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Abstract

By merging administrative data on public finances of all municipalities in Germany with individual data from the German Socio-Economic Panel, we explore whether local public expenditures on sports facilities influences individual labor market outcomes. Our identification strategy follows a selection-on-observables approach and exploits the panel structure of the data covering 12 years between 2001 and 2012. The results of our matching estimations suggest that both women and men living in municipalities with high expenditure levels benefit, exhibiting approximately 7 percent of additional household net income on average. However, this income effect is fully captured by earning gains for men rather than women living in the household. Additional analysis suggests, that these gender differences, which can also be observed in terms of working time, hourly wage and employment status, appear plausible since women in the age cohort under consideration are less likely than men to engage in sports in general and in any of the publicly funded sports facilities in particular. Moreover, improved well-being and health are possible mechanisms that determine how the positive labor market effects for men may unfold.

Keywords

Labor market effects, public expenditures, sports, health, well-being

JEL Classification

Z20, H72, H75, J31

1. Introduction

Although the literature analyzing the effects associated with public expenditures on health (e.g., Cremieux, Ouellette & Pilon, 1999), education (e.g., Jackson, Johnson & Persico, 2016) and labor market programs (e.g., Ham, Swenson, İmrohoroglu & Song, 2011) is rich, little is known about related effects of public expenditures in other areas such as sports. This is surprising, given that (i) sports participation can improve health (e.g., Charness & Gneezy, 2009), educational (e.g., Stevenson, 2010) and labor market outcomes of individuals (e.g., Lechner, 2009) and that (ii) policy makers commonly legitimate public expenditures on sports with the explicit objective of fostering such effects (e.g., Federal Ministry of Interior, 2010).

We use nationwide micro-level panel data to explore whether sports-related public expenditures (SPEs) at the municipality level may unfold any beneficial effects at the individual level. In this regard, our study is both conceptually motivated by and closely related to Jackson et al. (2016), who explore the effects of public school district spending on educational and labor market outcomes of adults living in the United States. Our setting is Germany, where the total amount of annual public expenditures on sports is estimated at approximately €10 billion. The largest shares (i.e. about €3-4 billion each) are spent on physical education (P.E.) teachers in schools as well as the construction and maintenance of sports infrastructure (Pawłowski & Breuer, 2012). We focus on the latter since sports infrastructure forms the basis for sports activity *across all* age groups and recently also became an explicit policy target in order to reduce physical inactivity in society.⁴ Because money spent by regional authorities on sports facilities is commonly channeled through local authorities, we focus on the lowest administrative level, that is, municipalities.

⁴ For instance, the World Health Organization (WHO) recommends amongst others (2013, 34): “*Creation and preservation of built and natural environments which support physical activity in schools, universities, workplaces, clinics and hospitals, and in the wider community, with a particular focus on providing infrastructure to support active transport, i.e. walking and cycling, active recreation and play, and participation in sports.*”

The expenditure data come from the accounting records of more than 12,000 municipalities in Germany and are matched with meteorological data, information on the socioeconomic characteristics of the local population and extensive individual data from a representative panel of German households, the German Socio-Economic Panel (SOEP). To consider that individuals may not only benefit from the expenditures of their own municipalities but also neighboring ones, we construct a distance-weighted expenditure measure.

Because public expenditures are policy variables and individuals may deliberately make location choices based on the availability of a sports infrastructure, we follow a selection-on-observables approach and exploit the panel structure of our data to identify the effects of interest. In this regard, we control for regional characteristics (e.g., population size, population density, weather conditions and geographic information) and individual characteristics (e.g., educational level, family status and household composition) expected to jointly influence public expenditures and labor market outcomes. Moreover, by conditioning on pre-exposure sports participation, labor market performance and various health and social capital indicators, we are able to indirectly control for unobservable confounding factors.

Overall, our matching analysis reveals sizable effects of local sports facility expenditures on individual labor market outcomes. For both men and women, we observe a significant (average) increase in household monthly net income of approximately €190, or 7 percent, when moving from medium to high levels of SPE. Interestingly, however, these effects are fully captured by earnings gains for men rather than women living in the household.⁵ Such gender differences can also be observed in terms of working time, hourly wage and employment status: While we do not observe any statistically and economically significant effects for women, we find that (on average) men work an hour more and benefit by a €1 increase in hourly wage as well as a 2–3 percent increase in the probability of being employed full time when moving to

⁵ In general, this finding is reinforced by our results for the comparison between *low* and high SPE levels. However, the estimated effects for household income are less precise and not significant at the conventional level.

comparably higher levels of SPE. Finally, we find that older rather than younger men benefit from comparably higher SPE levels.

Additional analysis based on the SOEP Innovation Sample (SOEP-IS) suggests that the revealed effect differences appear plausible.⁶ For example, women in the age cohort under consideration are less likely than men to engage in sports *in general* and use any of the publicly funded sports facilities *in particular*. Moreover, younger men, though they are more active than older men, have a comparably higher probability of engaging in sports outside any of the publicly funded sports facilities. Finally, although opportunities to test whether these effects unfold from (SPE-induced) differences in sport participation patterns are limited, we do find some indirect evidence that improved well-being and health are possible mechanisms that determine how these effects may unfold.

The structure of the paper is as follows. Section 2 presents the institutional setting and the sports-related expenditure data. Section 3 outlines the econometric specification, including details about the sampling, identification and estimation strategies. Section 4 discusses the findings, and Section 5 summarizes the findings and concludes the paper. Appendix A offers more information on the data cleaning, transforming and enriching process. Appendix B provides a description of variables and additional estimation results, including information about the operational characteristics of the estimators. Appendix C contains results of the robustness checks. Appendix D displays the results about effect heterogeneity, and Appendix E reports the results about possible mechanisms that determine how the effects may unfold.

⁶ The SOEP-IS was established in 2012, covers more than 3,000 households and included a module on physical activity in 2013, 2015 and 2017 (Richter & Schupp, 2015).

2. Sports-related public expenditures: data and measure

Sports in Germany are subsidized at all three administrative levels, that is, by federal, regional and local authorities.⁷ Regional and local authorities in particular aim to foster leisure sports participation (Pawlowski & Breuer, 2012). Because money from regional authorities is commonly channeled through local authorities, we focus our analysis on the lowest administrative level: district and urban municipalities/cities, including Hamburg, Bremen and Berlin.⁸

Expenditure data from these more than 12,000 municipalities come from the Research Data Center (RDC) of the Federal Statistical Office and Statistical Offices of the *Länder* (2018a) and cover the financial years between 2001 and 2006. They include expenditures for the construction and maintenance of leisure sports facilities, sports airfields, sports stadiums, sports fields, tennis courts, toboggan and bobsled runs, sports schools, gyms, ski jumps, indoor or outdoor pools and Olympic sports facilities (Federal Statistical Office, 2016).⁹ Since individuals may not only benefit from the expenditures (and the resulting services and facilities) of their own municipalities but also neighboring ones (though to a lesser extent due to higher travel costs), we construct a distance-weighted expenditure measure instead of taking the expenditure from the municipality of residence. Our measure considers, for an individual k living in municipality m , per capita expenditures of the municipality of residence D_m as well as the sports-

⁷ Note that Steckenleiter et al. (2019) use the same data analyzing the impact of SPE on the probability that an individual will engage in sports (see the discussion in Section 4.5). Therefore, Section 2 has certain overlaps with the data description in Steckenleiter et al. (2019). However, including this information is indispensable to fully shed light on the empirical strategies employed in both papers.

⁸ These three cities are independent from any of the other 13 states (*Länder*) in Germany.

⁹ To work with these data, we converted all figures to 2004 euros using the Consumer Price Index from the Federal Statistical Office (2017) and then cleaned, transformed and enriched the data in several steps. For example, since an increasing number of municipalities have transformed sports facilities (particularly swimming pools) into owner-operated community enterprises (OCPs) over time, we added financial data for all sports-related OCPs from the annual balance sheets of public funds, institutions and enterprises in Germany (RDC of the Federal Statistical Office and Statistical Offices of the *Länder*, 2018b). Moreover, because some funded sports facilities (particularly soccer stadiums) are predominantly used by professional sports clubs only, we reduced all figures by income from rental fees. The intuition behind this approach is that comparably higher construction and maintenance costs for sports facilities such as professional soccer stadiums are accompanied by comparably higher rental fees. Therefore, we reduced all figures in the 12 cities hosting any of the FIFA World Cup 2006 games by the amounts spent for the construction and renovation of stadiums for this event. For more information on the data cleaning, transforming and enriching process, see Appendix A.

related expenditures of all neighboring municipalities D_i within a certain radius around the municipality of residence:

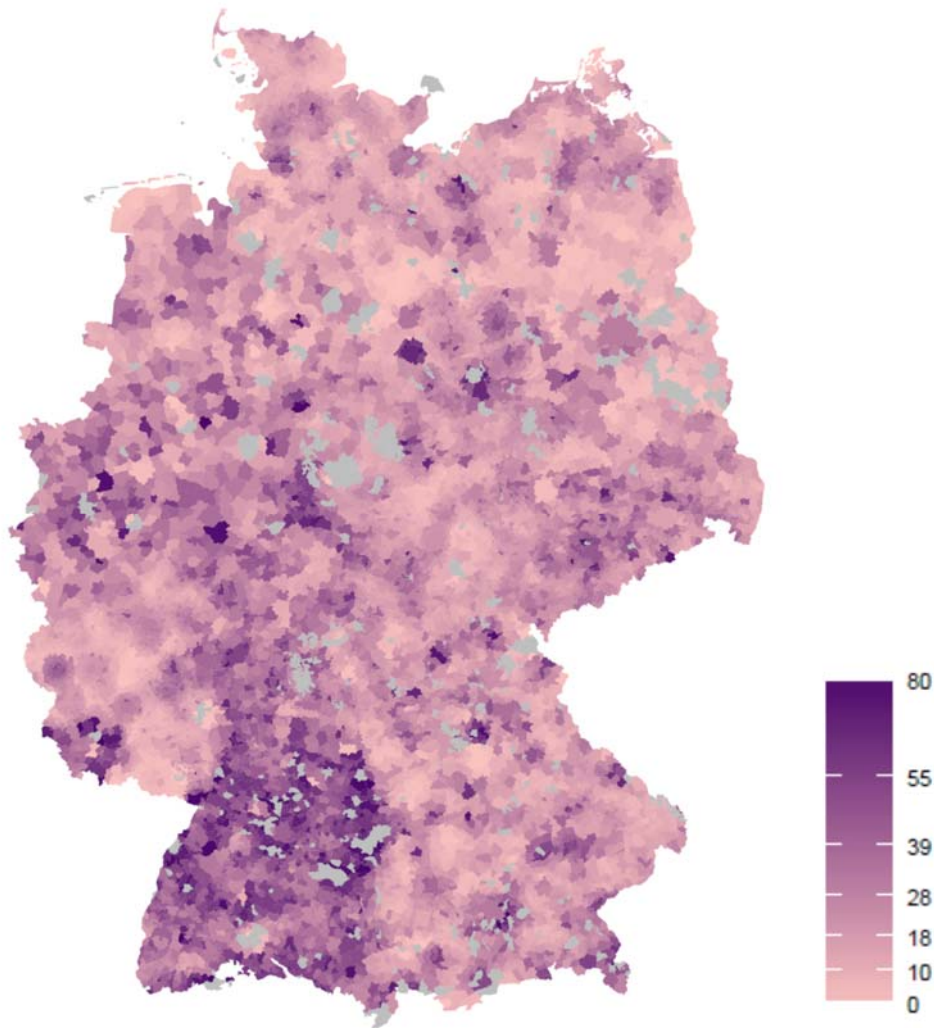
$$D_k = \frac{x}{r} D_m + \left\{ \frac{(r-x)}{r} \left[\frac{\sum w'_i D_i}{\sum w'_i p_i} \right] \right\}, \quad (1)$$

where x measures the distance between the geometric centers (calculated as polygon centroids) of the closest neighboring municipality and the municipality of residence, r measures the radius, p measures the population size of the neighboring municipalities, and $w'_i = (1/d_i)/(\sum 1/d_i)$ as further weight with d measuring the distance to the geometric center. In summary, this measure ensures that (i) the shares of expenditures for all municipalities under consideration for constructing each D_k add up to 100 percent and that the expenditures of the municipality of residence is weighted more (ii) the larger the municipality of residence is and (iii) the farther away the neighboring municipalities are.

Figure 1 shows the distribution of these distance-weighted per capita expenditures (five-year average, 2002–2006) across Germany. Because some outliers are present, we kept observations with positive SPE values only up to the 99th percentile in this figure as well as in our estimations.¹⁰ While we observe comparably larger amounts spent in Baden-Württemberg (located in southwest Germany), a significant within-state variation in SPE is generally evident across Germany, underscoring the relevance of analyzing the lowest administrative level in our study, in line with Harris, Evans and Schwab (2001).

¹⁰ By construction, our expenditure measure has negative values for municipalities exhibiting sports facility-related income (i.e., rental fees) higher than the corresponding (running) costs. Moreover, some municipalities spent considerably more than the others during the observation period. We decided to delete these municipalities from our analysis (denoted as gray areas in Figure 1). Note that although Figure 1 is based on all municipalities in Germany, the estimation sample consists of only the subsample of municipalities matching any of the SOEP observations. Therefore, some deviations occur in the percentile figures. In this regard, SPE values up to the 99th percentile in our estimation sample measure up to €85 (instead of €80 as in the full sample; see Figure 1).

Figure 1: Distance-weighted sports facility per capita expenditures in Germany.



Notes: This figure displays mean (2002–2006) net values (i.e., based on expenditure grouping number 999 minus income grouping number 399) in 2004 euros between 0 and the 99th percentile (gray areas display municipalities with corresponding expenditure levels outside this range). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a, 2018b), own calculations.

3. Empirical strategy

We explore the effects of local SPEs from 2002 to 2006 on labor market outcomes in the period 2007–2012 by following and comparing individuals with similar characteristics in 2001 over time. We do so by merging our distance-weighted expenditure measure as defined in Section 2 with individual information from the SOEP¹¹ on a *yearly basis*. Merging on a yearly

¹¹ The SOEP is a longitudinal panel survey containing a representative sample of German households since 1984 (Wagner, Frick & Schupp, 2007). Data are merged by using the official residence municipality key code (*Amtlicher Gemeindeschlüssel – AGS*). Because SOEP data, including the official residence municipality key code, are subject

basis allows us to allocate ‘true’ expenditure values to individuals who relocated within the exposure period 2002–2006 before averaging the expenditure measure over five years. Averaging the expenditure measure seems reasonable to smooth out any sports facility ‘investment shocks’ that might occur over time. To work with these panel data, we have to impose a couple of sample restrictions (see Section 3.1). Moreover, to address selection and endogeneity issues, we exploit the panel structure of our data and apply a selection-on-observables approach by controlling for all relevant variables jointly influencing local sports expenditures and our outcome variables. These confounders include several *regional characteristics* (e.g., population size and density, weather conditions and geographic information) as well as *individual characteristics* (e.g., sociodemographics; information on sports participation behavior; various education, health, social capital and labor market indicators) taken from the pre-exposure year 2001 (see Section 3.2). To estimate the effects of interest, we discretize our expenditure measure in three states by cutting off at the 33rd and 66th percentiles and employ radius matching with bias adjustment (see Section 3.3).

3.1 Sampling

As explained previously, our panel data cover an observation window of 12 years: the pre-exposure year 2001, an exposure period between 2002 and 2006 and a post-exposure period between 2007 and 2012, during which we estimate the labor market effects. Similar to Lechner (2009) and Lechner and Sari (2015), we are predominantly interested in *long-run* labor market outcomes. A long observation window, however, comes along with two problems: greater panel attrition and the increasing probability of retirement for older individuals.¹² Therefore, we decided to restrict our analysis to a six-year (post-exposure) observation window between 2007

to severe restriction policies, data merging and analysis took place in the RDC of the German Economic Institute (*Deutsches Institut für Wirtschaftsforschung* – DIW) in Berlin.

¹² Although we are able to test for any panel attrition in our study (see Section 4.3), smaller samples generally suffer from efficiency loss.

and 2012. To work with this panel, we *first* restricted our sample to individuals who had a valid interview in 2001 and the first outcome year under consideration (i.e., 2007). At this stage, we also excluded individuals with missing values in lagged expenditure, lagged outcomes or any confounding variable used in our models (see Section 3.2). *Second*, we restricted our sample to all individuals aged 20 years and older in the pre-exposure year and also excluded individuals not yet graduated in 2001. *Third*, we imposed an upper age limit of 52 years in 2001 because these individuals would be aged 63 years in 2012 and as such still below the average age of retirement (German Statutory Pension Insurance Scheme, 2017). Moreover, we excluded any individuals who were still in the education system from 2007 onward (e.g., trainees, students, civilian servants, conscripts). *Finally*, to avoid the results being driven by outliers in expenditures we restricted the sample to observations up to the 99th percentile and only kept observations with positive values for the expenditure variable. These restrictions resulted in a data set with 3,071 men and 3,427 women for our analysis in 2007. To avoid further efficiency loss in the first-year models, we opted against a balanced panel approach, which would have required that no observation have any missing data in any of the other outcome years.

3.2 Identification

Public expenditures are policy variables,¹³ and individuals may deliberately make location choices based on the availability of sports infrastructure¹⁴; therefore, selection and endogeneity issues are obvious concerns in our setting. To address these concerns, we exploited the panel structure of our data and applied a *selection-on-observables* approach. The key idea of this approach is that after conditioning on *observed* confounding variables, selection into the

¹³ For example, local authorities may use observed sports activity levels to determine SPE levels, or they may be influenced by neighboring municipalities' spending behaviors (i.e., spatial dependency between local authorities, as discussed by, e.g., Moscone, Knapp & Tosetti, 2007).

