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DISCUSSION PAPER SERIES

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ABSTRACT

Caring Connections in Italy: The Role of Immigrant Caregivers in Improving the Welfare of Elders and Reducing Public Health Costs

We examine the impact of migrant-provided home-based care on elderly health in Italy, focusing on hospitalisation frequency, length of stay, and mortality. To address potential endogeneity between local health conditions and immigrant settlement , we use an instrumental variable approach. Our results show that an higer supply of migrant caregivers reduces both the frequency (extensive margin) and duration (intensive margin) of hospital admissions. One percentage point increase in the immigrant-to-elderly population ratio leads to a 4% decline in long-term and rehabilitation inpatient admissions, with no effect on acute inpatient. We also find a 1.5% reduction in average admission duration, rising to 3.3% for LRI cases. These effects are primarily driven by diagnoses related to traumatic injuries, musculoskeletal and genitourinary conditions—areas closely linked to home-based mobility and care management. Back-of-the-envelope calculations suggest that the observed 1.3 percentage point average annual increase in the migrant-to-elderly ratio during our study period corresponds to an estimated 9% reduction in elderly LRI hospitalisation costs, yielding annual public savings of approximately 0.66% of total hospitalisation expenditures.

JEL Classification: F22, H51, I11, I18, J14, J61

Keywords: ederly, home-based care, immigration, long-term care

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1. Introduction

The economic impact of immigration has been the subject of extensive academic literature, with a primary focus on labour market effects. Less attention has been paid to the impact on domestically produced goods and services and on the allocation of household time. A substantial share of low-skilled immigrants specializes in the provision of domestic services that substitute or complement the time devoted by the household members to domestic production.

At the same time, population aging across Western societies has led to a growing demand for long-term care (LTC) [1] services. Consequently, many elderly individuals rely on informal non-specialized home-based care provided by family members, given the limited capacity of the formal (public) care system. Such informal care is essential for supporting daily activities, managing medications, and maintaining health, thereby reducing the likelihood and duration of hospitalisation (Barnay & Juin, 2016; Charles & Sevak, 2005; Van Houtven & Norton, 2004). There is also an indirect effect of informal care on the health status of the elderly that is generally overlooked. The presence of a caregiver reduces social isolation and thus contributes positively to health dynamics and mortality (Fawaz and Mira, 2023).

However, demographic and socioeconomic trends—including declining fertility and rising female labour force participation—are diminishing the availability of family-based informal care. Households are, therefore, increasingly turning to paid home-based care. While countries such as Germany, France, and the UK rely on formal providers such as NGOs or private firms, Southern European countries—including Italy, Spain and Greece—depend more heavily on domestic workers, with immigrants comprising a large share of this workforce. In Italy, immigrants account for approximately 60% of domestic workers and 80% of live-in caregivers (Mariani & Rosati, 2022). Recent immigration flows have helped to fill gaps in LTC provision, yet little is known about the implications of this shift for elderly health outcomes or the health care system more broadly. Bettin & Sacchi (2020) provide some evidence, but comprehensive causal evidence remains scarce.

[1] Throughout this paper, we will use the following terminology: Acute Inpatient (AI) stays, which refer to hospitalizations for serious and urgent conditions requiring immediate treatment, such as trauma, heart attacks, or emergency surgeries; Long-Term and Rehabilitation Inpatient (LRI) stays, also known as Post-Acute Care, which provide ongoing medical treatment or rehabilitation in hospital settings for patients who are stable but still require care following an acute hospitalization; Length of Stay (LoS), which denotes the number of days from admission to discharge; and Long-Term Care (LTC), which refers to non-hospital care provided in nursing homes or home-based settings for individuals needing assistance with daily living activities, though not necessarily requiring continuous medical supervision.

To address this gap, our study analyses the impact of immigrant-provided home-based care in Italy on various adverse and costly health outcomes, including hospitalisations, their duration, and mortality rates among the elderly population. We also provide estimates of the potential fiscal savings associated with reduced reliance on inpatient care. The relationship between elderly home-based care and hospitalisation is complex, depending on factors such as the health condition of the care recipient, the availability and competence of non-specialized home caregivers, and the quality and availability of alternative care options. Non-specialized home-based care can play a crucial role in identifying early symptoms, managing chronic conditions, promoting healthy behaviours, supporting medication adherence, and facilitating post-hospitalisation recovery (Kemper et al., 2008; Costa-Font et al., 2018). In addition to improving health outcomes directly, such care can reduce the utilisation and cost of inpatient services (Rice et al., 2009; Weaver & Weaver, 2014). Rice et al. (2009) show that home-based care can mitigate the inefficient utilisation of long-term hospital services. Similarly, Weaver & Weaver (2014) find that the presence of informal care, while not necessarily reducing the likelihood of hospitalisation, significantly shortens the Length of Stay (LoS) in hospital.

For our analysis, we use the Hospital Discharge Dataset ("Schede di Dimissione Ospedaliera" – SDO) which includes all publicly funded hospitalisations across public and private facilities between 2006 and 2015 at the province level (NUTS-3). The SDO contains detailed information on both the sociodemographic and clinical aspects of each hospitalisation, such as diagnosis, procedures, duration, and tariffs that allows the calculation of the relevant costs. We merge these data with provincial-level (NUTS-3) measures of the immigrant-to-elderly population ratio, defined as the number of immigrants aged 15–64 relative to natives aged 65 and over.

A key empirical challenge arises from the potential endogeneity of immigrant location choices. Immigrants may self-select into areas with higher demand for care or better health infrastructure. To address this, we implement an instrumental variable strategy based on a shift-share (Bartik-style) design à la Card (Altonji & Card, 1991; Card, 2001), leveraging historical settlement patterns of immigrants across Italian provinces. We rigorously assess the validity of our instrument following the recent literature on Bartik instruments (Borusyak et al., 2022; Goldsmith-Pinkham et al., 2020) and confirm the plausibility of our instrument. To further test the soundness of our research design, we use the long-difference variation of the distribution of immigrants and of the outcome variables over the period of our analysis (between 2006 and 2015). Then, to address possible concerns about reverse causality, we conduct a placebo test for the period 2001–2005 showing that the instrument-predicted

change in the immigrant share over the period does not correlate with the variation in our main outcome variables in the previous period.

We show that home-based care provided by immigrants has the potential to generate savings in inpatient healthcare expenditures through two distinct channels. First, on the extensive margin, we find that a one percentage point increase in the immigrant-to-elderly ratio leads to a reduction of approximately 118 long-term and rehabilitation inpatient (LRI) hospitalisations per 100,000 elderly residents—equivalent to a 4% decrease from the baseline. No statistically significant effect is found for acute inpatient (AI) stays. Second, on the intensive margin, the same increase in immigrant presence results in a 1.5% reduction in average length of stay, with an even larger effect of 3.3% for LRI hospitalisations. These reductions are primarily driven by cases involving traumatic injuries, musculoskeletal disease, and genitourinary disorders—conditions particularly sensitive to the quality of home-based support. Moreover, we also observe a significant reduction in mortality, especially for female.

Considering both the intensive and extensive margins, a back-of-the-envelope calculation, indicates that the annual increase in the migrant-to-elderly population ratio (averaging 1.3 percentage points annually during our analysis period) accounts for roughly 9% LRI hospitalisations expenditures dedicated to the elderly observed in the study. The inflow of immigrants over our study period may have resulted in annual savings to the public budget equivalent to approximately 0.66% of total expenditures on hospitalisation. These effects are likely to become more important over time, especially given the pace of demographic aging in Italy, implying potentially larger future savings and growing reliance on migrant-provided LTC.

2. Long-term care for the elderly in Italy

According to the OECD,[2] Italy's health expenditure in 2019, covering all functions, amounted to 8.7% of GDP, in line with both the OECD and the EU averages. In the same year, Italy allocated approximately 1.7% of its GDP to public spending on LTC, slightly exceeding the EU average of 1.6%. While these figures remained stable in the years leading up to 2019, they showed a significant increase in 2020 due to the Covid-19 pandemic, posing a great challenge to the sustainability of the public LTC.

[2] https://www.oecd.org/health/ (last accessed on 29th January 2024)

Italian public LTC is structured around two schemes: public provision of services, and cash caregiving allowances. Cash allowances account for a large share of the funding (52% in 2019) and consist of monthly payments disbursed to individuals with disabilities or severe dependency, irrespective of their income (NNA, 2021).[3] Financed through general taxation and managed by the central government, they provide assistance to roughly 11% of the population aged 65 and above.

Public provision of services is managed by local health authorities and encompass Integrated Home Care (Assistenza Domiciliare Integrata - ADI), and Home Care Service (Servizio di Assistenza Domiciliare - SAD). ADI provides medical, nursing, and rehabilitation services to individuals lacking self-sufficiency, facing frailty, and/or suffering from chronic illnesses. On the other hand, SAD is primarily dedicated to the essential needs of the elderly population, such as personal hygiene, dressing, mobility, and medication management. The coverage rate of these services is significantly lower compared to cash transfers, with residential care reaching approximately 3% of the potential beneficiaries and home-based care around 5% of the target population. The challenge of ensuring sufficient public home-based care for the elderly is particularly pronounced in Southern regions, where the scarcity of formal public services and low employment rates compel families to take on the responsibility of organising alternative care arrangements, increasingly relying on informal caregivers (Melchiorre et al., 2021).

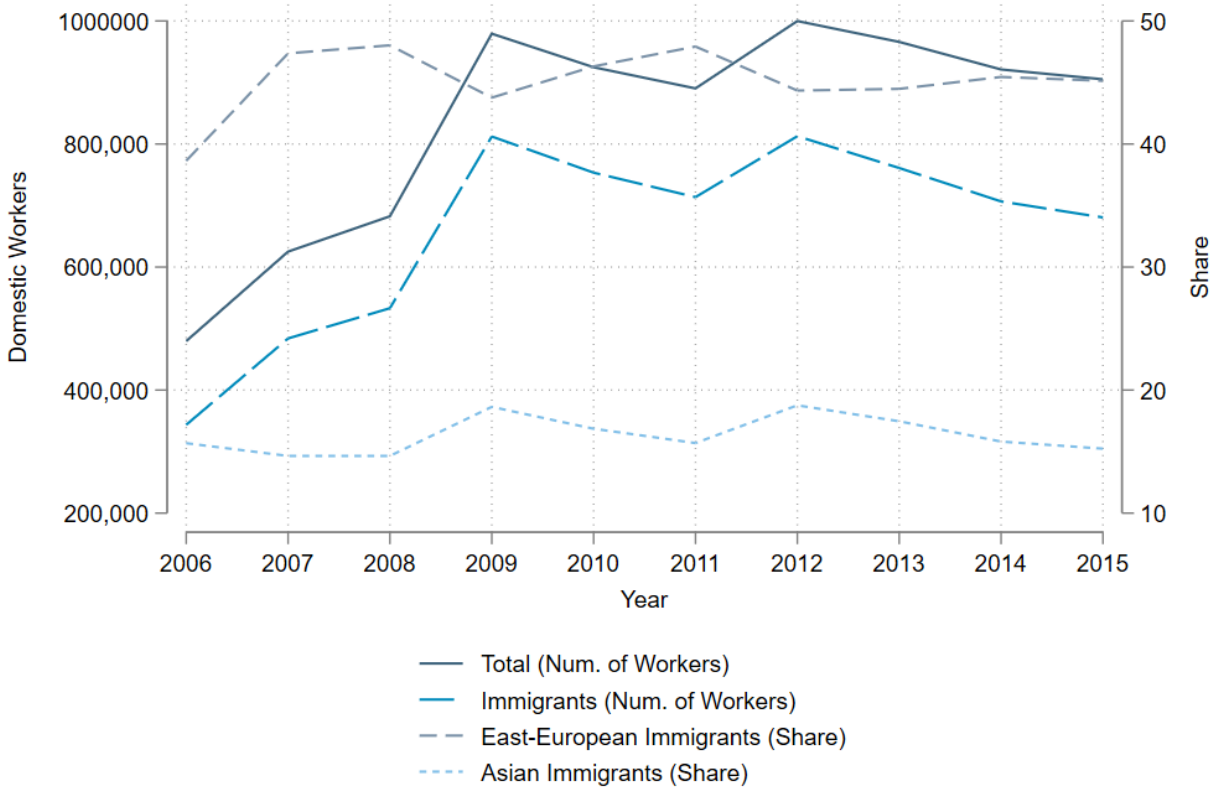
The Italian family model traditionally relies on family members to care for the elderly. Women, in particular, represent about 57% of informal home-based LTC providers, frequently reducing their working hours or exiting the workforce to care for their relatives (Peri et al., 2015). In 2020, informal caregivers accounted for around 10% of Italy's total population and 13% of its labour force, devoting roughly 20 hours per week to caregiving duties (NNA, 2021).

