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Research Article

The short- and long-term determinants of fertility in Uruguay

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The short- and long-term determinants of fertility in Uruguay

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Abstract

BACKGROUND
Uruguay was one of the pioneers of the demographic transition in Latin America and the Caribbean. It experienced very early declines in both fertility and mortality, but teenage fertility remained high until recently.

OBJECTIVE
We study the short- and long-term determinants of fertility at different reproductive age stages (less than 20 years old, 20 to 29 years old, and 30 years old and over).

METHODS
We employ time-series analysis methods based on data from 1968 to 2021 and panel-data techniques based on department-level statistical information from 1984 to 2019.

CONCLUSION
Our time-series analysis indicates a cointegration (long-term) relationship between fertility and economic performance, education, and infant mortality, with differences observed by reproductive age stage. It finds a negative relationship between income and fertility for women aged 20 to 29 that persists for women aged 30 and over and a negative relationship between education and adolescent fertility. A panel-data exercise with econometric techniques allowing us to control for unobserved heterogeneity confirms that income is a relevant factor for all groups of women and reinforces the crucial role of education in reducing teenage fertility. We also identify a negative correlation between fertility and employment rates for women aged 30 years old and over. Our study suggests a very relevant role for education in curbing fertility, especially among teenagers. It also confirms the importance of the level of economic development, providing support for conventional

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structural or diffusion, maternal role incompatibility, and institutional theories. Our evidence on female employment is not robust to the estimation method.

CONTRIBUTION
We provide the first comprehensive analysis of fertility at different stages of reproductive life for a Latin American and Caribbean country based on a long series of statistical data. Moreover, the case of Uruguay is particularly interesting because of the idiosyncratic features of this magnitude in the country. Our results yield additional evidence that contributes to increasing our understanding of the determinants of this phenomenon and informs policymakers regarding the design of interventions that shape fertility.

1. Introduction

Uruguay's fertility behaviour has idiosyncratic features. The country was one of the pioneers of the demographic transition in Latin America and the Caribbean, with very early declines in both fertility and mortality. Its fertility rate was 2.7 children per woman in 1950, a figure that the continent did not reach until the end of the 20th century. Nevertheless, adolescent fertility – with its well-known negative public health and socio-economic consequences – remained high until recently.[4] It peaked in 1997 at 74 births per 1,000 women, stabilised at approximately 60 births per thousand women in the following years, and experienced a marked decline from 2014 to 2021, when it reached 26 births per 1,000 women (Ministerio de Salud Pública 2023).

This resistance to a downward trend in adolescent fertility is not exclusive of Uruguay. It is actually a feature shared with the other countries of Latin America and the Caribbean (Rodríguez Vignoli 2017). In fact, the initial differences between Uruguay and the other countries of the region decreased after the mid-1990s, when most of them began a continuous process of fertility reduction (Cabella and Pardo 2014). As a result, by 2015 most of the region were in the low fertility category, with an average of 2 children per woman (Cabella and Nathan 2018). However, between 2015 and 2021, Uruguay stands out from other countries in the region due to a pronounced decline in total fertility (reaching its minimum in 2020, at 1.48 births per woman). This fall was mainly the outcome of the decline of adolescent fertility.

[4] Adolescent fertility is particularly relevant because of its impact throughout the life of teenage mothers: It is due to low educational attainment, poor labour market outcomes, and poverty (Engelhardt, Kögel, and Prskawetz 2004; Fletcher and Wolfe 2009; Hoffman and Maynard 2008; López Gómez et al. 2016; Paranjothy et al. 2009; Varela Petito 2004; Varela Petito et al. 2014; Varela Petito, Tenembaum, and Lara 2014). Teenage pregnancies are often unplanned (Antón, Ferre, and Triunfo 2018; Buckles, Guldi, and Schmidt 2019), receive less prenatal care, and have worse birth outcomes on average (Joyce and Grossman 1990; Kost and Lindberg 2015; Kost, Maddow-Zimet, and Kochhar 2018; Moreira Wichmann 2019).

The literature has attempted to explain the determinants of fertility at different stages of reproductive life using different conceptual frameworks, methodological tools, and types of data. The results are ambiguous, which underlines the importance of providing new empirical evidence that sheds light on this phenomenon.

The aim of this paper is to investigate the determinants of fertility among women aged 15 to 19 (teenage fertility), 20 to 29 (intermediate fertility), and 30 and over (late fertility) in Uruguay. For this purpose, we use both time-series analysis methods, based on data from 1968 to 2021, and panel-data techniques, based on department-level statistical information from 1984 to 2019.

Our research contributes to the literature in several ways. First, we are able to gather and systematise historical statistical information on fertility and its potential determinants at the national and regional level. Such a work results in the reconstruction of long series of data that allow us to examine a number of socio-economic indicators that aim to approximate the various hypotheses explaining fertility at different age stages of life.[5]

Second, to the best of our knowledge, our paper is the first in-depth study using data of this type focused (i.e., devoted to the study of a single country using such long series and so varied methodological tools) on a Latin American and Caribbean country. Our intention is to proceed in the same spirit as previous literature that covers several decades and employs similar techniques, which focuses on the United States (Kearney and Levine 2015), Japan (Kato 2021; Suzuki 2019) and Italy (Cazzola, Pasquini, and Angeli 2016).

The use of both time-series and panel-data techniques, which draw on different assumptions (whose merits we discuss below), and the consideration of fertility patterns at different reproductive age stages allows gaining a more comprehensive and robust understanding of fertility behaviour from a demographic perspective and its association with determinants than previous works. Although we do not leverage an experimental or quasi-experimental research design (and we recommend some caution in the interpretation of the results), such an extensive exercise should allow arriving to findings close to causal effects – specifically when supported by both sorts of approaches. Long-term historical statistics make possible to employ time-series techniques, particularly to estimate cointegration relationships and to distinguish between short- and long-run impacts.

Our panel-data analysis also benefits from the availability of this kind of data: It exploits within-department variation – which attenuates endogeneity concerns by controlling for time-constant unobserved region-level factors. To our knowledge, despite the considerable body of literature on fertility in the region – and, to some extent, for the country – there is not previous research centred on Uruguay making use of these methods and, as explain in more detail below, the evidence for Latin American and the Caribbean as a whole from this methodological angle is scarce. Although we can find excellent

[5] The database is readily available from the authors upon request.

works on the development of fertility in Uruguay – particularly, since the nineties – this rigorous research has an eminently descriptive purpose.

Furthermore, this paper intends to contribute to the existing literature on the subject of fertility by providing additional evidence that cumulatively helps to increase our knowledge of its determinants. Such a process can inform the design of sound social policies (e.g., related to family planning or support of work–life balance).

After this introduction, the rest of the chapter unfolds as follows. The second section summarises the theoretical framework for studying fertility dynamics and explains in more detail the contributions of our work to the existing literature. The third section includes a description of the methodology and data for the country (time series) and regional analyses (panel-data). The fourth section presents our results. Last, we discuss the main conclusions and implications of our study.

2. Theoretical framework and literature review

2.1 Theoretical framework

Demographic literature has historically proposed several theoretical perspectives to explain reproductive behaviours of population. Those approaches differ in their emphasis and potential applicability depending on the demographic context considered (a high or low fertility environment). Despite the conceptual advances which demography has witnessed, no single theory can adequately account for all the determinants of fertility on its own.

First, the demographic transition theory (Notestein 1945; United Nations 1973) describes the shift from a population with high fertility and mortality to one with low fertility and mortality as a result of economic development. Originally used to explain the demographic change in Great Britain during the Industrial Revolution, it postulates that fertility decline is a consequence of a country's modernisation, economic growth, and development, with the reduction in infant mortality and rural-to-urban migration being the main drivers.

This theory often constitutes the basis for subsequent theoretical explanations, the researcher community agrees that it is also incomplete. The sociological perspective of the proximate determinants of fertility model (Davis and Blake 1956; Bongaarts 1978) covers some key aspects overlooked by this demographic transition theory, such as biological, technological, or cultural dimensions, not included in its analysis.

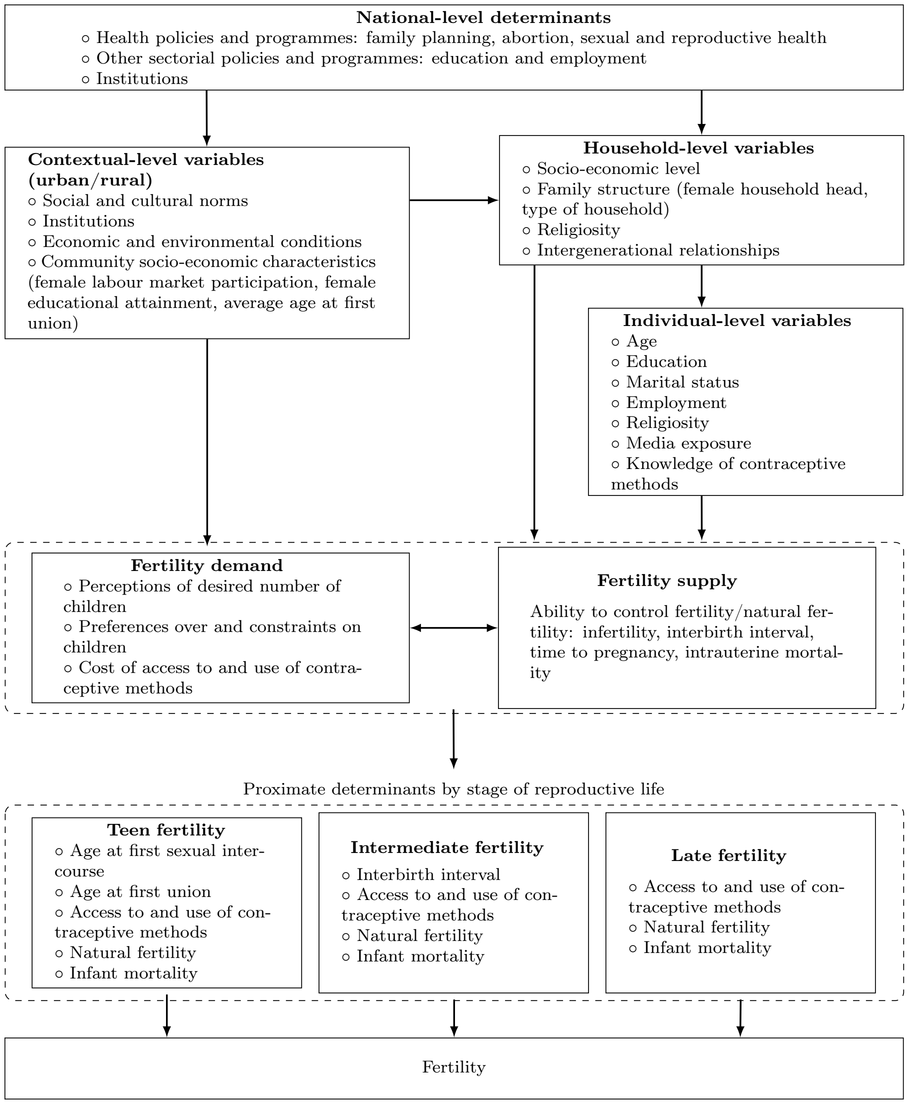
The model of Davis and Blake (1956) proposes a set of intermediate determinants of fertility, inspiring the simplified approach of Bongaarts (1978) that focuses on so-called proximate determinants of fertility. These factors differ according to the stage of reproductive life and comprise three categories: exposure (nuptiality and age of sexual initiation), deliberate control of fertility (access to and use of birth-control methods and abortion), and natural fertility. The latter factor refers to the absence of contraception and depends on women's exposure and reproductive conditions (such as sexual abstinence, age at first sexual intercourse, coital frequency, miscarriages, infertility and, breastfeeding). In turn, these causes and dynamics of fertility imply several empirically testable hypotheses.

