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ENVIRONMENTAL SURROUNDINGS AND PERSONAL WELL-BEING IN URBAN CHINA

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Abstract: We examine the relationship between atmospheric pollution, water pollution, traffic congestion, access to parkland and personal well-being using a survey administered across six Chinese cities in 2007. In contrast to existing studies of the determinants of well-being by economists, which have typically employed single item indicators to measure well-being, we use the Personal Well-Being Index (PWI). We also employ the Job Satisfaction Survey (JSS) to measure job satisfaction, which is one of the variables for which we control when examining the relationship between environmental surroundings and personal well-being. Previous research by psychologists has shown the PWI and JSS to have good psychometric properties in western and Chinese samples. A robust finding is that in cities with higher levels of atmospheric pollution and traffic congestion, respondents report lower levels of personal well-being *ceteris paribus*. We find that a one standard deviation increase in suspended particles or sulphur dioxide emissions is roughly equivalent to a 12-13 per cent reduction in average monthly income in the six cities. This result suggests that the personal well-being of China's urban population can be enhanced if China were to pursue a more balanced growth path which curtailed atmospheric pollution.

KEYWORDS China, Environment, Pollution, Personal Well-Being.
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Environmental Surroundings and Personal Well-Being in Urban China

1. Introduction

Psychologists have long studied the determinants of personal well-being (see Diener *et al*., 1999; Kahneman *et al*., 1999). While the interest of economists in this topic is more recent, there is now a sizeable literature on the 'economics of happiness' (see Frey & Stutzer, 2002, 2005; Dolan *et al*., 2008 for reviews). Over the last two decades growing subsets of the economics of happiness literature have emerged examining the determinants of personal well-being during economic transition from socialism to capitalism and the relationship between environmental variables and personal well-being. The impetus for the first development was the emergence of a number of post-socialist economies in Central and Eastern Europe in the 1990s. These represented interesting natural laboratories in which to test key hypotheses in the economics of happiness literature pertaining to the relationship between variables such as absolute income, relative income and unemployment and personal well-being. The impetus for the second development was growing scientific evidence supporting the existence of climate change and an increased awareness of the need to address climate change among the peoples of the world. However, despite the seriousness of the trade-offs that large transitional economies, such as China, face between the need to maintain rapid economic growth and preserving the environment and the concomitant environmental challenges this poses, there has been little research on the relationship between the environment and personal well-being in transitional economies.

This study examines the relationship between environmental surroundings and personal well-being across six Chinese cities; Chengdu, Dalian, Fushun, Fuxin, Fuzhou and Wuhan. It makes two contributions to the literature on the determinants of

personal well-being. First, it adds to the scant literature on the determinants of personal well-being in China and specifically the relationship between environmental variables and personal well-being in China and other transitional economies. China has serious environmental problems that can be expected to impact on the personal well-being of its citizens. According to the World Bank, China has 16 of the 20 most polluted cities in the world and only 1 per cent of China's urban population of 560 million breathe air considered safe in the European Union (World Bank, 2007). In several recent surveys of the 'life satisfaction' of Chinese urban residents, respondents have listed environmental degradation at the top of their list of concerns (BBC Monitoring Asia Pacific 2007, 2008). Citizen complaints about the environment, expressed on official hotlines and in letters to local officials, have been increasing at a rate of 30 per cent per annum and were expected to exceed 450,000 in 2007 (Economy, 2007). Together with corruption, growing income inequality and mounting unemployment, the environment is one of the major causes of social unrest in China, with more than 50,000 pollution disputes in 2005 (Zhang, 2007).

The second contribution is that we use arguably better measures for personal well-being and job satisfaction – one of the control variables we employ when examining the relationship between environmental variables and personal well-being - than those which have been employed by economists to this point. Economists typically use single item indicators to measure personal well-being and job satisfaction of the form: How satisfied are you with your job (or life) all things considered? Responses are typically on a five (or ten) point scale ranging from 'completely dissatisfied' to 'completely satisfied'. In employing single-item indicators it is common to justify such an approach on the ground that psychologists have shown responses to this question to be a good indicator of personal well-being. Welsch (2002) is one of

several examples in the economics literature. He employs a single-item indicator: 'Taking all things together, would you say you are: - very happy, quite happy, not very happy, not happy at all' from the World Database of Happiness in which respondents answered on a four-point scale. In justifying the use of this scale Welsch (2002, p. 474) states:, 'measures of happiness are generally found to have a high scientific standard in terms of internal consistency, reliability and validity, and a high degree of stability over time (Diener *et al*., 1999; Frey & Stutzer, 2000)'.

However, in the psychology literature on personal well-being, where multi-item indicators are almost universally used, the use of a single item indicator has been widely criticized on two grounds. The first is that the researcher cannot estimate the internal consistency of a single item indicator, with the result being that such indicators are subject to low levels of internal reliability (see Pollard, 1996; Wanous *et al.,* 1997; Oshagbemi, 1999). Andrews and Whithey (1976) found single item indicators of personal well-being to have relatively low reliabilities (test-retest correlation 0.40-0.66), even when asked twice in the same session one hour apart. Test-retest correlations for multi-item indicators tend to be much higher – in the range 0.82 to 0.84 for temporal intervals of up to 10 weeks (Krueger & Schkade, 2007). The second is that single item indicators are not able to capture the multidimensionality of psychological constructs and hence construct validity is compromised. These criticisms cast doubt over the reliability of much of the economics literature that has employed single item indicators to measure personal well-being.

