Is Posner Right? An Empirical Test of the Posner Argument for Transferring Health Spending from Old Women to Old Men

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ABSTRACT

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Posner (1995) proposes the redistribution of health spending from old women to old men to equalize life expectancy. His argument is based on the assumption that women's utility is higher if they are married. Thus, extending the lifespan of men would benefit women. Using life satisfaction data from the German Socio-Economic Panel Study (SOEP), we conduct an empirical test of this assumption. We apply a two-step estimation strategy: first, we use a propensity score matching approach to generate a control group of non-widowed women. The average level of life satisfaction in the control group serves as a reference to measure the degree of adaptation to widowhood. In the second step, the life satisfaction trajectories of both groups are estimated using penalized spline regressions. The results suggest bereavement has no enduring effect on life satisfaction, and that falsifies Posner's assumption.

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1 Introduction

Increasing life expectancy opens up new possibilities to gain extra experience of life—both to enjoy more pleasure and to suffer from further pain. One of the burdens of greater longevity is that aging societies have to carry the costs of growing health expenditures caused by age-related morbidity. Medical-technological progress accompanied by exploding costs has led to an ongoing public discussion on the rationing and prioritizing of health care (e.g., Singer 2009). Thus, the question of how scarce resources should be allocated among different groups of society is of increasing importance in aging societies: who should receive costly medical diagnosis and treatment—old or young, men or women, rich or poor?

In his 1995 book, *Aging and Old Age*, Richard Posner contributes to this discussion from an economic perspective (cf. Posner 1995). Among other things, Posner deals with the distribution of health spending in the light of sex-specific differences in life expectancy. Posner expounds several arguments for increasing health spending on males and reducing it on females. The main arguments build on diminishing marginal utility and on the utility of marriage, and are formalized by Rasmusen (1996). Under weak assumptions, Rasmusen shows that society's marginal gain from increasing male life expectancy exceeds the marginal loss from reducing that of females. The crucial assumption in Posner's and Rasmusen's work is that the utility of widowed women is lower compared with that when the partner is still alive. However, so far there is no convincing empirical evidence supporting this assumption. Therefore, the aim of the present study is to test empirically whether widowed lifetime has a lower value in terms of utility than otherwise.

Using answers to questions about general life satisfaction as a direct indicator of utility, we apply a two-step estimation strategy to analyze the impact of the spouse's death. First, we impute the counterfactual level of life satisfaction that a widowed woman would have experienced had her partner not died by generating a sample of matched treated (i.e., widowed) and control (i.e., non-widowed) units. Therefore, we need not make any assumptions about that level, but we can estimate it from the data. For that purpose, we apply a propensity score matching approach. In the second step, the life satisfaction trajectories of the matched pairs are estimated

with a nonparametric regression approach using penalized splines. The nonparametric regression framework allows a highly flexible estimation of the life satisfaction trajectories without relying on explicit functional form assumptions. The results of the empirical analysis indicate that women experience a severe decline in life satisfaction even before the spouse's death. Then, over the three to four years following the event, well-being clearly recovers, though the initial level of life satisfaction is not fully re-established. From this finding, it cannot, however, be concluded that widowed women are less satisfied with their lives. In fact, they are equally as satisfied as the women in the control group. Hence, we infer that there is no long-lasting reduction in widowed women's utility compared with a non-widowed control group.

The paper is organized as follows: in Section 2, we briefly review the Posner argument. A short overview of previous evidence is given in the following Section. Section 4 introduces our two-step estimation strategy. The sample design and the estimation results are provided in Sections 5 and 6, respectively, and the last section draws a conclusion.

2 The Posner argument for reallocating health spending

Posner's starting point is the descriptive empirical statement that average life expectancy of women in the United States clearly exceeds that of men. The observation of greater female life expectancy applies, of course, not only to the United States. Figure 1 shows the development of sex-specific life expectancies at birth since the 1960s. In 2006, women regularly have a higher life expectancy than men: in Germany, life expectancy of women exceeds that of men by about 5.2 years on average. For the United States, a similar magnitude of difference is reported. A detailed analysis of sex mortality differences in the United States can be found in Preston and Wang (2006). In Japan, where, according to statistics from the World Health Organization (2009), life expectancy for women is the highest in the world, there is also a considerable difference (6.8 years) in sex-specific mortality, whereas the gap observed in the United Kingdom (4.3 years) is comparatively small.

Figure 1
Sex-specific life expectancy in four countries
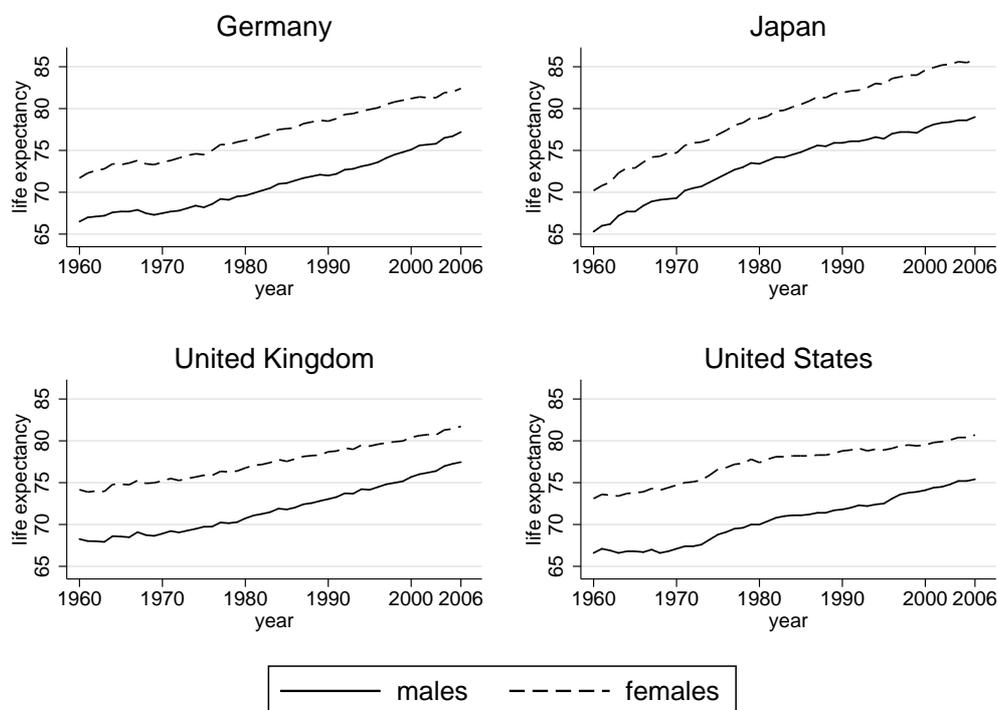
Source: Data for Germany, Japan, and the United States are from Organisation for Economic Co-operation and Development (2009). Data from United Kingdom are from the Human Mortality Database, University of California, Berkeley (USA), and the Max Planck Institute for Demographic Research (Germany), available at *www.mortality.org* or *www.humanmortality.de* (data downloaded on 7 March 2009).

Despite the trend of increasing life expectancy of both sexes, the data do not provide an unambiguous picture of the development of the sex gap. While there is evidence that the sex gap has narrowed in the United States and in many European countries (e.g., Gjonca et al. 2005, Robert-Koch-Institut 2007), such a tendency cannot be found in, for example, Japan. Various biological and nonbiological reasons for the sex gap in life expectancy are discussed in the literature (cf. Gjonca et al. 2005). For example, female hormones reduce the risk of heart diseases and degenerative diseases. In contrast, male hormones, particularly testosterone, not only contribute to these diseases, but they also promote hazardous and risky behavior so that a higher frequency of accidental and violent deaths can be detected among men: unhealthy behavior, such as drinking and smoking, is more likely to be observed in males (cf. Waldron 1976). Because such behavior is associated with higher rates of liver cirrhosis and respiratory

cancers, for example, they could be partly responsible for the higher male mortality. In addition, more recent research has brought to light the impact of genetic factors on women's longevity (cf. Christensen et al. 2000).

Posner points out that the higher longevity of women has consequences for health expenditures.[1] Again, the connection between longevity and health expenditures is not only valid for the United States, which is Posner's focus, but can also be detected in other countries. In Germany, for example, medical expenses for women are, on average, 1.4 times higher than for men (cf. Robert-Koch-Institut 2007). In 2002, per capita spending amounted to 3,160 Euros for women and 2,240 Euros for men. In particular, costs incurred by diseases of the muscular and skeletal system show an unequal distribution between the sexes.

Starting from the fact of sex differences in life expectancy, Posner examines the question of whether health expenditures should be reallocated between the sexes. More precisely, his analysis looks at a society's marginal utility that results from spending one more dollar on research into men's and women's diseases, respectively. A formal representation of Posner's argument can be found in Rasmusen (1996). The utilitarian position taken has an important consequence for the way the question of how health expenditures should be distributed is discussed. It is not primarily important how many extra life years are achieved by the additional expenditures, but instead it is of greater concern how much utility is produced for women and men. So, it is not longevity that is considered as an outcome, but the direct benefit to individuals. Although utility depends on longevity, they are not identical.