In Figure 1, drawing on the seminal contribution of Davis and Blake (1956) and the later adaptations by Bongaarts (1978) and Ojakaa (2022), we illustrate the large number of variables affecting fertility and their interactions. There are four different levels of analysis at which they operate. First, it is relevant to highlight the role of national-level factors, such as country-wide policies and programmes on sexual and reproductive health, education, employment, and other institutional features. This set of factors operates at the following three other levels: community (differences between urban and rural contexts, or large and small towns), household (where one can include variables related to income, religion, or household size), and individual (age, education, marital status, employment status, etc.). The interaction between these four levels affects both the demand and supply of fertility and therefore the intermediate fertility variables, which vary according to the reproductive age stage in which women are (adolescent, intermediate, or late).

Next, the so-called conventional structural hypothesis derives not only from the demographic transition theory but also microeconomic models and the threshold hypothesis. The former are the result of applying economic analysis, with rational choice as the main workhorse, to fertility, particularly to explain families' preferences for having children (Becker and Lewis 1973; Easterlin 1969; Leibenstein 1974). This body of literature develops a supply–demand theoretical framework for fertility, where this variable is the result of the supply of children (number of surviving children in the absence of birth control), demand for children (due to preferences about the number of offspring), and cost of regulating births. The latter, the threshold hypothesis (United Nations 1963), states that fertility will decline only after socio-economic and health conditions have reached a certain level.

From a socio-cultural perspective, the ideational or diffusionist hypothesis suggests that fertility change is due to changes in perceptions, ideas and attitudes about birth control. These changes have their roots in the expansion or diffusion of family planning organisations and mechanisms and the increase in women's educational attainment. However, many authors emphasise that the operation of these forces requires the prior achievement of a certain level of socio-economic development (Caldwell, Orubuloye, and Caldwell 1992; Cleland and Wilson 1987; Cleland 2001; Fort, Schneeweis, and Winter-Ebmer 2016; Hirschman and Guest 1990).

Figure 1: Determinants of fertility



Source: Authors' elaboration from Bongaarts (1978), Davis and Blake (1956), and Ojakaa (2022).

The drive to understand how social institutions shape reproductive behaviour led to the emergence of the institutional perspective. This framework emphasises the importance of contextual factors, with a particular focus on the relationship between institutions and marriage, fertility decisions, and education. It aims to reconcile macro and micro perspectives (Farooq and Simmons 1985).

The conceptual frameworks outlined above provided an explanation for the transition from high to low fertility regimes. Since the late 1960s, however, most developed countries have undergone drastic processes of fertility decline, entering 'low' and 'very low fertility' regimes. This process led to the search for new theoretical explanations to understand the factors behind these processes.

The concept of the second demographic transition, developed mainly by the demographers Lesthaeghe and van de Kaa (1986), has been used to describe and analyse changes in family composition and reproductive behaviour in societies where fertility rates have fallen drastically and where there have been significant changes in attitudes and practices relating to the family. The series of cultural and ideological changes that occurred in the last decades of the twentieth century brought about a change in mentality that made individualism the norm, leading individuals to assess the costs of losing their autonomy when considering having children. The second demographic transition is characterised by a postponed age of marriage and motherhood, a rise in divorce rates, and an increase in cohabitation. Originally formulated for European countries, this concept has since been applied to other demographic contexts (Lesthaeghe 2010). One criticism of this approach is that it does not include a gender perspective and does not take into account the impact of economic changes (Bernhardt 2004).

In this sense, an increase in females participating in the labour force is central to understanding reproductive changes throughout history. The so-called maternal role incompatibility hypothesis focuses on disentangling the potential and eventual problems of reconciling preferences over the number of children with working life prospects (Cramer 1980; Lehrer and Nerlove 1986; Spitze 1988). Similarly, the societal response hypothesis argues that the existence of policies aimed at minimising conflicts between motherhood and female labour market participation (e.g., available and affordable childcare, generous parental leave, or changes in attitudes towards working mothers) could prevent an increase in female employment from translating into a decline in fertility (Brewster and Rindfuss 2000; Rindfuss, Guzzo, and Morgan 2003).

According to McDonald (2000), gender relations can vary between the household and other spheres. Achieving greater gender equality within the household is necessary for the shift from high to low fertility. However, persistent inequalities in areas such as labour markets and formal education can mean that women end up having more children than they intended.

Reproductive desires and preferences also emerge as a relevant element for explaining fertility. This particularly applies to low fertility contexts, where the desired number of children exceeds the actual one. In this respect, some conceptual frameworks focus understanding individual choices and, specifically, on how intentions play a key role in illuminating reproductive behaviour at the micro level. Aspirations integrate attitudes (perceived costs and benefits), subjective norms (peer influence), and perceived control over actions. This framework associates more favourable attitudes and subjective norms towards childbearing with more behavioural control and hence higher fertility intent (Aizen and Klobas 2013). Other theoretical developments, such as the theory of conjunctural action, emphasise that intentions also include non-rational, cognitive elements and how these elements influence the decision to, for example, continue an unwanted pregnancy (Bachrach and Morgan 2013).

This section summarises the main disciplinary perspectives of and explanations on fertility behaviour in demographic regimes. However, we are aware of the existence of other significant theoretical approaches to fertility in the literature, which we are not able cover here because it is beyond the scope and empirical orientation of this paper.

Bridging the theoretical insights summarised above and empirical practice is challenging. It requires a search for variables that adequately approximate the different dimensions suggested by the theory. To capture the socio-economic dimension, the variables most commonly chosen in the literature are GDP per capita or household expenditure (Buckles, Hungerman, and Lugauer 2021; Chatterjee and Vogl 2016; Sobotka, Skirbekk, and Philipov 2011); unemployment (Cazzola, Pasquini, and Angeli 2016; Currie and Schwandt 2014); development indicators such as the Gini index, basic infrastructure and services, and health and education expenditure (Bettio and Villa 1998; Engelhardt, Kögel, and Prskawetz 2004; Engelhardt and Prskawetz 2004); female educational attainment (either enrolment rates or average years of schooling by cohort) (Ainsworth, Beegle, and Nyamete 1996; Sackey 2005; Schultz 1973; Vavrus and Larsen 2003); and labour market indicators (women's labour market participation, female wages, and the gender pay gap) (Kato 2021). The most widely used variables to approximate demographic aspects are population structure and mortality (total or infant). Finally, to operationalise institutional aspects and public policies, which cut across all the other dimensions, a popular strategy is to specify main milestones in the implementation of or drastic changes in public interventions, among others, related to family planning or education (Carr and Packham 2017; Kearney and Levine 2015; Paton, Bullivant, and Soto 2020).

2.2 Literature review

The previous empirical literature to which this study refers includes both time-series and panel-data analyses. The former type of research tends to highlight the role of macro-level determinants of fertility. Specifically, these studies emphasise the relevance of female labour force participation, unemployment (both male and female), infant mortality, and women's education, among other factors. Nevertheless, this literature is inconclusive with respect to these determinants. A consensus is lacking regarding whether the relationships are causal (even in Granger's sense) or whether they could even be bidirectional (Chatterjee and Vogl 2016; Sobotka, Skirbekk, and Philipov 2011; Kato 2021; Audi and Ali 2016).

The evidence on the effect of GDP per capita is more complex. Fertility appears to be procyclical, but it also tends to fall in the long term with economic growth and in the short run with recessions (Audi and Ali 2016; Chatterjee and Vogl 2016; Sobotka, Skirbekk, and Philipov 2011). The effect also differs across reproductive age stages, with the fertility of women aged 30 and over being the most sensitive to economic fluctuations. The related literature even discusses whether fertility actually declines after economic crises or, in contrast, whether such a development actually precedes the recorded output losses since it is extremely dependent on short-term expectations, as suggested by Buckles, Hungerman, and Lugauer (2021) for the United States. For this reason, (i.e., the anticipatory behaviour of fertility), these authors are quite critical of the use of unemployment and other business cycle indicators as explanatory factors for fertility. By contrast, other studies, such as Currie and Schwandt (2014), which link fertility and unemployment by cohort, suggest an important role for labour market prospects. Specifically, they find that women aged 20 to 24 are the most affected group, and the negative impact increases over time. The long-term effect on fertility is largely driven by women who remain childless.

Previous works also make use of other measures of economic performance, such as women's wage levels, female labour market participation, and the gender pay gap. For instance, Kato (2021), using data from 1980 to 2019 for Japan, with its low fertility rate, and labour shortage (circumstances very far from the Uruguayan reality), suggests that women's average earnings have a negative impact on childbirth. Their results highlight the importance of the opportunity cost of having children and the need to design policies that improve work–life balance.

The inclusion of female education makes it possible to test the validity of the diffusion hypothesis. By way of example, the work of Audi and Ali (2016), employing time series from 1971 to 2014 for Tunisia, finds a negative impact of women's schooling level on fertility.

The United States followed a similar path to Uruguay's. Although the decline was not monotonic, its total fertility rate more than halved between 1900 and 2017, and teenage fertility did not decline until recently. Buckles, Guldi, and Schmidt (2019) examine the heterogeneity in fertility trends across different demographic groups. They find that the reduction in fertility in recent decades followed the reproductive behaviour of young and single women, whereas married women and those above 30 saw an increase in their fertility. These authors' results also confirm the positive correlation between declines in fertility and in the proportion of unplanned pregnancies.

The literature using panel-data exploits differences either between regions within the same national boundaries or among countries to shed light on the main determinants of fertility. Regarding the former, we can highlight the study by Kearney and Levine (2015) for the United States, whose main finding is the role played by the expansion in access to family planning services, which explains 13% of the drop in teenage fertility between 1991 and 2010. The work of Cazzola, Pasquini, and Angeli (2016) for Italy emphasises the importance of unemployment, especially in the case of male rates. The Japanese case has also received some attention. Suzuki (2019) finds that female wages have a non-negligible negative impact on fertility whereas, according to the analysis of Kato (2021), differences in birth rates are due to childcare availability and female labour force participation.

Regarding cross-country literature, most of the existing works centre on developed countries. For instance, Sobotka, Skirbekk, and Philipov (2011) confirm the negative impact of economic crises on fertility rates. In terms of policies, D'Addio and d'Ercole (2006) show that social transfers that reduce the direct cost of children and provisions that allow mothers to better balance work and family have a significant impact on birth rates. The analysis of Kato (2021) comes to similar conclusions with regard to the economic environment but, surprisingly, opposite ones for family policies. The author also stresses the importance of female labour market conditions. Interestingly, Paton, Bullivant, and Soto (2020) find no effect of the expansion of sexual education on fertility. Among the studies focusing on developing regions, we can mention the work of Ojakaa (2022) for sub-Saharan Africa, which emphasises the role of age at first marriage and contraceptive prevalence. For Latin America, Palloni and Rafalimanana (1999) analyse the relationship between infant mortality and fertility rates between 1920 and 1990 and find small positive effects of infant mortality on fertility. Finally, Adsera and Menéndez (2011) use aggregate data to examine the relationship between the business cycle and fertility in 18 Latin American countries between 1950 and 2003. These authors find a pro cyclical relationship, particularly between the level of unemployment and fertility. Subsequently, they employ individual-level data for a smaller group of countries, confirming the positive relationship between fertility and economic performance, but it is not homogeneous. Motherhood was increasingly delayed or avoided, particularly among urban women with higher levels of education and from younger cohorts.[6]

[6] Apart from the works mentioned in the main text (mainly carried out by economists), which aim – at least to some extent – to disentangle causality relationships, there is a rich body of research that adopts a more descriptive and demographic perspective, such as, among many others, Bay, Del Popolo, and Ferrando (2004) and Chackiel and Schkolnik (2003).