Although the public sector offers support to informal caregivers, such as paid leave, tax deductions, and vouchers for hiring domestic workers, these measures are often inadequate and unequally distributed across regions. Consequently, many informal caregivers rely on paid domestic work to supplement or replace the time they dedicate to elderly care. As of 2015, the last year of our sample, according to data from the Italian National Institute for Social Security (Istituto Nazionale Previdenza Sociale – INPS), there were 905,224 domestic workers with a regular work contract, of which more than 75% were immigrants and approximately 85% were women (DOMINA, 2022). The main regions

[3] Cash transfers for LTC are not subject to conditionalities on the use but only on the assessed need.

of origin of the foreign domestic workers are Eastern Europe, accounting for approximately 45% of the sectoral workforce, and Asia, accounting for a further 15% (see Figure 1).

Figure 1: Domestic Workers in Italy (2006-2015)



Notes: Author's elaboration on INPS data obtained from "National Observatory on Domestic Work" (DOMINA, 2022). *The definitions of domestic workers follow the ILO standard classifications, referring to individuals who perform work in or for a private household or households on a full-time or part-time basis as live-in or live-out workers.*

The presence of migrant caregivers in Italy has become widespread and they are commonly referred to as *badanti* (derived from *badare*, meaning "to care for"). These caregivers assist elderly individuals with daily tasks such as personal hygiene, meal preparation, companionship, and mobility. Often living with those they care for, *badanti* provide continuous, round-the-clock support, enabling the elderly to remain in their homes rather than relocating to nursing facilities.

Various data sources can be used to approximate the supply of domestic workers in the economy. These include data from the National Institute for Social Security (INPS) on regular employment contracts, the Labour Force Survey (LFS), which covers both employed and unemployed workers, and administrative records on resident foreigners (*popolazione residente*). The latter require mandatory registration with local authorities, providing a comprehensive and reliable measure of migrant stocks

over time and across provinces. We briefly compare these sources and justify our choice of variable for the estimates.

To assess the supply of informal caregivers in Italy, we rely on administrative data from the Italian National Statistical Institute (Istat). This dataset includes information on regular migrants aged 15 to 64 who resided in Italy between 2006 and 2015. Using data on regular migrants offers several advantages over alternative sources.

First, the yearly stock of migrants, disaggregated by country of citizenship, has been available since 2006. This longitudinal dataset can be linked to the 1991 census, enabling us to compute the instrumental variable required for our identification strategy (see Section 4.2 for details on the empirical specification and instrument validity).

Second, administrative data provide a more accurate representation of the actual supply of informal caregivers than other sources. In contrast, INPS data capture only formal employment contracts, yet nearly half of domestic workers in Italy do not have a contract despite being legal residents in many cases (DOMINA, 2022). As illustrated in Figure 2, INPS data show two notable spikes in 2009 and 2012, coinciding with amnesty laws that allowed migrants already residing in Italy to regularize their employment. Specifically, Law 102/2009 enabled migrants working in domestic services without a formal contract to legalize their employment status, significantly affecting the formalization of the sector. Law 109/2012, on the other hand, was a regularization program (*sanatoria*) that allowed irregular migrants to formalize their status through proof of employment. While this initiative had a broader impact on migrant workers across various sectors, its effect on overall contract numbers was more muted compared to Law 102/2009, which specifically targeted domestic workers.

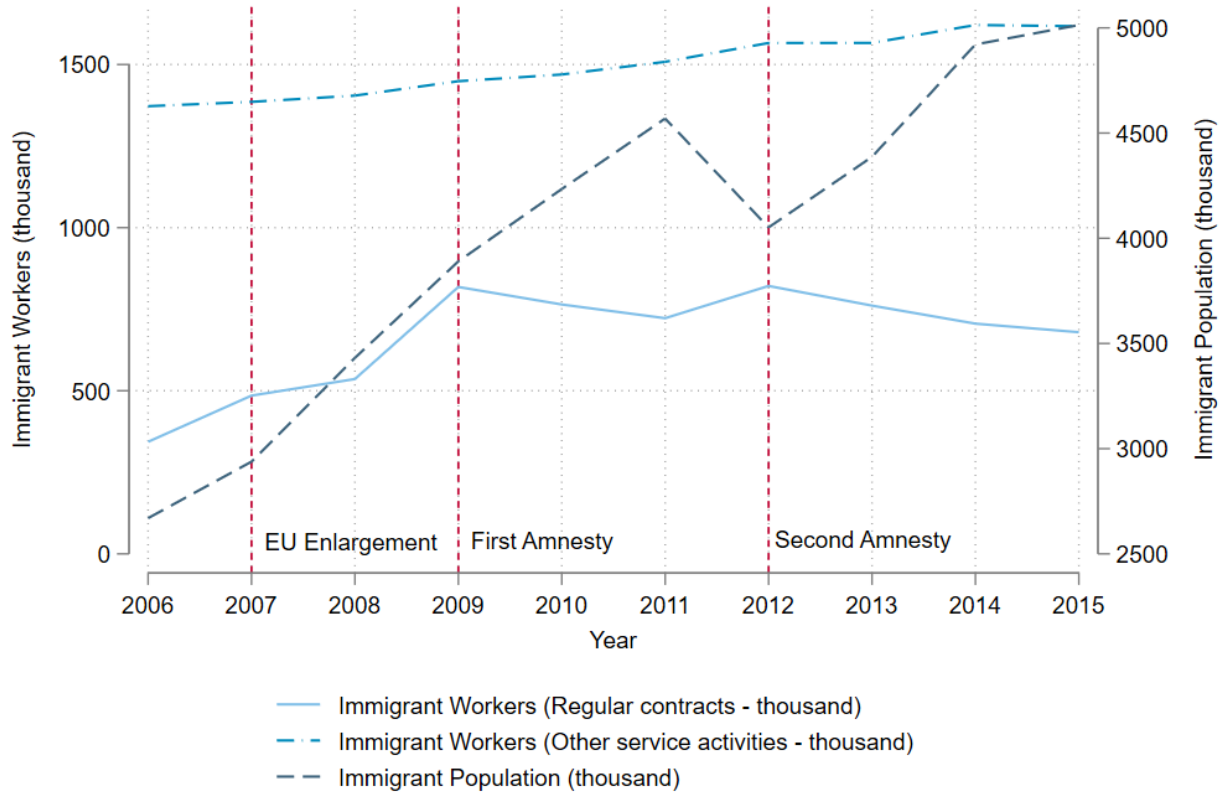
Lastly, and again in contrast to INPS data, LFS data are based on broad sectoral classifications, making it difficult to isolate caregiving services. Trends observed in LFS data between 2006 and 2015 diverge from those seen in other sources, likely due to the aggregation of caregiving with other occupational categories (see in Figure 2 the light blue dotted line, “other service activities”).

In summary, data on resident regular migrants offer a clearer and less noisy measure of the supply of informal caregivers than INPS and LFS data. This dataset includes workers with and without formal employment contracts and more accurately reflects shifts in the supply of caregiving services to the households. To further validate this choice, we examined the sectoral distribution of newly arrived

migrant workers (Figure 3), revealing that half of new migrants were employed in household services ("Other services").[4] This underscores the crucial role of immigrants in Italy's caregiving workforce. Given data availability, the presence of migrants serves as the best indicator for measuring the supply of informal caregivers in Italy.

As a robustness check we also used the numbers of labour contracts for domestic services provided by INPS in the estimates. The results (available on request) are fairly similar to those presented here, albeit for obvious reasons the F test for instruments validity is substantially lower. More specifically, we cannot replicate the instrumental variable using the INPS dataset since, for reasons of confidentiality, we do not have information on the exact workers' nationality. This is an additional reason to rely on administrative data to calculate the instrumental variable.

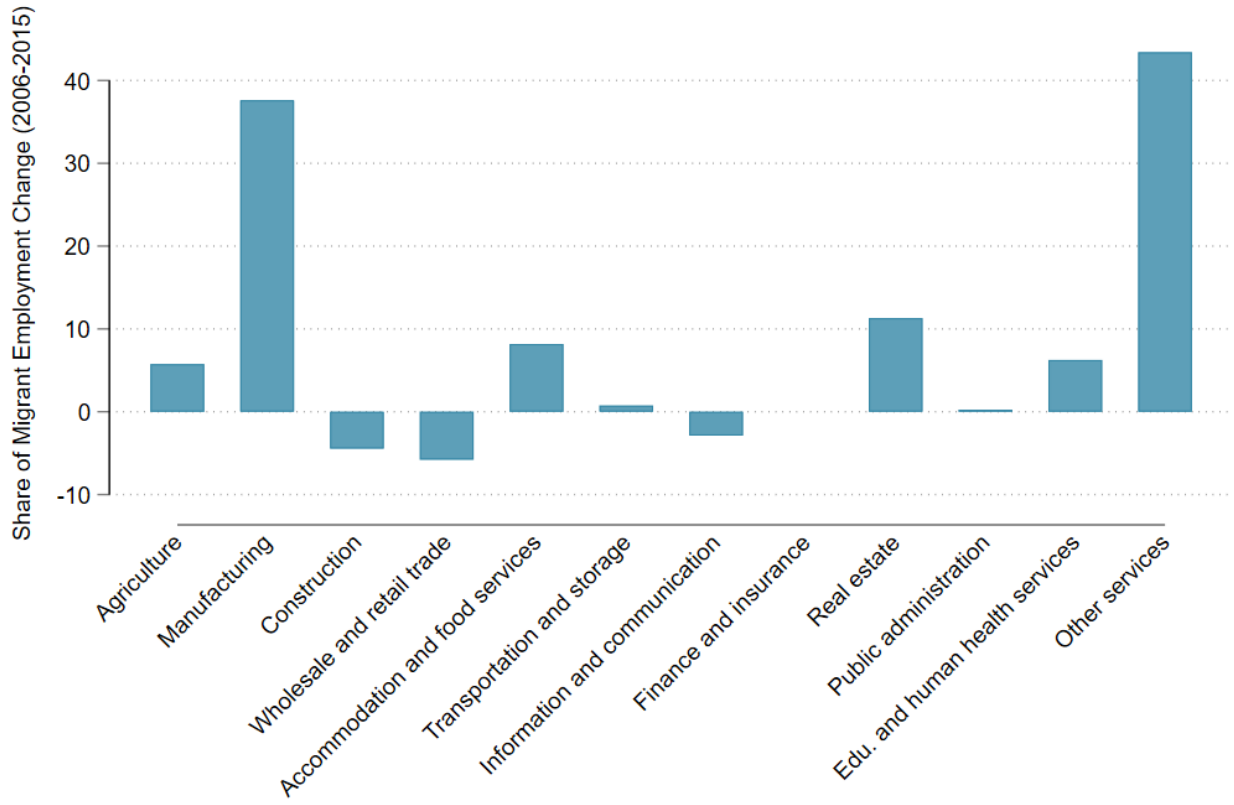
Figure 2: Comparing different data sources on the supply of informal caregivers (2006-2015)



[4]During the period of analysis, new migrants in Italy show a strong specialization in two sectors: Other services and, to a lesser extent, Manufacturing. In some sectors, the change is negative, indicating a shift in labour supply from these sectors (namely, Construction and Wholesale and retail trade) to Other services and Manufacturing.

