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Connections between Research and Policy: The case of fertility diffusion and regional demographic policy in Portugal[§]

Abstract

There are missing links between research and policy that can be provided by better information on the real world. This is important not only to evaluate the contribution of research to the policy makers and to society, but also to design policies based on evidences. Three models for meeting such objectives are presented, emphasizing the role of (a) journals, (b) government and (c) the researchers. We provide outline examples of the three approaches, focussing on regional demographic policies in Portugal.

Keywords: Evidence based policy; Fertility and Demography; Regional development; Portugal.

1. Introduction

"The mantra of excellence is ubiquitous in the research funding system of the UK and other scientifically advanced nations. ... As Lord Willetts, then [UK] minister for universities and science, put it in 2010: "Excellence is and must remain the driver of funding decisions, and it is only by funding excellent research that the maximum benefits will be secured for the nation." Yet this is to look at the funding system entirely from the researchers' perspective. It is excellence for science, not for society. UK Research and Innovation is pledged to ensure that "everyone in society benefits from world-leading research and innovation"." (Conway, 2020).

As the quote demonstrates, there is growing expectation that research should bear demonstrable impact upon society. Then, establishing the connections between policy and underlying research, through effective documentation, is important both for researchers and policymakers. However, it is challenging to clearly document research-policy links. We highlight three types of research – diagnostic, innovative and evaluative – involving different levels of engagement with the policymakers. We also highlight significant challenges in the conduct, delivery, and documentation of policy research, including large temporal lags, as well as acknowledging and negotiating countervailing influences from the democratic and political space and engagements with policy delivery.

Considering how research interacts with policy in different types of policy research, we synthesize research-policy links into three potentially complementary approaches. These are: (a) journals identifying important policy issues and inviting researchers to bring their expertise and current research to bear upon these questions; (b) government, central banks and multilateral agencies in their policy guidance documenting research contributions to help set principles upon which policy is based; and (c) researchers documenting the direct connection between research and policy using policy journals as outlets.

Section 2 highlights the role and importance of policy research in the decision-making process. Section 3 presents the three models together with specific examples, highlighting in particular the proactive role of policy journals. In Section 4, we provide an example of one model applied to Portuguese regions. Finally, Section 5 concludes.

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2. Policy research and its contribution

As highlighted by Weiss (2007), policy research contributes at three levels, providing: data and information to better understand the state of the world; causal relations and theories of the state of the world; and decision making tools suitable to evaluate the impact of policies. We consider three main types of policy research (Figure 1): (a) Diagnostic research (helps policy understand a problem better); (b) Innovative research (helps policy develop solutions to problems, for example, RCT (randomized control trials) or socio-economic structural models); and (c) Evaluative research (helps policymakers evaluate success in addressing the problems they are trying to solve). These types require different engagement between policymakers and researchers, and hence their documentations differ. For example, diagnostic research can happen independent of policy and can also serve the political and democratic space. By contrast, innovative research requires close engagement with policymakers to develop interventions suitable for rigorous scientific appraisal. And finally, evaluative research 'requires' independence from policymakers in its delivery, yet adequate dissemination requires constructive engagement with policymakers. This final object can be compromised by external agents, such as the mainstream media, aiding debate in the political or democratic space, but often at the expense of learning effective policy lessons.

This, then, leads us to consider the mechanisms through which research interacts with policy. There are three key aspects to this research-policy link. First, there generally tends to be a lag between research, policy and impact. This is true even for policy targeted research, which makes documenting the impact challenging. Policymaking often involves iterative cycles, demanding that research engage and evolve continuously. This iterative process is often difficult, even impossible, to anticipate at the start. Then, the questions to be answered towards the end of the policy process can often be determined by how research has engaged at the start of the process, and throughout the process. Hence documentation should not look at the relationship between policy and research as a one-off.

Second, universities and research institutions typically make use of public funds, and hence funders bear a responsibility to document how the research provides value to society (Martin, 2011). In the 1970s, there was considerable interest on the value of research to society (Rose and Rose, 1970) and social responsibility of researchers (Rip and Boeker, 1975; Nelkin, 1979). This, together with constraints in public research funding, led to a demand for public accountability (Irvine and Martin, 1983). Data were collected on inputs and outputs, pioneered by CHI Research and Leiden University (Narin, 1976; Moed et al., 1985). In the UK, regular evaluation of all public research institutions started in 1986, continually evolving over several iterations, into the current Research Excellence Framework (REF, 2021). However, the social value of such evaluation has arguably diminished over time (Martin, 2011). Despite sophistication, measuring societal impact is still challenging (Donovan, 2007; Grant et al., 2009). In the UK, the onus is now upon researchers and their institutions to document evidence of the link between research and impact. We return to the question of research impact later.

