The Impact of Housing Quality on Health and Labor Market Outcomes

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Extended abstract

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Environmental factors have long been considered as a major determining factor of individual's health. In the last decade, numerous studies have consistently provided estimates on sizable detrimental effects of air and water pollution on human health. Air pollution has been related to significant increases in infant mortality rates (Currie and Neidell, 2005), (low) birth weights (Currie and Neidell, 2005), school absence (Currie et al., 2009) hours of sick leave (Hanna and Oliva, 2015), and respiratory and heart-related hospital admissions (Schlenker and Walker, 2016). In the last years, the literature has also documented direct effects of pollution shocks on individual productivity beyond health in different economic sectors, such as agriculture (Zivin and Neidell, 2012), pear packers (Chang et al., 2014) and call centers (Chang et al., 2016).

Most of the existing literature focuses on outdoor or ambient air pollution, traditionally disregarding indoor environments. Surprisingly little is known about the indoor environmental conditions on occupants' health and productivity. The average individual in a Western society spends more than 90 percent of her time indoors, most of it at home (Klepeis et al., 2001). Moreover, the U.S. Environmental Protection Agency (EPA) documents significant differences in pollutant concentrations between indoors and outdoors - up to 5 times higher concentration indoors. The aim of the paper is to examine how indoor housing conditions affect occupants' health and labor outcomes. In particular, we exploit variation in indoor house conditions created by wave in house renovations generated by a large-scale governmental loan program in East Germany in the aftermath of the German reunification (1990-2000).

Most of our understanding of the effect of housing conditions on health comes from the epidemiological literature and is based on small-scale intervention studies linking specific dwelling deficiencies (e.g. mold) to occupant illnesses (e.g. asthma) (Thomson, 2013). In addition, recent

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quasi-experimental research focusing on primitive housing in developing countries shows a significant impact of improvements in the indoor environment (e.g. flooring or electrification) on occupant health and quality of life. However, these settings are hardly applicable to the general building stock in most developed countries (Cattaneo et al., 2009). However, these settings are hardly applicable to the general building stock in most developed countries. In this paper, we aim at estimating the change in house conditions in a developed country, with starting conditions of the housing portfolio much closer to the average dwelling in Western societies nowadays.

In order to estimate the causal effect of a major renovation of the dwelling on occupants' health and labor market outcomes, we use the *German Socio-Economic Panel Study (SOEP)* and apply an instrumental variable approach. The SOEP is a yearly population representative longitudinal study of about 11,000 households and 30,000 individuals in Germany (see Wagner et al., 2007) and contains detailed information on housing conditions as well as on health status and labor market outcomes. Due to the availability of the instrument (see discussion below), we restrict the analysis to tenants in East Germany and the time period 1992 until 2000. We define a binary treatment variable which takes the value of one if respondents report a modernization with respect to the heating, windows, bath room or other major parts of the apartment within the last year before the interview, and zero otherwise. Table 1 displays the socio-economic characteristics of both treated and non-treated households in the sample. The table shows no significant differences in socio-economic characteristics between the two groups.

Table 1: Socio-Economic Differences between Respondents that Do Not Reported a Renovation in Sample and Respondents that Reported a Renovation in Their Dwellings

	Non Renovated Houses		**Renovated Houses**	
	Individuals	Mean	Individuals	Mean
Current health (from 1 to 5)	7,563	2.56	9,192	2.63
Days sick leave last year	7,567	642	9,192	6.79
Visits doctor last three months	7,951	2.50	9,047	2.57
Years of education	10,017	12.01	11,526	11.96
Individual net labor income (in euros)	5,990	912.10	6,765	931.60
Household income (in euros)	10,069	1,603	11,442	1,590
Household members	10,322	2.89	11,744	2.70
Age of respondent	10,322	43.46	11,744	43.97
Female (1=yes)	10,322	0.53	11,744	0.53
Working (1=yes)	10,322	0.58	11,744	0.58
Unemployed (1=yes)	10,322	0.11	11,744	0.12
Construction year dwelling	10,208	1962	11,573	1961

The identification strategy is based on an instrumental variable approach exploiting regional variation in the roll-out of a massive governmental loan program (*KfW-Wohnraum-*

Modernisierungsprogramm, KfW program hereafter) in East Germany in the aftermath of the German reunification as an instrumental variable for the individual probability to experience a major renovation (treatment). The program consisted of reduced interest payments and was implemented by the German public bank *KfW* (*Kreditanstalt für Wiederaufbau*). The main aim of the KfW program was to incentivize the East German real estate industry to invest in modernization of existing dwellings and hence to equalize living conditions in West and East Germany after reunification. Between October 1990 and January 2000, a total amount of 79 billion DM (corresponds to 40 billion Euro) was allocated to private and public house owners to renovate or extend existing dwellings. The clear majority of the budget (71%) was used for renovations, while only 7% used to build new dwellings and 22% to increase energy efficiency of dwellings (see Reich, 2000). In total, 3.6 million dwellings have been renovated based on the program which corresponds to about 50% of all existing dwellings in East Germany at the time of the reunification. In order to identify the effects of this intervention, we take advantage of the regional variability in the implementation of the program (see Figure 1). We have access to yearly loan take-up within the KfW program for counties in East Germany in the period 1992-2000 (Source: KfW). Based on this information, we construct the instrument Z_{jt} as the yearly amount of the subsidy per inhabitant in county j:

$$Z_{jt} = Subsidy_{jt}/population_{jt} \tag{1}$$

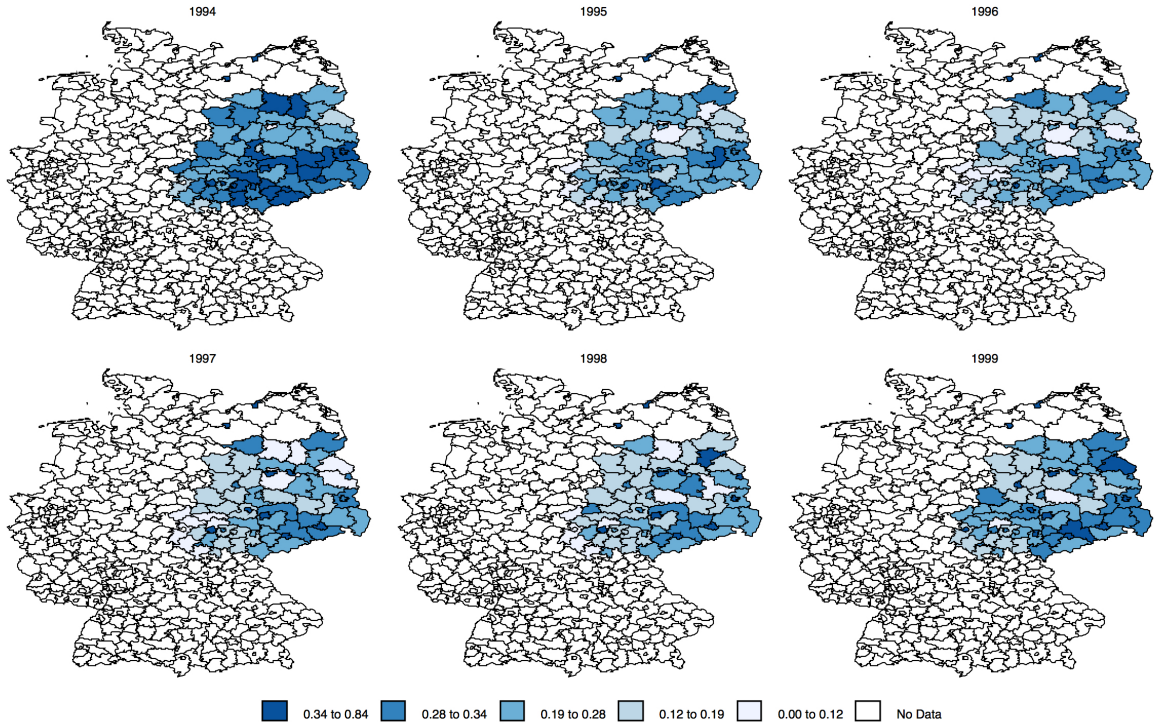
Given the scope and impact of the program, we argue that the instrument affects the individual probability to report a major renovation of their own dwelling. Tenants who live in a county with a relatively high loan intensity in a certain year are more likely to experience a renovation compared to tenants living in a county with a low intensity. The first stage results strongly support the relevance of the instrument. Furthermore, we do include county fixed effects in order to take potential endogenous selection of counties into account. Therefore, we use within county variation over time to identify the causal parameters. In such a setting, we argue that the exact timing of the renovation can be assumed to be exogenous to the tenant. Assuming validity of the instrument, we estimate the causal local average treatment effect δ using the two-stage least squares estimator (2-SLS, e.g. Angrist and Imbens, 1995):

$$Treat_{ijt} = \alpha_1 + \gamma_1 Z_{jt-2} + \gamma_2 Z^2_{jt-2} + \beta_1 X_{ijt} + \eta_j + U_{ijt} \tag{2}$$

$$Y_{ijt} = \alpha_2 + \delta \hat{Treat}_{ijt} + \beta_2 X_{ijt} + \eta_j + V_{ijt} \tag{3}$$

where $Treat_{ijt}$ indicates whether individual i living in county j at year t reports a major renovation or not. X_{ijt} denotes individual characteristics, η_j county fixed effects and Y_{ijt} the outcome variables. The instrument Z_{jt-2} is used with two lags because of the time gap between loan approval and actual implementation of the renovation. In addition to the level of the instrument,

Figure 1: Distribution Loan Take-up per Inhabitant Across Counties over Years of the Program



Note: Distribution of loan take-up per inhabitant in years 1992 and 1993 omitted for space limitations (available upon request).

we include a squared term Z^2_{jt-2} to allow for a non-linear relationship between the instrument and the treatment indicator.

First regression analyses show a strong power of our instrument in predicting the probability of being treated, as reflected by the high value of F-statistic in the first stage (over 10). The estimation results from the second stage indicate significantly positive effects on occupants' health.

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