Demographic Change and Female Labor Supply*

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Abstract

Demographic change can be regarded as one of the most pressing problems of developed countries. As a consequence, Germany is challenged by population aging, being one of the oldest countries worldwide. This trend does not only cause increased pressure on social security systems, but also affects labor markets by means of a persistently aging and retiring workforce. Evaluating the limited number of possible counteracting measures, an increasing labor supply of underrepresented groups is among the most promising approaches. In light of this, our paper deals with the question whether or not females increase their labor supply in an aging society using small-scale regional data. Since investigations of the exact mechanisms behind this relationship are relatively scarce, we try to evaluate whether there are heterogeneous effects for different skill levels. Our fist results show that the old-age dependency ratio indeed has a positive effect on female labor force participation, indicating that women might serve as a general factor attenuating labor market effects of an aging society. Women at the lower end of the skill-distribution might particularly fill in vacancies or take on jobs emerging in the health and care sector.

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1 Introduction

As a consequence of demographic change, population aging [1] is one of the most urgent issues concerning social security systems, productivity and growth as well as labor market outcomes. With a current share of over 20% of the population aged 65 and above and a constantly increasing old-age dependency ratio (DR), Germany ranks fourth worldwide according to the World Population Prospects (United Nations, Department of Economic and Social Affairs, Population Division, 2017). These numbers underline the serious scale population aging has already reached in Germany. One of the effects of population aging is a declining workforce, which is driven by a rising share of the working age population approaching retirement age combined with a decreasing number of younger workers moving up, which is caused by fertility rates below replacement level. In a highly productive country like Germany this may have negative effects on labor productivity and overall economic growth, giving rise to the question of how to counteract this trend and slow down or even reverse the shrinking of the workforce. In addition, the financial pressure on social security systems will grow especially in the case of Germany, where health and pension systems are financed on a pay-as-you-go basis. In the German context, this will particularly lead to an increased individual burden for employees subject to social security contributions.

The three most relevant channels through which this might be counteracted all operate through increased labor force participation of previously underrepresented groups. This can be implemented by either increasing immigration, raising the retirement age or encouraging higher participation rates of other parts of the population having a labor market participation ratio below average such as females. This paper focuses on the latter. Previous studies have proven that even enormous migration inflows, equivalent to those during the recent massive inflow to Germany in 2015, do not suffice to halt population aging and in consequence a declining workforce (Fertig and Schmidt, 2003). Thus, policy makers frequently discuss modifying retirement policies, changing incentives to work for other underrepresented groups or alternative measures to increase the active labor force.

One of the groups with potentially high unused labor market potential are females, since the female labor force participation (FLFP) rate is still more than ten percentage points below that of males (United Nations, Department of Economic and Social Affairs, Population Division, 2017). Research has already shown that female labor supply does react to demographic pressure, but evidence on the exact relationship between an aging society and female labor supply is relatively scarce.[2] Therefore, our paper aims to shed

[1] In the present context, demographic change is defined as the transition from high fertility rates and low shares of an elderly population to low fertility rates combined with an increasing elderly share (Bloom and Luca, 2016). Based on this, population aging describes the growing median age of a population, which is a consequence of demographic change.

[2] For evidence on female labor supply under demographic pressure, see for example Acemoglu *et al.*

light on this relationship and its heterogeneous effects across different skill levels.

In particular, we want to assess whether an increase in the DR leads to changes in the FLFP using data from the German Microcensus (MC) for 1995–2015. We estimate the relationship on the year-region-skill level, assuming that workers are better substitutable within certain skill levels in a specific region and year as opposed to a level neglecting the corresponding skill level. In doing so we contribute to the existing literature applying the skill-cell approach, led by Borjas (2003). Different from the migration literature, where this approach is usually applied, we add a regional dimension to it and do not assume that individuals compete on a national labor market.

We expect a higher DR to cause a higher FLFP, for two reasons. First, workers on the verge of retirement may be substituted by more capable female workers. Consequently, we abstain from the traditional assumption of imperfect substitutability across different ages, which is usually suggested by the existing literature (Brunello, 2010). Second, there arises a growing need for personnel in nursing or social professions in general, which may induce more women to enter the labor force. Therefore, we assume that rising FLFP, as a consequence of a growing proportion of elderlies, might be driven from increases in FLFP in the service and the healthcare sector. If this is the case, the results would imply, that the increase of female labor supply would indeed be a valid policy instrument to counteract some of the adverse labor market effects of demographic change.

We add to the existing literature, that links rises in FLFP to changes in the demand for social skills or changes in occupations requiring more interpersonal skills. Nevertheless, in contrast to previous studies we directly relate these variations to demographic change. Moreover, our paper is closely related the literature examining rising participation rates among elderly, in particular elderly women. Finally, it contributes to the large body of literature which accounts for increases in FLFP using either the sex-ratio or the cohort-size approach. However, except from Fertig and Schmidt (2003) none of these papers establish a direct connection to demographic change. To our best knowledge, until now no one has examined the link between population aging and rising FLFP.

The rest of the paper is structured as follows. Section 2 gives an overview about the existing literature related to FLFP and demographic change. In Section 3 we describe our empirical strategy to estimate the relationship between these two as well as the data set used for this purpose. Section 4 deals with our results and Section 5 concludes.

2 Literature

Historically, changes in FLFP have been attributed to a number of causes either on the demand or the supply side of the labor market, among others fertility changes, altering social

(2004); Cardoso and Morin (2018).

norms, increases of women's own or their partner's wages, shifts in educational attainment, a growing demand for typically female labor or combinations of these determinants (Juhn and Potter, 2006). However, none of these factors manage to predict FLFP entirely consistent with actual figures of female labor supply over the past decades (Macunovich, 2012). As stated by Macunovich (2012) fluctuations in cohort size lead to a simultaneous impact of various single factors and is able to account for the actual course of FLFP in the US. Therefore, previous literature additionally used changes in the demographic composition to explain variations in FLFP in various contexts.