The utility assigned to the extra life years gained from the additional expenditure plays the key role in Posner's argument. He assumes that the value of an additional life year depends on the ratio of elderly men to elderly women. When the number of elderly women exceeds that of elderly men, then, by assumption, an additional year of life for women is worth less than for men. Posner (1995) states that "the more women there are *relative to men* [...], the likelier is the

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[1] Posner (1995) actually turns his attention to the "allocation of public funds between research on diseases of old men and research on diseases of old women" (p. 273). In this paper, we refer to these research expenses when we speak somewhat loosely of health expenditures.

value of extending the life of an elderly man by a given amount to exceed the value of extending the life of an elderly woman by the same amount [...], since a scarcity of elderly men increases women's demand for longer male life" (p. 276). Rasmusen (1996) expresses the assumption as follows: "the woman's utility is higher if her husband is still alive" (p. 338). It is important to point out that it is the women themselves who ascribe a lower value to their own life years gained when the ratio of men and women decreases.

Consequently, given the empirical facts of higher female life expectancy and higher female health expenditures in conjunction with the premise that elderly women's utility depends positively on the presence of elderly men, Posner produces a logically correct conclusion: health expenditures should be reallocated so that male life is lengthened. Such redistribution would benefit not only men but also women, because the timing of their widowhood is postponed. (The costs women have to bear consist only of a slight reduction of their life spent widowed.) Posner concludes that "women as a group might benefit from policies that promote greater equality in the number of men and women—for example policies that added a year to female longevity but two years to male longevity" (Posner 1995, p. 277). Hence, women might, under certain circumstances, prefer the relatively shorter extension of their life expectancy.

Rasmusen (1996) points out that the Posner argument remains valid even if one drops the assumption that women's utility is higher when their spouses are alive. The formal proof of the Posner argument only requires that marginal utility is positive and diminishes with a longer duration of life. In this case, the redistribution from elderly women to elderly men leads to an increase in society's total utility. This holds as long as the life expectancy of women is greater than that of men.

While the empirical evidence related to women's higher life expectancy and the higher health expenditures is, as the remarks at the beginning of this section have shown, entirely uncontroversial and valid not only for the United States, Posner provides, however, no evidence for his assumption that the utility of widowed women is permanently lower compared with that of women whose partner is alive. But it is precisely this point that gives the Posner argument its special charm and persuasiveness: the reduction of expenditures for elderly women would ben-

efit the women because their widowed and, by assumption, less valuable lifetime is postponed and shortened. Although Posner gives some reasons for his opinion that women benefit from increasing male longevity—for example, women may value male companionship, they are more likely to engage in sexual activity when they are married, and they are better off financially— the assumption of higher utility of marriage lacks empirical evidence. Therefore, the aim of the present study is to test empirically the assumption that widowed lifetime is valued lower in terms of utility.

3   Previous evidence on the impact of marital change

Previous research in psychology offered evidence that individuals perceive widowhood as a severe life event: in a seminal study by Holmes and Rahe (1967), respondents rated the death of the spouse as the most stressful event out of 43 major life events. More recent research shows in greater detail how widowhood is connected with experiences of grief, anxiety, and depression. Using data from the Changing Lives of Older Couples (CLOC) study—a prospective survey that focuses on married couples in which the husband is aged 65 or older at the time of the first interview—Carr et al. (2000) show that widowed women who were financially dependent on their spouse experience higher levels of anxiety than less financially dependent ones. Moreover, marital conflict correlates with the level of grief: the lower the level of marital conflict (i.e., the better the marital quality), the higher the level of grief.

Another strand of research is concerned with the impact of marital change on health behavior and self-rated health outcomes. Umberson (1992) supplies evidence that, especially for men, marriage is beneficial because the spouse monitors the partner's health behavior. Thus, widowhood and divorce are likely to increase the prevalence and incidence of alcohol and tobacco consumption. As a consequence, it is not surprising that marital dissolution is associated with a decline in self-rated health: using data from the Health and Retirement Study (HRS), a representative survey of Americans aged 50 and over, Hughes and Waite (2009) establish that widowed persons experience an inferior state of health compared with those who are married. Moreover, on the basis of data from the National Health Interview Survey (NHIS) from 1972 to

2003, Liu and Umberson (2008) find that the gap in self-rated health reported by widowed and married individuals has widened since the 1970s. However, the underlying reasons responsible for this development are not yet clear.

The studies cited so far use specific indicators—grief, anxiety, depression, health behavior, and self-rated health—to investigate the effects of widowhood. These indicators may be appropriate for identifying the mechanisms through which the loss of a spouse affects the life of the surviving partner. However, they give only very limited information about how the overall quality of life is judged by the bereaved, and hence these studies are not appropriate for making inferences about widowed women's utility. Here, the analysis of life satisfaction provides a better informational basis for global assessment of the quality of life after bereavement.

An example of a study using life satisfaction data is Lucas et al. (2003). On the basis of the first 15 waves of the German Socio-Economic Panel Study (SOEP), the authors analyze the long-term impact of changes in marital status (widowhood and marriage) on life satisfaction. The study's focus is on the question of whether individuals adapt to marital changes such that they return to a baseline level (set-point) of life satisfaction. The model specifications explicitly take into account three different phases: a baseline phase, a subsequent reaction phase, and an adaptation phase. Comparing the level of life satisfaction in the adaptation phase with that of the baseline phase, Lucas and colleagues conclude that there are long-lasting effects of widowhood: the bereaved have a lower level of life satisfaction after the loss of their spouse (adaptation phase) compared with the level prior to the event (baseline phase).

If we were to decide the validity of Posner's premise on the basis of this result, we would come to the conclusion that it is a correct assumption, as even after 8 years, satisfaction is below the initial baseline level. However, the approach by Lucas and colleagues illustrates two basic problems in the analysis of the effects of widowhood on well-being. First, researchers have to make a decision about the reference level of life satisfaction used for comparison purposes. However, it is questionable whether the pre-event level against which Lucas et al. compare the widowed women's life satisfaction is the appropriate reference level. Second, a disadvantage of parametric modeling is that identification of the impact of widowhood depends crucially on

the correct specification of the models. For example, Lucas et al. do not take into account any anticipatory effects that occur more than one year before the event. Such effects, if existing, are wrongly included in the baseline level. Because it is difficult to determine the duration of the reaction phase and the anticipation phase a priori, the model specification should ideally make no assumptions about the duration of each phase. Therefore, we defer the decision about Posner's premise until we have solved these problems in the following section.

4 Estimation strategy

The central research question of the present study is to assess the effect of the spouse's death on life satisfaction of the surviving partner. The interest lies in the question of whether and to what extent the widowed person's life satisfaction responds to such a drastic event. More formally, our attention is on

$$\tau = y^1 - y^0, \tag{1}$$

where y^1 denotes life satisfaction of a widowed individual, and y^0 is the counterfactual outcome, i.e., the life satisfaction the individual would have experienced had the spouse not died. We regard the counterfactual outcome as the appropriate reference level against which to compare widowed women's life satisfaction. Since we wish to analyze the effect on widowed persons, the relevant measure to answer the research question is the average treatment effect on the treated (ATT), which is defined as

$$E(\tau|W=1) = E(y^1|W=1) - E(y^0|W=1), \tag{2}$$

where

$$W = \begin{cases} 1, & \text{if the person is or will be widowed;} \\ 0, & \text{otherwise.} \end{cases} \tag{3}$$

However, the average outcome for widowed individuals that would be realized had their partner not died, $E(y^0|W = 1)$, cannot be observed due to the missing counterfactual outcome. This problem is known as the fundamental problem of causal inference (cf. Holland 1986). A solution to the problem is to compare the average life satisfaction of widowed and non-widowed individuals:

$$E(y^1|W = 1) - E(y^0|W = 0) = \left[E(y^1|W = 1) - E(y^0|W = 1)\right] + \left[E(y^0|W = 1) - E(y^0|W = 0)\right]$$

(4)

The difference in life satisfaction observed in both groups is, however, only equal to the ATT if there is no selection bias, i.e., when the second term in square brackets in equation 4 is zero. A selection bias occurs when life satisfaction of widowed and non-widowed individuals in the base state is different. For example, analyzing the relationship between well-being and age, Wunder et al. (2009) provide evidence for Germany and Britain that people aged 65 and older experience a substantial decline in well-being. In addition, elderly persons are also more likely to experience the death of their partner. Hence it can be assumed, with some plausibility, that widowed persons would also have reported a lower life satisfaction had their partner not died, simply because of the fact that these persons are, on average, older than non-widowed individuals.

A solution to the problem of selection bias is available in the potential outcome approach (cf. Rubin 1974, 2005). The potential outcomes are estimated on the basis of a matching approach: the counterfactual life satisfaction of the widowed persons is imputed using control units from a comparison group. We perform matching on the propensity score to generate a comparison group of non-widowed persons who have the same characteristics as the widowed individuals (cf. Rosenbaum and Rubin 1983, 1985). The propensity score $e(\mathbf{x})$ is the conditional probability of being affected by the spouse's death given the covariates. Selecting only individuals with the same value of the propensity score, it is possible to adjust for differences in the distribution of the observed characteristics $\mathbf{x}$ in the widowed and non-widowed groups. Since it is most unlikely that we will find treated and control units with identical propensity score values, we

apply caliper matching. That is, the widowed persons are matched with the nearest control units, where nearness is defined in terms of a certain range of the propensity score.