Third, over the past 20 years, 'evidence-based policy' has gained momentum, encouraging policymakers to use scientifically validated evidence. At one level, questioning whether governments should base policies on evidence seems tautological. At the same time, public scrutiny has increased, fuelled not least by the big-data explosion of public information. This rationalist movement is captured by Smith (1996), urging "evidence-based approach" to reduce partisanship and promote a scientific process (Morton, 2010). Now, the idea is popular and promoted for example by the Australian and UK governments (Boaz et al., 2002; DEFRA, 2006; Banks, 2009). In the US, there is a growing movement of "What Works Cities", under which more than 100 cities with a population of 30,000 and above have pledged to use evidence and data to improve their policymaking (Bloomberg, 2015). Even if purely scientific approaches to policy is not without its "discontents", evidence-based policy is more of a norm rather than an exception in advanced countries (Cartwright and Stegenga, 2011). This, therefore, also places an onus upon policymakers and the state to evidence a link between policy and research.

Further, there is a key role for policy journals. Evidence and critical analysis is only one part of policy consideration. Also important are the role of politics and democracy, which make documenting the impact quite tenuous; see, for example the UK Civil Service (2018). But the important point is that research should not only speak to policymakers, but the wider public in order that it can also shape politics and democracy. Here lies a key challenge for policy journals in how to place make research more accessible to the mainstream. This emphasizes appropriate and adequate documentation.

However, while the academic merit of research can be measured by citations, peer reviews and research funding (Rigby, 2011; Wand and Shapira, 2015; Wand et al., 2018), the economic and societal impact is harder to measure (Grant et al., 2009; Martin, 2011). The Australian Research Council (2017) defined research impact as “*the demonstrable contribution that research makes to the economy, society, environment and culture beyond the contribution to academic research*”. Similarly, REF (2021): “*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life beyond academia*”. It is noteworthy that research evaluation does not encompass academic impact “*the demonstrable contribution that excellent ... research makes in shifting understanding and advancing scientific, method, theory and application across and within disciplines*” (ESRC 2018) and neither does it include capacity building “*through technical and personal skill development*” (ESRC 2018). However, they follow the OECD-DAC’s broader definition “*as any long-term effect, whether intended, unintended, positive, negative, direct or indirect*”. Then, the impact (or change) “*does not have to be positive. Interesting lessons are often learnt from recognising negative changes, or where there has not been any change. Often, the most interesting observations and lessons result from exploring why no change or negative outcomes may have arisen*” (Tilley et al., 2017).

Figure 1 - Research approaches and public policy challenges

3. How to take research to policy makers?

Establishing the connections between research and policy is challenging. Different research requires different forms of engagement with policymakers. The link between research and policy is mediated not only by temporal lags between research, policy change and impact, but also considerations for the roles of politics and democracy and delivery of policy. In addition, there are the key challenges of policy relevant research. First, measurement of the societal outcome and drawing a close connection between policy and outcome. Second, drawing a clear correspondence between the research and the impact, allowing for intended and unintended outcomes. Third, clear theoretical and empirical analyses to identify causal channels and counterfactuals.

Below, we describe three alternate but complementary approaches.

3.1. Journal initiative to address specific policy issues

In the first model, the agency for documentation comes explicitly from policy journals interested in drawing connections between research and policy. One useful avenue is through *Special Issues* on topics of current policy interest. The current *Regional Science Policy and Practice* (RSPP) Special Issue on “Evidence-Based Policymaking” provides an excellent example, identifying a question of policy interest and inviting researchers to bring their expertise, current research and knowledge to bear upon it. There are plenty of other calls for papers listed on the journal webpage (RSAI 2020). These can in principle encompass all the three types of policy research (diagnostic, innovative and evaluative), but as discussed earlier, the engagement with policymakers is different for each type.

Our second example comes from *Statistics and Public Policy* (SPP), which in 2014 made data on cancer incidence in Florida available to researchers encouraging them to apply current knowledge to

investigate whether there were spatial concentration and their causal patterns. This was based on previous research (Amin et al., 2010) identifying clustering of pediatric cancer in Florida. Then, SPP engaged inter-disciplinary research teams to independently analyse the data for 2000–2010. This produced a suite of policy-oriented research articles, whose findings were published (Amin et al., 2014; Heaton, 2014; Wang and Rodriguez, 2014; Zhang et al., 2014; and Lawson and Rotejanaprasert, 2018), together with an introduction (Banks and Lohr, 2014), a discussion (Waller, 2015) and a policy brief (ASA, 2015). This was also followed by another subsequent study in the same journal (Kirpich and Leary, 2017). This rich collection of evidence contributed to substantial impact in government and public debate. There were press reports (Nolan, 2016; Wright, 2016; Waymer, 2017), commentaries by advocacy groups (Farago, 2015; SaintPetersBlog.com, 2015), and a response from the Florida Department of Health (Nolan, 2016).