¹⁴ This behavior can be described as a kind of Tiebout (1956) sorting effect; that is, the consumer-voter moves to the municipality whose local government best satisfies his or her set of preferences.

level of SPE is random (Imbens, 2004). To ensure that this so-called conditional independence assumption (CIA) holds, we must control for all variables jointly influencing local public expenditures on sports facilities and individual labor market outcomes. These confounders include various *regional* and *individual characteristics*, as explained next.¹⁵

Our first set of variables covers several *regional characteristics*, selected to control for any confounding influences at the *aggregate* (municipality) level. (i) The first variable we consider is population size as a relevant predictor for both the availability and conditions of local (sports) infrastructure¹⁶ as well as the labor market conditions and prospects of individuals. To better consider the latter aspect, we use population size in the corresponding BIK region instead of population size in the municipality only.¹⁷ Similar arguments hold with regard to population density (i.e., rural vs. urban areas). Since population density is not directly considered in the BIK regions, we also control for (ii) population per square kilometer and (iii) its interaction with the different BIK regions. To directly control for the economic conditions as well as the level of education in the municipalities, we include (iv) the share of unemployed people in the working age population (v) and the share of graduates with higher education entrance qualification of total graduates.¹⁸ While it is common practice in the public spending literature to control for sociocultural conditions in the municipalities in general (e.g., Busemeyer, 2007), controlling for the composition of the population with migration background is particularly relevant in our setting given the popular policy claim that sports can serve as a tool for integration (e.g., German Olympic Sports Confederation, 2019). Although we are not able to implement any fine-grained measure here, we control for (vi) the share of foreigners in a municipality.

¹⁵ All confounders are measured in the pre-exposure year (2001), if not stated otherwise.

¹⁶ We expect that, in general, larger municipalities have better opportunities to build and maintain such infrastructure because of economies of scale.

¹⁷ A BIK region (BIK Aschpurwis & Behrens, 2001) is made up of all municipalities for which at least 7 percent of its employed inhabitants (as identified by social insurance contributions) commute to the same core city. We take BIK regions with 500,000 and more inhabitants as a reference category and differentiate between three additional categories as dummies in our models: BIK regions with 0–49,999, 50,000–99,999 and 100,000–499,999 inhabitants.

¹⁸ For both measures, we take the six-year average (2001–2006) to avoid picking up any year-specific fluctuation.

We also expect weather conditions to influence the investment and maintenance costs for (sports) infrastructure in a municipality as well as the labor market outcomes of individuals. Although the literature has extensively documented the effects of temperature, precipitation and windstorms on labor productivity and other economic outcomes (for a review, see Dell, Jones & Olken, 2014), to the best of our knowledge, no study has addressed these variables' possible effects on infrastructure investments and maintenance costs before. However, it seems plausible to assume that practicing outdoor sports is less popular in rainy areas and that providing opportunities for outdoor sports such as public parks or green areas is less cost-intensive than providing and maintaining indoor sports facilities. Therefore, we also control for (vii) the average sum of precipitation and (viii) the average sunshine duration per year.¹⁹ Finally, we control for (ix) the region where the municipality is located: south (including the states Baden-Wuerttemberg and Bavaria), north (including the states Lower-Saxony and Schleswig-Holstein as well as the city states Bremen and Hamburg), west (including the states of Hessen, Rhineland-Palatine and Saarland) and east (including the states of Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt and Thuringia as well as the city-state Berlin). Controlling for the region in Germany is important given the significant regional variation in sports facility spending, with comparably higher expenditures in southern Germany (see Figure 1), which is also a comparably more prosperous region and has better labor market conditions and prospects for individuals.

Our second set of variables covers several *individual characteristics* as measured by the SOEP. Whereas we use regional characteristics to control for any confounding influences at the *aggregate* (municipality) level, individual characteristics condition on top of factors expected to influence both the labor market performance and the level of SPE at the *disaggregate* (individual) level. In this regard, we do not expect any individuals (other than the decision makers

¹⁹ Similar to the share of unemployed citizens in the working age population and the share of graduates with higher education entrance qualifications of total graduates, we intend to avoid picking up any year-specific fluctuations. Because weather conditions are subject to changes in both the short and long run, we decided to consider long-term averages covering the period 1981–2010.

in the local government) to directly influence the level of SPE. However, (sports active) individuals may deliberately make location choices based on the availability and quality of local sports infrastructure.²⁰

To systematically address this potential confounding issue, we control for all characteristics that previous research has shown to jointly influence individuals' sports participation behavior and labor market performance (for an overview, see Lechner, 2009): (i) being married, (ii) being divorced, (iii) having German citizenship, (iv) number of children in the household and (v) age. In addition, we include two sets of educational measures in our models. The first set considers the (vi) highest school degree (measured as lower secondary school or no school degree, intermediate secondary school degree and upper secondary school degree or other graduation diploma). The second set considers (vii) individuals' level of (higher) education/training (measured as still pursuing education, no vocational degree, vocational degree or university degree). To directly control for differences in sports participation behavior in the pre-exposure period, we also include (viii) whether an individual participated at least monthly in sports, as indicated in the SOEP. Moreover, we consider differences in labor market performance in the pre-exposure period directly by including (ix) monthly household net income, (x) gross earnings, (xi) working time per week, (xii) hourly wage and (xiii) full-time employment.²¹ Finally, we also control for various health and social capital indicators from the pre-exposure period because they could influence sports participation behavior and labor market performance in the subsequent years. To this end, we control for (xiv) satisfaction with health, (xv) satisfaction

²⁰ While we do not know anything about the extent to which leisure-time sports facilities might stimulate location choices in practice, some evidence shows that income and family status might increase the probability of living closer to professional sports facilities (e.g., Ahlfeldt & Kavetsos, 2014). Moreover, several studies investigating the socioeconomic determinants of location choice in general show some evidence for the United States that comparably less populated areas have relatively higher marriage rates (Lichter, LeClere & McLaughlin, 1991) and that the probability of living in suburban areas increases with increasing age (Alba & Logan, 1991).

²¹ We converted all monetary measures used in our estimations to 2004 euros using the Consumer Price Index from the Federal Statistical Office (2017). Hourly wage is not readily available in the SOEP, so we computed it by dividing monthly gross earnings by weekly hours ($\times 4.3$). We also controlled for hourly wage in our estimations to allow for more flexibility.

with life, (xvi) the number of doctor visits per year and (xvii) the physical component (PCS) and (xviii) mental component summary scales (MCS).²² The three available social capital indicators are dummies measuring interpersonal networks as (xix) whether an individual helped out friends, neighbors or relatives at least monthly and social engagement as (xx) frequency of volunteer work in clubs or social services (at least monthly) and (xxi) general involvement in a citizens' group, political party and/or local government.

This rich set of regional and individual characteristics allows us to control for the most relevant *observable* confounders. Moreover, although we are unable to control for genetics or any psychological, cognitive or emotional factor that might influence both sports participation behavior and individual labor market performance *directly*, we argue that conditioning on pre-exposure sports participation, labor market performance and the various health and social capital indicators enables us to *indirectly* control for such *unobservable* confounders at least to some extent. In this regard, the available measures 'control' for some sort of individual fixed effects as Lechner (2009) argues.

3.3 Estimation

We opt for a matching type estimator because it is more flexible and more robust with respect to the statistical assumptions imposed (Imbens, 2004). Similar to Lechner and Sari (2015), who estimate the labor market effects for three sports activity levels (active versus moderately active versus inactive), we discretize our SPE measure as defined in Section 2 in three states: low (€0–€20), medium (€20–€31) and high (€31–€85), using the 33rd and 66th percentiles as cutoffs. Doing so allows us to compute and compare overall three average treatment effects (ATEs): the labor market effects of moving from low to medium, from low to high and

²² The PCS and MCS are superordinate scales available since 2002 on a biannual basis and had been derived by Andersen et al. (2007) from an internationally applied inventory of health measures (the so-called SF-12v2 indicators) using explorative factor analysis. Because data from these scales are not available for 2001, we took both measures from the 2002 SOEP survey.

from medium to high SPE levels. Because we assume the CIA to hold across all strata, the sample reduction results of Lechner (2001) apply; that is, for estimating any one of these three effects, participants in the irrelevant treatment state are deleted for the purpose of this particular estimation. However, doing so requires that observations *on support* for a certain group are the same across estimations. In other words, when estimating the effects of low versus high and medium versus high levels of SPE, the same observations must be considered in the treatment group (high SPE level). To ensure that this is the case, we implemented an iterative approach; that is, we deleted any observations off support after each estimation and re-estimated all models (including propensity scores) until all remaining observations were on support.²³ Finally, given considerable gender-specific differences in terms of both sports activity patterns (e.g., Eccles & Harold, 1991) and labor market participation (e.g., Fitzenberger, Schnabel & Wunderlich, 2004), we decided to estimate all effects for women and men separately.²⁴ We estimated all effects by radius matching with bias adjustment, as Lechner, Miquel and Wunsch (2011) suggest. A simulation study (Huber, Lechner & Wunsch, 2013) shows that this matching estimator performs particularly well.²⁵ We based inference on bootstrapping the sample 99 times.²⁶

²³ A common support statistic of our estimated models is available in Table B.3 in Appendix B.

²⁴ Note that using the 33rd and 66th percentile cutoffs does not necessarily mean that we end up with an equal number of observations in each group for each estimated model, because the SPE measure is discretized for the full sample (before splitting it into the men/women strata) and we consider only observations *on support* in the models.

²⁵ For computations, we used STATA and the corresponding command *radiusmatch* as developed by Huber, Lechner and Steinmayr (2015). Our specification mainly follows the default options; that is, we employed a linear bias correction as well as a multiplier of 300 and a quantile of 90, indicating that the radius is equal to 300 percent of the maximum distance in pair matching and that we used the 90th quantile of the distances in pair matching. All analyses needed to be conducted in the RDC of the DIW in Berlin, because regional information in the SOEP is subject to severe data restriction policies. Unfortunately, the infrastructure at the DIW did not allow us to employ more advanced machine learning estimators.

²⁶ In this regard, it might be questioned whether the number of bootstrap replications is sufficiently large. Again, the infrastructure at the DIW seriously limited our estimation options. However, while we were not able to compute a larger number of bootstrap replications for all the different models estimated, we compared the results of one stratum (men, 2008) after bootstrapping 99 and 499 times. Overall, the results did not change much, in line with some recent, more general evidence suggesting that reliable inference can be obtained with very small numbers (there: 49) of bootstrap replications (see Bodory, Camponovo, Huber & Lechner, 2018). Therefore, we are not concerned about any serious problem in this regard.

4. Results

We first describe our findings for the selection process (Section 4.1). We then turn to discussing the labor market effects (Section 4.2) as well as the results for the robustness checks (Section 4.3), effect heterogeneity (Section 4.4) and possible mechanisms (Section 4.5).

4.1 Selection process

Table 1 provides an overview on conditional mean values as well as the marginal effects of all regional characteristics and the individual labor market indicators used in the selection models based on the main specification.²⁷ The data show that several mean values of the variables differ significantly between the three samples, which underscores the relevance of controlling for them in the first stage. A closer examination of the six models reveals that, in particular, the high versus low and high versus medium samples differ significantly; however, these differences are less evident when comparing the medium versus low samples, as reflected in the comparably lower pseudo- R^2 of the probit models for the medium versus low samples. Moreover, the observable patterns do not differ much between the male and female samples, suggesting that women and men with comparable characteristics are equally distributed in all subsamples.

With the exception of the medium versus low comparison, the data show that the larger the BIK region, the higher is the level of SPE. Moreover, the higher the population density (share of unemployed citizens in the working age population), the higher (lower) is the probability of observing medium rather than high or low SPE levels. In addition, the higher the share of foreigners in the municipality, the higher is the level of SPE, which might reflect the policy

²⁷ To calculate the ATEs, we needed to re-estimate all probit models for each year because we have an unbalanced panel with a decreasing number of observations due to panel attrition, as discussed in Section 3.1. Although all individual characteristics as described in Section 3.2 are included in all models, Table 1 only reports the results for the individual labor market indicators, which are the focus of our study. In general, we observe only a few significant differences in the individual characteristics (all results are reported in Table B.1 in Appendix B).

in line with the claim that sports can serve as a vehicle for integration. The coefficients are, however, only significant for women.

Table 1: Mean values and marginal effects of the selection models (selected variables).

Characteristics (1)	Men 20–52 years in 2001						Women 20–52 years in 2001					
	Mean in subsample			Marginal effects			Mean in subsample			Marginal effects		
	High (2)	Med (3)	Low (4)	H–L (5)	H–M (6)	M–L (7)	High (8)	Med (9)	Low (10)	H–L (11)	H–M (12)	M–L (13)
Population size and density												
Population size ≥ 500k	.44	.38	.32	R	R	R	.46	.41	.32	R	R	R
Population size 100k–499k (L)	.18	.19	.12	-.20**	-.53***	.15	.17	.18	.11	-.04	-.27***	.05
Population size 50k–99k (M)	.02	.04	.07	-.09	-.41	.13	.03	.04	.08	-.002	-.19	.02
Population size 0–50k (S)	.35	.38	.49	-.11**	-.42***	.17**	.34	.37	.49	-.11*	-.37***	.10*
Population density	1.8	1.7	1.2	.02	-.14***	.10***	1.8	1.8	1.3	.02	-.10***	.06***
Population density × L	.38	.35	.17	.16***	.22***	.03	.32	.34	.17	.08*	.10**	.07**
Population density × M	.04	.07	.10	-.05	.09	-.06	.04	.07	.11	-.09*	-.008	-.03
Population density × S	.29	.22	.17	.08***	.18***	-.02	.29	.21	.20	.07**	.17***	-.008
Population characteristics												
Share of unemployed ¹⁾	7.1	8.9	9.2	-.02***	.02	-.03***	7.2	8.9	9.4	-.02***	.01***	-.03***
Share of graduates with HEEQ ¹⁾	24	25	23	.003	-.0003	.005**	24	25	23	.0009	-.002	.002
Share of foreigners	1.9	1.5	1.2	.03	.03	.005	1.9	1.5	1.2	.06**	.02	.04**
Weather conditions												
Average precipitation ²⁾	2.1	2.0	2.0	.33***	.28***	.06	2.1	2.0	2.0	.29***	.25***	.02
Average sunshine duration ²⁾	.47	.46	.45	.98***	.12	.80**	.47	.47	.46	.31	-.51	.34
Region												
North-Rhine Westphalia	.22	.20	.21	R	R	R	.25	.20	.20	R	R	R
Southern Germany	.40	.18	.17	.10**	.20***	-.05	.38	.19	.16	.12***	.22***	-.02
Northern Germany	.04	.14	.20	-.20***	-.27***	-.03	.03	.13	.21	-.29***	-.31***	-.09***
Western Germany	.19	.12	.08	.20***	.14***	.13**	.19	.12	.09	.16***	.15***	.07
Eastern Germany	.14	.35	.34	.13**	-.17**	.19***	.15	.36	.34	.17***	-.16**	.27***
Labor market indicators												
Household net income in EUR	2733	2577	2592	0.000009	.00001	-.00001	2,640	2,568	2,505	.00002*	0.000005	.00001
Gross earnings in EUR	2731	2424	2271	0.000007	.00002	.00001	1,165	1,165	1,086	-.00002	-.00002	.000006
Working time per week	41	39	38	.0008	.001	-.0003	23	23	23	.0006	.002**	-.001
Hourly wage in EUR	14	13	12	-.0003	-.004	-.0005	8	8	8	.003	-.001	.003
Employed full time	.88	.84	.81	.02	-.009	.04	.39	.39	.38	.019	.006	-.0008
# of observations, pseudo-R ²	985	1,051	1,009	22	13	7	1,095	1,150	1,135	21	12	8
<i>All other individual characteristics as described in Section 3.2 are included in the models and are displayed in Table B.1 in Appendix B.</i>												
# of observations, pseudo-R ²	985	1,051	1,009	22	13	7	1,095	1,150	1,135	21	12	8

Notes: All figures are based on the 2007 sample. Because we have an unbalanced panel with a decreasing number of observations due to panel attrition, we needed to re-estimate all probit models for each year to calculate the corresponding ATEs (results are available on request). The high (med) [low] sample consists of individuals living in a municipality with high (medium) [low] level of distance-weighted per capita SPEs as defined in Section 2. The dependent variables in the probit models are dummies measured as 1 for the relatively higher expenditure level (i.e., for the H–M-model high, for the H–L-model high and for the M–L-model medium. Independent variables are measured prior to the dependent variable if not stated otherwise, that is, ¹⁾ measured between 2001 and 2006, ²⁾ measured between 1981 and 2010. Significance levels are as follows: * $\equiv p \leq 10\%$, ** $\equiv p \leq 5\%$, *** $\equiv p \leq 1\%$. R denotes the reference category. A detailed description of all variables is provided in Table B.1 in Appendix B. Table B.2 in Appendix B reports the results for all variables, including the individual characteristics not displayed here. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a, 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Furthermore, weather conditions and location influence the level of SPE as expected: Expenditures increase with increasing precipitation rates, and municipalities in the northern

states spend comparably less than North Rhine-Westphalia, whereas municipalities in the western and southern states spend comparably more. Moreover, the probability of observing low SPE levels in a municipality is lower in the eastern states than North Rhine-Westphalia. Finally, although individual labor market indicators suggest that living in municipalities with comparably higher SPE levels is correlated with comparably more success in the labor market, only 2 of 30 marginal effects are significant, in line with the observation that few significant differences in individual characteristics can be observed (see Table B.2 in Appendix B).

4.2 Labor market effects

We next turn to the estimated ATEs as described in Section 3.3. Figure 2 shows the corresponding effects on an annual basis of moving from low to medium, from low to high and from medium to high SPE levels for monthly (a) net household income, (b) net earnings and (c) gross earnings. To see how these effects develop and whether (and to what extent) controlling for our confounding variables was successful, we also include the corresponding estimates for the pre-exposure (2001) and exposure period (2002–2006) in each graph. Overall, the intuition is that balancing out the different confounding influences worked better the closer the estimated ATEs were to zero in 2001, and a negative (positive) deviation from zero indicates a potential downward (upward) bias of our estimates. Accordingly, the balancing worked slightly better for men than for women with regard to household income and vice versa with regard to earning measures.

As Figure 2 shows, although we do not observe any significant effects on income and earnings for moving from low to medium SPE levels (see dotted lines), we do find that men (women) have an average²⁸ gain in net household income of around €180 (€210) when moving

²⁸ We use the term ‘average’ here and in the following discussion to refer to the six-year average in the post-exposure period (2007–2012), if not stated otherwise.

from medium to high (dashed lines) and €140 (€80) when moving from low to high SPE levels (solid lines). The latter effects (high vs. low), however, are not significant at the conventional level owing to comparably less precise estimates, particularly for the female stratum.²⁹

If we consider the differences in the level of balancing in 2001 between men and women, the effects of moving from medium to high SPE levels seem to converge between gender at approximately €190–€200.³⁰ By contrast, however, significant gender differences occur in terms of the estimated effects on earnings: Whereas men have an average gain in net (gross) earnings of approximately €90 (€150) when moving from medium to high SPE levels, the corresponding effect size for women is less than half and (with one exception) not significant. Moreover, if we again consider the differences in the level of balancing in 2001 indicating a downward (upward) bias of results for men (women), these findings suggest that any household income effect when moving from medium to high SPE levels is captured by earning gains for men rather than women living in the household. Our findings for moving from low to high SPE levels reinforce this interpretation: Although we do not observe any significant effects for women, we observe an average gain in net (gross) earnings of approximately €160 (€260) for men. Considering that the corresponding ATEs from 2001 indicate an upward bias of our estimates for both earning measures (in contrast with the household income measure), the ATEs for household income and (net) earnings for men seem to converge, by and large.