2.3 The social and institutional national context of previous related research for Uruguay

Uruguay, located in the southern cone of Latin America, has particular social and political characteristics. From a historical perspective, the development of the welfare state began in Uruguay at the end of the19th century and was consolidated by the middle of the next one, several years before the rest of the countries in the region, shaping the constitutive characteristics of contemporary Uruguay. A series of social and political transformations, among which the early secularisation of education and health stand out, led to the development of the social protection system. This period saw the establishment of a universal health system, a free and compulsory education system, the introduction of the eight-hour working day, sickness insurance, unemployment and accidents at work insurance, compulsory rest days, paid maternity leave, and old-age pensions (Birn and Pollero 2023).

Nowadays, Uruguay has demographic and health indicators similar to those of developed countries, including a low infant mortality rate, a low fertility rate, an ageing population, a high life expectancy, a high female labour force participation rate, and a high level of urbanisation, among others.[7] Although classified as a high-income economy for more than a decade (Hamadeh, Van Rompaey, and Metreau 2023), it displays increased levels of inequality and diminished educational outcomes for its development level in comparison to developed countries. This poses a threat to the future growth and prosperity of the nation.

From a demographic point of view, since 2015, Uruguay has joined the group of countries with very low fertility (less than 1.5 births per woman in 2021) with indicators typical of the second demographic transition (increase in delay in motherhood, increase in consensual unions). When considered from a historical perspective, Uruguay is significantly ahead of the other countries in the region from a demographic standpoint, as it initiated the demographic transition early.[8] This transition began at the end of the 19th century when the fertility rate in Uruguay was 2.7 children per woman, a rate that became widespread in Latin America and the Caribbean during only the late 1990s.

[7] Calvo (2016), Pellegrino (1997, 2010, 2013), and Pellegrino et al. (2008) provide an excellent assessment of the evolution of Uruguayan demographics during the last 100 years. The interested reader can find an overall comparative perspective of reproductive and fertility topics in Latin America and the Caribbean in works like Chackiel (2004), Esteve, Castro-Martín, and Castro Torres (2022), Guzmán et al. (2006), Pantelides (2004), Rodríguez-Vignoli and Cavenaghi (2014), and Schkolnik and Chackiel (1998).

[8] According to Barrán and Nahum (1979), the main factors that explain such a premature transition were the cultural impact of European immigration, an earlier integration with the Western model, the precocious urbanisation process, the high relevance of (non-labour intensive) extensive cattle farming, the land distribution (with large latifundia preventing rural population development), and the prevalence of economic activities that did not foster the growth of intermediate cities and consolidated the preponderance of the capital, Montevideo, the main exporting harbour of the country.

This initial difference in the reproductive behaviour of Uruguay with the countries of the region converges in the last two decades, when the majority of the countries of the region enter in low fertility regimes (Cabella and Nathan 2018; Pardo and Varela 2013). The crucial difference between our region and the European countries that have driven these demographic changes is that this process hides deep-seated inequalities, which are manifested in high adolescent fertility rates. In Uruguay, adolescent fertility remained high and fairly resistant to decline until the early years of the 21st century, hindering the progress of the global fertility decline (Varela Petito, Tenembaum, and Lara 2014).[9] It is only since 2016 that fertility has once again experienced a notable decline in Uruguay's reproductive history (births were reduced by 33% in six years), mainly due to the decline in fertility among adolescents and young women (Cabella et al. 2023). The legalisation of abortion and the deployment of several public actions (from the expansion of access to contraception methods to the rollout of new strategies to prevent teenage pregnancy or even initiatives fostering youth civic participation) seem to have played a substantial role in this spectacular reduction.

From our point of view, previous literature on fertility patterns in Uruguay adopts a different angle than ours. Previous works, fully embedded in a demographic perspective, have mainly a descriptive aim. They try to explore, dissect, and decompose the main trends in fertility, often offering some interpretation of the associations.

A substantial body of literature has devoted much attention to the heterogeneity of fertility patterns before the aforementioned recent decline since 2016, finding large gaps between birth rates by socio-economic strata, very high and very poor among socially disadvantaged and better-off population, respectively (among others, Fernández-Soto, Pardo, and Pedetti [2020], Nathan, Pardo, and Cabella [2016], Nathan and Pardo [2019], Pardo, Cabella, and Nathan [2020], Peri and Pardo [2008] and Varela Petito, Pollero, and Fostik [2008]).[10] Most of this highly valuable research only intends to draw conclusions for general or teenage fertility.[11] It is also worth mentioning the studies of Cabella, Nathan, and Pardo (2019) and Cabella et al. (2023), who characterise the recent drop in fertility rates by paying attention to educational differences and birth orders. To our knowledge, research on Uruguay aiming to estimate causal relationships focuses on the decriminalisation of abortion (Antón, Ferre, and Triunfo 2018; Cabella and Velázquez 2022) or the deployment of contraceptive subdermal implants (Ceni et al. 2021; Ferre, Triunfo, and Antón 2023) leveraging quasi-experimental settings.

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[9] The literature on Uruguay tended to consider the low educational attainment and poor living conditions of some strata of female adolescents as the main break for teen birth rates.

[10] This seems to be a common feature for the region (Castro Torres 2020).

[11] Spatial differences have also attracted interest (Cabella, Nathan, and Pardo 2019; Blanes et al. 2018; Varela Petito et al. 2014). This research points out converging fertility rates across departments (less heterogeneous than mortality rate) and the generalised drop in fertility since 2016. All authors agree that regional differences are of a secondary relevance compared to those due to socio-economic status.

3. Data and methods

As mentioned in the previous sections, we explore the drivers of fertility employing time-series and panel-data techniques. Our study does not profit from an experimental or quasi-experimental research design. We employ two different methods (and datasets), which allow identifying the causal effects of covariates under certain (not always testable) assumptions. Nevertheless, even though we tend to rely on those findings who are supported by both approaches, our setup does not grant causality. Therefore, although the analyses should at least identify relevant correlations and have a descriptive value, the reader should interpret our estimates with caution.

In the specific fertility analysis presented in this research, these techniques have both advantages and disadvantages. Because of data availability reasons, we can consider a longer period of analysis in the time-series exercise. Furthermore, modern time-series methods allow distinguishing between long-run (equilibrium) and short-run relationships between variables. Nevertheless, regional panel-data allow controlling for unobserved time-constant regional heterogeneity (relying on within-department variation), including other covariates not available for the (longer) period used in the time-series exercise and, given the number of regions, profiting from a larger statistical power (due to the bigger sample). As in both cases we obtain some of the variables from Uruguayan household surveys, precision and measurement errors are likely to be lower in the time-series analysis.

As shown in the previous section, there are a number of many theoretical traditions that account for fertility, comprising a large number of variables. Nevertheless, in our paper, data availability fully determines which ones we can consider in our empirical analysis. In this respect, we intend to include as many factors highlighted by the different theories as possible, and we briefly relate each covariate to the corresponding theoretical perspective.

3.1 Time series country-level analysis

In this section, we describe the dataset set and methods used in the time-series analysis of the evolution of fertility at different age stages of reproductive life (adolescents, women aged 20 to 29, and women aged 30 and over).

In this exploration, we collect information on the following covariates: GDP per capita, female employment rate (share of employed women in relation to female working-age population), female secondary gross enrolment rate (number of women in secondary education as a percentage of women aged 12 to 17), and infant mortality rate (number of deaths of children under one year of age, expressed per 1,000 live births). We use GDP per capita as a proxy for socio-economic development.[12]

Our consideration of the female employment rate and secondary school enrolment allows us to test the validity of the diffusion hypothesis. These variables capture shifts in women's preferences over and attitudes towards fertility. In particular, educational attainment might improve women's access to information on contraceptive methods and increase their intra-household bargaining power.

Infant mortality rate plays a key role in the demographic transition hypothesis and in other modern population theories. The relationship between fertility and infant mortality can be difficult to unravel because of various underlying mechanisms. These channels can range from purely physiological effects, where the death of an infant triggers resumption of mothers' menstruation and ovulation, thus increasing their likelihood of a new conception, to replacement or insurance mechanisms (whereby families aim for a specific number of surviving children beyond the desired family size), distortions in the market for potential partners, and competition between children for maternal care and household resources (Palloni and Rafalimanana 1999; Wolpin 1998). Additionally, infant mortality can serve as an indicator of the quality of a country's health systems and level of access to medical care.[13]

The availability of information on fertility and covariates over time varies considerably. Overall, in our econometric exercise, we are able to analyse teenage fertility over the period 1968–2021 and the rates of the other two age groups from 1978 to 2021. Reconstructing the time series of these variables is not trivial, requiring substantial effort and the combination of different sources. First, the adolescent fertility rate comes from statistical information from the Uruguayan National Institute of Statistics (Instituto Nacional de Estadística 2023e) and the World Development Indicators (WDI) (World Bank 2023), whereas we obtain the other two fertility rates by combining vital statistics from the Ministry of Public Health and population projections from the National Statistics Institute (Instituto Nacional de Estadística 2023c; Ministerio de Salud Pública 2023). We retrieve historical data on GDP per capita (in constant 1990 US$) from the Montevideo–Oxford Latin American Economic History Data Base (Economic and Social History Programme of the University of the Republic and Latin American Centre and the Depart-

[12] Note that the definition of female secondary gross enrolment rate implies that this variable could take values higher than 100.

[13] As suggested by Pellegrino (2010), the reduction in the infant mortality rate reflects positive achievements in terms of social and sanitary policies. Overall, such a decline may be due to both medical advances and public health interventions and the overall rise of life standards (McKeown 1976). Alternatively, we considered the percentage of population aged more than 60 years as an indicator of population structure in both time-series and panel-data analysis, with the same purpose of infant mortality rate. We obtain similar results as in the case of including the latter variable. Also, as regarding infant mortality rate, the results for the share of elderly population is not robust across methods and even across econometric specifications in the panel-data analysis. These results, omitted here for the sake of brevity, are available from the authors upon request.

ment of International Development of the University of Oxford 2023), and the female high school enrolment rate comes from the WDI (World Bank 2023). We reconstruct our series on the female employment rate using information from Centro Latinoamericano de Economía Humana (1990) and Instituto Nacional de Estadística (2023a).[14] Finally, we obtain the infant mortality rate for the period of interest from Instituto Nacional de Estadística (2023d). Table 1 shows the descriptive statistics of the variables included in our econometric exercise. The interested reader can also find the time series of all the covariates used in the analysis in the Appendix (Figure A-1).

