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Present bias predicts low adoption of profitable technologies: The case of livestock vaccination in northern Laos

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Keywords: Technology adoption , vaccination, Foot and Mouth disease, Present bias

JEL Classification: O10, O13, Q16

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The case of livestock vaccination in northern Laos[1]

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1. Introduction

Foot and Mouth Disease (FMD) is a highly transmissible viral disease that affects cloven-hoof animals, including cattle and buffalo. Despite a low mortality among adult animals, it often leads to significant losses via lower body condition of affected animals and, importantly, reduced market value due to trade barriers imposed to control the spread of this disease. Eradication programs rely on complex mixes of quarantine, testing and, crucially, vaccination, a well-known and proven technology in many contexts (Blancou, 2002, Blacksell, et al. 2019).

Existing estimates of the benefit cost ratio of vaccinating cattle against this disease suggest that there is a US$5.3 return per dollar spent on vaccinations in northern Lao PDR (hereafter Laos), the context of this work (Nampanya, et al. 2018). However, despite such large returns, data from the same region suggests that more than 70% of producers fail to vaccinate their animals. Vaccination against FMD seems to be another puzzling example of a large bill left on the sidewalk.

Building on the "poor but rational" hypothesis (Schultz 1964), conventional explanations for such puzzles emphasize the importance of external constraints created by market failures, particularly in credit and information markets (see Feder, Just and Zilberman (1985) for an early and influential review of this work). A leading complementary explanation builds on insights from research in behavioral economics which show that, for some individuals, the decision to allocate a budget between two time periods depends on the proximity of the future (Thaler (1981); see Ericson and Laibson (2019) for a recent review). The inconsistency between future plans and current actions resulting from these preferences, parsimoniously captured in the $\beta - \boldsymbol{\delta}$ model (Laibson 1997, O'Donoghue and Rabin 1999), has been argued to explain, at least partially, why firms may overlook investment opportunities even when returns to capital are highly attractive (Kremer, Rao and Schilback 2019), even in the case of divisible investments for which credit constraints should be negligible (Duflo, Kremer and Robinson 2011).

This paper explores the predictive power of this explanation for the low adoption of livestock vaccination against FMD among cattle producers in northern Laos. In the next section, we contextualize the significance of FMD control in Laos and present a brief review of common explanations for the low adoption of livestock vaccination. We conclude that, contrary to what has happened with vaccination against human diseases, there has been a generalized lack of attention to behavioral characteristics as explanations for the lack of adoption of this technology in the context of preventing zoonoses. Section 3 outlines the data used in this paper while section 4 presents the results, showing that individuals who exhibit present-bias in an experimental task are also less likely to vaccinate their cattle against FMD. This result is precisely estimated, economically significant and robust to the inclusion of a large number of other adoption correlates. Using the approach to sensitivity analysis proposed in Oster (2019), our results also suggest that this effect is robust to the influence of unobserved determinants of the vaccination decision. We conclude in Section 5 with a discussion of the policy implications of these findings.

2. Foot and Mouth Disease and the puzzle of low adoption of vaccination

Foot and Mouth Disease (FMD) is a highly transmissible viral disease that affects cloven-hoof animals, including cattle and buffalo. Infected animals develop fever, inappetence, lameness and the development of severe lesions on their mouth and feet, limiting their mobility and feeding ability. Although mortality is usually low (less than 2% among adult cattle, although up to 5% among young animals), these symptoms lead to loss of body weight and, ultimately, value. Most importantly, given its high infectiousness (which can lead to morbidity rates of 90-100% of animals that directly or indirectly contact a sick animal), international guidelines severely restrict the trade of susceptible animals and their products (OIE, 2014). Such trade barriers are present not only between FMD-free countries (essentially, developed countries) and those where the disease is present, but also between countries where the disease is present, given the existence and spatial delimitation of different variants of the virus responsible for the disease. As a result, potential exporting countries are prevented from accessing markets with higher meat prices (including, increasingly, China and other middle-income countries), potentially depriving producers in affected countries from benefiting from what Delgado et al (1999) called "the livestock revolution".

Despite a long history of efforts to eradicate this disease (Blancou, 2002), FMD-free status has mostly been limited to developed countries and, more recently, Latin American countries. This distribution reflects the benefits of disease eradication (potentially much higher for countries with a comparative advantage in livestock production) as well as the capacity to implement a host of biosecurity measures, from the culling of infected animals to quarantine and mass vaccination of livestock when FMD-free status is not otherwise achievable.