Notes: Authors' elaborations on INPS and Istat data. INPS data are obtained from "National Observatory on Domestic Work" (DOMINA, 2022). Data on immigrant workers employed in "Other service activities" sector (Letter T of NACE Rev. 2) are available from Istat (http://dati.istat.it/), as well as data on the immigrant population living in Italy.

Figure 3: Distribution of the change of migrant employment by sector (2006-2015)



Notes: Authors' elaboration on LFS data (Istat). Each bar represents the ratio between the sectoral variation of the migrant employment and the overall variation of the migrant employment over the period 2006-2015.

Recent studies focusing on the immigrant population in the United States and Germany have observed an increasing specialisation of immigrants in delivering formal institutional LTC within nursing homes. Furtado & Ortega (2024) and (Grabowski et al., 2023) document that a higher presence of immigrant among nursing home workers results in increased utilisation rates and better health outcomes for residents, particularly in settings with a higher proportion of Hispanic staff. While Italy's reliance on immigrant workers in institutionalized LTC is low, primarily due to regulatory and training barriers that limit their participation, the country heavy dependence on migrants for home-based care offers a unique context for our study.

In Italy, immigrants have significantly affected the provision of domestic informal care services, thus affecting the demand for institutionalised LTC and complementing the efforts of household members

involved in caregiving and domestic activities. To the best of our knowledge, the role of immigrants in providing paid home-based care has been largely overlooked in the existing literature. We will make use of the variation in the availability of domestic services across space and time, due to differences in the number of working-age immigrants in Italy to study the effect of paid home-based services on elders' health.

3. Data

The core of our analysis is conducted using Hospital Discharge Data (SDO) spanning from 2006 to 2015,[5] collected by the Italian Ministry of Health. The data refer to all publicly-funded hospitalisations within public and private hospitals. Italy's universal public healthcare system offers free hospitalisations, eliminating cost barriers and selection mechanisms, providing an ideal setting for the analysis.

The SDO data provide extensive information about hospitalisations, including their type, the primary and secondary diagnosis, procedures, and discharges, as well as various socio-demographic characteristics such as age, gender, nationality, place of birth, and residence.

We focus on the hospitalisations of Italian citizens aged 65 and over. Following the standard classification of admissions, we distinguish between Acute Inpatient (AI) stays, which refer to hospitalizations for serious and urgent conditions requiring immediate treatment, such as trauma, heart attacks, or emergency surgeries, and Long-Term and Rehabilitation Inpatient (LRI) stays, also known as Post-Acute Care, which provide ongoing medical treatment or rehabilitation in hospital settings for patients who are stable but still require care following an acute hospitalization

We focus on both the incidence and the duration (Length of Stay - LoS) of AI and LRI stays. In particular, we consider the ratio of both kinds of hospitalisations to the native population aged 65 and above for each province-year pair. The average LoS is computed by dividing the total number of hospitalisation days in a province-year pair by the number of hospitalisation events.

[5] The data collection starts in 2004. Nonetheless, to have a sufficient time span to carry out pre-trend tests, we exclude the first two years from the main analysis.

Based on the International Statistical Classification of Diseases and Related Health Problems (ICD-9) codes, we group the hospitalisations in eight major diagnostic groups.[6] For the disease-specific subgroups of hospitalisations, we compute the frequency and the average LoS as discussed above. Finally, as an additional and comprehensive health outcome, we rely on age-standardized mortality data obtained from the database Health for All by the Italian National Statistical Office (Istat). Our analysis focuses on mortality among individuals aged 75 and older, available for the years 2003-2016. As shown in Table 1 (Panel a), the annual average of hospital discharges per 1,000 residents aged 65 and older is 395. AI cases show an average of 367 cases, while LRI discharges constitute a significantly smaller proportion averaging nearly 28 stays per 1,000 residents above 65 years of age. On average, hospitalisations last around 10 days, with AI stays lasting about 9 days and LRI admissions averaging 29 days. According to Panel (b) of Table 1, age-standardized mortality among individuals aged 75 and older averages 643 deaths per 10,000 residents for women and 790 deaths for men, with the overall mortality rate being 716 deaths per 10,000 residents.

Table 1: Descriptive statistics on hospitalisations and mortality

	Obs.	Mean	St. Dev.
Panel a: Hospitalisations			
Hospitalisations per capita (All cases)	1030	0.395	0.073
Hospitalisations per capita (AI)	1030	0.367	0.0709
Hospitalisations per capita (LRI)	1030	0.028	0.013
Average Length of stay (All cases)	1030	10.299	1.441
Average Length of stay (AI)	1030	8.635	0.926
Average Length of stay (LRI)	1030	29.005	6.285
Panel b: Mortality			
Mortality (total)	1030	716.301	42.503
Mortality (women)	1030	643.344	41.981
Mortality (men)	1030	789.494	49.554

Notes: The data refer to 103 provinces spanning the time period from 2006 to 2015. Statistics in Panel (a) are derived from an initial sample of hospital discharges within the entire population of Italian citizens aged 65 and older, accounting for approximately 4 million hospitalisations annually. Statistics are weighted by the relevant province 65+ population size. Data in Panel (b) refer to official Istat province-level age-standardized mortality for 10,000 individuals aged 75 and older for the same period. AI refers to Acute Inpatient stays, while LRI to Long-Term and Rehabilitation Inpatient stays.

The main explanatory variable included in the analysis is the number of immigrants of age between 15 and 64 as a ratio of the native population over 65 obtained from the administrative data collected by

[6]Mental Disorders, Cancers, Nervous System Disorders, Circulatory Disorders, Respiratory Disorders, Genitourinary Disorders, Musculoskeletal Disorders, and Traumatic Injuries.

the Italian statistical institute (Istat). Additionally, we employ a set of province-level controls that account for the time-varying local socio-economic and demographic characteristics: per-capita income, the share of widows and widowers in the population over 65.[7] Table 2 presents the relative summary statistics.

We combine hospitalisation and mortality data with the administrative data on the number of immigrants and other characteristics, creating a balanced panel of 103 provinces over the period 2006-2015, for a total of 1030 observations.

Table 2: Descriptive statistics of migration and other province-level data

	Obs.	Mean	St. Dev.
Share of immigrants	1030	24.2	0.118
Instrumented Share of Immigrants	1030	33.8	0.300
Income pc (log)	1030	13.726	0.830
Widowers (%)	1030	1.633	0.725
Widows (%)	1030	2.287	0.957
Population over 65 years (weight variable)	1030	113.741	115.081

Notes: The statistics refer to 103 provinces spanning the time period from 2006 to 2015. The number of immigrants is expressed as a ratio to the resident population aged 65 and older and reported in the table for 100 individuals. The statistics concerning immigration are weighted by province 65+ population size. Population 65 and older is used as weight variable, and it is expressed in thousands.

4. Empirical analysis

4.1 Conceptual Framework

Framing our analysis in the Grossman (1972) model, we assume that investment in health is obtained through the use of four inputs: hospital care, informal LTC (provided by relatives), and non-specialized home-based LTC (provided through services by hired non-specialized personnel, co-resident or not) and formal care in hospitals or nursing homes.

In the case of informal LTC provided by relatives, the price is given by the opportunity cost of time, while the price of hospital care and nursing homes might include, besides the out-of-pocket expenditures, the monetary value of the disutility of being in a institutional setting rather than at home.

[7] In a further robustness test we also control for the share of native women aged between 45 and 64 as ratio of native population over 65 (see Appendix C). According to NNA (2022) this group consists of about 57% of total informal caregivers in Italy. Therefore, with this specification, we show that the impact of home-based care is robust also when we net out the presence and availability of informal caregivers.

To analyse the effects of a change in the supply of market provided informal care on the welfare of the elders would, in principle, require to assess how the other forms of care are affected, to consider also the indirect effects on the overall care provided. The analysis of the supply of informal care by family members and its relationships with market and publicly provided formal and informal care depends substantially on how the link between the elder and her family members (typically the offspring), are modelled. As shown in the survey by Klimaviciute & Pestieau (2023), the results depend crucially on the assumptions relative to the presence of altruism and on its direction (ascending, descending or bilateral). Moreover, this theoretical literature has mostly, if not exclusively, considered only formal care provided in public or private institutions as an alternative to informal care provided by family members.

The absence of data with the necessary granularity on the time devoted by relatives to informal care, does not allow us to attempt to identify the indirect effects of an increase in paid informal care and to distinguish among the different models[8]. Our estimates, therefore, are fully reduced forms with the parameters subsuming the different "structural" effects. For example, if paid household care is a substitute for care provided by household members, the estimates will reflect the impact of the increase in the supply of paid care net of any possible substitution effects as well as any effect due to the different "quality" of the various forms of care.

In the estimates, however, we control for some of the characteristics of the household that might affect the provision of care.[9]

In what follows, we thus carry out reduced form estimates of the impact of home-based LTC provided by hired migrant workers on the use of hospital care, as proxied by the hospitalisation episodes and duration, and on the health status of the elders, proxied by the age-standardized mortality rate.

4.2 Identification strategy

The presence of immigrants is likely to be endogenous to the use of formal care and the health status of the elderly population. Immigrants might self-select based on their willingness and ability to provide quality healthcare in locations with growing demand for domestic workers, associated with the

[8] Some of the model that use various version of the altruistic model are also observationally equivalent.

[9] In particular, we consider the initial shares of widows and of widowers as proxies for (the lack of) family members as well as the average female labour force participation at provincial level to control for some factors affecting the potential supply of care by the household members.

increasing needs of the elderly. This is likely to exert an attenuation bias on the estimation of the impact of the arrival of immigrants on the health status of the elders.

A similar and mirrored selection mechanism could drive the elders in need of assistance to move to places where the supply of non-institutionalized care is growing. Moreover, immigrants and the elderly might both be influenced by changes in local conditions such as socio-economic factors, neighbourhood characteristics, or healthcare infrastructures. For example, provinces with worsening economic prospects might attract fewer immigrants seeking employment and, at the same time, feature less healthy elderly individuals.

While province and year-fixed effects absorb time-invariant effects and common time trends in the estimates, the issue of a possible bias arising from time-varying omitted variables affecting both immigrants flows and health conditions concurrently remains a concern.

The mobility of individuals over 65 is very limited in Italy, with a mere 0.8 percent changing their main residence in 2017.[10] Consequently, we can consider their location to be exogenous with respect to the availability of informal care. However, this assumption does not hold for immigrants, who select their location upon arrival and exhibit a relatively high rate of subsequent mobility (Mariani et al., 2023).

