Demand for climate-resilient housing

Experimental evidence from Vietnam

June 9, 2017

Henrik Lindhjem[1], Sofie Waage Skjeflo[2], Tuan Huu Tran[3], Phong Van Giai Tran[4], Tuan Anh Tran[5], Haakon Vennemo[6] and Nina Bruvik Westberg[7]

Abstract

We present preliminary results from a randomized field experiment in Da Nang in Central Vietnam. We assess the take-up of a microcredit program that aims to increase the adoption of climate resilient housing among near-poor urban households. Households were randomly assigned offers of either a loan and technical assistance package or a cash transfer in addition to the loan and technical assistance. The aim of this study is to investigate the difference in take-up of the packages, and how this differs with respect to household characteristics. This again speaks to the broader question of what are the necessary incentives for households to invest in climate resilient housing. We find that households that were offered the cash transfer in addition to the loan and technical assistance, are almost twice as likely to accept. Household heads with less education are less likely to accept the offer of a loan and technical assistance only.

[1]Menon Centre for Environmental and Resource Economics
[2]Vista Analyse
[3]College of Economics, Hue University
[4]ISET-Vietnam
[5]ISET-Vietnam
[6]Vista Analyse
[7]Corresponding author: Vista Analyse, nbwestberg@vista-analyse.no. This work is supported by the Nordic Development Fund under the Nordic Climate Facility.

1 Introduction

Climatic hazards such as coastal flooding, tropical storms and typhoons[8] pose a significant threat to low income households in growing cities in Vietnam. With strong rural-urban migration by low-income households (Nguyen et al., 2015), many households cannot afford permanent, high-quality housing, and are at risk of severe structural damage to their homes (UN, 2014). In addition, since the 1986 reform (Doi Moi Policy), there has been a shift from traditional construction materials, such as wood and clay tiles, towards the use of modern materials, such as cement blocks and corrugated steel sheets, but without adjusting construction practices to incorporate resilience to climate hazards (Norton and Chantry, 2008). According to official estimates, almost 1,5 million houses were damaged, and about 50 000 houses totally destroyed due to storms and floods between 1999 and 2013, with most of the damage occurring in Central Vietnam (Tran, 2016). Storms and floods disproportionally affect low-income households who often live in houses that are constructed with structurally weak materials and techniques. These households frequently reconstruct their houses after storm damage using the same building principles, thereby reproducing their vulnerability (Tran et al., 2013). A number of programs have addressed these issues, and made efforts to promote storm- and flood resilient housing for low income households (see for instance Norton and Chantry, 2008; Tran et al., 2013).

This paper presents results from an ongoing randomized control trial of a microcredit program aiming to increase the adoption of climate resilient housing in the coastal city of Da Nang. The programme is implemented by Women's Union, a mass organization operating throughout Vietnam with the aim of enabling women to take part in national development. The underlying motivation of the program is that enabling households to invest in resilience rather than relief and repairs, provides long term benefits to both the household and to society. Based on a cost-benefit analysis of climate resilient housing, Tuan et al. (2015) find positive returns to investment, even without taking into account non-monetary costs of typhoon damage and possibly increased typhoon intensity due to climate change. A high marginal return to a technology (in this case, climate resilient

[8] A typhoon is a rotating system of clouds and thunderstorms with wind speeds exceeding 74 miles per hour, originating in the Northwest Pacific region (http://www.nhc.noaa.gov/climo/).

housing), indicates that there may be market failures that constrain adoption (Foster and Rosenzweig, 2010). In this case, likely barriers to adoption include information barriers (both lack of knowledge about the returns to investment, and lack of knowledge of how to manage the technology) and credit constraints. The program we evaluate aims to mitigate the credit constraint of low income households through providing access to credit for housing construction or retrofitting, and providing information and technical assistance to implement climate resilient building principles.