In Southeast Asia, FMD is classified as 'eradicated with vaccination' in The Philippines and Timor-Leste and, until the recent outbreak in 2022, Indonesia, reflecting both long efforts to control the disease and the insular nature of the these countries, which increased the feasibility of eradication campaigns. In contrast, it was considered endemic in mainland Southeast Asia (Blacksell, et al. 2019). In Laos, the setting of our study, its place as a transit hub in the transboundary live trade in South East Asia, through which cattle originating from as far as Bangladesh and western Myanmar transit en-route to the growing Chinese market, is believed to be at the origin of frequent epidemic breakouts (Khousny, et al. 2008), with important impacts on the livelihoods of cattle producers. Nampanya, et al. (2018) estimate the cost of lost animal productivity at US$13 million, a value that is approximately 5% of the total revenue from livestock exports.

Given its low cost (US$2.1 -US$2.5 per vaccinated animal, including delivery costs, in Laos) and high efficacy (lowering infection to as little as 1%, when the entire local herd is vaccinated), vaccination plays a pivotal role in programs intended to limit such losses, as it is widely seen as one of the most cost-effective ways of protecting the health of susceptible livestock (FAO 2020). Reflecting these values, Nampanya, et al. (2018) estimate a benefit-cost ratio of 5.3 for this investment. With such attractive returns, it is reasonable to expect the continuation of high vaccine adoption rates once mass livestock vaccination programs are completed. However, this has not been the case, with vaccination rates often drastically falling after the conclusion of such programs.

Attempts to explain the low adoption of livestock vaccines are limited, with those that focus specifically on FMD being even more limited. As with other analyses of technology adoption, non-adoption is thought to reflect different market failures, either on the supply-side (in which case the limitations of manufacturing or distribution of such vaccines are typically emphasized), or demand (usually stemming from financial or informational constraints, high transaction costs, with intra-household frictions associated with gender roles receiving recent attention). The analysis of this body of work suggests several conclusions.

Firstly, the cost benefit analysis that underlies most of this work assumes that supply-side barriers, such as weak veterinary services and poor storage and distribution infrastructure, are solved, i.e that vaccines are available. Although these factors are known to affect demand, (Donadeu, et al. 2019) they are largely outside the control of individual households, so they cannot explain local heterogeneity in this decision.

Secondly, the conventional explanation for household heterogeneity and non-adoption focuses on the importance of financial constraints. Poor households face, by definition, major liquidity constraints, with limited opportunity to access the funds necessary to pay for vaccination, regardless of initial intentions (Railey, et al. 2018). It is also suggested that wealthier households are more capable of absorbing any shocks from negative side-effects of adoption, thereby reducing the risks of adopting new technologies (Bola, Wiredu and Diagne 2012).

Thirdly, accessibility to veterinary services may matter, as it determines the importance of non-monetary transaction costs, including the opportunity costs of time dedicated to accessing vaccination services. Most commonly, excessive waiting times, difficult to reach vaccination points and poor transportation infrastructure are all likely to increase the perceived costs of vaccination given the opportunity cost of the cattle producers' time as well as greater travel costs. It is possible that, once these additional heterogeneous costs are considered, estimates of benefit-cost ratio from vaccination become negligible (Railey, et al. 2018).

Finally, among the more traditional explanations for non-adoption, disease knowledge has also received some attention, following the intuition that being aware of the real effects of a disease as well as of the effectiveness of vaccines may provide motivation for producers to vaccinate their livestock (Donadeu, et al. 2019). This hypothesis has guided work on the provision of information as one way to combat low adoption rates of vaccines, although the effectiveness of these initiatives is largely unknown.

Finally, contrary to vaccination decisions in human health (reviewed, for example, in Brewer et al 2017), behavioral explanations have not received much attention. In this article, we focus on the role of present bias in explaining the low adoption of vaccines. Vaccination incurs an immediate cost (in money or discomfort) with a pay-off received in the future through the form of healthier livestock and the income it generates. As present bias reflects a desire for instant gratification, individuals who exhibit those preferences are more likely procrastinate, endlessly postponing costly immediate decisions (like vaccination).

3. Data

We use household data collected as part of a study on the impact of decentralized provision of extension services conducted between 2018 and 2020. The data used here was collected in November 2019 among 852 households across 71 villages in four districts of northern Laos (Figure 1). Among the households surveyed, 616 raised cattle and, as elsewhere in the region, the adoption of vaccination against FMD is low: only 173 producers (less than 30%) vaccinated all or part of their herd against this disease in the previous 12 months. In addition to data on the decision to vaccinate, the survey collected information on several proxies for the different vaccine adoption constraints discussed in the previous section.