To mitigate potential endogeneity stemming from immigrants' location and time-varying omitted-variables, we adopt an instrumental variable (IV) approach. Specifically, we use a version of the Card instrument, pioneered by Altonji and Card (1991) and further developed by Card (2001), which exploits the different timing and size of migrant inflows by origin, distributing them across provinces on the basis of the 1991 shares of immigrants by origin. As shown in recent literature (Borusyak et al., 2021; Goldsmith-Pinkham et al., 2020) this *shift-share* instrument can be considered exogenous, conditionally on a set of validity tests that we perform and discuss in section 5.3.

More precisely, our instrument uses the shares observed in 1991 of immigrants coming from ten different world regions (North Africa, Other Africa, East Europe, Asia, South America, Oceania, North America, and Western Europe) and is defined as:

$$Z_{i,t} = \sum_m \lambda^m_{i,1991} \times Imm^m_{ITA,t} \quad (1)$$

[10] https://demo.istat.it/ (last access 8th April 2024)

where $\lambda_{i,1991}^{m}$ is the share of immigrants observed in 1991 in province i from region of origin m, and $Imm_{ITA,t}^{m}$ is the stock of working-age immigrants in Italy at time t from region of origin m.
Consequently, the second-stage equation takes the following form:

$$H_{i,t} = \beta_1 \widehat{M_{i,t}} + \beta_2 X_{i,t} + \lambda_i + \tau_t + \epsilon_{i,t} \quad (2)$$

where $H_{i,t}$ denotes one of the health outcomes (hospitalisations frequency, average LoS, and mortality) in province i and year t. $\widehat{M_{i,t}}$ indicates the instrumented share of immigrants aged 15-64 as a ratio of the population aged 65 and older, and $X_{i,t}$ is a vector of control variables at the province level, including per-capita income, the percentage of widows, and the percentage of widowers. λ_i and τ_t are province and time fixed effects, respectively.
We test the validity of our instrumental-variable approach in several ways, many of which leverage the variation in both immigrant share and health outcomes over the whole period, namely the overall change between 2006 and 2015. Therefore, we first show that the long-difference specification between 2006 and 2015 yields comparable results to the main specification, which instead exploits yearly variations.
Using this result as a benchmark, we mitigate reverse causality concerns by controlling for the fact that the instrument-predicted change in immigrant share during our analysis period (2006-2015) does not explain variations in the main outcome variables in the pre-sample period. Additionally, we explicitly test for the exogeneity of the initial (1991) immigrant shares, which may potentially be endogenous to local economic and health conditions. In particular, it is crucial to rule out any spurious correlation between past shares and persistent trends in local economic and health conditions. To this aim, following Goldsmith-Pinkham et al. (2020), we check whether the 1991 shares are exogenous and not correlated with pre-treatment trends.
Lastly, we confirm the robustness of our results by controlling for lagged changes in outcome variables (between 2001 and 2005 for hospitalisations frequency and average LoS and between 2003 and 2005 for mortality), as in Dix-Carneiro et al. (2018). This specification helps mitigate concerns regarding pre-existing trends in the health status of the elderly that could be correlated with future migration shocks.

5. Results

5.1 Instrumental variable results

As *prima facie* evidence of the relevance of the instrument, we show the results of the first-stage regression. As displayed in Table 3, the coefficient of the instrumental variable described in equation (1) in section 4.2, is positive and significant, and the weak IV test (the Kleibergen- Paap rk Wald F statistics) is high at around 17.

Table 3: First-Stage Regression

	Share of immigrants
Instrumented share of immigrants	0.184***
	(0.045)
Observations	1030
Number of provinces	103
Year FE	YES
Province FE	YES
Controls	YES

*Notes: Authors' own calculations on Health Ministry's and Istat data. The reported coefficient comes from a panel fixed effects model at the province level for the years 2006-2015. The dependent variable is the ratio between the working-age immigrant population over the native population aged 65 and older. The control variables include: the (log of) income per capita, and female and male widow shares (%). The regression is weighted by the province population 65+. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

The exclusion restriction of the instrument hinges on the assumption that the 1991 distribution of immigrants by area of origin across provinces is not correlated with hospitalisation and mortality in the period under analysis (2006-2015), except through its impact on current immigration. As mentioned earlier, we carry out several tests to substantiate this assumption, detailed in section 5.3. Before that, we present the results of the 2SLS estimations assessing the impact of immigrant workers on the health conditions of the elderly.[11]

5.1.1 Hospitalisations

The coefficient estimates reported in Table 4 suggest that the presence of migrants does not affect the overall hospitalisation rate; however, when we disaggregate them by AI and LRI stays, we find that the latter are significantly and negatively affected by the presence of immigrants. An increase of one

[11] In appendix we show the OLS results.

percentage point in the ratio between the number of working-age immigrants and the native population over 65 (e.g., from 0.242 to 0.252) leads to a reduction of around 118[12] LRI cases per 100 thousand elderly residents, representing roughly 4% of the baseline average. This is not surprising as acute (AI) stays typically address conditions that require specialized intensive medical care and can be hardly substituted by non-specialised home-based care. As Bolin et al. (2008) show, informal care is unlikely to replace formal acute care when specialized medical expertise is required. On the contrary, for long-term and rehabilitation inpatient cases, to a certain extent, home-based care can represent a viable substitute. In such less severe cases, informal care can either substitute for hospitalizations or complement lower levels of formal care, such as doctor visits or medical check-ups. In fact, when a patient's medical needs are manageable at home, adequate caregiver support and home adaptations are available, and the patient prefers to stay in a familiar environment, home-based LTC can substitute for long-term inpatient stays. Importantly, the OLS estimates presented in Appendix Table B.1 indicate the presence of a selection bias. The OLS results show indeed a positive correlation between the share of immigrants and the number of AI episodes. Arguably, immigrants tend to settle in provinces where the health status of the elderly is relatively poorer and the demand for their services higher.

5.1.2 Average LoS

Interestingly, the total average LoS in the hospital setting is reduced by the presence of immigrants, as shown in Table 5. An increase of one percentage point (e.g., from 0.242 to 0.252) in the ratio between the working-age immigrants and the native population over 65 leads to a reduction of around 0.14 days in hospital stays, which represents about 1.5% at the mean duration (with the average being 10 days). The effect holds for LRI cases with a reduction that amounts to 0.96 days, roughly 3.3% relative to the average duration of around 29 days.

Indeed, the duration of LRI stays episodes appears to be most responsive to the availability of home-based care. This is because hospital discharges can happen sooner if elderly individuals receive assistance at home for medical treatments, basic daily activities, and outpatient medical visits, thereby reducing the necessity for prolonged hospital stays, as also shown by Costa-Font et al., (2018).

When examining the different causes of hospitalisations mentioned earlier (as detailed in Section 5.2.2), it is evident that the observed effect is primarily driven by a subset of causes. For instance, there

[12] This is computed by multiplying the coefficient by 0.01 and then by 100,000 residents.

is a significant reduction of around 11 days in the length of stay for hospitalisations with primary diagnoses related to traumatic injuries, respiratory disease, and genitourinary disorders.

Table 4: Number of hospitalisations. IV results

	(1) AI & LRI	(2) AI	(3) LRI
Share of immigrants	0.0603	0.178	-0.118***
	(0.397)	(0.374)	(0.031)
Income per capita (log)	0.115	0.107	0.009
	(0.142)	(0.129)	(0.015)
Widowers (%)	0.0664**	0.064**	0.003
	(0.0336)	(0.032)	(0.005)
Widows (%)	-0.0154	-0.016	0.001
	(0.0213)	(0.020)	(0.003)
Observations	1,030	1,030	1,030
R-squared	0.675	0.685	0.121
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	17.133	17.133	17.133

*Notes: Estimates of equation 2. For each hospitalisation type, the dependent variable is calculated as the number of relevant hospitalisations over the native population 65+. In column 1 we include all hospitalisations, in column 2 we focus on Acute Inpatient (AI) stays, and in column 3 on Long-Term and Rehabilitation Inpatient (LRI) stays. The endogenous regressor is the ratio between the working-age immigrant resident population over the size of native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01.*

A reduction in the length of stay in the hospital was also found in Weaver and Weaver (2014) for informal care provided by family members. Also Van Houtven & Norton (2004) found informal care to be a substitute to LoS (given that the individual had any inpatient episode). Our results strengthen and extend this evidence for the case in which care is provided by immigrants possibly as a substitute for family members.

5.1.3 Mortality

The findings presented in Table 6 suggest that the presence of immigrants is likely to reduce the mortality rate, with the results mainly driven by the effect on women. The estimates indicate a

consistent direction of health improvements associated with the availability of immigrant workers. Beyond managing medical and clinical treatments, caregivers are also inclined to encourage healthy lifestyles. Moreover, they provide emotional support, thereby fostering overall wellbeing and the life satisfaction of the elderly (Nemitz, 2022).

The gender gradient observed in the results can be attributed to the more favourable survival pattern of women compared to men among the population aged 75 and over. On average, women tend to have a higher life expectancy, making them more likely to benefit from home-based care at older ages.

Another reason that could explain the positive effect observed only in the female sub-sample is that women are more likely than men to take on caring responsibilities at all ages, including caring for grandchildren. The carer therefore relieves older women of the disproportionate burden of care, thereby improving their life expectancy (Eibich and Zai, 2024).

Table 5: Length of stay. IV Estimates

	(1) AI & LRI	(2) AI	(3) LRI
Share of immigrants	-14.17***	-3.033	-95.66***
	(2.856)	(2.251)	(28.15)
Income per capita(log)	-1.483*	-0.668	-8.784*
	(0.835)	(0.612)	(5.327)
Widowers (%)	-0.806*	-0.735**	-1.565
	(0.466)	(0.345)	(2.848)
Widows (%)	0.0486	-0.0121	-0.236
	(0.365)	(0.432)	(1.898)
Observations	1,030	1,030	1,030
R-squared	0.076	0.153	-0.037
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	17.133	17.133	17.133

*Notes: Estimates of Equation 2. For each hospitalisation type, the dependent variable is calculated as the total hospitalisation days over the number of relevant hospitalisations. In column 1, we refer to all hospitalisations, in column 2, to Acute Inpatient (AI) stays, while in column 3, to Long-Term and Rehabilitation Inpatient (LRI) stays. The endogenous regressor is the ratio between the working-age immigrant resident population over the size of native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01.*

Table 6: Standardized mortality rates. IV estimates

	(1) Total	(2) Female	(3) Male
Share of immigrants	-189.0**	-235.4***	-142.7
	(76.57)	(67.94)	(104.5)
Income per capita(log)	-6.433	-16.52	3.653
	(34.33)	(36.21)	(37.59)
Widowers (%)	-9.409	1.852	-20.67
	(17.19)	(14.81)	(22.36)
Widows (%)	-9.999	-10.78	-9.216
	(6.513)	(6.745)	(8.192)
Observations	1,030	1,030	1,030
R-squared	0.438	0.454	0.428
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	17.133	17.133	17.133

*Notes: Estimates of Equation 2. The dependent variable is represented by age-standardized mortality for 10,000 population aged 75 and older. The endogenous regressor is the ratio between the working-age immigrant population over the size of native population aged 65 and older. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Each regression is weighted by the province population 65+. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01.*

