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ORIGINAL RESEARCH

The Value of Pets: The Quantifiable Impact of Pets on Life Satisfaction

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Abstract
There is substantial evidence from psychology and medicine that pets are associated with better health and higher life satisfaction of their human companions. Yet whether this relationship is causal or purely a correlation remains largely unknown. We use an instrumental variable approach to overcome this, specifically exploiting relationships in which neighbours ask individuals to look over their property when traveling, which is correlated with pet companionship. We control for baseline relationships with neighbours as well as various other potential sources of bias. Using the Innovation Panel as part of the UK Household Longitudinal Survey, we find that a pet companion increases life satisfaction by 3 to 4 points on a scale of 1 to 7. Moreover, we estimate the size of the impact of pets on human life satisfaction and wellbeing in monetary units. We find that having a pet companion is worth up to £70,000 a year in terms of life satisfaction, similar to values obtained in the literature for meeting with friends and relatives on a regular basis.

Keywords Life Satisfaction · Human-animal interaction · Pet effect · Health Promotion · Interspecies Interaction · Wellbeing

JEL Classification I30 · C18 · C26 · D91

> "*Until one has loved an animal, a part of one's soul remains unawakened.*" - Anatole France
>
> "*If there are no [pets] in heaven then, when I die, I want to go where they went.*" - Will Rogers

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1 Introduction

Animal companionship is ubiquitous, with many humans identifying themselves as 'pet-lovers'. There is now a large and increasing literature showing the potential benefits of pets for human health,[1] but the main reason people keep companion animals is because they derive life satisfaction from doing so. Yet, the literature has not provided causal estimates of exactly how happy pets make us. We know that pets act as 'social catalysts' and by this they contribute to life satisfaction. However, pets also contribute to life satisfaction directly. We aim to estimate this effect in monetary units.

Despite ample literature showing the association of pet companionship with human health, the evidence that this relationship is causal is not conclusive. Determining a causal relationship is difficult because there is potentially reverse causality. It could be that happy and healthy people decide to take a pet as a companion rather than pets making people happy and healthy. It could also be that more lonely and depressed people decide to take a pet as a companion in order to manage their loneliness or depressive symptoms.[2] If we want to design policy interventions that reduce the surging healthcare costs worldwide, determining the direction of causality is crucial.

We aim to overcome reverse causality by means of an instrumental variables approach. This is something that to our knowledge has not been done before and is the second main contribution of the paper to the literature. Our instrument, discussed more in what follows, is based on the individual caring for their neighbours' property, which may include pets. We control for the quality of the relationship an individual has with neighbours.

There are claims that different pet types are associated with specific personality types of humans, however there is little systematic evidence for these associations. We use a large sample of the UK population to determine which personality type is associated with which type of pet. Controlling for personality type when estimating the impact of pets on life satisfaction is important because it could be that personality contributes directly to life satisfaction independently of pet companionship.

In this paper, we explore the nexus between pets and human health, and place a specific value on life satisfaction derived from pets. Section 2 reviews the relevant literature exploring the relationship between pets and human health. Section 3 sets out our model and data sources. Section 4 presents our results and Sect. 5 concludes with a short discussion.

2 Related Literature on the Impact of Pets on Mental Health

One of the most well-established mechanisms through which animals improve the physical health of humans is through their ability to reduce stress symptoms. The mere action of petting or viewing an animal has been shown to decrease blood pressure and/or heart rate (e.g., Allen et al., 2002; Allen, 2003; Shiloh et al., 2003; Barker et al., 2005; Khalid & Dildar, 2019; El-Qushayri et al., 2020). The presence of a pet dog or cat has been shown to lower heart rate and blood pressure more than the presence of friends or family during stressful situations such as an arithmetic exercise or cold pressor test (Allen et al., 1991,

[1] E.g., Wells (2009), Smith (2012), and Wells (2019).

[2] Unfortunately, our dataset does not allow us to determine how an animal was obtained (whether purchased, adopted from a shelter, found on the street or given by a friend or relative…). Therefore, we will refer throughout the study to pets as 'companion animals' and to 'have been taken as companions'.

2001, and 2002). This effect can be achieved by simply viewing moving or stationary images of animals (DeSchriver & Riddick, 1990; Wells, 2005).

Pet interactions also improve emotional health and act as social catalysts. As postulated by Bowlby (1979) in his famous 'attachment theory', humans need to be attached to somebody for the sake of forming and maintaining a relationship to achieve a sense of well-being. Dog owners are likely to consider their pet a member of their family and seek comfort from their pet. Dogs require their carers to leave the house several times a day for walks and, once outside, they are bound to encounter people. Therefore, dog carers are more likely to form friendships with people in their neighbourhoods when they're out and therefore dogs act as social catalysts (McNicholas & Cellis 2000; Coren, 2010; Bao & Shreer 2016). More importantly, perhaps, dogs have a positive impact on the health of their human caregivers by increasing their mobility through walking and jogging (Headey et al., 2008; Thorpe et al., 2006). Pet caregivers generally consider their pets to be members of their families and treat them as they would treat human family members or friends (Archer, 1997), improving psychological wellbeing and life satisfaction. Moreover, pet caregivers enter a network of mutual obligation (Cobb, 1976). Studies have shown that caring for a pet or simply interacting with it can help people live longer, healthier lives even when faced with ageing or severe illnesses (Johnson, 2008; Cerulli et al., 2014; Fleishmann et al. 2015; Brooks et al., 2016; Ko et al., 2016; Sollami et al., 2017; Hui et al. 2020).

Pet companionship also reduces feelings of loneliness and isolation (e.g., Headey, 1999; Jessen et al., 1996; Mahalski, et al., 1988) and hence pets are particularly advantageous for people living alone (Zasloff & Kidd, 1994). Numerous studies show that feelings of loneliness and social exclusion can be decreased or prevented through the presence of a pet in the home (e.g., Banks & Banks, 2002; Headey, 1999; McConnell et al., 2011). Pets play a crucial role in counteracting depression, with animal assisted activity and therapy being associated with fewer depressive symptoms (Jessen et al., 1996; Le Roux & Kemp, 2009; Lem et al., 2016; Moretti et al., 2011; Muldoon et al., 2017; Roberts et al., 1996; Souter & Miller, 2007). The evidence about associations between pets and depression reduction is not always unequivocal, varying depending on the methods and sample used, but is overwhelmingly positive.[3]

Pets also appear to boost self-esteem. Bustad (1990) reported higher levels of self-esteem in women who participated in a dog training program at a correctional centre in the US.[4] Several studies show that having a pet companion can boost children's and young adults' confidence and self-esteem (e.g., Bierer, 2000; Hyde et al., 1983; Purewal et al., 2017). This effect appears to be particularly strong for people with disabilities (Allen & Blascovich, 1996; Mader et al., 1989; Steffens & Bergler, 1998).

One biological channel through which pets affect us is related to our sense of touch, and another is attachment. Touch is one of the first senses an infant learns from, and will often associate soft touches, for example, with security and wellbeing. Pets can fulfil both the

[3] A negative relationship could appear if, for example, reverse causality is present and more depressed people decide to take a pet companion as a means to manage depressive symptoms, making the present analysis which determines the direction of causality even more important. A prominent example for this potential reverse causality can be found in the small literature aiming to find an ameliorating effect of pets on human wellbeing during the Covid pandemic. If people took a pet as a companion during this time to try to deal with feelings of loneliness and distress, and if they were impeded by the imposed restrictions to perform the usual activities (exercise, socializing etc.), a negative relationship could emerge which is not stemming from the pet to human life satisfaction but the other way round (Amiot et al., 2022; Hulm 2022).

[4] This could be, however, because of a feeling of accomplishment of learning a new skill and unrelated to pet companionship as an anonymous referee correctly pointed out.

need for touch and for attachment, and by this enhance the emotional wellbeing of their human companions (Levinson, 1984).

The positive effects of pets, however, could be offset by risks and problems associated with them such as allergies, parasites, physical injuries, infections, financial stress and emotional distress caused by pets (Smith, 2012; Brooks et al., 2018; Hui et al. 2020; Applebaum et al., 2021), making this study that aims to estimate the 'net pet effect', even more important.[5]

Most of the studies mentioned above do not go beyond the level of correlations between human wellbeing and companion animals, recommending further research in this area (Wells, 2019). The relatively few randomized control trials and experiments that have been performed tend to involve small sample sizes and inconclusive results. Moreover, none of the studies above quantify in monetary units the value owners accrue for psychological wellbeing and life satisfaction as a result of pet care. We believe this is crucial for any cost–benefit analysis of policy interventions involving pets designed to reduce the surging healthcare costs related to mental health worldwide.

3 Data and Methodology

3.1 Data

We make use of the Innovation Panel (IP), a survey conducted as part of the UK Household Longitudinal Study (UKHLS), Understanding Society, to analyse the relationship between pets and life satisfaction.[6] The survey contains the relevant questions about pets. The IP currently includes around 2,500 representative households and has 16 waves, including the wave that appeared in November 2024. Importantly, it includes information on life satisfaction, personality traits, and pet companionship, alongside other controls that we are interested in. We make use of wave 3 (2010), when the questions about pets and personality were asked, however we use other waves to attain data on other variables, notably life satisfaction is recorded in various waves. We apply responses by an individual in wave 3 regarding pets and personality to observations of the same individual in later waves. Our regression analysis includes 2617 observations and 1980 households with non-missing data on all variables. Individuals can appear in multiple waves. In our main IV specification with 2617 observations, there are 769 unique individuals. We include time fixed effects to account for changes to the sample over time and time-related confounders.

3.1.1 Measure of Life satisfaction

Life satisfaction is measured from responses to the following question, "Please choose the number which you feel best describes how dissatisfied or satisfied you are with the following aspects of your current situation: Life overall." The responses are on a seven-point scale (1 denotes that a person is not satisfied at all and 7 denotes that a person is completely satisfied).

[5] The net pet effect is the positive pet effect minus the negative effect derived from allergies, parasites, physical injuries, infections, financial stress, and emotional distress.

[6] The main variables used are: https://www.understandingsociety.ac.uk/documentation/innovation-panel/variables/sclfsato/, https://www.understandingsociety.ac.uk/documentation/innovation-panel/variables/pet/, https://www.understandingsociety.ac.uk/documentation/innovation-panel/variables/whatpet3/

We treat life satisfaction as a continuous variable and employ OLS and IV rather than treat it as an ordered variable (which would involve using ordered probit or logit) as studies have shown there is little difference in the results when treating life satisfaction as a continuous or ordered variable (Ferrer-i-Carbonell & Frijters, 2004), and we avoid making a distributional assumption on the error term.[7]

This single-item measure might not seem ideal to some researchers, especially those with a background in psychology or medicine. However, the measure is well-established, has been used in numerous studies related to pets, and validated in several others (e.g., Argan et al., 2018; Clark & Oswald, 2002; Diener et al., 2013; Oswald & Wu, 2010; Powdthavee, 2008).