[Figure 1]

Our main focus is on the importance of present bias, which we measured using a convex time budget (CTB), as in Andreoni and Sprenger (2012). Respondents were asked to choose between a smaller payment earlier versus a larger payment later, where both earlier and later were one of three different time intervals (today, in 4 weeks, and in 8 weeks).[3] These choices allow us to estimate two parameters: a measure of present bias (β) and a discount factor ($\boldsymbol{\delta}$). The median of these two parameters, representing a preference for the present per day, are 0.987 (β) and 0.991 ($\boldsymbol{\delta}$), values that are similar to those found in other studies (Andreoni and Sprenger (2012), Clot and Stanton (2014)). As found in other field studies (Ashraf, Karlan and Yin 2006, Clot and Stanton, 2014) approximately 25% of the respondents prefer the earlier payoff in all choices, preventing us from obtaining estimates of the two parameters of interest (β and $\boldsymbol{\delta}$). In the analysis, we assume that β = $\boldsymbol{\delta}$ = 0 for these respondents and include a dummy variable to account for this assumption. In addition, two observations with very large estimates of future

[3] See appendix A for instructions.

bias ($\beta > 2$) were excluded from the analysis and one respondent did not respond to the CTB task.

In addition to data on the vaccination decision and time preferences, we have data on several proxies for wealth (durables, agricultural and transport assets, all aggregated into different asset indexes using principal component analysis), herd size (number of cattle and buffalos owned by the household) and land (crop and pasture/forest area owned by the household, measured in hectares). Together, they proxy for the capacity to afford vaccination services, as well as the relative importance of raising cattle in the portfolio of household activities.

We proxy for access to vaccines and vaccination services by including proximity to the district headquarters in terms of distance (km) and in terms of travel time (hours), distinguishing between dry and wet seasons, as control variables. Although we do not have data on knowledge about the disease or the subjective evaluation of vaccine efficacy, we can control for access to official extension services (measured by the number of extensions visits by local officers) and whether the village was allocated to the pilot extension program mentioned at the start of this section.

Finally, we also control for the role of gender in livestock management, by accounting for two pathways through which women are involved in raising livestock: a dummy variable for whether a woman (household head or otherwise) has decision-making autonomy concerning cattle management practices (i.e. if they decide on the management or sales of cattle) and a dummy variable which indicates if at least one female household member is involved in the day-to-day activities of raising cattle. Additionally, we also control for the gender of the household head.

In addition to these variables, we are also able to include a set of variables that are potentially important but have, so far, been neglected: risk preferences, trust, and locus of control. Risk aversion is quantified using the approach presented in Eckel and Grossman (2003).

Respondents are asked to select their preferred option when presented with several pairs of (real) payoffs with the probability 50:50 of receiving it[4]. Trust was quantified by asking respondents about how confident they are that a lost wallet containing 200,000KIP (roughly AU$30) and their own personal information would be returned to them, conditional on being found by someone from inside or outside their village (allowing us to quantify levels of trust towards fellow villagers and outsiders). Finally, we control for locus of control (LOC), a variable that measures the strength of belief that people have control over the situations and experiences that affect their lives.[5]

We present summary statistics for these variables in Table 1, distinguishing between producers who do not vaccinate (column (1)) and those who do (column (2)). As shown in column 3, although we find no obvious difference in terms of present bias, households that vaccinate are wealthier in terms of durable and transport assets but less wealthy in terms of agricultural assets and crop land, which may suggest some degree of specialization in cattle production. Households which vaccinate also live closer to district headquarters (in terms of both distance and travel time) and are more likely to live in villages which were randomly allocated to receive the extension program mentioned at the start of this section. They are also more likely to be headed by a woman, although there seems to be no difference in terms of other variables included to measure gender differences (female participation in cattle production or decision-making). Finally, households which vaccinate also scored higher on the internal locus of control questions, indicating they believe that they have greater control over the outcomes in their life.

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[4] See appendix B for the description of this task.

[5] Respondents were asked 16 questions incorporating both internal and external factors subsequently creating two measures of LOC. See appendix C for the specific questions.

[Table 1]

4. Empirical estimates

We are interested in estimating the impact of present bias on the decision to vaccinate cattle against FMD. More formally we use OLS to estimate the following:

$V = f\ [\beta, \boldsymbol{\delta}, M, X, \varepsilon]$

where V is a dummy variable that equals 1 if the cattle producer vaccinated all or part of their herd and 0 otherwise, β and $\boldsymbol{\delta}$ represent present bias and discounting, M represents other motivations/constraints for adoption discussed in section 2 and X is a set of control variables (gender, age and education of the household head, and district fixed effects), while ε represents an error term, clustered at village level. To facilitate the comparison of the relative importance of the effect of these very different variables, they were standardised to have means of 0 and standard deviation of 1. We start by regressing this decision on the measures of time preferences (β and $\boldsymbol{\delta}$) alone and then sequentially including the variables proxying for the different explanations discussed above. The results are presented in table 2. To facilitate a judgement on the relative importance of each of these explanations, figure 2 graphically presents the estimates of the effect of each of these variables.