For this purpose, part of the existing literature employs changes in the sex ratio to explain shifts in FLFP. Acemoglu *et al.* (2004) use an exogenous supply shock, in particular the war-related conscription of men in the US during WWII, to examine changes in female labor supply and find that it did not only lead to a temporary increase in hours worked but also had long lasting effects on employment and wages of women as well as men. Likewise Cardoso and Morin (2018) use war casualties form the Portuguese Colonial War to construct a causal relationship between exogenous changes in the sex ratio caused by a decreased male population and rising FLFP rates. In particular, they argue that firms responded to the reduction of the male workforce in rising their demand for female labor. This did not only increase FLFP, but also women's presence in traditionally male occupations and led to a narrowing of the gender wage gap even in subsequent time periods.

As opposed to those papers examining exogenous shocks at the expense of men, a second major part of the literature examining the effect of sex ratios on FLFP deals with an increasing share of men relative to women. For example, Amuedo-Dorantes and Grossbard (2007) use regional variations in birth rates to explain reduced female labor supply in response to an increasing sex ratio and attribute it to an increasing share of marriages, which is named as the "marriage market effect". The authors argue that due to a larger share of men, more women become married and thus do not face the need to participate in the labor market. Their results are in line with Angrist (2002), who previously showed the inverse relationship between FLFP and the sex ratio by means of variations in the fluctuation of immigrants.

Besides, another strand of the literature uses variations in the respective cohort size (of women) to account for changes in FLFP. Even though they do not put particular emphasis on female labor supply, for Germany, Fertig and Schmidt (2003) reveal a U-shaped relationship between individual's probability to be employed and their own cohort size and find more pronounced effects for females. Additionally, to our knowledge they are the only ones who have previously examined a direct relationship between labor force participation rates and demographic change. In contrast to Fertig and Schmidt (2003), Okoampah (2016), who uses German data on cohorts born during times of peak birthrates, does not find any employment effects of changing cohort sizes except for men in highly specialized occupations. Different from Amuedo-Dorantes and Grossbard (2007), Macunovich (2012), who employs variations in cohort sizes as well, finds a positive relationship between age-time varying sex-ratios and FLFP.

Previous studies suggest that the relationship between demographic change and FLFP can be explained through three channels, namely general substitution effects, demand shifts favoring female-dominated occupations or tasks and increased FLFP in older ages.

First, general labor market theory would predict that FLFP rises due to a reduction of the overall workforce. As a consequence of population aging the potential workforce reduces due to a decreasing share of potential younger workers entering the labor market and an increased share of older workers reaching retirement age, given a constant retirement age (for Germany seeHamm *et al.* (2008)). Further assuming a fixed labor demand, market wages rise to fill emerging vacancies and now reach or surpass the reservation wage of people who were not part of the active labor force before. As it was shown by previous literature, the reservation wage of women tend to be higher due to their usually higher involvement in household production and inter-household transfers (see for example Heckman (1974)). Therefore, provided that reservation wages of women are met increasingly, the previously described impact may be stronger compared to men in an overall setting.

Contrary to the widely believed fear of labor shortage, Garloff and Wapler (2016) and Leibfritz and Roeger (2008) state that this fear is only reasonable at first glance as labor demand is likely to react to decreasing labor supply, which would counteract the initial effect of an increasing number of vacant jobs. Using a matching model, Garloff and Wapler (2016) find that, if anything, retiring workers are replaced by middle-aged workers, indicating significant occupational changes. This promotes the assumption that FLFP may increase due to certain occupational or task shifts rather than simple replacement effects due to labor shortage.

Second, due to changes in the demographic composition, labor demand for occupations in the service sector or tasks including interpersonal skills, such as elderly care, may increase substantially. In recent decades, there as been a substantial shift from manufacturing to service sector jobs in general, which can be seen for example in Ngai and Petrongolo (2017) for the US or Olivetti and Petrongolo (2016) for OECD countries. Moreover, it has been shown that women seem to be endowed with these kind of skills or present in these types of occupations to a larger extend (Borghans *et al.*, 2014). Whether this can be explained by genetical differences or persistent social norms is still a matter of debate not only in economics but particularly in psychology.[3] Taken together, this may have caused an increase in FLFP in occupations traditionally requiring those social skills or

[3]See Borghans *et al.* (2008) for a detailed overview of the existing literature regarding the examination of psychological traits in Psychology and Economics.

occupations changing their requirements accordingly. To the extent that population aging leads to a substantial increase in the demand for these skills or occupations, particularly related to elderly care, which are usually performed by women this would explain the steep increase in FLFP at the lower end of the skill distribution.

Third, supposing retirement age is mandatory at a certain age, but rather determined by choice, another explanation, which is suggested by previous literature, is that women tend to work longer in old age compared to men (Goldin and Katz, 2018). For their most recent birth cohort under study Goldin and Katz (2018) largely attribute the rising FLFP to cohort effects. As can be seen form official population statistics, women in general have a higher average life expectancy (German Federal Statistical Office, 2018). This may have an effect on their labor force participation either because they are mentally and physically able to work longer compared to men, because they need to provide for themselves for a longer period in old age or a combination of both. In light of this theory, rising FLFP rates migt just be a mechanical effect due to the higher life expectancy of females.

Within this paper, we put emphasis on the first two channels and rule out a positive impact of women working in old age by restricting our estimation on those women in the usual working age, i.e. 18 - 64.