3.1.2 Big 5 Personality Traits

The UKHLS/Innovation Pannel collects information on 'Big Five' (Saucier, 1994) personality traits (Openness, Conscientiousness, Extraversion, Agreeability and Neuroticism = OCEAN) which we use in our model. We treat them as fixed as we only have information about these in one wave (wave 3 from 2010).[8] Literature has found that personality traits are relatively stable over time (Cobb-Clark & Schurer, 2012).

Each personality trait is quantified by the averaged answer to questions related to the trait, each measured on a scale from 1 (does not apply to me at all) to 7 (applies to me perfectly). Whilst we acknowledge that these measures might not be perfect and that others might be better suited to measure personality, such as, for example, the Myers-Briggs Type Indicator (MBTI), or the Eysenck Personality Questionnaire (Eysenck, 2017), we use the measures in the survey for convenience and because they have been used in previous studies about pets that we can compare our results with (e.g. Bao & Schreer, 2016; Gosling et al., 2010; McConnell et al., 2011).

3.1.3 Pet Companionship

Pet companionship is measured by two questions, "Do you or anyone in your household own a pet, such as a dog or cat?" and if the answer is yes then, "What kind of pet do you own?", with the option to choose from, Dog(s), Cat(s) and Other type of pet(s). This is a multiple-choice question and hence we can determine whether the respondent has pets or not and if they do whether they have cats, dogs, or another type of pet.

The pet companionship variable is measured in the same wave as personality, allowing us to capture both at the same time. While personality has been found to be stable over time, pet companionship may not be. Unfortunately, the dataset does not allow us to determine this. However, there is a positive probability that pets (most of which are cats and dogs) survive over much (or all) of this time period, or that humans take as a companion a similar pet upon death. People typically self-identify as either 'dog people' or 'cat people' and usually seem to take as a companion over their lifespan the same type of pet that fits their preference (e.g. Bao & Schreer, 2016; Gosling et al., 2010). There may be measurement error in the recording of pet companionship, being another source of bias in OLS, however the instrumental variable estimates should overcome this bias if present.

[7] The typical advantages and disadvantages of ordered scales apply.

[8] Note however, that the UKHLS and the Innovation Panel survey timelines are not identical: https://www.understandingsociety.ac.uk/documentation/mainstage/user-guides/main-survey-user-guide/survey-timeline/

3.1.4 Instrument

As mentioned, happy/unhappy people could be more likely to take a pet as a companion and it is very probable that there are other variables that may impact both pet companionship and life satisfaction.

As an instrument for pet companionship, we use a dummy variable derived from the answer to the following question, "When a neighbour is not at home, how often do you and other neighbours watch over their property?" Answers range from 1 (often) to 4 (never). The dummy takes the value 1 if the answer is 1 or 2 and the value 0 if the answer is 3 or 4, quantifying the frequency of watching over the neighbour's property. We call this "TOTORO". Using a binary instrument improves relevance because switching from "never or rarely" to "sometimes or often" predicts pet companionship very well, as seen in the first stage regressions. In unreported first stage regressions using the original multivalued variable, the relationship was weaker, for example, because switching from "never" to "rarely" minimally affects pet companionship. Instances in which looking over neighbour's property is pet-related may induce an individual to attain a pet. This will make the instrument relevant. It is certainly the case that not all instances of looking over a neighbour's property are pet-related, and such instances likely do not influence the decision to attain a pet. This, however, does not invalidate the instrument, but only weakens the correlation between the instrument and the treatment (pet companionship). We show in the first stage regressions that looking over neighbour's property does significantly predict pet companionship, thus this weakened correlation is not a major concern.

Felton and Stewart (2024) provide an excellent description of conditions needed for instruments to be valid. The instrument must satisfy unconfoundedness, that there is no variable which determines the value of the instrument that also affects life satisfaction. We acknowledge that watching over a neighbour's property might reflect a good relationship with neighbours which may have an impact on life satisfaction directly. Relationships imply good social capital, which is a significant determinant of life satisfaction (Powdthavee, 2008). However, in estimation we control for how well the individual gets along with neighbours by using answers to, "How much do you agree or disagree with this statement about your neighbourhood: This is a close-knit neighbourhood" with answers ranging from 'strongly agree'=1 to 'strongly disagree'=5'. By controlling for living in a neighbourhood where people support each other, we hopefully account for relationships with neighbours, and the instrument satisfies "conditional unconfoundedness" as defined by Felton and Stewart (2024). As a second concept, the instrument must satisfy exclusion, the instrument does not affect the outcome for any reason other than through treatment. In context, it may be that neighbours pay an individual to look over their property while away, which affects life satisfaction. Such payments are likely small, and we do not consider this a major concern.

3.1.5 Social Capital

Social capital is perhaps the most important determinant of life satisfaction. We believe that the questions that we include about the relationship with neighbours are already a good proxy for social capital. However, we further control for variables that describe the relationship an individual has with family and friends.

Regarding family relationships, we include a variable about how much the respondent feels family lets them down scaled from (1) a lot, to (4) not at all, and include a variable about how easy or difficult the respondent finds it to visit family or relatives when desired.

We also gather data about the relationship an individual has with their closest friend and the frequency of meeting them, ranging from most days (1) to less often (4).

3.1.6 Mental and Physical Health

Mental and physical health are not only important determinants of life satisfaction but might also impact the decision to take a pet as a companion or not. We account for poor physical health using two dummy variables. One is the answer to the following question: "In general, would you say your health is: poor", and one that records whether the respondent is long-time sick or disabled.

We measure mental health through the answer to the following question: "During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)" measured from 1 (all of the time) to 5 (none of the time). We construct a dummy variable for poor mental health that takes the value 1 if this multivalued variable takes the value 1 or 2.

3.1.7 Further Controls

We use a variety of controls usually included in the previous studies in the literature, including: age, age squared, sex, ethnicity, education, living in an urban area, gross monthly income, marital status, employment status, number of children in the household, household size, and whether the house is owned or not. A comprehensive table with descriptive statistics of the variables can be found in Table 8 in the Appendix.

3.2 Methodology

In this section we discuss our empirical methods and the instrumental variable approach we use.

3.2.1 Life Satisfaction Approach

Economists have relatively recently developed 'the life satisfaction approach' to assess the size of the effect of different factors on life satisfaction. The process involves using simple regression analysis to determine the *implicit price* of different factors or occurrences in life. For example, economists have shown using life satisfaction surveys that marriage, compared to being single, is worth around £70,000 a year for a representative person in Great Britain. Separation, on the other hand, is equivalent to around minus £170,000 a year (Clark & Oswald, 2002). The method generalizes to different determinants of life satisfaction and has been used to calculate the life satisfaction loss induced by intangibles such as the fear of crime (Moore & Shepherd, 2006) or aircraft noise (Van Praag & Baarsma, 2005). This method has been used extensively in environmental valuation (e.g. Ambrey & Fleming, 2014; Bertram & Rehdanz, 2015), and has also been used to value social interaction (Powdthavee, 2008).

The life satisfaction approach assumes that an individual maximizes utility derived from consumption of environmental goods, marketable goods (e.g., housing) and one numeraire, and that the indirect utility function is given by

$$U = V(P, Y, A) \tag{1}$$

where U is utility,P is the price of the marketable good (such as housing), Y is the numeraire (income) and A is the level of the good or amenity (e.g., scenery, or pet companionship in our case). Using self-reported life satisfaction as a proxy for utility and estimating dV/dA elicits the marginal value of pet companionship if pet companionship, income, housing prices, and other relevant amenities and controls are included in the life-satisfaction (LS) regression.

The typical LS regression includes different demographic, socio-economic, and other variables, and typically income in log form to account for its declining marginal utility,

$$LS_i = \beta_0 + \beta_A A_i + \beta_Y \ln\left(Y_i\right) + \beta_X X_i + \beta_Z Z_i + \varepsilon_{ij} \tag{2}$$

where LS_i is the stated level of life satisfaction of respondent i, Y_i is the income of the individual, A_i is pet companionship for which we want to elicit the willingness to pay (WTP) or value, X_i are demographic and socio-economic characteristics of the respondent, and Z_i are other characteristics. The coefficients of interest are β_A and β_Y.

The estimated relationships can be used to derive the implicit marginal rate of substitution (MRS) between pet companionship (A_i) and income (Y_i), i.e. the amount of money that an individual would be willing to give up for a change in the pet variable, given that utility stays constant. The MRS is thus the absolute value of the slope of the indifference curve. For the given specification, the MRS, evaluated at the mean of income (Y), can be calculated as follows,

$$MRS = \frac{\frac{\partial LS_i}{\partial A_i}}{\frac{\partial LS_i}{\partial Y_i}} = \frac{\frac{\partial LS_i}{\partial A_i}}{\frac{\partial LS_i}{\ln(Y_i)}\frac{\partial \ln(Y_i)}{\partial Y_i}} = \frac{\frac{\partial LS_i}{\partial A_i}}{\frac{\partial LS_i}{\ln(Y_i)}} Y_i = \left(\frac{\beta_A}{\beta_Y}\right) Y_i \tag{3}$$

Therefore, the estimated coefficients for pet companionship and income can be used to calculate the implicit WTP, or value to the individual, of pet companionship.

The big advantage of the method is that the value of the pet for the individual can be estimated without asking individuals directly about this quantity. This is presumably a cognitively less demanding task and there is no reason to expect strategic behaviour, or different biases derived from a hypothetical scenario. Most importantly, LSA can capture effects that affect an individual's life satisfaction through a process unnoticed by the individuals themselves.

3.2.2 Instrumental Variable Approach

As we expect pet companionship to be endogenous, Ordinary Least Squares (OLS) is unlikely to be the best linear unbiased estimator. We attempt to overcome this by estimating an instrumental variables (IV) model in which watching over the neighbour's property (TOTORO) is the instrument. We posit that individuals who watch over neighbours' property are more likely to take pets as companions themselves than individuals who don't. Furthermore, we claim that watching over neighbours' property will not be correlated with the uncontrolled-for determinants of satisfaction.