The example also highlights engagement with the political and democratic space. Here we take the agenda forward in two ways. First, we document this as a journal-led approach for recording the connection between research and policy. Second, we highlight specific datasets and evidence as an additional tool for encouraging evidence-based policymaking and documentation.

3.2. Policymaker initiatives to document research-policy links

In our second model, the agency for documentation lies with policymakers. Evidence-based policymaking imply that policymakers would benefit from emphasizing the connection between scientific research and policy. Thus, this approach may be particularly suited to evaluative research, but there can also be diagnostic or innovative research. This raises important methodological challenges. Specifically, evidence-based policy must have the following characteristics (Cartwright and Stegenga, 2011):

- (a) test a (causal) theory as to why policy will be effective and what its impacts will be;
- (b) develop a counterfactual as to what would have happened if the policy were not implemented;
- (c) appropriate measurement of the impact;
- (d) evaluate both direct and indirect effects of the policy;
- (e) quantify uncertainties and control for other influences; and
- (f) ensure testing and replicability of findings.

Documenting the evidence base requires capacity for scientific study that few policymaking agencies possess. Typically, large government departments, central banks and multilateral agencies maintain research departments who document the connections of policies with the underlying research or knowledge base.

An alternate mechanism constitutes encouraging a direct documentation of research in the policy guidance highlighting principles on which policy is based. Several government departments in the UK commission reports by experts documenting research links which are then used to develop policy, see, for example, Barker (2004, 2014) and Aron and Muellbauer (2010).

Regional governments in the UK also follow a similar approach. For example, consider a unique and exemplary report (Biggar Economics, 2019) commissioned by the Scottish Government to define 'local area' to standardise socio-economic impact assessment and evaluate direct and indirect effects of marine projects. The primary object was not policymaking, but innovative policy research to establish scientific principles for policy through an evaluation of the relevant academic research, current best practice and stakeholder engagement.

Several principles were thus highlighted: dual geographies ('local' and wider area); appropriate impact measures; identifying epicentres of the 'local area'; accountability; understandability; and connected

geography. The principles were underlined by documenting the underlying research and research-policy links. This enables documenting the link between policy and research in government policy advice and engagements with citizens. Another interesting aspect of this example lies in its subtle engagement with delivery of policy, even though no specific policy was directly involved.

3.3. Researcher initiative facilitated by journal

In some instances, confidentiality or sensitivity may preclude the government and policy community from publicly highlighting a direct connection between research and policy. Then, it may be incumbent upon the researchers to document the research-policy link, while retaining confidentiality of strategic or sensitive evidence, using policy journals as outlets.

Here, agency lies with the researcher, but the journal plays a key facilitation role. The research itself is likely innovative or evaluative, in the latter case potentially *ex post* and reporting redacted elements of the research. As an example of this model, we document how regional demographic policy in the interior regions of Portugal was partly shaped by research; see Zhang et al. (2021) for methodological development and interpretation of results, while we discuss the policy impact in Section 4.

There are also opportunities for researchers to proactively engage with policy processes to place evidence into the public sphere and shape outcomes. For example, the UK Government (2008) *Code of Practice for Consultation* set out criterion for developing public consultation. These include requirement that “[f]ormal consultation should take place at a stage when there is scope to influence the policy outcome”. Further, “[c]onsultation documents should be clear about the consultation process, what is being proposed, the scope to influence and the expected costs and benefits of the proposals.” In this instance, researchers have an opportunity to engage directly with policy processes in areas of their interest to shape outcomes and to present evidence for which the Government needs to respond directly too. Specifically, there is a requirement that “[c]onsultation responses should be analysed carefully and clear feedback should be provided to participants following the consultation”. This criterion provides a mechanism for the UK Government to document how it has treated input from researchers. However, this requires researchers to systematically follow policy development in areas of their interest, which is a significant transaction cost especially with internationally relevant research.

4. The case of Fertility Diffusion and Regional Demographic Policy in Portugal

Spatial and temporal dynamics are key elements of regional demographic study (Entwistle, 2007). The complexity of spatio-temporal patterns is perhaps most evident in fertility, combining fertility behaviour and health outcomes, both of which evidence substantial social and spatio-temporal diffusion (Gomes et al. 2016). Fertility behaviour is also endogenously related to regional economic performance, and the regional economy in turn exhibits substantial spatial concentration. Hence, study of spatio-temporal dynamics in fertility is challenging, but with important implications for regional policy, for example in interior Portugal.

