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# Fertility, economic development, and remittances in post-communist times

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**ABSTRACT**

This study investigates fertility responses to remittances across developed and developing countries in post-communist times. We first collected fertility, remittances, and income statistics over the 1995–2020 period and created a new vulnerability index that identifies less economically developed states with high fertility rates and dependent on remittances. We then examined the global fertility effects of remittances between 1995 and 2015 via Ordinary Least Squares, Fixed Effects, and Instrumental Variable estimation methods. The baseline regression results suggest that the relationship between remittances and fertility rates of remittances-receiving countries is generally inverse. We also found that the fertility-reducing power of remittances is heterogeneous worldwide. To illustrate the findings, we constructed two heat maps for 196 countries. The first one depicts the distribution of the vulnerability index, and the second one is dedicated to variations in the fertility effects of remittances across countries based on the vulnerability index.

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Fertility rate; international migration; remittances; economic development

## 1. Introduction

As the world becomes more globalized and unified, an increasing number of people pursuing a better life are choosing to become migrants. It is thus not surprising that the international migration stock has been constantly increasing, comprising 280 million people in 2020 (IOM, 2021). Consequently, migrants and the households they left behind often live between countries as transnational families. An integral feature of this lifestyle is related to cash and in-kind transfers, typically known as remittances, sent by migrants to their children, spouses, and parents. At the country level, remittances have exceeded official development assistance and foreign direct investment, becoming an essential source of external finance (UN, 2020). Remittances also became an effective coping strategy for households in developing countries: Adams and Page (2005), based on data from 71 low- and middle-income countries, demonstrate that increased levels of international remittances are associated with a significant decline in poverty. Considering the significance of remittances at both the country- and individual levels, there is a more general question of how remittances affect the socio-economic behavior of those who receive these transfers.

Although numerous studies have been devoted to various impacts of migration, the existing literature fails to provide a conclusive answer on how migration affects the development process. The classical and neoclassical migration paradigms of Ravenstein (1885) and Lewis (1954) incorporate migration into the process of transition from a less advanced to a more developed state. The decisions of migrants, mainly determined by economic reasons, were considered a crucial element of convergence between regions. As summarized by King (2018), a source country could expect to benefit from emigration due to the elimination of excess labor supply, multiple positive effects of remittances, and technological know-how induced by return and circular migrants.

Conversely, migration literature is also characterized by a pessimistic view on the possible alterations caused by migration since they might lead to economic dependency and stunted development in migrant-sending regions (Bohra-Mishra, 2013). The mechanisms behind the adverse effects of migration can be found in the cumulative causation theory of Myrdal (1957), where it is shown that core countries capture human capital and subvert the economic prospects of peripheries. In this case, migration exerts only short-term positive effects via increased financial transfers and causes long-term losses to the economic productivity of migrant-sending regions. Source countries with high emigration are thus predicted to

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eventually become reliant on remittances and trapped in the vicious cycle of poverty (Nzima et al., 2016).

According to De Haas (2012), heterogeneity in the migration-development nexus can be described as a 'pendulum'. More specifically, by investigating the long history of development-related migration studies, the author suggests that the times of positive or negative effects of remittances can be linked to historical events and ideological shifts. Similarly, Gamlen (2014) considers paradigmatic changes in migration studies, starting from the optimism of the post-World War II period to the skepticism of the early 1970s and back to even more optimistic views of the early 2000s, and proposes that this relationship might be determined by economic cycles to a certain extent. In the years when the economy is performing well, scholars and policymakers might be unwilling to consider the adverse effects of remittances, while in the crisis years, skepticism might be preventing them from considering the positive transformations associated with migration.

Given the indeterminacy in the theoretical literature, empirical studies tend to investigate the impact of migration on specific aspects of development over specific periods rather than concentrating on economic development as a whole. The purpose of this study is to investigate the impact of international remittances on one of the central socio-economic issues, fertility trends in post-communist times. To do so, we apply Ordinary Least Squares (OLS), Instrumental Variable (IV), and Fixed Effects (FE) estimation methods to macroeconomic data over the 1995–2015 period. The results of this study mainly contribute to the migration literature by establishing that the global effects of remittances are negative in the post-communist era. Moreover, the previous studies tend to consider the aggregate effects of remittances, and we also contribute to the literature by demonstrating that the fertility responses to remittances are heterogeneous across the world. Finally, we contribute to the cartographic literature by creating global heat maps that identify less and more vulnerable countries based on the newly proposed vulnerability index and how remittances affect fertility in these countries.

The rest of the paper proceeds as follows. Section 2 reviews the related literature. Section 3 provides a brief description of the vulnerability index. Section 4 presents the results of econometric estimations. Section 5 describes the magnitude of the fertility effects of remittances around the globe and presents two global heat maps. Section 6 concludes.