Because $e(\mathbf{x})$ is unknown, we estimate the propensity score from the available data using a probit regression

$$e(\mathbf{x}) \equiv P(W = 1|\mathbf{x}) = \Phi(\mathbf{x}'\boldsymbol{\beta}), \tag{5}$$

where $\Phi(\cdot)$ denotes the standard normal distribution function. Equation 5 says that the probability of becoming widowed depends on individual characteristics in the vector $\mathbf{x}$. $\boldsymbol{\beta}$ denotes the corresponding coefficient vector. The procedure is available in the Stata ado-file -psmatch2- by Leuven and Sianesi (2003). Only a single match (with replacement) is used because this leads to the most credible inference with the least bias (cf. Imbens 2004).

After matching treated and control units, we selected all person-year observations of these units that were available in the data set. Thus, our definition of the widowed group is such that all observations of an individual who is or will be widowed are considered. This approach allows us to estimate the life satisfaction trajectories of widowed persons prior to their spouse's death because these periods are explicitly under consideration. So, anticipated treatment effects, i.e., effects of the spouse's impending death, can be revealed by the ATT as it is defined in equations 2 and 3.

Since the control units do not experience the event of their spouse's death, we define a hypothetical treatment: it is assumed that, in the matching period, the control units have the same time distance to the hypothetical treatment as the treated units have to the spouse's death.

The comparison of the average life satisfaction of widowed individuals and non-widowed control units is performed using penalized spline (P-spline) regressions. The decisive advantage of a nonparametric approach for the present analysis is that splines do not require assumptions about the functional form of the model and, as a consequence, allow a highly flexible estimation of the life satisfaction trajectories. A general overview of semiparametric and nonparametric regression models can be found, for example, in Ruppert et al. (2003) and Wu and Zhang (2006).

We apply a mixed-model representation to estimate the P-splines smoother (cf. Brumback et al. 1999). In the context of the present study, this approach has several advantages compared with traditional smoothing techniques, such as regression spline methods and smoothing spline methods: First, P-splines are relatively robust with respect to the location and number of knots. Second, the formulation within a mixed-model framework allows us to apply standard software packages for mixed-model analysis (cf. Ngo and Wand 2004). We use the command -xtmixed-implemented in the statistical software Stata 11. Third, applying a mixed-model representation has the further advantage that estimators for the variance components are readily available as a smoothing parameter. Fourth, the mixed-model framework is better suited for bootstrapping than other smoothing models (cf. Kauermann et al. 2009).

The effect of the time distance on the observed or hypothetical event for life satisfaction is expected to depend on whether an individual is widowed or not. For that reason, a model with interaction is considered: the binary treatment status (widowed or non-widowed) interacts with the variable indicating the time distance. In a general form, the nonparametric model with binary interaction that allows the effect of the time distance to depend on the treatment status can be written as

$$y_{is} = f_{W_i}(s_{is}) + \eta_{is}. \tag{6}$$

In this model, y_{is} denotes the response variable of individual i. s indicates the time distance with respect to the event. The year the event occurs is $s = 0$, and $s < 0$ and $s > 0$ are the years before and after the event, respectively. f_1 and f_0 are two smooth curves representing the life satisfaction trajectories of widowed ($W = 1$) and non-widowed ($W = 0$) individuals, respectively. η is a one-way error component consisting of an unobservable individual specific effect μ_i and an idiosyncratic error ε_{it} (cf. Baltagi 2005). The μ_i is assumed to be i.i.d.$(0, \sigma_\mu^2)$ and independent of the $\varepsilon_{it} \sim$ i.i.d.$(0, \sigma_\varepsilon^2)$.

Following Coull et al. (2001) and Ruppert et al. (2003) and applying a truncated polynomial of order p, the P-spline model can be written in detail as follows:

$$y_{is} = \beta_0 + \sum_{j=1}^{p} \beta_j s_{is}^j + \sum_{k=1}^{K} u_k (s_{is} - \kappa_k)_+^p + W_i \left(\gamma_0 + \sum_{j=1}^{p} \gamma_j s_{is}^j + \sum_{k=1}^{K} v_k (s_{is} - \kappa_k)_+^p \right) + \eta_{is}. \quad (7)$$

The mixed-model formulation of this P-spline model can be obtained assuming $u_k \sim \text{i.i.d.}(0, \sigma_u^2)$ and $v_k \sim \text{i.i.d.}(0, \sigma_v^2)$. The knot points inside the range of s are denoted $\kappa_1, ..., \kappa_K$. The term $\gamma_0 + \sum \gamma_j s_{is}^j$ in equation 7 represents the deviation between f_1 and f_0, and the term $\sum v_k (s_{is} - \kappa_k)^p$ represents deviations from the overall smooth term $\sum u_k (s_{is} - \kappa_k)^p$ (for details cf. Coull et al. 2001). We use third-order polynomials (i.e., $p = 3$) and $K = 13$ knots.

The estimation of the smooth function is obtained from the best linear unbiased predictions (BLUPs) for the parameters of the mixed model in equation 7. However, a procedure to calculate the standard errors of the random part of the model is not implemented in the software package used. For that reason, the standard errors are bootstrapped: 50 bootstrap samples are drawn from the sample and the mixed model is re-estimated for each of them. In order to maintain the matched pairs, bootstrapping is performed using clusters. The results obtained from these estimations are used to approximate the standard errors that are, again, applied to calculate confidence bands of the smooth functions. Thus, inferences about the statistical significance of the ATT can be drawn from a simple eyeball test: the ATT is regarded as insignificant when the confidence bands overlap.

5 Data and sample design

The present analysis uses data from the German Socio-Economic Panel Study (SOEP). The SOEP is a representative longitudinal study of private households that follows the same respon-

dents over time (cf. Wagner et al. 2007).[2] In the SOEP, information over a period of almost 25 years, from 1984 to 2007, is available. However, we had to discard the years 1990 and 1993 because a central variable is not available: the information about the numbers of nights stayed in hospital was not collected in the respective waves. In 1986, the information about disability status was imputed using the value of the preceding year because the relevant question was only in the questionnaire for individuals who had not been interviewed before. Moreover, 154 widowed persons who remarried and became widowed again are excluded from the analysis because it is undecided whether the married period between the deaths of the consecutive spouses should be considered as a pre- or posttreatment phase.

In the SOEP, the life satisfaction question is expressed as follows: "How satisfied are you with your life, all things considered?" The answer is measured on an 11-point scale ranging from 0 (completely dissatisfied) to 10 (completely satisfied). The distribution of life satisfaction is shown for widowed and non-widowed women in Figure 2. For both groups, the median is seven and the most frequent score (mode) in the sample is 8. The non-widowed females report an average level of life satisfaction of 7.0. In contrast, widowed females assess their life satisfaction, on average, at 6.7 points. A two-group mean-comparison t-test indicates that the difference in life satisfaction between widowed and non-widowed women is highly statistically significant.

Inferences about the causal effect of the spouse's death on the surviving partner's life satisfaction should not, of course, be based on these raw data. As alluded to in the preceding section, the lower average life satisfaction of widowed women may simply be the result of the fact that these persons are, on average, older and may be in poorer health, for example. As the widowed women are not similar in characteristics to the non-widowed women, we introduce a comparison group of non-widowed individuals that have the same characteristics by matching on the propensity score.

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[2] The data used in this paper are extracted using the add-on package PanelWhiz v2.0 (Nov 2007) for Stata. PanelWhiz was written by Dr. John P. Haisken-DeNew (john@panelwhiz.eu). The PanelWhiz-generated do-file to retrieve the SOEP data used here and any PanelWhiz plug-ins are available upon request. Any data or computational errors in this paper are our own. Haisken-DeNew and Hahn (2006) describe PanelWhiz in detail.

Figure 2
Distribution of life satisfaction of non-widowed and widowed women
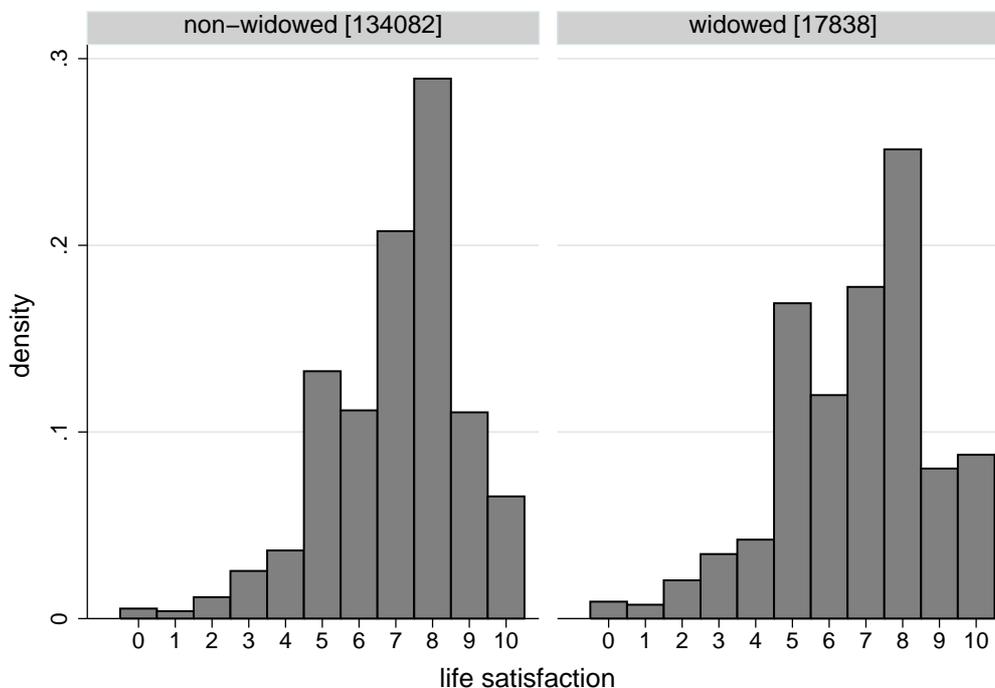
Note: Widowed women are defined as widowed in the survey year. This definition is different from the one introduced in equation 3. The number in square brackets indicates the number of person-year observations, nT.
Source: SOEP 1984–2007.