More specifically, for TOTORO to be a valid instrument, it should not affect life satisfaction directly or be correlated with uncontrolled-for determinants of satisfaction. In particular, we are concerned with the possibility that watching over neighbours' property might directly influence life satisfaction because it reflects a better relationship with neighbours. Thus, we control for the quality of relationships with neighbours. We estimate the following,

$$Pet_i = \alpha + X_i\prime\beta + \delta CKN_i + \gamma TOTORO_i + u_i \; Stage\ 1 \tag{4}$$

$$LS_i = \kappa + X_i\prime\rho + \varphi CKN_i + \tau Pet_i + v_i \; Stage\ 2 \tag{5}$$

CKN_i is the "close-knit neighbourhood" variable. $X_i\prime$ denotes a vector of other controls.

4 Results

4.1 Data Description

A comprehensive table with descriptive statistics can be found in Table 8 in the Appendix. The analysis includes individuals aged 16–99, an age where they could potentially take care of a pet.[9] This produces 33,177 observations in total, rising from 1870 individuals in wave 2 to 3,061 in wave 14. Due to missing data, not all individual-wave observations are present in the final analysis.

The average life satisfaction score for the whole sample is 5.24 and is not significantly different between men and women. There are more women (54%) than men (46%) in our sample. The relationship between age and life satisfaction shows a pronounced 'U-form', sometimes also called the 'Life satisfaction Smile' reaching its global minimum at around 44 years of age (Fig. 1). This minimum point is sometimes referred as the 'midlife nadir' or 'midlife crisis' and this type of pattern is typically found in the life satisfaction literature (Cheng et al., 2017; Powdthavee, 2008).

Overall, our sample seems to be representative for the UK population and for the time period analysed. The sample is similar to the UK samples used in other papers in the life satisfaction literature (e.g., Gschwandtner et al., 2022; Powdthavee, 2008). In 2010 (wave 3), 369 respondents reported that they care for a cat, 373 respondents reported that they care for a dog and 222 respondents reported that they care for other pets. Even though these numbers might not appear large, they result in a percentage of around 22% of individuals in the sample population. Numbers are comparable to, or even larger than, numbers from other samples used in the literature. For example, Bao and Schreer (2016), the study that is most similar to ours, has only 168 pet carers out of which there are 68 cat carers, 89 dog carers and 11 other pet carers. As we do not have any information about the type of other pets in our sample, and in order to be able to compare with the vast majority of the literature on pets, we focus our analysis on cats and dogs, notwithstanding the importance of other pets for human life satisfaction and wellbeing as mentioned in the literature review above.

[9] Of course, we cannot be certain that these respondents do not have pet allergies, live in properties that pets are allowed, or don't have a disability that prevents them from taking care of a pet. Unfortunately, the data do not allow us to control for such factors.

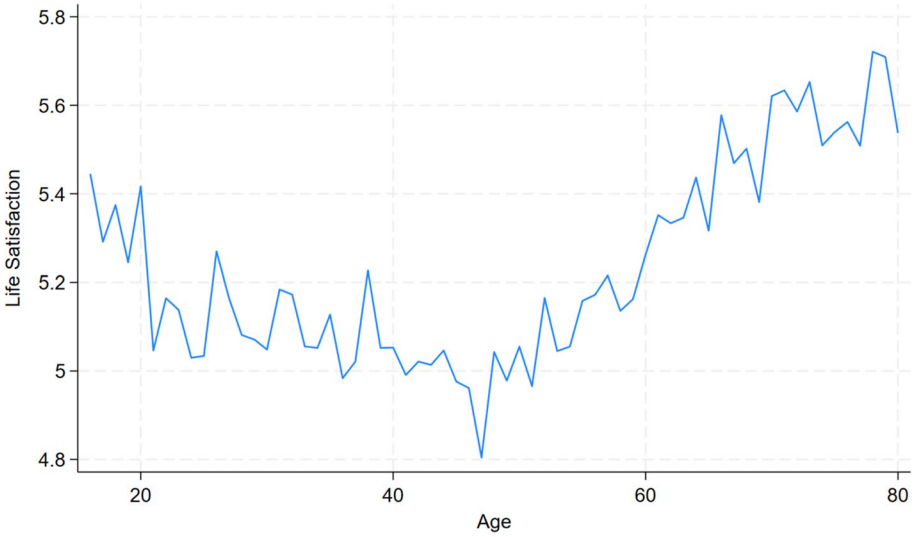

Fig. 1 Relationship between Age and Life Satisfaction

Table 1 below compares various variables between pet carers and non-pet carers. To determine if there are significant differences we perform simple t-tests for differences in means.

When comparing the raw data for pet carers and non-pet carers we notice that, contrary to expectations, the life satisfaction of pet carers appears to be lower on average (and significant at the 5% level) in our sample. This could be because our sample might include people that took a pet as a companion in order to deal with their loneliness and depression (reverse causation). Even though on average the mental and physical health of pet carers and non-pet carers appear to be very similar, it could be that lower life satisfaction of pet carers is driven by other dimensions of mental health not captured by our data, making it even more important to account for the direction of causality. According to the literature, life satisfaction increases as people pass their mid-life crisis, reaching the highest level after retirement. This increase in life satisfaction despite decreasing physical function as people age is reflected in our 'U-shape' Fig. 1 and is often referred to as the 'Paradox of Human Aging'.

Most of the differences between pet and non-pet carers are significant. It can be observed that, on average, as expected and as the literature reveals, pet-carers appear to be more open, conscientious and extroverted (Bao & Schreer, 2016; McConnell et al., 2011). They also tend to be married, have more children living with them in the household, and therefore have a larger household size.

Results reveal that the life satisfaction of cat and dog carers is not significantly different in our sample (Table 2) which is similar to other findings (e.g., Taylor et al., 2006). However, cat carers appear to be significantly more open and conscientious than dog carers, but also significantly less extroverted, similar to what other studies have found (e.g., Bao & Scheer 2016). The difference in means for neuroticism points in the direction of higher neuroticism for cat carers, but it is only marginally significant at the 10% level. Other studies have found that cat carers, or self-identified cat-people, score significantly higher on this trait (Gosling et al., 2010; Reevy & Delgado, 2020).

Table 1 Comparison of pet carers and non-pet carers

Variable	No-Pet Mean (SD)	Pet Carer (Mean SD)	Diff (Sig)	t-stat
Life Satisfaction	5.29 (0.03)	5.20 (0.03)	− 0.09**	− 1.99
Openness	4.57 (0.02)	4.62 (0.02)	0.06**	2.24
Conscientiousness	5.49 (0.15)	5.53 (0.15)	0.04*	1.83
Extraversion	4.47 (0.18)	4.68 (0.19)	0.20***	7.75
Agreeableness	5.69 (0.01)	5.67 (0.01)	− 0.02	− 1.02
Neuroticism	3.57 (0.02)	3.55 (0.02)	− 0.02	− 0.67
Age	57.14 (0.22)	51.47 (0.20)	− 5.67***	− 18.98
Income	2127.26 (19.18)	2189.41 (20.65)	62.15**	2.21
Retired	0.41 (0.01)	0.24 (0.01)	− 0.17***	− 21.11
Unemployed	0.03 (0.00)	0.04 (0.00)	0.01**	2.20
Married	0.57 (0.01)	0.62 (0.01)	0.05***	5.62
Child	0.19 (0.00)	0.26 (0.01)	0.08***	10.18
Own Home	0.47 (0.01)	0.35 (0.01)	− 0.12***	− 13.92
Household Size	2.42 (0.02)	2.82 (0.02)	0.39***	16.68
Poor Mental Health	0.07 (0.00)	0.07 (0.00)	0.00	− 0.96
Poor Physical Health	0.06 (0.00)	0.06 (0.00)	0.00	0.05

Because the relationship between pet companionship and age of human caregivers appears to play an important role in general, and also for the difference between cat and dog owners in particular, we have produced two histograms of the age of cat and dog caregivers (noting that age strongly correlates with life satisfaction). Both Figs. 2 and 3 suggest that people are much less likely to be pet caregivers as they grow older, a result also reflected in Table 1. Overall, the two graphs seem to confirm the statistics from Tables 1 and 2, which reveal a higher level of cat companionship in older age compared to dogs, despite pet companionship decreasing with age in general.

4.2 Estimation Results

The specific empirical form that the life satisfaction Eq. (2) takes in the present study is,

$$LS_{it} = \beta_0 + \beta_\alpha Pet_i + \beta_o P_{oi} + \beta_c P_{ci} + \beta_e P_{ei} + \beta_a P_{ai} + \beta_n P_{ni} + \beta_Y \ln\left(Y_{it}\right) + \beta_X X_{it} + \varepsilon_{ij} \tag{6}$$

where LS_{it} is the reported life satisfaction of the individual at time t; *Pet* is a dummy variable for pet companionship (we separately consider dogs and cats), P_o, P_c, P_e, P_a, and P_n are the personality scores for the Big 5 Personality Traits (o = openness, c = conscientiousness, e = extraversion, a = agreeability, and n = neuroticism), Y is the gross monthly equivalised income,[10] and X is a vector of control variables that are known to influence well-being. X includes dummies for gender, employment status, health, education, age, age squared, household size, number of children, ethnicity, a measure for social capital, mental

[10] Equivalised income is a measure of household income that takes account of the differences in a household's size and composition.

Table 2 Comparison of cat and dog carers

Variable	Cat Carer Mean (SD)	Dog Carer (Mean SD)	Diff (Sig)	t-stat
Life Satisfaction	5.19 (0.05)	5.23 (0.06)	− 0.04	− 0.53
Openness	4.71 (0.03)	4.52 (0.03)	0.19***	4.44
Conscientiousness	5.67 (0.02)	5.47 (0.02)	0.20***	5.89
Extraversion	4.64 (0.03)	4.80 (0.03)	− 0.16***	− 3.77
Agreeableness	5.69 (0.02)	5.65 (0.02)	0.04	1.31
Neuroticism	3.59 (0.03)	3.51 (0.03)	0.09*	1.76
Age	52.86 (0.31)	51.16 (0.34)	1.70***	3.73
Income	2466.37 (36.1)	2022.03 (28.94)	444.34***	9.42
Retired	0.24 (0.01)	0.24 (0.01)	0.00	0.29
Unemployed	0.03 (0.00)	0.05 (0.00)	− 0.02**	− 2.94
Married	0.65 (0.01)	0.59 (0.01)	0.05***	3.63
Child	0.21 (0.01)	0.26 (0.01)	− 0.05***	− 3.65
Own Home	0.34 (0.01)	0.35 (0.01)	− 0.01	− 0.45
Household Size	2.67 (0.03)	2.87 (0.03)	− 0.20***	− 5.16
Poor Mental Health	0.07 (0.01)	0.06 (0.01)	0.01	1.13
Poor Physical Health	0.07 (0.01)	0.05 (0.01)	0.02**	2.15

and physical health, neighbourhood cohesion, and other variables. Please see Table 8 in the Appendix for a full list of controls.