## 2. Related literature

Migration and remittances may affect fertility patterns in several ways. First, remittances increase household income, which in turn creates a quantity-quality dilemma of having more or fewer children (Anwar & Mughal, 2016). In this case, we should consider the fertility effects of remittances in terms of income and substitution effects (Becker, 1960). The decision of households about how to use remittances might determine which of the effects is more pronounced. For instance, remittances might be used to finance the education of children (Demurger & Wang, 2016), or additional income might be used for conspicuous consumption, such as excessive wedding celebrations (Danzer et al., 2013). More generally, it was previously assumed that the relationship between fertility and economic development is negative (Fox et al., 2018). Due to higher opportunity costs of childbearing (Becker, 1960) or changes in order needs (Lesthaeghe, 2010), fertility was typically expected to decrease as nations progressed. Nevertheless, another, more recent strand of the literature suggests that fertility and development trends could co-move (e.g., Esping-Andersen & Billari, 2015). This ideological transition could possibly be caused by changes in the numbers of migrants and volumes of remittances in the post-communist era. Thus, the direction of the income effects of remittances on fertility might be period-specific.

Migration is also characterized by social remittances, new values, possibly towards fertility, transferred from host countries that modify the attitudes of people in source countries (Levitt, 1998). These changes are not necessarily positive, as exposure to migration might result in the disruption of traditional kinship systems and care structures (De Haas, 2010). In addition, migration might be associated with a spatial relocation of large numbers of people, causing changes in the structure of the population and fertility patterns (McKenzie, 2008). Finally, remittances can fasten the process of demographic transition (Fargues, 2018). In lower-income, migrant-sending communities, households might be able to achieve the preferred number of children with lower birth rates due to incidental economic advancements brought about by remittances.

Despite the multiplicity of the remittances-fertility nexus, the number of studies on this topic is not substantial; more importantly, most previous research has been regionally constrained (Anwar & Mughal, 2016; Katz & Stark, 1986; Mughal & Anwar, 2014; Naufal & Vargas-Silva, 2009). Generally, existing studies tend to confirm that the relationship between remittances and fertility is inverse; however, they diverge in the arguments provided to explain the results obtained. In particular, Anwar and Mughal (2016) highlight the financial effects of remittances as a critical mechanism by which fertility rates are altered. Conversely, according to Katz and Stark (1986) and Naufal and Vargas-Silva (2009), the relationship

between remittances and fertility is mainly determined by the motives for sending remittances and the changes in norms and attitudes of households. Finally, we should mention the cross-national study of Beine et al. (2013), where the authors investigate the fertility effects of remittances in a sample of 145 countries for the years between 2000 and 2005 based on the concept of fertility norms diffusion. The authors propose a test of the diffusion of fertility norms and find that a decrease in the fertility norm to which migrants are exposed is associated with a decrease in their home country's fertility.

## 3. Vulnerability index

To investigate the relationship between fertility, economic development, and remittances, we constructed a sample based on the data for these variables sourced from cross-national databases collected by the World Bank for 196 countries in the 1995–2020 period. The selection of countries is not geographically constrained; only the countries with missing statistics on remittances are omitted.[1] The choice of the time interval is also not arbitrary: the 1990s were marked by the establishment of new states and the integration of their economies into the global markets, turning migration into a worldwide phenomenon.

Following conventional practice, we proxy fertility patterns by total fertility rate (births per woman). For a remittance variable, it is possible to consider remittances in relative or absolute terms. Another concern is whether to investigate per capita or aggregated values of remittances. To capture both financial effects and the significance of remittances for the economy of countries, we proxy the remittance variable by the remittances-to-GDP ratio (total amount of remittances officially received relative to GDP).[2] Fertility and remittance variables are based on the averaged data over 1995-2020. It is generally assumed that various economic development settings can be characterized by or result from different income levels. Thus, we proxy economic development by the World Bank income classification (4 income groups – low, lower-middle, upper-middle, and high) and similarly consider the 1995–2020 period. Since the income variable is categorical and comprises 4 categories, we assign a numerical value to each category from 1 to 4. Then, we average data over the years and round obtained values to the closest integer value. Each averaged income group is comprised of 42, 55, 44, and 52 countries respectively. To make the fertility and remittance variables comparable to the income variable, we sort the data for these variables in ascending order and assign countries into 4 groups in almost equal proportions. The number of countries per group based on the remittance variable is 49. Regarding fertility-based division, the number of countries is 48, 49, 49, and 48.