Table 1: Summary statistics of time-series data

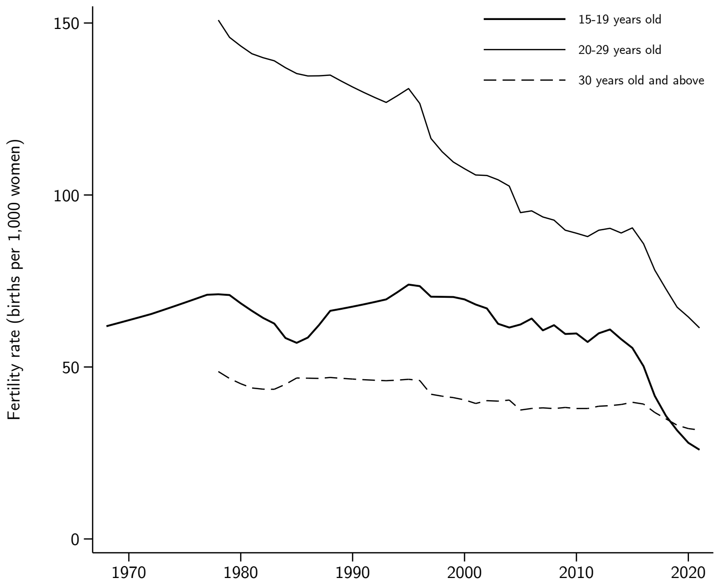
	Mean	Standard deviation	Minimum	Maximum
Fertility rate 15–19	61.883	10.808	25.972	73.957
Fertility rate 20–29	110.676	24.784	61.358	150.842
Fertility rate 30–49	41.559	4.486	31.669	48.676
GDP per capita	7,982.376	2,711.117	4,747.161	13,267.110
Female employment rate	38.761	9.122	23.100	52.400
Female high school enrolment	89.742	22.015	61.727	131.253
Infant mortality rate	23.525	15.731	6.200	61.879

Note: The number of observations is 54 (1968–2021) in all cases except for the 20–29 and 30+ fertility rates, where it is 44 (1978–2021).

Figure 2 shows the evolution of the fertility rate by age group from 1978 to 2021 (the time window for which we have information on all of the groups). Different patterns emerge. First, the adolescent birth rate remained relatively high until 2015, when it experienced a rather abrupt fall. Second, the fertility rate of women between 20 and 29 years old underwent a sustained decline throughout the whole analysed period that accelerated in 2016. Last, the fertility of women aged 30 and above decreased at a much slower pace over the more than four decades considered in the analysis.

[14] The Uruguayan national household survey is not nationally representative until 1995. Nevertheless, since its inception, it has covered all municipalities with 5,000 inhabitants. Therefore, to construct homogeneous series, we restrict all the statistical information based on this database to the mentioned localities.

Figure 2: Evolution of age-specific fertility rates in Uruguay (births per 1,000 women, 1968–2021)



Source: Authors' analysis from Instituto Nacional de Estadística (2023e) and World Bank (2023).

Naturally, the period covered by our analysis witnessed the enactment of several potentially relevant education- and health-related laws. Unfortunately, the degrees of freedom of our research design and the fact that some of the developments were contemporaneous prevent us from disentangling the causal effect of these policies. Below, in the results section, we discuss the inclusion of a linear time trend and dummies for certain subperiods of time.[15]

Regarding methods, in principle, we aim to estimate the relationship between fertility rates and the covariates of interest through the following linear model:

$$y_t = \mu + \delta' X_t + \xi_t \ , \tag{1}$$

[15] Unfortunately, there is no reliable historical information on the patterns of use or availability of contraception methods. See, e.g., Antón, Ferre, and Triunfo (2018) and Cabella and Velázquez (2022) on the impact of the decriminalisation of abortion or Ceni et al. (2021) and Ferre, Triunfo, and Antón (2023) on the effect of the introduction of subdermal contraceptive implants.

where y_t is the fertility rate (in natural logs), X_t represents a vector comprising the covariates mentioned above (in natural logs), and ϵ denotes the random disturbance term.

To proceed with the time-series analysis, first of all, we must check whether the variables included in the analysis are stationary using the augmented Dickey–Fuller (ADF) (Dickey and Fuller 1981) and Phillips–Perron (PP) (Phillips and Perron 1988) unit-root tests. The latter is robust to heteroscedasticity and serial correlation and does not require specification of the form of the lag structure.

Second, having established the stationarity of the series, we examine the existence of cointegration between fertility and the variables described above using the tests proposed by Engle and Granger (1987), Johansen (1995), Pesaran and Shin (1999), and Pesaran, Shin, and Smith (2001).

Previous tests have been shown to be highly sensitive to the chosen model specifications. In third place, to address this issue, we decide to employ the autoregressive distributed lag (ARDL) model in our investigation of cointegration (Pesaran and Shin 1999; Pesaran, Shin, and Smith 2001):

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \phi_i y_{t-1} + \sum_{i=0}^{q} \beta_i' X_{t-i} + \epsilon_t \; , \tag{2}$$

where t is a linear time trend, ϵ denotes the random disturbance term, and p and q are the number of lags of the dependent and independent variables, respectively. In practice, we allow for a different structure of each variable (so that q can vary for each of the four covariates). We use the Bayesian information criterion to determine the optimal number of lags (which may be different for each variable). The advantage of this model over other approaches is that it allows for mixed orders of cointegration and performs better with small samples.

Fourth, in the case of evidence of cointegration, we can rewrite equation 2 as

$$\begin{aligned} \Delta y_t = {} & \alpha_0 + \alpha_1 t - \gamma \left(y_{t-1} - \theta' X_{t-1} \right) + \sum_{i=1}^{p-1} \psi_{y_i} \Delta y_{t-1} + \omega' \Delta X_t \\ & + \sum_{i=1}^{q-1} \psi_{X_i}' \Delta X_{t-i} + u_t \; , \end{aligned} \tag{3}$$

where θ denotes the long-run coefficients (the equilibrium relationship between the covariates and fertility); γ represents the error correction term – the (negative) speed-of-adjustment coefficient, which measures how fast the dependent variable responds to deviations from the equilibrium relationship; and ψ_{y_i}, ω, and ψ_{X_i} capture short-term fluctuations (unrelated to the long-term equilibrium).

Finally, we carry out goodness-of-fit tests on the ARDL model, including tests for first-order autocorrelation (Breusch–Godfrey [Breusch 1978; Godfrey 1978] and Durbin–Watson [Durbin and Watson 1950, 1951, 1971]), heteroscedasticity (White [1980], Breusch–Pagan [Breusch and Pagan 1979], and Cook–Weisberg [Cook and Weisberg 1983]), and normality (D'Agostino, Belanger, and D'Agostino Jr. 1990). In addition, we examine Granger (1969) causality and compute impulse response functions and the error variance decomposition.

3.2 Panel-data department-level analysis

Our panel-data exercise uses statistical information for the country's 19 administrative units (departments) and the period 1984–2019 to provide additional insight into the dynamics of fertility in Uruguay. This strategy allows us to increase the statistical power of the analysis and control for time-constant department-level heterogeneity through fixed-effects techniques, thereby mitigating endogeneity problems.

It is worth noting the existence of significant territorial disparities within the country. The department of Montevideo (which includes the country capital of the same name) concentrates 40% and 50% of the national population and GDP, respectively (Observatorio Territorio Uruguay 2023). From a multidimensional perspective, although the human development index (HDI) experienced sustained progress across the whole country from 2008 to 2018, again, a non-negligible gap between Montevideo and the rest of Uruguay is observable (Observatorio Territorio Uruguay 2023). In 1998, Montevideo was the only department to exhibit very high human development (above 0.800), while the rest of the regions had high HDI values (between 0.700 and 0.800). In 2018, apart from Montevideo, four other departments (Colonia, Maldonado, Flores, and Florida) had crossed the threshold of very high human development. Cerro Largo, Rivera, Rocha, Treinta y Tres, Tacuarembó, and Artigas were, in descending order, the areas with the lowest HDI values in Uruguay.

To build our database, we rely on a variety of sources, balancing the convenience of long series with the availability of statistical information. Since we can include a larger number of variables in this analysis than in our time-series econometric exercise, the period covered here is shorter. The process of selection of right-hand-side variables in this exploration follows the same theoretical principles as the time-series analysis. The main difference with the latter is that we can include the share of total females represented by the women in each bracket (with the aim of controlling for population age structure; the larger the role of each segment is, the greater the expected association with fertility) and two contextual-level variables (such as the percentage of women married or in a union in each age bracket and the gender pay gap). In principle, the last two variables should positively affect fertility because of the obvious relationship between fertility and unions and the opportunity cost of childbearing embedded in the pay gap.[16]

As in the time-series approach, we model age-specific fertility rates as a linear function of several covariates. We compute department-level fertility rates from vital statistics (Ministerio de Salud Pública 2023) and population projections (Instituto Nacional de Estadística 2023f). First, the covariates include the demographic structure of the department through the percentage of each age group of total women aged 15 to 49, calculated from population projections (Instituto Nacional de Estadística 2023f). The second variable, derived from the national household survey (Instituto Nacional de Estadística 2023b), is the percentage of women in each age group married or in a union. To assess the role of education, we consider a demand-side indicator, the average years of schooling of women in each age group, derived from Instituto Nacional de Estadística (2023b). Fourth, using the same data source, we consider a set of variables that aim to capture the opportunity cost of having children, such as age-specific female employment rates. In fifth place, we also consider the gender gap, calculated as the ratio of women's average labour income to men's average earnings. Furthermore, our analysis considers average household disposable income per capita in national currency units at December 2010 prices. The infant mortality rate is computed from Ministerio de Salud Pública (2023).[17]

Table 2 shows the summary statistics of the variables included in our analyses.[18]

Figure 3 illustrates how the age-specific fertility rate fell across the whole national territory over the analysed period. Nevertheless, it also shows that the timing of this decline varies from one department to another.

[16] We could not build a similar variable of population age structure in the time-series analysis because of data availability problems.

[17] As mentioned in the times-series exercise, we also estimate the model including the percentage of population aged more than 60 years and replacing the infant mortality rate by this variable. Our results do not change substantially and the association between this variable and fertility is not robust across specifications. These estimations are available from the authors upon request.

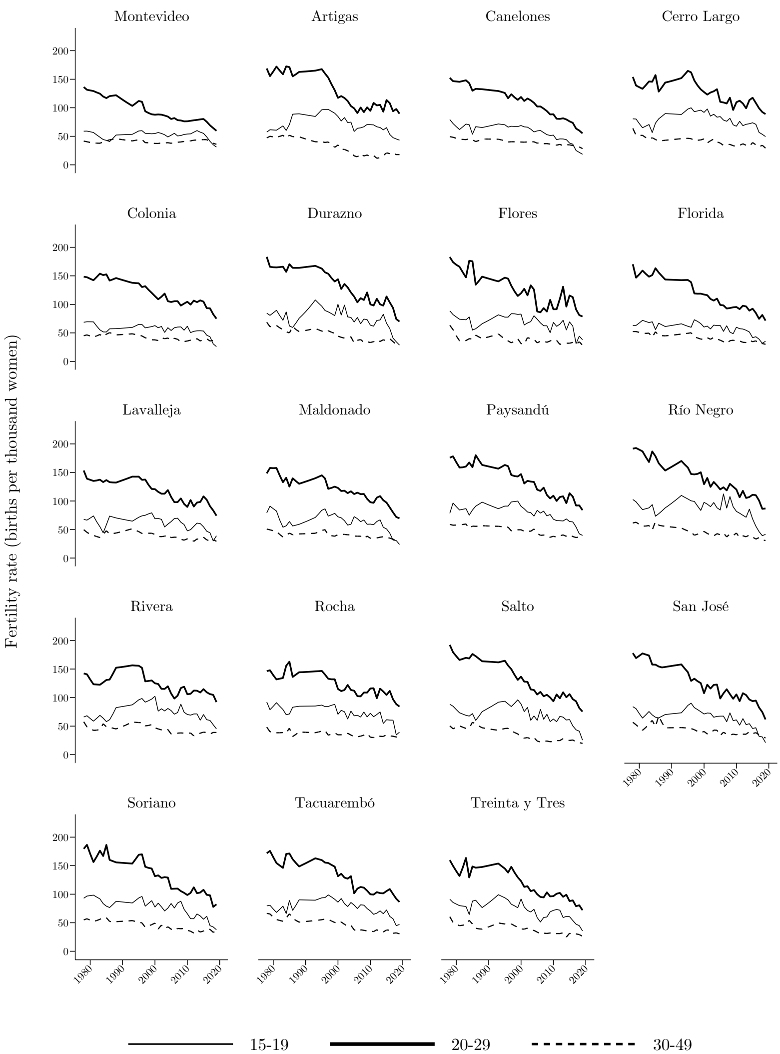
[18] As in the time-series analysis, to rely on homogenous series, we limit our analysis of the Uruguayan household survey to municipalities with 5,000 inhabitants or more.