4.2.1 OLS Estimates

Table 3 below presents OLS results (without instrumenting) separately for cats and dogs, comparing owners of cats to all other individuals, then comparing owners of dogs to all other individuals. These results are similar to results from many of the studies that have analysed the correlation between pet companionship and life-satisfaction/well-being. Without instrumenting, results are likely biased by reverse causality as previously explained. As mentioned in the literature review, several studies find a positive relationship in raw data. However, there are also some studies that find a negative and significant relationship (e.g., Amiot et al., 2022; Hulm, 2022; Miltiades & Shearer, 2011). There are also some that find no relationship at all (e.g., Fraser et al., 2020; Gilbey et al., 2007; Herzog, 2018). Similar to this later group, the relationship between pet companionship and life-satisfaction is insignificant in our data when we use OLS.

In Table 3 the coefficient for cat companionship is negative but not significant whilst all the other coefficients, when significant, typically have the expected sign. The final two columns of Table 3 show almost identical coefficients and significance for the controls and a positive but not significant coefficient for dog companionship.

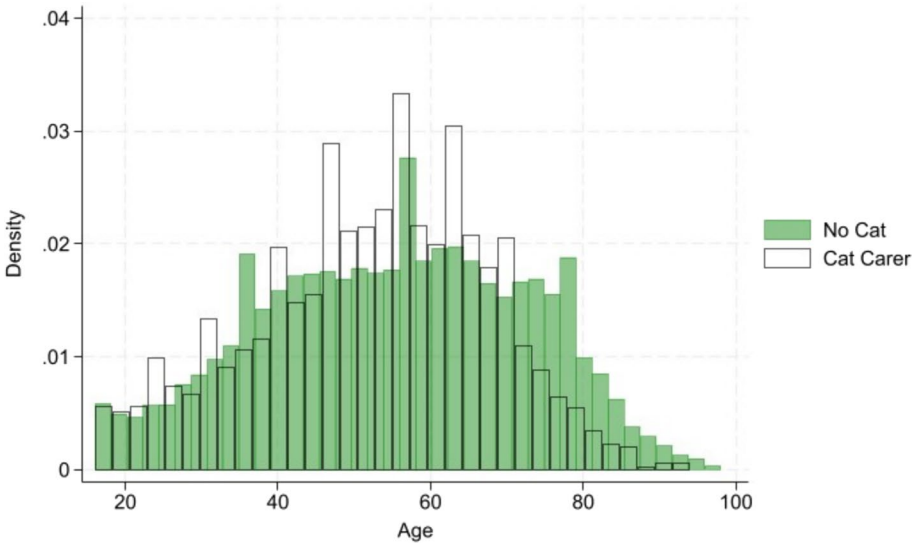

Fig. 2 Density of cat caregivers and non-caregivers by age

4.2.2 Instrumental Variable Estimates: Causal Estimation Results

Table 4 presents the results when using the same set of controls and instrumenting pet companionship using the instrument TOTORO, separately for cats and dogs.

For both cats and dogs, the striking difference to Table 3 is that the 'pet coefficient' becomes positive and significant (only at the 10% level for cats). We believe this shows that, after filtering out potential reverse causality and the effect of omitted variables, the causal impact of pets on life-satisfaction is positive and of meaningful magnitude.

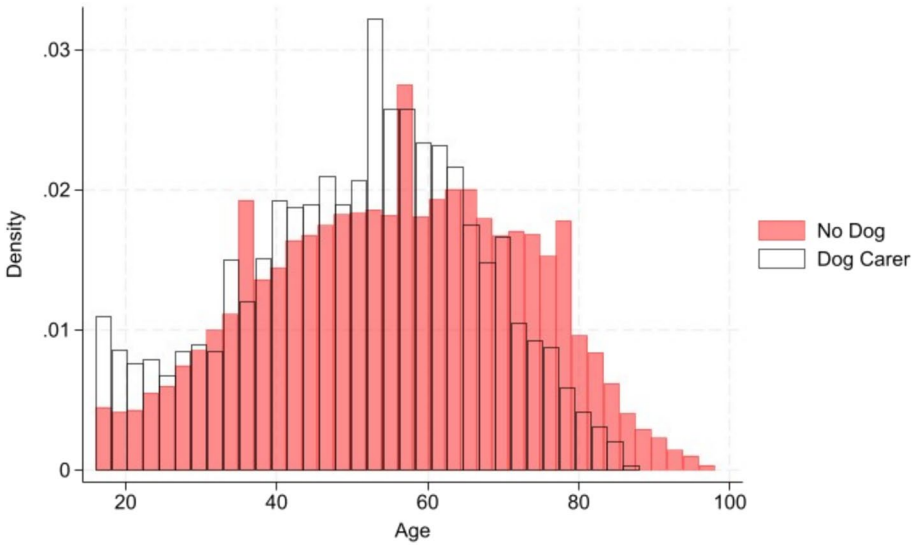

Fig. 3 Density of dog caregivers and non-caregivers by age

Table 3 Pet companionship and Life-Satisfaction (dependent variable) OLS estimation

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Cat Companion	− 0.09	(0.06)		
Dog Companion			0.005	(0.06)
Log Income	0.17***	(0.04)	0.17***	(0.04)
Neighbour Cohesion (CKN)	− 0.03*	(0.02)	− 0.03*	(0.02)
Openness	0.03	(0.02)	0.03	(0.02)
Conscientiousness	0.03	(0.03)	0.03	(0.03)
Extroversion	0.02	(0.02)	0.02	(0.02)
Agreeableness	0.03	(0.03)	0.03	(0.03)
Neuroticism	− 0.12***	(0.02)	− 0.12***	(0.02)
Age	− 0.03**	(0.01)	− 0.03**	(0.01)
Age square	0.00***	(0.00)	0.00***	(0.00)
Woman	0.12**	(0.05)	0.12**	(0.05)
BF Daughter or Son	0.17**	(0.07)	0.17**	(0.07)
BF Sister or Brother	− 0.27***	(0.09)	− 0.28***	(0.09)
BF Parent	− 0.10	(0.09)	− 0.10	(0.09)
BF Grandparent	− 0.11	(0.16)	− 0.12	(0.16)
BF Aunt, Uncle or Cousin	0.06	(0.38)	0.06	(0.38)
BF Other Relative	0.00	(0.18)	− 0.00	(0.18)
In touch with BF once a week	0.02	(0.06)	0.02	(0.06)
In touch with BF once a month	0.05	(0.07)	0.05	(0.07)
In touch with BF less often	− 0.21*	(0.11)	− 0.20*	(0.11)
Living in an Urban area	0.01	(0.06)	0.01	(0.06)
Poor Mental Health	− 1.29***	(0.12)	− 1.28***	(0.12)
Poor Physical Health	− 0.59***	(0.14)	− 0.59***	(0.14)
Own House	0.15**	(0.07)	0.16**	(0.07)
Education: GCSE (11 years)	0.02	(0.06)	0.02	(0.06)
Education: A-levels (13 years)	0.05	(0.10)	0.04	(0.10)
Education: Higher (e.g. University)	− 0.03	(0.08)	− 0.04	(0.08)
Visit family	0.13	(0.10)	0.13	(0.10)
Not let down by family	0.04	(0.04)	0.03	(0.04)
Ethnicity: any other White Backg	0.18	(0.14)	0.21	(0.14)
Ethnicity: White and Black African	− 0.43	(0.36)	− 0.38	(0.36)
Ethnicity: White and Asian	− 1.61***	(0.30)	− 1.62***	(0.29)
Ethnicity: any other Mixed Backg	0.52*	(0.31)	0.53*	(0.31)
Ethnicity: Indian	− 0.25	(0.24)	− 0.22	(0.24)
Ethnicity: Pakistani	− 0.08	(0.26)	− 0.05	(0.26)
Ethnicity: Chinese	0.06	(0.55)	0.10	(0.55)
Ethnicity: Other Asian or British	1.41***	(0.44)	1.44***	(0.44)
Ethnicity: Caribbean Black	− 1.39***	(0.44)	− 1.39***	(0.45)
Ethnicity: African Black	− 0.78**	(0.32)	− 0.75**	(0.32)
Ethnicity: Other	− 0.04	(0.17)	− 0.01	(0.17)
Job status: Employed	− 0.02	(0.10)	− 0.01	(0.10)
Job status: Unemployed	− 0.38*	(0.21)	− 0.37*	(0.21)

Table 3 (continued)

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Job status: Retired	0.21*	(0.11)	0.22**	(0.11)
Job Status: Maternity Leave	0.53*	(0.30)	0.56*	(0.30)
Job Status: Family Care	0.16	(0.19)	0.16	(0.19)
Job Status: Student (FT)	0.43	(0.26)	0.43*	(0.26)
Long Time Sick or Disabled	− 0.72***	(0.23)	− 0.70***	(0.23)
Job Status: Govt Training	1.86***	(0.26)	1.78***	(0.25)
Job Status: Unpaid, family business	− 0.16	(0.18)	− 0.22	(0.18)
Job Status: Furloughed (paid)	1.19***	(0.29)	1.22***	(0.29)
Job Status: short time working	0.46***	(0.15)	0.49***	(0.15)
Job Status: something else	− 0.03	(0.51)	− 0.03	(0.52)
Living as a Couple	1.13***	(0.31)	1.14***	(0.30)
Child(ren)	0.01	(0.09)	0.02	(0.09)
Separated	− 0.47***	(0.18)	− 0.48***	(0.18)
Divorced	− 0.04	(0.09)	− 0.05	(0.08)
Household Size	0.01	(0.03)	0.01	(0.03)
Time Dummies	Yes		Yes	
Constant	4.08***	(0.51)	4.10***	(0.51)
Observations	2,635		2,635	
R-squared	0.265		0.264	

Standard errors are clustered at the household level, *, **, and **denote significance at 10, 5, and 1% level

In the final two columns of Table 4, the coefficient for dog companionship, as for cat companionship, is large and positive. It is significant at the 5% level, suggesting a positive causal relationship between dog companionship and life satisfaction when reverse causality and potential omitted variables are corrected for.

We implement a Durbin-Wu-Hausman test of the null hypothesis that OLS estimates are consistent. We strongly reject the null that OLS estimates are consistent for both cat and dog companionship.

We also use the Kleibergen-Paap test. The null hypothesis is that the instrument fails relevance. We reject the null hypothesis and claim that the instrument is relevant in both IV regressions. The first stage results are presented in Table 9 in the Appendix. For both cats and dogs, the instrument TOTORO is significant at the 5% level or better.