**Table 1.** Vulnerability index.

| Baseline grouping | Number of countries | Vulnerability level | Number of countries |
|---|---|---|---|
| −6 | 7 | Very high | 28 |
| −5 | 21 | | |
| −4 | 21 | High | 51 |
| −3 | 15 | | |
| −2 | 15 | | |
| −1 | 15 | Medium | 40 |
| 0 | 8 | | |
| 1 | 17 | | |
| 2 | 14 | Low | 43 |
| 3 | 14 | | |
| 4 | 15 | | |
| 5 | 21 | Very low | 34 |
| 6 | 13 | | |

As a final step, we build a composite index that captures the indeterminacy of the migration-development nexus and identifies vulnerable states based on fertility, income, and remittances. To do so, we assign negative values of −2 and −1 each time if a country belongs to the lowest and pre-lowest fertility, income, and remittance groups. Similarly, positive values of 1 and 2 are assigned to countries in the opposite distribution tails of the fertility, income, and remittance variables. Then, we sum previously assigned numerical values for each country and build an index of vulnerability that varies between −6 and 6. Finally, we transform the index into a 1-to-5 scale by merging interim groups, as shown in Table 1. The table also demonstrates the initial and final distributions of the index.

## 4. Econometric analysis

### 4.1. Baseline results

To capture a correlation between fertility and remittances, we first estimate a basic OLS regression based on averaged cross-country data. In addition to remittances, we model fertility as a function of several control variables. The descriptive statistics for the used variables are presented in Table 2. Due to missing data on control variables and to achieve higher comparability between the remittance and 2005 passport cost (used as an instrument in the subsequent estimation) variables, we restrict the sample to 158 countries over the period between 1995 and 2015. The selection of controls is motivated by the studies of Anwar and Mughal (2016) and Wang and Sun (2016). These variables can be categorized into factors that affect the desired fertility level and capture transformations associated with demographic transition, economic development proxies, and empowerment indicators.

Table 3 presents the results of the estimations. In the first estimation column, we present the

**Table 2.** Descriptive statistics.

| Variable | Description | Source | Mean | St. Dev. |
|---|---|---|---|---|
| Fertility | Total fertility rate, births per woman | World Development Indicators | 3.08 | 1.57 |
| Remit/GDP | Personal transfers (cash or in kind) and compensation of employees received as % of GDP | World Development Indicators | 4.41 | 6.49 |
| Contraceptive | Contraceptive prevalence % for women ages 15-49, any methods | World Development Indicators | 49.80 | 21.63 |
| LEB | Life expectancy at birth, total (years) | World Development Indicators | 67.80 | 9.01 |
| FLFP | Female labor force participation rate as % of female population ages 15+, national estimate | World Development Indicators | 50.32 | 15.25 |
| ln(Income) | Natural logarithm of real GDP per capita based on PPP | World Development Indicators | 8.88 | 1.11 |
| Education | Primary school gross enrollment % | World Development Indicators | 102.25 | 13.64 |
| Urban | Urban population as % of total population | World Development Indicators | 51.62 | 21.49 |
| Democracy | Composite score of political rights and civil liberties from 1 (free) to 7 (not free) | Freedom in the World | 3.28 | 1.79 |
| Mortality | Number of infant deaths per 1,000 live births | UNICEF Data | 34.27 | 27.76 |
| ln(Consumption) | Natural logarithm of real consumption per capita, national prices | Penn World Table | 8.55 | 1.06 |
| Human capital | Composite index based on years of schooling and returns to education | Penn World Table | 2.33 | 0.68 |
| Income group | World Bank country and lending groups, ranging from low (1) income to high (4) income | World Bank | 2.09 | 0.62 |
| Passport/GDP pc | Costs of obtaining a passport as % of GDP per capita in 2005 | Passport Cost Data | 4.11 | 9.08 |

Note: except for passport costs, the statistics are averaged over the 1995–2015 period.

regression in which the treated and outcome variables are log-transformed, while the non-transformed version of the regression is presented in the second estimation column. More specifically, the level specification indicates that a percentage point increase in the remittances-to-GDP ratio is expected to decrease fertility by nearly 0.03. Based on the logarithmic specification, a one percent increase in the remittances-to-GDP ratio is expected to decrease fertility by nearly 0.05%. Overall, the logarithmic and level specifications yield comparable and statistically significant estimates; for interpretation purposes, the latter version is considered in further analyses. The relationship between fertility and the main control variables is in line with expectations: the effects of average income, contraceptive prevalence, and labor force participation of women are inverse, while an increase in infant mortality is associated with increased fertility.