An overview of the characteristics that were used to estimate the propensity score can be found in Table 1. We regard these variables as important for either the assignment, i.e., the "rule" or mechanism that determines whether a person is widowed or not, or the outcome of interest, life satisfaction. It is supposed that the assignment mechanism based on these covariates describes why some individuals become widowed. Hence, the event of the spouse's death is assumed to be random conditional on the propensity score. Since our database, the SOEP, collects information about all members in the household, we are able not only to use the women's characteristics for the analysis, but also to incorporate the variables from their husbands.

The values of the covariates were measured four years prior to the spouse's death, ensuring that the control variables are unaffected by that event. In addition, we also performed the matching five years prior to the event as a check of robustness: on the basis of the matching five years prior, we are able to check whether the outcome is affected by the event four years prior.

Table 1
Characteristics used in the matching

Characteristic	Description
Women	
Life satisfaction	Initially, the variable is measured on an 11-point scale. In the estimation of the propensity score, a dummy variable representation was used instead. This achieves better balancing. The satisfaction scores zero and one were put together in one category because of the small number of observations.
Average satisfaction	To ensure that treated and control units are comparable not only with respect to life satisfaction in the matching period, we also included a moving average of the levels of life satisfaction using the three preceding years. A square term of this variable is also included.
Labor market biography	The labor market biography is considered with three variables measuring the number of years in each of the following states: employed full-time, employed part-time, and unemployed.
Marriage history	Number of years married
Age	A linear, square, and cubic term of age is included.
Health status	The health status is captured using information about the disability status and the number of nights stayed in hospital.
Income	Per capita income of the household
Education	Number of years of education
Household size	Number of persons living in the household
Kids	The woman's number of children
Nationality	A dummy variable indicating whether the woman is German
Panel year	Dummy variables for the year of the interview
Panel attrition	Attrition indicators for the years between the matching period and the event
Spouse	
Life satisfaction	The original 11-point scale is used.
Education	Defined as above
Labor market biography	Defined as above
Age	Defined as above
Health status	Defined as above

The diagnostic analysis of the balancing of the covariates and the distribution of the propensity score can be found in Appendix A. After we performed matching on the propensity score using a caliper of 0.005, the t-tests for equality of means of the covariates in the widowed and non-widowed groups are not statistically significant. In addition, the standardized bias shows that the difference in the means is considerably smaller after the matching is applied.

In the present study, the matching approach is well suited to adjust for the differences in covariates and to remove the bias in the comparison of both groups, because there is a large group of potential control units available. The number of widowed women observed four (five)

years before the event of the spouse's death amounts to 477 (432) individuals, respectively. However, because one (three) of these women was (were) not in the region of common support, the treatment group used consists of 476 (429) treated women. From the large reservoir of 92,258 non-widowed control person-year observations of the same sex, 448 (413) best matches were selected (with replacement). That is, 11 (8) control group observations were used twice as the best match, and two (zero) control group observations were used three times as the best match.

The full sample consists of all observations preceding and succeeding the matching period so that we are able to describe the life satisfaction trajectories over time (cf. Section 4). The widowed group comprises 8,033 person-year observations, whereas the control group consists of 6,936 person-year observations. (For the robustness check with matching five years prior to the event, the numbers are 7,508 and 6,493, respectively.) The difference in total person-year observations between the treated and control units results from the fact that the best match is not necessarily observed for the same number of waves as the widowed women. Table 5 in Appendix B shows the sample size for both groups with respect to the time of the event. The maximum time distance to the event in the widowed group is 23 years. This value applies when the spouse's death occurred in 2007, the latest wave of the SOEP used in our analysis, and the woman was interviewed as early as 1984, when the first wave was collected.

6 Empirical Evidence

In this section, we present the life satisfaction trajectories of widowed and non-widowed women estimated using nonparametric regressions. The results obtained from samples with matching periods five and four years prior to the spouse's death are shown in Figures 3 and 4, respectively. The plots are restricted to a time interval of 21 years, from 10 years before to 10 years after the event. The reasons for that are first, the sample size is rather small for time points outside this interval (cf. Appendix B), and second, the time interval shown is sufficient to answer the research question.

A key assumption underlying the matching approach is the conditional independence assumption (cf. Lechner 1999). It states that the treatment assignment and the outcome are conditionally independent given the covariates. In the present context, the assumption implies that differences in the life satisfaction trajectories of widowed and non-widowed women (with the same characteristics) can be attributed to the event of the husband's death. Although it is not possible to test this assumption directly, its plausibility can be assessed using indirect tests (cf. Imbens 2004). We apply an indirect test using lagged values of the outcome. In particular, we expect that life satisfaction is not affected by the event in the interval prior to the matching period. Since there is in fact no significant difference between the life satisfaction trajectories of widowed and non-widowed women prior to the matching period—the curves shown in Figures 3 and 4 follow an almost identical course and the confidence bands clearly overlap—we regard this as evidence supporting the conditional independence assumption. In addition, the fact that the curves in Figures 3 and 4 show quite similar trajectories subsequent to the matching period may be seen as further support for the matching quality because the inferences derived from these curves do not depend on the matching period.

The life satisfaction trajectories of widowed women can be described thus. In the first stage, two to three years prior to the event, we observe a significant decrease in life satisfaction of the widowed women. In comparison, no apparent change in the curve's shape is seen in the control group. This suggests that the spouse's death has a clear impact on the quality of a woman's life before the death actually occurs. Here, a fatal illness of the spouse, for example, may cause psychological and physical distress for the wife, who is often an informal caregiver (cf. Organisation for Economic Co-operation and Development 2005). The caregiver spouse lacks social support from the sick spouse and, in addition, may be socially isolated because of the caring responsibilities (cf. Williams 2004). This situation in the years preceding the spouse's death may be held responsible for the anticipated downward trend in life satisfaction.

In the year of the spouse's death, the loss of life satisfaction is most severe. The affected women experience a decline in satisfaction of approximately one point on the 11-point scale, on average. This result is in line with previous studies by Lucas et al. (2003) and Clark et al. (2008), for example, that found effects of similar magnitude. In the succeeding phase, after

Figure 3
Trajectories of female life satisfaction (matching 5 years prior to event)
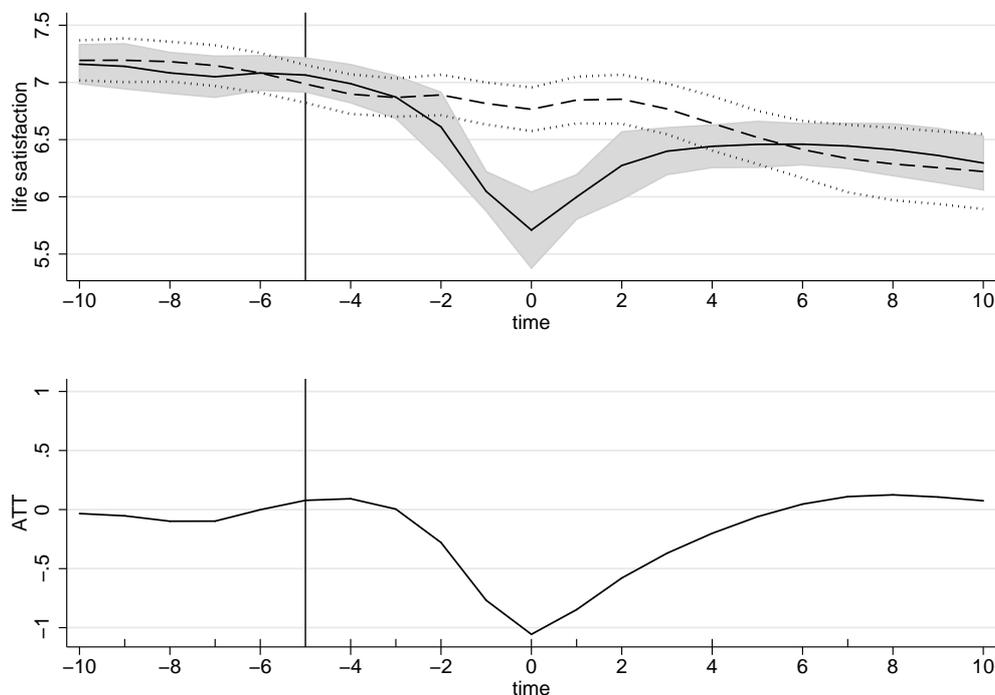
Note: Matching was performed 5 years prior to a spouse's death. The matching period is indicated by the vertical line. The 95% confidence bands for the expected value of life satisfaction are based on standard errors that were bootstrapped with 50 replications. Ticks above the x-axis denote the knot points used in the P-spline regression.
Source: SOEP 1984–2007 (without 1990, 1993)

the death of the spouse, a restoration effect leads to a rapid improvement in life satisfaction. Restoration is almost as intense as deterioration was before the event. Three to four years after the event, virtually no significant difference between the life satisfaction of widowed and non-widowed women can be detected. Hence, on a medium-term basis, the level of life satisfaction of widowed women is no different from that of non-widowed women.