Stage 1 results for cats (Table 9 in the Appendix) reveal that cat companionship is significantly and positively correlated with the personality trait openness, corroborating other results from literature (see for example Bao & Schreer, 2016 Table 2 and citations within).

Stage 1 results for dogs (Table 9 in the Appendix) reveal that more personality traits are significantly associated with dog companionship than with cat companionship. Extroversion and agreeableness have positive coefficients, while neuroticism and conscientiousness have negative coefficients.

In order to test the hypothesis that pets are a substitute for partners, and as a means of robustness, we created an interaction term between pets and being married and have run the instrumental variable regressions described in Eq. (4) for both cats and dogs.

Table 4 Pet companionship and Life-Satisfaction (dependent variable) IV estimation

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Cat Companion	3.74*	(2.19)		
Dog Companion			2.93**	(1.42)
Log Income	0.15**	(0.07)	0.31***	(0.09)
Neighbour Cohesion (CKN)	− 0.03	(0.03)	− 0.03	(0.03)
Openness	− 0.09	(0.07)	0.03	(0.03)
Conscientiousness	0.04	(0.04)	0.07*	(0.04)
Extroversion	0.00	(0.03)	− 0.04	(0.04)
Agreeableness	− 0.03	(0.06)	− 0.03	(0.05)
Neuroticism	− 0.11***	(0.03)	− 0.06	(0.04)
Age	− 0.08**	(0.03)	− 0.05***	(0.02)
Age square	0.00**	(0.00)	0.00***	(0.00)
Woman	− 0.00	(0.10)	0.07	(0.07)
BF Daughter or Son	0.21	(0.14)	0.13	(0.11)
BF Sister or Brother	− 0.69**	(0.29)	− 0.26**	(0.13)
BF Parent	− 0.23	(0.17)	− 0.09	(0.12)
BF Grandparent	− 0.50	(0.36)	0.44	(0.31)
BF Aunt, Uncle or Cousin	− 0.09	(0.47)	− 0.12	(0.48)
BF Other Relative	− 0.23	(0.30)	0.36	(0.31)
In touch with BF once a week	0.13	(0.11)	− 0.18	(0.13)
In touch with BF once a month	− 0.30	(0.24)	0.02	(0.10)
In touch with BF less often	− 0.11	(0.20)	− 0.15	(0.15)
Living in an Urban area	− 0.05	(0.12)	0.17	(0.12)
Poor Mental Health	− 1.15***	(0.20)	− 1.17***	(0.17)
Poor Physical Health	− 0.85***	(0.26)	− 0.84***	(0.23)
Own House	0.44**	(0.21)	0.22**	(0.10)
Education: GCSE (11 years)	− 0.09	(0.12)	0.23*	(0.13)
Education: A-levels (13 years)	− 0.48	(0.36)	0.47*	(0.24)
Education: Higher (e.g. University)	− 0.40	(0.26)	0.15	(0.15)
Visit family	0.20	(0.17)	0.16	(0.13)
Not let down by family	− 0.03	(0.07)	0.10*	(0.05)
Ethnicity Mixed White	1.19*	(0.64)	0.25	(0.25)
Ethnicity: White and Black African	1.23	(1.03)	0.43	(0.55)
Ethnicity: White and Asian	− 2.19***	(0.62)	− 0.75	(0.56)
Ethnicity: any other Mixed Backg	1.14**	(0.56)	1.28***	(0.49)
Ethnicity: Indian	0.70	(0.63)	0.33	(0.36)
Ethnicity: Pakistani	1.18	(0.78)	0.21	(0.38)
Ethnicity: Chinese	1.36	(0.93)	0.61	(0.54)
Ethnicity: Other Asian or British	2.61***	(0.83)	1.93***	(0.52)
Ethnicity: Caribbean Black	− 1.74*	(0.99)	− 0.76	(0.56)
Ethnicity: African Black	0.62	(0.86)	0.03	(0.51)
Ethnicity: Other	1.09	(0.68)	− 0.28	(0.34)
Job status: Employed	0.37	(0.28)	− 0.10	(0.13)
Job status: Unemployed	0.22	(0.46)	− 0.58*	(0.30)

Table 4 (continued)

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Job status: Retired	0.79**	(0.40)	0.10	(0.16)
Job Status: Maternity Leave	1.88**	(0.88)	0.65	(0.42)
Job Status: Family Care	0.28	(0.35)	0.12	(0.27)
Job Status: Student (FT)	0.61	(0.44)	0.42	(0.39)
Long Time Sick or Disabled	0.19	(0.62)	− 0.40	(0.32)
Job Status: Govt Training	− 1.45	(1.92)	2.38***	(0.48)
Job Status: Unpaid, family business	− 2.66*	(1.47)	0.35	(0.37)
Job Status: Furloughed (paid)	2.44***	(0.80)	1.90***	(0.51)
Job Status: short time working	1.76**	(0.79)	− 1.41	(0.93)
Job Status: something else	0.08	(0.89)	− 0.22	(0.65)
Living as a Couple	1.59***	(0.40)	1.22***	(0.22)
Child(ren)	0.35	(0.26)	0.23	(0.16)
Separated	− 0.68**	(0.31)	− 1.31***	(0.48)
Divorced	− 0.25	(0.19)	− 0.11	(0.13)
Household Size	− 0.07	(0.07)	− 0.01	(0.04)
Time Dummies	Yes		Yes	
Constant	5.39***	(1.21)	2.56**	(1.04)
Observations	2,617		2,617	
F-stat	107.47		127.62	
Underidentification Test (LM Stat)	4.27 p-value = 0.04		7.34 p-value = 0.01	
Endog test (Chi-sq): DWH robust	10.92 p-value < 0.01		10.41 p-value < 0.01	

Standard errors are clustered at the household level, *, **, and ***Denote significance at 10, 5, and 1% level

We included a binary variable for being married as a control. We instrument the interaction of pet companionship with being married using the interaction of TOTORO with being married. Results are presented in Table 10 in the Appendix. For dogs, the baseline effect on satisfaction is positive, with a p-value of 0.13. The interaction is negative but insignificant, suggesting that the positive effect of life satisfaction may be lower for people who are married. For cats, the baseline effect is also positive and has a p-value of 0.81. The interaction is positive but insignificant with a massive standard error. We observe that the interaction term between pets and being married reduces the coefficient for dogs and hypothesise that pet companionship can potentially be viewed as a substitute for relationships at home.

4.3 Monetary Value of Pets

Reverse causality, omitted variables, and measurement error are all potential sources for bias regarding the coefficient for income, and ignoring them would likely lead to an underestimation of the income coefficient (Powdthavee, 2010). Reverse causality is present if people who are happier earn a higher income. There is now ample evidence that this is likely the case (e.g. Gardner & Oswald, 2007; Lyubomirsky et al., 2005). A related

problem is that costs of income generation, such as working hours, stress, health risks, commuting, etc. are inherently difficult to control for. Omission of such factors may induce downward bias regarding the coefficient for income, and their omission might be one reason why the income coefficient is often found to be very low (Luechinger, 2009). Finally, the income data might be imperfect or measured with error; it could be that what matters for life satisfaction is not the absolute income that we measure, but the relative income, such as income compared to a reference group, own past income, or a specific aspirational income (see Clark & Oswald, 1996; Stutzer, 2004; Ferrer-i-Carbonell, 2005; Clark et al., 2008). Moreover, attenuation bias towards zero, which results from classical measurement error, can further bias the income coefficient downwards (Powdthavee, 2010).

A solution to these problems is to find an instrument for income, a variable that is correlated with income but has no independent effect on life satisfaction, which is not easy to find. We instrument for income using two instruments previously used in the literature (1) payslip information, similar to Powdthavee (2010) and (2) father's years of education, similarly to Knight and Gunatilaka (2011). The Innovation Panel asks their interviewers to try and see the actual payslip of the survey respondent and the recency of the payslip (whether this the most recent payslip, or an older payslip). The payslip is usually issued by the respondent's employer, and typically contains information on gross income and all taxes and any other deductions. The idea is that when the payslip is more recent, the information about income is likely to be more accurate. This is designed to address measurement error. The second instrument used is father's highest educational qualification when the respondent was aged 14. Father's years of education has been used as an instrument for income, see for example Knight and Gunatilaka (2011) who argue that the instrument is unlikely to affect life satisfaction directly but that it is highly correlated with income (p 23). According to the test results shown in their paper, the instrument is relevant and valid. Nevertheless, we acknowledge concerns. Occupational choice is endogenous to individual preferences and is likely to be related to both receiving a payslip and parent's occupation. Moreover, occupational choice is very likely to influence life satisfaction. Lacking better instruments, we follow prior practice and acknowledge there may be concerns.

Tables 5 and 6 present the coefficients of the regressions using instruments both for pets and for income. The last column applies Eq. (3) to estimate the WTP for pet companionship. As shown in Table 8, the average monthly gross income in our sample is £2,194.34 and we multiply this value by 12 in order to obtain a yearly income of £26,332.08. The average yearly income is then multiplied by the ratio of the coefficients for the pets and income to obtain the willingness to pay (WTP) values reported in the last columns of the two tables.

When instrumenting, the coefficient for income increases meaningfully. The value of pet companionship is around £70,000, which is comparable with the values obtained by Powdthavee (2008) for meeting with friends and relatives once or twice a week (Table 6, p 1472). Given that, as argued before, pets are considered by many as best friends and family members, these values appear to be plausible. Given the larger benefits of dogs for health than of cats, it may be that a larger value for dogs is expected. However, one needs to consider that dogs also have higher 'maintenance costs' compared to cats. They usually need to be taken out once or twice a day, no matter what type of weather, and they might be more expensive to take care of if they cannot be taken on holidays. Cats are in general more independent than dogs and easier to take care of. The advantage of the life satisfaction approach is that it is best suited to include all of these effects in the

Table 5 WTP Estimates for Cats

Variable	OLS	IV Cats	IV Cats and Income	WTP (using IV for both cats and Income and an annual income of £26,332.08)[a]
Cat companion	− 0.09 (0.06)	3.74 (2.19)*	4.05 (2.24)*	£73,044.47
Log Income	0.17 (0.04)***	0.15 (0.07)**	1.46 (0.76)*	
Observations	2581			
R squared	0.81			
F-stat (Sanderson Windmeijer)	31.55 (0.00)			
Overidentification- Hansen J-Statistic (Chi sq *p*-value)	2.46 (0.12)			
Anderson-Rubin Wald Test F (*p*-value)	29.76(0.00)			

Standard errors are clustered at the household level, *, **, ***Significance at 10, 5, 1%. Includes controls for neighbour, personality, age, homeownership, education, race, time and for being divorced

[a]WTP was calculated using the formula in Eq. (3)

valuation, without the pet carer even noticing this. Our estimates may seem large. To put them in context, note that IV estimates represent the treatment effect for the subpopulation for which the instrument affects the treatment. In context, we estimate the effect of pet companionship on life satisfaction for individuals who are induced to own a pet when looking over their neighbours' pets. This is a subpopulation that likely has a large treatment effect – these are people who, when looking after neighbour's pets realize how much they enjoy it, and thus choose to have a pet. The average treatment effect in the population may be much lower. Note that our interpretation of estimates as representative of the treatment effect for a subpopulation relies on a monotonicity assumption (see Felton & Stewart, 2024), that the instrument monotonically affects treatment. In context, that there are no individuals who, if neighbours don't ask them to watch property choose to attain a pet and, if neighbours ask them to watch property, do not choose to attain a pet. This would occur if people realize they don't want a pet by taking care of other people's pets, but, in their ignorance, would attain a pet if they didn't take care of other people's pets. We find this unlikely in our circumstance. Nevertheless, we state the assumption for transparency.