When the coefficients are standardized in the third estimation column of Table 3, the impact of remittances is less prominent than of income per capita, mortality, and contraceptive prevalence but slightly

**Table 3.** Baseline regressions.

| | ln(Fertility) | Fertility | Fertility | Fertility | Fertility |
|---|---|---|---|---|---|
| ln(Remit/GDP) | −0.047*** | | | | |
| | (0.015) | | | | |
| Remit/GDP | | −0.028*** | −0.113 | −0.117** | −0.020** |
| | | (0.010) | | (0.057) | (0.009) |
| Contraceptive | −0.007*** | −0.023*** | −0.320 | −0.029*** | −0.021*** |
| | (0.002) | (0.005) | | (0.009) | (0.003) |
| Democracy | −0.010 | −0.048 | −0.054 | −0.056 | −0.065** |
| | (0.012) | (0.038) | | (0.057) | (0.025) |
| LEB | −0.010 | −0.026* | −0.145 | −0.015 | −0.053*** |
| | (0.012) | (0.015) | | (0.027) | (0.010) |
| FLFP | −0.006*** | −0.010** | −0.098 | −0.013 | |
| | (0.001) | (0.004) | | (0.009) | |
| ln(Income) | −0.192*** | −0.440*** | −0.306 | −0.821*** | |
| | (0.038) | (0.111) | | (0.265) | |
| ln(Consumption) | | | | | 0.451*** |
| | | | | | (0.127) |
| Mortality | 0.005** | 0.018** | 0.318 | 0.012 | 0.001 |
| | (0.002) | (0.007) | | (0.012) | (0.001) |
| Education | 0.003** | −0.000 | −0.004 | 0.005 | |
| | (0.001) | (0.005) | | (0.009) | |
| Human capital | | | | | −0.447* |
| | | | | | (0.247) |
| Urban | 0.0003 | 0.003 | 0.042 | 0.004 | −0.023*** |
| | (0.001) | (0.004) | | (0.005) | (0.008) |
| | | | | Remit/GDP | |
| Passport/GDP pc | | | | −0.172** | |
| | | | | (0.078) | |
| Estimation method | OLS | OLS | OLS | IV | FE |
| Observations | 158 | 158 | 107 | 107 | 591 |
| $R^2$ | 0.817 | 0.836 | 0.836 | 0.744 | 0.672 |
| Endog. test, *p*-value | | | | 0.026** | |
| Weak IV test, *p*-value | | | | 0.040** | |

Note: robust standard errors in parentheses, ***$p<0.01$, **$p<0.05$, *$p<0.1$. The variables in the first and last two estimation columns are unstandardized, while the variables in the third estimation column are standardized. The endogeneity test is the robust regression-based test, and the weak IV test is the Wald test.

more pronounced than of female labor force participation.[3] We can also mention that the effects of life expectancy and primary education vary across specifications. In contrast, the estimates for urban population and democracy are statistically insignificant in both specifications. Overall, the explanatory power of the selected variables is assumably strong, given a high value of the regression's coefficient of determination.

In the upper panel of Figure 1, we illustrate the fertility-reducing effects of remittances in binned scatter plots. This figure non-parametrically plots the average fertility value for each remittance value after controlling for the effects of control variables. Each of the 20 bins in the graph corresponds to nearly 8 countries and indicates that neither outliers nor functional form cause the relationship between remittances and fertility.

The OLS estimations might be affected by endogeneity. The remittance variable is typically endogenous in relation to fundamental macroeconomic variables due to a variety of reasons such as reverse causality or omitted variable biases.[4] To recover exogenous variation in the remittances-to-GDP ratio, we use the costs of obtaining a passport as an instrument in the IV regression in the fourth estimation column. Extra costs are expected to decrease the number of people who can migrate and, thus, the amounts of remittances sent by international migrants (Koechlin & Leon, 2007). As for the 'randomness' of the instrument, it is plausible to assume that passport costs and fertility rates are uncorrelated at the country level after conditioning on economic development. The first-stage results are in line with predictions and indicate that the remittances-to-GDP ratio decreases as passport costs increase.[5] When we consider the second-stage regression, the results confirm the fertility-reducing effects of remittances. However, the instrumented estimate for the remittance variable is more than 4 times as large as its baseline counterpart, possibly because of a decrease in the sample size. In the lower panel of Figure 1, we illustrate the first- and second-stage regressions in binned scatter plots. Each of the 20 bins in the right graph corresponds to nearly 5 countries and indicates that the average fertility value is inversely associated with binned predicted values of the remittance variable. Compared to the case without instrumenting, the predicted data points are skewed to the left, highlighting the increased magnitude of remittance effects. Similarly, the left plot for the first-stage regression indicates that outliers do not cause the relationship between remittances and passport costs.