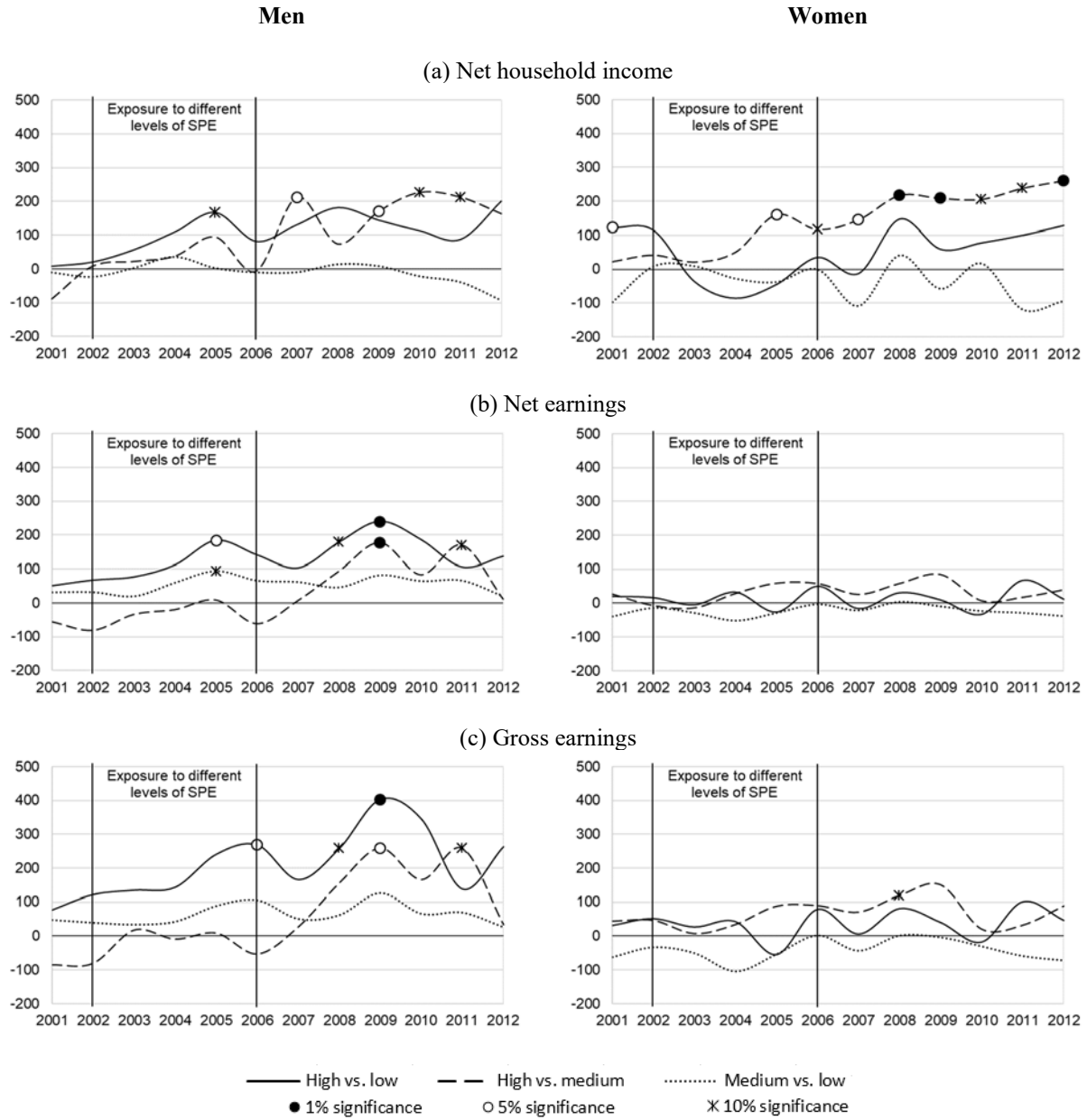
To determine whether these gender-specific differences are reflected by differences in other labor market indicators as well, we also estimate the corresponding effects on working time per week, hourly wage³¹ and the probability of being employed full time (see Figure 3).

²⁹ As Tables B.4 and B.6 in Appendix B show, the mean and median biases are significantly larger for most covariates in the high versus low (H–L) models than the high versus medium (H–M) models.

³⁰ The 2001 ATEs for net household income show a *negative* deviation from zero (indicating a downward bias) for men, whereas the corresponding deviation for women is *positive* (indicating an upward bias).

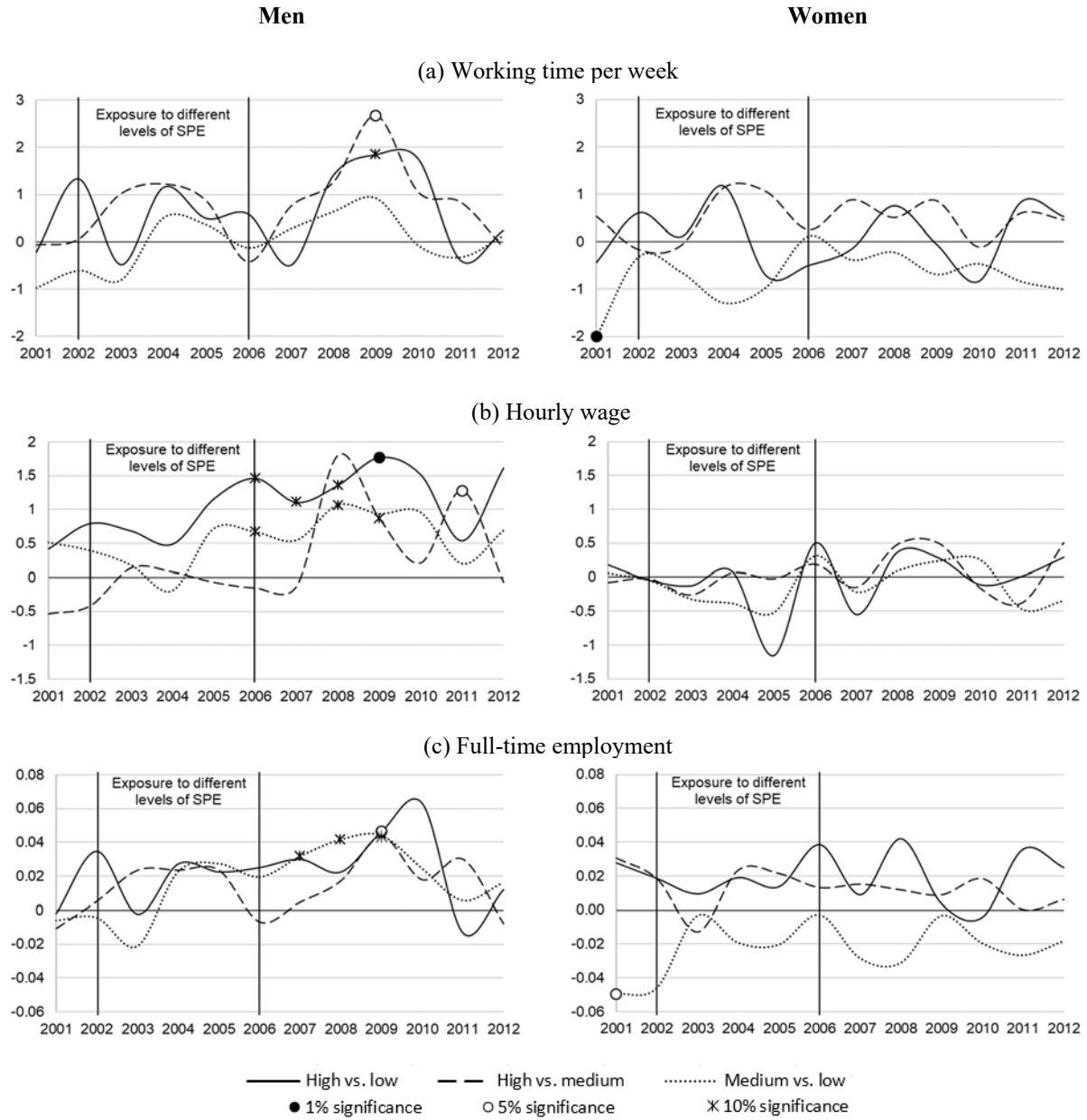
³¹ Because hourly wage is not available in the SOEP, we approximated it by dividing monthly gross earnings by weekly hours ($\times 4.3$). For nonworkers, hourly wage measures zero.

Figure 2: Effects of different levels of SPE on household income and earnings.



Notes: Radius matching results for men and women. This figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on household income and earnings. All 2001 ATEs are calculated as mean differences between matched treated and untreated observations from the balancing tests of the 2002 estimations. We approximate the effects for net earnings in 2001 by multiplying the effects for gross earnings with the samples' average net-to-gross earnings ratio (i.e., 65.6% [63.5%] for men [women]). For common support statistics, see Table B.3 in Appendix B. Tables B.4 and B.6 in Appendix B provide an overview of the balancing statistics of all covariates for the estimated matching models from the post-exposure period (2007–2012). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Figure 3: Effects of different levels of SPE on working time, wages and employment status.



Notes: Radius matching results for men and women. This figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on hourly wages, employment status and working time per week in hours. All 2001 ATEs are calculated as mean differences between matched treated and untreated observations from the balancing tests of the 2002 estimations. For common support statistics, see Table B.3 in Appendix B. Tables B.4 and B.6 in Appendix B provide an overview of the balancing statistics of all covariates for the estimated matching models from the post-exposure period (2007–2012). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

As Figure 3 indicates, we do not observe any significant effects in the post-exposure period for the three measures for women, but we do find some significant effects for men. In

general, however, the corresponding estimates are more volatile than the estimates for income and earnings. For example, moving from medium to high SPE levels is accompanied by an average increase in working time of about one hour in the post-exposure period. This effect is of comparable size for men when moving from low to high SPE levels. However, we only observe a significant estimate in 2009 for both models. Furthermore, we find a significant increase in hourly wage between (on average) €0.7 and €1.3 in the post-exposure period for all three models when moving to comparably higher SPE levels. Considering the differences in the level of balancing in 2001 between the models, these effects seem to converge at approximately €1 for the low versus high and the medium versus high comparisons. Similarly, we observe an average increase of approximately 2–3 percent in the probability of being employed full time in the post-exposure period when moving to comparably higher SPE levels. However, these effects are only significant in 2009 for the low versus high and the medium versus high comparisons.

In summary, we observe a significant (average) increase in household net income of approximately €190 in the post-exposure period when moving from medium to high SPE levels. These effects are, however, fully captured by earning gains for men rather than women living in the household. Moreover, while our estimates for other labor market indicators are generally volatile, the gender differences we observe for earnings are broadly confirmed. Although we do not find any significant effects for women in the post-exposure period, our results suggest that (on average) men work about one hour more and see a benefit of a €1 increase in wage as well as an approximately 2–3 percent increase in the probability of being employed full time when moving to comparably higher SPE levels. In this regard, however, the observed effects when moving from low to medium SPE levels are not large enough to significantly change average household income or earnings.

4.3 Robustness checks

To establish the robustness of these findings, we re-estimate our models with different samples and with different specifications of both measures and models. First, we test whether our results in the exposure periods are driven by individuals who were still in the education system between 2001 and 2006 because (for example) students are not randomly distributed across municipalities.³² Although we expect the available regional and individual confounders to account for this issue, empirical testing seems advisable considering that the estimated ATEs in the (pre-)exposure period(s) already provide important information of the balancing and about how effects develop over time. Red lines in Figures C.1 and C.2 in Appendix C show the estimates for all samples *excluding* individuals who were still in the education system in 2001–2006 (e.g., trainees, students, civilian servants, conscripts; approximately 10–11% of the sample). Although some minor deviations in effect sizes emerged and balancing out the different confounding influences for the low versus high comparison worked better when individuals still pursuing education are *included*, the results do not indicate that our main findings are affected.

An additional robustness check considers the identification strategy employed. A natural candidate to be included in our selection models is SPE measured in the pre-exposure year 2001. In general, controlling for lagged SPE is certainly a comparably stricter condition that might add more credibility to our identification strategy. However, we avoided this approach as a main specification because it requires a sufficiently large variation between the 2001 and the (average of the) 2002–2006 SPE levels, both within subject and between subjects. Consequently, this approach emphasizes comparisons between treatment and controls close to the thresholds (i.e., between medium versus low and high versus medium SPE levels). Moreover,

³² We only excluded individuals who were still in the education system in 2007 or later in the main specification to keep as many observations as possible.

it reduces the probability of finding adequate matching partners for the extreme case, that is, the comparison between high and low SPE levels.³³ Figure C.3 in Appendix C displays the estimates for the male panel in the post-exposure period including lagged SPE.³⁴ As expected, we observe only a few significant estimates as a result of a considerable loss in precision. Moreover, the average gains in net household income (approximately €140 [€120]), gross earnings (approximately €150 [€120]) and net earnings (approximately €90 [€80]) when moving from medium (low) to high SPE levels decrease, particularly for the latter comparison (i.e., low vs. high SPE levels). With regard to the other labor market indicators, a similar picture emerges in terms of effect size and precision of the estimates.

We also test the results when using our original ‘pure’ SPE measure instead of the radius measure as defined in Section 2. As could be expected, the results (displayed in Figure C.4) do differ (in some parts, considerably) from the results we derived when using our radius measure. We still observe some positive gains in net household income (average effect: €170) and net earnings (average effect: €130) when moving from low to high SPE levels that are comparable in size to our estimates using the distance-weighted radius measure. However, none of the income and earning ATEs for the other two comparisons (high vs. medium or medium vs. low) are significant. Moreover, only the effect on full-time employment is significant (and of similar size compared with our radius measure estimates) for the medium versus low comparison.

Finally, we test whether panel attrition may be an issue by checking whether being in either of the SPE groups leads to selective attrition, which could potentially invalidate our estimates. To do so, we make use of the full data set after deleting all observations with missing values for our confounding variables and estimate the effects of SPE level on a binary outcome

³³ This finding is confirmed by the common support statistics indicating comparably more observations off support (see Table B.3 in Appendix B) as well as the balancing statistics indicating comparably higher mean and medium biases for most covariates, in particular for the high versus low models (see Table B.4 in Appendix B).

³⁴ As a result of computational constraints imposed by the infrastructure at the DIW, we could not estimate all robustness checks for the pre-exposure and exposure periods.

variable, which equals 1 if there is missing information in any outcome variable of interest of the respective year for a particular individual. Note that such a test goes beyond a pure panel attrition test and is somewhat stricter in that individuals also drop out of our analysis in years for which we do not observe any outcome (though they may still remain in the panel). Although only 1 of 10 estimates is significant at the 10 percent level for women when moving from medium to high SPE levels, 4 of 10 estimates for men and women are significant when moving from low to high SPE levels.³⁵

In summary, while excluding individuals who were still in the education system between 2001 and 2006 changes hardly any findings for the exposure period, both controlling for lagged SPE in the selection process and using the pure (instead of our radius) SPE measure changes our findings for the post-exposure period. Importantly, however, even for these specifications we observe some positive labor market effects when moving to comparably higher levels of SPE. Moreover, while controlling for lagged SPE in the selection process leads to an expected loss in precision, using the pure SPE measure does not appropriately capture the situation for individuals who may arguably benefit from sports infrastructure in their neighboring municipalities. Therefore, these results remain as a robustness check in our analysis. Finally, while we cannot fully rule out any panel attrition bias in general, our test results indicate that at least the main findings for the medium versus high comparison are hardly affected.

4.4 Effect heterogeneity

From a policy perspective, it is highly relevant to understand whether certain societal groups benefit more or less than others. As mentioned previously, significant differences occur in terms of gender. While men and women exposed to comparably higher levels of SPE benefit from an increase in household income, additional analysis reveals that these gains in income

³⁵ Results are available on request.

are captured by earning gains for men rather than women living in the household. To determine whether this result is plausible, we need to more closely investigate men and women's differing sports participation habits. To do so, we make use of the SOEP-IS, which covers more than 3,000 households. It was established in 2012 (Richter & Schupp, 2015) and included a module on physical activity in 2013, 2015 and 2017.³⁶ According to these data, approximately 38 percent of women (35% of men) in the age cohort of interest (20–52 years) did not engage in any sports. Within our observation window (2013–2017), the share of inactive men remained rather stable, while the corresponding share of inactive women increased. As a consequence, the gender gap in terms of inactivity increased about 5 percentage points within four years. We also observe significant gender differences in the settings in which sport is practiced. In this regard, 16 (12) percent of women (men) engage in their first sport with a commercial sports provider, which is in line with the finding that 56 percent of members in fitness centers in Germany are female (Deloitte, 2018). Overall, these figures suggest that women are generally less likely to engage in sports than men. Moreover, active women have a higher probability of engaging in sports outside any of the publicly funded sports facilities. Therefore, we confirm the plausibility of assuming that women have a lower probability of benefiting from higher levels of SPE than men.

To test whether any of the observed labor market effects depend on age, we split the male sample into two groups (men aged 20–36 years and men aged 37–52 years in 2001). The results for the post-exposure period appear in Figure D.1 in Appendix D. Although we do not observe any effects at the conventional level of significance for the younger cohort, we find several significant effects for the older cohort. With regard to net household income and compared with estimates for the full male sample, these effects are larger (€220) for the high versus low SPE

³⁶ The module, developed by Lechner and Pawlowski (2013), includes various questions about participation patterns in the first and second most frequently practiced sport. Unfortunately, we are not able to use these data in our main analysis because essential information (e.g., respondents' residence before 2013) is not available.

groups and of similar size (€170) for the high versus medium SPE groups. With regard to the other labor market indicators, we find an average positive effect of an increase in working time (1.4 hours), hourly wage (€1) and the probability of being employed full time (4%) for the high versus low comparison. The corresponding effects for the high versus medium comparison are not significant however (with the exception of working time in 2009). Furthermore, the probability of being employed full time is on average approximately 5–6 percent higher for the medium versus low SPE groups. Again, we use the SOEP-IS data to shed light on whether these age-specific differences for men seem plausible. According to the data, approximately 24 percent of the younger cohort (men aged 20–36 years) did not engage in any sports. This share is considerably higher (44%) for the older cohort (men aged 37–52 years). Although the share of inactive men increased during our observation window (2013–2017) by 2 percentage points in the younger cohort and decreased by 3 percentage points in the older cohort, the gap is still considerable. At the same time, however, younger cohort members have on average a 5-percentage-point higher probability than older cohort members (15% vs. 10%) of engaging in their first sport with a commercial sports provider. Therefore, although younger cohort members have a higher probability of practicing sports in general, they are more likely to do so outside any of the publicly funded sports facilities. We thus conclude that it is not unlikely that younger men have a lower probability of benefiting from higher levels of SPE than older men.

