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Risk Preferences under Extreme Poverty: A Field Experiment¹

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Summary

The puzzle between poverty and risk aversion is still incomplete as there is no theory that can reconcile all the behaviors documented so far. This paper emerges from the fact that, recent experimental evidence, found in psychology and economics, suggests that some decisions made under risk respond to reference points (status quo and others) challenging the theory of Expected Utility. To explain such behaviors, several hypotheses have been raised, of which the Cumulative Prospect Theory of Kahneman and Tversky stands out. Yet, even this theory still presents some limitations. This paper develops a theory where individuals respond to income references, which result of diverse income related exclusion mechanisms, so referenced behaviors can be consistent with rational choices. According to this theory some income references affects the behavior, either by being near them or by deciding over high stakes that involves them. The extremely poor have the reference of the income that guarantees the consumption of calories to ensure a healthy and longer life. While the poor have the reference of the minimum income to avoid income determined exclusion. To test the reference of the extremely poor, an experimental exercise was conducted with 92 individuals from households living under poverty and extreme poverty in Bogotá, Colombia. Experiments on Baseline Risk and Loss Aversion were conducted with high stakes monetary payments; the highest was 23% of the country's monthly minimum wage. We first analyze the selection of risky options according to an order according to the risk that each option implied. Additionally an alternative method is proposed that uses an average measure of risk aversion instead of ordered options to capture the fact that there are differences in the steps. We use an analysis of a Regression Discontinuity Design where, if there is a treatment like being undernourished determined by a critical value of single variable as income then, if all the other variables does not change around the critical value, any change in a dependent variable, for example risk aversion can be explained by the incidence of the treatment. In the Base Risk exercise some households were offered the opportunity to achieve the income enough to avoid undernourishment for one month while in Loss Aversion some framed options would result in entering undernourishment. The results suggest that being below and near the reference income decreases significantly the households risk aversion while the contrary holds when being near and above. This can be understood as if the incentive to leave undernourishment significantly decreases risk aversion while avoiding it increases risk aversion.

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I. INTRODUCTION.

Do the poor stay poor because of individual preferences and apparent irrationality? Or, do they stay poor because their situation bounds the choices they have and sometimes determines their seemingly irrational choices? The two possible answers lead to different understandings of poverty³ and, in such way, different strategies to confront and fight it.

Irving Fisher stated in 1930, as cited by Cardenas and Carpenter (2006) that “[a] small income, other things being equal, tends to produce a high rate of impatience, partly from the thought that provision for the present is necessary both for the present itself and for the future as well and partly from lack of foresight and self-control”. This common belief implies that, somehow, the rationality of the poor is not consistent with economic growth and development, and that their situation is, at least partly, a consequence of their irrational choices. Understanding poverty in such way has consequences in the formulation of government policies and the attitudes of society towards those who are poor. As this has been the dominant understanding of poverty, for over 70 years the fight on poverty has focused on redistribution strategies from the “productive and rational” non poor to the “irrational” poor. This belief is still strong. For example, Tanaka et al. (2008) state that, “[i]f people are extremely averse to financial risk, they may be reluctant to create businesses that may have inherently risky cash flows. If people are impatient, they may be reluctant to invest and educate their children. Taken together, risk-aversion and impatience may explain, in part, why some people remain poor” working as a poverty trap.

But, is it true that the economic rationality of the poor differs from that of the non poor? If so, what happens when they move from being poor to non poor, will their rationality change?

³ There are various definitions of poverty, for example Sen relates poverty to a state where there is no liberty while Adam Smith related it to living without shame. This paper however defines poverty as being below a poverty line. Extreme poverty refers to the state where the individual or household cannot afford to buy a basket of food that provides them with a minimum consumption of calories.

It has to be acknowledged that the risky situation they face may affect their decision process. Duflo (2003) stated that the “[m]odern development economics emerged with the realization that poverty changes the set of options available to individuals. Poverty thus affects behavior, even if the decision maker is ‘neo-classical’”. Even if the behavior of the poor suggests that their rationality is in fact different, this paper develops a theory of rational choices where the differences in their behavior can be explained by the existence of income references.

The discussion over the rationality of the poor and how their situation bounds their choices has been enriched by a growing number of empirical studies. Yet, the empirical literature of risk aversion and poverty has found evidence that seems somehow contradictory.

On one hand, some studies have found that the poor have a higher taste for risk, which is a higher probability to undertake risky activities or choices in experiments, surveys or the real life. In uncontrolled environments, they seem to choose to live in the underground economy⁴ as described by Elijah and Uffort (2007) and Zuleta (2002) or entrepreneurship as shown by Banerjee and Duflo 2006 (BD hereafter); and in controlled environments, such as the experiments conducted by Bosch-Domenech and Benach (2005), they take higher risks.

On the other hand, some studies have found that the poor choose less risky activities following strategies such as the income smoothing, proposed by Morduch (1995). These types of behaviors are also described by Tanaka *et al* (2008).

There are even other papers, as that of Binswager (1980), which found no significant difference whatsoever⁵.