As the OLS and IV estimations do not include many controls, the effects of the included controls might also be biased mainly because of omitted variable bias. To address this, instead of averaging data, we use the panel specification of Wang and Sun (2016) based on country and period indicator terms in the last column of Table 3. The results of panel FE estimations, including the estimate for the effects of remittances, are mostly in line with the previous findings. However, there are differences. For example, when we consider a different proxy of economic

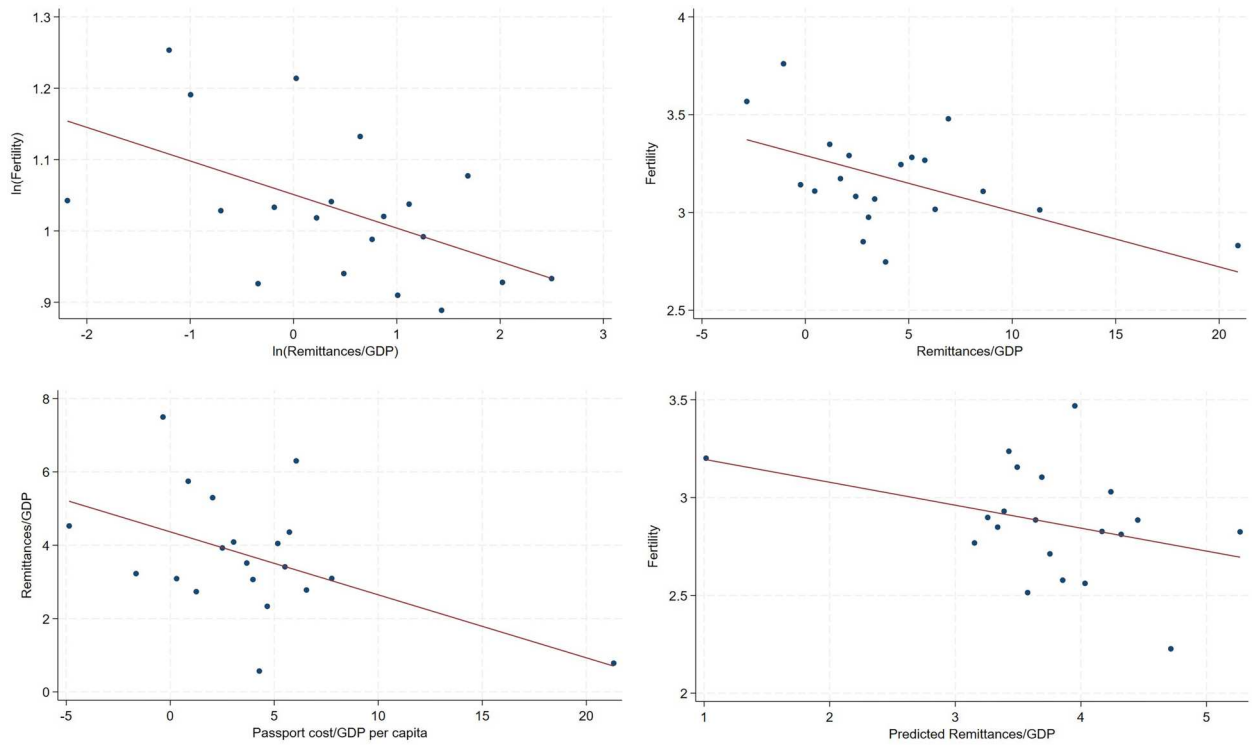


**Figure 1.** Fertility effects of remittances in post-communist times.

development (consumption rather than labor supply and income), its effects become positive. Similarly, the effects of the newly added human capital index are negative, while the effects of enrollment rates are insignificant. Thus, unlike the stable negative effects of remittances, the effects of controls should be interpreted cautiously and, ideally, instrumented in future studies.

### 4.2. Split-sample comparisons

To identify whether the effects of remittances are heterogeneous, we create 3 subsamples for fertility rate, the remittances-to-GDP ratio, and income level based on averaged data over the 1995–2015 period. As in Section 3, we sort data and divide the sample into almost equal proportions for the fertility and remittance variables. Each subsample comprises 52, 54, and 52 countries in both cases. To disaggregate categorical income variable, we merge lower and upper middle-income groups, and keep low- and high-income groups. In this case, the number of countries per group becomes 37, 91, and 30. We then assign indicator variables for each of the 9 subsamples and add them to the baseline OLS estimations.