The underlying research was diagnostic, innovative and evaluative largely sequentially, though the documentation here focuses on the first two. Substantial research-policy time lag is notable. The research also involved engagement with politics and democracy, and with delivery of policy, though we highlight the third aspect only briefly.

Though Portugal follows the trend of developed countries in the third phase of demographic transition, the spatial-temporal evolution of the fertility rate by age-group is somewhat unique. In the past few decades, substantial political and socio-economic transformations had considerable impacts on the

fertility rate, with rapid fertility decline: total fertility rates significantly decreased from 3.19 in 1960 to 1.35 in 2011, and the population replacement threshold (2.07 children by women) was consistently breached since 1982. In November 2007, Portuguese President Cavaco Silva famously said: “*A country without children is a nation without a future*” (Mail Online, 2012).

The number of new births fell to a 60-year low in June 2012, a 19 percent fall year-on-year. The situation was very acute: “*For over a generation of families fertility rates in Portugal have been falling. Today, only one other OECD country has a lower fertility rate (Korea). Sustainable fertility is important to ensure dependency ratios don't threaten Portugal's welfare systems and future productivity. Total fertility rates are sensitive to income shocks such as the global financial crisis; a further fertility dip is evident in Portugal since the onset of the financial crisis*” (OECD, 2011).

Regional diversity is also prominent. While the above changes occurred across the country, the intensity was different across regions and age-groups. There was a declining fertility rate in younger age groups and an increase in the older age groups. Moreover, higher total fertility rate moved from the northern regions to the southern and metropolitan areas, as fertility in younger groups had a sharper decrease in the north while the increase in older groups was stronger in the south and Lisbon. Together, demographic change impacted upon spatial variations in skills supply (OECD, 2014).

It is important for demographic analyses and policymaking to model spatial diffusion well, so that predictions and counterfactual policy experiments can reflect endogenous spatial spillovers. This is particularly important for fertility, which has substantial social learning and network influences. Likewise, it is important to obtain accurate forecasts of demographic variables, by regions and over time, as well as the uncertainty associated. We consider theories of fertility diffusion together with Bayesian hierarchical models with separable spatio-temporal dependence structure. Estimation borrows strength from neighbouring regions and all years. To understand fertility diffusion better, we do not assume the spatial structure as a given, but rather estimate this using Portuguese regional data. In the following subsections, we first discuss fertility, followed by methodology and estimated regional trends in fertility transition, and finally policy implications. In doing so, we highlight a contribution along the third model of documenting research-policy connections focusing on previous methodological research.

4.1. Social and Spatial Diffusion in Fertility

Following from Castro et al. (2015) and Zhang et al. (2021), we extend quantitative research in demography along several dimensions. First, the literature acknowledges substantial spatial diffusion in fertility (Tolnay, 1995; Weeks et al., 2000). Long run dynamics have been explained by the demographic transition model (Thompson, 1929; Notestein, 1945; Blacker, 1947), describing transition from high towards low birth and death rates as economic development advances. Then, macrostructural features like urbanisation, industrialisation, and education determine the demand for children by influencing their economic value. However, following the Princeton European Fertility Project (Coale and Watkins, 1986), the "diffusion" view, emphasizing cultural influences on fertility, has become prominent. European fertility transition has been more persistent, and less spatially concentrated, than a strictly structural model of fertility decline. Further, changes in structural factors like literacy and industrialisation are only weakly related to the timing of fertility decline. Similarly, spatial patterns in twentieth-century US fertility (Tolnay, 1995) is related to diffusion of reproductive patterns through endogenous social networks. Two sources of such diffusion are highlighted: information diffusion for example on birth control measures; and diffusion of ideas relating to marriage, family and sexuality through social communication leading to an ideational shift. This places societal culture at the centre of demographic study of fertility: “belief systems (values, norms, language, religion, ideologies), cultural traditionalism, cultural homogeneity, and socialization of individual actors” (Wejnert, 2002).

Likewise, proximity and diffusion also explain spatial patterns in contraceptive choice (Entwisle et al., 1997), religious practice (Land et al., 1991) and poverty and inequality (Lobao and Saenz, 2002; Gundersen and Ziliak, 2004; Flippen, 2010). These spatial patterns have important implications for policy (Case et al., 2003; Gundersen and Ziliak, 2004; de Castro, 2007). Arguably, family planning programs have had limited impact on fertility because politics, and not spatial analysis, typically determine the location of public reproductive facilities (Fuller, 1974). While these discussions focus on diffusion, similar patterns can result from spatial concentration of macrostructural characteristics. Indeed, it has been observed that inclusion of structural variables reduces the explanatory power of spatial effects (Berry and Berry, 1992).