Table 2: Summary statistics of regional panel-data

	Mean	Standard deviation	Minimum	Maximum	Between-region standard deviation	Within-region standard deviation
Fertility rate 15–19	70.8	17.4	18.5	112.4	11.2	13.6
Fertility rate 20–29	123.0	26.7	55.2	186.9	11.5	24.3
Fertility rate 30+	42.0	8.1	24.8	71.0	3.8	7.2
% of women 15–19	14.3	0.9	12.0	16.5	0.7	0.6
% of women 20–29	25.0	1.4	21.7	29.3	1.0	1.0
% of women 30–49	45.3	2.3	37.9	50.2	1.5	1.7
% of women married 15–19	1.9	0.9	0.0	5.6	0.4	0.8
% of women married 20–29	22.1	3.2	10.2	32.0	1.4	2.9
% of women married 30–49	76.0	3.5	65.8	89.1	1.7	3.1
Average years of schooling of women 15–19	8.9	0.4	7.8	10.2	0.4	0.8
Average years of schooling of women 20–29	9.8	0.8	7.9	12.2	0.4	0.7
Average years of schooling of women 30–49	9.1	1.0	6.9	12.1	0.5	0.9
Employment rate of women 15–19	16.2	6.9	0.0	50.0	2.7	6.4
Employment rate of women 20–29	51.7	8.5	29.3	73.1	5.3	6.8
Employment rate of women 30–49	64.4	9.5	38.1	84.8	3.1	9.0
Gender pay gap	0.9	0.1	0.4	1.5	0.0	0.1
Average disposable income per capita	7,180.0	1933.7	3,853.4	13,994.7	1,246.9	1,504.7
Infant mortality rate	14.7	7.5	0.0	46.4	1.7	7.3

Note: The number of observations is 665 (19 departments from 1984 to 2019).

Figure 3: Evolution of age-specific fertility rates by department in Uruguay (births per 1,000 women, 1976–2021)



Source: Authors' analysis from Ministerio de Salud Pública (2023) and World Bank (2023).

The number of departments (19) is well below 50, which prevents us from using clustered standard errors to deal with serial correlation issues (Angrist and Pischke 2008). We therefore follow the advice of Békés and Kézdi (2021) on dealing with few cross-sectional units in panel-data: We employ Newey–West standard errors (Newey and West 1987) that are robust to heteroscedasticity and autocorrelation up to the order suggested by the literature in our left-hand-side variable. In this respect, previous research emphasises that the error term of econometric models analysing the determinants of annual fertility rates tend to follow an AR(1) process (see, e.g., Brehm and Engelhardt [2015] and Prskawetz, Mamolo, and Engelhardt [2010]). As a robustness check, we compute the standard errors following the procedure described by Driscoll and Kraay (1998), which additionally allows for cross-sectional dependence between departments.

We consider all the variables in levels, without using the log transformation. In this setup, we do not have to worry about stationarity or normality (given the sample size). Furthermore, some departments exhibit zero values for certain variables.

Therefore, we estimate models of the following form:

$$y_{it} = \kappa + \lambda' Z_{it} + \eta_i + \tau_t + \upsilon_{it} \, , \tag{4}$$

where κ is an intercept, y_{it} is the age-specific fertility rate in logs of department i in year t, Z_{it} is a vector containing the time-varying covariates of interest, η_i is a department fixed effect, τ_t is a year fixed effect, and υ_{it} represents a time-varying disturbance. It is possible to group the 19 departments into six major geographical regions (metropolitan region, centre, east, northeast, littoral south, and littoral north). Our specification allows us to include group-specific linear time trends. This provides a useful robustness check: We can assess whether the results simply follow pre-existing regional trajectories over time.

4. Results

4.1 Time-series country-level analysis

According to the unit-root tests described in Subsection 3, whose results we present in the Appendix (Table A-1), the variables included in our model are first-difference stationary – $I(1)$. We allow for a maximum of two lags because of the limited statistical power due to our sample size and number of variables. The results of the tests for cointegration (Tables A-2–A-4) indicate the existence of at least one cointegration relationship.

On the other hand, as mentioned earlier, the ARDL model for each series indicates the optimal lag structure to be as follows: (2,0,0,0,2) for teen fertility, (2,1,0,0,1) for intermediate fertility, and (1,2,0,0,1) for late fertility.

In Table A-5, we present the results of the goodness-of-fit tests. They indicate that we cannot reject the null hypotheses of absence of serial correlation, homoscedasticity, and normality.

To check the stability of the parameters in our econometric models, we perform cumulative sum of squares tests for structural change (Brown, Durbin, and Evans 1975). The plot shown in Figure A-1 indicates that the cumulative sum of the squared recursive residuals is approximately within the 95% confidence interval for the target value based on the null hypothesis of the parameter at each point all the time for the three fertility rates.

Since we observe relevant changes in the late fertility rate in 1996 and 2004 and an abrupt fall in all three rates from 2016, we include three dummy variables to account for these changes and ensure the stationarity of the time series.

Table 3 presents the main findings of our time-series analysis. For brevity, we focus on those relationships for which the p-values are lower than 0.1. The results show the existence of a long-term relationship between fertility and the covariates (the p-values of the speed of adjustment are lower than 0.1). The mentioned error correction term indicates that the fertility rate adjusts to temporary deviations at a rate of between 17.5% and 25.4% per year, depending on the age group. Regarding the estimated long-run coefficients, which we interpret as elasticities, first, we find a negative association between the GDP and fertility of only women aged 30 an over. Second, the association between fertility and the female employment rate is positive (and the p is below 0.1) in all cases. A 1% increase in the share of employed women comes with a rise of fertility by between 0.229% (women aged 20 to 29) and 0.475% (women aged 30 and over). Third, female high school enrolment seems to be positively correlated with adolescent fertility and negatively associated with that of women aged 30 and over. Fourth, infant mortality rate is relevant only for the latter group of women, with a positive relationship.

The existence of discrepancies between the short- and long-run coefficients simply indicates the complexity of the dynamic interactions between fertility and the covariates. Regarding adolescent fertility, we can interpret the short-term relationships as indicative of the necessary initial conditions for curbing this age-specific rate. Namely, a decline in teenage fertility requires an increase in women's educational attainment. Specifically, a 1% rise in female secondary school enrolment reduces the adolescent fertility rate by 0.379% with a two-year lag. However, this variable exhibits a positive association with the fertility of the other two age groups (0.143 for women aged 20 to 29 and 0.146 for women aged 30 and over). Nevertheless, this finding is consistent with the evidence reported by Fort, Schneeweis, and Winter-Ebmer (2016) for England and continental Europe. For the former, these authors find support for a negative relationship between education and total fertility. This effect does not hold for mainland Europe. These authors suggest that this discrepancy might be due to the higher adolescent birth rate in England, where the increase in educational attainment associated with the expansion of compulsory schooling exerted an almost mechanical negative impact on fertility.

Finally, as mentioned above, the relationship between GDP per capita and fertility is far from simple, and in the short term, it may be the opposite of the inverse relationship that one expects in the long run. For example, economic or social crises may temporarily increase fertility due to uncertainty and the need for family support or in response to policies that encourage childbearing. In the long term, however, one anticipates an inverse relationship, associated with better access to education, increased employment opportunities and improved health-care services. The relationship also differs according to the stage of reproductive life, with the late stage being the most sensitive to economic fluctuations, as observed in Table 3. For women aged 30 and over, we find a negative association at time t (-0.171) and a positive one at $t - 1$ (0.153).

The coefficient of the temporal dummy variable 2016–2021 accounts for a decrease of 0.110% in the adolescent fertility rate and of 0.049% in the intermediate fertility rate during the period of interest. We believe that this variable may capture changes that occurred in those years or in previous years. Uruguay launched several public policies that could potentially affect fertility, especially adolescent fertility, such as the following: the Sexual and Reproductive Health Law (2008) (Ministerio de Salud Pública 2008), an expansion of the range of available contraceptives (including subdermal implants) from 2015 onward, and the creation of a network of sexual health service providers and the expansion of reproductive health services, including spaces for adolescents and the creation of a strategy for the prevention of unwanted adolescent pregnancies. The *p*-value of the dummy variable is above 0.1 for the late fertility rate, which may simply reflect that the aforementioned policies mainly targeted other groups. Regarding other temporal variables, the negative trend in the adolescent fertility rate (-0.010) and an increase in subsequent fertility rates in 2004 (0.064) stand out. The latter could have to do with the economic growth after the 2002 crisis. For instance, Uruguay's GDP grew by 11.1% in 2004 (Banco Central del Uruguay 2023).

According to Granger's (1969) causality criterion, we detect a bidirectional relationship between the adolescent fertility rate and the secondary school enrolment rate. Table A-6 shows that, in the past, the education variable was able to predict, in the Granger sense, the current rate of adolescent fertility and vice versa. This underlines the relevance of education as a policy measure to influence the adolescent fertility rate but not fertility across reproductive age stages.

Table 3: Estimation results of the ARDL model

	(I)	(II)	(III)
	Fertility rate (in logs) of women aged		
	15–19	20–29	30 and above
Error correction term	–0.175 (0.039) [0.000]	–0.254 (0.083) [0.005]	–0.194 (0.942) [0.028]
Long-run relationships			
$\log(\text{GDP per capita})_t$	0.060 (0.044) [0.174]	–0.022 (0.051) [0.664]	–0.165 (0.047) [0.001]
$\log(\text{Female employment rate})_t$	0.302 (0.076) [0.000]	0.229 (0.099) [0.027]	0.475 (0.108) [0.000]
$\log(\text{Female high school enrolment})_t$	0.295 (0.068) [0.000]	0.140 (0.068) [0.839]	–0.171 (0.055) [0.004]
$\log(\text{Infant mortality rate})_t$	0.054 (0.050) [0.286]	0.054 (0.050) [0.289]	0.080 (0.047) [0.096]
Short-run relationships			
$\Delta(\log(\text{Age-specific fertility rate}))_{t-1}$	0.454 (0.112) [0.000]	0.320 (0.165) [0.065]	
$\Delta(\log(\text{GDP per capita}))_t$		–0.127 (0.070) [0.077]	–0.171 (0.073) [0.023]
$\Delta(\log(\text{GDP per capita}))_{t-1}$			0.153 (0.079) [0.061]
$\Delta(\log(\text{Female high school enrolment}))_t$	0.050 (0.091) [0.584]	0.143 (0.078) [0.076]	0.146 (0.082) [0.087]
$\Delta(\log(\text{Female high school enrolment}))_{t-1}$	–0.379 (0.091) [0.000]		
Year 1996			0.021 (0.019) [0.304]
Year 2004			0.064 (0.021) [0.006]
Years 2016–2021	–0.110 (0.025) [0.000]	–0.049 (0.014) [0.001]	0.007 (0.014) [0.621]
Linear time trend	–0.009 (0.003) [0.003]	–0.004 (0.004) [0.240]	0.002 (0.003) [0.482]
No. of observations	52	42	42
Mean of dependent variable	61.868	108.882	41.268
ARDL model structure	(2,0,0,0,2)	(2,1,0,0,1)	(1,2,0,0,1)

Notes: Standard errors in parentheses and *p*-values in brackets. All the models include an intercept. The structures of the three models in the table are ARDL(2,0,0,0,2), ARDL(2,1,0,0,1), and ARDL(1,2,0,0,1), respectively.