In summary, we observe some effect heterogeneity by gender and age. While both men and women exposed to comparably higher levels of SPE benefit from an increase in household income, these gains are captured by earning gains for men rather than women living in the household. Additional analysis reveals that these effects unfold more for older (aged 36–52 years) than younger (aged 20–36 years) men. While both findings are supported by some de-

scriptive figures from the SOEP-IS on gender and age differences in terms of sports participation habits, it is important to note that the disaggregated analysis by age strata suffers from an efficiency loss due to comparably smaller sample sizes.³⁷

4.5 Exploring mechanisms

The underlying assumption of our analysis is that differences in per capita SPEs among municipalities are associated with differences in the quantity and/or quality of sports facilities. Although we are unable to test this assumption at the local level given a lack of data, we find some supportive evidence at the regional level by correlating the average level of SPE with different indicators for sports facility provision in the 16 states (*Länder*).³⁸ Because greater access to sports facilities increases sports participation (Huang & Humphreys, 2012) and higher levels of exercise in turn improve productivity, which is rewarded in the labor market (Lechner, 2009 and Lechner & Sari, 2015), we argue that the observed labor market effects may unfold from the SPE-induced differences in sports participation behavior.

To test this assumption directly, we used the continuous nature of our SPE measure as well as the available sports participation measure in the SOEP and estimated dose-response functions with various specifications.³⁹ Although we did not observe this expected relationship in our data, it is important to note that the available measure in the SOEP only considers the frequency of sports participation and does not measure any differences in intensity and/or duration of sports participation. A certain composition of all three characteristics describing sports participation is, according to the World Health Organization (2010), however, required for

³⁷ We also tested whether any labor market effects depend on whether children are living in the household by re-estimating our models for men living with and without children in the household separately. Our assumption was that comparably higher levels of SPE might positively affect the participation patterns of children, which in turn might enable parents to increase their productivity at work. However, we do not find this relationship in the data.

³⁸ We find some positive correlations between the average level of SPE and the total number of sports facilities as well as the area (in square meters per 1,000 inhabitants) covered by outdoor and indoor pools; the correlation is significant at the 10 percent level (see Table E.1 in Appendix E).

³⁹ Results are documented elsewhere (see Steckenleiter, Lechner, Pawlowski & Schüttoff, 2019).

achieving positive health effects.⁴⁰ Therefore, we performed another more indirect test for differences in sports participation behavior by testing for differences in well-being and health.

To do so, we estimated and compared the effects for men between our main specification and the main specification including satisfaction with health, satisfaction with life and number of doctor visits per year, as well as the physical component (PCS) and the mental component summary scales (MCS) *from the corresponding year* as additional covariates in the selection process. The idea is that any labor market effects caused by an increase in health-enhancing sports participation should disappear when controlling for differences in health status.⁴¹ Figure E.1 in Appendix E displays the effects of different levels of SPE on household income, earnings, working time, wages and full-time employment for *men* during the post-exposure period excluding and including our health measures from the corresponding year as additional covariates in the selection process. Visual inspection of these graphs suggests that some effects indeed decreased when controlling for the various health measures. This reduction is more striking for even years (2008, 2010 and partly 2012), for which we could control for the most sophisticated health measures available, the PCS and MCS.

Table E.2 in Appendix E quantifies the overall effect of controlling for the health measures. The table displays the ATEs for both specifications (ATE and ATE_{Health}) and the average change (in percentage) between ATE and ATE_{Health} calculated for all years in the period 2007–2012 (Change¹) as well as only for years with significant estimates (Change²).⁴² After controlling for the different health measures, we found a reduced effect for net household income and earnings of approximately 15 percent as well as a reduced effect for wage (being

⁴⁰ Supported by various studies offering empirical evidence for this, the WHO guidelines suggest that 150 minutes (75 minutes) per week of moderate (vigorous) regular physical activity is required to achieve any positive health effects.

⁴¹ Data for constructing the PCS and MCS measures were only gathered in even years since 2002 and therefore are not available for 2007, 2009 and 2011.

⁴² Both change indices were only calculated if either ATE or ATE_{Health} is significant for at least two years.

employed full time) of approximately 8–10 (6) percent.⁴³ Importantly, when controlling for PCS and MCS is possible, these values increase to approximately 40 percent for income and earnings and approximately 20 percent for wage and being employed full time for even years.

Overall, these findings suggest that the estimated positive effects on labor market outcomes are indeed driven by health-enhancing sports participation, though other channels beyond health remain relevant. In this regard, Lechner (2009) notes that such channels might relate to, for example, social networking. Indeed, using SOEP data, Schüttoff, Pawlowski, Downward and Lechner (2018) show that regular sports participation positively affects adolescents' social capital through volunteering, helping friends and civic involvement. Unfortunately, however, information on these measures is only available for uneven years and thus is not available for 2008, 2010 and 2012, which makes any joint effect analysis together with all health measures impossible.

5. Conclusion

By merging administrative data of all municipalities in Germany with individual data from the SOEP, we explore whether local public expenditures on sports facilities influence individual labor market outcomes. We approach the issue that public expenditures are policy variables and individuals may deliberately make location choices based on the availability of sports infrastructure by exploiting the panel structure of our data and controlling for variables expected to jointly influence public expenditures and labor market outcomes. To this end, we use several regional characteristics to control for any confounding influences at the *aggregate* (municipality) level and several individual characteristics to control for any confounding influences at the *disaggregate* (individual) level.

⁴³ We observe too few significant effects for calculating the corresponding changes for working time.

Overall, our matching analysis reveals sizable effects of public expenditures on individual labor market outcomes. For both men and women, we observe a significant (average) increase in household monthly net income of approximately €190 (approximately 7% of average household income⁴⁴) when moving from medium (€20–€31) to high (€31–€85) levels of SPE. This figure translates into an average increase in annual spending of approximately €2.5 million for a medium-sized city with 75,000 inhabitants. Interestingly, however, these effects are captured by earning gains for men rather than women living in the household. Additional analysis confirms and supports these apparent gender differences. Whereas we do not observe any significant effects for women, we find some evidence suggesting that (on average) men work one hour more and benefit by a €1 increase in hourly wage as well as a 2–3 percent increase in the probability of being employed full time when moving to comparably higher SPE levels. Moreover, descriptive figures of the SOEP-IS show that women in the age cohort under consideration are less likely than men to engage in sports *in general* and in any of the publicly funded sports facilities *in particular*. We also find that older (aged 37–52 years at the beginning and 48–63 years at the end of our observation window) rather than younger (aged 20–36 years at the beginning and 31–47 years at the end of our observation window) men benefit from higher SPE levels. This result is also supported by some descriptive figures coming from the SOEP-IS data suggesting that the younger cohort has a comparably higher probability of engaging in sports outside any of the publicly funded sports facilities. Finally, although possibilities to test whether these effects unfold from (SPE-induced) differences in sports participation patterns are limited, we find some evidence that improved well-being and health are possible mechanisms.

With this study, we intend to contribute to the rich literature analyzing the effects associated with public expenditures, which to date has largely neglected investigating types of pub-

⁴⁴ Average household net income is calculated as frequency weighted average of the six income figures for 2007, as displayed in Table 1.

lic spending that might indirectly improve health, educational and labor market outcomes. Unfortunately, however, while health, education and labor markets are clearly defined settings, sport and sports participation are not, which results in some imprecision in our analysis. For example, in contrast with Jackson et al. (2016) and others who examine the effects of local school spending, we have difficulty in specifying the exposure period required for the effects we found to unfold. Although our findings suggest that controlling for exposure to different levels of SPE over five years is sufficient to reveal positive effects, specifying more precisely the conditions under which these effects unfold requires more attention in future studies.

Moreover, even the more established literature from settings such as health, education and labor markets remains rather silent about opportunity cost arguments to date – probably because health, education and labor markets are topics that are in the policy focus of all local, regional and national governments around the world. This, however, is not the case for sports (at least not to a similar extent), for which the budget is frequently in competition for scarce public money available for other ‘cultural’ areas such as museums or theaters. In this regard, it would be relevant to test whether and to what extent public spending on other areas beyond health, education and labor markets might be associated with any effects on labor market outcomes as found for sports in this study. However, whether this will be possible in the future depends not only on data quality but also on data protection rules and regulations, which have also considerably limited the scope for implementing more comprehensive econometric techniques in our study.

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Appendix A: Data cleaning, transforming and enriching process

The Scientific Use Files (SUFs)⁴⁵ for 2001–2006 consist of information on all four types of local authorities: urban municipalities/cities (*kreisfreie Städte*) and rural districts (*Landkreise*), which comprise more than 12,000 municipalities (*Gemeinden*), the majority of which are organized in municipality associations (*Gemeindeverbände*). In our analyses, we focus on the lowest administrative units only, that is, urban municipalities/cities (*kreisfreie Städte*) and district municipalities (*kreisangehörige Gemeinden*), because municipality associations' budgets are commonly made up of the affiliated municipalities' budgets and rural districts' SPEs are negligibly small.⁴⁶ The SUF data are available as long format only, which means each revenue and expenditure group for each expenditure category for each local authority makes a single observation, summing to more than 5 million revenue/expenditure group-expenditure category-municipality-observations per year. To work with these data, we transformed them into a wide format with each type of local authority as single observation.

Next, we generated the municipality key codes (AGS) for the period 2001–2012 and pooled them with the RDB to build unique identifiers for further pooling our data with local-level information from other sources. The original key code available in the SUF (*Berichtsstellenschlüssel*) consists of the code of the administrative district (*Regierungsbezirk*) (one digit), the rural district (two digits), the last two digits of the municipality's association (two digits) and the code for the municipality (three digits). The AGS, by contrast, consists of eight digits, comprising information on the federal state (two digits), the administrative district (one digit), the rural district (two digits) and the municipality (three digits) only.

⁴⁵ Official reference to the data: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a).

⁴⁶ Some municipality associations recorded sports-related incomes and expenditures. However, because the budgets of municipality associations are made up of the affiliated municipalities and we operate with gross values of municipality accounts (see subsequent explanation), all sports-related incomes and expenditures of municipality associations are already included in the municipality accounts used in our analysis.

During these transformations, the data were cleaned. For the municipalities in Saxony-Anhalt (ST), the codes in the SUF were outdated, so we updated them with information from the municipal directories. Furthermore, some urban municipalities and district municipalities merged over time, such that they had the same AGS in later waves (i.e., between 2002 and 2006); therefore, the number of municipalities decreased from $n = 12,930$ to $n = 12,291$ (see Table A.1).

Table A.1: Development of the number of municipalities between 2002 and 2006 in the RDB.

Federal state	2002	2003	2004	2005	2006
Baden-Wuerttemberg (BW)	1,111	1,111	1,111	1,111	1,110
Bavaria (BY)	2,056	2,056	2,056	2,056	2,056
Berlin (BE)	1	1	1	1	1
Brandenburg (BB)	886	436	421	420	420
Bremen (HB)	1	1	1	1	1
Hamburg (HH)	1	1	1	1	1
Hesse (HE)	426	426	426	426	426
Lower Saxony (NI)	1,022	1,022	1,022	1,022	1,021
Mecklenburg-Western Pomerania (MV)	979	964	873	851	849
North Rhine-Westphalia (NW)	396	396	396	396	396
Rhineland-Palatinate (RP)	2,306	2,305	2,306	2,306	2,306
Saarland (SL)	52	52	52	52	52
Saxony (SN)	535	525	519	514	510
Saxony-Anhalt (ST)	1,027	1,027	1,027	1,027	1,027
Schleswig-Holstein (SH)	1,124	1,123	1,123	1,123	1,123
Thuringia (TH)	1,007	1,006	998	998	992
Total	12,930	12,452	12,333	12,305	12,291

Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a); own calculations.

To generate a balanced panel, we manually aggregated information on merging municipalities for earlier waves. A comparison of the RDB with the municipal directory of the corresponding years indicates some differences in the overall numbers of local authorities in Germany for some years. Such differences occurred for two reasons: premature mergers and belated mergers. Premature mergers of municipalities in the RDB occur because some municipalities that are listed as single municipalities in the municipal directory were already aggregated in the RDB (e.g., Bitterfeld-Wolfen, Dessau-Roßlau, Elsteraue, Bördeland). Because disaggregated sport-related expenditures for premature merger municipalities were not available, we

decided to use the already merged observations. Belated merger of municipalities in the RDB occur because some municipalities that are listed as single municipalities in the RDB were already aggregated in the municipal directory (e.g., several municipalities in Brandenburg in 2001, such as Brodowin and Serwest, which were already merged with Chorin in the municipal directory). We fixed this issue with a subsequent aggregation of the to-be-merged municipalities. To facilitate additional analyses, we harmonized the database so that for every municipality, only a single observation remained. After reformatting, we applied further data checks and removed any remaining inconsistencies.

Overall, eight variables are included in the SUFs: EF1: municipality key code (*Amtlicher Gemeindeschlüssel – AGS*), EF1U1: region (*Bundesland*), EF2: year (*Erhebungsjahr*), EF3: figures in euros or number of inhabitants (*numerische Angaben*), EF4: classification number (*Gliederungsnummer Bund*), EF5: grouping number (*Gruppierungsnummer Bund*), EF6: municipality size range (*Gemeindegrößenklasse*), EF7: local authority type (*Gebietskörperschaft*) and EF8: authority name (*Gemeindebezeichnung*). The classification (EF4) and grouping (EF5) numbers are of particular interest in our project because they unambiguously identify the various kinds of public incomes and expenditures at the local level (including the money from regional authorities channeled through the local authorities). Our target variables are total expenditures (EF5: 999 *Ausgaben des Verwaltungs- und Vermögenshaushalts*) for sports facilities (EF4: 56 *eigene Sportstätten*) and swimming pools (EF4: 57 *Badeanstalten*) including leisure sports facilities, sports airfields, sports stadiums, sports fields, tennis courts, toboggan and bobsled runs, sports schools, gyms, ski jumps and Olympic sports facilities as well as indoor and outdoor pools (Federal Statistical Office, 2016).⁴⁷

⁴⁷ We did not consider the general category ‘funding of sport’ (EF4: 55 *Förderung des Sports*) because it is very broad and imprecise; it includes general funding of sports clubs and sports association and particular funding measures to support high-performance sport as well as leisure sport (e.g., by subsidizing trainers and coaching programs) (Federal Statistical Office, 2016).

Finally, because heterogeneity in accounting standards has increased between municipalities since 2007, we focus our analysis on the financial years before that year.⁴⁸ More precisely, we took the five-year average of municipality expenditures on sports facilities (including swimming pools) between 2002 and 2006, converted to 2004 euros using the Consumer Price Index from the Federal Statistical Office (2017), as a basis for our expenditure measure.

Over time, an increasing number of municipalities have transformed sports facilities and/or swimming pools into *owner-operated community enterprises* (OCPs, *Eigenbetriebe*), for which incomes and expenditures are not available in the official accounting data of the SUFs. To harmonize the database, we added information on all sports-related OCPs coming from the annual balance sheets of public funds, institutions and enterprises in Germany accessed via computer workplaces in the Research Data Center of the Regional Statistical Office in Stuttgart/Baden-Württemberg (RDC of the Federal Statistical Office and Statistical Offices of the Länder, 2018b). To avoid any double-accounting, we reduced all OCP figures by the amount of subsidies received from municipalities because these subsidies are already included in the accounting figures of the SUFs. Due to strict non-disclosure conditions, we were only allowed to keep the accounting information of OCPs for municipalities running at least three sports-related OCPs. To reach this threshold, we combined the original categories sports facilities (EF4: 56 *eigene Sportstätten*) and swimming pools (EF4: 57 *Badeanstalten*) into a single category and added ‘artificial’ accounting data of OCPs for those municipalities running less than three sports-related OCPs. To minimize the measurement error for these municipalities, we randomly assigned accounting data of small OCPs (identified as municipalities with less than 10,000 inhabitants) and adjusted the figures of contaminated municipalities in a second step by subtracting the population-weighted accounting data.⁴⁹

⁴⁸ Some local/regional authorities have changed from fiscal accounting (*Kameralistik*) to double-entry bookkeeping (*Doppik*), which made a comparison of municipalities with different accounting standards impossible.

⁴⁹ Note that we deleted from analysis any observations that occurred in municipalities used to adjust the figures of contaminated municipalities.

The accounting data available do not allow us to distinguish between high-performance and leisure sports facilities; however, the majority of sports facilities are commonly used jointly by high-performance and leisure sports participants/clubs, so we do not consider this problem major. An exception, however, are professional soccer stadiums. Although we were unable to disentangle soccer stadium–related expenses in our data, we make use of the fact that professional soccer clubs (as long as the clubs do not own the stadium) must pay rent to the municipalities/affiliated OCPs for staging games. In other words, comparably larger sports facility expenditures by communities/OCPs that have professional soccer stadiums are usually accompanied by comparably larger sports facility–related incomes. To consider this potential bias, we focus on net expenditures only.⁵⁰ While this approach purges a potential bias due to soccer stadium–related maintenance expenditures, it does not consider the larger investments made for the construction and renovation of soccer stadiums, which might be a concern particularly considering the construction/renovation of several soccer stadiums for the FIFA World Cup 2006 falls within our observation window. Therefore, we further decided to reduce the SPEs in the 12 cities hosting any of the FIFA World Cup 2006 games by the amounts spent for the construction/renovation of stadiums for this event. We gathered this information from official accounting books of the cities. As expected, most of the FIFA World Cup 2006–related expenses fall into our category of interest (i.e., sports facilities; see Table A.2).

⁵⁰ We do so by subtracting sports facility–related income (income grouping number 399 *Einnahmen des Verwaltungs- und Vermögenshaushalts* in the purchased SUF) from our expenditure measure.