In order to explain these and other deviations from the dominant theory of expected utility (EU) proposed by Von Neumann and Morgenstern (1944, VNM hereafter), the theories that use the influence of reference points have managed to predict better than EU⁶. Even though

⁴ They define underground economy where the “[a]gents engaged in underground/ informal activities circumvent, escape, or are excluded from the institutional system of rules, rights, regulations, and enforcement penalties that govern formal agents... we can identify four specific types of “underground” economic activity: illegal, unreported, unrecorded, and informal.” (Elijah and Uffort (2007, p. 4)

⁵ Other papers that found no difference are cited by Tanaka *et al* (2008) in the references therein.

⁶ Refer to Köseguı & Rabin (2009) and the references therein. Additionally, Masatioglu & Uler (2007) compare the explanatory power of the classic theory of EU, the Prospect Theory of Kahnemann and Tversky

there have been some recent attempts to include the references the EU, such as that of Masatioglu and Uler (2007, MU hereafter), it has been the Cumulative Prospect Theory of Kahneman and Tversky (1991, CPT hereafter) the most extensively used.

The behavioral economics approach is widely influenced by the Prospect Theory (PT hereafter) of Kahneman and Tversky that was subsequently improved by the same authors as the CPT. These theories state the existence of a reference point that creates different risk behaviors related to the size of the bet and the existence of possible losses. Those who have followed this theory have taken as the usual reference points the status-quo, the lagged status quo and the mean of a chosen lottery⁷ as well as objectives established by the households themselves⁸.

Still, all of these theories have some limitations. Some of them do not make it clear on how the reference points are established. Others do not solve how, if every household establishes its reference points independently, can this help us predict the behavior of society. If the reference point is the status-quo, why are there some households, especially the poor, which will not defend their status quo by undertaking less risky activities?

Duflo (2003) emphasizes that, regarding poverty, “[w]hat is needed is a theory of how poverty influences decision-making, not only by affecting the constraints, but by changing the decision-making process itself.” This paper is an attempt to elaborate such theory. It proposes a mechanism, related to time and access to markets that differ in size, which incentivizes apparently irrational behaviors. This mechanism works in the presence of income references, created by efficiency reasons and ultimately reflected in the consumption, labor and investment markets. Such references are common for all the agents and give reason of unexpected variation in risk aversion when income is near the critical points or when the stakes are high enough. The resulting value function with jumps allows, in contrast with theories such as that of MU, PT and CPT, to predict some social behaviors since the critical points are common to all the households. This Objective Function can also

and an alternative theory that they propose. They also show that the explanatory power goes from 58% of EU to around 70% when the reference points are introduced.

⁷ Köseguir and Rabin (2007).

⁸ These alternative approaches usually come from the psychology for example the reference of aspirational levels developed by Lopes (1987).

reconcile the two behaviors documented for the poor of “income smoothing”⁹ and risk loving¹⁰.

This paper focuses on the case of the poor and the extremely poor. In the case of the extremely poor, the revealed preference will vary depending on the availability of means, or lack of them, to effectively secure a minimum consumption that ensures a healthy and longer life; in the case of the poor, to secure the income enough in order to avoid income determined exclusion. Additionally, numerous discontinuities are proposed, so market determined behaviors are not only expected from the poor but they are only more frequently observed on them. This is because, in order to see market determined behaviors in higher strata, the stakes have to be higher.

An experiment was carried out in order to test the reference of the extremely poor providing evidence that suggest that the poor identify the reference and that being near to the reference affects their behavior attitudes towards risk.

The remainder of this paper is organized as follows: Section II presents some literature on poverty and risk aversion that suggest some patterns in this relationship; III is a literature revision on the utility approach to risk; section IV develops the theoretical model of the value functions with jumps; section V presents the econometric analysis; and section VI that closes the paper providing some concluding remarks.

II. SELECTED EMPIRICAL EVIDENCE

This section is a small survey of papers that suggest some patterns and behaviors that relate poverty and risk aversion. For consistency with the remainder of the paper, it is restricted to the evidence that can be directly related with income, assets or total wealth.

Nielsen (2001) found in Madagascar that the most poor amongst a society of miners usually undertake activities with a high risk on the returns, even when there exists the option of

⁹ Murdoch (1995) finds that the poor seem to follow a strategy of Income Smoothing instead of the most common strategy of Consumption Smoothing. He says that, because the poor are more vulnerable to adverse shocks, they will choose activities with lower returns but lower risks minimizing the exposure to downward results.

¹⁰ Banerjee (2006) shows that effectively, a great proportion of the poor and the extremely poor choose to undertake risky activities such as the entrepreneur. However, when they undertake such enterprises, they do it at non optimal scale and with a very low probability of success, due to the lack of access to credit (loans) and probably also psychological issues related to be doing something they, otherwise, wouldn't do.

fixed wages. He finishes with a reflection on why, if the probability of finding a gem is extremely low they would continuously choose to keep on looking for gems? Banerjee and Duflo (2006), when they characterized the activities that the poor choose to generate their income, arrive to the conclusion that “[i]n several ways, the poor are trading off opportunities to have higher incomes”. They also show that lots of poor households are involved in high risk activities specially entrepreneurship. Finally they find that, simultaneously, even in the rural sector, specialization is not common nor do they diversify their sources of income in order to be able to mitigate the risks of idiosyncratic shocks on the activities. Diversification, in this case, increases the expected value of the gains, but also decreases the probability of exceptionally high gains. Lack of diversification can be understood then as a risky choice, probably chosen because it opens the possibility to cover the minimums.