An explanation for the restoration effect can be seen in adaptation. In this sense, the restoration effect on life satisfaction can be understood as a reaction to the altered circumstances. For example, the surviving spouse has to take over the task of household management and financial responsibilities that were previously handled by the deceased spouse (e.g., Utz et al. 2004, Ha et al. 2006). Therefore, we suppose that the restoration in life satisfaction results from the successful adaptation of the surviving partner to these responsibilities. The evidence for an

Figure 4
Trajectories of female life satisfaction (matching 4 years prior to event)
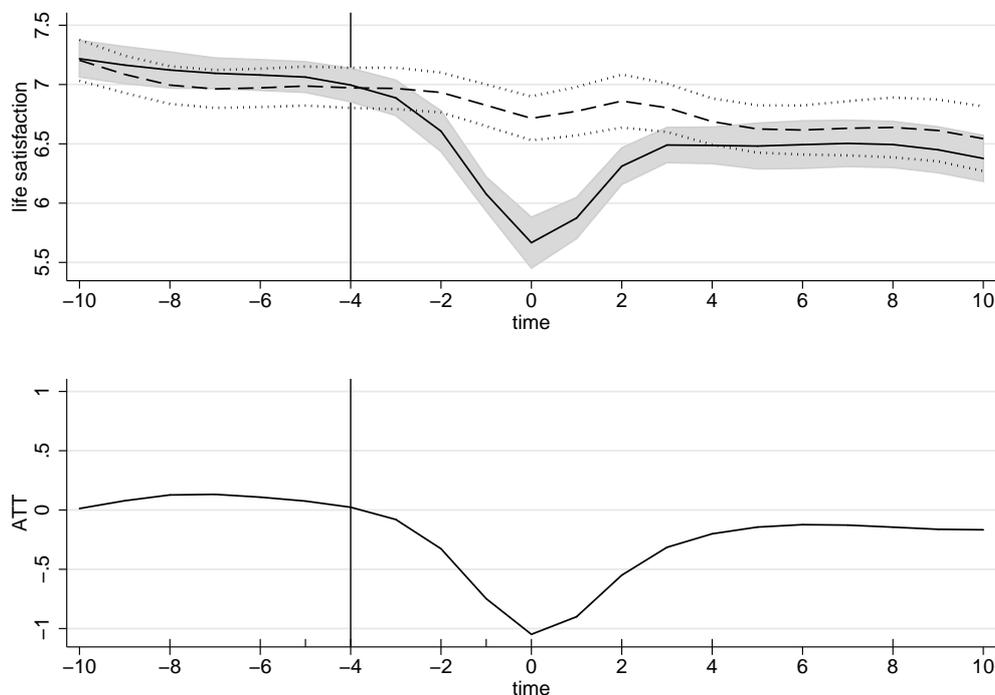
Note: Matching was performed 4 years prior to a spouse's death. The matching period is indicated by the vertical line. The 95% confidence bands for the expected value of life satisfaction are based on standard errors that were bootstrapped with 50 replications. Ticks above the x-axis denote the knot points used in the P-spline regression.
Source: SOEP 1984-2007 (without 1990, 1993)

adaptive process found in the present study does not, however, support the set-point theory of well-being—a concept put forward by Brickman and Campbell (1971) and criticized recently, e.g., by Headey (2007)—because the satisfaction level observed prior to the event is not fully recovered. Life satisfaction of widowed women is, even in the long term, lower after their spouse dies.

The analysis of life satisfaction trajectories leads us to an assessment of the Posner argument for transferring health spending from old women to old men. The key assumption of Posner and Rasmusen is that utility derived from married lifetime is higher than utility from widowed lifetime. From our empirical analysis, we infer that the hypothesis is right as far as the utility or satisfaction level prior to the event of the spouse's death is concerned: the widowed women do not reach this level again. However, the widowed women are, on a medium-term basis, no less

satisfied with their life than non-widowed women (with the same characteristics). The fact that there is no treatment effect observed approximately three years after the event of the spouse's death results from the slight gradual decline in life satisfaction that takes place in the control group. Possible reasons for this finding may be seen in an age-related deterioration of health, for example. A detailed discussion of the underlying reasons is, however, beyond the scope of the present study. After all, the empirical evidence presented in this study falsifies Posner's premise. Although this does not refute Posner's considerations as a whole, his argument loses, to a large degree, the power of its persuasiveness.

7 Conclusion

Posner advocates an allocation of health-care resources such that society's utility is increased. To attain this aim, he proposes transferring health spending from old women to old men to equalize life expectancy. His considerations are based on the assumption that bereaved women experience lower utility compared with that experienced in life with a partner. The policy relevance of Posner's argument, however, remains unclear until the validity of his assumption is empirically tested. In the present study, we used data on life satisfaction from the SOEP to conduct an empirical test of Posner's premise: are widowed women less satisfied with their lives?

A two-step estimation strategy was put forward in this paper to find an answer to this question. The approach allows us to identify a causal effect of widowhood on the self-assessed quality of life. First, we estimated the counterfactual level of life satisfaction of widowed women on the basis of a control group of non-widowed women with the same characteristics. Second, we performed the comparison of treated and control units using nonparametric regressions. Thus, the approach does not require assumptions about the duration of adaptation to the event.

Our study brought to light that Posner's assumption is right in the sense that widowed women are, in the long run, not as satisfied with their lives as at the time they were married. This observation is, however, not attributable to the marital transition and the spouse's death.

Rather, our analysis indicates that widowed women experience, after they have adapted to the new situation, similar levels of life satisfaction to those of comparable non-widowed women. Therefore, we revealed Posner's assumption to be false: widowed women are, on a mid-term basis, no less satisfied with their lives. This finding also calls into question Posner's argument for transferring health spending from old women to old men as a policy to improve women's well-being (or utility). Our analysis gives rise to the supposition that women would not benefit from such reallocation.

The redistribution of health expenditures at the expense of women would most likely be counterproductive, because evidence suggests that older women are already disadvantaged in some countries. For example for the United States, Blustein (1995) finds that older women with low incomes are less likely to undergo mammography screening because the required co-payments represent an obstacle. Therefore, we believe that old women's utility might be more likely to increase if they receive support in caring for their sick husband. As the results of our study clearly indicate that life satisfaction is negatively affected even two years before the death of partner, directly supporting families during this time would be more likely to increase women's utility.

References

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data*, John Wiley & Sons, Chichester.

Blustein, J. (1995). Medicare coverage, supplemental insurance, and the use of mammography by older women, *The New England Journal of Medicine* **332**(17): 1138–1143.

Brickman, P. and Campbell, D. T. (1971). Hedonic relativism and planning the good society, *in* M. H. Appley (ed.), *Adaptation Level Theory. A Symposium*, Academic Press, New York, pp. 287–302.

Brumback, B. A., Ruppert, D. and Wand, M. P. (1999). Variable selection and function estimation in additive nonparametric regression using a data-based prior: Comment, *Journal of the American Statistical Association* **94**(447): 794–797.

Carr, D., House, J. S., Kessler, R. C., Nesse, R. M., Sonnega, J. and Wortman, C. (2000). Marital quality and psychological adjustment to widowhood among older adults: A longitudinal analysis, *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* **55**(4): S197–207.

Christensen, K., Kristiansen, M., Hagen-Larsen, H., Skytthe, A., Bathum, L., Jeune, B., Andersen-Ranberg, K., Vaupel, J. W. and Orstavik, K. H. (2000). X-linked genetic factors regulate hematopoietic stem-cell kinetics in females, *Blood* **95**(7): 2449–2451.

Clark, A. E., Diener, E., Georgellis, Y. and Lucas, R. E. (2008). Lags and leads in life satisfaction: A test of the baseline hypothesis, *Economic Journal* **118**(529): F222–F243.

Coull, B. A., Ruppert, D. and Wand, M. P. (2001). Simple incorporation of interactions into additive models, *Biometrics* **57**(2): 539–545.

Gjonca, A., Tomassini, C., Toson, B. and Smallwood, S. (2005). Sex differences in mortality, a comparison of the United Kingdom and other developed countries, *Health Statistics Quarterly* **26**(Summer): 6–16.

Ha, J.-H., Carr, D., Utz, R. L. and Nesse, R. (2006). Older adults' perceptions of intergenerational support after widowhood: How do men and women differ?, *Journal of Family Issues* **27**(1): 3–30.