5.2. Results by diagnostic groups

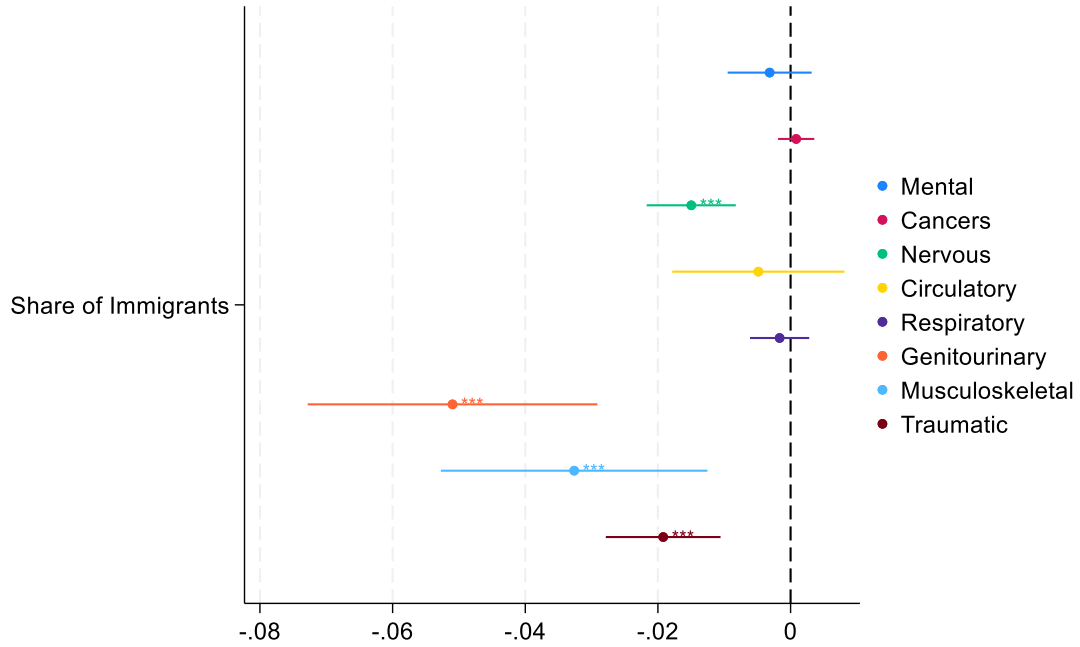
To provide a more comprehensive analysis and validate our findings, we disaggregate LRI stays into eight major diagnostic groups.

5.2.1 Hospitalisations

Figure 4 and Table 7 show that an increase in the share of immigrants leads to a reduction of LRI stays for diagnoses related to nervous system disorders, genitourinary disorders, musculoskeletal disorders and traumatic injuries. Specifically, we can observe a reduction of 51 cases every 100,000 residents related to genitourinary system disorders (column 6 in Table 7) as having the assistance of caregivers can indeed help elders with better hygiene practices. Additionally, as indicated by Rogers et al. (2008) and Lean et al. (2019), urinary infections, which are common among the elderly, may occur due to factors such as limited mobility and dehydration, both of which are likely to be alleviated in the presence of home-based care. The promotion of mobility is further evidenced by the observed

reduction in hospitalisations attributed to musculoskeletal disorders and traumatic injuries, estimated at approximately 32 and 19 cases per 100,000 residents, respectively. World Health Organization (2008) estimates that 28 to 35% of older adults over the age of 65 fall each year and accidental falls are the most common cause of all injury-related hospitalizations among older adults (Kuspinar et al., 2019). Informal caregivers can identify and modify environmental falls risk factors, as well as lifestyle in terms of diet, nutrition and exercise routines (Montero-Odasso et al., 2022). Conversely, we find no effect on the frequency of hospitalisations due to mental, cancers, cardiovascular disorders, or respiratory which seems plausible due to the more severe and acute nature of such hospitalisation events, potentially less influenced by home-based care.

Figure 4: LRI hospitalisations by major diagnostic group



*Notes: The coefficient estimates come from eight distinct IV regressions at the province-year level, each for one dependent variable defining long-term and rehabilitation inpatient (LRI) admissions for 8 major diagnostic groups: mental, cancers, nervous system, respiratory, circulatory, genitourinary, musculoskeletal, and traumatic injuries. The explanatory variable is the ratio between the working-age immigrants over the native population aged 65 and older. Each regression controls for province and year fixed effects and is weighted by the province population 65+. * p<0.1 ** p<0.05 *** p<0.01*

Table 7: IV results for LRI hospitalisations by major diagnostic groups

	(1) Mental	(2) Cancers	(3) Nervous	(4) Respiratory	(5) Circulatory	(6) Genitourin.	(7) Musculoskel.	(8) Traumatic
Share of immigrants	-0.00316	0.000841	-0.0150***	-0.00165	-0.00486	-0.0510***	-0.0326***	-0.0192***
	(0.00323)	(0.00139)	(0.00343)	(0.00228)	(0.00663)	(0.0111)	(0.0103)	(0.00441)
Income per capita (log)	-0.00106	0.000868	-0.00116	0.000286	0.00140	0.00376	0.00207	0.00124
	(0.000813)	(0.000584)	(0.00156)	(0.000641)	(0.00258)	(0.00485)	(0.00244)	(0.00263)
Widowers (%)	-5.84e-05	-0.000108	-0.000398	0.000805	0.00116	0.000207	-0.000602	0.000494
	(0.000370)	(0.000220)	(0.000472)	(0.000577)	(0.00121)	(0.00161)	(0.00143)	(0.000509)
Widows (%)	0.000519	9.67e-05	0.000266	-0.000447**	-0.000963**	0.00102	0.000975	0.000339
	(0.000537)	(0.000113)	(0.000257)	(0.000222)	(0.000435)	(0.00104)	(0.00113)	(0.000327)
Observations	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030
R-squared	0.009	0.120	0.065	0.108	0.169	0.064	0.174	0.029
Number of provinces	103	103	103	103	103	103	103	103
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES	YES	YES
F Stat	17.133	17.133	17.133	17.133	17.133	17.133	17.133	17.133

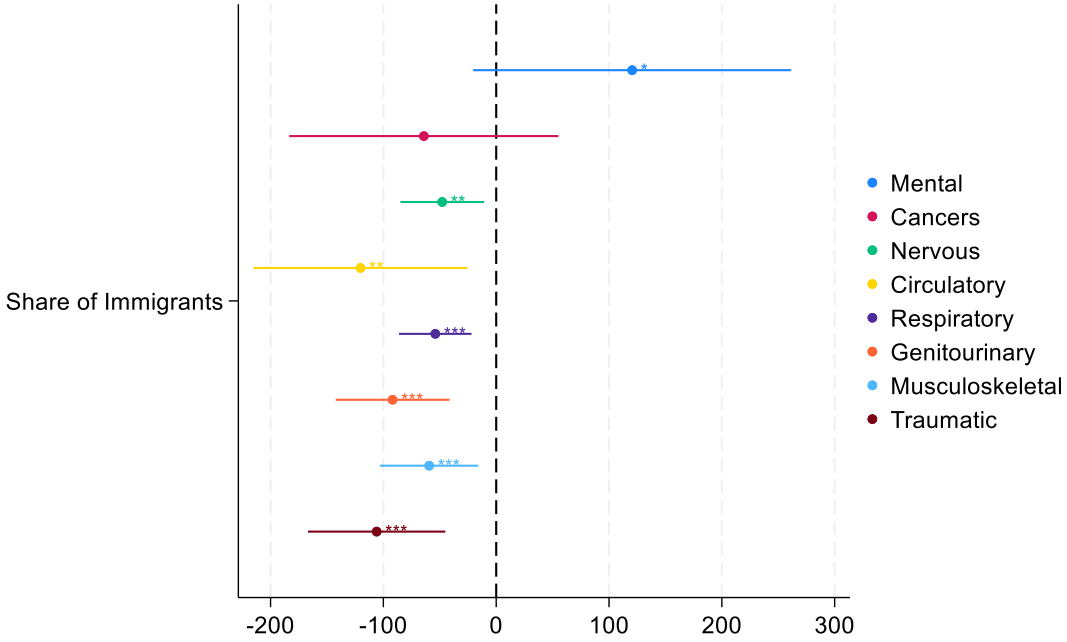
*Notes: The dependent variables are long-term and rehabilitation inpatient (LRI) admissions for 8 major diagnostic groups: mental (column 1), cancers (column 2), nervous system (column 3), respiratory (column 4), circulatory (column 5), genitourinary (column 6), musculoskeletal (column 7) and traumatic (column 8). The explanatory variable is the ratio between the working age immigrants over the native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis * p<0.1 ** p<0.05 *** p<0.01*

5.2.2 Average LoS

Concerning the length of stay of LRI episodes, Figure 5 and Table 8 show a significant reduction in the duration of stays due to nervous system disorders, circulatory disorders, respiratory system disorders, genitourinary system disorders, musculoskeletal system disorders, and traumatic injuries. In particular, the presence of immigrant home-based care is found to reduce the duration of hospital stays for traumas by around 1 day,[13] which is likely related to home-based rehabilitation, exercise, and mobility. The duration of hospital stays appears to be also reduced for disorders related to the respiratory system (by 0.54 days) and cardiovascular issues (by 1.2 days). While the two diagnostic groups do not appear to be affected by the provision of home-based care in terms of the likelihood of hospitalisation, regarding duration, we find sizeable effects likely due to the substitutability between the hospital setting and home-based care in case of issues such as medication management, oxygen therapy, monitoring, and clinical control visits.

[13] This number is computed multiplying the coefficient in Table 8 (column 8) by 0.01 (1 p.p. increase in immigrant share).

Figure 5: LRI average LoS by diagnostic groups



*Notes: The coefficient estimates come from eight distinct IV regressions at the province-year level, each for one dependent variable defining the length of long-term and rehabilitation inpatient (LRI) episodes for 8 major diagnostic groups: mental, cancers, nervous system, circulatory, respiratory, genitourinary, musculoskeletal, and traumatic injuries. The explanatory variable is the ratio between the working-age immigrants over the native population aged 65 and older. Each regression controls for province and year fixed effects and is weighted by the province population 65+. * p<0.1 ** p<0.05 *** p<0.01*

Table 8: IV results for LRI average LoS by diagnostic groups

	(1) Mental	(2) Cancers	(3) Nervous	(4) Respiratory	(5) Circulatory	(6) Genitourin.	(7) Musculoskel.	(8) Traumatic
Share of immigrants	120.5*	-64.11	-47.87**	-53.98***	-120.2**	-91.83***	-59.43***	-106.0***
	(71.94)	(60.87)	(18.90)	(16.39)	(48.34)	(25.73)	(22.23)	(31.04)
Income pc (log)	-18.80	-1.341	-3.125	-6.153	-8.502	-10.01**	-4.805	-6.266
	(17.37)	(9.333)	(7.349)	(6.002)	(6.152)	(4.533)	(4.245)	(6.214)
Widowers (%)	30.45*	-1.373	-6.209	-1.363	-0.352	-3.625	-0.900	-4.020
	(17.72)	(3.850)	(4.618)	(3.521)	(3.563)	(3.310)	(3.117)	(4.113)
Widows (%)	-18.50	-2.048	1.491	0.361	0.309	0.316	-0.477	1.142
	(14.79)	(1.980)	(2.303)	(2.125)	(2.440)	(2.122)	(1.789)	(3.018)
Observations	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030
R-squared	-0.003	0.051	0.026	-0.004	-0.093	0.013	0.056	0.015
Number of provinces	103	103	103	103	103	103	103	103
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	YES	YES	YES	YES	YES	YES	YES	YES
F Stat	17.133	17.133	17.133	17.133	17.133	17.133	17.133	17.133

*Notes: The dependent variables are long-term and rehabilitation inpatient (LRI) episodes average LoS for 8 major diagnostic groups: mental (column 1), cancers (column 2), nervous system (column 3), respiratory (column 4), circulatory (column 5), genitourinary (column 6), musculoskeletal (column 7) and traumatic (column 8). The explanatory variable is the ratio between the working age immigrants over the native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis * p<0.1 ** p<0.05 *** p<0.01*

5.3 Robustness tests for panel IV results

To conduct validity tests of our instrumental variable and assess the robustness of our estimates to alternative specifications, we require data preceding our analysis period, namely 2001-2005. For the period 2001-2003, such data are only available at the regional level. To bridge this gap, we employ a multivariate imputation approach, leveraging regional data and other controls used in the main regressions to impute provincial-level data for those years. Regarding mortality data, Istat provides standardised mortality rates at the province level from 2003 to 2015, enabling us to run similar validity tests considering 2003 to 2005 as the pre-period.