Finally, to understand the relative importance of each factor in explaining the variability of the time series, we estimate impulse response functions (IRFs) of both the fertility rate and its determinants. IRFs describe the dynamic response of a system to a shock or impulse. It shows how the fertility reacts over time to a sudden change in one of its inputs. This information can be used to understand the transmission of shocks or policy interventions. Figure A-2 in the Appendix shows that an increase in high school enrolment is correlated with a decrease in fertility in the short run but that the strength of this association is relatively small and diminishes over time. However, the largest response corresponds to changes in fertility itself. These can be associated, for example, with shocks to fertility preferences or to fertility behaviour.[19]

As an alternative measure to the IRFs, we present the forecast error variance decomposition with different time horizons for each model in Tables A-7–A-9. The IRFs provide information on the dynamic response of the system but do not reveal the sources of variability in the time series. The main salient finding is that more than 75% of the variation in fertility in the long run is due to its own shocks rather than to its determinants. Anyway, it is worth highlighting the contribution of education by age group. Secondary school enrolment accounts for 10.8% of the variation in adolescent fertility in the first period, and the association vanishes over time. In contrast, for women aged 20 to 29 and those aged 30 and over, the initial contribution is very low but grows over time (more than 8% after eight time periods).

4.2 Panel-data department-level analysis

Table 4 shows the results of our fixed-effects panel-data analysis. The first column of the table presents the estimates of the model that includes both time and department fixed effects. The second one also includes region-specific linear-time trends to assess the robustness of the results. As above, our comments focus on those estimates whose *p*-values are below 0.1.

According to the estimation results, the share of women in each age group does not seem to play a role in fertility, except that of women aged 15 to 19. In this case, a one-percentage-point increase in the share of teenagers among women of fertile age raises adolescent fertility by more than four per thousand points. In the context of a declining proportion of adolescents and fertility rates in this age group, a negative coefficient would suggest that the reduction in adolescent fertility is more relevant than what would be expected based on population ageing alone. This finding may indicate that additional factors beyond demographic shifts, such as changes in social norms or increased access to contraception, are contributing to the decrease in adolescent fertility.

[19] In principle, in orthogonal IRFs, the results depend on the order in which one includes the variables in the model. In practice, however, they are similar in all cases in our analyses, irrespective of the order.

Age of women in conjugal unions is positively correlated with the fertility of women aged 20 to 29 and especially those aged 15 to 19. A one-percentage-point increase in the share of women who are married or in a union comes with a rise in fertility of almost one point per thousand points for teenagers and about half a point for women aged 25 to 29. For women aged 30 years old and over, the model with regional time trends identifies a negative relationship between this segment's share and their fertility. Although this finding is remarkable, this variable may capture couples' preferences regarding parenthood (e.g., delaying it for personal or professional reasons). In addition, individuals who marry at a later age are more likely to use contraceptive methods for family planning or health reasons.

The analysis also suggests that the average number of years of schooling leads to a reduction in teenage fertility. In the remaining cases, the impact of this variable either is very imprecise (p-value above 0.1) or is sensitive to the inclusion of regional trends.

Regarding the female employment rate, our results are consistent with those presented in the previous section. This variable is correlated with the fertility only of the oldest group of women. This pattern could have to do with the higher opportunity costs of having children and work–life balance problems for this demographic segment relative to the other, younger ones.

We employ the gender pay gap as an attempt to capture the relationship between women's reproductive and labour market behaviour and decisions. The lack of robustness of these results to the inclusion of regional linear time trends does not allow us to draw any relevant conclusions. Household income appears to exhibit a negative association on the fertility of all segments of women. Several factors may explain this result: higher child-rearing expenses as income rises (e.g., a greater use of private education), larger opportunity costs or even cultural beliefs about parenthood that differ by socio-economic level (e.g., better-off couples may decide to have a smaller number of children to gain more autonomy in their lives). An increase of 1,000 national currency units in household income is associated with a one-point-per-thousand reduction of the fertility of women aged 15 to 19 and 30 and over. The magnitude of this relationship is twice as large for women aged 20 to 29.

Last, infant mortality is positively associated with the fertility of women aged 20 to 29. The correlation is null for adolescents and sensitive to the inclusion of regional time trends for the oldest segment of females. In societies with high mortality rates, in the early stages of the demographic transition, one would expect a fall in infant mortality to precede the decline in fertility. This is not the case in Uruguay, where we therefore hypothesise that infant mortality may capture department-level differences in quality of life and access to health-care. Families in the territories with the best conditions on these dimensions might show an increased willingness to have children because they perceive better future life chances for their offspring.

The results of the model using Driscoll–Kraay standard errors are remarkably similar to those of our main specification (Table A-10).

Table 4: Estimation results of the panel-data model for regional fertility rates

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Fertility rate of					
	women aged 15–19		women aged 20–29		women aged 30 and above	
% of women in the age bracket	–4.336	–4.253	–0.410	–0.023	–0.012	0.045
	(1.036)	(0.909)	(0.884)	(0.798)	(0.457)	(0.347)
	[0.000]	[0.000]	[0.643]	[0.977]	[0.979]	[0.898]
% of women married (age-specific)	0.852	0.978	0.445	0.570	–0.086	–0.132
	(0.446)	(0.431)	(0.166)	(0.170)	(0.067)	(0.060)
	[0.057]	[0.024]	[0.007]	[0.000]	[0.204]	[0.027]
Average years of schooling (age-specific)	–4.341	–3.445	0.716	0.500	4.390	0.868
	(1.480)	(1.564)	(1.042)	(0.994)	(0.681)	(0.347)
	[0.003]	[0.028]	[0.492]	[0.615]	[0.000]	[0.152]
Age-specific female employment rate	0.108	0.077	0.099	0.017	–0.327	–0.150
	(0.066)	(0.065)	(0.074)	(0.068)	(0.064)	(0.049)
	[0.102]	[0.236]	[0.184]	[0.801]	[0.000]	[0.003]
Gender pay gap	9.676	4.113	0.839	–3.580	4.356	1.088
	(3.379)	(2.729)	(4.152)	(3.579)	(2.283)	(1.816)
	[0.004]	[0.132]	[0.840]	[0.318]	[0.057]	[0.549]
Average disposable income per capita	–0.001	–0.001	–0.002	–0.002	–0.001	–0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
	[0.302]	[0.010]	[0.000]	[0.000]	[0.064]	[0.002]
Infant mortality rate	–0.201	–0.159	–0.275	–0.244	–0.083	–0.112
	(0.110)	(0.102)	(0.110)	(0.097)	(0.062)	(0.053)
	[0.067]	[0.118]	[0.013]	[0.012]	[0.178]	[0.036]
Year fixed effects	✓	✓	✓	✓	✓	✓
Department fixed effects	✓	✓	✓	✓	✓	✓
Region-specific linear time trends		✓		✓		✓
R^2	0.866	0.885	0.943	0.951	0.678	0.799
No. of observations	684	684	684	684	684	684
Mean of dependent variable	61.718	61.718	107.679	107.679	41.283	41.283

Notes: Standard errors robust to heteroscedasticity and first-order autocorrelation in parentheses and *p*-values in brackets. All the models include an intercept.

5. Discussion

This study has examined a range of factors that influence fertility throughout the reproductive life, using time-series data from 1968 to 2021 and panel-data from regional statistical sources from 1984 to 2019. We have focused on fertility across three stages: adolescent (15 to 19 years), intermediate fertility (20 to 29 years), and late fertility (30 to 49 years). The analysis conducted in these pages has allowed testing some of the theoretical hypotheses put forward in the literature. In any case, we recommend caution in the interpretation, as we lack an experimental or quasi-experimental research design, the use of multiple methods, and remarkably long data series which enhances our understanding of fertility behaviour.

Compared to most Latin American and Caribbean countries, Uruguay has atypical characteristics. It underwent the first demographic transition at an early stage. For decades, it has had quite low fertility rates among women aged 20 and over but, until recently, experienced a relatively high teen birth rate, especially among women of low socio-economic status. Moreover, most births take place outside of marriage, against a background of rising divorce rates. These features have led some observers to suggest that the country is undergoing a second demographic transition.

In this paper, we use two different approaches to understand the main factors correlated with fertility. As discussed in Section 3, each method has both merits and shortcomings. In order to summarise and make sense of our results, we emphasise those findings supported by both econometric strategies and give less relevance to those where they conflict.

This work has considered a range of socio-economic indicators – GDP per capita and department-level average household income per capita – to test the relevance of some of the conventional structural or diffusion, maternal role incompatibility, and institutional theories. Specifically, the study has used two economic indicators that reflect the social and economic conditions that shape the lives of Uruguayan women. On the one hand, GDP per capita is a better approximation of economic cycles, although the literature suggests the existence of time lags and differences throughout a woman's reproductive cycle. On the other hand, departmental average per capita income better captures the actual appropriation of economic output by households.

Previous literature suggests that the relationship between the level of income or GDP per capita and fertility is complex. In the long term, one expects a negative association, but short-run shocks might shape this relationship, which may also vary by age group. In the time-series analysis, we have detected such differences between short- and long-run relationships only for the fertility of women aged 30 years old and above. The results of the panel-data econometric exercise (which does not allow us to distinguish between short- and long-term associations) indicate a negative association between income and fertility at all ages. These estimates may well capture greater availability of and access to contraceptive methods, greater educational opportunities, and an increase in the opportunity cost of having children. The work of Adsera and Menéndez (2011), which exploits a panel with 18 Latin American and Caribbean economies for the period 1950–2003, finds a pro cyclical pattern of fertility, but the control variables differ and their results capture an average (regional) effect.

Another relevant dimension that allows us to understand reproductive decisions is female employment because of the potential conflict between professional career and motherhood. The increase in women's employment may have a negative impact on fertility, as women might decide to postpone motherhood or reduce the number of children to prioritise their labour market performance. Contrary to expectations, our time-series analysis has shown a positive association between female employment and fertility. Nevertheless, the econometric exercise using regional data, which allows us to control for unobserved heterogeneity and age-specific female employment rates, has revealed a negative relationship. This result could reflect the opportunity costs of children, which raises the relevance of designing social protection policies that alleviate work–life balance problems, such as making affordable childcare widely available or providing appropriate parental leave. Our take on these results is coherent with the reading of previous works like Fernández-Soto, Pardo, and Pedetti (2020), Pardo and Varela (2013), and Peri and Pardo (2008).