Haisken-DeNew, J. P. and Hahn, M. (2006). Panelwhiz: A flexible modularized Stata interface for accessing large scale panel data sets, mimeo.

Headey, B. (2007). The set-point theory of well-being needs replacing: On the brink of a scientific revolution?, *SOEP Papers 55*, DIW Berlin, The German Socio-Economic Panel (SOEP).

Holland, P. W. (1986). Statistics and causal inference, *Journal of the American Statistical Association* **81**(396): 945–960.

Holmes, T. H. and Rahe, R. H. (1967). The social readjustment rating scale, *Journal of Psychosomatic Research* **11**(2): 213–218.

Hughes, M. E. and Waite, L. J. (2009). Marital biography and health at mid-life, *Journal of Health and Social Behavior* **50**(3): 344–358.

Imbens, G. W. (2004). Nonparametric estimation of average treatment effects under exogeneity: A review, *The Review of Economics and Statistics* **86**(1): 4–29.

Kauermann, G., Claeskens, G. and Opsomer, J. D. (2009). Bootstrapping for penalized spline regression, *Journal of Computational and Graphical Statistics* **18**(1): 126–146.

Lechner, M. (1999). Earnings and employment effects of continuous off-the-job training in East Germany after unification, *Journal of Business Economic Statistics* **17**(1): 74–90.

Leuven, E. and Sianesi, B. (2003). Psmatch2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing, Statistical Software Components, Boston College Department of Economics.

Liu, H. and Umberson, D. J. (2008). The times they are a changin': Marital status and health differentials from 1972 to 2003, *Journal of Health and Social Behavior* **49**: 239–253.

Lucas, R. E., Clark, A. E., Georgellis, Y. and Diener, E. (2003). Reexamining adaptation and the set point model of happiness: Reactions to changes in marital status, *Journal of Personality and Social Psychology* **84**(3): 527–539.

Ngo, L. and Wand, M. P. (2004). Smoothing with mixed model software, *Journal of Statistical Software* **9**(1): 1–54.

Organisation for Economic Co-operation and Development (2005). *Long term care for older people*, OECD, Paris.

Organisation for Economic Co-operation and Development (2009). OECD health data.
      URL: *www.oecd.org/health/healthdata*

Posner, R. A. (1995). *Aging and old age*, University of Chicago Press, Chicago.

Preston, S. H. and Wang, H. (2006). Sex mortality differences in the United States: The role of cohort smoking patterns, *Demography* **43**(4): 631–646.

Rasmusen, E. (1996). The posner argument for transferring health spending from old women to olden men, *Economics Letters* **53**(3): 337–339.

Robert-Koch-Institut (ed.) (2007). *Gesundheit in Deutschland*, Gesundheitsberichterstattung des Bundes, Robert Koch-Institut, Berlin.

Rosenbaum, P. R. and Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects, *Biometrika* **70**(1): 41–55.

Rosenbaum, P. R. and Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score, *The American Statistician* **39**(1): 33–38.

Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies, *Journal of Educational Psychology* **66**(5): 688–701.

Rubin, D. B. (2005). Causal inference using potential outcomes, *Journal of the American Statistical Association* **100**(469): 322–331.

Ruppert, D., Wand, M. P. and Carroll, R. J. (2003). *Semiparametric Regression*, Cambridge Series in Statistical and Probabilistic Mathematics, Cambridge University Press, Cambridge.

Singer, P. (2009). Why we must ration health care.
URL: *http://www.nytimes.com/2009/07/19/magazine/19healthcare-t.html*

Umberson, D. (1992). Gender, marital status and the social control of health behavior, *Social Science & Medicine* **34**(8): 907–917.

Utz, R. L., Reidy, E. B., Carr, D., Nesse, R. and Wortman, C. (2004). The daily consequences of widowhood: The role of gender and intergenerational transfers on subsequent housework performance, *Journal of Family Issues* **25**(5): 683–712.

Wagner, G. G., Frick, J. R. and Schupp, J. (2007). The German Socio-Economic Panel Study (SOEP) – Scope, evolution and enhancemants, *Schmollers Jahrbuch (Journal of Applied Social Science Studies)* **127**(1): 139–169.

Waldron, I. (1976). Why do women live longer than men?, *Social Science & Medicine* **10**(7-8): 349–362.

Williams, K. (2004). The transition to widowhood and the social regulation of health: Consequences for health and health risk behavior, *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* **59**(6): S343–349.

World Health Organization (ed.) (2009). *World Health Statistics Report*, World Health Organization.
URL: *http://www.who.int/whosis/whostat/en/*

Wu, H. and Zhang, J.-T. (2006). *Nonparametric Regression Methods for Longitudinal Data Analysis*, John Wiley & Sons, Hoboken.

Wunder, C., Wiencierz, A., Schwarze, J., Küchenhoff, H., Kleyer, S. and Bleninger, P. (2009). Well-being over the life span: Semiparametric evidence from British and German longitudinal data, *IZA Discussion Papers 4155*, Institute for the Study of Labor (IZA).

A   Balancing the means of covariates

Table 2
Covariate balance: females matched five years before the spouse's death

Variable	Matching	Widowed	Control	Standard. bias	Bias re- duction	t	p>|t|
Women's characteristics							
Life satisfaction (reference: category 10. completely satisfied)							
Category 0 or 1	Before	0.005	0.007	-3.7		-0.68	0.494
	After	0.005	0.005	0.0	100.0	0.00	1.000
Category 2	Before	0.009	0.010	-0.4		-0.08	0.933
	After	0.009	0.012	-2.4	-485.0	-0.33	0.738
Category 3	Before	0.023	0.022	0.8		0.16	0.874
	After	0.023	0.021	1.6	-107.6	0.23	0.817
Category 4	Before	0.039	0.033	3.3		0.72	0.473
	After	0.040	0.056	-8.7	-163.4	-1.12	0.263
Category 5	Before	0.146	0.121	7.2		1.55	0.121
	After	0.147	0.161	-4.1	42.8	-0.57	0.571
Category 6	Before	0.118	0.110	2.6		0.55	0.581
	After	0.119	0.126	-2.2	15.9	-0.31	0.755
Category 7	Before	0.164	0.214	-12.7		-2.51	0.012
	After	0.163	0.138	6.6	48.2	1.05	0.294
Category 8	Before	0.292	0.302	-2.2		-0.46	0.646
	After	0.289	0.289	0.0	100.0	0.00	1.000
Category 9	Before	0.097	0.115	-5.9		-1.18	0.236
	After	0.098	0.107	-3.0	48.9	-0.45	0.653
Average satisfaction	Before	7.106	7.162	-3.6		-0.77	0.442
	After	7.100	7.059	2.7	26.6	0.38	0.707
Avg. satisfaction squared	Before	53.084	53.648	-2.6		-0.57	0.571
	After	53.021	52.464	2.6	1.1	0.37	0.712
Years employed full-time	Before	15.184	11.915	27.5		6.31	0.000
	After	15.078	14.777	2.5	90.8	0.34	0.734
Years employed part-time	Before	5.447	4.186	16.3		3.87	0.000
	After	5.483	5.573	-1.2	92.9	-0.15	0.881
Years unemployed	Before	0.269	0.636	-28.0		-4.52	0.000
	After	0.270	0.220	3.8	86.3	0.92	0.357
Years married	Before	36.231	22.673	102.4		20.03	0.000
	After	36.207	35.986	1.7	98.4	0.25	0.806
Age	Before	60.500	46.581	110.0		21.26	0.000
	After	60.480	60.608	-1.0	99.1	-0.16	0.875
Age squared	Before	3795.7	2354.3	107.5		22.18	0.000
	After	3793.6	3823.3	-2.2	97.9	-0.32	0.750
Age/1000 cubed	Before	2.5E-04	1.3E-04	102.1		22.41	0.000
	After	2.4E-04	2.5E-04	-3.3	96.8	-0.45	0.654
Disability status	Before	0.169	0.085	25.5		6.28	0.000
	After	0.168	0.198	-9.2	64.1	-1.15	0.252
Nights in hospital	Before	3.331	1.762	14.7		4.01	0.000
	After	3.354	3.487	-1.2	91.5	-0.14	0.888
HH-income (per capita)	Before	791.83	868.78	-12.7		-2.33	0.020
	After	792.92	794.87	-0.3	97.5	-0.06	0.950
Education (years)	Before	10.374	11.293	-41.0		-7.61	0.000
	After	10.374	10.402	-1.2	97.0	-0.21	0.837
Household size	Before	2.488	3.194	-68.0		-11.93	0.000
	After	2.492	2.497	-0.4	99.3	-0.08	0.937
Kids	Before	2.090	2.011	6.0		1.32	0.187
	After	2.093	2.235	-10.7	-79.4	-1.41	0.158
Nationality: German	Before	0.882	0.798	23.0		4.32	0.000
	After	0.881	0.895	-3.8	83.3	-0.65	0.516
Panel year (reference: 1984)							
1985	Before	0.039	0.031	4.6		1.00	0.315
	After	0.040	0.044	-2.5	44.5	-0.34	0.734