Tables 5, 6, 7 present relevant statistics for the instruments including first stage results. The results in Table 7 show that both payslip and father's years of education are highly correlated with income and therefore relevant ($p < 0.05$). For estimation of both dogs and cats, the Sanderson-Windjemeier F-test of excluded instruments implies that relevance holds ($p < 0.01$) and in both cases we fail to reject the null hypothesis that instruments are valid in the Hansen J test ($p > 0.1$). The weak identification test shows that instruments are not weak. The Anderson-Rubin-Wald test suggests that OLS estimation is inconsistent, and the instrumenting is necessary ($p < 0.01$). Overall, the results suggest that the instruments are valid. Nevertheless, Table 5 shows the standard error for the coefficient estimate of cat companionship is quite large, 2.24, so the point estimate should be interpreted cautiously.

As a robustness check we ran a regression with life satisfaction as a dependent variable and both cats and dogs as regressors simultaneously instrumenting with TOTORO, payslip, and father's education using the same controls as above. The estimated coefficients for both cats and dogs remain significant, and the estimated coefficient for income is significant at the 10% level. Results are presented in Tables 11 and 12 in the appendix.

5 Discussion, Limitations and Conclusions

There is a common understanding, and significant empirical support, that pets are good for us both from a psychological and physical point of view (Wells, 2019). In the present paper we estimate the monetary value of pets for their human caregivers using the life satisfaction approach.

Moreover, as evidence from the Covid pandemic has shown, people might decide to take a pet as a companion in order to deal with their loneliness or with their mental health issues. In the present paper, we disentangle the direction of causality and estimate the direct effect of pets on human life satisfaction by using an instrumental variable approach.

We find that without instrumenting, the effect on life satisfaction of cats is negative and the one of dogs is close to zero but, in both cases, insignificant. However, when

Table 6 WTP Estimates for Dogs

Variable	OLS	IV Dogs	IV Dogs and Income	WTP (using IV for both dogs and Income and an annual income of £26,332.08)[a]
Dog companion	0.005 (0.06)	2.93 (1.42) **	2.29 (0.80)***	£66,264.25
Log Income	0.17 (0.04)***	0.31 (0.09)***	0.91 (0.55)*	
Observations	2581			
R squared	0.91			
F-stat-Sanderson Windmeijer (*p*-value)	24.16 (0.00)			
Overidentification- Hansen J-Statistic (Chi sq *p*-value)	1.00 (0.32)			
Anderson-Rubin Wald Test F (*p*-value)	29.76(0.00)			

Standard errors are clustered at the household level, *, **, ***Significance at 10, 5, 1%

Includes controls for neighbour, personality, age, homeownership, education, race, time and for being divorced

[a]WTP was calculated using the formula in Eq. (3)

Table 7 First stage regression results for Income (dependent variable) for Cats and Dogs

Instrument	Coefficient	Robust Standard Errors	t-statistic
TOTORO	− 0.037	0.031	− 1.21
Payslip	0.128**	0.026	4.99
Father's education	0.004***	0.001	4.12
Weak Identification Test–Kleinberger Papp Wald F statistic	21.01		
Overidentification test of all instruments-Hansen J Statistic (Chi sq *p*-value)	2.46(0.117)		

Standard errors are clustered at the household level, *, **, ***Significance at 10, 5, 1%. Includes controls for neighbour, personality, age, homeownership, education, race, time and for being divorced

instrumenting, both the impact of dogs and cats on human life satisfaction turn positive, large, and are strongly significant. Therefore, the present paper answers the question whether overall pets are good for us with a resounding 'Yes'.

The present method does not ask pet caregivers about the impact of their pets on their wellbeing but estimates this through the impact of a pet companionship dummy on life satisfaction. This poses a lower cognitive burden on the respondents and avoids several types of biases that could derive from respondents wanting to give a socially desirable answer related to pets. The method can also capture effects that affect an individual's life satisfaction through a process unnoticed by the individuals themselves.

Moreover, the present method enables us to set a monetary value on pet companionship by estimating the trade-off ratios between pet companionship and income. The monetary values we obtained are up to £70,000 for both cats and dogs. We believe that these values are realistic and can be used for health care practice and policy aiming to increase wellbeing and life satisfaction of humans involving pets.

Regarding personality traits, our results reveal that while cat carers appear to be more open, dog carers appear to be more extroverted, agreeable and less neurotic. Overall, pet carers in general appear to be more open, conscientious, and extroverted than non-pet carers. The significant association between pet companionship and personality underlines the importance of controlling for it in the analysis of the relationship between pet companionship and life satisfaction.

However, the present study has shortcomings. We only have information about cats and dogs as these are the most prevalent pet types, but we do not wish to underestimate the importance of other types of pets for wellbeing such as fish, hamsters, rabbits, reptiles, or horses.

Ideally data would have been measured at more points in time as we could then see how pet companionship might change over time. The literature suggests that the effect may be strongest when the pet is first taken as a companion and then decrease over time according to the hedonic adaptation theory (Bao & Schreer, 2016; Frederick & Loewenstein, 1999).[11]

More or other measures for personality, such as the Myers-Briggs Type Indicator or the Eysenck Personality Questionnaire, could have been used if data would have been available. Future studies might consider using primary data and collecting information on these personality measures.

[11] For these and other reasons, collecting primary data might have been better even if more expensive or difficult to get. We plan in future to do so.

The results in the present study bring strong support for the hypothesis that pets increase human life satisfaction and wellbeing similarly to family and friends and that, to some extent, they are even a substitute for these. The value of pets for their human caregivers appears to be very high, comparable to the one that has been obtained in other studies for meeting with friends and relatives on a regular basis or even with being married (Clark & Oswald, 2002; Powdthavee, 2008). We have used throughout the paper the term 'human caregivers' but in light of the results obtained in the present study the question can be raised regarding who is actually taking care of who.

Appendix

See Tables 8, 9, 10, 11, 12.

Table 8 Data Descriptions, sample means (standard deviations): UKDS Innovation Panel 2009–2022 (waves b-o)

Variables	Descriptions	Mean (SD)	Min	Max
Life Satisfaction and Pets				
Life Satisfaction (LS)	LS score, coded so that 1 = very dissatisfied, 7 = very satisfied	5.24 (1.40)	1	7
Women	Gender of the respondent, women = 1 (men = 0)	0.54 (0.50)	0	1
LS Women	Average LS for Women	5.24 (1.40)	1`	7
LS Men	Average LS for Men	5.25 (1.39)	1	7
Cat Carers (369)	People that mentioned to care for a Cat	0.24 (0.43)	0	1
Dog Carers (373)	People that mentioned to care for a Dog	0.22 (0.41)	0	1
Other Pets (222)	People that mentioned to care for other Pets	0.14 (0.35)	0	1
Women Cat Carers (210)	People that mentioned to care for a Cat (restricted to women)	0.24 (0.43)	0	1
Women Dog Carers (217)	People that mentioned to care for a Dog (restricted to women)	0.23 (0.42)	0	1
Women Other Pet Carers (133)	People that mentioned to care for other Pets (restricted to women)	0.15 (0.36)	0	1
LS Cat Carers	Average LS for Cat Carers	5.21 (1.43)	1	7
LS Dog Carers	Average LS for Dog Carers	5.25 (1.44)	1	7
LS Other Pets	Average LS for Other Pets Carers	5.14 (1.51)	1	7
LS No Pets	Average LS for people with no pets	5.29 (1.39)	1	7
Personality				
Openness	Average Score combining 3 items (original, artistic, active imagination) on a scale from 1 = does not apply to me at all to 7 = applies to me perfectly	4.60 (1.28)	1	7
Conscientiousness	Average Score combining 3 items (thorough, lazy reversed, efficient) on a scale from 1 = does not apply to me at all to 7 = applies to me perfectly	5.51 (1.08)	1	7
Extraversion	Average Score combining 3 items (talkative, sociable, reserved reversed) on a scale from 1 = does not apply to me at all to 7 = applies to me perfectly	4.47 (1.29)	1	7
Agreeableness	Average Score combining 3 items (rude reversed, forgiving, kind) on a scale from 1 = does not apply to me at all to 7 = applies to me perfectly	5.68 (0.98)	1	7
Neuroticism	Average Score combining 3 items (worries, nervous, stressed) on a scale from 1 = does not apply to me at all to 7 = applies to me perfectly	3.56 (1.41)	1	7
Personality and LS				
LS and Openness	Average LS for high Openness (Score = 7)	5.5 (1.34)	1	7

Table 8 (continued)