5.3.1 Validity of the shift-share instrument

The shift-share instrument has been widely used in analysing migration-related economic issues. The exclusion restriction, while not directly testable, depends on the assumption that the distribution of 1991 is not correlated with the outcomes of interest during the analysis period (2006-2015), except through its impact on current migration, known as the *network effect*.

Firstly, we exploit the variation in immigrant shares in the long difference between 2006 and 2015 to ensure comparability with the set of validity tests we aim to perform. We regress the 2006-2015 change in the main outcomes (LRI stays, AI stays, average LoS, and mortality rate) on the change in predicted immigrant shares over the same period, employing both OLS and 2SLS methods. Table 9 shows that results are similar to those obtained using yearly variation.

Next, we perform a falsification test to mitigate potential issues of reverse causality, examining whether the instrument-predicted change in the immigrant shares during our analysis period (2006-2015) explains changes in the main outcome variables in the pre-sample period (Table 10). We run a cross-sectional linear regression model, where the dependent variables are the changes in LRI episodes in column (1), AI cases in column (2), and the average LoS in column (3) in the period between 2001 and 2005. In column (4), relative to the mortality rate, the dependent variable refers to the period 2003-2005. The results indicate that the change in the instrument-predicted immigrant share in the 2006-2015 period, is not significantly correlated with changes in the outcomes considered in the pre-estimation period, suggesting that reverse causality is unlikely to constitute a threat to our identification strategy.

Table 9: Long-difference results (2006-2015)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Change in LRI cases		Change in AI cases		Change in LoS (all)		Change in tot. mortality	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Change in the share of immigrants	0.105***	0.045	0.002	0.393	-5.400*	-11.998**	-216.189**	-314.965**
	(0.026)	(0.053)	(0.106)	(0.296)	(2.977)	(4.704)	(102.040)	(149.402)
Observations	103	103	103	103	103	103	103	103
R-squared	0.200	0.157	0.076	-0.059	0.215	0.134	0.197	0.187
Controls	YES	YES	YES	YES	YES	YES	YES	YES
F Stat	-	19.89	-	19.89	-	19.89	-	19.89

*Notes: The estimation model is a cross-sectional regression. The unit of analysis is the province. The explanatory variable is the change in the share of immigrants over the period of analysis (2006-2015). The control variables include the change in (log) income per capita and female and male widows (%) over the period of analysis (2006-2015). Each regression is weighted by the province population 65+. AI refers to Acute Inpatient stays, while LRI to Long-Term and Rehabilitation Inpatient stays. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis. * p<0.1 ** p<0.05 *** p<0.01*

Table 10: Reverse causality

	(1) $\Delta_{(2001\text{-}2005)}$ LRI	(2) $\Delta_{(2001\text{-}2005)}$ AI	(3) $\Delta_{(2001\text{-}2005)}$ LoS	(4) $\Delta_{(2001\text{-}2005)}$ Mortality
Variation of Predicted Immigration Share (2006-2015)	-0.000695	0.0737	6.597	125.6
	(0.0147)	(0.0869)	(7.065)	(162.1)
Observations	103	103	103	103
R-squared	0.048	0.072	0.083	0.060
Controls	YES	YES	YES	YES

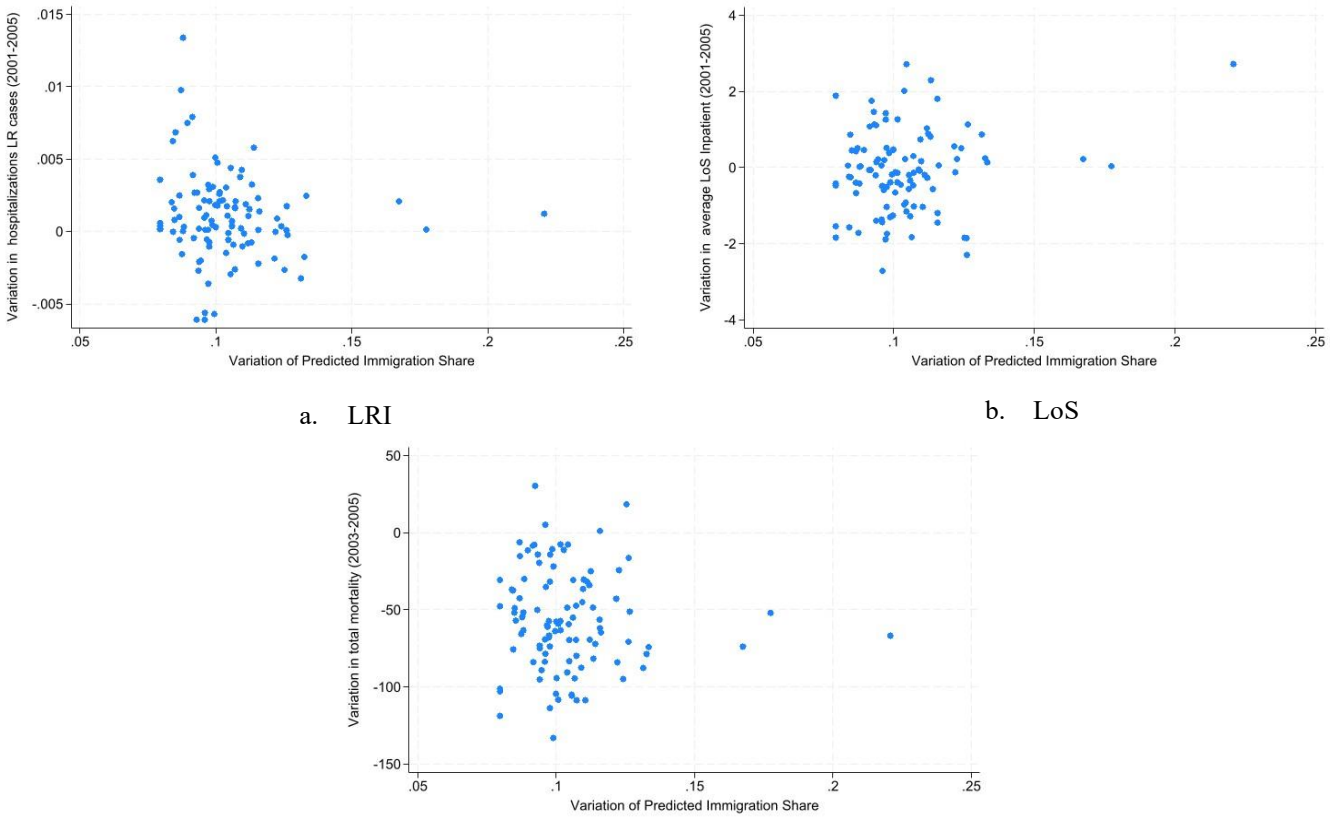
*Notes: The main explanatory variable is the variation of predicted immigration share between 2006 and 2015. The dependent variables are differentiated over the period 2001-2005 (AI refers to Acute Inpatient stays, while LRI to Long-Term and Rehabilitation Inpatient stays, LoS to the average length of stay for total hospitalisations) or 2003-2005 (total mortality for over 75). The control variables at the province level include the (log) income per capita, female and male widows (%). Robust standard errors, clustered at the province level, in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.*

In Figure 6, we provide visual evidence to further examine the potential for reverse causality. The horizontal axis in each panel of the figure displays the change in the instrument-predicted immigrant share over the analysis period, while the vertical axis represents the variation in a preceding period for LRI stays (2001-2005) in Panel a, average LoS of hospitalisations (2001-2005) in Panel b, and mortality (2003-2005) in Panel c. It is easy to see that there is no correlation between the pairs of variables, reinforcing our confidence in the absence of pre-trends among them.

One main concern when using the shift-share instrument is the potential endogeneity of the initial shares of the country-of-origin groups. To address this concern, we first assess the relevance of each country-of-origin share in generating the identifying variation in the instruments by calculating the Rotemberg weights, as in Goldsmith-Pinkham et al. (2020). The results are reported in Table 11. Panel a indicates that the weights are all positive confirming that all the shares are positively correlated with the instrument. Consequently, the estimated coefficient represents a convex combination of the individual country estimates, denoted as β_k. Panel b displays the correlation among the components of the IV estimates (g_k and z_k), the Rotemberg weights (α_k), the just-identified coefficient estimates (β_k), the first-stage F-statistic of the immigrant share (F_k), and the variation in the immigrant shares across locations (Var(z_k)). The

correlation highlights the significance of both the shares and the shifts in identifying variation. Panel c shows that immigrants from East Europe carry the largest weight. Lastly, Panel d reports statistics on how the values of β_k vary with the positive and negative Rotemberg weights.

Figure 6: Reverse causality



a. LRI

b. LoS

c. Mortality

Notes: The x-axis reports the variation of predicted immigration share in the period 2006-2015. The y-axes report the variation in a pre-period for four main variables: the change in Long-term and rehabilitation hospitalisations between 2001 and 2005 (Figure a); the change in the average length of stay between 2001 and 2005 (Figure b); and the mortality rate for the population 75+ between 2003 and 2005 (Figure c).

Table 11: Rotemberg weights

Panel a: Negative and positive weights

	Sum	Mean	Share
Negative	-0.000	-0.000	0.000
Positive	1.000	0.167	1.000

Panel b: Correlations of origin aggregates

	α_k	g_k	β_k	F_k	Var(z_k)
α_k	1				
g_k	0.982	1			
β_k	-0.228	-0.228	1		
F_k	-0.004	-0.157	0.180	1	
Var(z_k)	0.855	0.777	-0.141	0.457	1

Panel c: Top-5 Rotemberg weight origins

	$\widehat{\alpha_k}$	g_k	$\widehat{\beta_k}$	95 % CI
East Europe	0.576	1.27e+06	-0.145	(-0.500,0.010)
Asia	0.310	4.72e+05	-0.041	(-0.185,0.135)
North Africa	0.027	1.45e+05	0.038	(-0.150,0.500)
South America	0.050	97634.000	-0.045	(-0.190,0.120)
Other Africa	0.037	1.36e+05	-0.059	(-0.195,0.215)

Panel d: Estimates of β_k for positive and negative weights

	α-weighted Sum	Share of overall β	Mean
Negative	0.000	-0.001	-0.131
Positive	-0.100	1.001	-0.061

Notes: The table reports statistics on the Rotemberg weights (Goldsmith- Pinkham et al. 2020). Panel a reports the share and sum of negative weights. Panel b reports correlations between the weights (α_k), the immigrant share (g_k), the just-identified coefficient estimates (β_k), the first-stage F-statistic of the immigrant share (F_k), and the variation in the immigrant shares across locations (Var(z_k)). Panel c reports the top five nationalities according to the Rotemberg weights. The 95 percent confidence interval is the weak instrument robust confidence interval using the method from Chernozhukov & Hansen (2008) over *a range from -10 to 10. Panel d reports statistics about how the values of β_k vary with the positive and negative Rotemberg weights.*

Finally, in line with Goldsmith-Pinkham et al. (2020), we also test for any correlation between the initial shares of an immigrant group and the pre-period change in the outcome variables. The results presented in Table 12 indicate no significant correlation between the initial share from East Europe and the pre-period change.