The advantage of using a multi-item measure that captures the potential multidimensionality of job or life satisfaction is that respondents may be satisfied with some aspects of their jobs or lives, but dissatisfied with others and hence a multi-item

instrument is able to measure job and life satisfaction across these different domains. Multi-item indicators are more reliable than single item indicators because multi-item indicators are the sum of multiple items, hence they benefit from error reduction through aggregation (Kahneman *et al.,* 2006; Krueger & Schkade, 2007).

We take advantage of the fact that psychologists have spent many decades developing and refining multidimensional measures of personal well-being and job satisfaction, with the result being measures that are psychometrically sound in terms of validity and reliability and for which much normative data exist. In employing these measures we seek to take seriously calls for multidisciplinary work on well-being and, in particular, calls to bring economics research on well-being closer to other disciplines (see eg. Hulme & Toye, 2006). The fact is that while economists have made considerable advances in examining important correlates with personal well-being that would add to the psychology literature, the economics literature on personal well-being is largely ignored by psychologists or at least not given the recognition that the volume of research suggests it should. This is, in large part, because economists use single item indicators of well-being. This has resulted in the creation of two almost parallel literatures on personal well-being which generally do not speak to each other. We suggest using properly validated instruments in economics studies of happiness is an important step in getting the literatures to communicate and learn from each other in terms of methodological approach and substantive findings.

To measure personal well-being we use the personal well-being index (PWI) (International Wellbeing Group, 2006) which is a scale that probes respondents' level of life satisfaction along seven domains. The PWI is now being used by psychologists in over 50 countries (International Wellbeing Group, 2006) and has been translated

into myriad languages, including Chinese (Mandarin, Cantonese and Tibetan) (International Wellbeing Group, 2006; Davey *et al*., 2008). The World Bank has suggested it would serve as a 'good model' for measuring personal well-being across the world's cities as part of a broader project to monitor city performance globally (Hoornwerg *et al*., 2006). In addition to being validated in several western samples, the PWI has been validated in China. Previous use of the PWI in China by psychologists has shown it to be a culturally appropriate instrument – it has good validity and reliability and demonstrates similar psychometric properties among both Chinese and western samples (Huang & Xing, 2005; Lau *et al*., 2005; Chen & Davey, 2008; Davey *et al*., 2008). To measure job satisfaction we use the Job Satisfaction Survey (JSS) (Spector, 1997). The JSS, which is a 36 item multidimensional measure, subsumes nine components of job satisfaction and is one of the most widely used instruments to measure job satisfaction in the psychology literature. The JSS has also previously been validated in Chinese samples (Spector *et al*., 2004).

2. China and the Environment

Since China launched its economic reforms in the 1ate 1970s it has experienced spectacular economic growth. However, China's high rate of economic growth has been predominantly fuelled by burning dirty coal which has generated considerable environmental problems. Coal provides about 70 per cent of China's energy needs. In 2006 China consumed 2.4 billion tons of coal, which was more than Japan, the United Kingdom and the United States combined (Economy, 2007). Consumption of coal in China is so high because it is inefficient. Chinese buildings rarely have thermal insulation and require twice as much energy to heat and cool as buildings in similar climates in Europe and the United States. Coal contributes 90 per cent of China's sulphur dioxide emissions and about 70 per cent of China's total dust, nitrous oxide

and carbon dioxide emissions (Zhang, 2007). In 2005 China became the leading source of sulphur dioxide emissions globally and now China has twice the sulphur dioxide emissions of the United States with some estimates suggesting that in the future China's sulphur dioxide emissions will be up to five times their current level.

The World Bank (2007) estimates the health costs of air and water pollution to be 4.3 per cent of Gross Domestic Product (GDP) and the non-health impacts to be 1.5 per cent of GDP, making the total cost of air and water pollution in China 5.8 per cent of GDP. In 2004 for the first, and only, time the Chinese government reported figures for Green GDP, which is GDP adjusted to reflect the costs of pollution. The pollution-adjusted rates of economic growth in most provinces were close to zero (Kahn & Yardley, 2007). China's air pollution contributes to a range of health problems and pollution has become a major source of premature death. An internal report by the Chinese Academy of Environmental Planning in 2003 estimated that 300,000 people die each year from ambient air pollution, mostly of heart disease and lung cancer. The report suggested an additional 110,000 deaths were attributable to indoor air pollution from toxic fumes caused by poor ventilation (Kahn & Yardley, 2007). These figures have since increased. The World Bank (2007) concluded that outdoor air pollution caused 350,000 to 400,000 premature deaths per annum, indoor pollution caused a further 300,000 deaths, while 60,000 people per annum die from diarrhea, bladder and stomach cancer and other diseases resulting from water pollution.

3. Theoretical Relationship between the Environment and Personal Well-being

Environmental quality is related to personal well-being through the influence of both environmental goods and environmental bads. Raising the level of environmental goods and/or reducing the level of environmental bads will improve personal well-being (MacKerron & Mourato, 2008). Environmental goods include open spaces

such as parkland. Access to parkland could be correlated with higher personal well-being through two channels (see MacKerron & Mourato, 2008). First, access to green spaces brings people closer to nature and increases personal well-being via biophilia, which is the psychological benefits humans receive from interacting with other living organisms (Wilson, 1993). Second, access to green spaces increases opportunities for social interaction, and exercise, which reduces anxiety, depression levels and improves mental and physical health (Dolan *et al*., 2008). There are several relevant studies in the psychology literature (see Ferrer-i-Carbonell & Gowdy, 2007). For example, Ulrich (1984) found that surgery patients who stayed in rooms with a window recovered faster and needed less medication than those who did not. The California Energy Commission (2003) found that a better view improved office worker job performance and was associated with fewer negative health symptoms.