Some preference reversals associated with the income and changes in the size of the stakes are documented by Bosch-Domenech & Benach (2005). They find that, on average, more accommodated participants tend to risk more when the stakes are low, but this pattern does not hold for the large sums. This reversal is expected when the new size of the stake includes a reference that was not included up to that moment. Because the poor have their references closer to their endowed income, the preference reversals will appear first in them.

Specifically related to the subsistence, Dillon and Scandizzo (1978) found that whenever the subsistence was at stake, when there is a possibility of getting payments lower than those that assured the minimum, risk aversion increased whenever the possible payments decreased. However, once the subsistence is assured, the risk aversion decreases.

Finally, Barclay's (2007) made a survey with 790 mass-affluent (with at least \$100,000 in investable assets), high net worth (with at least \$1 million in investable assets) and ultra high net worth individuals (with in excess of \$3 million in investable assets). In this survey they found some evidence that would suggest a strong reference in the million dollars worth of assets. They claim that, “[w]e often see attitudes to risk change after people have realized their wealth. Wealthy individuals tend to become more risk averse than they have been in the wealth creation phase of their life. While high appetite for risk is seen as an

important influence on the wealth of those at the upper end of the asset spectrum of US\$1 million, those same individuals do not necessarily take more risks in their investments once they are wealthy.”¹¹ Now if we wonder, why those below the threshold did not invest in the same financial products as those above in the first place, as it seems the returns on those are high enough to maintain the High Net Worth’s life style?, they provided a simple response associated with costs of entry: “Respondents with assets in excess of US\$1 million are more likely to have invested in hedge funds, derivatives and private equity in the past three years than those with assets below that threshold. One reason for this is structural – most of these investments carry a minimum investment that is sufficiently high to restrict them to the top wealth brackets.”¹²

III. LITERATURE REVISION ON THE UTILITY APPROACH TO RISK

A. EU and Single Time Decisions

Even though the concept of economic risk appears in the literature since the eighteenth century, it was only in 1944, when VNM defined the EU, that it could be defined in an abstract manner for the first time. In 1948, Friedman and Savage complemented the work of VNM and defined for the first time the taste or aversion for risk; in their paper, besides the widely known and used concave utility function, they open the possibility to utility functions with several inflection points (see figure 1). If this would be the case, they claimed that their theory could explain why there are households that simultaneously play lotteries and take insurances. However, Markowitz (1952) argues that the S Shaped utility function would also mean that the rich households near the inflection point would not take insurances against great losses with low probabilities of occurrence, and that they would never accept a fair game; nonetheless, the concept of risk aversion remained. He proposed, instead, a utility curve with three inflection points (see figure 2) where the second one is the “customary” wealth that coincided with current wealth in most of the cases. He expected the poor to have the first and third inflection point closer than a middle class individual

¹¹ Barclay’s (2007) p.6

¹² Ibid p. 12

while the rich would have those inflection points farther. Pratt (1964) widens the classical theory of risk by including the concept of risk prime.

Still, almost as long as EU has existed, there has been a documentation of behaviors that cannot be explained by it. These behaviors have been issued as paradoxes; the persistence of such paradoxes has raised the necessity to complement or reconsider EU.

Specifically addressing the issues of poverty and preference reversals, the orthodoxy offers several alternatives. The first one is that such behaviors are not paradoxes as the poor seem to have a different risk aversion from those that are not poor; however, it has never been explained why the poor should be different, this is just an assumption made by the models. Cox and Sadiraj (2002) and Masagtioglu and Ok (2006) propose, in a more axiomatic approach how the aversion for losses can be fitted into EU. Cox & Sadiraj proposes imposed references while Masatioglu & Ok establish a status quo bias due to restricted decisions.

B. Time Discounting

Given the recurrence of paradoxes in some specific settings of interest, one of the alternatives was to include several periods in the analysis. The theory of Discounted Utility (DU hereafter), initially proposed by Samuelson (1937) has varied through time¹³. An example of the classic DU is Sandmo (1970) who studies the case for two periods. In these early models, the way to discount was through a time invariant discount rate. However, even after DU was included, some analogous paradoxes to those of EU exist as it is presented by Lowenstein and Prelec (1992). In this field, again, it has been the behavioral economics, with the hyperbolic and quasi-hyperbolic discount rates, the approach that best fits the data and can explain anomalies that are present in the standard discount rate¹⁴.

When time is introduced in the evaluation frame, the same question arises when looking at the explanation offered by the orthodoxy that the poor have higher discount rates¹⁵. Why would the poor differ from those who are not poor? In fact, if this is the case, it would be

¹³ For a very good summary of DU theories refer to Frederick *et al.* (2002).

¹⁴ Actually, “the first suggestion of other ways to discount was made by an economist, Strotz.” (Frederick *et al.*, 2002, p.8). But the recent papers on this approach come from the Behavioral economics area.