Table A.2: FIFA World Cup 2006–related expenditures of the 12 cities hosting games between 2001 and 2006 in millions of euros.

City hosting games	Subcategory general funding of sport (55 <i>Förderung des Sports</i>)	Subcategory sports facilities (56 <i>eigene Sportstätten</i>)	Owner-operated community enterprises	Σ	Notes
Berlin	7.060	33.313	0	40.373	1)
Dortmund	0	0	0	0	
Frankfurt a. M.	0	17.248	0	17.248	2)
Gelsenkirchen	0	0	0	0	3)
Hamburg	0	3.923	0	3.923	4)
Hannover	.137	30.458	0	30.595	5)
Kaiserslautern	54.621	0	0	54.621	6)
Cologne	4.013	7.849	0	11.862	7)
Leipzig	1.700	77.593	0	79.293	8)
Munich	.170	0	0	.170	9)
Nuremberg	.031	.562	2.574	3.167	10)
Stuttgart	0	60.095	0	60.095	11)
Σ	67.731	231.042	0	301.348	

Notes: Real values as reported in the official accounting books of the German cities; figures were converted to 2004 euros using the Consumer Price Index from the Federal Statistical Office (2017) in Germany after inclusion in the RDB.

¹⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Berlin is zero (German Federal Government, 2006). However, reported figures in the official accounting books are not directly related to the stadium but include compensation payments for the local first division football club (Hertha BSC Berlin) to develop training facilities during the construction period as well as other expenditures related to the FIFA World Cup 2006.

²⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Frankfurt is €64 million (German Federal Government, 2006). However, the budget of the stadium's operating company is recorded in a non-sports related category and therefore is not considered in the regional database of this research project. Thus, only direct subsidies (€17.248 million) are considered for adjusting the regional database of this project.

³⁾ The stadium was constructed before the period under consideration (i.e., 2001–2006).

⁴⁾ The stadium was constructed before the period under consideration (i.e., 2001–2006). Reported FIFA World Cup 2006–related expenditures in the official accounting books are not related to the stadium.

⁵⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Hannover is €24 million (German Federal Government, 2006). However, between 2001 and 2002 the city's official accounting books reported approximately €7 million of stadium-related expenditures.

⁶⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Kaiserslautern is €8 million (German Federal Government, 2006). However, reported figures in the official accounting books (and thus also in the regional database of this research project) include subsidies from regional authorities (i.e., Rhineland-Palatinate).

⁷⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Cologne is €26 million (German Federal Government, 2006). However, the budget of the stadium's operating company is recorded in a non-sports related category and therefore is not considered in the regional database of this research project. Thus, only other FIFA World Cup 2006–related expenditures (€11.862 million) are considered for adjusting the regional database of this research project.

⁸⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Leipzig is €12 million (German Federal Government, 2006). However, reported figures in the official accounting books (and thus also in the regional database of this research project) include subsidies from both regional authorities (i.e., Saxony) and the German federal government.

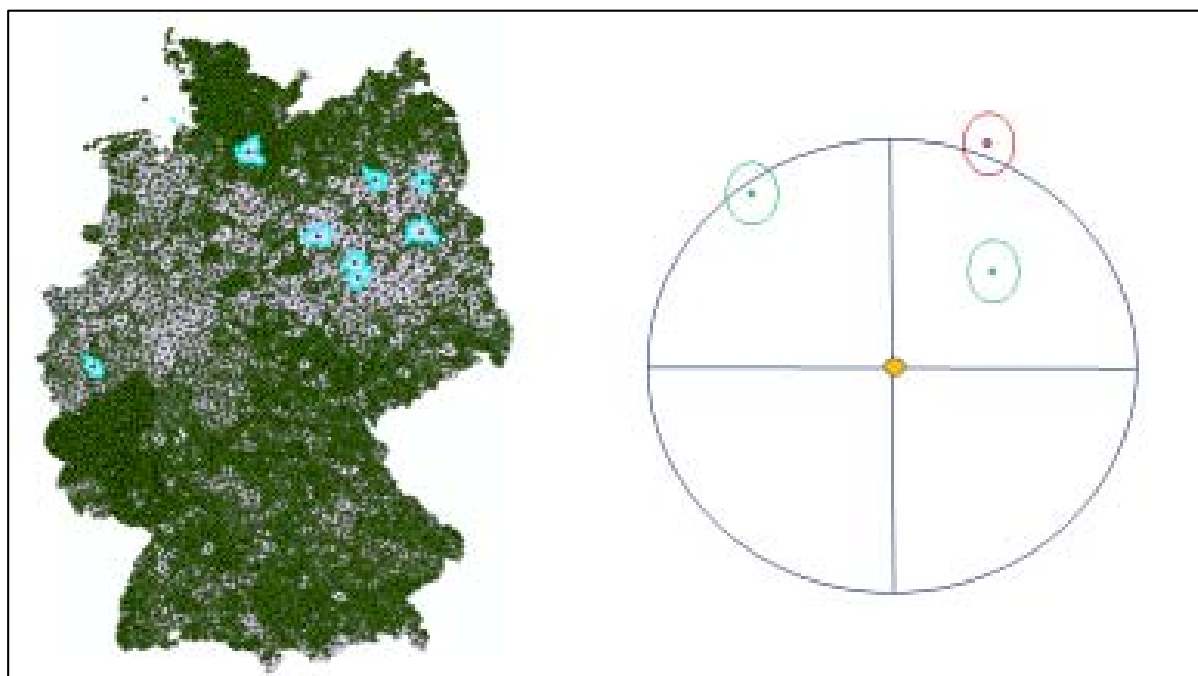
⁹⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Munich is zero (German Federal Government, 2006). However, reported figures in the official accounting books are not related to the stadium but include other expenditures related to the FIFA World Cup 2006.

¹⁰⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Nuremberg is €28 million (German Federal Government, 2006). However, the budget of the stadium's operating company is recorded in a non-sports related category and is therefore not considered in the regional database of this research project. Thus, only other FIFA World Cup 2006–related expenditures (€3.167 million) are considered for adjusting the regional database of this research project.

¹¹⁾ The total amount spent by local authorities for the construction/renovation of the stadium in Stuttgart is €36 million (German Federal Government, 2006). However, reported figures in the official accounting books (and thus also in the regional database of this research project) include subsidies from regional authorities (i.e., Baden-Wuerttemberg).

To compare figures across differently sized municipalities, we converted all figures into per capita figures. Moreover, individuals may benefit from expenditures (and the resulting services and facilities) of not only their own municipalities but also neighboring ones (although to a lesser extent due to higher travel costs). Therefore, we developed a distance-weighted expenditure measure, as further explained in Section 2. To determine the radius size r , we used a representative survey of citizens living in a metropolitan area in southern Germany (i.e., Stuttgart) based on Computer Assisted Telephone Interviews. In this survey, respondents were asked about their maximum willingness to spend travel time to reach a facility for engaging in their sports. We took the average stated value of 26 minutes (Pawlowski, Breuer, Wicker & Poupaux, 2009) and used information from the German mobility report (infas, DLR, 2010) to convert these figures into three distance measures.⁵¹

Figure A.1: Distribution of geometric centers (centroids) for each municipality in Germany.



Notes: Left: Distribution of centroids for each municipality in Germany (green points, with the largest municipalities in terms of square kilometers colored turquoise). Right: Example of included (green) and excluded (red) municipalities in our distance-weighted expenditure measure. Source: Own calculations.

⁵¹ According to this report, the average speed in core cities (densely populated suburban districts) [rural areas] is 26 (31) [33] kilometers per hour allowing to travel 11.3 (13.4) [14.3] kilometers within 26 minutes.

To work with these regional data, we merged further information with the information derived from the SUF: We added detailed municipality characteristics such as (un)employment rates, proportion of recreational/open/natural spaces, migration rates and many others from a database called INKAR (indicators and maps on spatial and urban development [*Indikatoren und Karten zur Raum- und Stadtentwicklung*]) from the Federal Institute for Research on Building, Urban Affairs and Spatial Development (*Bundesinstitut für Bau-, Stadt- und Raumforschung – BBSR*) from the 2013 edition (BBSR, 2013). We used the municipality key code (AGS) for 2011 to merge the two data sets. Because data for municipalities organized in municipality associations (*Gemeindeverbände*) are only available at the aggregate (i.e., municipality associational) level, we assigned each municipality the (same) value of the corresponding municipality association. Moreover, we took population figures and information on the district area in square kilometers from the municipality directories (2001–2006) of the Federal Statistical Office (2002; 2003; 2004; 2005; 2006; 2007). For Bremen and other municipalities where this information was not automatically generated in the pooling process, we manually added it. Finally, we took meteorological data for average precipitation in millimeters, temperature in degrees Celsius and sunshine hours from the Climate Data Center of the German Weather Service (*Deutscher Wetterdienst – DWD*) for the period 1981–2010 (DWD, 2016). After deleting extreme locations (e.g., weather stations on mountains like Zugspitze or Brocken), we pooled municipalities with this information from the closest weather station based on geographic coordinates by using the STATA command `geonear`.

Appendix B: Variable descriptions and further estimation results

Table B.1: Variable descriptions.

Variables	Description	Type
SPE	Sports facility expenditures between 0 and 99 percentiles	Metric
Population size and density		
Population size $\geq 500k$ (R)	Population in 2001: 500,000 or more inhabitants	Dummy
Population size 100k–499k (L)	Population in 2001: 100,000–499,999 inhabitants	Dummy
Population size 50k–99k (M)	Population in 2001: 50,000–99,999 inhabitants	Dummy
Population size 0–50k (S)	Population in 2001: 0–49,999 inhabitants	Dummy
Population density	Population per km ² ; divided by 100	Metric
Population density $\times L$	Population in 2001 $\times$ Population per square km	Metric
Population density $\times M$	Population in 2001 $\times$ Population per square km	Metric
Population density $\times S$	Population in 2001 $\times$ Population per square km	Metric
Population characteristics		
Share of unemployed	Share of unemployed in the working age population (mean of 2001–2006)	Metric
Share of graduates with HEEQ	Share of graduates with higher education entrance qual. (mean of 2001–2006)	Metric
Share of foreigners	LN of share of foreigners (Census 2011)	Metric
Weather conditions		
Average precipitation	LN of precipitation in mm; average sum per year 1981–2010; divided by 100	Metric
Average sunshine duration	LN of sunshine duration in hours; average per year 1981–2010; divided by 1000	Metric
Region		
North-Rhine Westphalia (R)	North-Rhine Westphalia (yes = 1)	Dummy
Southern Germany	Baden-Wuerttemberg and Bavaria (yes = 1)	Dummy
Northern Germany	Bremen, Hamburg, Lower-Saxony, Schleswig-Holstein (yes = 1)	Dummy
Western Germany	Hessen, Rhineland-Palatine, Saarland (yes = 1)	Dummy
Eastern Germany	Berlin, Brandenburg, Meckl.-West Pom., Saxony, Saxony-A., Thuringia (yes = 1)	Dummy
Sociodemographic characteristics		
Married	Married (yes = 1)	Dummy
Divorced	Divorced (yes = 1)	Dummy
German nationality	German (yes = 1)	Dummy
# of children in household	Number of children in household	Metric
Age: 20–29 years (R)	20–29 years old (yes = 1)	Dummy
Age: 30–39 years	30–39 years old (yes = 1)	Dummy
Age: 40–52 years	40–52 years old (yes = 1)	Dummy
Level of education		
Lower second. school/no degree (R)	Lower secondary school / no degree (yes = 1)	Dummy
Intermediate secondary school	Intermediate secondary school (yes = 1)	Dummy
Upper secondary school	Upper secondary school (yes = 1)	Dummy
Other graduation diploma	Other graduation diploma (yes = 1)	Dummy
In education (R)	In education (yes = 1)	Dummy
No vocational degree	No vocational degree (yes = 1)	Dummy
Vocational degree	Vocational degree below university (yes = 1)	Dummy
University degree	University degree (yes = 1)	Dummy
Sports participation		
Sports activity at least monthly	Sports activity at least monthly (yes = 1)	Dummy
Health indicators		
Satisfaction with health (0–10)	Satisfaction with health (scale 1–10)	Metric
Satisfaction with life (0–10)	Satisfaction with life (scale 1–10)	Metric
# of doctor visits per year	Number of doctor visits per year	Metric
Physical health scale (0–100)	Physical component summary scale “physical health” (scale 0–100)	Metric
Mental health scale (0–100)	Mental component summary scale “mental health” (scale 0–100)	Metric
Social capital indicators		
Helping friends at least monthly	At least monthly (yes = 1)	Dummy
Voluntary work at least monthly	At least monthly (yes = 1)	Dummy
Civic involvement	Monthly or less often (yes = 1)	Dummy
Labor market indicators		
Household net income in €	Monthly household net income	Metric
Net earnings in €	Monthly net labor income	Metric
Gross earnings in €	Monthly gross labor income	Metric
Working time per week	Number of working hours per week	Metric
Hourly wage in €	Hourly wage	Metric
Employed full time	Full-time employment (yes = 1)	Dummy

Table B.2: Mean values and marginal effects of the selection models.

Characteristics (1)	Men 20-52 years in 2001						Women 20-52 years in 2001					
	Mean in subsample			Marginal effects			Mean in subsample			Marginal effects		
	High (2)	Med (3)	Low (4)	H-L (5)	H-M (6)	M-L (7)	High (8)	Med (9)	Low (10)	H-L (11)	H-M (12)	M-L (13)
Population size and density												
Population size ≥ 500k	.44	.38	.32	R	R	R	.46	.41	.32	R	R	R
Population size 100k–499k (L)	.18	.19	.12	-.20**	-.53***	.15	.17	.18	.11	-.04	-.27***	.05
Population size 50k–99k (M)	.02	.04	.07	-.09	-.41	.13	.03	.04	.08	-.002	-.19	.02
Population size 0–50k (S)	.35	.38	.49	-.11**	-.42***	.17**	.34	.37	.49	-.11*	-.37***	.10*
Population density	1.8	1.7	1.2	.02	-.14***	.10***	1.8	1.8	1.3	.02	-.10***	.06***
Population density × L	.38	.35	.17	.16***	.22***	.03	.32	.34	.17	.08*	.10***	.07**
Population density × M	.04	.07	.10	-.05	.09	-.06	.04	.07	.11	-.09*	-.008	-.03
Population density × S	.29	.22	.17	.08***	.18***	-.02	.29	.21	.20	.07**	.17***	-.008
Population characteristics												
Share of unemployed ¹⁾	7.1	8.9	9.2	-.02***	.02	-.03***	7.2	8.9	9.4	-.02***	.01***	-.03***
Share of graduates with HEEQ ¹⁾	24	25	23	.003	-.0003	.005**	24	25	23	.0009	-.002	.002
Share of foreigners	1.9	1.5	1.2	.03	.03	.005	1.9	1.5	1.2	.06**	.02	.04**
Weather conditions												
Average precipitation ²⁾	2.1	2.0	2.0	.33***	.28***	.06	2.1	2.0	2.0	.29***	.25***	.02
Average sunshine duration ²⁾	.47	.46	.45	.98***	.12	.80**	.47	.47	.46	.31	-.51	.34
Region												
North–Rhine Westphalia	.22	.20	.21	R	R	R	.25	.20	.20	R	R	R
Southern Germany	.40	.18	.17	.10**	.20***	-.05	.38	.19	.16	.12***	.22***	-.02
Northern Germany	.04	.14	.20	-.20***	-.27***	-.03	.03	.13	.21	-.29***	-.31***	-.09***
Western Germany	.19	.12	.08	.20***	.14***	.13**	.19	.12	.09	.16***	.15***	.07
Eastern Germany	.14	.35	.34	-.13**	-.17**	.19***	.15	.36	.34	.17***	-.16**	.27***
Socio-demographic characteristics												
Married	.65	.63	.64	-.009	-.01	-.02	.66	.64	.65	.03	.007	.03
Divorced	.05	.06	.06	-.05	-.02	-.06	.09	.09	.07	.05	.05	.05
German nationality	.87	.92	.94	-.06	-.02	-.03	.86	.91	.94	-.11***	-.02	-.10**
# of children in household	.94	.90	.96	-.02**	-.007	-.01	.95	.90	.98	-.02**	.004	-.02*
Age: 20–29 years	.17	.16	.17	R	R	R	.19	.21	.21	R	R	R
Age: 30–39 years	.41	.37	.37	-.01	-.01	.01	.40	.35	.34	.08***	.06*	.01
Age: 40–52 years	.42	.47	.45	-.04	-.04	.02	.41	.44	.45	.02	.03	-.02
Level of education												
Lower second. school/no degree	.33	.32	.32	R	R	R	.29	.25	.26	R	R	R
Intermediate secondary school	.27	.35	.38	-.01	.02	-.03	.38	.43	.47	.01	.04	-.03
Upper secondary school	.30	.27	.26	-.02	.03	-.06	.24	.25	.22	.08**	.06	-.004
Other graduation diploma	.10	.06	.05	.05	.08	.04	.09	.07	.05	.009	-.006	.008
In education	.06	.05	.05	R	R	R	.05	.07	.06	R	R	R
No vocational degree	.12	.11	.11	-.009	.003	-.05	.19	.12	.14	.01	.10**	-.10*
Vocational degree	.71	.74	.76	-.001	.01	-.05	.67	.72	.73	.004	.02	-.01
University degree	.22	.21	.17	.03	.005	.0004	.16	.20	.19	-.06*	-.02	-.04
Sports participation												
Sports activity at least monthly	.40	.37	.37	-.03	-.02	-.008	.35	.36	.33	.006	-.005	.01
Health indicators												
Satisfaction with health (0–10)	7.3	7.1	7.1	-.007	.005	-.009	7.2	7.1	7.0	.01*	.006	.007
Satisfaction with life (0–10)	7.2	7.0	7.0	.01	.005	.005	7.2	7.1	7.1	-.02**	-.008	-.01
# of doctor visits per year	6.7	7.0	6.9	-.0005	.0002	-.0001	9.9	10	10	-.0002	.0003	-.0005
Physical health scale (0–100) ³⁾	53	53	53	-.0003	-.0005	.0009	53	52	52	-.0009	.0005	-.0004
Mental health scale (0–100) ³⁾	50	50	50	-.0002	.0006	-.0007	48	47	48	.0006	.001	-.001
Social capital indicators												
Helping friends at least monthly	.53	.49	.52	.03*	.06***	-.01	.46	.43	.43	.04*	.04**	.02
Voluntary work at least monthly	.19	.17	.21	-.009	.002	-.01	.13	.13	.13	-.02	-.03	.02
Civic involvement	.09	.10	.11	-.05	-.05	-.0004	.08	.07	.08	-.04	.06	-.04
Labor market indicators												
Household net income in €	2733	2577	2592	0.000009	.00001	-.00001	2640	2568	2505	.00002*	0.000005	.00001
Gross earnings in €	2731	2424	2271	0.000007	.00002	.00001	1165	1165	1086	-.00002	-.00002	0.000006
Working time per week	41	39	38	.0008	.001	-.0003	23	23	23	.0006	.002**	-.001
Hourly wage in €	14	13	12	-.0003	-.004	-.0005	8	8	8	.003	-.001	.003
Employed full time	.88	.84	.81	.02	-.009	.04	.39	.39	.38	.019	.006	-.0008
# of observations, Pseudo R ²	985	1051	1009	22	13	7	1095	1150	1135	21	12	8

Notes: All figures are based on the 2007 sample. Because we have an unbalanced panel with a decreasing number of observations due to panel attrition, we needed to re-estimate all probit models for each year to calculate the corresponding ATEs (results are available upon request). The high (med) [low] sample consists of individuals living in a municipality with high (medium) [low] levels of distance-weighted per capita SPEs as defined in Section 2. The dependent variables in the probit models are dummies measuring 1 for the relatively higher expenditure level; that is, for the H–M-model high, for the H–L-model high and for the M–L-model medium. Independent variables are measured before the dependent variable if not stated otherwise; that is, ¹⁾ measured between 2001 and 2006, ²⁾ measured between 1981 and 2010, ³⁾ measured in 2002. Significance levels: * $\equiv p \leq 10\%$, ** $\equiv p \leq 5\%$, *** $\equiv p \leq 1\%$. R denotes the reference category. A detailed description of all variables is provided in Table B.1 in Appendix B. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Table B.3: Common support statistics for the estimated matching models for *men* (with/without lagged SPE) and *women* (without lagged SPE).