Variable	Matching	Widowed	Control	Standard. bias	Bias re- duction	t	p>|t|
1986	Before	0.065	0.028	17.6		4.62	0.000
	After	0.063	0.068	-2.2	87.4	-0.28	0.783
1987	Before	0.051	0.029	10.9		2.63	0.009
	After	0.047	0.037	4.8	56.5	0.68	0.496
1988	Before	0.046	0.028	9.6		2.26	0.024
	After	0.047	0.037	4.9	48.4	0.68	0.496
1989	Before	0.065	0.027	18.1		4.80	0.000
	After	0.065	0.061	2.2	87.6	0.28	0.779
1991	Before	0.032	0.026	3.7		0.80	0.423
	After	0.033	0.037	-2.8	24.5	-0.37	0.711
1992	Before	0.049	0.039	4.9		1.07	0.285
	After	0.049	0.040	4.6	6.3	0.66	0.507
1994	Before	0.051	0.039	5.6		1.23	0.218
	After	0.051	0.061	-4.5	19.3	-0.59	0.553
1995	Before	0.044	0.040	1.9		0.40	0.687
	After	0.044	0.047	-1.2	38.8	-0.16	0.870
1996	Before	0.039	0.040	-0.3		-0.06	0.950
	After	0.040	0.044	-2.4	-689.5	-0.34	0.734
1997	Before	0.056	0.039	7.7		1.75	0.080
	After	0.056	0.044	5.5	29.0	0.78	0.435
1998	Before	0.051	0.041	4.5		0.99	0.321
	After	0.051	0.058	-3.3	26.7	-0.45	0.653
1999	Before	0.090	0.041	20.0		5.15	0.000
	After	0.091	0.084	2.8	85.8	0.36	0.717
2000	Before	0.111	0.066	16.0		3.80	0.000
	After	0.112	0.110	0.8	94.9	0.11	0.913
2001	Before	0.088	0.066	8.4		1.87	0.062
	After	0.089	0.091	-0.9	89.6	-0.12	0.905
2002	Before	0.065	0.069	-1.6		-0.32	0.746
	After	0.065	0.061	1.9	-18.1	0.28	0.779
Attrition in 1	Before	0.016	0.059	-22.7		-3.78	0.000
	After	0.016	0.016	0.0	100.0	0.00	1.000
Attrition in 2	Before	0.002	0.097	-44.6		-6.64	0.000
	After	0.002	0.000	1.1	97.5	1.00	0.318
Attrition in 3	Before	0.005	0.126	-50.7		-7.61	0.000
	After	0.005	0.009	-1.9	96.2	-0.82	0.413
Attrition in 4	Before	0.125	0.147	-6.4		-1.29	0.198
	After	0.126	0.142	-4.8	25.8	-0.70	0.484
Spouse's characteristics							
Life satisfaction	Before	6.780	7.074	-15.0		-3.48	0.000
	After	6.806	6.767	2.0	86.5	0.29	0.774
Education (years)	Before	11.170	11.883	-28.5		-5.40	0.000
	After	11.167	11.132	1.4	95.1	0.23	0.817
Years employed full-time	Before	33.086	24.947	76.5		14.35	0.000
	After	33.089	33.030	0.6	99.3	0.09	0.931
Years employed part-time	Before	0.816	0.424	13.4		4.33	0.000
	After	0.822	0.799	0.8	94.1	0.10	0.923
Years unemployed	Before	0.567	0.563	0.2		0.06	0.956
	After	0.566	0.555	0.7	-167.7	0.09	0.928
Age	Before	64.498	49.331	120.1		22.97	0.000
	After	64.392	64.692	-2.4	98.0	-0.38	0.703
Age squared	Before	4290.7	2621.3	117.4		24.31	0.000
	After	4276.1	4321.5	-3.2	97.3	-0.47	0.641
Age cubed	Before	2.9E+05	1.5E+05	111.7		25.06	0.000
	After	2.9E+05	3.0E+05	-3.8	96.6	-0.52	0.606
Disability status	Before	0.412	0.137	64.8		16.55	0.000
	After	0.410	0.413	-0.5	99.2	-0.07	0.945
Nights in hospital	Before	6.440	1.529	36.9		12.77	0.000
	After	6.238	7.247	-7.6	79.4	-0.69	0.491

Source: SOEP 1984-2007.

Table 3
Covariate balance: females matched four years before the spouse's death

Variable	Matching	Widowed	Control	Standard. bias	Bias re-duction	t	p>|t|
Women's characteristics							
Life satisfaction (reference: category 10. completely satisfied)							
Category 0 or 1	Before	0.006	0.007	-1.4		-0.30	0.765
	After	0.006	0.015	-10.2	-612.8	-1.27	0.204
Category 2	Before	0.015	0.010	4.6		1.12	0.264
	After	0.015	0.011	3.8	16.3	0.58	0.562
Category 3	Before	0.017	0.022	-3.8		-0.78	0.435
	After	0.017	0.013	3.0	20.0	0.54	0.591
Category 4	Before	0.040	0.033	3.6		0.81	0.417
	After	0.040	0.027	6.7	-88.8	1.08	0.281
Category 5	Before	0.178	0.121	16.0		3.79	0.000
	After	0.179	0.212	-9.4	40.8	-1.31	0.191
Category 6	Before	0.099	0.110	-3.7		-0.78	0.435
	After	0.097	0.090	2.1	43.7	0.33	0.739
Category 7	Before	0.187	0.214	-6.8		-1.45	0.147
	After	0.187	0.166	5.3	23.1	0.85	0.396
Category 8	Before	0.254	0.302	-10.8		-2.29	0.022
	After	0.254	0.252	0.5	95.6	0.07	0.941
Category 9	Before	0.105	0.115	-3.4		-0.73	0.467
	After	0.105	0.107	-0.7	80.3	-0.11	0.916
Average satisfaction	Before	7.088	7.162	-4.7		-1.07	0.286
	After	7.087	6.936	9.5	-101.3	1.34	0.180
Avg. satisfaction squared	Before	52.973	53.648	-3.1		-0.71	0.475
	After	52.964	51.365	7.4	-136.8	1.08	0.279
Years employed full-time	Before	15.547	11.915	30.6		7.36	0.000
	After	15.519	15.760	-2.0	93.4	-0.29	0.776
Years employed part-time	Before	5.172	4.186	13.0		3.18	0.001
	After	5.183	4.978	2.7	79.2	0.38	0.703
Years unemployed	Before	0.376	0.636	-18.7		-3.37	0.001
	After	0.376	0.408	-2.2	88.1	-0.47	0.640
Years married	Before	36.543	22.673	102.0		21.52	0.000
	After	36.557	36.630	-0.5	99.5	-0.08	0.932
Age	Before	61.130	46.581	112.7		23.34	0.000
	After	61.149	61.034	0.9	99.2	0.15	0.884
Age squared	Before	3885.1	2354.3	110.6		24.74	0.000
	After	3887.6	3876.8	0.8	99.3	0.12	0.907
Age/1000 cubed	Before	2.5E-04	1.3E-04	105.5		25.46	0.000
	After	2.5E-04	2.5E-04	0.7	99.3	0.10	0.920
Disability status	Before	0.159	0.085	23.0		5.84	0.000
	After	0.160	0.187	-8.4	63.5	-1.11	0.266
Nights in hospital	Before	2.015	1.762	3.3		0.68	0.496
	After	2.019	1.607	5.3	-62.8	0.94	0.348
HH-income (per capita)	Before	780.12	868.78	-15.4		-2.82	0.005
	After	779.99	773.96	1.0	93.2	0.24	0.808
Education (years)	Before	10.384	11.293	-40.6		-7.92	0.000
	After	10.387	10.296	4.0	90.1	0.75	0.453
Household size	Before	2.486	3.194	-67.2		-12.57	0.000
	After	2.487	2.450	3.6	94.7	0.70	0.486
Kids	Before	2.092	2.011	6.1		1.42	0.156
	After	2.090	2.090	0.0	100.0	0.00	1.000
Nationality: German	Before	0.887	0.798	24.5		4.81	0.000
	After	0.887	0.874	3.5	85.8	0.60	0.550
Panel year (reference: 1984)							
1985	Before	0.052	0.031	10.7		2.69	0.007
	After	0.053	0.057	-2.1	80.4	-0.28	0.776
1986	Before	0.038	0.028	5.5		1.29	0.197
	After	0.038	0.032	3.5	35.6	0.53	0.596
1987	Before	0.059	0.029	14.3		3.76	0.000
	After	0.059	0.050	4.1	71.2	0.57	0.569
1988	Before	0.046	0.028	9.5		2.35	0.019
	After	0.044	0.053	-4.4	53.1	-0.60	0.546