The purpose of the randomized control trial is twofold: First, to assess the impact of investing in climate resilient housing on a number of household outcomes, amongst them various indicators of resilience, subjective resilience and well-being, household consumption, and investment in non-housing assets. Here we are interested in both the intention-to-treat effect and the treatment effect on the treated. Secondly, to inform programme design through investigating the necessary level of incentives provided in order to enable households to invest in climate resilient housing. Here we are interested in the take-up of two "incentive packages", one with a subsidized loan and free technical assistance for house retrofitting or reconstruction, and one with cash transfer in addition to the loan and technical assistance. We are also interested in the characteristics of the households that accept each package, since we want to know which households can be reached through scaling up the programme, and which types of households may have to be targeted through other channels. This paper addresses the second purpose of the RCT, by investigating the take-up of each of the two incentive packages, and investigating the characteristics of the households that accept each package.

The rest of this paper is organized as follows. Section 2 presents a theoretical model of the decision problem of the household, and section 3 explains the experiment. The data and results are presented in section 4 and section 5 concludes.

2 Theoretical background

Consider a household i that maximizes expected utility over consumption and housing consumption in two periods. In period 2, the household enters state 1 (no typhoon) or state 2 (typhoon). The household may have access to two saving and investment technologies in period 1. One is bank

savings (S), which may be positive or negative (borrowing). Saving pays off with the interest r in both states. The other is housing reinforcement (H), which only pays off if there is a typhoon.

To simplify, we assume two states of the world in period 2. The state "no typhoon" occurs with probability p. The state "typhoon" occurs with probability $(1-p)$. Utility over ordinary consumption and housing is additive. We suppress utility of existing assets, such as existing houses. Utility of housing in the state "no typhoon" is normalized to zero. Hence, utility of housing in the state "typhoon" is negative, unless the household has invested in housing reinforcement in period 1.

The utility function of the households is $U(C_1) + \theta p U(C_2) + \theta(1-p)(U(C_2) - V(H))$, where θ is the subjective time discount factor of the household. The unconstrained maximization problem of the household is then:

$$\max_{C_1,C_2,S,H} U(C_1) + \theta p U(C_2) + \theta(1-p)(U(C_2) - V(H)) - \mu(C_1 + S + H - R) - \rho(C_2 - (1+r)S) \quad (1)$$

R in the problem is certain discounted household income, which can be used for either consumption or saving. Income is certain for simplicity. In the interior solution of the unconstrained maximum we obtain the following first order conditions:

$U'(C_1) - \mu = 0$

$\theta U'(C_2) - \rho = 0$

$-\mu + \rho(1+r) = 0$

$-\theta(1-p)V'(H) - \mu = 0$

This leads to rules of motion for consumption and housing:

$$U'(C_1) - (1+r)\theta U'(C_2) = 0 \quad (2)$$

$$-\theta(1-p)V'(H) - U'(C_1) = 0 \quad (3)$$

The first rule of motion is familiar in intertemporal savings problems and says that the marginal utility of consumption in period one should equal the marginal utility of consumption in period

two while considering the interest on saving period one consumption and the subjective displeasure (discount factor) of deferring consumption.

The other rule of motion says that the marginal utility of consumption in period one should equal the expected marginal benefit of housing consumption in period two. (Since $V'(H)$ is negative $(-V'(H))$ is positive). The logic of this equation is that the benefit of housing consumption in the "typhoon" state should be balanced against the cost in terms of foregone consumption in period one.

We cannot expect that households in our sample are in the interior of an unconstrained optimum. But we can use the Lagrange function to define the household marginal willingness to pay for reinforced housing as follows:

$$q = -\theta(1-p)V'H - \mu = q(r, p; H, R, \theta) \tag{4}$$

As above, the benefit of housing reinforcement is the increase in utility $(-V'(H))$ should a typhoon occur $(1-p)$ and considering the subjective displeasure of deferring consumption (θ). The cost of housing reinforcement (μ) by definition equals the marginal impact of income on overall utility. The interpretation is that by spending on housing the consumer has less income to spend overall. The cost of housing reinforcement depends on the parameters of the system. The marginal willingness to pay, q, equals the difference between the benefit of housing reinforcement and its cost, that is the *net* marginal utility of housing reinforcement.

Each household i is expected to have an individual willingness to pay $q(i)$. Here we are interested in their willingness to pay at $H(i) = 0$. In other words, what is their willingness to pay for housing reinforcement before the do any reinforcement? Based in the work of Tuan et al. (2015), an unconstrained household is expected to have a positive willingness to pay for reinforced housing. However, many households do in fact express a negative willingness to pay. These are the households that need a financial incentive to reinforce their homes. Their negative willingness to pay equals their demand for financial support. We are interested in these households.