[Figure 2]

These results provide three main conclusions. Firstly, the magnitude of the effect of present bias and discounting is clearly important: an increase of one standard deviation in the value of β increases the probability of adoption by more than 14 percent, an effect that is substantially larger than that of the second largest influence, durable assets ownership. Secondly, the magnitude of the effect of present bias is largely unchanged across the different specifications. Finally, although the inclusion of additional control variables reduces the precision of our estimates, present bias is always significant at the 5% level. Based on these results, it seems clear that greater present bias (ie, lower values of β) are associated with lower adoption of vaccination against FMD, even when controlling for other correlates of adoption.

[Table 2]

In testing the robustness of our results, we use two different approaches. Firstly, we examine whether these results reflect either the importance of future bias (β>1) or our imputation of a value of β=0 for those respondents who always chose the earliest option. We do that by restricting the estimating sample, first by excluding those observations for whom we assumed a value of β = 0 and secondly, by excluding the observations where β>1. The results, when controlling for the same variables as in Table 2, column 6, are presented in Table 3, show that our conclusions regarding the importance of present bias remain unchanged.

[Table 3]

Our second robustness test analyzes the stability of our estimate of the effect of present bias with respect to omitted variables, using the approach proposed by Oster (2019). We assume equal covariance between the observed and unobserved variables in the model, and that the maximum R^2 (after accounting for unobserved variables) is 1.3 times the value of the R^2 in table 2 (i.e, R_{max} = 0.215). Under these assumptions, the estimated lower bound of β is 0.013 > 0, suggesting that our conclusion regarding the importance of present bias is robust to reasonable assumptions about the importance of unobserved variables. In short, present bias matters when explaining the decision not to vaccinate, and this effect is plausibly causal, given reasonable assumptions about the importance of unobserved confounders of this decision.

5. Conclusion

Despite its high returns, the adoption of vaccination against FMD among cattle producers in northern Laos is still relatively low. Perhaps unsurprisingly, given the low costs of this technology, its lack of novelty and the relatively high wealth of cattle producers, we don't find much support for traditional explanations for low adoption that rely on failures in access to credit or information.

Instead, the results presented in the previous section support the hypothesis that present bias matters in explaining this puzzle. Deciding to vaccinate involves incurring an immediate cost with delayed benefits, and producers who put a heavier weight on immediate outcomes may postpone this decision and ultimately, not vaccinate their livestock.

This result suggests that slight changes in the choice architecture faced by producers may nudge them to adopt this technology with minimal intervention (Thaler, Sunstein and Balz 2012). In other words, changing the structure of how vaccinations services are offered may have large implications in its adoption. The range of possible changes is vast, from early commitments to the use of an input (as in Duflo, Kremer and Robinson (2011)), to the definition of plans, coupled with the use of specific prompts and reminders (Milkman, et al. 2011) or, perhaps more radically, a redefinition of default in vaccination from opting-in to opting-out (Blumenstock, et al. (2018), Yan and Yates (2019)), perhaps linked with the creation of mutual obligations to vaccinate among a group of livestock producers, sustained and enforced by peer pressure (Bryan, Karlan and Nelson (2010)) that may be justified by the externalities associated with vaccination. Although all these mechanisms may face logistical problems in developing countries, their consideration enlarges the set of potential solutions to the challenges posed by present bias. Their ultimate impact, in terms of living standards in our context, is obviously an empirical question, but it is expected to be large given the importance of livestock for local economy, including towards other crucial household decisions such as education (Marsh, et al. 2016).