¹⁵ Nielsen 2001.

expected that a household, that was poor in the previous period but is not poor this period, changes its discount rates according to the situation.

C. Reference Dependent Behaviors

Finally, reference dependence is a behavior that has been frequently observed. Reference dependence means that the behavior is influenced by some reference as the present endowment (status quo), aspirational levels (self induced objectives) or other. In such a way, Masatioglu (2007) shows that the EU theory is a weak theory, explaining around 50% of the variability, against 70-75% that is explained by theories such as PT or modifications of the classical theory as Masatioglu and Ok (2006) that include the existence of references in the decision making process.

1. Alternative to EU: PT and CPT

Given that standard EU, as it has been remarked by Rabin (2001), has been insufficient to explain a wide range of behaviors, various alternatives have been proposed, standing out PT and CPT. Wu, Zhang and Gonzales (2004) describes Kahneman and Tversky's seminal paper of PT as if "they presented convincing empirical demonstrations that highlighted some general descriptive deficiencies with expected utility, as well as a powerful formal theory for organizing these demonstrations", while they did it with "an unique combination of simplicity and depth".

If a household presents their proposed utility function then, being under the reference point or deciding over probable loses, will generate a risk loving behavior while being higher than it or deciding over feasible wins will result in risk aversion. PT and CPT propose a utility function that suffers a change in the concaveness at the reference point, convex before the reference point and concave after it (see figure 3). Wu *et al.* explain that their four-fold pattern can be explained with a *value function* and a *probability weighting function*. The probability weighting function over weights small probabilities and under weights medium and large probabilities.

2. Subsistence as a Reference

Rank dependent functions¹⁶, from the followers of PT, and safety first strategies¹⁷, from the followers of EU, have been some other options proposed. Safety first is directly related to subsistence as Masson's utility function with a jump (see figure 4). The only short come of these theories is that safety first is assumed to the model, commonly introduced as a fixed cost of falling below the level, but not explained.

Another alternative has consisted on utility functions that remain being zero until a minimum point and after that the individual has a normal utility function as that of Zuleta (2002, see figure 5). This goes along with the theory of Sen (1999) who stated that, the individual that is living below the minimum to be free, in his or hers society, will enter a state of depression that will make him indifferent to any combination of values below the minimum¹⁸. This means risk neutrality for those below; if the decision involves both levels above and below the minimum, then the household will be risk lover; and if the decision only involves levels above the minimum then it will be risk averse.

3. Recovering EU: including Reference Dependence in EU

Recently there have been some attempts to introduce reference dependence in EU as that of Masatioglu and Ok (2006). Mentally constrained sets, which depends on the status quo, modifies how the utility function fans out from the origin in a Machina Triangle. These slight variations make reference dependence consistent with EU. However, their proposals lack of the simplicity of EU or CPT.

D. State of the Art

Even if there is a consensus that standard EU is sufficient, currently there is no consensus over which alternative theory is the best to describe the individual's behavior under risk.

On one hand, recent EU modifications have been able to incorporate many behaviors by introducing some minor variations as Masatioglu and Ok (2006) do for reference

¹⁶ Refer to Wu *et al.* (2004) for a survey in choice under risk.

¹⁷ For example Dillon and Scandizo (1978).

¹⁸ However in experiments made with individuals in poverty and extreme poverty, over options that did not provided the possibility to change their status, exists significant variability on risk aversion. Some evidence is found in the data obtained in the experiments made by the BID during 2007.

dependence, but these attempts lack of the simplicity desired in general theories. On the other hand, Behavioral Economics with PT and CPT have increased the number of followers as the deviations from EU are consistently found in economic experiments and it is more empirically concordant. However, still PT and CPT lack the parsimony of EU and suffer from some “paradoxes” of its own. PT, “[i]n particular, permits ‘non-transitive preferences,’ which is subject to the usual ‘money-pump’ arguments, and ‘non-convex indifference curves,’ which often results in extreme choices (corner solutions)”¹⁹ and, as Wu *et al.* (2004, p.408) remarks, “admits stochastic dominance and is limited to two non-zero outcomes”.

Classical alternatives as the one of MU, and the behavioral alternatives of PT and CPT, have aggregation problems.

This paper retakes DU in the form of a value function, which only differs from EU, on the jumps. This ensures that all the desirable characteristics are maintained if no jumps are included, but the existence of these jumps can explain referenced behaviors.

IV. THEORETICAL ANALYSIS : THE VALUE FUNCTION WITH JUMPS

Traditionally, the analysis of decisions under risk has depended on the number of periods that involve the decision taken: if the decision is made only once, with immediate realizations of the risk, then the analysis is restricted to a single period, but if the decision has its realizations in more than one period then the frame used is one that includes several periods of time.

This logic, even if it seems to be quite obvious, is not always correct. This is because the realizations of the risks taken in a onetime decision can have repercussions in the future. Let us imagine that you are presented with a game that has only two options: either you take one million dollars for sure or, depending of the toss of a coin, gain zero or five million dollars with equal probability. This decision is taken only once and the gains are given immediately.