3 Empirical Strategy and Data

Building on an estimation strategy originally derived from the migration literature, we add a regional dimension to the skill cell approach from Borjas (2003).[4] He proposed the skill cell approach to estimate the effects of migrants on the outcomes of native workers and relies on the assumption that workers in the same cell, but with a different level of experience, are imperfect substitutes for each other. We slightly modify this assumption and suggest that workers within the same year, labor market region (LMR) and skill level are better substitutable than workers from the same region, but with different skill levels, workers from other regions, but with the same skill level, or workers form other regions with different skill levels.

Using this approach, we aim to generate sufficient variation to identify the effect of a growing elderly population on female employment, if we assume that the elderly population is not balanced over year-region-skill cells. According to this, our units of observation are year-region-skill cells, which are constructed as described below.

Our first cell dimension is time-related and simply consists of the five survey years considered.

As our regional level, we have decided to use LMRs instead of districts in order to actually capture the relationship between the elderly share and employed women within

[4]Other authors who use this approach include Card (2001) and Bonin (2005).

the same region, which should minimize expected commuting effects occurring at the district level. The LMRs are based on definitions provided by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) for each of our survey years.[5] Urban and rural districts at the third level of the Nomenclature of Territorial Units for Statistics (NUTS-3) serve as the starting point for the definition of LMRs. Generally, the LMRs are based on commuting flows between two districts and additional side conditions. These side conditions include LMRs tailored according to the boundaries of districts and federal states. Moreover, the LMRs should provide more than 65% of the jobs for all employed and more than 65% of all jobs should be occupied from workers within the LMR. Besides, there should be no overlapping between districts or LMRs and the communting time for each way should not be larger than 45 minutes. Due to various reforms at the district and municipality level as well as changing commuting behavior, the LMRs are not consistent over time. In particular, the number of LMRs varies from 224 in 1995, 225 in 2000, 271 in 2005 and 2010 to 258 in 2015.[6]

The inconsistencies in the observes number of LMRs are caused by three factors. First, new LMRs are constructed, which may either consist of districts former assigned to other LMR or newly formed districts. Second, we observe the dissolution of LMRs as a consequence of either the dissolution of districts or changing commuting flows, i.e. the districts are added to LMR, that already existed before or to new LMRs. Third, existing LMRs may change over time, either through the addition of new districts, the reassignment of former districts of former districts or simple renaming.

The skill dimension builds on completed vocational training and consists of three categories in order to reflect the German secondary and tertiary education system. We have decided to abstain from the usual approach employing four different skill levels, to have a sufficiently high number of observations in each cell and lose as few cells as possible. The lowest category (low-skilled) covers persons without vocational education, solely possessing any kind of school-leaving qualification, whereas the second (medium-skilled) category consists of persons with at least one year of completed vocational training. The highest skill level (high-skilled) includes persons with a degree either from a university or a university of applied sciences as well as foremen, master craftsmen and technicians.[7]

We will implement this approach on the year-region-skill[8] level, using OLS regressions with female labor market outcomes on the regional-skill-year level as the dependent variable.

The baseline model is defined as follows:

[5] For the exact definition and further information, see https://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/deutschland/regionen/AMR/amr_node.html.

[6] A detailed overview about the composition of LMRs in each survey year is available upon request.

[7] For a detailed description of the three skill levels see Table A3. We decided to stick with the German names of vocational degrees to avoid inaccuracies related to translation issues.

[8] We exclude all persons living in shared accommodation.

$$E_{trs} = \beta DR_{tr} + \gamma X_{tr} + \delta X_{trs} + \eta_t + \vartheta_r + \nu_s + \varepsilon_{trs},$$

where E_{trs}, is the logarithmic female labor market outcome at time t, in region r and skill level s. The logarithmic DR, DR_{tr} at the year-region (tr) level, i.e. our cohort-size measure, is defined as

$$DR_{tr} = \frac{P65_{tr}}{WAP_{tr}},$$

where $P65_{tr}$ is the number of people aged 65 and above in a year-region cell and WAP_{tr} is corresponding working age population (all persons aged 18 - 64). Referring to the working age population, we largely follow the current defintion of the International Labour Organization (ILO) (International Labour Organization, 2018).[9] We use the variation of DR_{tr} on the region-year level, because we argue that there is substitutability between skill levels which would be neglected if we restricted it on the year-region-skill level.

X_{tr} is a vector containing control variables at the year-region level, such as unemployment rate and population size, whereas X_{trs} captures indicators on the year-region-skill level. In particular, this includes the mean age of women, the share of women without German citizenship, the share of women in part-time employment and the average number of children living in the household. η_t, ϑ_r and ν_s are vectors of fixed effects associated with year, LMR and skill level, respectively. These linear fixed effects control for systematic differences in FLFP, which occur related to different survey years, LMRs and skill levels of women in a specific cell. Thus, we identify the effect of DR_{tr} on female labor market outcomes within a skill level, a LMR, and a year. Finally, ε_{trs} is our remaining error term.

All estimations are weighted by the population size in the respective year-region-skill cell and standard errors are clustered at the same level.

We use data from the German Microcensus (MC), which is provided by the Federal Statistical Office of Germany. The MC was implemented in 1957 for West Germany and since 1991 it is conducted for the new federal states of Germany (including East Berlin) as well. It is based on a representative one percent sample of the German population. On an annual basis, it surveys a large number of socio-demographic and employment characteristics on the household and individual level as well as regional information on a small scale level. This combination of detailed socio-demographic, employment and regional information makes the MC particularly useful in our case. In addition to the usual set of questions, special programs on varying sample fractions are conducted in certain

[9]The different age range follows from our sample restrictions, which we describe in detail below.

years. For our empirical analysis, we use a pooled cross-section of five-year intervals for the time span ranging from 1995 to 2015.