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Figures

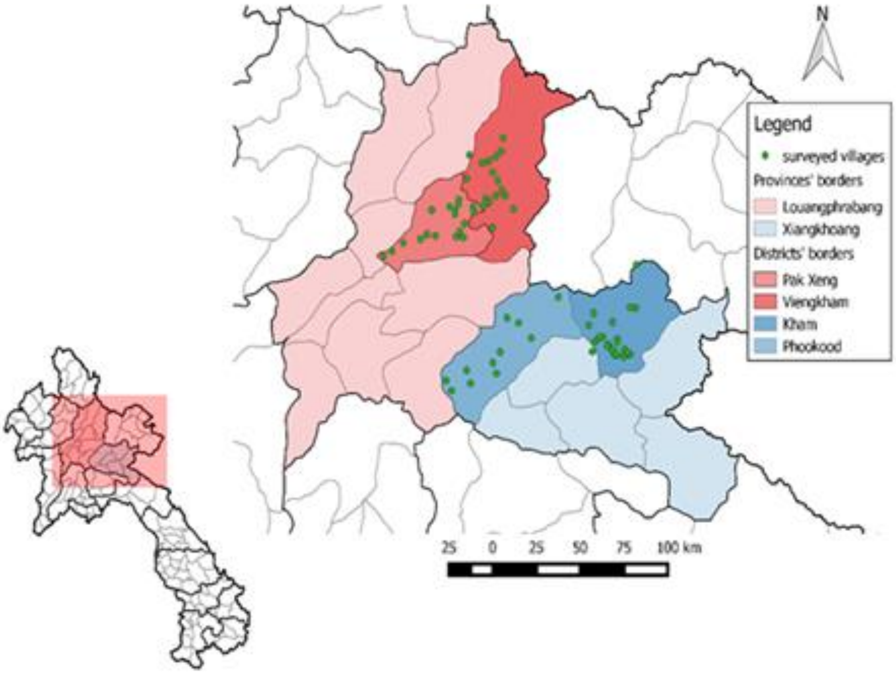

Figure 1: Map of surveyed villages in Laos

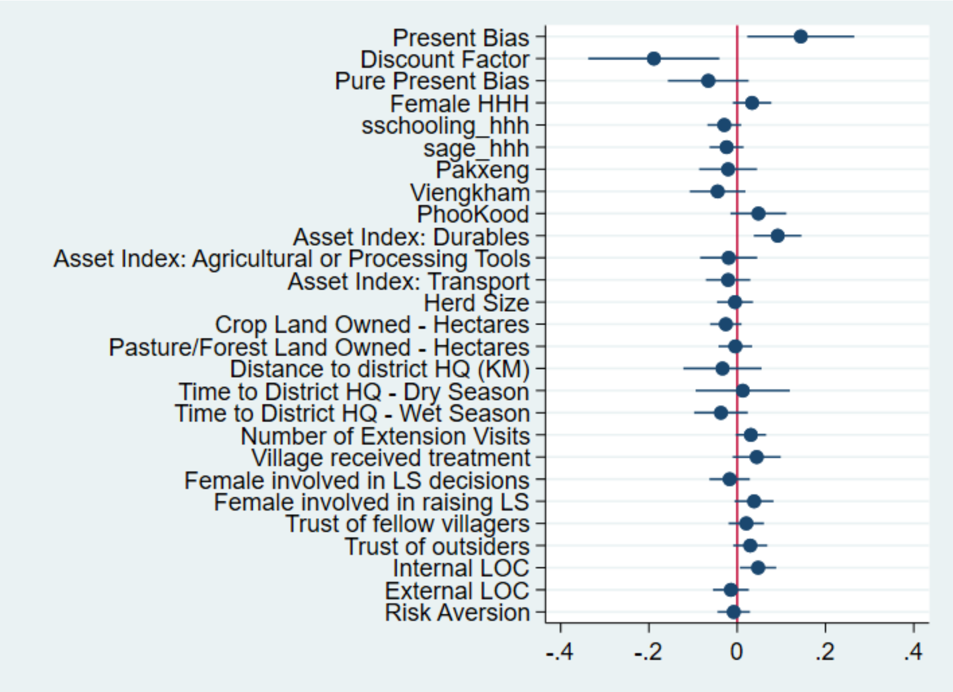

Figure 2: Explaining the decision to vaccinate against FMD (standardised coefficients with 95% confidence intervals)

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Tables
Table 1: Summary Statistics: non-adopters vs adopters

		Non-Adopters (1)	Adopters (2)	Difference
Motivation	Variable	Mean / [SD]	Mean / [SD]	(1)-(2)
Time preferences	Present Bias	0.691	0.693	-0.001
		[0.022]	[0.035]	
	Discount Factor	0.711	0.688	0.024
		[0.021]	[0.035]	
Demographics	Female Household head	0.025	0.052	-0.027*
		[0.007]	[0.017]	
	Education Household Head (years)	46.427	47.509	-1.081
		[0.612]	[0.946]	
	Age of the Household Head	5.164	5.324	-0.160
		[0.136]	[0.223]	
Wealth	Asset Index: Durables	-0.060	0.527	-0.587***
		[0.045]	[0.056]	
	Asset Index: Agricultural Tools	0.036	-0.439	0.475***
		[0.046]	[0.088]	
	Asset Index: Transport	0.050	0.270	-0.221**
		[0.048]	[0.070]	
	Herd Size	8.807	9.341	-0.534
		[0.358]	[0.658]	
	Crop Land Owned – Hectares	3.228	2.516	0.712***
		[0.144]	[0.205]	
	Pasture/Forest Land Owned – Hectares	0.743	0.585	0.158
		[0.084]	[0.110]	
Access	Distance to district HQ (KM)	28.302	22.445	5.857***
		[0.868]	[1.417]	
	Time to District HQ – Dry Season	0.973	0.676	0.296***
		[0.035]	[0.047]	
	Time to District HQ – Wet Season	2.032	1.275	0.757***