Environmental bads include congestion and pollution. Congestion can be expected to lower personal well-being through raising commuting stress levels. Pollution can be expected to lower personal well-being through its adverse effects on health. Awareness of the adverse health effects of pollution on health and the ecosystem can also be expected to lower personal well-being independent of the objective health effects. Ferrer-i-Carbonell and Gowdy (2007) and MacKerron and Mourato (2008) found a negative correlation between perceptions of pollution and well-being. The personal well-being of certain segments of the population may be more adversely affected by perceptions that pollution is a problem. For example, Bickerstaff and Walker (2001) suggested that for those individuals with children there is a stronger negative association between perceptions of pollution and personal well being because of the perceived adverse effects of poor air quality on family members.

4. Existing Empirical Studies

There are a growing number of studies which examine the determinants of personal well-being in transitional economies in Central and Eastern Europe and the former Soviet Union (see eg. Andren & Martinsson, 2006; Eggers *et al.,* 2006; Frijters & Van Praag, 1998; Frijters *et al.,* 2006; Graham *et al.,* 2004; Hayo & Seifert, 2003; Hayo, 2007; Lelkes, 2006; Namazie & Sanfey, 2001; Sanfey & Teksoz, 2007). There are fewer studies, however, of the determinants of well-being in China. Appleton and Song (2008), Cheung and Leung (2004) and Smyth *et al.* (2008) considered the determinants of personal well-being in urban China. Knight *et al.* (2008) studied the determinants of personal well-being in rural China, while Knight and Gunatilaka (2007) studied the determinants of the personal well-being of off-farm migrants.

Few studies of personal well-being in transitional economies have considered the relationship between the environment and subjective well-being. Among the few studies which do, Frijters and Van Praag (1998) found that climate is correlated with the standard of living in Russia and that people dislike cold winters and hot summers. Knight *et al.* (2008), in their study for rural China, found that people living in hilly and mountainous terrains reported lower levels of personal well-being *ceteris paribus*. Smyth *et al.* (2008) found that in cities with high levels of atmospheric pollution, environmental disasters and traffic congestion, Chinese citizens reported significantly lower levels of well-being *ceteris paribus* while in cities with greater access to parkland, Chinese citizens reported significantly higher levels of well-being *ceteris paribus*. Smyth *et al.* (2008) also found that a marginal change in the level of atmospheric pollution has a much larger impact on personal well-being than a marginal change in environmental disasters and traffic congestion.

Among studies of the relationship between personal well-being and the environment for developed countries, several studies have found a negative relationship between the level of atmospheric pollution and personal well-being (Di Tella & MacCulloch, 2008; Mackerron & Mourato, 2008; Rehdanz & Maddison, 2008; Welsch, 2002, 2006). Van Praag and Baarsma (2005) found a negative relationship between perceived aircraft noise and personal well-being, but objective noise measures were not significant. Other studies have found a statistically significant relationship between personal well-being and climate with warmer weather in colder climates improving personal well-being (Brereton *et al*., 2008; Rehdanz & Maddison, 2005).

To summarize, most studies that have considered the relationship between personal well-being and the environment have used data for developed countries. There are few studies that have considered the relationship between the environment and personal well-being in transitional countries. Moreover, the methodological robustness of all of these studies is open to question because each of these studies uses a single item indicator to measure personal well-being. As discussed above, the problem with single item indicators is that their internal consistency cannot be estimated and multidimensionality of the constructs cannot be captured.

5. Empirical Approach and Data

5.1. Empirical Specification

We express personal well-being *(PWB)* as a function of environmental variables *(EV),* job satisfaction *(JS),* and personal characteristics *(P).* This relationship can be expressed as follows where ε is the error term, reflecting unobserved random factors.

$$PWB=f(EV, JS, P, \varepsilon) \quad (1)$$

To measure personal well-being we used the PWI (International Wellbeing Group, 2006) and to measure job satisfaction we used the JSS (Spector, 1997). To measure environmental surroundings in the city in which the respondent lives we used four variables. These are area of parkland per capita (parks), waste water discharge per capita (waste water), passenger vehicles per capita (congestion) and sulphur dioxide in the air per capita and suspended particles in the air per capita as alternative measures of atmospheric pollution (atmospheric pollution). For the personal characteristics of the respondents we use common controls; namely, age, age squared, education, gender, marital status, the number of the respondent's dependent children, average monthly income and income relative to others living in the same city.

To estimate Equation (1) we use ordinary least squares (OLS) because the PWI is the average of seven domains of life satisfaction. This amounts to treating personal well-being as cardinal (as psychologists generally do) as opposed to ordinal (as economists usually do). In a methodological paper using German national household panel data, Ferrer-i-Carbonnel and Fritjers (2004) find that the determinants of personal well-being are not sensitive to the choice between OLS and latent variable methods. Knight *et al.* (2008), in their study of the determinants of personal well-being in rural China and MacKerron and Mourato (2008) in their study of life satisfaction and air quality in London also find that the results are robust to using OLS or ordered probit. To ease the interpretation of the coefficients we take the natural log of the dependent variable. Thus, the percentage change in the PWI can be measured in terms of a one unit change in each independent variable (for a similar approach see Welsch, 2002).

5.2. Instruments

The Personal Wellbeing Index (PWI)

The PWI is a seven item global scale measured on a 0-10 Likert scale, ranging from 'completely dissatisfied' (0) to 'completely satisfied' (10). The PWI asks people how satisfied they are in relation to seven life domains: standard of living, personal health, achievement in life, personal relationships, personal safety, community-connectedness and future security. These areas of satisfaction should collectively indicate people's satisfaction with their life as a whole (International Wellbeing Group, 2006). Extensive psychometric analyses have demonstrated the reliability, sensitivity and validity of this measure of personal well-being in western and Chinese samples (Cummins *et al*., 2003; Chen & Davey, 2008; Lau *et al*., 2005; Davey *et al*., 2008).