Our main variable of interest is FLFP, which we define as the proportion of employed women over all women in a corresponding cell. Employed women can be either full or part-time employed within our final sample as described below. FLFP varies between zero and one.[10]

We first restrict our analysis to people living at their main residence in private households.[11] We also drop observations, which cannot be assigned a LMR.[12] The DR, the unemployment rate, as well as the population size of the labor market region are estimated based on these initial restrictions.

Afterwards, we drop all observations for which the skill level is missing. Additionally, we exclude those individuals, who are either civil servants, self-employed, part of the armed forces or currently in education and solely focus on persons aged between 18 and 64. Within the year-region-skill cells, we restrict our sample to married women. We have decided to not look at single or unmarried women, since it is widely known that the largest share of the increase in female labor supply is driven by behavioral changes of married women (Blau and Kahn, 2017). Finally, we exclude cells, where the number of women is lower than 20 as well as those cells, where less than three women are employed to meet statistical confidentiality requirements of the Federal Statistical Office.

This leaves us with 502,515 individual observations and 3,144 year-region-skill cells.[13] Therefore, based on our restriction we are still left with 83.91% of all possible cells, bit 98.58% of our observations.[14] To give some additional information on the number of observations, Table 1 shows summary statistics for the cell size in each survey year. Owing to the changing number and composition of LMRs, the average sample size naturally varies over the observed survey years. In particular, it is highest for 1995, where we on average observe 80 individuals per cell, and lowest for 2015, with an average of 60 individuals per cell. Apart from changes in LMRs the decreasing average of observations per cell, can additionally be explained by the growing number of cells, displayed in the last column of

[10]Please note, that this is in contrast to the usual definition of FLFP from the ILO, which adds unemployed individuals to the numerator as well. However, since we are interested in actual employment changes related to population aging, we decided to take only employed women into account.

[11]We exclude all persons living in shared accommodation. Moreover, our sample does not include individuals being asked in a retrospective manner about the previous year, which is done by the MC since 2005.

[12]This is only the case in 2010. Due to the dissolution of various administrative associations and subsequent new formation of five municipalities in Saxony-Anhalt, individuals from these municipalities cannot be assigned a LMR according to the valid definition of LMRs at that time.

[13]We loose 7,156 individual observations and 590 cells.

[14]The number of possible cells can be calculated as follows: $(224 + 225 + 271 + 271 + 258) \times 3 = 3747$, i.e. sum up the number of LMRs for each survey year and multiply this by the number of skill levels. Only four cells do not have any observations, 1 cell contains less than three employed women and 597 cells drop out, because they have less than 20 observations.

Table 1, over the time period considered. While we limit the minimum size of a cell to 20 observations, the maximum number of observations is 2,290.

Table 2 reports the descriptive statistics for our dependent variable, FLFP, the DR at the year-region level as well as our control variables. The average FLFP over all year-region-skill cells is 54% and ranges from 10% to 91%, whereas the average DR at the year-region level is 33% and varies from 18% to 67%. Across all year-region-skill cells the mean age of women is 46.5 and varies between 34.91, which is the lowest mean age of a cell, and 57.70. The share of women, who do not have German citizenship is 10% on average, but differs between 0% and 61%. On average, 30% of all women employed in all cells considered are employed part time and the corresponding share ranges from 0% to 71%. The average number of children living in a household is below 1, indicating that a lot of females in our sample live in households without children. The number of people living in a LMR ranges between 445 and 31,630, while the mean population size is 1,892. Finally, the number of persons living in a LMR ranges from 445 to 31,630 and the unemployment rate of LMRs is 8% on average.

4 Results

Figure 1 suggests that in the time period between 1995 and 2015 the average FLFP in Germany rose substantially. In particular, it increased from about 45% to almost 65% and the increase was most pronounced from 2005 onwards. The changes of the DR over the corresponding time period are illustrated by Figure 2. Like FLFP, the DR grew considerably from around 25% to about 37%.[15]

In Figure 3, the relationship between these two variables is depicted, where DR is measured on the region-year level, whereas FLFP is measured on the year-region-skill level. It presents the raw correlations between DR and the FLFP on the respective cell levels in form of a scatter diagram and a simple linear prediction. It clearly reveals a positive correlation between both factors. Additionally, at first glance, the correlation does not seem to be the result of any outliers.

Table 3 shows the estimates of the main specifications of our model. Column (1) displays the coefficients of the baseline estimation, excluding all fixed effects, whereas columns (2) to (4) include additional fixed effects in an ascending order. In column (1), the variable of interest, the DR, has a positive coefficient significant on the 0.1% level, suggesting that a higher share of older people in a cell indeed raises the FLFP. In particular, a 1% increase in the ratio of persons aged 65 and above over the entire population in a year-region cell on average leads to a 0.3% increase in the FLFP in a year-region-skill cell.

For column (1) all effects of the control variables have the expected signs and are highly

[15]The exact values for both the FLFP and the DR can be found in Tables A1 and A2 in the Appendix.

significant, except for the unemployment rate. As expected, average age decreases FLFP, which is a mechanical effect since older people tend to have lower participation rates, be it because of illness or the effects of pension systems.[16] Moreover, the migrant share within a cell reduces FLFP, since migrants in general and female migrants in particular experience lower participation rates (Algan *et al.*, 2010). The coefficient of the part-time share has a positive sign, possibly indicating a mechanical effect as well, because women in the labor force generally tend to have a higher propensity of not working full time, which raises the share of part-time workers in a particular cell. The average number of children has a negative effect also, since overall women are more likely to stay at home in the child raising phase and with an increasing number of children (Agüero and Marks, 2008). Furthermore the FLFP decreases with a growing number of individuals living in a LMR in each year, which is consistent with previous literature on the effect of the own cohort size on labor force participation in general (Brunello, 2010).