The recent literature has modelled diffusion as a function of proximity or distance between spatial units. However, the natural driver of diffusion should be socio-cultural distances, not geographic proximity. Fertility in Europe follows religious and linguistic contours (Coale and Watkins, 1986), and therefore vary across spatially proximate countries or regions. Socio-cultural distances are difficult to measure. Castro et al. (2015) and Zhang et al. (2021) extended recent literature in spatial econometrics and statistics (Bhattacharjee and Holly, 2013; Bhattacharjee and Jensen-Butler, 2013; Bailey et al., 2016; Bhattacharjee et al., 2016) that treats drivers of spatial diffusion as unknown parameters and developed methods for socio-cultural diffusion. Then, estimated diffusion reflects drivers that may not be closely related to geographic distances and contiguity, but socio-cultural, ideational or core-periphery relations. This new framework and methods for Bayesian inferences on an unobserved contiguity (adjacency) matrix allows explanations of diffusion to go beyond geographic distances. Together, we also consider spatio-temporal dynamics. This is very important in the current context, since previous literature has highlighted that onset of demographic transition in different places can be different, even proximate regions with similar macrostructural characteristics (Coale and Watkins, 1986; Watkins, 1987).

4.2. Methodology and Findings

The above discussion highlighted four main features: heterogeneity of fertility behaviour across age-groups (age-specific fertility rates); spatial patterns and heterogeneity across regions; socio-cultural and spatial diffusion; and spatial clustering in time trends, heterogeneous across regions and age groups, but spatially clustered. Regional data reflects spatial heterogeneity due to macrostructures, together with complex spatial diffusion due to endogenous social networks. By allowing diffusion to be based on a variable number of estimated spatial clusters, methodology in Castro et al. (2015) and Zhang et al. (2021) allows socio-cultural diffusion to shape fertility outcomes. This enriches spatial analysis and allows accurately modelling of social and cultural diffusion embedded in a spatial context.

Spatial heterogeneity combined with spatial clustering and diffusion produce a complex pattern which can only be fully revealed when the spatial units are small and representative of local contexts. Thus, modelling and estimation of fertility rates should aim to use shrinkage methods, borrowing strength from spatially related regions, consecutive years, and relevant age groups. Bigotte et al. (2014) studied the relationship between population dynamics and the hierarchy of urban centres in Portugal, using geographical contiguity to measure diffusion. Such reliance on geography as the sole driver is not adequate for fertility diffusion. Also, the recent rapid changes in the spatial patterns imply that spatial dependence should be captured by estimated spatial weight matrices, rather than ad hoc weights.

Castro et al. (2015) developed Bayesian small-area inference by spatial clustering of fertility rates across Portuguese regions in 2009. Apart from covariates, they used a conditional autoregressive (CAR) model (Besag, 1974; Mardia, 1988) for region-specific random effects. The spatial pattern was not assumed known, but inferred from the data by spatial clustering. Such flexible modelling of spatial diffusion allows identification of regions and clusters where policy initiatives need to be placed. Regeneration of the peripheral depressed regions in Portugal, through integrated demographic and economic policies, is

a key priority. Economic growth in peripheral regions depends on increasing fertility rates and attracting migrants, which then influences the ability of firms to locate there and create employment opportunities (Castro et al., 2012). Zhang et al. (2021) extended the methodology to spatial clustering of curves, applied to time trends of fertility rates across different regions. Here, we apply the methodology in Castro et al. (2015) and Zhang et al. (2021) to regional demographic policy.

Castro et al. (2015) identify different clusters, the south and the north, the former with a higher fertility rates. However, this static view is very simplistic, because the highest fertility rates have in recent decades moved from the rural and northern regions to the urban areas and the south. Zhang et al. (2021) emphasize these temporal patterns using new methodology.

For each region, year and age-group our data comprises the number of births (B) and the number of women in reproductive age (E); hence the fertility rate is $F=B/E$. Following Cressie and Chan (1989), we use the Freeman-Tukey transformation, $Y = \sqrt{10^3 E^{-1}}(\sqrt{B} + \sqrt{B + 1})$. Then, using Portuguese data for these $N=28$ (NUTS III) regions, $T=19$ years from 1991 to 2009, and $J=7$ age-groups,¹ Zhang et al. (2021) estimated their spatio-temporal mixed-effects model. Figure 2 suggests substantial local similarity in curve trends and levels. Therefore, Zhang et al. (2021) argue that estimating diffusion patterns by spatially connected clusters is meaningful for preserving regional adjacency but also capturing diffusion. The first 16 years of data are used for estimation and the final three years for model validation. The age-groups show different numbers of clusters and clustering configurations (Figure 2); see Zhang et al. (2021) for detailed discussion of spatial diffusion.