Year	Model	Group	Men				Women	
			Without lagged SPE		With lagged SPE		Without lagged SPE	
			On support	Off support	On support	Off support	On support	Off support
2007	H-L	Untreated	1,009	1	961	39	1,135	0
		Treated	985	0	974	17	1,095	29
	H-M	Untreated	1,051	5	1,035	17	1,150	2
		Treated	985	6	974	0	1,095	2
	M-L	Untreated	1,009	14	961	24	1,135	11
		Treated	1,051	0	1035	4	1,150	3
2008	H-L	Untreated	882	2	826	28	991	1
		Treated	820	22	699	149	913	39
	H-M	Untreated	885	22	871	12	981	1
		Treated	820	11	699	5	913	12
	M-L	Untreated	882	9	826	39	991	13
		Treated	885	0	871	24	981	1
2009	H-L	Untreated	830	0	795	38	955	0
		Treated	759	12	673	99	863	24
	H-M	Untreated	843	19	826	6	935	2
		Treated	759	11	673	10	863	4
	M-L	Untreated	830	14	795	11	955	11
		Treated	843	0	826	30	935	1
2010	H-L	Untreated	751	2	704	50	860	0
		Treated	677	10	599	90	770	10
	H-M	Untreated	745	23	731	11	840	0
		Treated	677	9	599	7	770	2
	M-L	Untreated	751	5	704	4	860	6
		Treated	745	0	731	26	840	0
2011	H-L	Untreated	722	0	664	43	827	1
		Treated	647	28	590	83	742	11
	H-M	Untreated	719	13	705	8	802	0
		Treated	647	6	590	8	742	1
	M-L	Untreated	722	14	664	29	827	5
		Treated	719	0	705	19	802	2
2012	H-L	Untreated	624	4	580	36	692	38
		Treated	544	19	478	88	615	8
	H-M	Untreated	607	24	597	11	679	28
		Treated	544	12	478	9	615	8
	M-L	Untreated	624	11	580	23	692	3
		Treated	607	1	597	24	679	2

Notes: Common support statistics of the estimated matching models. The H (M) [L] refers to the corresponding models including individuals living in a municipality with high (medium) [low] levels of distance-weighted per capita SPEs as defined in Section 2. The treated group consists of those in the relatively higher expenditure level, that is, for the H-M-model H, for the H-L-model H and for the M-L-model M. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Table B.4: Balancing statistics with the mean and median biases for the estimated matching models for *men*.

Year	Model		Mean	Med	Variables with %bias > 10 for the matched observations (M)
2007	H–L	UO	20.7	18.2	gross earnings, hourly wage, average precipitation, share of foreigners, share of graduates with HEEQ, population size 100k–499k, population density, population density × L, upper secondary school, vocational degree, age: 30–39 years
		MO	8.2	6.7	
	H–M	UO	14.3	9.2	
		MO	5.0	4.1	household net income, gross earnings, hourly wage, share of graduates with HEEQ
	M–L	UO	8.7	5.8	
		MO	4.5	3.7	population density, western Germany, age: 40–52 years
2008	H–L	UO	20.8	18.1	satisfaction with health, satisfaction with life, # of doctor visits per year, mental health scale, civic involvement, average precipitation, average sunshine duration, share of foreigners, share of graduates with HEEQ, population density, population density × L, Married, # of children in household, upper secondary school, no vocational degree, vocational degree, western Germany, southern Germany, age: 30–39 years, age: 40–52 years
		MO	10.5	9.3	
	H–M	UO	14.1	9.4	
		MO	4.2	3.2	share of graduates with HEEQ
	M–L	UO	9.6	6.2	
		MO	4.6	4.5	divorced, upper secondary school, university degree
2009	H–L	UO	20.0	16.8	hourly wage, satisfaction with life, civic involvement, average precipitation, average sunshine duration, share of foreigners, population size 100k–499k, population density, population density × L, population density × S, upper secondary school, no vocational degree, vocational degree, western Germany, eastern Germany, age: 30–39 years, age: 40–52 years
		MO	8.1	8.5	
	H–M	UO	13.4	9.2	
		MO	3.8	2.8	employed full time, mental health scale, share of graduates with HEEQ
	M–L	UO	9.4	5.5	sports activity, helping friends, average precipitation, share of foreigners, share of graduates with HEEQ, population size 100k–499k, population density × L, divorced, German nationality, intermediate secondary school, upper secondary school, other graduation diploma, northern Germany, southern Germany, age: 30–39 years, age: 40–52 years
		MO	7.9	6.1	
2010	H–L	UO	18.9	14.5	gross earnings, hourly wage, average precipitation, share of foreigners, population size 50k–99k, population density × M, population density × S, # of children in household, intermediate secondary school, upper secondary school, vocational degree, western Germany
		MO	7.9	8.4	
	H–M	UO	12.5	7.8	
		MO	3.9	3.0	share of graduates with HEEQ
	M–L	UO	9.9	6.0	
		MO	5.2	4.8	share of foreigners, population size 100k–499k, population density
2011	H–L	UO	18.4	11.6	household net income, civic involvement, average precipitation, share of foreigners, population density, population density × L, population density × S, number of children in household, upper secondary school, no vocational degree, vocational degree, western Germany, eastern Germany
		MO	7.4	5.3	
	H–M	UO	13.2	7.2	
		MO	5.4	4.4	household net income, population size 0–50k, population size 100k–499k × S, western Germany, southern Germany
	M–L	UO	8.8	4.9	
		MO	5.2	4.0	gross earnings, hourly wage, average precipitation, share of foreigners, population size 100k–499k, population density, population density × L
2012	H–L	UO	18.8	12.8	household net income, civic involvement, average precipitation, share of foreigners, population size 50k–99k, population density, population density × M, intermediate secondary school, upper secondary school, no vocational degree, vocational degree, western Germany, eastern Germany, age: 30–39 years, age: 40–52 years
		MO	7.7	6.4	
	H–M	UO	12.2	6.8	
		MO	4.3	3.7	hourly wage, sports activity, other graduation diploma
	M–L	UO	9.7	5.5	
		MO	5.1	4.3	satisfaction with health, share of foreigners, population density, population density × S, # of children in household

Notes: Balancing statistics with the mean and median (med) biases for the estimated matching models for men. The H (M) [L] refers to the corresponding models including individuals living in a municipality with high (medium) [low] levels of distance-weighted per capita SPEs as defined in Section 2. The treated group consists of those in the relatively higher expenditure level; that is, for the H–M-model H, for the H–L-model H and for the M–L-model M. MO refers to matched observations, and UO refers to unmatched observations. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Table B.5: Balancing statistics with the mean and median biases for the estimated matching models for *men* with lagged SPE.

Year	Model		Mean	Med	Variables with %bias > 10 for the matched observations (M)
2007	H-L	UO	22.1	17.6	lagged SPE, gross earnings, hourly wage, employed full time, working time, satisfaction with life, civic involvement, average sunshine duration, share of foreigners, share of graduates with HEEQ, population size 0-50k, population density, population density $\times$ S, married, German nationality, # of children in household, upper secondary school, other graduation diploma, no vocational degree, vocational degree, university degree, western Germany, southern Germany, eastern Germany, age: 30-39 years
		MO	14.4	13.4	
	H-M	UO	15.5	9.8	lagged SPE, gross earnings, hourly wage, # of doctor visits per year, voluntary work, average precipitation, share of foreigners, share of unemployed
		MO	8.9	8.1	
2008	M-L	UO	9.8	5.7	lagged SPE, share of foreigners, share of graduates with HEEQ, population density, population size 0-50k, population density, population density $\times$ S, intermediate secondary school, eastern Germany
		MO	4.6	3.6	
	H-L	UO	20.1	16.1	lagged SPE, employed full time, satisfaction with health, mental health scale, average precipitation, share of foreigners, share of graduates with HEEQ, population size 50k-99k, population size 0-50k, population density, population density $\times$ M, German nationality, no vocational degree, vocational degree, western Germany, eastern Germany
		MO	9.5	6.5	
2009	H-M	UO	13.3	9.6	share of foreigners, share of graduates with HEEQ, population size 0-50k, population density
		MO	4.4	3.3	
	M-L	UO	9.9	5.7	lagged SPE, # of doctor visits per year, share of foreigners, population size 0-50k, population density
		MO	5.5	4.5	
2010	H-L	UO	20.7	15.8	lagged SPE, gross earnings, hourly wage, employed full time, working time, satisfaction with life, # of doctor visits per year, physical health scale, civic involvement, average precipitation, share of foreigners, share of graduates with HEEQ, population size 100k-499k, population size 0-50k, population density, German nationality, # of children in household, upper secondary school, no vocational degree, university degree, western Germany, eastern Germany
		MO	13.9	10.1	
	H-M	UO	13.4	7.9	lagged SPE, gross earnings, hourly wage, working time, helping friends, share of foreigners, share of unemployed, share of graduates with HEEQ, population size 0-50k, population density, # of children in household, other graduation diploma, western Germany, eastern Germany, age: 30-39 years
		MO	8.9	8.1	
2011	M-L	UO	9.9	5.3	# of doctor visits per year, population size 0-50k, population density $\times$ S, married, # of children in household
		MO	4.7	2.8	
	H-L	UO	19.5	11.6	lagged SPE, gross earnings, hourly wage, employed full time, working time, satisfaction health, satisfaction life, physical health scale, average precipitation, average sunshine duration, share of foreigners, share of graduates with HEEQ, population size 100k-499k, population size 50k-99k, population size 0-50k, population density, married, German nationality, # of children in household, upper secondary school, other graduation diploma, western Germany, southern Germany, eastern Germany
		MO	12.4	10.3	
2012	H-M	UO	12.6	7.5	share of foreigners, share of unemployed, share of graduates with HEEQ, population size 0-50k, population density, university degree, eastern Germany
		MO	6.5	5.4	
	M-L	UO	10.3	6.1	lagged SPE, household net income, gross earnings, sports activity, share of foreigners, population size 50k-99k, population size 0-50k, population density, intermediate secondary school
		MO	6.2	5.1	
2011	H-L	UO	19.7	11.5	lagged SPE, household net income, gross earnings, hourly wage, employed full time, working time, satisfaction with health, satisfaction with life, physical health scale, sports activity, average sunshine duration, share of foreigners, share of graduates with HEEQ, population size 0-50k, population density, German nationality, upper secondary school, no vocational degree, university degree, western Germany, southern Germany, eastern Germany
		MO	12.8	11.8	
	H-M	UO	13.7	8.4	household net income, mental health scale, voluntary work, share of foreigners, share of unemployed, share of graduates with HEEQ, population size 0-50k, population density, vocational degree, university degree, eastern Germany
		MO	8.2	5.5	
2012	M-L	UO	9.3	5.3	lagged SPE, average precipitation, share of foreigners, western Germany, eastern Germany
		MO	5.6	3.6	
	H-L	UO	19.4	12.5	lagged SPE, gross earnings, hourly wage, satisfaction with health, satisfaction with life, # of doctor visits per year, physical health scale, helping friends, average precipitation, share of foreigners, share of unemployed, share of graduates with HEEQ, population size 100k-499k, population size 0-50k, population density, married, German nationality, upper secondary school, no vocational degree, university degree, western Germany, eastern Germany
		MO	12.1	10.8	
2012	H-M	UO	11.8	6.5	average precipitation, share of foreigners, share of unemployed, share of graduates with HEEQ, population size 100k-499k, population density, eastern Germany
		MO	5.8	3.8	
	M-L	UO	9.8	6.2	lagged SPE, civic involvement, population density, intermediate secondary school, university degree
		MO	5.2	4.8	

Notes: Balancing statistics with the mean and median biases for the estimated matching models for men with lagged SPE. The H (M) [L] refers to the corresponding models including individuals living in a municipality with high (medium) [low] levels of distance-weighted per capita SPEs as defined in Section 2. The treated group consists of those in the relatively higher expenditure level; that is, for the H-M-model H, for the H-L-model H and for the M-L-model M. MO refers to matched observations, and UO refers to unmatched observations. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

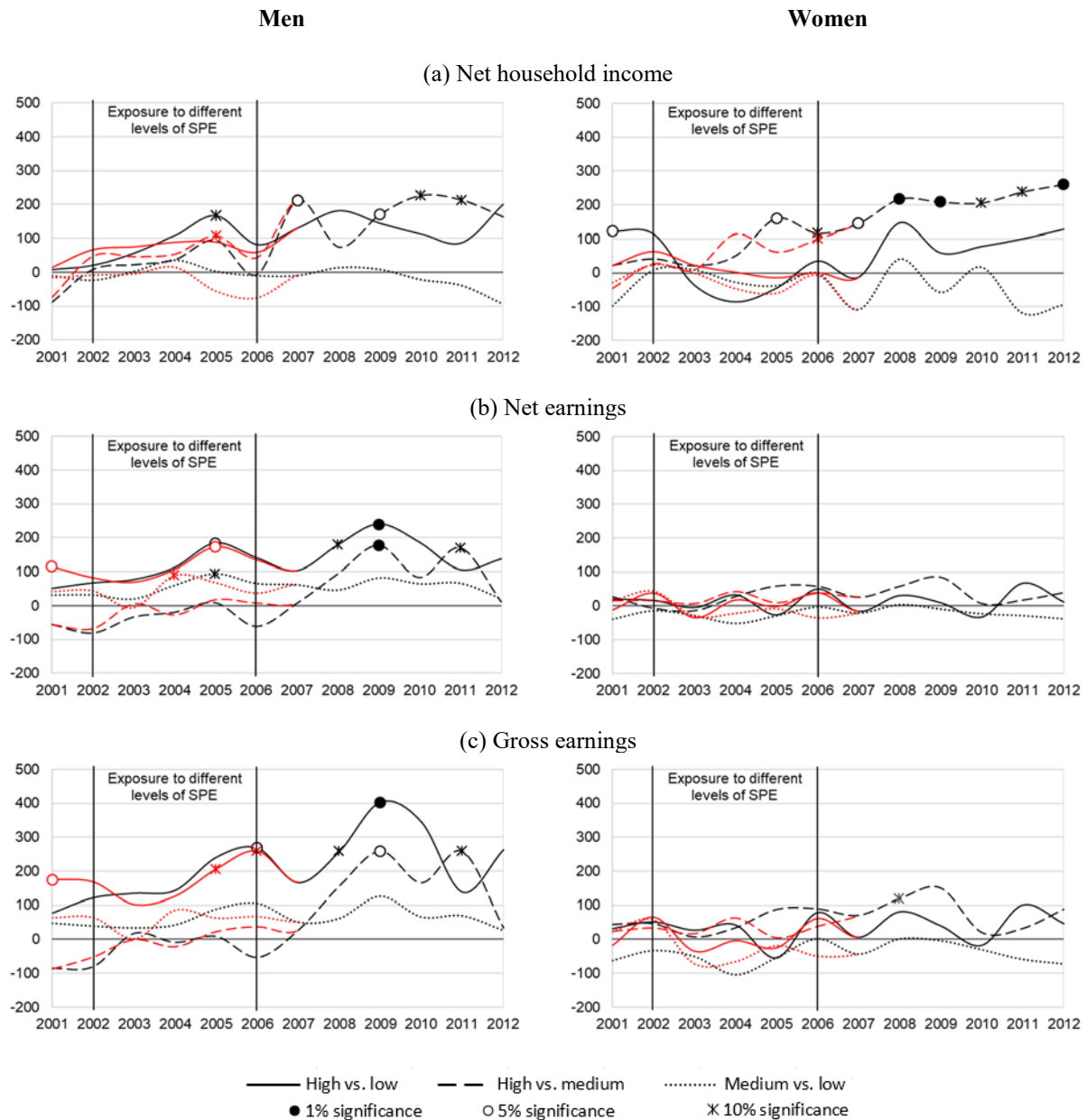
Table B.6: Balancing statistics with the mean and median biases for the estimated matching models for *women*.