When year fixed effects are included, the main variable of interest, i.e. the DR, becomes insignificant, as can be seen in column (2). The patterns concerning our explanatory variables does not vary much when year fixed effects are included. Neither the magnitude, nor the significance of the control variables change dramatically. This suggests that the correlation between DR and FLFP stems from variation within regions and years, rather than overall variation over time, which supports our strategy to additionally include regional fixed effects.

Both of the following specifications (columns (3) and (4)), where year and labor market region, and year, labor market region and skill level fixed effects are added respectively, still point to a positive effect of the DR on FLFP, although it is only significant at the 5% level. The effect is relatively consistent with the one observed without any fixed effects (column(1)). The lower magnitude can be explained by the fact, that we remove all variations occurring due to specific survey years, LMRs or skill-levels. Precisely, the coefficient in column (4) can be interpreted as a 1% increase in the DR leading to a 0.08% rise in FLFP if we control for changes over time, within LMRs, and within skill levels. With respect to our control variables, the coefficients for the share of part-time employed women as well as the population size become insignificant in column (4). Additionally, the unemployment rate becomes highly significant, showing the expected negative relationship with the FLFP rate, while the other coefficients do not vary substantially.

To better understand where the positive relationship between DR and FLFP stems from, we differentiate our results according to skills. Table 4 depicts the results of our regression estimates for subsamples created based on the skill levels. All columns include year as well as region fixed effects. While the effect of FLFP is statistically significant at the

[16]For an extensive overview of the effects of old age on labor market outcomes, see Börsch-Supan (2013).

1% level for both low and high-skilled cells, and it is not significant at all for middle-skilled cells. Whereas a higher DR is correlated with higher FLFP for the subsample of low-skilled, it appears to have a negative effect concerning the high skilled. The signs and magnitudes of the coefficients on our control variables stay roughly the same as in the regression using the whole sample. These results contradict those of Garloff and Wapler (2016), who claim that most of the increases in the overal labor force participation should be observed for middle-skilled individuals.

The heterogeneous effects across skill levels can be explained by both, women filling the gaps left by a retiring labor force, as well as women taken newly created jobs in the health and care sectors. We would observe this pattern if older persons in low-skilled jobs have a higher probability of creating vacancies, which would then be filled by female employees. This seems reasonable, since low-skilled jobs are often more physically demanding than those at the upper end of the skill distribution. This may lead to a comparably higher number of people dropping out of low-skilled jobs immediately at or even before reaching the retirement age. Also, individuals in high-skilled jobs tend to work longer and thus create less vacancies that could be filled. Alternatively, assuming that a rising number of people aged 65 and above in a labor market region may mainly induce a growing demand for elderly care or other related services and that these jobs are predominately carried out by females at the lower end of the skill distribution, it also seems to be reasonable that the effect is on average positive for the low-skilled cells. Furthermore, high-skilled individuals are frequently concentrated in proximity to larger cities, where the DR is usually quite low compared to rural areas. Against this backdrop, it is likely that high-skilled individuals in general, have an incentive to leave rapidly aging regions with the prospect of better job opportunities in urban areas. At this point, we are not able to distinguish the two channels.

Overall, we find that in most specifications, the old-age dependency ratio has a positive effect on female labor supply, indicating that the activation of underrepresented groups might help attenuating negative labor market effects of an aging society.

5 Conclusion

The increasing number of retiring people in combination with a substantial lack of younger individuals who step in puts the concern of a decreasing workforce on top of the agenda in many developed countries of the world and in Germany in particular. The issue can generally be approached by means of exploiting unused labor market potential. This may either be done by increased migration, extended retirement age or increasing labor market participation of further underrepresented groups such as females.

As shown by a large body of literature, the current level of immigration does not suffice to mitigate a decreasing workforce and to fill in vacancies, because of that, other options to help mitigate the effects of demographic change have to be considered. One option is to increase the labor supply of previously underrepresented groups like older workers and females. This paper focuses on the latter.

Whereas large parts of the existing literature are concerned with the effects of own cohort size on labor market outcomes or, concerning females, sex-ratios on labor market outcomes, existing evidence on cross effects is rather scarce. In this paper we are especially interested in the relationship between shares of the elderly population and labor market outcomes with respect to women.

Therefore, we focus on the impact of demographic change on FLFP. In particular we investigate whether changes in the DR leads to changes of FLFP using a modified version of the skill cell approach originally proposed by Borjas (2003) in context of the migration literature. In doing so, we estimate the effect at the year-region-skill level employing data form the German Microcensus (MC) on the level of LMRs. A positive relationship between DR and FLPR can occur through two very different channels. First, due to vacancies left by retiring workers, labor market perspectives of women might be positively influenced, driving women into the labor force. Second, the growing population of older individuals create jobs in health and care related industries.

Our results support the intuition of a positive relationship between FLFP and the DR. We observe that an increase in the DR leads so a growing FLFP even if we control for year, region and skill specific fixed effects. Moreover, our results indicate that the positive relationship is largely driven by low-skilled women, whereas it it negative for the high-skilled, and insignificant for the middle-skilled females. This is in line with previous literature on gender distribution across different jobs. Insofar as women are employed in service related occupations to a larger extent and as there is a growing need for jobs such as elderly care, it appears to be reasonable, that the positive effects occurs at the lower end of the skill distribution. In addition it seems to be plausible that high-skilled women exhibit a negative employment effect of a rising DR, assuming that they are likely to center around urban areas and move away from rural ones, where the DR is commonly higher as opposed to more densely populated regions.