Hence, we focus on the following set of negative willingness to pay/demand for financial support:

$$Q = \int_{i(q=-\bar{q})}^{i(q=0)} q(i; r(i), p(i), R(i), \theta(i), H(i) = 0)di \tag{5}$$

We order individuals from the lowest willingness to pay, up to the cut off at zero. $-\bar{q}$ is the lowest of the q's. Note that the reasons for a demand for financial support that were emphasized as barriers above, show up as explanatory variables for $q(i)$: Demand for support may arise because the household faces a prohibitively high interest rate $r(i)$ on borrowing, or because the subjective probability of a typhoon is too low ($p(i)$), or simply because it has low income ($R(i)$). Factors such as a high subjective discount factor ($\theta(i)$) may also be at play, and there are other subjective differences and characteristics between households.

Incentive package 1 offers a low interest loan, and should influence $q(i)$ through a decrease in the loan interest rate $r(i)$. Both the income and substitution effect should contribute to a higher $q(i)$. Incentive package 2 exchanges part of the loan for a grant, and should influence $q(i)$ through a decrease in $r(i)$ and an increase in $R(i)$: The income effect is then given a boost from the grant element. We expect a higher impact on $q(i)$ from package 2, and hence higher uptake. In addition to the impact on $r(i)$ and $R(i)$, both packages will help neutralize unrealistic perceptions about the probability of a typhoon ($p(i)$). The value of package 2 is of course higher than the value of package 1, which should entice higher uptake.

A major goal of our research is to contribute understanding of what constitutes necessary financial support. In particular we would like to know the shape of the $q(i)$ curve between q_1 and q_2, where q_1 is incentive package 1 and q_2 is incentive package 2:

$$Q_{experiment1} = \int_{i(-q_2)}^{-q_1} q(i)di \tag{6}$$

How flat is the demand-for-support curve in this interval, illustrated in Figure 1? Will increasing the incentive from q_1 to q_2 enlist many additional households? If so, what are the characteristics of these households? These are questions we address in the next chapter.

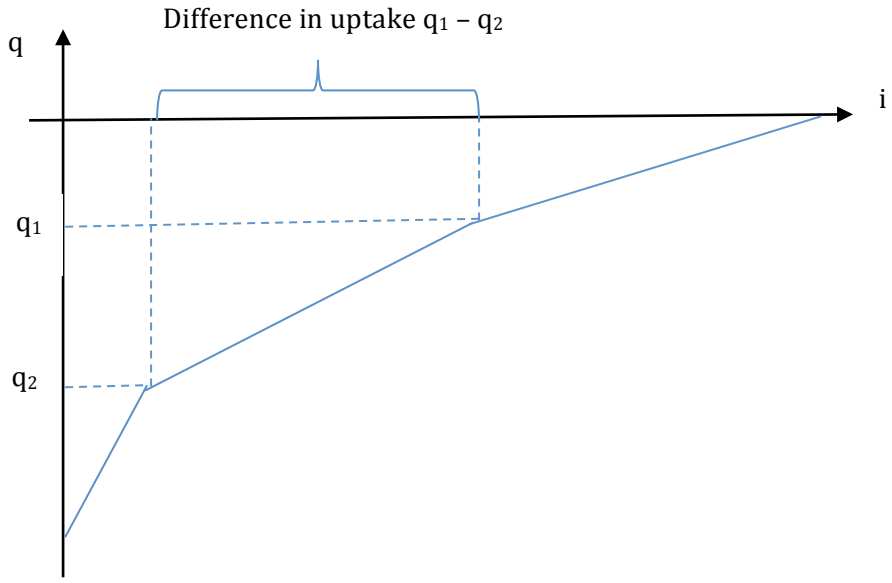

Figure 1: Willingness to pay for housing improvement, q

We are also interested in the group

$$Q_{experiment2} = \int_{i(-q_2)}^{0} q(i)di \tag{7}$$

How flat is the demand-for-support curve in this interval? In other words, how many reinforce their house without incentives, compared to those who do so with the strongest incentive? What are the characteristics of these households? This is another set of questions we address in the next chapter. We also note that experiment 1 and experiment 2 in combination imply a shape of the demand-for-support curve in the interval $(-q_1, 0)$.