Even if this game is played only once, the outcome will most likely have consequences in your future so it seems that the question of how many periods we should include in our

¹⁹ Masatioglu and Ok 2007

analysis does not only depend on the number of periods that the decision has but also on the size of the gain.

The remainder of the section provides some reasons, related to efficiency generate income based exclusion. This is translated into different market sizes offered to different income levels. This process of exclusion, and the fact that the income can be modified in time, affects the behavior if one or more references are at stake in any given decision.

The theoretical construction of the model will be developed in two complementary parts. First, we provide some feasible reasons for the discontinuities and explain where they are expected to be found. And second, we explain the mechanism of how these references modify the behavior, of those deciding on changes around the references. The model of the value function with a jump is constructed for a discrete time. In every period, the household makes choices that may, or may not, affect the future access to consumption of certain goods and services, periods of life or production activities. Whenever today's decisions have potential impact on the level of exclusion, we expected changes in the risk aversion.

We will consider a household as both, consumer and producer, so "market" refers to both: goods and productive activities.

A. Why Jumps? Efficiency Reasons for Exclusion Based on Income.

People usually think that if we restrict our analysis sufficiently, for example to a geographical territory like a city, then we can talk of a unique market open to all the households in that city. That is because you are probably used to be able to freely enter a shop and choose any product of our preference and then consume it. If we are able to do so, it seems natural to think that everybody can do the same. But, is this true for everybody? Arrow states that,

*"In particular, one of the most powerful constraints on an individual's freedom of action and choice is the size of his budget. His income determines his freedom to choose his consumption matter or to shift to jobs that are pleasanter or more rewarding personally. The price system does not provide within itself any defensible income distribution. In fact, the price system tends to obscure the fact that low income is a restriction on freedom. In such way, the average consumer is apt to ignore the fundamental restriction on the consumer's opportunities implied by poverty"*²⁰

²⁰ Arrow (1985)

Adato *et al.* (2006, p. 229) classify the manifestations of exclusion into the economic and social dimensions. “The economic dimension refers to exclusion from the opportunities to earn income, the labour market and access to assets. The social dimension refers to exclusion from decision making, social services and community and family support.” The dimension of our concern is the economic as it is directly related to the market. Indirect relationships, between poverty and other types of exclusion are most likely to exist but this subject is left open for further research.

Whenever talking about exclusion or discrimination, one immediately think of individual inborn characteristics that cannot be changed in time. This is how the IADB in their IPES 2008 states that “[s]ocial exclusion has been used to conceptualize the restrictions that hindered the functionings and access to opportunities of certain specific groups (women, indigenous peoples, afro-descendants and the handicapped).”²¹ Some authors, Klasen for example, have even compared being excluded to having a physical disability.

Even if it has been also said that “[e]xclusion is by nature a multidimensional, dynamic social process and therefore is not the ‘consequence’ of some particular ‘cause’ (in the sense of an event that precedes an outcome, without which the outcome would not have happened)”²², the exclusion is not always determined by time invariable characteristics, as gender, race, or a physical condition. Latinbarometer (2008) show that Latin Americans perceive poverty as the most important cause for being discriminated against and thus being excluded (see figure 6).

Here we identify five reasons to exclude an individual, based on the income, from the consumption of a good or from productive activities.²³ The main difference, between the income based exclusion and the types of exclusion based on time invariable characteristics, is that the income can be changed in time.

²¹ IPES 2008 “Outsiders? The Changing Patterns of Exclusion in Latin America and the Caribbean” p. 6

²² Ibid.

²³ This paper is not expected to be comprehensive. Most likely, there are additional reasons that could not be identified but the five proposed are sufficient to develop the theory proposed.

1. The Price

The price of equilibrium is the ultimate manifestation of efficiency in the markets as it is expected that it matches supply and demand. What is not evident, as stated by Arrow (1985), is that in this process is that if an individual's/household's budget is low enough, then the individual/household will be excluded from the consumption of any good or service beyond its budget restriction. Because most market societies also have markets for the food and the provision of basic services, in these specific cases, what the price is determining is the access to the necessary requirements for survival or the requirements to not be discriminated on the base of income.

2. Fixed Costs of Productive Activities

Productive activities with high returns usually have fixed cost. These costs represent an unbearable barrier of entry to those whose income is not enough to cover the costs and no access to credit. Argüello and Zambrano (2006) emphasize the importance of the fixed costs in the rural sector as the main determinant of the access to high return investments. In this case, the presence of fixed costs generates a poverty trap where the poor, which are below an asset threshold, are lead to the equilibrium with low investment rates and low returns. In such way, the reluctance of the poor to adopt new technologies in the rural sector, widely documented (Yesuff and Bluffstone, 2007, and the references therein), can be partially explained by the fixed costs of the new technologies combined with limited or lack of access to credit and extremely low saving capabilities.

3. Minimum Investments

Some markets, including the financial markets, present very high degrees of concentration on the supply side. Suppliers can follow then monopolistic or oligopolistic strategies. Even under strict regulations, these strategies are only diminished but do not disappeared as seen in the financial markets. These concentrated markets include the supply of goods: inputs in the case of the industrial

sector and merchandize in the case of commercial sector, or the financial products (investment options), in the case of the financial sector.

