Retaining population with water?
Irrigation policies and depopulation in Spain over the long term

Ignacio Cazcarro (Universidad de Zaragoza & ARAID)
Miguel Martín-Retortillo (Universidad de Alcalá de Henares, Madrid)
Guillermo Rodríguez-López (Universidad de Zaragoza)
Ana Serrano (Universidad de Zaragoza & IA2)
Javier Silvestre (Universidad de Zaragoza & IEDIS) (corresponding autor)
Facultad de Economía y Empresa (Campus Paraíso). c/ Gran Vía 2, 50005, Zaragoza, Spain. E-mail: javisil@unizar.es

Introduction

Depopulation, especially, but not only, rural, has become a major concern across many advanced and developing economies (e.g., Rodríguez-Soler et al., *Land Use Policy*, 2020). This is so because shrinkage poses a severe threat to local economies, not only limiting the opportunities for economic growth and complicating the provision of public services, but also potentially causing environmental problems. Spatial inequality may also be behind the rise in popular discontent and territorial-based populism.

Within the scope of public intervention, different types of place-based policies have been implemented or proposed for the development of shrinking areas, which often endure long periods of decay that lead to low-income traps and have difficulties adapting to changes in the economy (e.g., Rodríguez-Pose, *Cambridge Journal of Regions, Economy and Society*, 2018). Evidence has produced mixed results (Neumark and Simpson, *Handbook of Regional and Urban Economics*, 2015; Duranton and Venables, NBER Working Paper, 2018; McCaan, OECD-EC High-Level Workshop Series, 2023). However, an emerging—and empirical—consensus is that the extent of the agreement varies for each type of policy, and that to guide action research needs to properly isolate specific interventions and targets (e.g., Grover et al., The World Bank Productivity Project, 2022).

This paper aims to elucidate on the relationship between irrigation and population. It does so for Spain, the most irrigated country (together with Italy) and one of, if not the most depopulated countries in Europe (Rossi, The European Parliament, 2019; Bank of Spain, Annual Report, 2021; Gutierrez et al., *Journal of Regional Science*, 2023). Spain being a Mediterranean country traditionally characterized by severe environmental constraints on agricultural performance, irrigation has been heavily implemented and subsidized since the beginning of the twentieth century. In particular, between the 1950s and the early 1970s and during the 1990s and the first decade or so of the present century. Irrigation programs in rural and urban areas have also been claimed to contribute to the resettling of populations and reducing (intense) outward migration, by increasing agricultural output, productivity, competitiveness and, consequently, employment and the standard of living. For example, one expectation has been that irrigated agriculture would connect to post-primary economic activities such as agro-industry, providing jobs. Within political and academic spheres, with some minor variations, these arguments have been repeated right up until the present time. In fact, the most recent years have seen an increased enthusiasm on the part of the public administration. However, no evaluation of the causal effect of irrigation on population has been conducted to date.

Data and methods

Our database consists of information at the eleven population census dates between 1910 and 2011. The data are disaggregated at a high spatial level: the 8,122 Spanish municipalities, thus providing a large number of observations. We aim to engage with a recent literature that has turned to the use of historical data to analyze spatial aspects of economic activity, as long-term databases can offer better insights than modern data alone, especially in policy evaluation (Bartik, *Journal of Economic Perspectives*, 2020; Hanlon and Heblich, *Regional Science and Urban Economics*, 2022; Nagy, 2022, *Regional Science and Urban Economics*).

The outcome of interest is total population (Further options are discussed in the paper). The treatment variable is based on the extent of irrigation relative to total cultivated land. Seven covariates have been constructed or collected to allow for (climate, geographic, economic and political) determinants of population behavior other than irrigation, following a strategy akin to that of a very recent literature for the US and India (Hornbeck and Keskin, *American Economic Journal: Economic Policy*, 2015; Asher et al., manuscript, 2023; Blakeslee et al., *Journal of Development Economics*, 2023; Boudot-Reddy and Butler, manuscript, 2023).

We exploit a staggered difference-in-differences design, making the most of a setting in which irrigation started at different points in time. We chose the estimator proposed by Callaway and Sant'Anna (*Journal of Econometrics*, 2021; see also Roth et al., *Journal of Econometrics*, 2023). Our main analysis included the use of different comparison groups and allowed for treatment anticipation behavior. We also performed a series of robustness checks in relation to characteristics of municipalities, sub-samples, spillovers, and stability across space and time. To account for remaining unobserved time-varying confounding factors, the adopted methodology was complemented with the sensitivity analysis put forward by Rambachan and Roth (*The Review of Economic Studies*, 2023).

Results

Overall, we find a positive and significant effect on population only for irrigation developments that started in the relatively distant past. Principally, in the first peak in irrigation during the third quarter of the twentieth century. The effect is even negative for the most recent irrigation developments. At the same time, we find stronger effects in the smallest (<2,000 inhabitants) municipalities and municipalities farther away from cities, the latter less influenced by urban agglomeration externalities. In any case, effects are temporary or tend to level off. The results also show that one way of overcoming diminishing returns of irrigation over time is to greatly increase its intensity.

Discussion and conclusion

Our analysis has policy implications. The ongoing Spanish irrigation scheme (2002-2007) provides for the extension of irrigation to a wide range of areas over the coming years. If dealing with depopulation continues to be a primary goal of irrigation policy, our findings do not seem to offer a hope for betterment. At the very least, this paper adds the recommendation of honing the target. However, according to our findings, even in this scenario the effect seems to lose its strength over time. In any case, we discuss the trade-offs associated with increasing the intensity of irrigation. Irrigation entails not only benefits, such as food supply expansion, certainly, a key issue in the Spanish economy, but also environmental and economic costs (e.g., Schoengold and Zilberman, *Handbook of Agricultural Economics*, 2007). Not to mention the fact that the agricultural sector in Spain, primarily its irrigated cropland, accounts for around 80 percent of water use. Moreover, Spain has one of the highest, present and projected, hydric stress levels in Europe (Kuzma et al., World Resources Institute, 2023).