The PWI was originally developed in Australia and has been extensively tested on the Australian population. Sixteen surveys of the Australian population produced a maximum variation of 3.2 per cent in personal well-being, suggesting it is reliable (Cummins *et al.* 2003). In previous studies in Australia and other countries Cronbach's alpha corresponding to this measure lies between 0.70 and 0.85, indicating cultural sensitivity (International Wellbeing Group, 2006). Test-retest reliability coefficients are significant across one to two week intervals (Cummins *et al*., 2003; International Wellbeing Group, 2006). Construct validity has been determined for this measure as each of the seven domains typically explains about 30 to 60 per cent of the variance in 'satisfaction with life as a whole'. The seven domains also consistently form a single stable factor, accounting for 50 per cent of the variance in personal well-being in Australia and elsewhere (International Wellbeing Group, 2006). A correlation of 0.78 with the Satisfaction with Life Scale, demonstrates the convergent validity of the PWI (International Wellbeing Group, 2006).

The Job Satisfaction Survey (JSS)

The JSS is a 36 item, multidimensional measure which subsumes nine components of job satisfaction; namely, satisfaction with pay, promotion, supervision, fringe benefits, contingent rewards, operating procedures, co-workers, nature of work and communication (Spector, 1997). The response format of the JSS is a six-point Likert scale, ranging from 'disagree very much' (1) to 'agree very much' (6). The internal consistency of the JSS has been shown to range from $\alpha = 0.60$ for the co-worker scale to $\alpha = 0.91$ for the total scale, when a sample of 3067 individuals completed the survey (Spector, 1997). This indicates good internal consistency given that the conventionally accepted minimum standard for internal consistency is 0.70 (Spector, 1997). Test-retest reliability has ranged from $\underline{r} = 0.37$ to $\underline{r} = 0.74$ for a sample of 43 employees (Spector, 1997). The validity of this measure has been established with the multi-trait, multi-method design using the Job Descriptive Index as a validity instrument (Saane *et al*., 2003). The JSS has previously been shown to have good psychometric properties in Chinese samples (Spector *et al*., 2004).

5.3. Data

A written survey containing the PWI, JSS and questions on the personal characteristics of respondents (age, education, gender, marital status, their number of children and their average monthly income) was administered to individuals working in a variety of blue collar and white collar jobs across a range of sectors including government, heavy and light manufacturing, mining and services in six Chinese cities: Chengdu, Dalian, Fushun, Fuxin, Fuzhou and Wuhan in 2007. The industries in which surveyed employees worked reflected the importance of specific sectors in specific cities. For example, Fuxin has an extensive coal mining industry, while Fushun has predominantly heavy industries so most of the employees surveyed in those two cities worked in those industries. Chengdu, Wuhan and Fuzhou are representative of the

western, central and coastal regions of China and Dalian, Fushun and Fuxin are three major cities in Liaoning province in China's north-east. Individuals were selected using stratified random sampling based on the demographic profile of the city as per information contained in SSB (2008). Altogether, 3390 surveys were completed, consisting of 500 in Chengdu, 558 in Dalian, 515 in Fushun, 498 in Fuxin, 500 in Fuzhou and 819 in Wuhan. The personal characteristics of the respondents in the sample broken down according to city are given in Table 1. There were 2741 valid surveys, which represents an effective response rate of 80.9 per cent.

Insert Tables 1 & 2

Table 2 reports the mean satisfaction ratings for the PWI and compares them with the mean satisfaction ratings for the PWI for Hong Kong (Lau *et al*., 2005) and rural China (Davey *et al*., 2008). The mean for the PWI is in the normative range of 6-7 attained in previous studies for Chinese respondents and is similar to that obtained in Hong Kong (Lau *et al*., 2005), rural China (Davey *et al*., 2008) and in cities in Guangdong and Shandong (Chen & Davey, 2008; Huang & Xing, 2005). In western samples, the normative range for the mean of the PWI is 7-8. That mean values are generally 1 point lower in Chinese samples has been explained in terms of cultural bias. Chinese respondents self-report moderate scores in psychometric tests because of the high value attached to modesty in Chinese culture (Lau *et al*., 2005). There are several differences in mean responses across the components of personal well-being. In the sample employed in this study, as in the Hong Kong and rural China samples, satisfaction with health, personal relationships and personal safety are above the average PWI score, while satisfaction with standard of living, achievements in life, community connectedness and future security lie below the average PWI score.

The factor structure of the PWI and JSS were confirmed using confirmatory factor analysis. The seven items of the PWI formed a single factor, while the 36 items of the JSS (four items per component) factored into the nine components (pay, promotion, supervision, fringe benefits, contingent rewards, operating procedures, co-workers, nature of work and communication). Cronbach alpha, inter-domain correlations and covariances confirmed internal reliability while bivariate correlations confirmed the validity of the PWI and JSS. Among the PWI items, the seven item satisfaction ratings were averaged to create the PWI composite variable, which is the dependent variable in the models reported below. The four items in each component of the JSS were summed to get the nine components of job satisfaction, which are explanatory variables in the models reported below in addition to the environmental variables and personal characteristics of the respondents. The definition and descriptive statistics for all of the explanatory variables used in the regression models are given in Table 3. Information on the five environmental variables and the urban resident population in each of the cities are from various sources (SSB, 2008, 2008a, 2008b; LECR, 2008).