Year	Model		Mean	Med	Variables with %bias > 10 for the matched observations (M)
2007	H-L	UO	17.9	11.8	
		MO	5.9	4.6	average precipitation, share of foreigners, population size 100k–499k, population density, population density × L
	H-M	UO	11.4	6.2	
		MO	3.4	2.2	share of graduates with HEEQ
	M-L	UO	9.0	6.3	
		MO	5.0	4.0	household net income, population density × L
2008	H-L	UO	18.0	11.8	average precipitation, share of graduates with HEEQ, population size 100k–499k, population density × L, population density × S, divorced, no vocational degree, vocational degree
		MO	6.5	4.6	
	H-M	UO	11.8	7.4	
		MO	4.1	3.1	share of graduates with HEEQ
	M-L	UO	9.0	6.7	
		MO	3.3	2.3	intermediate secondary school, age: 30–39 years
2009	H-L	UO	18.4	12.1	average precipitation, average sunshine duration, share of foreigners, share of graduates with HEEQ, population density, divorced, German nationality
		MO	6.2	4.7	
	H-M	UO	11.8	6.1	
		MO	4.0	3.1	working time, share of foreigners, share of graduates with HEEQ, population density
	M-L	UO	9.5	5.3	
		MO	3.9	2.5	population size 100k–499k, population density × L, divorced
2010	H-L	UO	19.0	12.3	
		MO	6.4	5.8	average precipitation, divorced, German nationality, no vocational degree, population density × L
	H-M	UO	11.8	5.8	
		MO	4.9	4.3	employed full time, share of foreigners, share of graduates with HEEQ, population density, no vocational degree
	M-L	UO	9.9	6.4	
		MO	4.6	3.5	sports activity
2011	H-L	UO	18.0	9.9	working time, average precipitation, share of foreigners, share of graduates with HEEQ, population size 0–50k, population density, divorced, German Nationality
		MO	6.6	5.2	
	H-M	UO	11.4	5.6	
		MO	4.7	3.6	mental health scale, share of foreigners, share of graduates with HEEQ, German nationality, no vocational degree
	M-L	UO	9.3	4.8	
		MO	5.0	2.8	share of foreigners, population size 100k–499k, population density, population density × L, married, divorced, eastern Germany, age: 30–39 years
2012	H-L	UO	17.1	11.6	working time, satisfaction with health, helping friends, civic involvement, share of foreigners, population density × S, married, divorced, German nationality, other graduation diploma, no vocational degree, southern Germany
		MO	7.4	6.2	
	H-M	UO	10.8	5.8	
		MO	5.5	4.5	average sunshine duration, share of foreigners, share of graduates with HEEQ, population density, western Germany, southern Germany
	M-L	UO	9.1	5.9	
		MO	5.6	5.0	sports activity, helping friends, civic involvement, population size 100k–499k, population density × L, married, southern Germany, age: 30–39 years

Notes: Balancing statistics with the mean and median (med) biases for the estimated matching models for women. The H (M) [L] refers to the corresponding models including individuals living in a municipality with high (medium) [low] levels of distance-weighted per capita SPEs as defined in Section 2. The treated group consists of those in the relatively higher expenditure level; that is, for the H-M-model H, for the H-L-model H and for the M-L-model M. MO refers to matched observations, and UO refers to unmatched observations. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

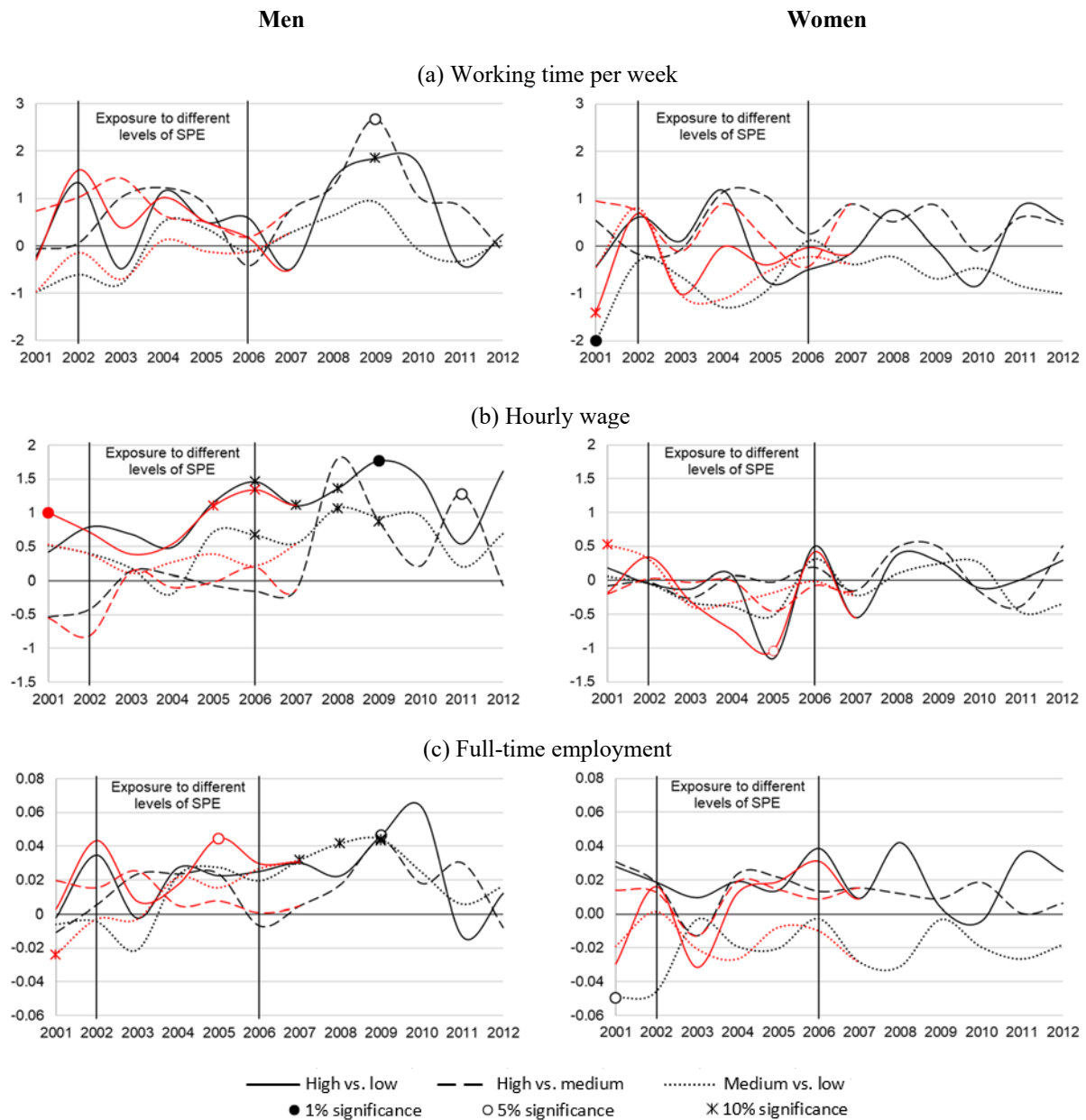
Appendix C: Robustness checks

Figure C.1: Effects of different levels of SPE on household income and earnings during the exposure period including (main specification, black lines)/excluding (red lines) any individuals who were still in the education system in 2001–2006.



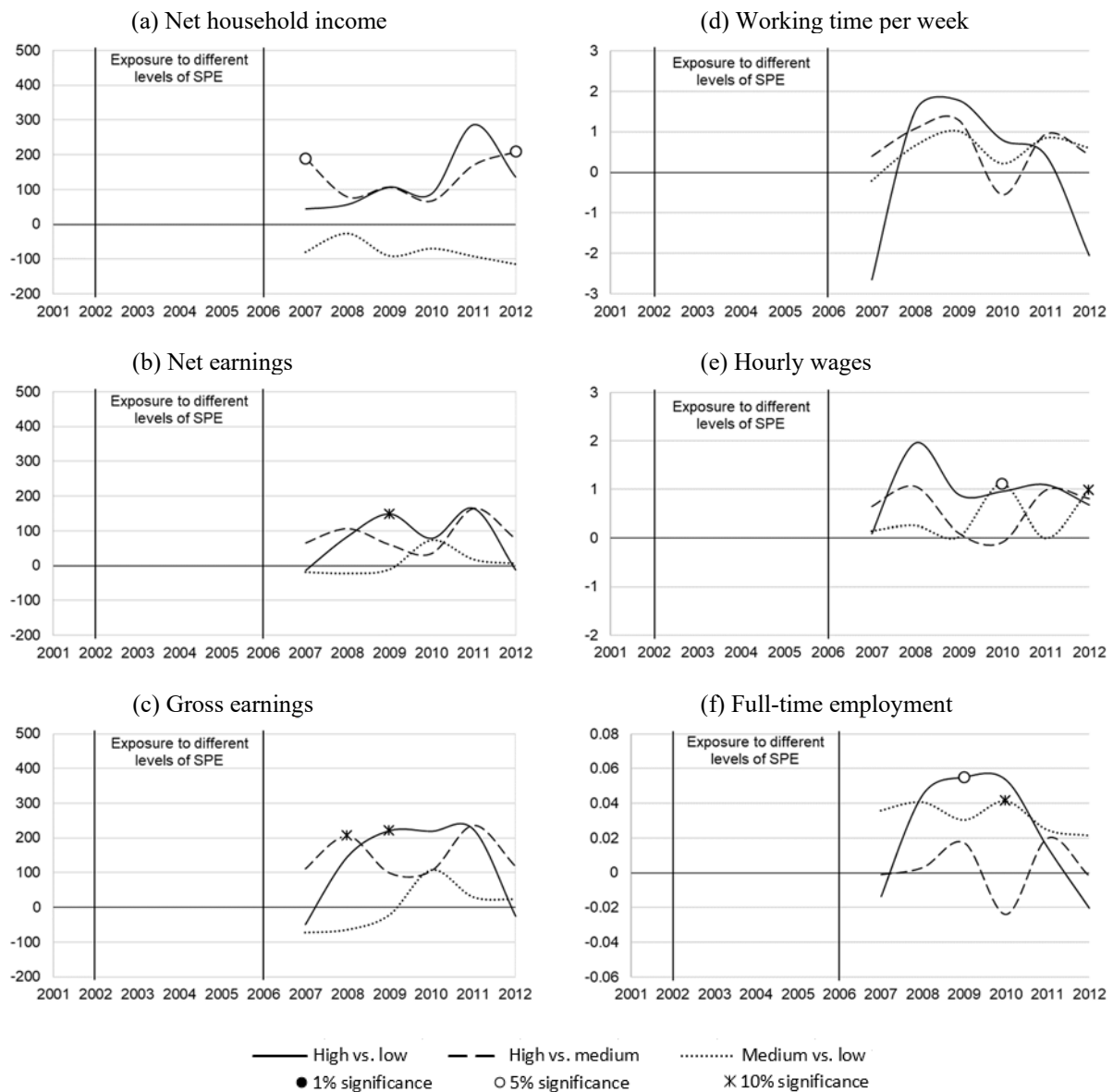
Notes: Radius matching results for men and women during the exposure period including (main specification, black lines)/excluding (red lines) any individuals who were still in the education system in 2001–2006 (e.g., trainees, students, civilian servants, conscripts). The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on household income and earnings. All 2001 ATEs are calculated as mean differences between matched treated and untreated observations from the balancing tests of the 2002 estimations. The effects for net earnings in 2001 are approximated by multiplying the effects for gross earnings with the samples' average net-to-gross earnings ratio (i.e., 65.6% [63.5%] for men [women]). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Figure C.2: Effects of different levels of SPE on working time, wages and employment status during the exposure period including (main specification, black lines)/excluding (red lines) any individuals who were still in the education system in 2001–2006.



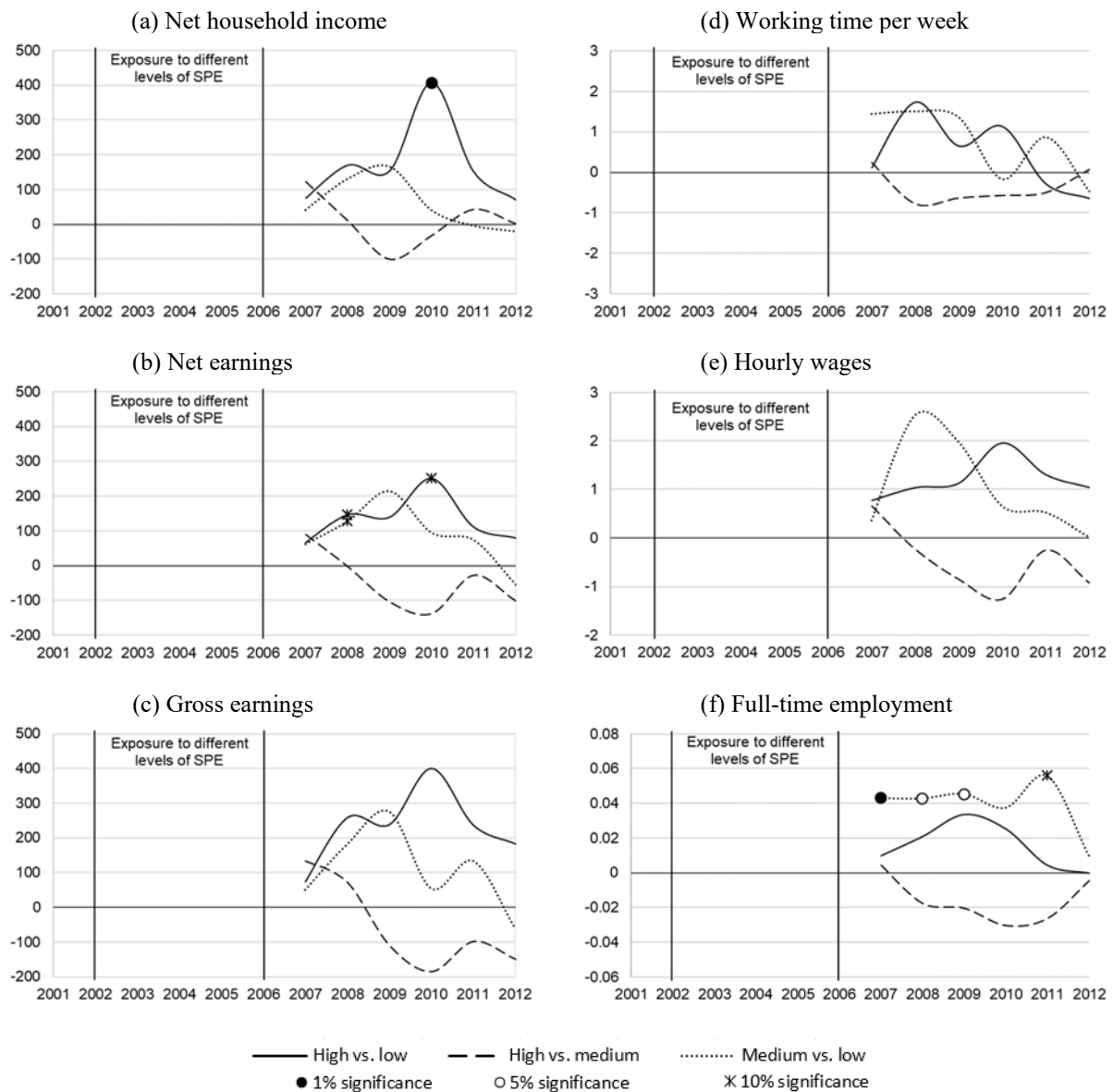
Notes: Radius matching results for men and women during the exposure period including (main specification, black lines)/excluding (red lines) any individuals who were still in the education system in 2001–2006 (e.g., trainees, students, civilian servants, conscripts). The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on hourly wages, employment status and working time per week in hours. All 2001 ATEs are calculated as mean differences between matched treated and untreated observations from the balancing tests of the 2002 estimations. The effects for net earnings in 2001 are approximated by multiplying the effects for gross earnings with the samples' average net-to-gross earnings ratio (i.e., 65.6% [63.5%] for men [women]). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Figure C.3: Effects of different levels of SPE on household income, earnings, working time, wages and full-time employment for *men* when including lagged SPE as additional control.



Notes: Radius matching results for men when including lagged SPE as additional control. The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on household income, earnings, working time, wages and full-time employment. Due to computational constraints caused by the infrastructure at the DIW, we were not able to estimate these models for the pre-exposure and exposure periods. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

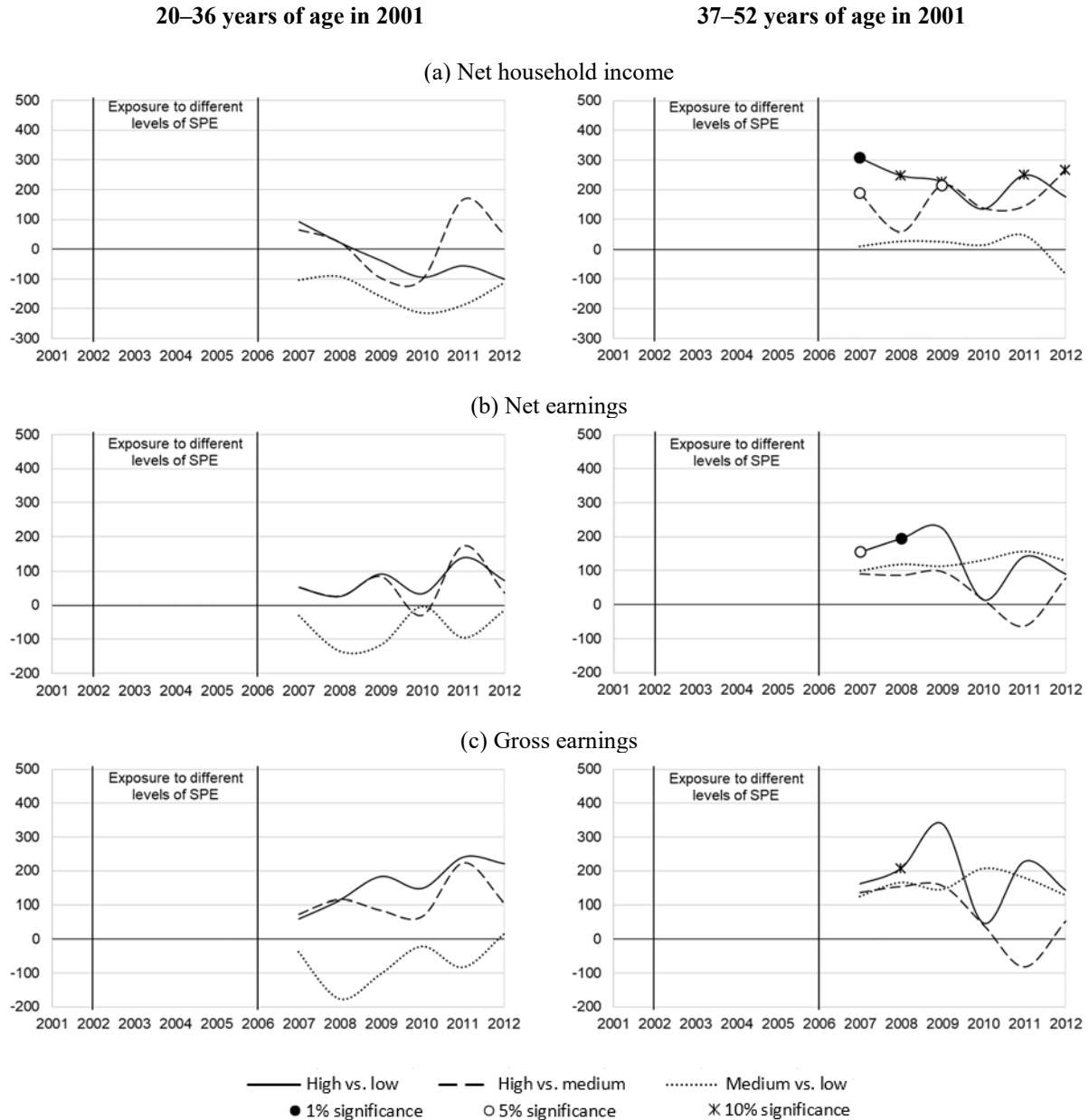
Figure C.4: Effects of different levels of SPE on household income, earnings, working time, wages and full-time employment for *men* when using the pure SPE measure.