3 Experiment

3.1 Study setting

Da Nang is located on the South Central Coast of Vietnam in the tropical storm belt. It is the third largest city of Vietnam, and has a fast growing population estimated at 1.03 million in 2015, with an average annual growth of about 2.9 percent per year since 2010 (GSO, 2016). Numerous climatic

hazards affect Da Nang, such as coastline erosion, landslides, floods and typhoons, with on average three to five tropical storms affecting the city per year (Tran et al., 2013). The peak typhoon season is from September until November. Past typhoons that have heavily affected Da Nang include Xansane in 2006, Ketsana in 2009 and Nari in 2013. Typhoon Xansane caused the collapse of 24 000 houses and damaged 325 000 houses in Central Vietnam (Tran, 2016), and 26 people in Da Nang were reported killed, mostly due to collapsing houses.[9] Typhoon Nari caused estimated damage to housing of about 4.6 billion USD, with 4200 severely damaged houses, and 122 completely collapsed houses (Tran, 2012). In 2011, the Women's Union of Da Nang and the Institute of Social and Environmental Transition (ISET) initiated the project *The Storm and Flood-Resistant Credit and Housing Scheme in Da Nang City*. With funding from the Rockefeller fundation, a microcredit and technical assistance program aimed at supporting storm resistant shelters in Da Nang City, was set up. Between 2011 and 2016, 237 new houses were constructed and 177 houses were retrofitted with support from the Women's Union revolving loan fund, with free technical assistance from local architects. When typhoon Nari hit in 2013, 244 households participating in the program had completed construction, and none of the completed houses suffered damages (Tran, 2012). The program was awarded the UNFCCC Lighthouse Activities Award in 2015 for its efforts to increase urban poor's resilience to climate change.[10]

Previous research indicates that investing in climate resilient features when retrofitting or reconstructing a house is profitable from a cost-benefit perspective. Tuan et al. (2015) use recall data from 98 households in Da Nang that were affected by the Xansane and Ketsana typhoons. The benefit of investing in resilient housing is calculated based on information about direct costs (damage to housing and other assets) and indirect monetary losses (loss of work days, medical costs). The avoided costs of typhoon damage is then compared to the additional cost of resilient housing construction, based on a number of principles such as choice of building material, reinforcement, anchoring and wall thickness. Assuming a return time of a category 1 storm (like Xangsane) every 12.5 years, the internal rate of return to climate resilient housing is as high as 20 percent, and assuming a return period of 25 years, the internal rate of return is 14 percent. Non mone-

[9] Associated Press, https://usatoday30.usatoday.com/weather/storms/2006-10-03-asia-typhoon_x.htm
[10] http://blog.i-s-e-t.org/we-are-honored-to-accept-the-unfcccs-lighthouse-activities-award/

tary benefits, such as the value of feeling safe, are not included in the analysis. According to this study, investing in climate resilient housing, as defined by the principles outlined and assuming a 10 percent discount rate for homeowners, is on average profitable.

3.2 Experimental design

Da Nang is organized into eight districts and 56 wards and communes (hereon called wards).[11] Our experiment takes place in 49 of these wards, covering seven districts. This excludes five wards in which most households reside in apartment buildings, rather than individual houses.

We first made a list of potential beneficiaries from each of the 49 wards. The local Women's Union units were asked to compile a list of six near-poor[12] households per ward that were eligible for participation in the program. The information provided to the wards is described in Appendix A. The number six was chosen due to budgetary constraints. The final number of households per ward varies however, but totals 306 households. According to the targeting criteria, the households had to have housing conditions vulnerable to climate risks, limited access to financial resources for strengthening climate resilience housing, have a stable job but low income, have some savings and be able to mobilize labor force for their housing improvement, have capacity for repayment, and have legal or any related documents to prove land ownership. The near-poor households were approached, and asked whether they had a need for house retrofitting or reconstruction to ensure storm resilience, and with the wish to carry out such retrofitting or reconstruction starting from March 2017.