The relationship between education and its impact on fertility has received extensive attention in the specialised literature. Overall, existing studies suggest a negative association between schooling levels and fertility for a variety of reasons, ranging from greater access to information, better job opportunities, or changes in culture, social norms, or preferences for motherhood. Our results have confirmed this relationship, particularly in the case of adolescent fertility. The possibility of curbing teenage motherhood by expanding education has emerged as a clear policy implication of this analysis. This finding is consistent with the interpretation of authors like Fernández-Soto, Pardo, and Pedetti (2020) or Varela Petito, Tenembaum, and Lara (2014), who consider that the resistance of adolescent fertility to decline has had to do with the persistence of low educational attainment among some population strata.

Given Uruguay's stage of the demographic transition, as argued above, one should expect a positive or null relationship between fertility and infant mortality. However, our results for this variable are not robust across estimation methods and analysed periods. This lack of conclusiveness in our findings could indicate that this variable reflects characteristics related to economic conditions and health-care that are not captured by other covariates. Therefore, we should not rule out endogeneity problems, and we should remind the reader that our results identify associations that are not necessarily causal (even though they at least have a relevant descriptive value). Our results are not totally at odds with the work of Palloni and Rafalimanana (1999). These authors find only modest support for the hypothesis of a positive effect of child mortality on fertility in the region.

The percentage of women in a union or married – available only for the panel-data analysis – seems to play a positive role in the case women aged 15 to 19 and 20 to 29 years. This result dialogues well with the previous literature for the region (Esteve, López-Ruiz, and Spijker 2013; Esteve and Florez-Paredes 2018). Those studies demonstrate that, at a macro level, the significant expansion of education in Latin America and the Caribbean over recent decades has paradoxically coincided with a certain stability in the age at which individuals marry or enter into consensual unions. This could suggest that union and cohabitation neutralise the negative impact of educational attainment on fertility.[20]

The sizeable fall in births in recent years – especially among teenagers – might also have been the consequence of different national policies implemented since 2008. Such government initiatives include the 2008 health-care reform (which moved health-care towards an integrated system), a new law on sexual and reproductive health in 2008, the setting of health-care targets related to teenagers in 2010, the expansion of contraceptive methods fully or heavily subsidised by the health-care system in 2011, the decriminalisation of abortion in 2012, initiatives to promote youth participation in civic life in 2014, or the rollout of a new strategy to prevent teenage pregnancy in 2016. Whereas these policies have received a great deal of attention in various studies demonstrating their relevance (see, e.g., Antón, Ferre, and Triunfo [2018], Cabella and Velázquez [2022], Balsa and Triunfo [2021], Ceni et al. [2021] or Ferre, Triunfo, and Antón [2023]), our research design, constrained by the number observations and the contemporaneous nature of the mentioned interventions, cannot adequately include them in the analysis and disentangle their causal effects. Therefore, they should be the object of subsequent separate research works.

Finally, apart from the convenience of interpreting our findings with caution (given that causality is not granted), one should bear in mind several limitations of our analysis. First, the time-series and the panel-data analyses consider different time frames (1968–2021 and 1984–2020, respectively). Second, the operationalisation of some variables is imperfect (e.g., in the time-series analysis, we cannot have age-specific data, and we compute some covariates from household surveys). Last, we recommend the reader to take the implications of our findings for policy with a grain of salt. Our results apply to Uruguay, a very specific national context, so their external validity is limited. Given the very heated contemporary debate on fertility interventions, we suggest caution when interpreting our results.

[20] Note that this does not mean that, other things being equal, the marginal effect of each is variable relevant (i.e., our findings).

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7. Data availability statement

The data used in this study primarily come from surveys that were processed under strict confidentiality protocols and acquired through the signing of requisite contracts. However, for transparency and reproducibility, the data-set and Stata code necessary to replicate the findings is accessible upon request from Zuleika Ferre:
zuleika.ferre@cienciassociales.edu.uy.

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Appendix

Figure A-1: Time series of the variables used in the time-series analysis (1968–2021)

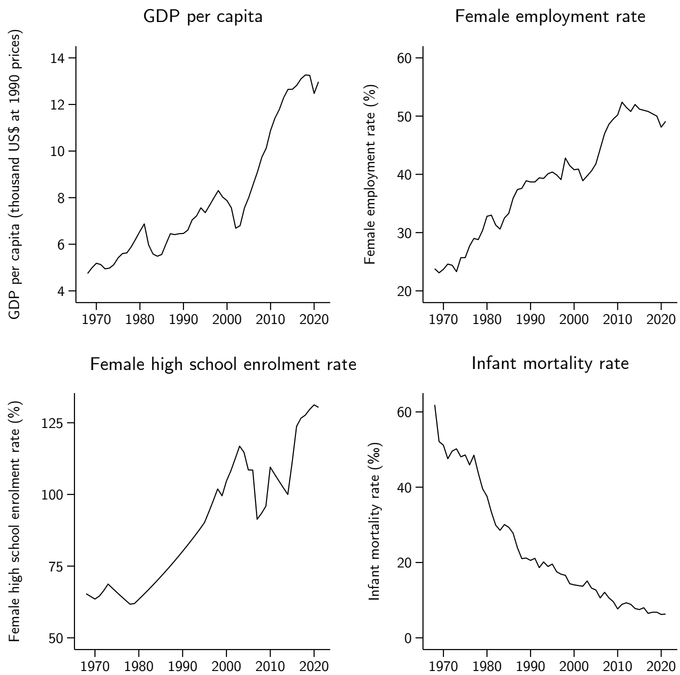


Table A-1: Results of unit-root tests

	In levels				In first differences			
	ADF test		PP test		ADF test		PP test	
	t	*p*-value	*t*	*p*-value	*t*	*p*-value	*t*	*p*-value
log (Fertility 15–19)	5.475	1.000	3.250	1.000	–2.871	0.049	–2.856	0.051
log (Fertility 20–29)	2.333	0.999	1.656	0.998	–3.680	0.004	–3.700	0.004
log (Fertility 30+)	0.412	0.982	–0.032	0.956	–4.647	0.000	–4.630	0.000
log (GDP per capita)	0.424	0.982	0.139	0.969	–5.109	0.000	–5.043	0.000
log (Employment rate)	–1.639	0.463	–1.639	0.463	–6.962	0.000	–6.969	0.000
log (Enrolment rate)	–0.089	0.951	–0.208	0.938	–5.777	0.000	–5.729	0.000
log (Infant mortality)	0.422	0.982	0.836	0.992	–9.662	0.000	–9.907	0.000

Notes: The results correspond to models with a constant and without a linear time trend. They remain the same when a linear time trend is included.

Table A-2: Results of Johansen test for cointegration

	Fertility rate of women aged					
	15–19		20–29		30 and above	
	Statistic	5% critical value	Statistic	5% critical value	Statistic	5% critical value
Trace						
Rank = 0	72.235	68.52	79.843	68.52	80.780	68.52
Rank = 1	41.241	47.21	45.862	47.21	50.889	47.21
Rank = 2	19.058	29.68	25.459	29.68	27.221	29.68
Rank = 3	5.535	15.41	10.221	15.41	11.291	15.41
Rank = 4	0.106	3.76	0.012	3.76	0.309	3.76
Maximum eigenvalue						
Rank = 0	30.993	33.46	33.982	33.46	29.891	33.46
Rank = 1	22.183	27.07	20.403	27.07	23.668	27.07
Rank = 2	13.523	20.97	15.238	20.97	15.930	20.97
Rank = 3	5.429	14.07	10.209	14.07	10.983	14.07
Rank = 4	0.106	3.76	0.012	3.76	0.309	3.76

Note: If rank = 0, there is no cointegration relationship; if rank = 1, there is at least one cointegration relationship, and so on.

Table A-3: Results of the Engle and Granger test for cointegration

	Fertility rate of women aged					
	15–19		20–29		30 and above	
	t-statistic	*p*-value	*t*-statistic	*p*-value	*t*-statistic	*p*-value
ADF test	–3.841	0.015	–3.941	0.011	–4.836	0.000
PP test	–3.867	0.014	–3.936	0.011	–4.830	0.000

Figure A-2: Cumulative sum of squares tests for parameter stability

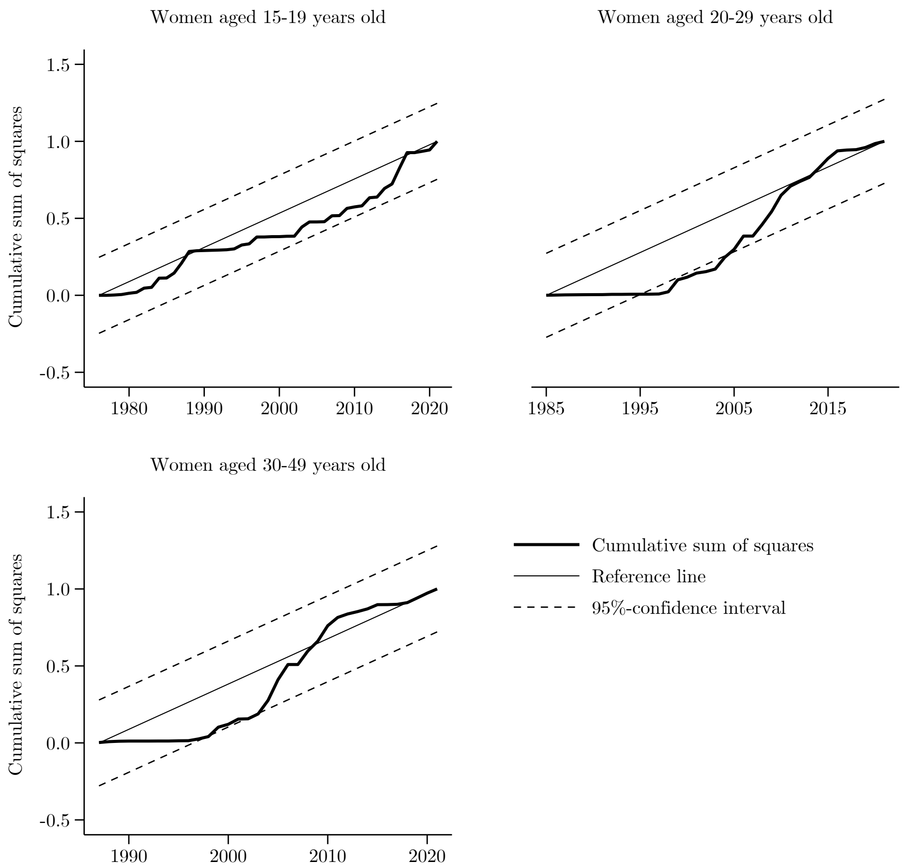


Table A-4: Results of Pesaran, Shin, and Smith test for cointegration

	Fertility rate of women aged		
	15–19	**20–29**	**30 and above**
F-statistic	6.242	3.138	3.968
p-value $I(0)$	0.003	0.113	0.001
p-value $I(1)$	0.016	0.310	0.005
t-statistic	4.452	3.043	1.594
p-value $I(0)$	0.004	0.106	0.307
p-value $I(1)$	0.045	0.353	0.606
Residual degrees of freedom	41	31	29
Model degrees of freedom	10	10	12
No. of observations	52	42	42
ARDL model structure	(2,0,0,0,2)	(2,1,0,0,1)	(1,0,0,0,1)

Table A-5: Results of tests of goodness of fit

	Fertility rate of women aged					
	15–19		20–29		30 and above	
	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
First-order autocorrelation test (Breusch–Godfrey)	2.163	0.149	0.410	0.527	1.570	0.220
First-order autocorrelation test (Durbin–Watson)	1.736	0.195	0.295	0.591	1.099	0.303
Heteroscedasticity test (White)	52.000	0.435	42.000	0.427	43.000	0.428
Heteroscedasticity test (Breusch–Pagan/Cook–Weisberg)	0.934	0.334	0.511	0.475	0.034	0.854
Normality test (D'Agostino et al.)	0.750	0.703	2.773	0.250	0.033	0.984

Note: The structures of the three models in the table are ARDL(2,0,0,0,2), ARDL(2,1,0,0,1), and ARDL(1,2,0,0,1), respectively.