The clustering configurations in Figure 2 offer important insights for regional demographic policy. Specifically, they highlight spatial clusters within which demographic transitions, across the age-groups, over time have been similar and closely related. The literature on fertility diffusion suggest that, within each cluster, there may be different driving social processes. This implies that policy need to focus on each individual cluster, subject to the policy priorities and processes, and identify drivers that can then influence the transition of fertility trends.

Source: based on Zhang et al. (2021)

Figure 2: Estimated clustering configurations by quinquennial age groups j ($j=1, \dots, 7$: ages 15 to 49 years old, from left to right), with cluster labels

Here, we use the above insights into spatial diffusion in fertility to propose regional demographic policy. Together, flexible modelling of spatio-temporal dependence offers excellent predictions (Zhang et al., 2021). Most importantly, the work offers valuable structural interpretation on fertility diffusion. Having highlighted diagnostic elements above, next we move to innovative research showing how the model is useful for evaluation of alternate policy scenarios and interventions. This involves developing and highlighting policy tools that take the structural model of fertility diffusion above towards policy aimed at demographic change.

4.3. Fertility Diffusion and Policy Implications

The empirical findings in Zhang et al. (2021), as illustrated in Figure 2, offer exciting new insights on spatial diffusion in fertility behaviour. First, the spatio-temporal model with spatial contiguity weights offers good description of regional fertility variation and time trends; this model fits the data better than a model with no dynamics, but also models with only spatial dynamics or only temporal dynamics.

¹ Seven quinquennial age-groups of women in their reproductive age: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-50 years old. Childbirth is a rare event, and the highest fertility rates occur in age-groups 25-29 and 30-34 years olds, followed by 20-24 years old (Figure 2). Hence these three age-groups are the most crucial in determining the number of children born.

However, the estimated adjacency matrix offers better explanation. Second, the clusters offer valuable insights into the nature of spatial diffusion based not only on geography but also socio-cultural linkages. The estimated clustering configuration for the age-group $j=2$ offers the best fit with the data and emphasizes the north-south divide; hence this forms the basis for our policy insights. This is also the period in life when many young women likely make their fertility plans, and their fertility decisions in later life are likely influenced by social and economic environment at this age (Stolzenberg and Waite, 1977; Hakim, 2003). Amongst OECD countries, Portuguese women have one of the highest rates of higher education and labour force participation. This indicates that diffusion of fertility behaviour may originate in major centres of education and jobs. Such social networks can also influence fertility decisions, and therefore fertility outcomes in future life.² See Castro et al. (2015) and Zhang et al. (2021) for further discussion linking the empirical results to regional demographic policy.

The above inferences offer useful policy implications. There has been great concern on the depressive demographic cycle affecting Portuguese peripheral areas towards the north and centre. Based on the above findings and corresponding evaluation of counterfactual scenarios, together with a model that combined economic and demographic change, Castro et al. (2012, 2015) reported demographic projections predicting that some of these areas may become literally empty by 2030. These projections then led to substantial public debate (see, for example, press reports in Gonçalves, Público and Expresso, all in 2013). Together, in a strongly worded policy advice, OECD (2011) suggested that: *“Portugal should try to invest more of their public family budget towards early year's supports ... Investment on early year's services is essential to enable families to flourish, is essential for future welfare state sustainability and economic growth.”*

Indeed, early-, mid- and late- childhood spending in Portugal significantly lag OECD levels. Further, childcare support for low-income families and parental leave policies are expected to promote sustainable fertility rates, particularly in the Portuguese context of high female labour force participation (over 60% of children live with both parents working full-time). Our work provides valuable insights into how such policies may be implemented. First, the problematic clusters are in the north and central regions of the country and this is where investments may be focused. Second, economic opportunities also need to be developed keeping in view the skills availability within these clusters (OECD, 2014). Special attention needs to be placed on the young population, 20-24 year old, which our analysis identifies as the key age-group for fertility diffusion. Even if the young are no longer expected to make a significant contribution to the birth rate, they can plan for their future fertility behaviour better if the conditions are conducive, such as first employment, job stability, flexible hours, child tax benefits, and high-quality public schools and kindergartens. The interplay between these policy measures must also be recognised. Finally, beyond improving material life conditions, attempts to change attitudes towards child-bearing and childcare should be made, to mitigate against declining fertility. This may be focused on the more urban areas and university hubs of the country apart from the capital Lisbon, such as Porto, Aveiro, Coimbra, Évora, Braga and Vila Real. The OECD LEED Programme (Local Economic and Employment Development) highlights the importance of the local level, the place where the integration of policy measures and strategies occurs (OECD, 2014). The spatial scale of our analysis does not allow capturing this local phenomenon explicitly and the impact that urban areas have as drivers of cultural and social behaviour, but it points to clusters centred on major cities and universities. Thus, our results identify the general dynamics and patterns that are extremely useful for policymakers, mainly in the context of the local provision of services of general interest, and its relationship with the spatial distribution of the population and the different socio-economic groups (Marques et al. 2020a, Marques et al. 2020b and Wolf, 2021),