The 306 households were surveyed between late December 2016 and early February 2017. The survey instrument included modules on household composition as well as different conditions and issues that may affect or be affected by the housing investment. This includes modules on income,

[11] Wards and communes are the same administrative unit, but the name differs between rural areas (communes) and urban areas (wards).

[12] The Da Nang City poverty lines were updated in 2016 (City People's Council, Da Nang City, 2015): Urban poor households: Income per capita per month (ICM) $<$ 1300000 VND, Urban near-poor households: 1300000 VND $\leq$ ICM $\leq$ 1690000 VND, Rural poor households: ICM $<$ 1100000 VND, Rural near-poor households: 1100000 VND $\leq$ ICM $\leq$ 1430000 VND. This corresponds to a near-poor poverty line of about 75 USD per capita per month in urban wards, and 63 USD per capita per month in rural areas of Da Nang. By comparison, the national poverty line for urban areas was set at 760 000 VND per capita per month for urban areas, and 615 000 VND per capita per month for rural areas, according to the General Statistical Office of Vietnam (General Statistics Office of Viet Nam, 2016).

consumption, assets as well as past storm exposure and housing repairs.

Randomization of wards into treatment and control groups took place after the baseline survey. We randomized using a random number generator. We chose to randomize at the ward/commune level so as to avoid spillover effects of information. Randomization was stratified at the district level, in line with the wishes of the Women's Union.

We have two treatment arms: package 1 and package 2. Households in package 1 are provided with a subsidized loan and free technical assistance for house retrofitting or reconstruction. Households in package 2 are given a cash transfer, in addition to the loan and free technical assistance. The loan is 30 million VND (close to one third of the value of an average house), while package 2 also consists of a grant of 10 million VND. The maximum loan repayment period is 40 months and the monthly interest on the loan is 0.75 percent, or about 9 per cent per year. The loan and grant is disbursed to the household when their house is dismantled or they have started retrofitting. The households start paying capital and interest monthly, starting from the first month that the loan is provided. The technical assistance includes technical designs of the new house/retrofitted house, as well as technical guidance during the building period. Figure 2 shows a map of Da Nang City, with the wards assigned to the two treatment arms and the control group.

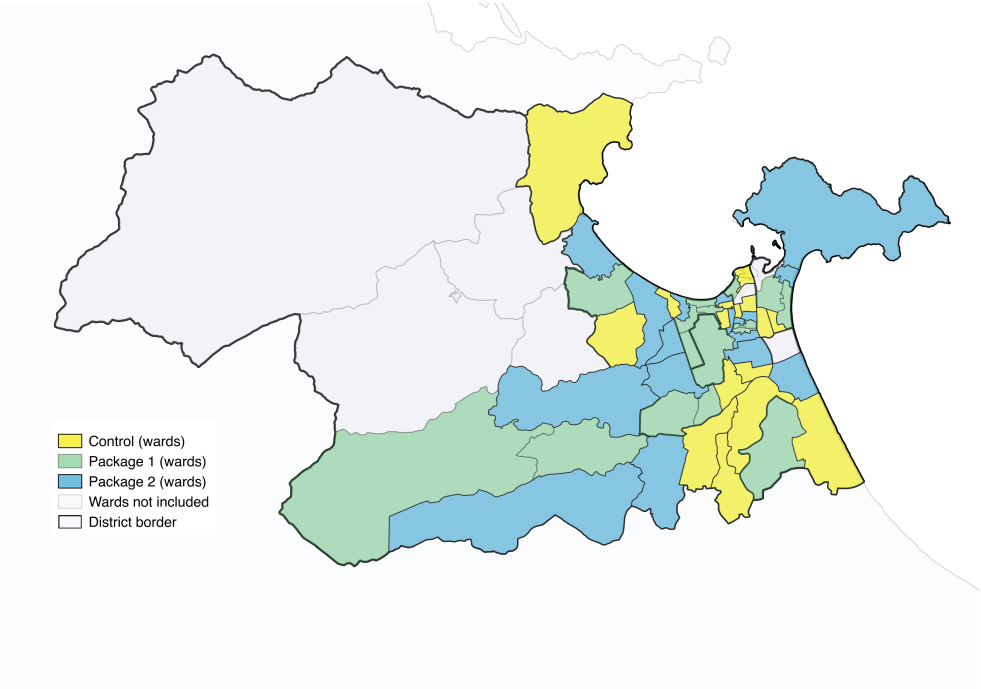

Figure 2: Map of Da Nang City with wards assigned to package 1, package 2 and control