To sum up, the unused labor market potential in the form of low-skilled women may indeed help to replace vacant positions or fill in jobs related to the growing need of nursing staff. However, women may not serve as perfect substitutes for workers at higher skill levels. Therefore, the vacancies arising due to the increasing number of retiring people in middle or high-skilled jobs need to be filled exploiting additional measures to tackle a decreasing work force.

Further research needs to be done on the exact channels through with the positive effect of an increasing number of people aged 65 and above relative to the overall population on FLFP. In particular, it would be needed to further perform separate regressions for different occupational sectors to support our suggested interpretation of an increasing demand of nursing employees, which is served by low-skilled women. Besides a detailed evaluation of age-categories and alteration of our sample restrictions appears to be useful to evaluate whether the third channel mentioned in the literature review serves as an additional explanation. Finally, the model should be extended by additional control variables for obscuring factors such as internal and international migration.

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Tables

Table 1: Cell Size 1995 - 2015

Year	Mean	Median	SD	Min	Max	N
1995	80	52	101	20	2290	565
2000	70	42	91	20	2317	590
2005	65	42	73	20	1907	665
2010	63	39	69	20	1755	656
2015	60	39	64	20	1370	668

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
All estimates are weighted using the relative population skize of year-region(-skill)-cells.

Table 2: Descriptive Statistics

	Mean	Median	SD	Min	Max	N
FLFP	0.54	0.55	0.15	0.10	0.91	3144
Dep. ratio (LMR)	0.33	0.33	0.07	0.18	0.67	3,144
Age	46.50	46.57	3.36	34.91	57.70	3,144
Migrant share	0.10	0.07	0.11	0.00	0.61	3,144
Part time share	0.30	0.30	0.13	0.00	0.71	3,144
No. of children in HH	0.79	0.78	0.30	0.04	2.27	3,144
Pop. size (LMR)	1,891.53	1,440.00	1,688.21	445.00	31,630.00	3,144
Unempl. rate (LMR)	0.08	0.06	0.05	0.01	0.28	3,144

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
All estimates are weighted using the relative population size of year-region(-skill) cells.

Table 3: Regression of FLFP on Dep. Ratio[1]

	(1)	(2)	(3)	(4)
Old-age dependency ratio	0.312***	0.0547	0.117*	0.0834*
	(0.0338)	(0.0350)	(0.0464)	(0.0418)
Average age	-0.0498***	-0.0572***	-0.0563***	-0.0308***
	(0.00323)	(0.00321)	(0.00306)	(0.00292)
Migrant share	-0.853***	-1.040***	-0.841***	0.102
	(0.0524)	(0.0570)	(0.0485)	(0.0669)
Part time share	1.318***	0.947***	1.196***	1.140***
	(0.0661)	(0.0730)	(0.0629)	(0.0615)
Average no. of children in HH	-0.299***	-0.261***	-0.158***	-0.190***
	(0.0317)	(0.0308)	(0.0285)	(0.0261)
Pop. size[2]	-0.007***	-0.007***	-0.016	-0.014
	(0.005)	(0.002)	(0.009)	(0.007)
Unempl. rate	-0.348	0.0202	-1.770***	-1.529***
	(0.193)	(0.210)	(0.309)	(0.248)
Cons.	1.964***	1.885***	1.830***	0.355*
	(0.190)	(0.182)	(0.179)	(0.166)
Year FE	no	yes	yes	yes
Region FE	no	no	yes	yes
Skill level FE	no	no	no	yes
N	3144	3144	3144	3144
R^2	0.522	0.571	0.719	0.787

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
Notes: Coefficients are weighted using the relative population size of each year-region-skill cell. Robust standard errors (clustered at the year-region-skill level) are reported in parentheses.

[1] FLFP and the dep. ratio are log-transformed.

[2] Population size is measured in thousands.

Asterisks denote statistical significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4: Regression of FLFP on Dep. Ratio[1] - Skill levels

	Low-skilled	Middle-skilled	High-Skilled
Dep. ratio	0.151**	-0.0153	-0.153**
	(0.0564)	(0.0227)	(0.0540)
Average age	-0.0307***	-0.0212***	-0.0250***
	(0.00453)	(0.00288)	(0.00361)
Migrant share	-0.452***	-0.230	-0.498**
	(0.109)	(0.160)	(0.159)
Part time share	1.705***	0.870***	0.916***
	(0.0988)	(0.0645)	(0.0856)
Average no. of children in HH	-0.114*	-0.0582*	-0.118**
	(0.0447)	(0.0241)	(0.0359)
Pop. size[2]	-0.0242	-0.0197***	-0.00895
	(0.0151)	(0.00418)	(0.00951)
Unempl. rate	-1.569***	-1.146***	-0.422
	(0.419)	(0.134)	(0.258)
Cons.	0.386	0.132	0.101
	(0.268)	(0.146)	(0.202)
Year FE	yes	yes	yes
Region FE	yes	yes	yes
N	1033	1248	863
R^2	0.875	0.860	0.761

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
Notes: Coefficients are weighted using the relative population size of each year-region-skill cell. Robust standard errors (clustered at the year-region-skill level) are reported in parentheses.
[1] FLFP and the dep. ratio are log-transformed.
[2] Population size is measured in thousands.
Asterisks denote statistical significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figures