According to split-sample regressions in Table 4, in countries with low fertility rates, the effects of remittances are almost the same as the general effects of remittances. The magnitude of the impact is lower in the case of countries with a medium level of fertility, and the interaction coefficient becomes statistically insignificant for high-fertility countries. Concurrently, when the share of remittances in GDP is low, an increase in the remittances-to-GDP ratio is associated with a notable decline in fertility. As the share increases, the magnitude of coefficients stabilizes, reaches that of the general effects of remittances, and remains statistically significant. Finally, the coefficient on the remittance variable for low-income countries is larger than in full-sample results. The effects are much more pronounced in the case of high-income countries, and the interaction term is statistically insignificant for the subsample of middle-income countries.

**Table 4.** Split-sample regressions.

| | Fertility | Fertility | Fertility |
|---|---|---|---|
| Remit/GDP | −0.027** | −0.887** | −0.051*** |
| | (0.013) | (0.383) | (0.015) |
| Medium level of Fertility | 0.682*** | | |
| | (0.120) | | |
| High level of Fertility | 2.341*** | | |
| | (0.231) | | |
| Medium level of Fertility × Remit/GDP | 0.026** | | |
| | (0.012) | | |
| High level of Fertility × Remit/GDP | −0.010 | | |
| | (0.016) | | |
| Moderate share of Remittances | | −0.343 | |
| | | (0.272) | |
| Large share of Remittances | | −0.545** | |
| | | (0.243) | |
| Moderate share of Remittances × Remit/GDP | | 0.660* | |
| | | (0.393) | |
| Large share of Remittances × Remit/GDP | | 0.858** | |
| | | (0.382) | |
| Middle Income group | | | −0.318 |
| | | | (0.262) |
| High Income group | | | 0.450 |
| | | | (0.379) |
| Middle Income group × Remit/GDP | | | 0.028 |
| | | | (0.020) |
| High Income group × Remit/GDP | | | −0.266** |
| | | | (0.121) |
| Contraceptive | −0.009** | −0.022*** | −0.022*** |
| | (0.004) | (0.005) | (0.005) |
| Democracy | −0.026 | −0.073* | −0.033 |
| | (0.031) | (0.037) | (0.037) |
| LEB | −0.009 | −0.025* | −0.039** |
| | (0.012) | (0.015) | (0.015) |
| FLFP | −0.003 | −0.012*** | −0.015*** |
| | (0.003) | (0.004) | (0.005) |
| ln(Income) | −0.105 | −0.560*** | −0.599*** |
| | (0.099) | (0.112) | (0.150) |
| Mortality | 0.012** | 0.016** | 0.012* |
| | (0.005) | (0.007) | (0.007) |
| Education | −0.004 | −0.002 | 0.002 |
| | (0.006) | (0.005) | (0.005) |
| Urban | −0.001 | 0.001 | 0.004 |
| | (0.003) | (0.004) | (0.004) |
| Observations | 158 | 158 | 158 |
| $R^2$ | 0.920 | 0.852 | 0.851 |

Note: robust standard errors in parentheses, ***$p$<0.01, **$p$<0.05, *$p$<0.1.

## 5. Global maps of fertility, economic development, and remittances

Using the regression coefficients from Table 4, we calculate the fertility effects of remittances for each country based on its fertility rate (3 groups), economic development (3 groups), and exposure to remittances (3 groups). For these estimations, we only consider statistically significant estimates. When the coefficient is insignificant, we assume the additional effect equals 0. The results of categorization, presented in Table 5, indicate that the fertility effects of remittances are heterogeneous across the globe and vary between −1.23 and −0.03 in 17 groups. To make the magnitude of the effects comparable to the proposed vulnerability index, we further group countries into 5 groups by merging the closest magnitude values. The average estimated magnitudes of the fertility effects of remittances in these categories are −1.21, −0.95, −0.56, −0.31, and −0.07.

Finally, in Figure 2, we illustrate the results of previous estimations via heat maps based on the shapefiles from Natural Earth.[6] The upper map dedicated to the distribution of the vulnerability index indicates that the most vulnerable countries are in Africa, Central, South, and Southeast Asia. Nevertheless, there are also vulnerable states in East Asia, Europe, and Latin America. The lower map presents the fertility-reducing effects of remittances. They are shown to be large in less vulnerable countries such as Japan and Switzerland and small in more vulnerable countries such as Haiti and Zimbabwe. When we consider the maps together, it is possible to conclude that as a country becomes more vulnerable, the effects of remittances are more likely to be negligible.