Following the randomization, the local Women's Union units at the ward/commune level were informed which category their households belonged to (package 1, package 2 or control), and the households were then contacted directly by the local Women's Union unit. The households were provided with the information both verbally and by means of an information brochure that detailed the specifics of the package, such as interest rate and repayment conditions of the loan. They were given a consideration period of roughly two weeks. Our measure of take up reflects their final decision. Actual reconstruction and retrofitting is currently taking place, and will for most of the households continue until September 2017. A few households have asked for permission to postpone reconstruction/retrofitting until after the next Vietnamese New Year, i.e. in 2018.

3.3 Baseline means and balance checks

Table **??** reports baseline means in columns 1-3 for the control group and the two treatment arms. Around half of the households are female-headed, in line with the Women's Unions' targeting of

women. The household heads are on average 54 years old, and have on average 6.5-8.5 years of education. The households consist on average four to five people. Average monthly income per person is around 1 340 - 1 660 thousand VND per month, whereas average monthly expenditures per person vary between 630 - 970 thousand VND, depending on the treatment arm. Around 46 percent of the households in each of the treatment arms have a loan from beforehand, whereas the same applies for just over 60 percent of the households in the control group. These loans are primarily for business activities, house construction/retrofitting/repairs and education expenses. A large share of the households own motorbikes, an important asset in the Vietnamese context, whereas between 52-68 percent of the households own a TV.

We have randomized at the ward level. Although all wards have identified households that are near-poor and satisfy the above mentioned criteria, there may be systematic differences between the wards. In column 4, Table **??** we report the p-value from a joint orthogonality test (F-test) of treatment arms. There seem to be some systematic differences between the groups, for instance, there is a statistically significant difference in the level of education, household size, expenditure and income, asset ownership and previous loan experience between the three groups. We acknowledge this by including the baseline variables as controls in the analysis.

In total, 112 households among the 214 households that were offered accepted the package, equivalent to 52 percent take-up rate. We have registered reasons for not accepting among 78 of the remaining 102 households. The most common reasons for declining are that the household cannot afford to repay or that they are not interested in a loan, either because they are already indebted or because they are simply not interested.

Table 1: Baseline means and balance checks

	(1) Control	(2) Treatment 1	(3) Treatment 2	(4) p-value from joint orthogonality test of treatment arms
Female household head	0.554	0.538	0.481	0.551
	(0.052)	(0.049)	(0.048)	
Age of household head	56.185	53.575	54.620	0.393
	(1.440)	(1.247)	(1.313)	
Education level of household head	6.511	8.500	6.824	0.002
	(0.497)	(0.400)	(0.398)	
Household size	4.793	4.028	4.444	0.009
	(0.213)	(0.137)	(0.169)	
Monthly income (1000 VND) per pers	1339.926	1658.638	1611.220	0.033
	(64.339)	(97.651)	(97.716)	
Monthly expenditures (1000 VND) per pers	898.882	630.789	974.610	0.000
	(65.024)	(53.710)	(67.581)	
Owns motorbike	0.837	0.934	0.861	0.088
	(0.039)	(0.024)	(0.033)	
Owns TV	0.522	0.679	0.620	0.074
	(0.052)	(0.046)	(0.047)	
Household member has a loan	0.620	0.462	0.463	0.042
	(0.051)	(0.049)	(0.048)	
Years lived in house	23.451	19.858	22.046	0.247
	(2.058)	(1.146)	(1.336)	
N	92	106	108	

4 Estimation strategy

We are interested in the take-up of the packages, in particular the difference in take-up between the two packages. We estimate the intention-to-treat (ITT) on the households in both the treatment and control groups, regardless of whether they were offered and whether they accepted.