Variables	Descriptions	Mean (SD)	Min	Max
LS and Conscientiousness	Average LS for high Conscientiousness (Score = 7)	5.48 (1.42)	1	7
LS and Extraversion	Average LS for high Extraversion (Score = 7)	5.34 (1.53)	1	7
LS and Agreeableness	Average LS for high Agreeableness (Score = 7)	5.38 (1.48)	1	7
LS and Neuroticism	Average LS for high Neuroticism (Score = 7)	3.77 (1.91)	1	7
Personality and Pets				
Openness and Cats	Average Openness for Cat Carers	4.73 (1.28)	1	7
Conscientiousness and Cats	Average Conscientiousness for Cat Carers	5.62 (1.12)	1	7
Extraversion and Cats	Average Extraversion for Cat Carers	4.65 (1.27)	1	7
Agreeableness and Cats	Average Agreeableness for Cat Carers	5.71 (0.99)	1	7
Neuroticism and Cats	Average Neuroticism for Cat Carers	3.53 (1.51)	1	7
Openness and Dogs	Average Openness for Dog Carers	4.58 (1.32)	1	7
Conscientiousness and Dogs	Average Conscientiousness for Dog Carers	5.45 (1.05)	1	7
Extraversion and Dogs	Average Extraversion for Dog Carers	4.78 (1.29)	1	7
Agreeableness and Dogs	Average Agreeableness for Dog Carers	5.68 (0.96)	1	7
Neuroticism and Dogs	Average Neuroticism for Dog Carers	3.45 (1.40)	1	7
Openness and other pets (OP)	Average Openness for OP Carers	4.44 (1.24)	1	7
Conscientiousness and OP	Average Conscientiousness for OP Carers	5.44 (1.01)	1	7
Extraversion and OP	Average Extraversion for OP Carers	4.60 (1.32)	1	7
Agreeableness and OP	Average Agreeableness for OP Carers	5.57 (1.00)	1	7
Neuroticism and OP	Average Neuroticism for OP Carers	3.64 (1.43)	1	7
Openness for no pets (NP)	Average Openness for people with no pets	4.57 (1.29)	1	7
Conscientiousness for NP	Average Conscientiousness for people with no pets	5.49 (1.09)	1	7
Extraversion for NP	Average Extraversion for people with no pets	4.58 (1.29)	1	7
Agreeableness for NP	Average Agreeableness for people with no pets	5.69 (0.98)	1	7
Neuroticism for NP	Average Neuroticism for people with no pets	3.57 (1.41)	1	7

Table 8 (continued)

Variables	Descriptions	Mean (SD)	Min	Max
Socio-Demographics				
Income	Gross household monthly income equivalised using OECD household size measure for adjustment	£2,194.34 (1,457.51)	0	20,000
Age	Age of respondent	50.32 (18.37)	16	99
Job Status				
Self Employed	Current employment situation of the respondent, self-employed = 1	0.07 (0.26)	0	1
Employed	Current employment situation of the respondent, In paid employment = 1	0.47 (0.50)	0	1
Unemployed	Current employment situation of the respondent, Unemployed = 1	0.04 (0.20)	0	1
Retired	Current employment situation of the respondent, Retired = 1	0.28 (0.45)	0	1
Maternity Leave	Current employment situation of the respondent, On Maternity Leave = 1	0.01 (0.08)	0	1
Family care or home	Current employment situation of the respondent, On Family care or home = 1	0.04 (0.19)	0	1
Student	Current employment situation of the respondent, Full Time Student = 1	0.05 (0.22)	0	1
Long Time Sick or Disabled	Current employment situation of the respondent, Long Time Sick or Disabled = 1	0.03 (0.18)	0	1
Government Training	Current employment situation of the respondent, Government Training = 1	0.00 (0.02)	0	1
Unpaid Family Business	Current employment situation of the respondent, Unpaid Family Business = 1	0.00 (0.03)	0	1
Apprenticeship	Current employment situation of the respondent, On Apprenticeship = 1	0.00 (0.04)	0	1
Furloughed	Current employment situation of the respondent, Furloughed = 1	0.00 (0.02)	0	1
Temporarily laid off/short time working	Current employment situation of the respondent, Temporarily laid off/short time working = 1	0.00 (0.01)	0	1
On Adoption Scheme	Current employment situation of the respondent, On Adoption Scheme = 1	0.00 (0.01)	0	1
Doing something Else	Current employment situation of the respondent, On Doing something else = 1	0.01 (0.08)	0	1
Education				
Education: GCSE	Education level of respondent, secondary level (11 years of education), i.e. GCSE	0.27 (0.44)	0	1

Table 8 (continued)

Variables	Descriptions	Mean (SD)	Min	Max
Education:A-Level	Education level of respondent, tertiary level (13 years of education), i.e. A-level	0.10 (0.29)	0	1
Education: High	Education level of respondent, higher education, i.e. University	0.10 (0.30)	0	1
Ethnicity				
British White	Respondent belongs to the following ethnic group: British/English/Scottish/Welsh/Northern Irish/White British/White Scottish (White) = 1	0.89 (0.32)	0	1
Irish White	Respondent belongs to the following ethnic group: Irish White = 1	0.00 (0.06)	0	1
Other White	Respondent belongs to the following ethnic group: Any Other White Background = 1	0.03 (0.17)	0	1
Gypsy	Respondent belongs to the following ethnic group: Gypsy = 1	0.00 (0.1)	0	1
Caribbean	Respondent belongs to the following ethnic group: Mixed: White and Black Caribbean = 1	0.01 (0.07)	0	1
African	Respondent belongs to the following ethnic group: Mixed: White and Black African = 1	0.00 (0.03)	0	1
Asian	Respondent belongs to the following ethnic group: Mixed: White and Asian = 1	0.00 (0.06)	0	1
Other Mixed	Respondent belongs to the following ethnic group: Mixed: Any other mixed background = 1	0.00 (0.06)	0	1
Indian	Respondent belongs to the following ethnic group: Indian (Asian or Asian British) = 1	0.02 (0.13)	0	1
Pakistan	Respondent belongs to the following ethnic group: Pakistani (Asian or Asian British) = 1	0.01 (0.12)	0	1
Bangladesh	Respondent belongs to the following ethnic group: Bangladeshi (Asian or Asian British) = 1	0.00 (0.02)	0	1
Chinese	Respondent belongs to the following ethnic group: Chinese (Asian or Asian British) = 1	0.00 (0.05)	0	1
Other Asian	Respondent belongs to the following ethnic group: Chinese (Asian or Asian British) = 1	0.01 (0.08)	0	1

Table 8 (continued)

Variables	Descriptions	Mean (SD)	Min	Max
Caribbean British	Respondent belongs to the following ethnic group: Caribbean (Black/Africa/Caribbean/Black British) = 1	0.01 (0.09)	0	1
African British	Respondent belongs to the following ethnic group: African (Black/African/Caribbean/Black British) = 1	0.01 (0.09)	0	1
Other Black	Respondent belongs to the following ethnic group: Any Other Black Background (Black/African/Caribbean/Black British) = 1	0.00 (0.02)	0	1
Arab	Respondent belongs to the following ethnic group: Arab = 1	0.00 (0.03)	0	1
Other Ethnic Group	Respondent belongs to the following ethnic group: Other Ethnic Group = 1	0.01 (0.09)	0	1
Household Size	Number of people living in the household	2.73 (1.36)	1	12
Own Home outright	Whether the respondent owns home outright, yes = 1	0.37 (0.48)	0	1
Child	Whether the respondent has one or more children living in the household	0.23 (0.42)	0	1
Married	Marital Status, married = 1	0.53 (0.50)	0	1
Living together as a couple	Marital Status, living together with a partner = 1	0.00 (0.06)	0	1
Separated	Marital Status, separated = 1	0.02 (0.14)	0	1
Divorced	Marital Status, divorced = 1	0.10 (0.30)	0	1
Poor Mental Health	During the past 4 weeks respondent has been feeling anxious or depressed all the time or most of the time	0.08 (0.27)	0	1
Poor Physical Health	Individual Assessment of physical health status: Poor	0.06 (0.24)	0	1
Urban	Respondent living in an urban area, urban = 1	0.76 (0.43)	0	1
Social Capital				
Visit Family	Respondent visits family or relatives when feeling like it	0.89 (0.32)	0	1
Not let down by Family	Respondent does not feel let down by family	3.46 (0.76)	1	4
In touch with best friend (BF) on most days	In touch with best friend, most days = 1	0.42 (0.49)	0	1
In touch with BF at least once a week	In touch with best friend, at least once a week = 1	0.36 (0.48)	0	1
In touch with BF at least once a month	In touch with best friend, at least once a month = 1	0.17 (0.38)	0	1
In touch with BF less often	In touch with best friend, less often = 1	0.05 (0.22)	0	1

Table 8 (continued)

Variables	Descriptions	Mean (SD)	Min	Max
BF: Spouse or Partner	Relationship of BF to respondent, Spouse or Partner = 1	0.65 (0.48)	0	1
BF: Son or Daughter	Relationship of BF to respondent, Son or Daughter = 1	0.12 (0.32)	0	1
BF: Brother or Sister	Relationship of BF to respondent, Brother or Sister = 1	0.08 (0.27)	0	1
BF: Parent	Relationship of BF to respondent, Parent = 1	0.07 (0.25)	0	1
BF: Grandparent	Relationship of BF to respondent, Grandparent = 1	0.03 (0.17)	0	1
BF: Grandchild	Relationship of BF to respondent, Grandchild = 1	0.00 (0.01)	0	1
BF: Aunt, Uncle or Cousin	Relationship of BF to respondent, Aunt, Uncle/ Cousin = 1	0.01 (0.11)	0	1
BF: Some other relative	Relationship of BF to respondent, Some other relative = 1	0.01 (0.08)	0	1
Relationship to Neighbours				
Close knit neighbourhood (CKN)	This is a close knit neighbourhood, Respondent Strongly agrees (1) to Strongly Disagrees (5)	1.16 (1.47)	1	5
Watch over neighbour property (TOTORO = instrument)	When a neighbour is not at home, how often does the respondent and other neighbours watch over their property?, often = 1 to never = 4*	2.91 (1.28)	1	4

*https://www.understandingsociety.ac.uk/documentation/innovation-panel/variables/nbrexch4_a/

Table 9 Pet companionship (dependent variable) First Stage results of IV estimation

