargan Test Statistic and p-value	81.4 [0.186]	67.8 [0.516]	30.9 [0.999]

Notes: The dependent variable is the Total Fertility Rate (Model I). The standard errors are in parentheses. The probability values are in brackets. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels.

Table 5
System GMM Estimations for Model I (Not Lagged Model) Total Fertility Rate (1996–2017)

Regressors	All Countries	Non-OECD Countries	OECD Countries
Lagged Total Fertility Rate	1.010*** (0.004)	1.016*** (0.002)	0.972*** (0.019)
Log Per Capita GDP	–0.023*** (0.003)	–0.019*** (0.003)	–0.001 (0.013)
Human Capital	0.126*** (0.010)	0.133*** (0.006)	0.053*** (0.014)
Log World Uncertainty Index	–0.439*** (0.076)	–0.337*** (0.035)	–0.580*** (0.138)
Constant Term	–0.187*** (0.037)	–0.248*** (0.024)	–0.121 (0.083)
Observations	2,114	1,536	578
Number of Countries	126	93	33
AR (1) Test Statistic and p-value	–3.64 [0.000]	–2.08 [0.038]	–3.85 [0.000]
AR (2) Test Statistic and p-value	1.18 [0.240]	1.07 [0.284]	0.62 [0.538]
Sargan Test Statistic and p-value	76.7 [0.195]	33.4 [0.349]	30.1 [0.999]

Notes: The dependent variable is the Total Fertility Rate (Model I). The standard errors are in parentheses. The probability values are in brackets. *** indicates statistical significance at the 1% level.

Table 6
Sensitivity Analysis for Fixed-Effects Estimations: Total Fertility Rate (1996–2017), (All Countries, Lagged Model)

Sensitivity Analysis	Coefficient	Model I	Model II
Results of the Benchmark Regressions	Lagged Log World Uncertainty Index	–0.391*** (0.108)	–0.405*** (0.110)
Including Lagged Female Labor Force Participation Rate	Lagged Log World Uncertainty Index	–0.389*** (0.109)	–0.407*** (0.110)
Including Lagged Log Total Population	Lagged Log World Uncertainty Index	–0.314*** (0.107)	–0.388** (0.110)
Including Lagged Total Unemployment Rate	Lagged Log World Uncertainty Index	–0.372*** (0.108)	–0.389*** (0.110)
Including Lagged Age Dependency Ratio	Lagged Log World Uncertainty Index	–0.328*** (0.101)	–0.330*** (0.101)
Including Lagged Urban Population	Lagged Log World Uncertainty Index	–0.369*** (0.109)	–0.406*** (0.110)
Including Lagged Life Expectancy at Birth	Lagged Log World Uncertainty Index	–0.207** (0.104)	–0.297*** (0.108)
Including Lagged Economic Growth	Lagged Log World Uncertainty Index	–0.356*** (0.110)	–0.364*** (0.112)
Including Lagged Market Gini Index	Lagged Log World Uncertainty Index	–0.361*** (0.117)	–0.387*** (0.118)
Including Lagged Transfers and Subsidies	Lagged Log World Uncertainty Index	–0.426*** (0.125)	–0.419*** (0.127)
Including Lagged Government Consumption	Lagged Log World Uncertainty Index	–0.420*** (0.117)	–0.396*** (0.119)
Including Lagged Top Marginal Income Payroll Tax Rate	Lagged Log World Uncertainty Index	–0.458*** (0.137)	–0.481*** (0.140)
Including Lagged Index of Labor Market Regulation	Lagged Log World Uncertainty Index	–0.458*** (0.137)	–0.490*** (0.141)
Including Lagged Index of Overall Globalization	Lagged Log World Uncertainty Index	–0.416*** (0.108)	–0.440*** (0.109)
Including Lagged Index of Economic Globalization	Lagged Log World Uncertainty Index	–0.405*** (0.108)	–0.419*** (0.109)
Including Institutional Quality: Lagged Executive Constraints Concept	Lagged Log World Uncertainty Index	–0.393*** (0.112)	–0.401*** (0.113)
Including Institutional Quality: Lagged Level of Institutionalized Democracy	Lagged Log World Uncertainty Index	–0.397*** (0.112)	–0.403*** (0.113)
Including Institutional Quality: Lagged Index of Polity2	Lagged Log World Uncertainty Index	–0.364*** (0.109)	–0.382*** (0.110)
Including Lagged Index of Conflicts	Lagged Log World Uncertainty Index	–0.386*** (0.108)	–0.402*** (0.109)
Excluding Extreme Units of Dependent Variables	Lagged Log World Uncertainty Index	–0.384*** (0.110)	–0.396*** (0.112)
Excluding Extreme Units of World Uncertainty Index	Lagged Log World Uncertainty Index	–0.382*** (0.117)	–0.407*** (0.119)
Excluding Latin American and Caribbean Countries	Lagged Log World Uncertainty Index	–0.462*** (0.129)	–0.459*** (0.130)
Excluding East Asia and Pacific Countries	Lagged Log World Uncertainty Index	–0.417*** (0.113)	–0.428*** (0.114)

Notes: The dependent variables are the Total Fertility Rate (Model I) and Δ Total Fertility Rate (Model II). Controls are included but not reported to save space. The standard errors are in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels.

Appendix I
List of Countries in the Dataset

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Bangladesh, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Congo DR, Congo Republic, Costa Rica, Côte d'Ivoire, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gabon, the Gambia, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea Republic, Kuwait, Kyrgyz Republic, Laos, Latvia, Lesotho, Liberia, Lithuania, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, the Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, the Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, the United Arab Emirates, the United Kingdom, the United States, the Uruguay, Venezuela, Vietnam, Yemen, Zambia, and Zimbabwe.