Variable	Matching	Widowed	Control	Standard. bias	Bias reduction	t	p>|t|
1989	Before	0.042	0.027	8.1		1.99	0.047
	After	0.042	0.042	0.0	100.0	0.00	1.000
1991	Before	0.055	0.026	14.4		3.84	0.000
	After	0.055	0.063	-4.3	70.3	-0.55	0.582
1992	Before	0.052	0.039	6.6		1.55	0.121
	After	0.053	0.055	-1.0	84.7	-0.14	0.886
1994	Before	0.050	0.039	5.3		1.23	0.220
	After	0.050	0.048	1.0	80.8	0.15	0.881
1995	Before	0.050	0.040	4.9		1.12	0.261
	After	0.050	0.044	3.0	37.9	0.46	0.647
1996	Before	0.034	0.040	-3.4		-0.71	0.476
	After	0.034	0.036	-1.1	67.2	-0.18	0.860
1997	Before	0.034	0.039	-3.0		-0.63	0.529
	After	0.034	0.034	0.0	100.0	0.00	1.000
1998	Before	0.052	0.041	5.2		1.21	0.228
	After	0.053	0.053	0.0	100.0	0.00	1.000
1999	Before	0.050	0.041	4.5		1.03	0.303
	After	0.050	0.044	3.0	32.8	0.46	0.647
2000	Before	0.096	0.066	11.3		2.70	0.007
	After	0.097	0.109	-4.6	59.0	-0.64	0.523
2001	Before	0.099	0.066	12.0		2.89	0.004
	After	0.099	0.099	0.0	100.0	0.00	1.000
2002	Before	0.088	0.069	7.2		1.66	0.097
	After	0.088	0.078	3.9	45.5	0.59	0.557
2003	Before	0.059	0.066	-3.2		-0.67	0.503
	After	0.059	0.059	0.0	100.0	0.00	1.000
Attrition in 1	Before	0.002	0.059	-33.6		-5.28	0.000
	After	0.002	0.002	0.0	100.0	0.00	1.000
Attrition in 2	Before	0.008	0.097	-40.4		-6.52	0.000
	After	0.008	0.002	2.9	92.9	1.35	0.179
Attrition in 3	Before	0.090	0.126	-11.6		-2.36	0.018
	After	0.090	0.082	2.7	76.6	0.46	0.644
Spouse's characteristics							
Life satisfaction	Before	6.704	7.074	-18.6		-4.60	0.000
	After	6.718	6.674	2.2	88.1	0.32	0.746
Education (years)	Before	11.224	11.883	-26.0		-5.24	0.000
	After	11.226	11.183	1.7	93.5	0.29	0.771
Years employed full-time	Before	32.864	24.947	73.9		14.67	0.000
	After	32.885	32.542	3.2	95.7	0.55	0.583
Years employed part-time	Before	0.669	0.424	9.7		2.86	0.004
	After	0.671	0.499	6.8	30.2	1.05	0.293
Years unemployed	Before	0.621	0.563	3.4		0.83	0.404
	After	0.621	0.603	1.1	67.9	0.17	0.865
Age	Before	65.067	49.331	122.4		25.03	0.000
	After	65.046	64.435	4.8	96.1	0.80	0.425
Age squared	Before	4376.0	2621.3	120.3		26.84	0.000
	After	4373.3	4288.6	5.8	95.2	0.89	0.375
Age cubed	Before	3.0E+05	1.5E+05	114.9		28.06	0.000
	After	3.0E+05	2.9E+05	6.7	94.2	0.96	0.336
Disability status	Before	0.405	0.137	63.1		16.92	0.000
	After	0.403	0.441	-8.9	85.9	-1.18	0.238
Nights in hospital	Before	5.463	1.529	34.2		10.78	0.000
	After	5.462	5.433	0.3	99.3	0.03	0.978

Source: SOEP 1984-2007.

Figure 5
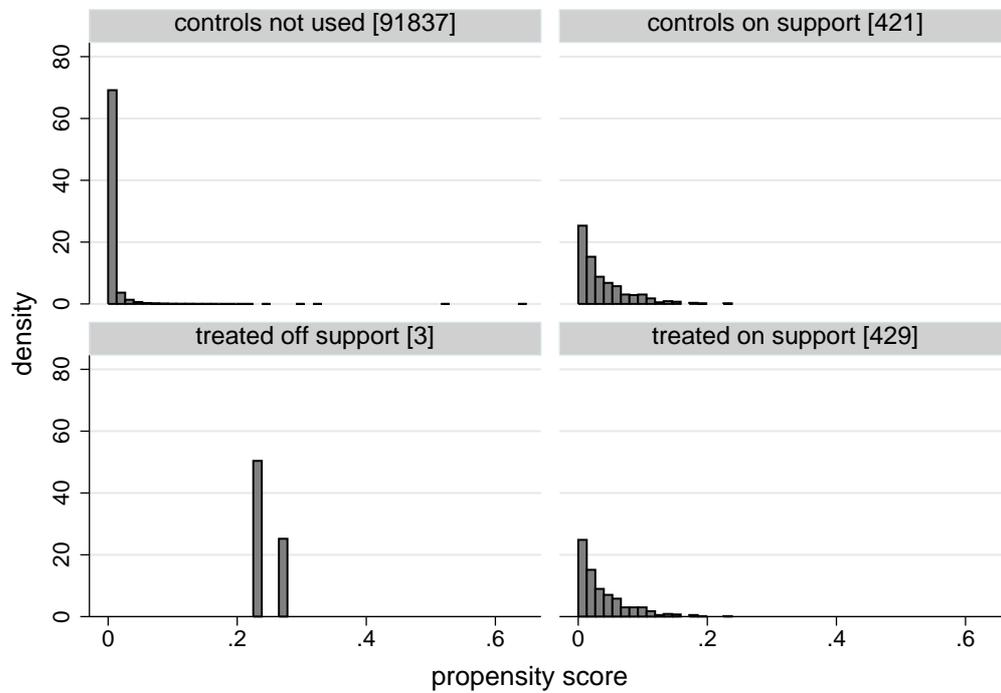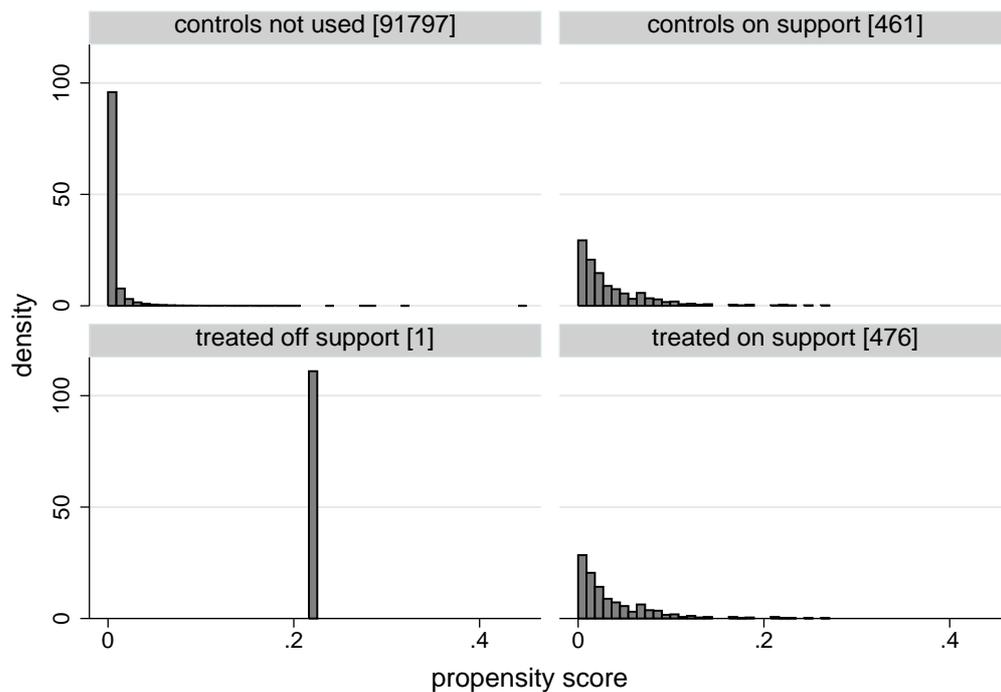**Common support (matching four years prior to event)**

Figure 6
Common support (matching four years prior to event)

B Descriptive Statistics

Table 5
Sample size with respect to time distance to event

time distance to event	matching: four years prior		matching: five years prior	
	control units	widowed women	control units	widowed women
-28	0	0	3	0
-27	0	0	4	0
-26	2	0	4	0
-25	2	0	5	0
-24	3	0	5	0
-23	6	10	10	10
-22	12	22	20	22
-21	25	32	35	32
-20	38	53	48	55
-19	46	67	61	68
-18	61	78	68	80
-17	74	90	83	93
-16	89	107	92	112
-15	108	130	111	135
-14	124	148	118	144
-13	135	155	133	167
-12	163	181	164	191
-11	194	211	174	198
-10	202	220	224	234
-9	230	249	259	262
-8	274	287	283	286
-7	317	333	339	333
-6	366	385	387	378
-5	417	437	409	429
-4	440	476	397	422
-3	434	475	397	428
-2	428	472	385	427
-1	396	433	340	375
0	364	476	313	429
1	320	410	270	367
2	278	344	227	316
3	235	289	182	262
4	190	242	151	219
5	161	207	135	185
6	138	176	117	158
7	118	151	103	132
8	109	136	86	116
9	94	110	74	92
10	80	88	70	85
11	74	86	54	67
12	54	73	39	59
13	39	53	39	49
14	36	46	33	35
15	31	36	23	27
16	17	28	14	19
17	7	14	5	7
18	5	10	0	3
19	0	7	0	0
nT	6936	8033	6493	7508

Source: SOEP 1984-2007 (without 1990, 1993).