Notes: Radius matching results for men when using the original ‘pure’ SPE measure. The figure displays ATEs of high versus low, high versus medium and medium versus low levels of per capita SPEs on household income, earnings, working time, wages and full-time employment. Due to computational constraints caused by the infrastructure at the DIW, we were not able to estimate these models for the pre-exposure and exposure periods. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

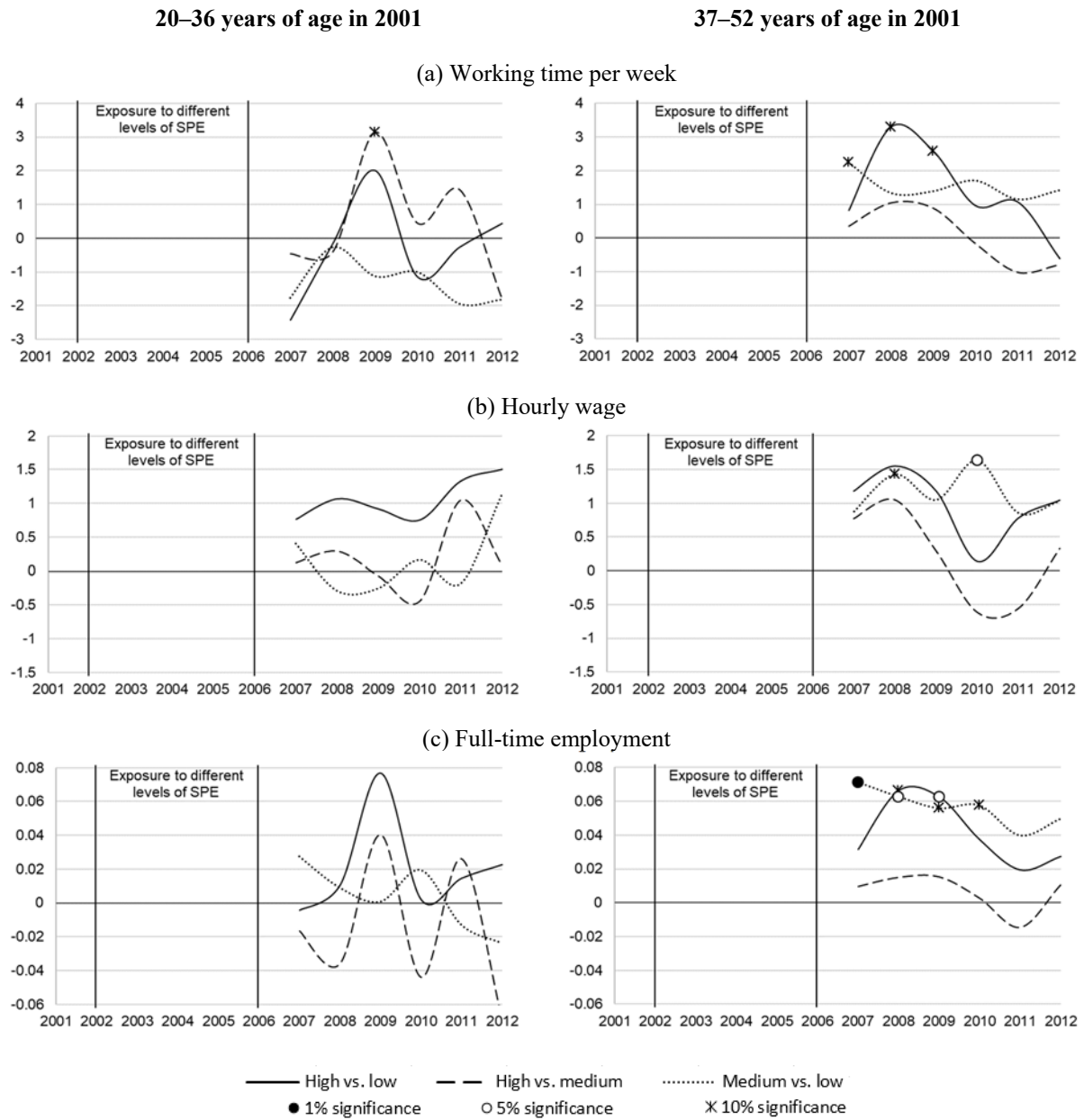
Appendix D: Effect heterogeneity

Figure D.1: Effects of different levels of SPE on earnings for *men 20–36/37–52 years of age* in 2001.



Notes: Radius matching results for men 20–36/37–52 years of age in 2001. The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on household income and earnings. Due to computational constraints caused by the infrastructure at the DIW, we were not able to estimate these models for the pre-exposure and exposure periods. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

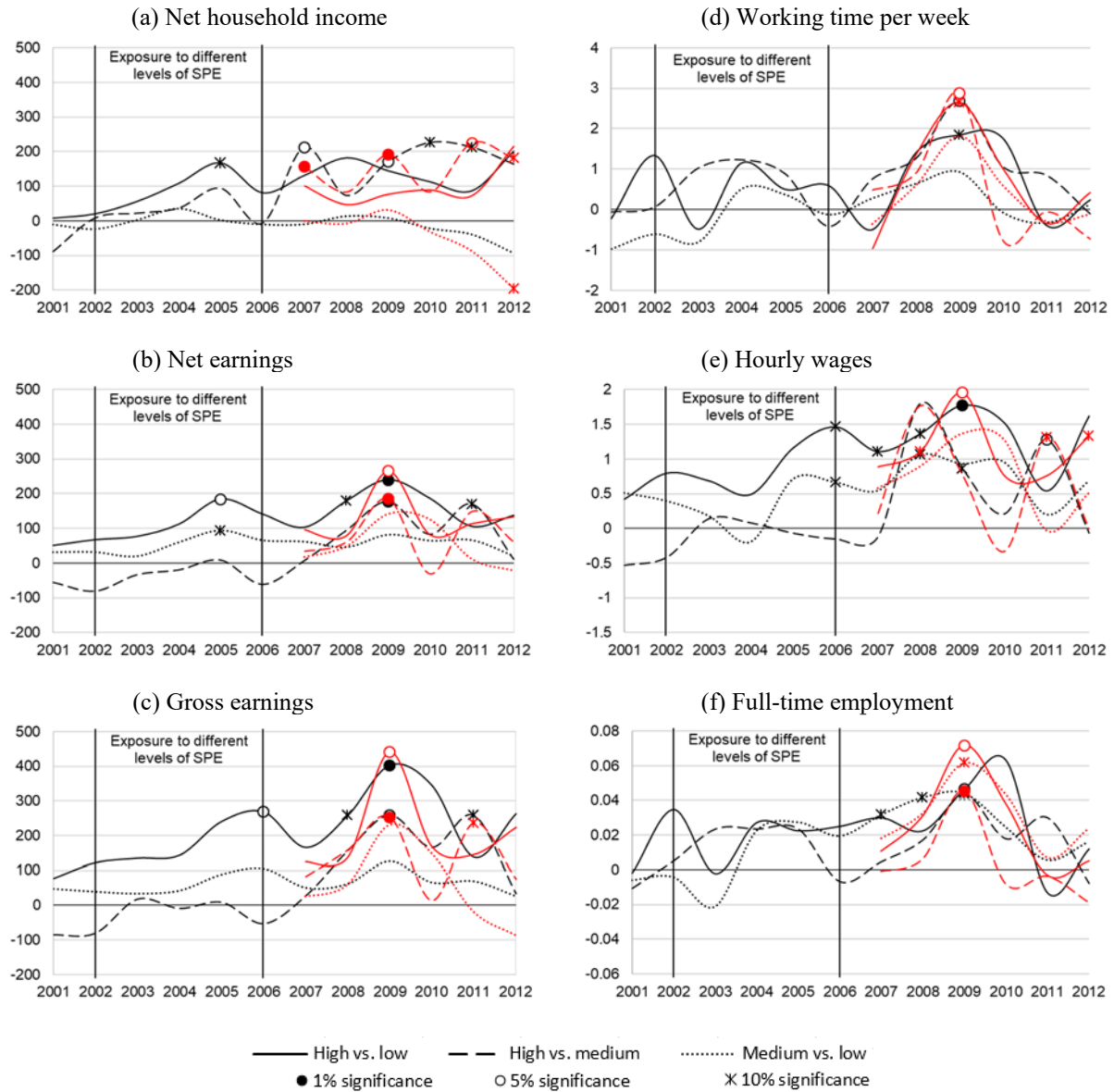
Figure D.2: Effects of different levels of SPE on working time, wage and employment status for men 20–36/37–52 years of age in 2001.



Notes: Radius matching results for men 20–36/37–52 years of age in 2001. The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on hourly wages, employment status and working time per week in hours. Due to computational constraints caused by the infrastructure at the DIW, we were not able to estimate these models for the pre-exposure and exposure periods. Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Appendix E: Exploring mechanisms

Figure E.1: Effects of different levels of SPE on household income, earnings, working time, wages and full-time employment for *men* during the post-exposure period excluding (main specification, black lines)/including (red lines) various health measures from the corresponding year as additional covariates in the selection process.



Notes: Radius matching results for men during the post-exposure period excluding (main specification, black lines)/including (red lines) satisfaction with health, satisfaction with life, the number of doctor visits per year as well as data from the PCS and MCS from the corresponding year as additional covariates in the selection process. The figure displays ATEs of high versus low, high versus medium and medium versus low levels of distance-weighted per capita SPEs (as defined in Section 2) on household income, earnings, working time, wages and full-time employment. All 2001 ATEs are calculated as mean differences between matched treated and untreated observations from the balancing tests of the 2002 estimations. We approximate the effects for net earnings in 2001 by multiplying the effects for gross earnings with the samples' average net-to-gross earnings ratio (i.e., 65.6% [63.5%] for men [women]). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

Table E.1: Average values of the SPE measures and different indicators of sports facility provision in the 16 states (*‘Länder’*) in Germany.

State in Germany (<i>‘Land’</i>)	SPE measures in € ¹⁾		# Sports facilities ²⁾	Area covered by pools in m ² per 1,000 inhabitants ³⁾		Estimated need for refurbishment in % ⁴⁾		
	Pure	Radius		Outdoor	Indoor	Fields	Gyms	Pools
<i>South</i>								
Baden-Wuerttemberg	52.0	48.8	18,556	47.5	14.7	(15.0) ⁵⁾	(11.2) ⁵⁾	(35.9) ⁵⁾
Bavaria	17.3	21.7	22,027	59.7	14.8	26.1	36.0	46.9
<i>North</i>								
Lower-Saxony	10.7	13.9	14,723	54.3	16.2	16.3	20.8	14.7
Schleswig Holstein	9.3	15.2	4,408	35.2	15.6	32.0	36.6	52.1
Bremen	25.3	22.2	741	34.1	12.4	57.8	66.4	65.2
Hamburg	7.4	12.1	1,852	11.5	8.1	(5.6) ⁵⁾	(16.6) ⁵⁾	30.8
<i>West</i>								
Hessen	31.9	32.9	10,189	54.7	15.5	35.9	40.8	54.8
Rhineland-Palatine	7.5	15.0	7,401	54.4	12.4	35.1	36.5	50.6
Saarland	44.1	42.4	1,659	73.4	18.8	51.1	58.6	70.9
North Rhine-Westphalia	27.8	27.2	21,531	31.7	15.2	34.0	36.8	55.8
<i>East</i>								
Brandenburg	10.0	12.2	3,978	31.7	7.2	70.8	56.7	56.5
Mecklenburg-West Pomerania	8.6	16.9	2,719	28.8	4.5	76.6	69.7	59.4
Saxony	23.6	25.7	6,096	121.7	8.2	71.8	70.2	62.1
Saxony-Anhalt	13.2	20.9	4,036	77.6	4.9	(57.3) ⁵⁾	(53.5) ⁵⁾	52.9
Thuringia	12.2	17.6	3,943	106.1	8.7	74.4	73.9	70.2
Berlin	29.1	29.1	3,095	11.6	10.2	52.0	56.1	76.8
Germany	16.9	21.4	126,954	52.1	13.3	36.7	41.8	49.1
Correlation with the pure SPE measure ⁶⁾			27.9	14.9	47.2*			
Correlation with the SPE radius measure ⁶⁾			27.6	8.3	51.6**			

Notes: ¹⁾ Pure and distance-weighted per capita SPE measures (mean of 2002–2006) as defined in Section 2 (sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b); own calculations.).

²⁾ Total number of sports facilities as of July 1, 2000 (source: Sports Minister Conference, 2003).

³⁾ Areas covered by indoor and outdoor pools in m² per 1,000 inhabitants as of July 1, 2000 (source: Sports Minister Conference, 2003).

⁴⁾ Estimated need for restoration in % of sports fields, gyms and pools as of July 1, 2000, excluding 400-meter tracks, sports fields < 5,000m², tennis courts and facilities for shooting sports (source: Sports Minister Conference, 2003).

⁵⁾ Unreliable estimates due to missing values > 20% (source: Sports Minister Conference, 2003).

⁶⁾ Correlations between the corresponding SPE measure and the indicators of sports facility provision based on information for n = 16 states (*Länder*), significance levels: * $\equiv p \leq 10\%$, ** $\equiv p \leq 5\%$, *** $\equiv p \leq 1\%$ (sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b); Sports Minister Conference (2003); own calculations.).

Table E.2: Comparing the effects for *men* between our main specification (ATE) and the main specification including various health measures from the corresponding year as additional covariates in the selection process (ATE_{Health}).

Outcome	Model	2007		2008		2009		2010		2011		2012		Average change ¹	Average change ²
		ATE	ATE _{Health}	ATE	ATE _{Health}	ATE	ATE _{Health}	ATE	ATE _{Health}	ATE	ATE _{Health}	ATE	ATE _{Health}		
Household net income in €	H–L	131	100	182	46	145	76	113	89	87	72	200	214		
	H–M	213**	157***	74	84	171**	191***	227*	84	213*	225**	164	181*	-13.2%	-16.9%
	M–L	-9	0	14	-7	9	32	-21	-31	-39	-87	-93	-195*		
Net earnings in €	H–L	103	96	179*	79	240***	265**	186	82	106	114	137	134	-18.9%	-23.4%
	H–M	7	33	93	60	177***	185***	82	-32	170*	148	11	61	-15.8%	-8.2%
	M–L	62	18	46	49	82	143	65	126	66	11	20	-22		
Gross earnings in €	H–L	166	124	258*	137	403***	440**	345	168	138	145	263	223	-21.4%	-15.9%
	H–M	27	82	156	158	259**	253***	166	14	258*	236*	33	76	-9.0%	-9.6%
	M–L	51	25	62	59	127	230	66	148	70	-19	26	-87		
Working time per week in hours	H–L	-.5	-1.0	1.4	1.4	1.8*	2.7*	1.8	1.0	-.4	-.3	.2	.4		
	H–M	.8	.5	1.3	.9	2.7**	2.9**	1.1	-.8	.8	-.1	-.1	-.7		
	M–L	.3	-.4	.6	.6	.9	1.8	-.1	.6	-.3	-.3	.1	-.1		
Hourly wage in €	H–L	1.1*	.9	1.4*	1.1*	1.8***	2.0**	1.5	.8	.5	.8	1.6	1.3**	-14.4%	-11.2%
	H–M	-.1	.2	1.8	1.8	.9*	.8	.2	-.3	1.3**	1.3**	-.1	.0	-5.8%	-4.6%
	M–L	.5	.6	1.1*	.9	.9	1.4	1.0	1.3	.2	.0	.7	.5		
Full-time employment in percentage	H–L	3.0	1.1	2.3	3.1	4.7**	7.2**	6.3	3.8	-1.3	-.3	1.2	.5		
	H–M	.5	-.1	1.7	.6	4.3*	4.5***	1.8	-.8	3.0	-.4	-.8	-1.9		
	M–L	3.2*	1.8	4.2*	3.3	4.4*	6.2*	2.5	4.4	.6	.7	1.6	2.4	13.8%	-6.2%

Notes: The table displays ATEs of high versus low (H–L), high versus medium (H–M) and medium versus low (M–L) levels of distance-weighted per capita SPEs (as defined in Section 2) on household income, earnings, working time, wages and full-time employment. ATE $\equiv$ results derived from our main specification, ATE_{Health} $\equiv$ results derived from our main specification including satisfaction with health, satisfaction with life, the number of doctor visits per year as well as data from the PCS and MCS from the corresponding year as additional covariates in the selection model (see Table B.1 in Appendix B for further information on the variable definition/measurement as well as Andersen et al. (2007) for a detailed description of the PCS and MCS). Significance levels: * $\equiv p \leq 10\%$, ** $\equiv p \leq 5\%$, *** $\equiv p \leq 1\%$. Average change¹ $\equiv$ average change (in percentage) between ATE and ATE_{Health} calculated for all years 2007–2012 (only calculated if ATE or ATE_{Health} are significant for at least two years, displayed in boldface), Average change² $\equiv$ average change (in percentage) between ATE and ATE_{Health} calculated only for years with significant estimates (in boldface) (only calculated if ATE or ATE_{Health} are significant for at least two years, displayed in boldface). Sources: RDC of the Federal Statistical Office and Statistical Offices of the Länder (2018a; 2018b) and SOEP; further data sources as discussed in detail in Sections 2 and 3 and Appendix A; own calculations.

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