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
TOTORO	0.04**	(0.02)	0.05***	(0.02)
Log Income	0.01	(0.02)	− 0.05***	(0.01)
Neighbour Cohesion (CKN)	− 0.00	(0.01)	0.00	(0.01)
Openness	0.03***	(0.01)	− 0.00	(0.01)
Conscientiousness	− 0.00	(0.01)	− 0.01*	(0.01)
Extroversion	0.01	(0.01)	0.02***	(0.01)
Agreeableness	0.01	(0.01)	0.02**	(0.01)
Neuroticism	− 0.00	(0.01)	− 0.02***	(0.01)
Age	0.01***	(0.00)	0.01**	(0.00)
Age square	− 0.00***	(0.00)	− 0.00***	(0.00)
Woman	0.03**	(0.02)	0.01	(0.01)
BF Daughter or Son	− 0.01	(0.03)	0.01	(0.03)
BF Sister or Brother	0.11***	(0.03)	0.00	(0.03)
BF Parent	0.03	(0.03)	− 0.00	(0.03)
BF Grandparent	0.11**	(0.06)	− 0.18***	(0.03)
BF Aunt, Uncle or Cousin	0.03	(0.08)	0.05	(0.08)
BF Other Relative	0.06	(0.07)	0.07	(0.07)
In touch with BF once a week	− 0.03	(0.02)	0.07***	(0.02)
In touch with BF once a month	0.09***	(0.03)	0.01	(0.03)
In touch with BF less often	− 0.03	(0.04)	− 0.02	(0.04)
Living in an Urban area	0.02	(0.02)	− 0.06**	(0.02)
Poor Mental Health	− 0.04	(0.04)	− 0.04	(0.03)
Poor Physical Health	0.06	(0.05)	0.08*	(0.04)
Own House	− 0.08***	(0.03)	− 0.02	(0.03)
Education: GCSE (11 years)	0.03	(0.02)	− 0.07***	(0.02)
Education: A-levels (13 years)	0.14***	(0.04)	− 0.15***	(0.03)
Education: Higher (e.g. University)	0.09***	(0.03)	− 0.07**	(0.03)
Visit family	− 0.02	(0.03)	− 0.02	(0.03)
Not let down by family	0.02	(0.01)	− 0.02	(0.01)
Ethnicity Other White	− 0.26***	(0.05)	− 0.01	(0.06)
Ethnicity: White and Black African	− 0.42***	(0.05)	− 0.26***	(0.05)
Ethnicity: White and Asian	0.15	(0.17)	− 0.31***	(0.05)
Ethnicity: any other Mixed Backg	− 0.18*	(0.09)	− 0.28***	(0.07)
Ethnicity: Indian	− 0.24***	(0.07)	− 0.19***	(0.03)
Ethnicity: Pakistani	− 0.31***	(0.04)	− 0.07	(0.08)
Ethnicity: Chinese	− 0.33***	(0.06)	− 0.16***	(0.06)
Ethnicity: Other Asian or British	− 0.33***	(0.07)	− 0.19***	(0.06)
Ethnicity: Caribbean Black	0.10	(0.18)	− 0.21***	(0.05)
Ethnicity: African Black	− 0.36***	(0.05)	− 0.25***	(0.04)
Ethnicity: Other	− 0.31***	(0.03)	0.07	(0.08)
Job status: Employed	− 0.10***	(0.04)	0.03	(0.03)
Job status: Unemployed	− 0.16***	(0.06)	0.07	(0.06)
Job status: Retired	− 0.15***	(0.05)	0.04	(0.04)

Table 9 (continued)

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Job Status: Maternity Leave	− 0.35***	(0.09)	− 0.03	(0.08)
Job Status: Family Care	− 0.05	(0.07)	− 0.01	(0.06)
Job Status: Student (FT)	− 0.06	(0.10)	− 0.01	(0.08)
Long Time Sick or Disabled	− 0.25***	(0.07)	− 0.11*	(0.06)
Job Status: Govt Training	0.87***	(0.10)	− 0.19**	(0.09)
Job Status: Unpaid, family business	0.63***	(0.07)	− 0.23***	(0.06)
Job Status: Furloughed (paid)	− 0.31***	(0.05)	− 0.21***	(0.05)
Job Status: short time working	− 0.37***	(0.06)	0.61***	(0.06)
Job Status: something else	− 0.04	(0.15)	0.05	(0.14)
Living as a Couple	− 0.10	(0.15)	− 0.00	(0.16)
Child(ren)	− 0.09**	(0.04)	− 0.07**	(0.03)
Separated	0.05	(0.06)	0.29***	(0.07)
Divorced	0.06*	(0.03)	0.03	(0.03)
Household Size	0.02**	(0.01)	0.01	(0.01)
Constant	− 0.34	(0.21)	0.55***	(0.18)
Time Dummies	Yes		Yes	
Observations	2,617		2,617	
R-squared	0.089		0.088	

Standard errors are clustered at the household level, *, **, and ***Denote significance at 10, 5, and 1% level

"TOTORO" is our instrumental variable and is a dummy that takes the value 1 if the answer to the question: "When a neighbour is not at home, how often do you and other neighbours watch over their property?" is 1 or 2 (often or sometimes) and 0 if the answer to the question is 3 or 4 (rarely or never)

Table 10 Robustness Check 1: Pet companionship and Life-Satisfaction (dependent variable) with interaction term between being married and having a pet (IV estimation)

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Cat companion	3.55	(4.38)		
Cat x Married	0.80	(9.01)		
Dog companion			2.54	(1.68)
Dog x Married			− 0.12	(2.01)
Married	− 0.31	(2.14)	0.39	(0.43)
Log Income	0.16**	(0.08)	0.27***	(0.08)
Neighbour Cohesion (CKN)	− 0.03	(0.05)	− 0.03	(0.03)
Openness	− 0.09	(0.11)	0.03	(0.03)
Conscientiousness	0.03	(0.16)	0.06	(0.04)
Extroversion	0.01	(0.04)	− 0.04	(0.04)
Agreeableness	− 0.04	(0.13)	− 0.03	(0.04)
Neuroticism	− 0.11***	(0.04)	− 0.08	(0.05)
Age	− 0.08*	(0.04)	− 0.07***	(0.02)
Age square	0.00***	(0.00)	0.00***	(0.00)
Woman	− 0.01	(0.17)	0.11	(0.07)
BF Daughter or Son	0.24	(0.30)	0.09	(0.10)
BF Sister or Brother	− 0.74	(0.68)	− 0.30**	(0.12)
BF Parent	− 0.27	(0.57)	− 0.10	(0.11)
BF Grandparent	− 0.53	(0.46)	0.34	(0.30)
BF Aunt, Uncle or Cousin	− 0.05	(0.51)	− 0.18	(0.59)
BF Other Relative	− 0.17	(0.58)	0.24	(0.30)
In touch with BF once a week	0.16	(0.29)	− 0.15	(0.13)
In touch with BF once a month	− 0.29	(0.33)	0.01	(0.10)
In touch with BF less often	− 0.06	(0.49)	− 0.17	(0.14)
Living in an Urban area	− 0.05	(0.19)	0.17	(0.11)
Poor Mental Health	− 1.14***	(0.24)	− 1.20***	(0.16)
Poor Physical Health	− 0.87**	(0.37)	− 0.81***	(0.22)
Own House	0.50	(0.56)	0.20**	(0.10)
Education: GCSE (11 years)	− 0.10	(0.15)	0.20	(0.13)
Education: A-levels (13 years)	− 0.56	(0.86)	0.40*	(0.23)
Education: Higher (e.g. University)	− 0.44	(0.46)	0.09	(0.15)
Visit family	0.24	(0.37)	0.12	(0.13)
Not let down by family	− 0.03	(0.08)	0.08	(0.05)
Ethnicity Mixed White	1.22	(0.78)	0.29	(0.24)
Ethnicity: White and Black African	1.20	(1.00)	0.58	(0.53)
Ethnicity: White and Asian	− 2.44	(2.45)	− 0.83	(0.51)
Ethnicity: any other Mixed Backg	1.30	(1.60)	1.12**	(0.52)
Ethnicity: Indian	0.78	(1.00)	0.26	(0.35)
Ethnicity: Pakistani	1.31	(1.30)	0.10	(0.37)
Ethnicity: Chinese	1.54	(1.84)	0.47	(0.54)
Ethnicity: Other Asian or British	2.57***	(0.86)	2.04***	(0.52)
Ethnicity: Caribbean Black	− 1.89	(1.63)	− 0.79	(0.55)

Table 10 (continued)

	Cats		Dogs	
	Coefficient	SE	Coefficient	SE
Ethnicity: African Black	0.76	(1.40)	− 0.17	(0.50)
Ethnicity: Other	1.15	(0.97)	− 0.22	(0.42)
Job status: Employed	0.40	(0.38)	− 0.10	(0.13)
Job status: Unemployed	0.26	(0.66)	− 0.53*	(0.29)
Job status: Retired	0.88	(0.79)	0.06	(0.14)
Job Status: Maternity Leave	1.95*	(1.17)	0.68*	(0.36)
Job Status: Family Care	0.31	(0.40)	0.07	(0.27)
Job Status: Student (FT)	0.62	(0.45)	0.42	(0.37)
Long Time Sick or Disabled	0.22	(0.75)	− 0.39	(0.30)
Job Status: Govt Training	− 1.32	(3.08)	2.16***	(0.50)
Job Status: Unpaid, family business	− 2.59	(2.54)	0.30	(0.41)
Job Status: Furloughed (paid)	2.35**	(1.03)	2.00***	(0.51)
Job Status: short time working	1.73	(1.28)	− 1.19	(1.19)
Job Status: something else	0.08	(0.95)	− 0.21	(0.61)
Living as a Couple	1.55***	(0.39)	1.44***	(0.18)
Child(ren)	0.38	(0.34)	0.17	(0.16)
Separated	− 0.71	(0.79)	− 0.98*	(0.56)
Divorced	− 0.29	(0.68)	0.13	(0.17)
Household Size	− 0.06	(0.06)	− 0.05	(0.04)
Constant	5.29*	(2.75)	3.50***	(1.18)
Observations	2,617		2,617	
R-squared	− 1.387		− 0.235	

Standard errors are clustered at the household level, *, **, and ***Denote significance at 10, 5, and 1% level

Table 11 Robustness Check 2: WTP Estimates for Cats and Dogs when instrumenting them simultaneously

Variable	OLS	IV Pet and Income	WTP (using IV for both cats and Income and an annual income of £26,332.08)
Cat companion	− 0.07 (0.06)	2.09(0.60)***	£52,413.38
Dog companion	0.06 (0.07)	1.90(0.82)**	£47,648.53
Log Income	0.23 (0.04)***	1.05(0.60)*	
Observations	2581		
R squared	0.89		
Kleinbergen-Paap rk Wald F statistic	20.387		
Underidentification test (Kleinbergen-Paap rk LM statistic) (Chi-sq)	1.256 (0.26)		
Hansen J statistic (overidentification test of all instruments): equation exactly identified	0.000		

Standard errors are clustered at the household level, *, **, ***Significance at 10, 5, 1%

Table 12 Robustness Check: First stage regression results for Income (dependent variable) for Cats and Dogs when instrumenting simultaneously

Instrument	Coefficient	Robust Standard Errors	t-statistic
TOTORO	− 0.037	0.031	− 1.21
Payslip	0.128***	0.026	4.99
Father's education	0.004***	0.001	4.12
F test (Prob > F)	16.71 (0.00)		
Sanderson-Windmeijer F test (Prob > F)	63.92 (0.00)		
Weak Identification Test – Kleinberger Papp Wald F statistic	20.39		
Weak-instrument-robust inference Anderson-Rubin Wald test Chi sq	90.29		

Standard errors are clustered at the household level, *, **, ***Significance at 10, 5, 1%

"TOTORO" is our instrumental variable and is a dummy that takes the value 1 if the answer to the question: "When a neighbour is not at home, how often do you and other neighbours watch over their property?" is 1 or 2 (often or sometimes) and 0 if the answer to the question is 3 or 4 (rarely or never)

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