Insert Table 3
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6. Results and Discussion

Table 4 reports the OLS regression results for the determinants of personal well-being, where the dependent variable is the natural log of the PWI. The goodness of fit of the results – adjusted-R^2 values around 0.2 – is at the lower end of that found in existing environmental quality and personal well-being research in which the range is typically 0.2-0.3 (Brereton *et al*., 2008; MacKerron & Mourato, 2008). Specification I is the 'baseline case' in which we do not include the environmental variables. The results for the job satisfaction components suggest that the relationship between job

satisfaction and personal well-being is multifaceted: some aspects of job satisfaction are correlated with personal well-being, while others are not. Coefficients on satisfaction with pay, promotion, co-workers and nature of work are positive and statistically significant at the 1 per cent level. The coefficients on the other facets of job satisfaction (supervision, fringe benefits, contingent rewards, operating procedures and communication) are all statistically insignificant.

Insert Table 4

The results for satisfaction with pay, promotion, co-workers and nature of work support the spillover hypothesis which states that that there is a positive relationship between job satisfaction and personal well-being because satisfaction (or dissatisfaction) at work spills over into life more broadly (Judge & Watanabe, 1994; Spector, 1997). This result is consistent with a large number of studies which have found support for the spillover hypothesis in western samples (see eg. Chacko, 1983; Clark, 1997; Jonge *et al*., 2001; Rice *et al*., 1992). Surveys for employees in urban China and elsewhere have consistently found that pay, the nature of work and collegiality are the factors that individuals value most in their job (Nielsen & Smyth, 2008). Hence, it is not surprising that these factors are correlated with respondents' broader sense of personal well-being. The results for satisfaction with supervision, fringe benefits, contingent rewards, operating procedures and communication, on which employees tend to not place as much value, support the segmentation hypothesis which states that there is no relationship between job satisfaction and personal well-being based on the premise that job satisfaction and personal well-being are independent constructs (Judge & Watanabe, 1994; Spector, 1997).

The results for the personal control variables in Specification I are generally consistent with expectations and findings from previous studies (cf. Dolan *et al*., 2008). We find the expected non-linear u-shaped relationship between age and personal well-being, with personal well-being at its lowest at age 41. This result is similar to that of Appleton and Song (2008) who found that life satisfaction in urban China was lowest at age 40 and Knight *et al*., who found that well-being in rural China was lowest at age 38. We find that those who are married, those with more children, those with higher own income and the better educated report higher levels of personal well-being *ceteris paribus*. Education and having children are only weakly significant (at the 10 per cent level) in the baseline case, although having children is significant at 5 per cent in Specifications II and III. In the base case specification, being married raises personal well-being 4.7 per cent. This result is consistent with several previous studies which have found that being married is associated with higher personal well-being (eg. Helliwell, 2003). Appleton and Song (2008) found that marriage was associated with higher life satisfaction in urban China. However, as Appleton and Song (2008) note, there might be an element of reverse causality at play here because happier people might be more attractive as marriage partners.

In the baseline specification each additional rung on the education ladder raises personal well-being 0.8 per cent. Most previous studies have found that the better educated report higher levels of personal well-being and that education has more of a positive impact in low income countries (Fahey & Smyth, 2004; Ferrer-i-Carbonell, 2005). Having a child, then having two or more children increases personal well-being 2.6 per cent. While previous studies have reached mixed conclusions about the well-being effects of having children (Dolan *et al*., 2008), the results reported here are consistent with those in Appleton and Song (2008) and Spector *et al*., (2004) who also

found that having dependent children was welfare-enhancing in urban China. This result may reflect the cultural importance that Chinese attach to family.

In Specification I, moving into a higher income category (measured in blocks of 500 RMB per month) raises personal well-being 1.9 per cent. In Specification I, gender and relative income are statistically insignificant. The reason relative income is statistically insignificant is likely to be that the relevant comparator – average income of urban residents in the city in which the respondent lives – is too broad. Recent studies have pointed out that individuals use a range of different peer groups when comparing their income to others including friends, neighbours and relatives (Kingdon & Knight, 2007; Knight *et al*., 2008), but we do not have the information in the survey to explore the relevance of any of these more direct comparators.

In Specifications II and III, in addition to job satisfaction and the personal characteristics of the respondent we include variables denoting atmospheric pollution, waste water discharge, access to parkland and traffic congestion. In Specification II atmospheric pollution is measured by particles in the air and in Specification III atmospheric pollution is measured by sulphur dioxide emissions. The results for job satisfaction and personal characteristics of the respondent are similar to Specification 1. One difference is that an increase in own income is associated with a larger increase in personal well-being in Specifications II and III. In Specification II and III, moving into a higher income category (measured in blocks of 500 RMB per month) raises personal well-being 3.6 to 4.0 per cent. In Specifications II and III gender is also significant. We find that the personal well-being of males is 1.9 per cent lower than that for females. This is consistent with previous studies of happiness around the world (see Dolan *et al*., 2008) and urban China (Appleton & Song, 2008).

The results in Specification II suggest that in cities with higher levels of atmospheric pollution (suspended particles) and traffic congestion, respondents report lower levels of personal well-being, while in cities with more parkland, respondents report higher levels of personal well-being *ceteris paribus*. The coefficient on waste water discharge is statistically insignificant. The results in Specification III suggest that respondents in cities with higher levels of atmospheric pollution (sulphur dioxide emissions), waste water discharge and traffic congestion report lower levels of personal well-being *ceteris paribus* at the 5 per cent level or better. The coefficient on access to parkland, however, is statistically insignificant. Overall, the results for atmospheric pollution and traffic congestion are robust to the measure of atmospheric pollution, but the results for waste water discharge and parkland are not.