		[0.143]	[0.148]	
	Number of extension visits	4.375	4.809	-0.434
		[0.186]	[0.260]	
	Treatment village	0.432	0.607	-0.175***
		[0.024]	[0.037]	
Trust	Trust of fellow villagers	0.636	0.618	0.018
		[0.023]	[0.037]	
	Trust of outsiders	0.648	0.671	-0.023
		[0.023]	[0.036]	
Gender	Female involved in Livestock decisions	3.101	3.219	-0.118***
		[0.017]	[0.027]	
	Female involved in raising LS	2.601	2.581	0.020
		[0.019]	[0.033]	
Behavioural	Internal LOC	0.375	0.410	-0.035
		[0.023]	[0.038]	
	External LOC	0.027	0.035	-0.007
		[0.008]	[0.014]	
	Risk Aversion	1.849	1.764	0.085
		[0.121]	[0.191]	
	N	440	173	
Note: ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.				

Table 2: Impact of present bias on the adoption of vaccines against FMD

	(1)	(2)	(3)	(4)	(5)	(6)
Present Bias	0.177***	0.158***	0.152***	0.143**	0.137**	0.144**
	(0.050)	(0.048)	(0.053)	(0.057)	(0.058)	(0.061)
Discount Factor	-0.197***	-0.186***	-0.173**	-0.175**	-0.169**	-0.189**
	(0.062)	(0.062)	(0.068)	(0.069)	(0.071)	(0.074)
Constant	0.284***	0.280***	0.273***	0.276***	0.275***	0.274***
	(0.032)	(0.027)	(0.024)	(0.024)	(0.024)	(0.023)
District Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
Demographic controls	No	Yes	Yes	Yes	Yes	Yes
Assets	No	No	Yes	Yes	Yes	Yes
Access to village	No	No	No	Yes	Yes	Yes
Gender and livestock production	No	No	No	No	Yes	Yes
Behavioral characteristics	No	No	No	No	No	Yes
Observations	613	613	613	613	613	613
R-squared	0.010	0.065	0.121	0.143	0.148	0.165

Note: ***, **, and * indicate significance at the 1, 5, and 10 percent respectively. Standard errors are clustered at the village level. See Table D1 for full results.

Table 3: Robustness tests

VARIABLES	$0 < \beta \leq 2$	$0 < \beta \leq 1$
Present Bias	0.148**	0.111**
	(0.057)	(0.053)
Discount Factor	-0.188**	-0.148**
	(0.075)	(0.069)
Observations	456	380
R-squared	0.179	0.155

Note: ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Robust standard errors are clustered at the village level. Additional controls are all those included in Table 2, column 6. See Table D.2 for full results.

Appendix

A – Convex Time Budget

To elicit our parameters of β and $\boldsymbol{\delta}$, we used a convex time budget with three different time intervals (Andreoni and Sprenger 2012). The payment bounds, 34,000 Kip and 14,000 Kip, are roughly equivalent to AU$5 and AU$2 respectively. For the first time interval, shown in table A.1 respondents were asked about their preference in receiving a sum of money today or in 4 weeks. The second time interval (see table A.2), respondents were given the choice of a sum of money today or in 8 weeks' time. The third time interval was a period of 4 weeks again, however, the first payment was to be received in 4 weeks' time, and the second payment in 8 weeks.

Table A.1: CTB – Today vs 4 weeks from today

Choice No	Payment dates	Alternative 1	Alternative 2	Alternative 3
1	Today AND in 4 weeks	34,000 Kip 0 Kip	17,000 Kip 17,000 Kip	0 Kip 34,000 Kip
2	Today AND in 4 weeks	32,0 00 Kip 0 Kip	16,000 Kip 17,000 Kip	0 Kip 34,000 Kip
3	Today AND in 4 weeks	30,000 Kip 0 Kip	15,000 Kip 17,000 Kip	0 Kip 34,000 Kip
4	Today AND in 4 weeks	28,000 Kip 0 Kip	14,000 Kip 17,000 Kip	0 Kip 34,000 Kip
5	Today AND in 4 weeks	24,000 Kip 0 Kip	12,000 Kip 17,000 Kip	0 Kip 34,000 Kip
6	Today AND in 4 weeks	20,000 Kip 0 Kip	10,000 Kip 17,000 Kip	0 Kip 34,000 Kip
7	Today AND in 4 weeks	17,000 Kip 0 Kip	8,500 Kip 17,000 Kip	0 Kip 34,000 Kip
8	Today AND in 4 weeks	14,000 Kip 0 Kip	7,000 Kip 17,000 Kip	0 Kip 34,000 Kip