Amongst the strategies they use is to discriminate on prices or returns. The differential prices can then be interpreted as costs of entry, not to the activity itself, but to lower costs or higher returns respectively. In the industry and commerce sector, buying its inputs from a supplier that can discriminate prices will be translated into different returns, depending on the quantity of input or goods bought, as the average costs change. The maximum amount that can be bought is constrained by the budget, so ultimately their total return will depend on the budget. In the case of the poor the budget is so low that, as Banerjee and Duflo (2006) present, “[g]iven that they have no money, borrowing is risky, and in any case no one wants to lend to them, the businesses they run are inevitably extremely small, to the point where there are clearly unrealized economies of scale”. In the financial sector, for example, Barclay’s (2007) find that the investors with investable assets below \$1 million choose different financial products than those above that threshold. They explain this behavior, not from possible differences in the risk aversion, as both groups concurred in the importance of risk taste, but from the existence of minimum investments for some of the high return investments.

4. Risk Signs

One sign of efficiency is to minimize costs. In some cases, this includes minimizing thefts and vandalism from both: consumers and employees.

a) On Consumption

Anecdotic evidence suggests that one of the basic and efficient strategies that the firms have developed is to prohibit the entry of individuals with “signs” of a high risk to steal. This same evidence suggests that the most common signs to be looked at are those related to clothes and sanitation. The group of people that are most likely to present such signs includes, amongst others, extremely poor and working people without the available income to buy what is necessary.

The exclusion for this reason even reaches the level of excluding individuals from the consumption of public goods and/or services. The case for public goods/services appears most of the times when the provision of those is given to the private sector. An article from a magazine in Colombia called SOHO (2005) provides evidence on that exclusion when they showed the case of a public park in Bogota. This park is surrounded by bars and restaurants whose clients belong to a middle-high and high socioeconomic class. In this specific case, the provision of security of a public park had been practically taken by a private firm; this firm was “prohibiting the entrance to the public park of people they would consider to be pauper”, the article continued, “Not to be suspect to be dangerous delinquents, but only pauper: they would see the clothes that each individual had, and if they had the ‘intuition’ that they came from the popular neighborhoods, they were beggars or they were hawkers then, they would arbitrarily claim their right to veto their entrance”. This type of exclusion has made that the poor, expecting this type of treatment, will in many cases exclude themselves by avoiding the situation.

b) On the Labor Market

Highly related to the latter, anecdotic evidence suggests that the risk of theft when the prospect worker is poor, or with “nothing to lose”, is perceived as high. Consequently, one individual of the household with characteristics similar to those described above won’t be considered to jobs where he or she has responsibilities over goods that can be easily stolen.

5. Underperformance

One of the consequences of starvation and daily undernourishment is that the productivity, of the individuals that suffer from any of these situations, is expected to be significantly lower. This is because such states slow down their physical and mental activities.

Based on the reasons described above, the society generates an exclusion process that depends on the income level. This means that two similar individuals, who only differ on

their income, are most likely to have different future paths only due to their different options available. The paths would depend on the relative position around a reference income, one with more exclusion and one with less exclusion.

Current income will determine how incomplete is the market the household faces today, but its decisions on consumption, labor supply and investment will also determine its future income and, for some cases, the level of exclusion.

B. Where Can We Expect the Jumps?

Based on the reasons for exclusion explained, we describe the two reference points related to poverty and extreme poverty and suggest how to find the other references that affect the non poor.

Because the first two references exist due to different mechanisms, we make the mathematical modeling for these two. All the remaining proposed references work in an analogous manner to the second discontinuity.

1. Minimum Consumption of Calories to Ensure a Healthy and Longer Life.

There are four nutritional states related to the consumption of food: Starvation, Daily Undernourishment, Properly Nourished and Obesity (not of our interest).

Starvation is the situation where the consumption of calories is extremely low or null. This state can rapidly lead to death, even though in most cases the death will be a result on a different disease that appeared by the cause of starvation²⁴. As the losses in life expectancy for this state are very high and quick, the incentive of leaving this state is very high.

Daily undernourishment is the most common case for poor households in the developing countries; it means not getting the minimum consumption of calories and vitamins necessary for a healthy life. The effects of being on this state does not restrict only to a lower life expectancy but also to general weakness (that can be considered as a reason to be

²⁴ A full description of the starvation process can be found in Concepts of Human Anatomy and Physiology Fifth Edition

excluded from a physical job) and mental slowness (that translated into difficulties in learning and understanding).²⁵

In a market society, in order to obtain food, as well as other basic goods and services, the households have to pay a price. If the income is very low then the households won't be able to reach the minimum consumption of calories. If that minimum is not reached then all the consequences related to the state of undernourishment are suffered including a lower life expectancy. According to this, the income needed to buy the minimum food in order to have a healthy life is the most immediate reference for the extremely poor.

Banerjee and Duflo (2007) have found sufficient evidence to assure that "[t]he poor, and particularly the extremely poor, have a lower chance of survival than those who are somewhat more well-off." More emphatically, "[o]n balance, [they] are tempted to interpret the evidence accumulated as revealing, at least in part, that poverty does kill."