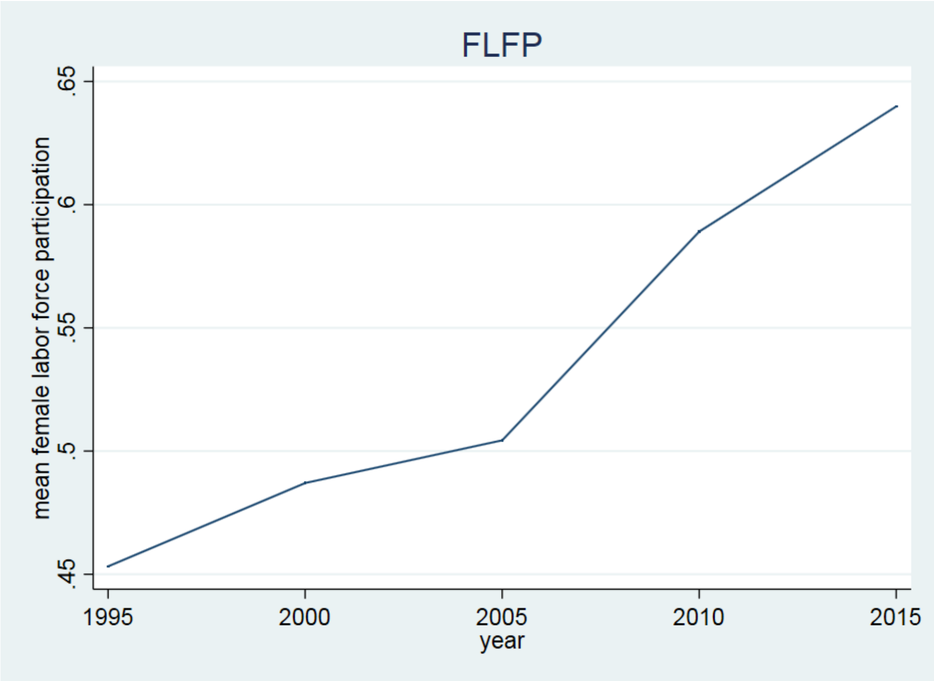

Figure 1: Female Labor Force Participation over Time
Source: German Microcensus, Federal Statistical Office; authors' calculations.

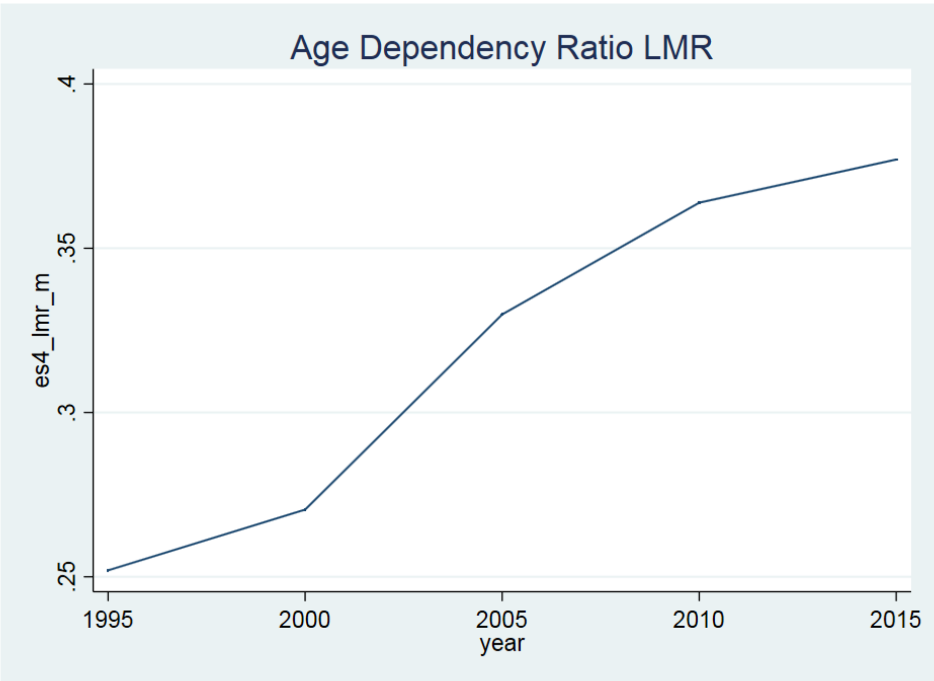

Figure 2: Old-Age Dependency Ratio over time
Source: German Microcensus, Federal Statistical Office; authors' calculations.

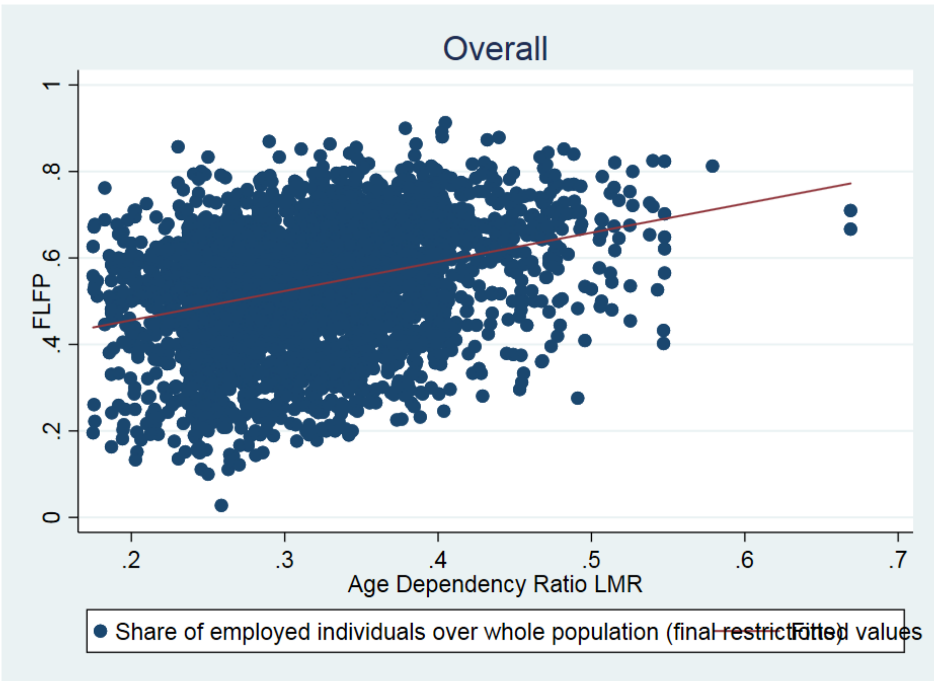

Figure 3: FEMALE LABOR FORCE PARTICIPATION AND OLD-AGE-DEPENDENCY RATIO

Source: German Microcensus, Federal Statistical Office; authors' calculations.