Choice No	Payment Dates	Alternative 1	Alternative 2	Alternative 3
9	Today AND in 8 weeks	34,000 Kip 0 Kip	17,000 Kip 17,000 Kip	0 Kip 34,000 Kip
10	Today AND in 8 weeks	32,000 Kip 0 Kip	16,000 Kip 17,000 Kip	0 Kip 34,000 Kip
11	Today AND in 8 weeks	30,000 Kip 0 Kip	15,000 Kip 17,000 Kip	0 Kip 34,000 Kip
12	Today AND in 8 weeks	28,000 Kip 0 Kip	14,000 Kip 17,000 Kip	0 Kip 34,000 Kip
13	Today AND in 8 weeks	24,000 Kip 0 Kip	12,000 Kip 17,000 Kip	0 Kip 34,000 Kip
14	Today AND in 8 weeks	20,000 Kip 0 Kip	10,000 Kip 17,000 Kip	0 Kip 34,000 Kip
15	Today AND in 8 weeks	17,000 Kip 0 Kip	8,500 Kip 17,000 Kip	0 Kip 34,000 Kip
16	Today AND in 8 weeks	14,000 Kip 0 Kip	7,000 Kip 17,000 Kip	0 Kip 34,000 Kip

Table A.2: CTB – Today vs 8 weeks from today

Table A.3: CTB – 4 weeks from today vs 8 weeks from today

Choice No	Payment Dates	Alternative 1	Alternative 2	Alternative 3
17	In 4 weeks AND in 8 weeks	34,000 Kip 0 Kip	17,000 Kip 17,000 Kip	0 Kip 34,000 Kip
18	In 4 weeks AND in 8 weeks	32,0 00 Kip 0 Kip	16,000 Kip 17,000 Kip	0 Kip 34,000 Kip
19	In 4 weeks AND in 8 weeks	30,000 Kip 0 Kip	15,000 Kip 17,000 Kip	0 Kip 34,000 Kip
20	In 4 weeks AND in 8 weeks	28,000 Kip 0 Kip	14,000 Kip 17,000 Kip	0 Kip 34,000 Kip
21	In 4 weeks AND in 8 weeks	24,000 Kip 0 Kip	12,000 Kip 17,000 Kip	0 Kip 34,000 Kip
22	In 4 weeks AND in 8 weeks	20,000 Kip 0 Kip	10,000 Kip 17,000 Kip	0 Kip 34,000 Kip
23	In 4 weeks AND in 8 weeks	17,000 Kip 0 Kip	8,500 Kip 17,000 Kip	0 Kip 34,000 Kip
24	In 4 weeks AND in 8 weeks	14,000 Kip 0 Kip	7,000 Kip 17,000 Kip	0 Kip 34,000 Kip

Appendix B: Risk Aversion

Respondents were asked which option they would choose, given a 50:50 chance of higher or lower payoff.

Table B.1: Table of pay-offs for risk aversion score

Option	Low payoff (Kip)	Higher Payoff (Kip)
1	25,000	25,000
2	23,000	30,000
3	21,000	35,000
4	19,000	40,000
5	17,000	45,000
6	15,000	50,000
7	13,000	55,000
8	10,000	60,000
9	7,000	63,000
10	5,000	64,000

Appendix C – Locus of Control

Both internal (I) and external (E) locus of control were measured by taking the average of the respective 8 responses presented in table C.1. Responses could be 1 (strongly disagree), 2 (disagree), 3 (agree) or 4 (strongly agree).

	Item	Locus of Contro
1	Whether or not I get to be a leader depends mostly on my ability	I
2	To a great extent, my life is controlled by accidental happenings	E
3	Whether or not I get into an accident with a vehicle depends mostly on how good of a driver I am	I
4	When I make plans, I am almost certain to make them work	I
5	Often there is no chance of protecting my personal interests from bad luck happening	E
6	When I get what I want, it's usually because I am lucky	E
7	How many friends I have depends on how nice a person I am	I
8	I have often found that what is going to happen will happen	E
9	Whether or not I get into an accident with a vehicle is mostly a matter of luck	E
10	It's not always wise for me to plan too far ahead because many things turn out to be a matter of good or bad fortune	E
11	Whether or not I get to be a leader depends on whether I am lucky enough to be in the right place at the right time	E
12	I can pretty much determine what will happen in my life	I
13	I am usually able to protect my personal interests	I
14	When I get what I want, it is usually because I worked hard for it.	I
15	My life is determined by my own actions	I
16	It's chiefly a matter of fate whether or not I have few friends or many friends.	E