**Table 5.** Magnitude of fertility-reducing effects of remittances.

| Calculations | Effects | Number of countries | Magnitude | Number of countries |
|---|---|---|---|---|
| −0.027-0.887-0.051-0.266 | −1.231 | 13 | Very large | 26 |
| −0.027+0.026-0.887-0.051-0.266 | −1.205 | 12 | | |
| −0.887-0.051-0.266 | −1.204 | 1 | | |
| −0.027-0.887-0.051 | −0.965 | 11 | Large | 23 |
| −0.027+0.026-0.887-0.051 | −0.939 | 12 | | |
| −0.027-0.887+0.660-0.051-0.266 | −0.571 | 16 | Moderate | 22 |
| −0.027+0.026-0.887+0.660-0.051-0.266 | −0.545 | 6 | | |
| −0.027-0.887+0.858-0.051-0.266 | −0.373 | 1 | Small | 80 |
| −0.027+0.026-0.887+0.858-0.051-0.266 | −0.347 | 2 | | |
| −0.887+0.858-0.051-0.266 | −0.346 | 1 | | |
| −0.027-0.887+0.660-0.051 | −0.305 | 39 | | |
| −0.027+0.026-0.887+0.660-0.051 | −0.279 | 36 | | |
| −0.027-0.887+0.660 | −0.254 | 1 | | |
| −0.027-0.887+0.858-0.051 | −0.107 | 14 | Very small | 45 |
| −0.027+0.026-0.887+0.858-0.051 | −0.081 | 29 | | |
| −0.027-0.887+0.858 | −0.056 | 1 | | |
| −0.027+0.026-0.887+0.858 | −0.030 | 1 | | |