Some studies have found that the negative effects of a bad environment are felt more by the young than the old and by the rich rather than the poor (see eg. Di Tella & MacCulloch, 2008). To examine this issue, we included Atmospheric Pollution*Age and Atmospheric Pollution*Income in Specifications II and III. However, in both Specifications II and III these interaction terms were statistically insignificant. We also examined whether the adverse effects of atmospheric pollution were felt more strongly by those with dependent children reflecting the perceived effects of pollution on their children, by including Atmospheric Pollution*Children in Specifications II and III. In both specifications, though, the interaction term was statistically insignificant. MacKerron and Mourato (2008) found that having children interacted with perceptions of pollution was statistically insignificant in their study of the relationship between perceived air quality and life satisfaction in London.

Consider the relationship between air pollution and personal well-being. In Specification II each additional kilogram of suspended particles per capita reduces personal well-being by 0.1 per cent and in Specification III, each additional kilogram of sulphur dioxide per capita reduces personal well-being by 0.2 per cent. A one standard deviation increase in sulphur dioxide emissions, equal to a rise of 7.9 kg per capita, reduces personal well-being by 1.6 per cent, while a one standard deviation increase in suspended particles, equal to 19.8 kg per capita, reduces personal well-being by 1.9 per cent. In Specification II, an additional 100,000 m^2 of parkland per capita raises personal well-being by 1 per cent. Thus, *ceteris paribus,* a standard deviation decrease in suspended particles has a well-being equivalent of an additional 190,000 m^2 in parkland per capita. Similarly, in Specification III, a one kilogram per capita reduction in sulphur dioxide emissions has a well-being equivalent of a 400,000 ton per capita reduction in waste water discharge.

An increase in atmospheric pollution also has a well-being equivalent in terms of income foregone. The effect of a one standard deviation increase in suspended particles has a roughly equivalent effect on personal well-being to a 240 RMB reduction in average monthly income at income levels up to 2000 RMB per month, while a one standard deviation increase in sulphur dioxide emissions has an equivalent effect on personal well-being to a 220 RMB per month reduction in average monthly income *ceteris paribus.* Given that the average monthly urban income across the six cities was 1846 RMB in 2007 (SSB, 2008), a one standard deviation increase in suspended particles or sulphur dioxide emissions is roughly equivalent to a 12-13 per cent reduction in average monthly income in the six cities. Di Tella and McCulloch's (2008) found that a one standard deviation increase in

emissions of sulphur oxides in OECD countries over 1975 to 1997 had a decrease on well-being equivalent to a drop in GDP per capita of 15 per cent.

Since a one-kilogram change in sulphur dioxide emissions is not particularly easy to visualize (Welsch, 2002) consider the example of Chengdu and Dalian. These cities provide a useful comparison because while Chengdu has slightly above average atmospheric pollution levels for Chinese cities (see Dollar, 2007), Dalian has clean air by Chinese standards. Dalian's relatively clean air reflects an ongoing environmental campaign by the Dalian municipal government designed to reduce industrial pollution as part of the Eleventh Five Year Plan (2006-2011). On a per capita basis the sulphur dioxide emission load of Chengdu is 32.5 kilograms, while the sulphur dioxide emission load of Dalian is 9.6 kilograms. Thus, *ceteris paribus* the 22.9 kg per capita higher sulphur dioxide emissions in Chengdu lowers personal well-being in that city relative to Dalian by 4.58 per cent, which is a non-trivial amount.

The World Bank study of China's environment concluded 'that the Chinese value the avoidance of health risks beyond productivity gains. This implies that people's preference for a clean environment and reduced health risks associated with pollution are stronger than past policies appear to have acknowledged' (World Bank, 2007, p. xix). The results reported here for atmospheric pollution support this conjecture. Policies to reduce atmospheric pollution in China have been discussed in detail elsewhere (Dollar, 2007; World Bank, 2007). Dollar (2007) suggests measures such as zoning that moves industry further out of the inner city; shifting to smokeless briquettes and eventually liquefied petroleum gas for home and small boiler heating; shifting to cleaner technologies for generating power from coal; shifting the bus and taxi fleet to natural gas; and investment to improve energy efficiency.

The World Bank is working with the State Environmental Protection Administration (SEPA) to develop 'an environmental health action plan' (World Bank, 2007, p. xx) that encompasses some of these measures. Since 2005 SEPA has championed an environmental impact law – a law requiring local officials to release information about environmental disasters, pollution statistics and the names of known polluters to the public – and an all-out effort to halt over 100 large-scale infrastructure projects that had proceeded without proper environmental impact assessments (Economy, 2007). The problem, however, is that when it comes to monitoring, SEPA is grossly understaffed. It has just 300 staff in Beijing and a few hundred more spread throughout China. This contrasts with the United States Environmental Protection Agency, which has 9000 staff in Washington DC alone (Economy, 2007).

One of the key recommendations of a recent OECD (2007) report is that there needs to be better monitoring and enforcement of environmental protection laws in China. But, such a 'top down' approach is unlikely to work without more staff. Because SEPA lacks staff to monitor compliance at the local level, enforcement of environmental laws is left to local officials. The incentives for local officials are to maintain economic growth, even when this occurs at the expense of the environment, because their reward structure, including promotion prospects, are tied to economic performance. China has a nascent environmental movement at the citizen level. The Chinese central government provides tacit support for this movement as a means of scrutinizing environmental enforcement at the local level, although criticism of the central government's strategies is not permitted (Larson, 2007; Mol & Carter, 2006).