² This issue has important connections with the link between age and lifecycle on the one hand, and fertility and employment decisions on the other. Whether the learning or lifecycle hypothesis (Stolzenberg and Waite, 1977) explain such choices or alternatives such as preference theory (Hakim, 2003) is an interesting question for future research, and one that our proposed methods can shed light on.

Clearly, the research in Castro et al. (2012, 2015) and Zhang et al. (2021) generated substantial public debate and policy impact, which is an example of engagement with politics and democracy. As discussed earlier, impact need not be solely positive. Indeed, the counterfactual analyses in Castro et al. (2012) show that impact of demographic policy focused solely on fertility transitions may be limited, but coordinated economic and demographic policy (both fertility and migration) show great promise (Gonçalves; 2013; Público, 2013; Expresso, 2013). An interesting highlight is the iterative engagement with the policy process which allowed the policy focus for interior regions of Portugal to move from fertility into migration. It is notable how the research here also engages with delivery of policy.

As a final point on policy delivery, but also evaluative research, the above evidence-based policy projections led the Portuguese government to constitute a Working Group to develop a common cross-border development strategy for the interior regions bordering Spain identified above. Notably, demographic and economic projections for the Spanish territories on the border are also similarly depressed. This Working Group resulted from a memorandum of understanding signed between the Governments of Portugal and Spain, during the Iberian (Portuguese-Spanish) Summit in Valladolid (November 2018) where the lead researcher on the above researcher was a Co-Chair; see University of Aveiro (2019). The Working Group has proposed policy measures to improve economic activity and migration into these regions.

5. Conclusion

We discuss channels through which the link between research and its impact, particularly upon policy, can be established and documented. Specifically, we highlight how policy research outlets play a very important role in highlighting the links between science and society and in designing policies based on evidences. In doing so, we abstract from basic research, whose primary aim is to acquire new knowledge of foundations without any particular application or use in view. However, it is a reasonable expectation that a significant proportion of research, both applied research and experimental development, should explore a pathway into impact upon society. We focus upon this latter category, and specifically upon promoting and documenting the link between research and public policy.

Specifically, we highlight best practices for documenting research-policy connections, in the context of research impact. We begin by briefly describing three main types of policy research: diagnostic research; innovative research; and evaluative research. Then, we propose three channels through which documentation of the link of policy with underlying research can be advanced. In doing so, we highlight the key role of policy journals. The three channels differ not only in the nature of documentation, but also in who takes the initiative.

The first approach is led by policy journals through identification of specific policy relevant issues and evidence and consequently publishing such research. The second is led by policymakers using experts to explicitly document evidence-based policymaking. The third channel constitutes researchers documenting the connection through policy papers and policy journals providing a suitable platform.

We provide outline examples of all three approaches. Specifically, for the third, we also provide an elaborate case documenting the connection of methodological research with crucial recent regional demographic policy for the Portuguese regions. The contributions here will potentially aid promotion of better connections between research and policy.

The broader context is the relationship between science and society, particularly in relation to policy research. In this regard, there is increasing consciousness and discussion of participatory policy design (Geman et al., 2017; Lakomý et al., 2019). Important issues include communication of research and the engagement and cognition of the public and policy community. Here, we focussed more narrowly on

different ways of informing and engaging policymakers and making research useful for their work. Future studies must also focus on ethical issues, their communication, and public perceptions, together with addressing the challenges and potential unintended consequences of research-society interactions.