Appendix

Table A1: Female Labor Force Participation 1995 - 2015

Year	Mean	Median	SD	Min	Max	N
1995	0.45	0.48	0.17	0.10	0.80	565
2000	0.48	0.50	0.15	0.13	0.83	590
2005	0.50	0.51	0.13	0.20	0.83	665
2010	0.58	0.58	0.13	0.26	0.88	656
2015	0.63	0.65	0.13	0.28	0.91	668

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
All estimates are weighted using the relative population size of year-region(-skill) cells.

Table A2: Old-Age Depedency Ratio (LMR) 1995 - 2015

Year	Mean	Median	SD	Min	Max	N
1995	0.25	0.25	0.04	0.18	0.36	565
2000	0.27	0.27	0.04	0.18	0.37	590
2005	0.33	0.33	0.05	0.19	0.55	665
2010	0.37	0.36	0.06	0.23	0.54	656
2015	0.38	0.38	0.07	0.22	0.67	668

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder, Microcensus, survey years 1995, 2000, 2005, 2010, 2015, own calculations.
All estimates are weighted using the relative population size of year-region(-skill) cells.

Table A3: Detailed Categories Skill level

Skill level	1995	2000	2005	2010	2015
1	kein berufl. Ausbildungsabschluss., nur allg. Schulabschluss				
2	Abschluss einer Lehr-/ Anlernausbildung; Berufl. Praktikum	Anlernausbildung,berufl. Praktikum; Berfusvorbereitungsjahr; Abschluss Lehrausbildung, Vorbereitungsdienst mittlerer Dienst in öffentl. Verwaltung; Berufsqualifizierender Abschluss an Berufsfach-,Kollegeschule Abschluss 1-jährige Schule Gesundheitswesen	Anlernausbildung,berufl. Praktikum; Berufsvorbereitungsjahr; Abschluss Lehrausbildung, Vorbereitungsdienst mittlerer Dienst in öffentl. Verwaltung; Berufsqualifizierender Abschluss an Berufsfach-,Kollegeschule Abschluss 1-jährige Schule Gesundheitswesen;	Anlernausbildung,berufl. Praktikum; Berufsvorbereitungsjahr, Berufsausbildung duales System, Abschluss Lehre Berufsqualifizierender Abschluss an Berufsfach-,Kollegeschule Abschluss 1-jährige Schule Gesundheitswesen	Anlernausbildung/berufl. Praktikum, Berufsvorbereitungsjahr, Lehre, Berufsausbildung duales System, Berufsqualifizierender Abschluss an Berufsfach-,Kollegeschule
3	Meister-/Techniker oder gleichwertiger Fachschulabschluss; Abschluss Fachschule ehem. DDR; Fachhochschulabschluss (auch Ingenieurschulabschluss); Hochschulabschluss	Meister-/Techniker oder gleichwertiger Fachschulabschluss, Abschluss 2 oder 3-jähr. Schule des Gesundheitswesens, Abschluss Fach- oder Berufsakademie; Abschluss Fachschule ehem. DDR; Fachhochschulabschluss (auch Ingenieurschulabschluss, ohne Verwaltungsfachhochschule); Hochschulabschluss; (wissenschaftl. Hochschule, auch Kunsthochschule) Promotion	Meister-/Techniker oder gleichwertiger Fachschulabschluss, Abschluss 2 oder 3-jähr. Schule des Gesundheitswesens, Abschluss Fach- oder Berufsakademie; Abschluss der Fachschule ehem. DDR; Abschluss Verwaltungsfachhochschule; Fachhochschulabschluss (auch Ingenieurschulabschluss) Abschluss Universität; Promotion	Meister-/Techniker oder gleichwertiger Fachschulabschluss, Abschluss 2 oder 3-jähr. Schule des Gesundheitswesens, Abschluss Fachakademie; Abschluss Fachschule ehem. DDR; Abschluss Verwaltungsfachhochschule Fachhochschulabschluss: Diplom, Bachelor, Master, auch Ingenieurschulabschluss; Abschluss Universität; Promotion; Vorbereitungsdienst für mittleren Dienst in öffentl. Verwaltung; Abschluss Berufsakademie (Diplom, Bachelor, Master)	Vorbereitungsdienst für mittleren Dienst in öffentl. Verwaltung; Ausbildungsstätten, Schule für Gesundheits- und Sozialberufe:1-jährig (z.B. Krankenpflegehelfer, Altenpflegehelfer, Rettungsassistent); Ausbildungsstätten, Schule für Gesundheits- und Sozialberufe:2-jährig z.B. Masseur, Medizinischer Bademeister, PTA, Podologe); Ausbildungsstätten, Schule für Gesundheits- und Sozialberufe: 3-jährig (z.B. Physiotherapeut) Ausbildungsstätten, Schulen für Erzieher/-innen; Abschluss Meister-/Technikerausbildung, gleichwertiger Fachschulabschluss; Fachschule ehem. DDR; Fachakademie (nur in Bayern); Diplom, Bachelor, Master, Magister, Staatsprüfung, Lehramtsprüfung an Universität; Fachhochschule, Verwaltungsfachhochschule, Berufsakademie; Promotion

Source: German Microcensus, Federal Statistical Office.