7. Conclusion

There are a growing number of economic studies examining either the determinants of well-being in transitional economies or the relationship between environmental surroundings and well-being. There are, however, few studies that examine the relationship between environmental surroundings and well-being in transitional economies. This paper makes two contributions to the literature. First, it examines the relationship between environmental surroundings and personal well-being for a large transitional country that has serious pollution problems. Second, it is the first study in the economics literature to use instruments developed by psychologists to measure personal well-being and job satisfaction; namely the PWI and JSS, which previous studies by psychologists have shown to have good psychometric properties. Using instruments such as the PWI and JSS has its costs compared with the single-item indicators typically employed by economists. Single item indicators are readily available in large-scale surveys used by economists such as the Eurobarometer and International Social Survey Program. Instruments with validated psychometric properties, such as the PWI and JSS are not, meaning that the researcher has to administer a dedicated questionnaire to collect this information. In addition to the extra cost, this also means that invariably sample sizes will be much smaller. However, if the economics literature on personal well-being is going to speak to the comparable psychology literature, a necessary first step is for economists to pay proper consideration to how personal well-being is best measured.

The study finds a strong negative association between atmospheric pollution and personal well-being. There is no doubt that China's economic reforms have been effective in increasing incomes and reducing the level of poverty in urban China. Rapid economic growth, however, has come at the expense of pollution levels. The findings in this study support the views advanced by the World Bank (2007), among

others, that the personal well-being of China's urban population could be enhanced by a more balanced approach to economic growth. The Chinese central leadership team of Hu Jintao and Wen Jiabao has expressed in principle support for this notion. The concept of a 'harmonious society' championed by the Hu-Wen administration uses the rhetoric of striving for 'economic and social development' where the benefits of higher growth are balanced against the need to address social problems including environmental protection. In using the rhetoric of the harmonious society, the Party-state seeks to reassure 'the people' that it is responsive to the social problems, including environmental degradation, that have accompanied China's rapid growth. What remains to be seen is whether the Chinese government has the political will to implement a more balanced growth strategy if slower growth leads to social unrest.

A potential limitation of this study is that we do not control for personality traits. Economists have typically controlled for personality traits by including variables to measure attitudes on social issues (Smyth *et al.,* 2008), mood (Knight *et al.,* 2008) or mental health indicators (Ferrer-i-Carbonell & Gowdy, 2007). However, none of these variables accurately depict personality traits as they are conceptualized in the psychology literature. Future research should control for stable aspects of the personality, such as the locus of control and dispositional optimism. Locus of control, defined by Rotter (1966) as a person's perception of their control over event outcomes, has been found to impact on personal well-being in a range of cultural contexts (see eg., Garcia *et al.*, 2002; Kulshrestha & Sen, 2006; Spector et al., 2001). Dispositional optimism, defined by Scheier and Carver (1985) as the propensity to generally expect favourable outcomes over unfavourable ones, has also been demonstrated to co-vary with perceived well-being (see eg., Isaacowitz, 2004). Of

course along with this recommendation, we would also encourage future studies to use psychometrically valid and reliable measures of these psychological constructs which capture the complex conceptualisation of these variables.

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Table 1
Characteristics of Respondents

	Fuzhou	Chengdu	Wuhan	Fushun	Dalian	Fuxin
Gender	%	%	%	%	%	%
Male	49.8	53.5	40.6	46.6	40.5	59.0
Female	50.2	46.5	59.4	53.4	59.5	41.0
Marital status	%	%	%	%	%	%
Single	46.9	43.8	34.2	26.8	43.2	14.8
Married	53.1	56.2	65.8	73.2	56.8	85.2
Age						
Mean	32.93	29.85	33.72	35.37	31.84	36.00
SD.	10.72	8.23	10.29	8.38	7.93	7.31
Number of children	%	%	%	%	%	%
Zero	46.6	48.7	37.6	35.7	59.6	29.6
One	45.9	43.8	51.6	62.5	38.7	67.8
More than one	7.5	7.5	10.8	1.8	1.6	2.7
Educational level	%	%	%	%	%	%
Junior middle school or below	5.9	11.1	8.7	4.3	4.2	13.4
Senior middle school	14.2	29.3	25.1	17.8	6.3	29.1
Technical school	28.9	26.1	30.4	34.8	21.2	27.1
Bachelor degree	41.8	29.0	29.1	38.9	53.4	26.9
Masters or PhD	9.2	4.4	6.6	4.2	14.9	3.5
Average monthly income	RMB	RMB	RMB	RMB	RMB	RMB
	%	%	%	%	%	%
500 or below	1.8	5.0	3.9	2.7	0.2	9.0
501-1000	17.3	25.3	27.1	14.1	6.1	30.1
1001-1500	22.2	18.0	23.8	23.7	14.6	27.3
1501-2000	22.4	24.6	16.9	23.5	23.6	21.0
2001-5000	29.2	22.4	24.1	35.4	47.7	11.0
over 5000	6.9	4.7	4.1	0.6	7.8	1.6

Source: Surveys administered in respective cities in 2007.

Table 2
Mean Satisfaction Ratings of the PWI

	This Sample	Rural China[a]	Hong Kong [b]
How satisfied are you with your standard of living?	6.2	6.4	6.6
How satisfied are you with your health?	7.1	6.9	6.9
How satisfied are you with what you are achieving in life?	6.5	5.8	6.3
How satisfied are you with your personal relationships?	7.5	7.0	7.2
How satisfied are you with how safe you feel?	7.1	7.0	6.8
How satisfied are you with feeling part of your community?	6.5	5.8	5.8
How satisfied are you with your future security?	6.2	6.0	6.0
Personal Wellbeing Index	6.7	6.4	6.6

Note: Respondents answered these seven items on a 0-10 Likert scale, ranging from 'completely dissatisfied' (0) to 'completely satisfied' (10). (a) Results for rural China are from Davey et al. 2008; (b) Results for Hong Kong are from Lau et al. 2005.