We estimate the following linear probability model:

$$Y_{hwd} = \alpha_0 + \alpha_1 T_1 + \alpha_2 T_2 + \mathbf{X'_{hwd}}\beta + \eta_{hwd} \tag{8}$$

where the dependent variable Y_{hwd} indicates whether the household accepted a package or not; h indicates household in ward w in district d. T_1 and T_2 are dummies indicating whether a household was offered package 1 or package 2, respectively. Since the treatment and control groups differed on a number of aspects, we control for these differences. The vector $\mathbf{X'_{hwd}}$ indicates a number of baseline characteristics. We include these to control for differences in baseline characteristics and to improve the precision of our estimates. η_{hwd} is a mean zero error term, and we cluster the standard errors at the ward level.

In addition we investigate whether take-up differs systematically according to baseline characteristics. Specifically, we are interested in gender, education and income.

5 Results

5.1 Take-up

The main results on take-up are reported in Table **??**. Not surprisingly, take-up is higher in the treatment groups than in the control group. By definition none of the households in the control group are registered as accepting a package, simply because they were not offered one. This does however not mean that none of the households in the control group may decide to reconstruct or retrofit their house to improve climate resilience in the same period as the treated households. This is something we will investigate in the follow-up survey, to be conducted in the spring of 2018.

We are more interested in the difference in take-up between the two packages. Households in

treatment 1 are 36.1 percentage points more likely to accept the package than in the control group, whereas households in treatment 2 are 63.2 percentage points more likely to accept. There is in other words a difference in take-up by close to 30 percentage points, which is statistically significant. Households in treatment 2 are roughly twice as likely to accept as the households in treatment 1.

The difference between the two packages, is that package 2 provides 10 mill. VND as a grant rather than as a loan. Package 2 is in other words more costly to provide. The grant will not be repaid, and thus the money paid out will not reenter into the revolving fund. Half of those that accepted package 2 are likely to have accepted package 1, if they were offered that package instead. On the other hand, if households are only offered package 1, then this results in lower take-up. The question then is: who are we reaching by offering a more attractive package?

Table 2: Take-up of packages

Package 1	0.361***
	(0.096)
Package 2	0.632***
	(0.080)
Female household head	0.069
	(0.051)
Age of household head	-0.000
	(0.002)
Education level of household head	0.003
	(0.007)
Household size	0.004
	(0.015)
Monthly income (mill. VND) per person	0.067
	(0.042)
Monthly expenditures (mill. VND) per person	0.034
	(0.062)
Owns motorbike	-0.026
	(0.058)
Owns TV	-0.003
	(0.059)
Household member has a loan	-0.059
	(0.048)
Years lived in house	-0.001
	(0.002)
Constant	-0.095
	(0.159)
Observations	305
Prob > F (Package 1 = Package 2)	0.000

Notes: Linear probability model. Dep.var.: take-up is set equal to 1 if household accepted package 1 or 2, and set equal to 0 if the household declined or was not offered a package. Standard errors in parentheses, clustered at the ward level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 Heterogeneity in take-up

We investigate whether take-up differs according to baseline characteristics, specifically gender, education and income. Results are reported in Table **??**. We find that the interactions between education and package 1 is positive and statistically significant from zero. The probability of accepting package 1 relative to package 2 increases with education, in line with our expectation that less educated may be less aware of the benefits of investing in climate-resilient housing. We find no statistically significant difference in take-up with regards to gender and annual income per person.

We also investigate whether there is any difference in whether the household chose to retrofit or rebuild their house depending on what package they received. We find that there is no statistically significant difference (results available upon request), although this may be because we are underpowered.