Short-term effects are not so easily identifiable as they are only mental or physical weakness; exclusion based on the perception of risk of theft is not very likely but the incentive of hunger persists. In the long run, identifiable physical and mental characteristics arise under these states. All these characteristics are easily perceived by other persons or group of people making the exclusion more likely. Because the early childhood is the period where the body builds up, the future effects on possible exclusion of persistent hunger or starvation are higher making this a critical age. Persistence of undernourishment generates invariable characteristics in the long run that can generate exclusion as stunting (low height for age), wasting (low weight for age) and underweight.

Fafchamps (1999) stated that, "[f]aced with the choice between enjoying leisure now and starving later or investing time in a risky activity such as crop production, risk averse households naturally choose to take risks and produce."

²⁵ "Daily undernourishment is a less visible form of hunger. For weeks, even months, its victims must live on significantly less than the recommended 2,100 calories that the average person needs to lead a healthy life. The body compensates for the lack of energy by slowing down its physical and mental activities. Hunger also weakens the immune system. Deprived of the right nutrition, hungry children are especially vulnerable and become too weak to fight off disease and may die from common infections like measles and diarrhoea". The World Food Programme (WFP)

2. Exclusion on Productive Activities or Consumption of Certain Goods.

All the references beyond the minimum to survive can be fitted into this category; however, even though the mechanism is the same for all of them, there are different implications for each reference. All of these references provide access to productive activities with higher returns. Exclusion based on income, from fixed costs of productive activities to underperformance are relevant for these references.

Lack of access to credit makes the poor excluded from productive activities mainly because of the fixed costs associated with certain activities. These activities are expected to have high returns. In this case, the discontinuity will respond to changes in the future returns over the investments of time and capital.

In Colombia, for example, the Fixed Term Certificates (CDT's for its acronym in Spanish), a very low risk investment, have different returns depending on the amount invested. If the amount is higher, the average return is higher. Other example, even though it is not properly documented, is the probability of getting to certain jobs. Anecdotic evidence suggests that the income may become a requisite on the access to some jobs by two different means: in the lower levels, an individual with very few assets or very low income represents a threat in security when the job comes with responsibility over easily stolen goods; and a person with nutritional deficiencies is expected to be less productive.

Finally, for example, Argüello and Zambrano (2006) find that the returns in the agricultural sector in Colombia have 2 inflection points. Very low levels of assets will lead to an optimal assets value with low return investments while, assets higher to a determined point generates higher investments and higher returns. All this seems to be associated with fixed costs that represent barriers of entry to certain productive activities.

C. How is behavior influenced by the References?

First we construct the value function with jumps and then we develop a decision model that takes into account the existence of the jumps.

To model the theory proposed, we use forward looking households that maximize value functions. These functions can be considered as an extension in time of EU. The value function is one that discounts the instantaneous utility obtained by optimal decisions made

in the future and adds the utility obtained in the present period. This extension remains in line with the theory of DU as we won't need to deviate from a single discount rate²⁶.

We depart from an individual that maximizes the sum of the expected utility derived from consumption in the present period and the discounted value of future instantaneous utilities obtained in the future consumptions. The future instantaneous utilities are those obtained under optimal decisions on the future. Because we focus on the poor and the extremely poor, we will assume no access to credit markets so the consumption is restrained by the income $C_t \leq M_t$, where M_t is the total budget in the time t .²⁷ We also assume that there are no costs of selling assets so assets and income are perfectly convertible, zero real returns on the assets ($r - \pi = 0$) and zero depreciation. In this manner, the budget in t , M_t , is composed of labor income in that period and the capital: $M_t = w_t l + K_t$, where the accumulation process is described by $K_t = M_{t-1} - C_{t-1}$.

The value function, $V_t(C_t)$, assigns a real number to a combination of present and future consumptions so it can be made a cardinal relation between preferences of the form $A \preceq B$ where A and B equals the total assets plus the gain of each decision.

In the absence of exclusion, the value function would be:

[Eq. 1] Value function with no exclusion.

$$V_t(C_t) = U(C_t) + \sum_{i=t+1}^T \beta^i \cdot V_i(C_i^*)$$

[Present utility] + [Discounted Future Utilities]

where T is the life expectancy and β is the discount rate. In this case, the future becomes irrelevant as it can be considered as a constant so the individual behaves according to EU.

However, in the presence of exclusion, the future path will depend on one of the following three variables depending on the case:

- a. Present consumption of food in the case of extreme poverty
- b. Present consumption of basic goods (including food) in the case of the poor
- c. Assets of the next period in the rest of the cases.

The resulting value functions will be:

²⁶ "A central assumption of the DU (Discounted Utility) model is that all of the disparate motives underlying intertemporal choice can be condensed into a single parameter the discount rate". Frederick *et al.* (2002).

²⁷ Including these options would only add to the complexity but the intuition remains the same.