Table 3
Definition of the Explanatory Variables

Variable	Definition	Descriptive Statistic
Job Satisfaction (Pay)	Sum of the four items in the pay component in the JSS where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=13.496, SD=3.201
Job Satisfaction (Promotion)	Sum of the four items in the promotion component in the JSS where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=22, Mean=13.784, SD=3.118
Job Satisfaction (Supervision)	Sum of the four items in the supervision component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=15.665, SD=3.508
Job Satisfaction (Fringe Benefits)	Sum of the four items in the fringe benefits component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=13.478, SD=3.350
Job Satisfaction (Contingent Rewards)	Sum of the four items in the contingent rewards component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=14.416, SD=2.997
Job Satisfaction (Operating Procedures)	Sum of the four items in the operating procedures component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=22, Mean=13.110, SD=2.674
Job Satisfaction (Co-workers)	Sum of the four items in the co-worker component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=7, Max=24, Mean=16.251, SD=2.553
Job Satisfaction (Nature of Work)	Sum of the four items in the nature of work component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=15.821, SD=3.276
Job Satisfaction (Communication)	Sum of the four items in the communication component in the JSS, where each item ranges from 1='disagree very much' to 6 'agree very much' that respondent is satisfied	Min=4, Max=24, Mean=15.075, SD=3.033
Gender	A dummy variable where 1=male; zero=female.	48.11% of respondents were male
Age	Age of the respondent in years.	Min=18, Max=60, Mean = 33.159, SD=9.154
Married	A dummy variable where 1=married; zero otherwise.	64.7% of respondents were married
Children	Number of respondent's children where 0=zero, 1=one and 2=more than one.	0=43.1%, 1=51.4%, 2=5.5%
Education	Education of the respondent (1=junior middle school or below; 2=senior middle school; 3=technical school; 4=bachelor's degree; 5=higher degree	1=8%, 2=20.6%, 3=28%, 4=36.3%, 5=7.1%
Income	Respondent's average monthly income (RMB) (1=500 RMB or less, 2=500-1000 RMB, 3=1000-1500 RMB, 4=1500-2000 RMB, 5= more than 2000 RMB.	1=3.8%, 2=20.2%, 3=21.4%, 4=21.9%, 5=32.7%
Atmospheric Pollution (SO^2)	SO^2 in the air (kilograms per capita) in the city in which the respondent lives in 2007.	Min = 9.6, Max=32.5, Mean=18.5, SD=7.9
Atmospheric Pollution (Particles)	Suspended particles in the air (kilograms per capita) in the city in which the respondent lives in 2007.	Min = 19.0, Max=72.0, Mean=41.16, SD=19.8
Waste Water	Waste water discharge (10^4 tons per capita) in the city in which the respondent lives in 2007.	Min = 77.64, Max=148.78, Mean=111.39, SD=27.97
Parks	Area of parkland (10^4 m^2 per capita) in the city in which the respondent lives in 2007	Min = 3.32, Max=9.36, Mean=5.22, SD=1.87
Congestion	Passenger vehicles per 10^4 people in the city in which the respondent lives in 2007.	Min=29.36, Max=59.85, Mean=40.69,SD=9.57

Table 4
Determinants of Personal Well-Being in the Six Cities: OLS Regression Results

	I		II		III	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	1.242*	14.857	1.383*	13.972	1.404*	12.679
Job Satisfaction (Pay)	0.014*	5.677	0.013*	6.474	0.013*	6.507
Job Satisfaction (Promotion)	0.007*	3.491	0.007*	3.688	0.007*	3.674
Job Satisfaction (Supervision)	-0.001	-0.680	-0.002	-0.916	-0.002	-0.931
Job Satisfaction (Fringe Benefits)	-0.001	-0.325	-0.001	-0.305	-0.001	-0.303
Job Satisfaction (Contingent Rewards)	-0.002	-0.814	-0.001	-0.655	-0.001	-0.648
Job Satisfaction (Operating Procedures)	0.001	0.771	0.001	0.500	0.001	0.513
Job Satisfaction (Co-workers)	0.010*	4.394	0.010*	4.949	0.010*	4.929
Job Satisfaction (Nature of Work)	0.018*	8.923	0.018*	10.878	0.018*	10.865
Job Satisfaction (Communication)	0.001	0.689	0.002	0.993	0.002	0.952
Gender	-0.015	-1.564	-0.019**	-2.068	-0.019**	-2.023
Age	-0.011**	-2.480	-0.014*	-3.108	-0.013*	-2.947
$Age^2/100$	0.013**	2.247	0.017*	2.911	-0.016*	2.766
Married	0.047*	3.134	0.043*	2.934	0.044*	2.975
Children	0.026***	1.829	0.029**	2.292	0.028**	2.200
Education	0.008***	1.749	0.009***	1.902	0.009***	1.908
Income	0.019*	4.415	0.040*	3.762	0.036*	3.456
Relative Income	-5.12E-06	-0.562	-1.83E-05***	-1.710	-1.56E-05	-2.310**
Atmospheric Pollution (SO^2)	_	_	_	_	-0.002**	-2.043
Atmospheric Pollution (Particles)	_	_	-0.001**	-2.792	_	_
Waste Water	_	_	-0.0002	-1.044	-0.0005*	-2.691
Parks	_	_	0.010*	2.711	0.003	0.937
Congestion			-0.003*	-2.953	-0.002**	-2.310
City Dummies?	YES		YES		YES	
Adjusted R^2	0.199		0.203		0.202	
Number of Observations	2741		2741		2741	

Notes: Dependent variable is log (PWI Index) *(**)(***) denotes statistical significance at 1(5)(10)%. All estimates employ White's heteroskedastic consistent standard errors.