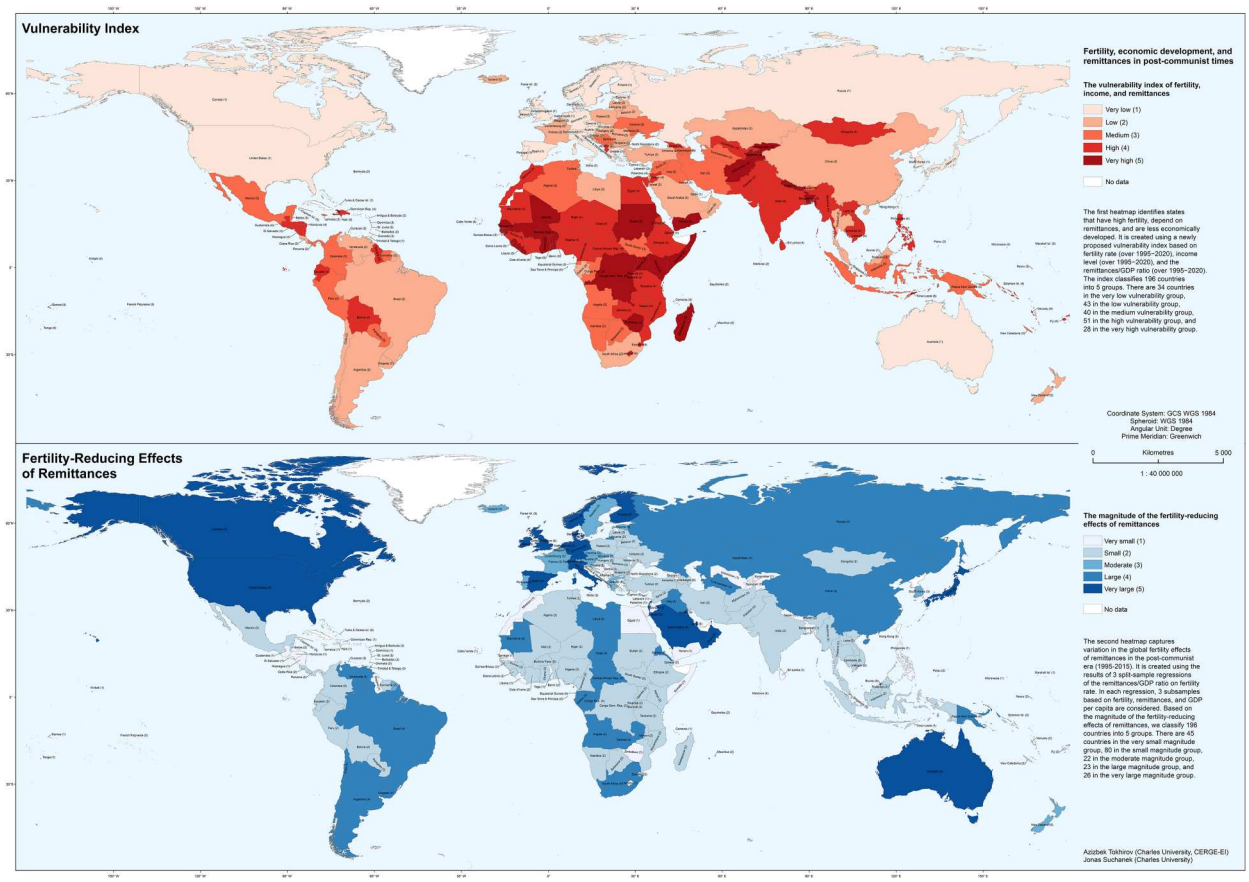


**Figure 2.** Combined map of fertility, economic development, and remittances.

## 6. Concluding remarks

The issue of overpopulation has been raised multiple times throughout modern history. This topic is particularly acute since the world saw an unprecedented population increase. Concurrently, after the fall of the Iron Curtain, the spread of capitalism and globalization around the globe led to increased access to migration, causing significant economic alterations. Considering these events, this study investigates how cross-border remittances affect global fertility rates in post-communist times. Fertility, in fact, is on the global agenda since the economic issues connected with fertility are currently peculiar to both lower- and higher-income countries. Moreover, given the history of migration-development nexus, the effects of remittances might be positive or negative. We thus produce global heat maps of fertility, economic development, and remittances to illustrate the relationship between these variables and show how the fertility effects of remittances vary worldwide.

To identify the fertility effects of remittances, we consider econometric estimation methods. The

baseline estimations reveal a general tendency of declining fertility rates in the countries that start to receive larger amounts of remittances. This finding extends the generalizability of the inverse fertility effects of remittances based on a specific region or a single country to the global setting. Unlike previous research, we do not explicitly consider the mechanisms via which remittances might affect fertility. Instead, we use a proxy for exposure to remittances that captures not only the financial effects of remittances, but also economic and demographic transformations associated with international migration. The results of heterogeneity analyses highlight that the fertility-reducing effects of remittances are inversely related to the vulnerability level of remittances-receiving countries. Specifically, split-sample estimations demonstrate that the impact of remittances is the most notable in the countries with low levels of exposure to remittances. The inverse trend is also more pronounced in higher-income countries and countries with low fertility rates.

To sum up, conclusions about the impacts of remittances should not be deduced from other countries since the characteristics of countries matter when determining fertility responses to remittances. Considering the association between remittances and fertility, global and local policy formulations to change fertility rates should explicitly consider the country's exposure to remittances, fertility rate, and income level. This could be done by analyzing econometric outputs or comprehensive heat maps. These kinds of maps could also be used to identify vulnerable states based on indices that combine different measures of socioeconomic development.

## Software

The presented maps were created using ESRI ArcGIS (ArcMap 10.7) software. We additionally utilized Excel (Microsoft 365) and Stata (mainly versions 16, 17, and 18) programs for data construction and analysis.

## Notes

1. Since the data restriction was based on remittances, the number of observations diverges between variables: 196 countries have remittances data, 194 countries have fertility data, and 193 countries have income data.
2. Instead of using the volume of remittances, which might capture the effects of a country's size (e.g., countries with large populations such as India and Mexico receive the largest volumes of remittances), we consider a relative measure. We decided to normalize remittances by GDP to capture the positive and negative effects of remittances. On the one hand, this variable indicates whether a country is exposed to positive financial and social flows from abroad. On the other hand, the higher value of this variable suggests that a country is more dependent on remittances and more likely to stagnate economically.
3. The variables are standardized to have a mean of 0 and a standard deviation of 1.
4. Reverse causality might occur, for example, because countries with lower fertility levels might have fewer people to supply migrants and, thus, receive lower volumes of remittances. Concurrently, numerous factors not considered in Table 3, including informal networks, might be correlated with fertility and migration decisions and, if unaccounted for, might distort the fertility effects of remittances. To formally test whether the remittance variable is, in fact, exogenous, we consider an endogeneity test. The result of the robust regression-based endogeneity test in the pre-last row of Table 3 indicates that remittances should be treated as endogenous.
5. Even with the significant first-stage coefficient, IV estimations might be biased because of the weak instrument problem. We argue that this is not the case in our setting because passports are typically given for 10 years, and we use data on passport costs as of 2005 for the 1995–2015 period. More generally, obtaining a passport is a reasonable proxy for migration costs because passport costs might go as high as 125% of annual per capita income. The study by McKenzie (2007) further indicates that high passport costs are associated with lower levels of migration and poor governance, including the quality of the bureaucracy. Thus, in addition to the monetary costs of migration, passport costs should also capture other difficulties of obtaining the necessary documents for emigration. To formally test the instrument's power, we consider the Wald test with the null hypothesis that the effect of remittances is zero. Based on the test results presented reported in the last row of Table 3, we conclude that the proposed instrument is not weak.
6. The design of the combined map is motivated by Machova et al. (2024).

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Data availability statement

The data used in the study are downloaded from publicly available sources stated in the text and available from the corresponding author on a reasonable request.

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