Table 12: Exogeneity of the initial (1991) shares of country-of-origin groups, OLS

Panel a	(1) Asia	(2) East Europe	(3) Other Europe	(4) North Africa	(5) Other Africa	(6) North America	(7) South America	(8) Oceania
Change in LRI cases (2001-2005)	1.457	2.044	0.035	0.258	1.782	1.350	1.627	1.464
	(1.451)	(2.319)	(0.937)	(0.533)	(1.114)	(0.942)	(1.192)	(1.156)
Observations	91	91	91	91	91	91	91	91
R-squared	0.745	0.539	0.644	0.814	0.680	0.658	0.732	0.628
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Panel b	(1) Asia	(2) East Europe	(3) Other Europe	(4) North Africa	(5) Other Africa	(6) North America	(7) South America	(8) Oceania
Change in AI cases (2001-2005)	0.111	0.689	0.019	-0.07	0.202	0.113	0.191	0.133
	-0.305	-0.503	-0.12	-0.093	-0.215	-0.183	-0.253	-0.209
Observations	91	91	91	91	91	91	91	91
R-squared	0.742	0.56	0.644	0.815	0.674	0.652	0.73	0.622
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Panel c	(1) Asia	(2) East Europe	(3) Other Europe	(4) North Africa	(5) Other Africa	(6) North America	(7) South America	(8) Oceania
Change in avg LoS (2001-2005)	0.002	0.013	0.000	0.004*	0.006	0.002	0.004	0.005
	(0.009)	(0.011)	(0.003)	(0.002)	(0.006)	(0.005)	(0.007)	(0.006)
Observations	91	91	91	91	91	91	91	91
R-squared	0.742	0.561	0.644	0.823	0.682	0.653	0.731	0.629
Controls	YES	YES	YES	YES	YES	YES	YES	YES

Panel d	(1) Asia	(2) East Europe	(3) Other Europe	(4) North Africa	(5) Other Africa	(6) North America	(7) South America	(8) Oceania
Change in mortality (2003-2005)	-0.000	0.001	0.000	-0.000	-0.001	0.000	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	91	91	91	91	91	91	91	91
R-squared	0.741	0.533	0.644	0.814	0.669	0.649	0.726	0.621
Controls	YES	YES	YES	YES	YES	YES	YES	YES

*Notes: The estimation model is a cross-sectional regression. The unit of analysis is the province. The dependent variables are the 1991 immigrant shares by area of origin. The explanatory variable is the change in Long-term and rehabilitation inpatient (LRI) hospitalisations over the years 2001-2005 in panel a; the change in acute inpatient (AI) hospitalisations over the years 2001-2005 in panel b, the change in the average length of stay (LoS) in panel c and the change in mortality (for the population 75+) over the years 2003-2005 in panel d. The controls at the province level include income pc (log), female and male widows (%). All the controls are the 2006 value. Each regression is weighted by the over-65 Italian population of the province. Robust standard errors, clustered at the province level, in parenthesis with * p<0.10, ** p<0.05, *** p<0.01.*

5.3.2 Pre-trend analysis

We further ensure the robustness of our estimates by accounting for existing pre-trends in hospitalisations, average length of stay, and mortality following the approach of Dix-Carneiro et al. (2018). As shown in Table 13, we enrich our model specification by including the change in the dependent variable in the pre-sample period as an additional control variable. Consistently with the estimates in Table 4, Table 5, and Table 6, the impact of immigration on LRI cases (in column 1), the average LoS (column 3), and total mortality (column 4) remains negative and significant. Conversely, no effect is detected for acute cases (column 2).

Table 13: Pre-trend analysis (Dix-Carneiro et al., 2018)

	(1) LRI	(2) AI	(3) LoS	(4) Mortality
Share of immigrants	-0.124***	0.208	-8.093***	-183.9*
	(0.0270)	(0.365)	(3.710)	(78.03)
Δ LRI	-0.0875**			
	(0.0665)			
Δ AI		-0.0200		
		(0.0490)		
Δ LoS			-0.0398***	
			(0.0114)	
Δ Mortality				0.01000
				(0.0109)
Observations	1,030	1,030	1,030	1,030
R-squared	0.129	0.686	0.293	0.440
Number of provinces	103	103	103	103
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Province FE	YES	YES	YES	YES
F Stat	15.806	21.901	8.512	17.235

*Notes: The dependent variables are: Long-term and rehabilitation Inpatient hospitalisations (LRI, column 1), acute cases (AI, column 2), average length of stay (LoS, column 3) and mortality for population 75+ (column 4). The main explanatory variable is the ratio between the working-age immigrants over the native population 65+. The controls at the province level include income pc (log), female and male widows (%). All the controls are the 2006 value. In these specifications, we added to the above-mentioned control variables the variation in the outcomes considered for the period 2001-2005 (the only exception is mortality, for which we used the period 2003-2005 due to data limitations). These variations are interacted with a trend variable. Each specification includes year and province fixed effect. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

5.4 Home-based care and public health spending

In this section, we conduct an assessment of the potential reduction in public health expenditures arising from an increase in the supply of non-specialized home-based care provided by immigrants. Given that the IV coefficient estimates may not represent average treatment effects for the entire Italian population, these calculations are intended as a back-of-the-envelope exercise designed to exemplify the implications of the estimates for public healthcare spending.

Our main findings, presented in Table 4, suggest that a rise in the ratio of working-age migrants to the population aged 65 and over by 0.116 (from 0.169 to 0.285) over the analysis period, equivalent to 0.013 annually, generated a reduction of LRI stays of 17,948 cases, representing a 5% decrease relative to the baseline.[14]

Given these findings, we assess the potential cost savings resulting from reduced hospitalisations attributed to migrant-provided home-based care. To quantify the costs associated with hospitalisations, we use Diagnosis Related Group (DRG) rates, a system that categorises hospital admissions by allocating specific costs and standard durations of hospitalisation to each admission. While the DRG rates are established nationally, regional variations exist due to healthcare decentralisation, allowing regions to adjust rates based on local strategies, cost of living, or infrastructure needs. As our analysis primarily focuses on quantifying the monetary consequences of home-based care provision at the national level, we rely on the national DRG rates. In particular, we consider hospitalisation costs for each illness group and hospitalisation type, focusing on LRI admissions.

In our context, supported by the evidence presented in the paper, savings in healthcare expenditure result from two distinct channels. Firstly, migrant-provided home-based care reduces the occurrence of long-term hospitalisations, impacting the extensive margin. Secondly, our findings demonstrate that, in addition to the reduced hospitalisation frequency, migrant home-based care also leads to shorter average hospital stays, influencing the intensive margin. To provide an accurate assessment of the total reduction, both effects must be taken into account.

[14] The reduction of 17,948 is computed by first multiplying the relevant coefficient (-0.118 in Table 4) by 0.013, and then by the average annual size of the Italian native elderly population, i.e. 11,700,000. The 5% share is computed by dividing the variation in the number of cases over the (average) total annual number of LRI stays at the national level 327,932.

Table 14: Back-of-the-envelope calculations of potential savings due to a reduction in LRI stays

Disorder group	Prevalence	Cost per hospitalisat.	Coef. Estimate (# of cases)	Estimated savings (100k)	Estimated savings 2007 (11.7 mln)	Estimated savings 2023 (14.2 mln)	Estimated savings 2050 (18.9 mln)
Genitourinary	0.00727	7762	-0.051000	-514,588	-60,206,786	-73,071,484	-97,338,421
Circulatory	0.00588	9251					
Traumatic Injuries	0.00296	9312	-0.019200	-232,416	-27,192,630	-33,003,021	-43,963,277
Musculoskeletal	0.00303	6371	-0.032600	-270,018	-31,592,124	-38,342,578	-51,076,094
Respiratory	0.00084	5648					
Nervous System	0.00174	9700	-0.015000	-189,154	-22,131,036	-26,859,890	-35,780,021
Cancers	0.00069	7043					
Mental	0.00043	5575	-0.003160	-22,903	-2,679,677	-3,252,257	-4,332,328
Total				-1,229,079	-143,802,252	-174,529,229	-232,490,141

Notes: The costs are expressed in current euro and are defined according to reimbursement rates registered in 2011. Population estimates refers to the 65+ Italian residents sourced from the Istat statistics and population projections. We assume a rise in the ratio of working-age migrants to the population aged 65 and over 1.3 percentage points annually, resulting from the overall rise by 11.6 percentage points over the analysis period.

The results of the back-of-the-envelope calculations on potential savings are presented in Table 14 and Table 15. As mentioned, these calculations refer to two channels, namely a reduced number and a reduced duration of hospitalisations. We specifically address LRI stays, where our analysis identified significant effects of immigrant home-based care provision. We focus on the eight most frequent hospitalisation types, as detailed in the second column of Table 14. Nervous system disorders, circulatory disorders, and traumatic injuries exhibit the highest costs (euros 9700, 9251, and 9312, respectively), as indicated in the third column of the Table 14.

Utilising the coefficient estimates indicating the reduction in the number of hospitalisations for each diagnostic group, as presented in Table 7 and detailed in the fourth column of Table 14, we calculate the potential savings on the extensive margin. This calculation assumes a 1.3 percentage point annual increase in the ratio between the number of working-age immigrants and the native population aged 65 and older, as evidenced in the analysis period considered. With the coefficient estimates and unit costs of admissions considered, the most substantial savings per 100 thousand residents are observed in genitourinary, musculoskeletal, and trauma-related hospitalisations, amounting to 515, 270, and 232 thousand euros annually, respectively. The cumulative savings across all categories would total 1,229 thousand euros annually.

To contextualise these figures, we scale the potential savings by the elderly population size, which stood at 11.7 million residents aged 65 and older in 2007, resulting in an annual savings of 143.8 million euros (sixth column in Table 14). Given the rapid aging of the Italian population, these savings may increase to 174.5 million euros based on current population estimates (14.2 million in 2023) and further to 232.5 million euros in 2050, based on Istat population projections, foreseen to rise to 18.9 million 65+ individuals by 2050.

Table 15: Back-of-the-envelope calculations of potential savings due to a reduction in the length of LRI stays.

Disorder group	Prevalence	Cost per hospitalisat.	Coef. estimate (# of cases)	Estimated savings (100k)	Estimated savings 2007 (11.7 mln)	Estimated savings 2023 (14.2 mln)	Estimated savings 2050 (18.9 mln)
Genitourinary	28.41	381	-91.83	-330,748	-38,697,534	-46,966,237	-62,563,659
Circulatory	28.40	499	-120.20	-457,718	-53,553,054	-64,996,015	-86,581,100
Traumatic Injuries	31.08	378	-106.00	-154,477	-18,073,864	-21,935,801	-29,220,650
Musculoskeletal	24.50	379	-59.43	-88,768	-10,385,887	-12,605,093	-16,791,227
Respiratory	25.01	339	-53.98	-20,009	-2,341,054	-2,841,279	-3,784,864
Nervous System	40.00	351	-47.87	-37,945	-4,439,604	-5,388,237	-7,177,663
Cancers	24.46	457		-	-	-	-
Mental	33.62	189		-	-	-	-
Total				-1,089,667	-127,490,997	-154,732,663	-206,119,163

Notes: The costs are expressed in current euro and are defined according to reimbursement rates registered in 2011. Population estimates refers to the 65+ Italian residents sourced from the Istat statistics and population projections. We assume a rise in the ratio of working-age migrants to the population aged 65 and over 1.3 percentage points annually, resulting from the overall rise by 11.6 percentage points over the analysis period.