Table A-6: Results of the Granger causality test

Equation		Women aged 15–19 χ^2	*p*-value	20–29 χ^2	*p*-value	30 and above χ^2	*p*-value
Δ log (Age-specific fertility rate)	Δ log (GDP per capita)	15.615	0.458	33.945	0.183	42.661	0.118
	Δ log (Female employment rate)	17.935	0.408	21.669	0.338	38.644	0.145
	Δ log (Female high school enrolment)	19.616	0.000	40.911	0.129	37.947	0.150
	Δ log (Infant mortality rate)	21.393	0.343	0.431	0.806	0.525	0.769
	All variables	36.464	0.000	14.113	0.079	11.990	0.152
Δ log (GDP per capita)	Δ log (Age-specific fertility rate)	0.547	0.761	0.464	0.793	2.256	0.324
	Δ log (Female employment rate)	0.172	0.918	0.126	0.939	0.406	0.816
	Δ log (Female high school enrolment)	0.686	0.710	0.652	0.722	0.699	0.705
	Δ log (Infant mortality rate)	16.503	0.438	14.417	0.486	14.225	0.491
	All variables	37.333	0.880	32.151	0.920	5.123	0.744
Δ log (Female employment rate)	Δ log (Age-specific fertility rate)	25.952	0.273	21.591	0.340	13.927	0.498
	Δ log (GDP per capita)	12.059	0.002	46.594	0.097	45.657	0.102
	Δ log (Female high school enrolment)	48.206	0.090	55.275	0.063	52.908	0.071
	Δ log (Infant mortality rate)	43.433	0.114	36.131	0.164	45.316	0.104
	All variables	19.084	0.014	12.498	0.130	11.552	0.172
Δ log (Female high school enrolment)	Δ log (Age-specific fertility rate)	74.073	0.025	21.333	0.344	22.475	0.325
	Δ log (GDP per capita)	16.055	0.448	0.213	0.899	0.185	0.912
	Δ log (Female employment rate)	18.124	0.404	2.603	0.272	23.554	0.308
	Δ log (Infant mortality rate)	0.765	0.682	26.545	0.265	24.514	0.294
	All variables	16.228	0.039	93.533	0.313	94.861	0.303
Δ log (Infant mortality rate)	Δ log (Age-specific fertility rate)	18.037	0.406	72.559	0.027	31.317	0.209
	Δ log (GDP per capita)	35.062	0.173	16.784	0.432	0.592	0.744
	Δ log (Female employment rate)	0.494	0.781	0.969	0.616	1.575	0.455
	Δ log (Female high school enrolment)	0.547	0.761	1.200	0.549	0.337	0.845
	All variables	92.138	0.325	16.008	0.042	11.151	0.193

Notes: The degrees of freedom refer to the number of constraints in the model (two in the case of the rows due to individual variables and eight in the case of the ones due to all variables) .

Table A-7: Variance decomposition of VAR model for fertility rate of women between 15 and 19 years old

Time period	log (Fertility rate 15–19)	log (GDP per capita)	log (Female employment rate)	log (Female high school enrolment)	log (Infant mortality rate)
1	1.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	0.766	0.050	0.031	0.108	0.044
	(0.090)	(0.051)	(0.035)	(0.060)	(0.046)
3	0.751	0.083	0.052	0.084	0.030
	(0.103)	(0.073)	(0.051)	(0.056)	(0.030)
4	0.760	0.082	0.052	0.079	0.027
	(0.115)	(0.082)	(0.055)	(0.059)	(0.029)
5	0.764	0.078	0.055	0.074	0.029
	(0.115)	(0.076)	(0.060)	(0.057)	(0.025)
6	0.767	0.077	0.055	0.073	0.029
	(0.115)	(0.073)	(0.061)	(0.056)	(0.024)
7	0.767	0.076	0.055	0.072	0.030
	(0.116)	(0.073)	(0.062)	(0.056)	(0.024)
8	0.768	0.076	0.055	0.071	0.030
	(0.117)	(0.073)	(0.062)	(0.056)	(0.024)

Note: Standard errors in parentheses.

Table A-8: Variance decomposition of VAR model for fertility rate of women between 20 and 29 years old

Time period	log (Fertility rate 20–29)	log (GDP per capita)	log (Female employment rate)	log (Female high school enrolment)	log (Infant mortality rate)
1	1.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	0.955	0.001	0.012	0.024	0.008
	(0.036)	(0.007)	(0.016)	(0.025)	(0.015)
3	0.929	0.005	0.013	0.049	0.005
	(0.062)	(0.013)	(0.023)	(0.050)	(0.011)
4	0.901	0.017	0.012	0.064	0.006
	(0.088)	(0.036)	(0.026)	(0.067)	(0.016)
5	0.876	0.032	0.011	0.073	0.008
	(0.109)	(0.057)	(0.028)	(0.077)	(0.020)
6	0.860	0.041	0.011	0.079	0.000
	(0.122)	(0.070)	(0.029)	(0.083)	(0.023)
7	0.850	0.046	0.010	0.083	0.010
	(0.132)	(0.078)	(0.030)	(0.089)	(0.025)
8	0.843	0.050	0.010	0.087	0.010
	(0.140)	(0.084)	(0.031)	(0.093)	(0.026)

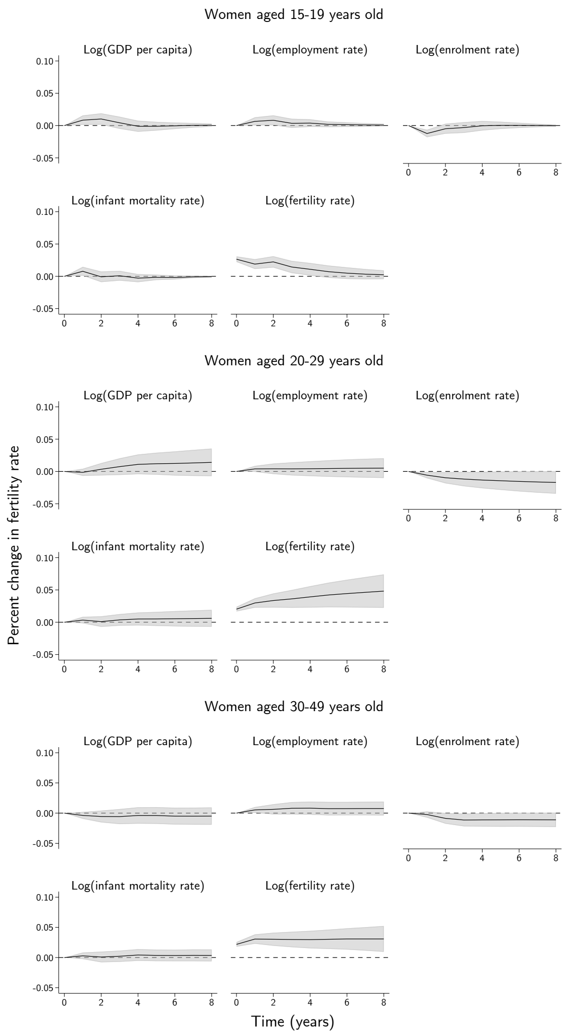
Note: Standard errors in parentheses.

Table A-9: Variance decomposition of VAR model for fertility rate of women 30 years or more

Time period	log (Fertility rate 30 or more)	log (GDP per capita)	log (Female employment rate)	log (Female high school enrolment)	log (Infant mortality rate)
1	1.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2	0.962	0.010	0.019	0.004	0.006
	(0.033)	(0.018)	(0.021)	(0.010)	(0.013)
3	0.920	0.018	0.027	0.032	0.004
	(0.068)	(0.035)	(0.036)	(0.041)	(0.011)
4	0.881	0.021	0.036	0.057	0.004
	(0.100)	(0.046)	(0.051)	(0.064)	(0.013)
5	0.862	0.020	0.042	0.070	0.007
	(0.119)	(0.048)	(0.062)	(0.077)	(0.020)
6	0.853	0.018	0.043	0.078	0.007
	(0.129)	(0.049)	(0.067)	(0.084)	(0.023)
7	0.847	0.019	0.044	0.082	0.008
	(0.135)	(0.053)	(0.070)	(0.089)	(0.024)
8	0.842	0.019	0.045	0.085	0.008
	(0.141)	(0.056)	(0.073)	(0.092)	(0.026)

Note: Standard errors in parentheses.

Figure A-3: Impulse response functions to a one-standard-deviation shock to covariates and fertility itself



Note: The grey-shaded areas indicate 90% confidence intervals.

Table A-10: Estimation results of panel-data model for regional fertility rates with Driscoll–Kraay standard errors

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Fertility rate of					
	women aged 15–19		women aged 20–29		women aged 30 and above	
% of women in the age bracket	-4.336	–4.253	-0.410	–0.023	-0.012	0.045
	(1.509)	(1.081)	(1.051)	(0.744)	(0.572)	(0.455)
	[0.007]	[0.000]	[0.699]	[0.975]	[0.983]	[0.922]
% of women married (age-specific)	0.851	0.978	0.445	0.570	-0.086	–0.132
	(0.449)	(0.387)	(0.139)	(0.123)	(0.064)	(0.049)
	[0.066]	[0.016]	[0.003]	[0.000]	[0.185]	[0.011]
Average years of schooling (age-specific)	-4.341	–3.445	0.716	0.500	4.390	0.868
	(1.652)	(1.678)	(1.164)	(1.181)	(0.969)	(0.723)
	[0.013]	[0.048]	[0.543]	[0.674]	[0.000]	[0.238]
Age-specific female employment rate	0.108	0.077	0.099	0.017	-0.327	–0.150
	(0.057)	(0.058)	(0.060)	(0.060)	(0.087)	(0.059)
	[0.066]	[0.196]	[0.104]	[0.775]	[0.001]	[0.016]
Gender pay gap	9.676	4.113	0.839	–3.580	4.356	1.088
	(3.927)	(3.190)	(2.113)	(4.094)	(2.244)	(1.872)
	[0.019]	][0.206]	[0.872]	[0.388]	[0.060]	[0.565]
Average disposable income per capita	-0.001	–0.001	-0.002	–0.002	-0.001	–0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
	[0.455]	[0.046]	[0.006]	[0.001]	[0.279]	[0.030]
Infant mortality rate	-0.201	–0.159	-0.275	–0.244	-0.083	–0.112
	(0.149)	(0.132)	(0.053)	(0.112)	(0.056)	(0.051)
	[0.185]	[0.235]	[0.069]	[0.037]	[0.147]	[0.034]
Year fixed effects	✓	✓	✓	✓	✓	✓
Department fixed effects	✓	✓	✓	✓	✓	✓
Region-specific linear time trends		✓		✓		✓
R^2	0.866	0.885	0.943	0.951	0.678	0.799
No. of observations	684	684	684	684	684	684
Mean of dependent variable	61.718	61.718	107.679	107.679	41.283	41.283

Notes: Standard errors robust to heteroscedasticity, first-order autocorrelation and cross-sectional dependence in parentheses and *p*-values in brackets. All the models include an intercept.