Table C.1: Locus of Control

D. Full Results

Table D.1: Impact of present bias on the vaccination decision

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Time Preferences	Time Preferences	+ Wealth	+ Access	+ Gender	+ Behavioral
Present Bias	0.177***	0.158***	0.152***	0.143**	0.137**	0.144**
	(0.050)	(0.048)	(0.053)	(0.057)	(0.058)	(0.061)
Discount Factor	-0.197***	-0.186***	-0.173**	-0.175**	-0.169**	-0.189**
	(0.062)	(0.062)	(0.068)	(0.069)	(0.071)	(0.074)
I (β = δ= 0)	-0.018	-0.048	-0.043	-0.052	-0.054	-0.066
	(0.044)	(0.042)	(0.043)	(0.042)	(0.043)	(0.046)
Asset Index: Durables			0.125***	0.086***	0.087***	0.092***
			(0.024)	(0.026)	(0.025)	(0.027)
Asset Index: Agricultural or Processing Tools			-0.025	-0.021	-0.023	-0.019
			(0.031)	(0.031)	(0.031)	(0.032)
Asset Index: Transport			-0.008	-0.021	-0.020	-0.021
			(0.024)	(0.025)	(0.025)	(0.025)

Herd Size	-0.005	0.000	-0.001	-0.005
	(0.020)	(0.020)	(0.020)	(0.020)
Crop Land Owned - Hectares	-0.036**	-0.030*	-0.029	-0.026
	(0.017)	(0.018)	(0.018)	(0.018)
Pasture/Forest Land Owned - Hectares	-0.007	0.001	0.001	-0.004
	(0.019)	(0.018)	(0.019)	(0.019)
Distance to district HQ (KM)		-0.032	-0.036	-0.033
		(0.044)	(0.045)	(0.044)
Time to District HQ - Dry Season		0.007	0.011	0.013
		(0.053)	(0.053)	(0.054)
Time to District HQ - Wet Season		-0.030	-0.034	-0.037
		(0.028)	(0.029)	(0.030)
Number of extension visits		0.027*	0.026	0.031*
		(0.016)	(0.016)	(0.017)
Treatment village		0.048*	0.047*	0.044
		(0.027)	(0.027)	(0.027)
Female involved in making decisions (dummy)			-0.016	-0.017

					(0.023)	(0.023)
Females involves in raising Livestock (dummy)					0.039*	0.038*
					(0.022)	(0.022)
Internal LOC						0.047**
						(0.021)
External LOC						-0.014
						(0.020)
Trust in fellow villagers						0.021
						(0.020)
Trust in outsiders						0.029
						(0.019)
Risk Aversion						-0.008
						(0.018)
Constant	0.284***	0.280***	0.273***	0.276***	0.275***	0.274***
	(0.032)	(0.027)	(0.024)	(0.024)	(0.024)	(0.023)
Observations	613	613	613	613	613	613
R-squared	0.010	0.065	0.121	0.143	0.148	0.165

Demographic controls	No	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	No	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Robust standard errors are clustered at the village level

Table D.2: Robustness tests

VARIABLES	$0 < \beta \leq 2$	$0 < \beta \leq 1$
Present Bias	0.148**	0.111**
	(0.057)	(0.053)
Discount Factor	-0.188**	-0.148**
	(0.075)	(0.069)
Asset Index: Durables	0.103***	0.090***
	(0.031)	(0.033)
Asset Index: Agricultural or Processing Tools	-0.018	-0.003
	(0.036)	(0.042)
Asset Index: Transport	-0.022	-0.035
	(0.029)	(0.030)
Herd Size	0.004	-0.008
	(0.021)	(0.024)
Crop Land Owned - Hectares	-0.020	-0.018
	(0.021)	(0.024)
Pasture/Forest Land Owned - Hectares	-0.007	0.008
	(0.019)	(0.022)
Distance to district HQ (KM)	-0.043	-0.052
	(0.042)	(0.042)
Time to District HQ - Dry Season	0.031	0.030
	(0.048)	(0.053)
Time to District HQ - Wet Season	-0.062**	-0.059*
	(0.027)	(0.030)
Number of Extension Visits	0.039**	0.018
	(0.019)	(0.029)
Village received treatment	0.033	0.030

	(0.026)	(0.027)
Female involved in LS decisions	-0.031	-0.051
	(0.030)	(0.033)
Female involved in raising LS	0.038	0.039
	(0.028)	(0.031)
Internal LOC	0.037	0.043*
	(0.023)	(0.025)
External LOC	-0.021	-0.007
	(0.025)	(0.030)
Trust of fellow villagers	0.008	0.000
	(0.022)	(0.022)
Trust of outsiders	0.013	0.007
	(0.018)	(0.019)
Risk Aversion	0.313***	0.296***
	(0.037)	(0.036)
Observations	456	380
R-squared	0.179	0.155

Note: ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Robust standard errors are clustered at the village level. Demographic characteristics and district fixed effect are included, but not reported.