Beyond the extensive margin considerations, it is crucial to incorporate potential savings stemming from a decrease in the duration of LRI stays (intensive margin). While certain hospitalisations may be entirely avoided for individuals with home-based care, others, though occurring, are likely to have shorter durations as care can be administered in a home setting.

In Table 15, we present the daily costs of hospitalisations (third column) and the corresponding coefficient estimates presented in Table 8, reiterated here in the fourth column. Given these coefficient estimates and assuming a one percentage point increase in the ratio between the number of working-age immigrants and the native population aged 65+, coupled with the prevalence of respective hospitalisations outlined in the second column of Table 14, the potential savings for 100 thousand elderly individuals would

predominantly arise from genitourinary hospitalisations, and overall total saving would culminate in an annual reduction of around 1,090 thousand euros.

Considering the size of the elderly population at various time points (2007, 2023, and 2050), the corresponding savings at the intensive margin would be 127.5 million, 154.7 million, and 206.1 million euros, respectively.

Taking into account both the intensive and extensive margins, the potential secondary care savings in 2007 could amount to 271.3 million euros. This constitutes approximately 9% of the SDO costs allocated to LRI elderly admissions for the eight diagnostic groups considered, totalling 3,122.5 million euros in 2007. In 2023, the potential savings in secondary care could amount to 329.3 million euros. Considering that total public spending on hospitalisations amounted to 50,135 million euros in 2022, these savings represent approximately 0.66% of the total relevant annual public expenditure.[15] In the long-term perspective, and considering Italy's rapid population ageing, these potential savings are likely to become increasingly relevant and could rise further.

6. Conclusions

The arrival of immigrants specialising in the provision of domestic services is likely to reshape household time allocation, influencing a broad range of outcomes from the business cycle to fertility decisions (Mariani and Rosati, 2022). However, one aspect largely overlooked in the literature is the impact on elderly welfare resulting from increased availability of paid, non-specialized home-based care. As population aging intensifies and family-based support networks weaken, both institutional and home-based care systems face mounting pressure. This paper provides novel causal evidence on the impact of immigration on elderly health, focusing on hospitalisation incidence, length of stay, and mortality. Using an instrumental variable approach to address the endogeneity of immigrants' location choices, and validating our instrument rigorously, we find that the arrival of immigrants significantly reduces hospitalisation rates and duration—particularly for long-term and rehabilitation inpatient (LRI) stays. These effects extend to reductions in elderly mortality, especially among women, suggesting substantial improvements in elderly health.

[15] This data is taken from the system of health account SHA, by Istat.

Disaggregated analyses reveal that reductions in LRI hospitalisations are primarily driven by conditions related to the nervous system, genitourinary system, musculoskeletal system, and traumatic injuries. In terms of average length of stay (LoS), we observe widespread reductions across several diagnostic categories, with declines of up to 1.2 days for circulatory system disorders.

We quantify the fiscal implications by estimating cost savings associated with both reduced hospitalisation frequency and duration. Our back-of-the-envelope calculations suggest that the average annual increase in the migrant-to-elderly ratio (1.3 percentage points during the study period) corresponds to a reduction of approximately 9% in elderly LRI hospitalisations—translating to potential annual savings of 0.66% of total hospital expenditures. These figures likely understate the full fiscal impact. Migrant-provided care may also substitute for institutionalized long-term care, yielding further public savings we cannot quantify due to data limitations.

It is worth noting, however, that these public cost savings imply an increase in private costs, as households bear the expense of paid home-based care. Nevertheless, available estimates (DOMINA, 2022) suggest that these private costs are substantially lower than the corresponding public savings. Moreover, the increased availability of immigrant domestic workers appears to substitute for informal family care (particularly by women), leading to higher labour supply and household income. This, in turn, helps offset the cost of hiring paid caregivers. Nonetheless, the shift from public to private caregiving expenditures raises important distributional and welfare considerations. Future research should further explore these dynamics to assess the broader implications of migrant-driven care provision for equity and long-term sustainability in elder care systems.

Appendix A. Descriptive statistics by diagnostic group

Table A1 shows the descriptive statistics for long-term and rehabilitation inpatient (LRI) cases by the most prevalent major diagnostic groups considered in the analysis.

Table A1: Descriptive statistics for LRI cases by disease

	Obs.	Mean	St. Dev.
Panel a: Hospitalisations			
Mental	1030	.000428	.0004453
Cancers	1030	.000693	.0009226
Nervous	1030	.001736	.0012235
Circulatory	1030	.005875	.0032728
Respiratory	1030	.000841	.0008245
Genitourinary	1030	.007266	.0040977
Musculoskeletal	1030	.003033	.0021787
Traumatic	1030	.002962	.0021208
Panel b: Average LoS			
Mental	1030	33.619	17.045
Cancers	1030	24.461	9.702
Nervous	1030	40.000	8.726
Circulatory	1030	28.399	6.786
Respiratory	1030	25.013	5.766
Genitourinary	1030	28.412	6.786
Musculoskeletal	1030	24.500	6.829
Traumas	1030	31.076	7.318

Notes: The data refer to 103 provinces spanning the time period from 2006 to 2015. Statistics are weighted by the relevant province 65+ population size.

Appendix B. OLS Results

Table B.1, Table B.2 and Table B.3 report the results of the OLS regression.

Table B.1: OLS results for hospitalisation

	(1) AI & LRI	(2) AI	(3) LRI
Share of immigrants	0.219	0.237*	-0.0181
	(0.140)	(0.133)	(0.0210)
Income pc(log)	0.0635	0.0515	0.0119
	(0.128)	(0.116)	(0.0126)
Widowers (percent)	0.0652***	0.0596***	0.00559
	(0.0216)	(0.0211)	(0.00388)
Widows (percent)	0.0114	0.0135	-0.00210
	(0.0286)	(0.0303)	(0.00337)
Observations	1,030	1,030	1,030
R-squared	0.618	0.634	0.042
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES

*Notes: OLS Estimates (including year and province fixed effects). The dependent variables are: total hospitalisations over native population 65+ (column 1), acute inpatient (AI) hospitalisations over native population 65+ (column 2), long-term and rehabilitation inpatient (LRI) hospitalisations over native population 65+ (column 3). The explanatory variable is the ratio between the working age immigrants over the native population 65+. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

Table B2: OLS results for average LoS

	(1) Total	(2) AI	(3) LRI
Share of immigrants	-4.407**	-2.343*	-16.15
	(1.929)	(1.378)	(11.78)
Income pc(log)	-0.422	-0.555	-2.167
	(0.631)	(0.465)	(2.976)
Widowers (percent)	-0.672*	-0.739***	-3.822
	(0.378)	(0.257)	(2.628)
Widows (percent)	-0.532	-0.273	-0.430
	(0.611)	(0.414)	(1.352)
Observations	1,030	1,030	1,030
R-squared	0.157	0.181	0.065
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES

*Notes: OLS Estimates (including year and province fixed effects). The dependent variables are: average LoS for total hospitalisations (column 1), for acute inpatient (AI) hospitalisations (column 2), for long-term and rehabilitation inpatient (LRI) hospitalisations (column 3). The explanatory variable is the ratio between the working age immigrants over the native population 65+. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

Table B.3: OLS results for mortality

	(1) Mortality(tot)	(2) Mortality(f)	(3) Mortality(m)
Share of immigrants	-49.49	-69.84	29.44
	(72.97)	(65.47)	(75.48)
Income pc (log)	-43.70	-63.51	-31.24
	(45.51)	(40.25)	(54.88)
Widowers (percent)	-12.80	-6.437	-21.25
	(15.88)	(15.02)	(19.97)
Widows (percent)	-22.67	-17.22	-27.14*
	(15.87)	(12.94)	(14.76)
Observations	1,030	1,030	1,030
R-squared	0.333	0.402	0.294
Number of provinces	103	103	103
Year FE	YES	YES	YES
Province FE	YES	YES	YES

*Notes: OLS Estimates (including year and province fixed effects). The dependent variables are: total mortality for the population 75+ (column 1), mortality for the female population 75+ (column 2), mortality for the male population 75+ (column 3). The explanatory variable is the ratio between the working age immigrants over the native population 65+. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

Appendix C. Adding a control for informal care provided by family members

In order to control for the fact that some households may choose to use one of the household members as informal caregiver, we add the share of women aged 45-64 over the Italian population 65+ in the main regression. As the table below shows, the results do not change.

Table C.1: Hospitalisations (with share of women 45-64 years old as additional control)

	(1) AI and LRI	(2) AI	(3) LRI
Share of immigrants	0.0801	0.187	-0.107***
	(0.408)	(0.379)	(0.0357)
Observations	1,030	1,030	1,030
R-squared	0.675	0.685	0.147
Number of provinces	103	103	103
Controls	YES	YES	YES
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	16.703	16.703	16.703

*Notes: Estimates of Equation 2 (including year and province fixed effects) with the addition of the share of women 45-64 years as control variable. In column 1 we include all hospitalisations, in column 2 we focus on acute inpatient (AI) hospitalisations, and in column 3 on long-term and rehabilitation inpatient (LRI). The endogenous regressor is the ratio between the working-age immigrant resident population over the size of native population aged 65 and older. Each regression is weighted by the province population 65+. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

Table C.2: Average LoS (with share of women 45-64 years old as additional control)

	(1) AI and LRI	(2) AI	(3) LRI
Share of immigrants	-13.67***	-2.487	-102.9***
	(2.896)	(2.406)	(28.19)
Observations	1,030	1,030	1,030
R-squared	0.094	0.162	-0.068
Number of provinces	103	103	103
Controls	YES	YES	YES
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	16.703	16.703	16.703

*Notes: Estimates of Equation 2 (including year and province fixed effects) with the addition of the share of women 45-64 years as control variable. In column 1 we refer to all hospitalisations, in column 2 to acute inpatient (AI) hospitalisations, while in column 3 to long-term and rehabilitation (LRI) hospitalisations. The endogenous regressor is the ratio between the working-age immigrant resident population over the size of native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

Table C.3: Mortality (with share of women 45-64 years old as additional control)

	(1) Total	(2) Female	(3) Male
Share of immigrants	-117.9	-173.8**	-61.96
	(73.24)	(77.19)	(93.55)
Observations	1,030	1,030	1,030
R-squared	0.465	0.474	0.445
Number of provinces	103	103	103
Controls	YES	YES	YES
Year FE	YES	YES	YES
Province FE	YES	YES	YES
F Stat	16.703	16.703	16.703

*Notes: Estimates of Equation 2 (including year and province fixed effects) with the addition of the share of women 45-64 years as control variable. In column 1 we refer to standardized mortality rate of total population 75+, in column 2 of female population 75+, while in column 3 of male population 75+. The endogenous regressor is the ratio between the working-age immigrant resident population over the size of native population aged 65 and older. Each regression is weighted by the province population 65+. The reported F Statistics is the Kleinbergen–Paap rk Wald F statistics. Robust standard errors, clustered at the province level, in parenthesis with * p<0.1 ** p<0.05 *** p<0.01*

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