Table 3: Heterogeneity in take-up

	1	2	3	4
Package 1	0.421***	0.031	0.186	0.015
	(0.119)	(0.109)	(0.098)	(0.144)
Package 2	0.634***	0.634***	0.643***	0.641***
	(0.079)	(0.079)	(0.080)	(0.080)
Female household head	0.115	0.049	0.067	0.078
	(0.063)	(0.050)	(0.051)	(0.060)
Education level of household head	0.005	-0.009	0.004	-0.007
	(0.007)	(0.008)	(0.007)	(0.008)
Annual income (mill. VND) per person	0.006	0.006	0.002	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
Package 1 * Female household head	-0.136			-0.072
	(0.095)			(0.091)
Package 1 * Education level of household head		0.041**		0.035*
		(0.015)		(0.014)
Package 1 * Annual income (mill. VND) per pers			0.009	0.005
			(0.005)	(0.005)
Observations	305	305	305	305
Prob > F (Package 1 = Package 2)	0.000	0.000	0.000	0.000

Notes: Linear probability model. Dep.var.: take-up is set equal to 1 if household accepted package 1 or 2, and set equal to 0 if the household declined or was not offered a package. Variables not reported: *household size*, *monthly expenditures (mill. VND) per person*, *owns motorbike*, *owns TV, household member has a loan* and *years lived in house*. Standard errors in parentheses, clustered at the ward level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Conclusion

We present preliminary results from a randomized field experiment in Da Nang, Vietnam. Households were randomly provided with a loan and technical assistance package or a cash transfer in addition to a loan and technical assistance. The aim of this study is to investigate the difference take-up of the packages, and how this differs according to household characteristics. This again speaks to the broader question of what are the necessary incentives for households to invest in climate resilient housing.

We find that households that were offered a cash transfer in addition to the loan and technical assistance are almost twice as likely to accept, than households not offered a cash transfer. In particular less educated household heads are less likely to accept package 1 as opposed to package 2. This suggest that there may be informational and/or financial barriers that result in underinvestment in climate resilient housing that persist despite the loan and technical assistance package.

References

City People's Council, Da Nang City (2015). The Resolution to adopt the Poverty Reduction Plan for 2016-2020 in Da Nang.

Foster, A. D. and Rosenzweig, M. R. (2010). Microeconomics of technology adoption. *Annu. Rev. Econ.*, 2(1):395–424.

General Statistics Office of Viet Nam (2016). General poverty rate by residence and by region and year.

GSO (2016). Statistical yearbook of vietnam 2015. Technical report, General Statistical Office of Vietnam.

Nguyen, L. D., Raabe, K., and Grote, U. (2015). Rural–urban migration, household vulnerability, and welfare in Vietnam. *World Development*, 71:79–93.

Norton, J. and Chantry, G. (2008). Vaccinate your home against the storm – reducing vulnerability in Vietnam. *Open House International*, 33(2).

Tran, T. A. (2016). *Developing Disaster Resilient Housing in Vietnam: Challenges and Solutions*. Springer.

Tran, T. A., Tran, V. G. P., Tran, T. H., and Mulenga, M. (2013). Community consultation for long-term climate-resilient housing in Vietnamese cities: a comparative case study between Hue and Da Nang. *Asian Cities Climate Resilience, IIED*.

Tran, V. G. P. (2012). Statistical yearbook of vietnam 2015. Technical report, Institute for for Social and Environmental Transition International (ISET).

Tuan, T. H., Tran, P., Hawley, K., Khan, F., and Moench, M. (2015). Quantitative cost-benefit analysis for typhoon resilient housing in Danang city, Vietnam. *Urban Climate*, 12:85–103.

UN (2014). Migration, resettlement and climate change in Viet Nam. reducing exposure and vulnerabilities to climatic extremes and stresses through spontaneous and guided migration. Technical report, United Nations Viet Nam.

Appendix A

Information to ward leaders/WU at ward level on the selection of eligible households
The Women's Union of Da Nang is carrying out a survey to investigate the need for storm resilient housing in Da Nang City. The project is carried out with funding from the Nordic Development Fund, and will support the Da Nang City's Resilience Strategy. In this first round, the Women's Union is carrying out a mapping of the need for housing retrofitting and reconstructions for households with houses that are vulnerable to storms. The six households will be visited for a more detailed survey at a later point, tentatively in December 2016.

At this point, the Women's Union would like to identify households categorized as **near poor, with a need for house retrofitting or reconstruction to ensure storm resilience, and with the wish to carry out such retrofitting or reconstruction starting from March 2017.** We are therefore asking each ward to provide a list of six households that fit these criteria. If there

are more than six households in the ward that fit the criteria, we would also like a specification of how the six households were nominated among the larger group of households.