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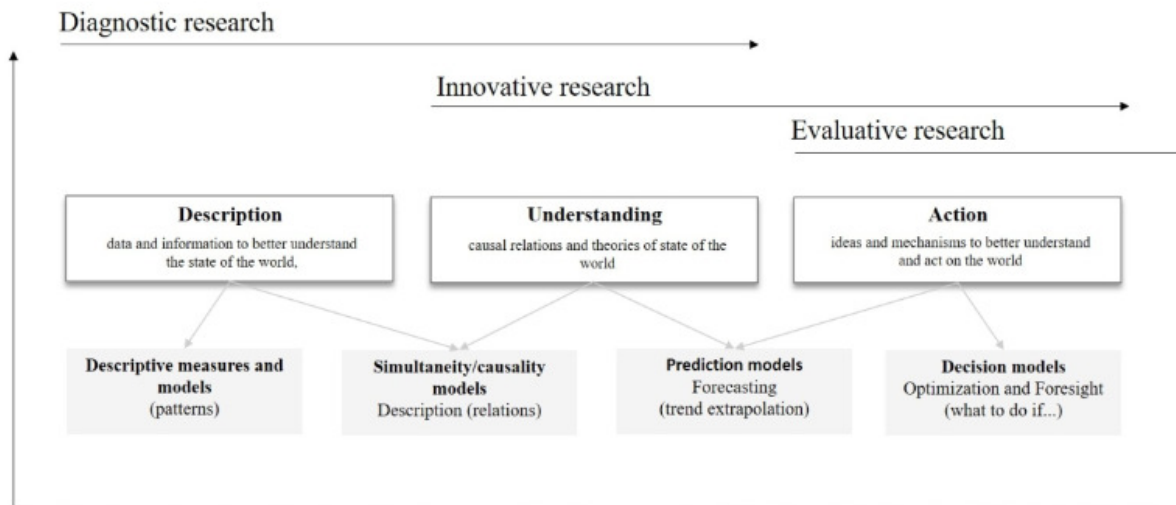
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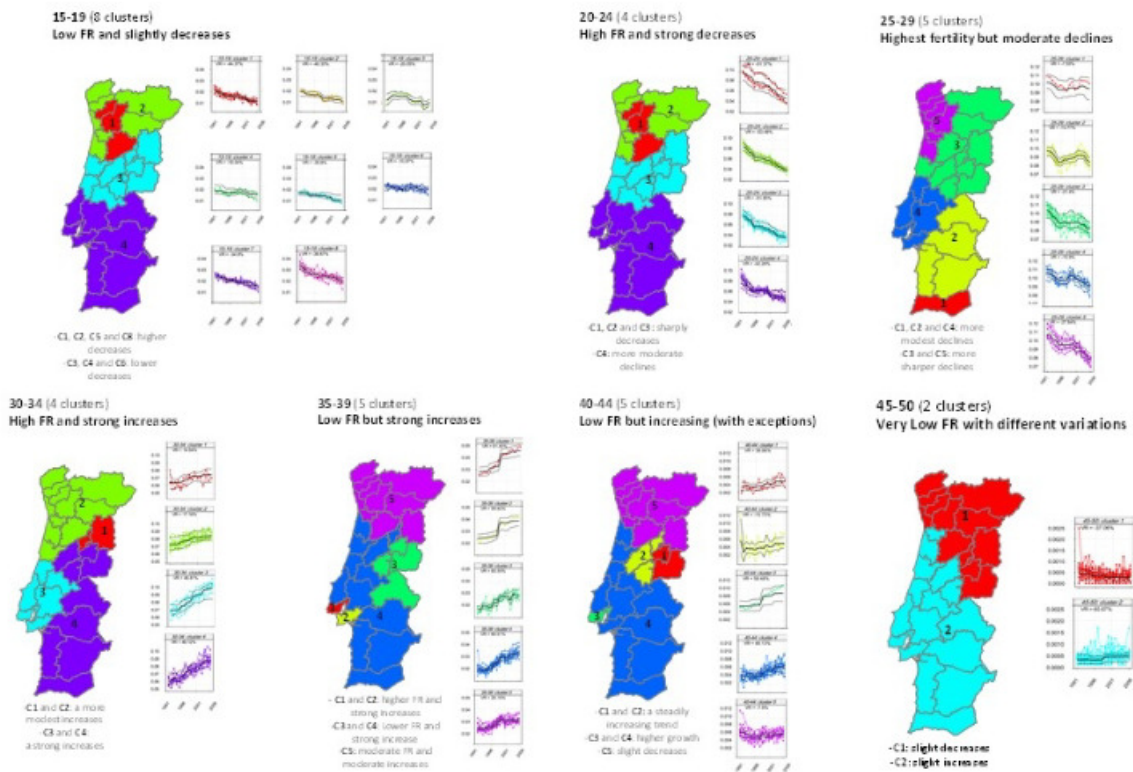
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Figure 1



Research approaches and public policy challenges

Figure 2



Estimated clustering configurations by quinquennial age groups