[Eq. 2] Value functions with exclusion:

a) Extreme Poverty and loss of life expectancy

$$V_t(C_t) = U(C_t) + \begin{cases} \sum_{i=t}^T \beta^i \cdot V_i(C_i^*) & \text{if } C_t \geq C_{\min food} \\ \sum_{i=t}^{T-loss} \beta^i \cdot V_i(C_i^*) & \text{if } C_t < C_{\min food} \end{cases}$$

b) Poverty and exclusion from consumption and productive activities

$$V_t(C_t) = U(C_t) + \begin{cases} \sum_{i=t}^T \beta^i \cdot {}^{high}V_i(C_i^*) & \text{if } C_t \geq C_{basic needs} \\ \sum_{i=t}^T \beta^i \cdot {}^{low}V_i(C_i^*) & \text{if } C_t < C_{basic needs} \end{cases}$$

c) Exclusion of productive activities or higher returns

$$V_t(C_t) = U(C_t) + \begin{cases} \sum_{i=t}^T \beta^i \cdot {}^{high}V_i(C_i^*) & \text{if } K_{t+1} + M_t - C_t \geq K_{\min of entry} \\ \sum_{i=t}^T \beta^i \cdot {}^{low}V_i(C_i^*) & \text{if } K_{t+1} + M_t - C_t < K_{\min of entry} \end{cases}$$

The references on equations 2.a. and 2.b. are of a consumption level, however these references are ultimately of an income level as income determines the maximum consumption. The difference in the future path for 2.b and c respond to ${}^{high}w_{t+1} \cdot l > {}^{low}w_{t+1} \cdot l$. The graphical representation of the resulting value function for the case of one jump can be seen in the figure 7.

The existence of the jumps on the references will affect the behavior of those with options involving gains in both sides of the references.

D. How the Presence of the Jumps Affects the Behavior?

First we explain what the decision procedure of the households is:

- 1) All the possibilities are evaluated to see if any has final capital in both sides of a reference.
- 2) For those with final capital in both sides, add the gain or loss in the future value taking into account the probability of that event.
- 3) With a similar evaluation of expected utility, choose the option of the higher expected value.

Step two is consequence of a simplification that uses the following identity.

[Identity 1] Transformation of the future value

$$\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) = \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) + \left[\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) \right]$$

Or by analogy,

$$\sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) = \sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \left[\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) \right]$$

In the case of an extremely poor facing two options with equal expected value: a riskless option with consumption below the $\text{ref}C$ and a risky option with a probability p to finish below the $\text{ref}C$ and probability $(1-p)$ to finish above the riskless option so:

$$\text{lower}_{\text{risky}}C < \text{riskless}C < \text{higher}_{\text{risky}}C$$

and

$$p \cdot \text{low}_{\text{risky}}C + (1-p) \cdot \text{high}_{\text{risky}}C = \text{riskless}C$$

The preference relation $\preceq$ is determined by calculating which option has the highest expect value, so we have to determine the following inequality

[Ineq. 1]

$$\begin{aligned} U(\text{riskless}C) + \sum_{i=t+1}^T \beta^i \cdot \text{low} V_i(C_i^*) &\geq p \cdot \left[U(\text{low}_{\text{risky}}C) + \sum_{i=t+1}^T \beta^i \cdot \text{low} V_i(C_i^*) \right] + (1-p) \left[U(\text{high}_{\text{risky}}C) + \sum_{i=t+1}^T \beta^i \cdot \text{high} V_i(C_i^*) \right] \\ &\quad \text{using identity 1 ...} \\ U(\text{riskless}C) &\geq \left[p \cdot U(\text{low}_{\text{risky}}C) + (1-p)U(\text{high}_{\text{risky}}C) \right] + (1-p) \left[\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) \right] \end{aligned}$$

So we can observe that the difference between EU and the value function with jumps is the gain in the future value, weighted by the probability of a high gain.

If the individual is risk averse in present consumption then,

$$U(\text{riskless}C) > p \cdot U(\text{low}_{\text{risky}}C) + (1-p)U(\text{high}_{\text{risky}}C)$$

So the final decision will be

$$\begin{cases} \text{choose risky if } (1-p) \left[\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) \right] > U(\text{riskless}C) - \left[p \cdot U(\text{low}_{\text{risky}}C) + (1-p)U(\text{high}_{\text{risky}}C) \right] \\ \text{choose riskless if } (1-p) \left[\sum_{i=t}^T \beta^i \cdot \text{high} V_i(C_i^*) - \sum_{i=t}^T \beta^i \cdot \text{low} V_i(C_i^*) \right] < U(\text{riskless}C) - \left[p \cdot U(\text{low}_{\text{risky}}C) + (1-p)U(\text{high}_{\text{risky}}C) \right] \end{cases}$$

We depict in figure 8, a choice where an individual that is risk averse in present consumption choose a risky option.

E. Multiple Discontinuities

If we take into account multiple discontinuities, as it is proposed, then we end up with a value Function as that in the figure 9.

Now, with incomplete information, the socioeconomic class is most likely to be used by the individuals as a proxy for income levels so the references beyond extreme poverty and poverty are most likely to be the minimum income to live in a certain socioeconomic level. Friedman and Savage (1948), when they proposed the S shaped utility function, expressed that “the segments of diminishing marginal utility correspond to socioeconomic classes, the segment of increasing marginal utility to a transitional stage between a lower and a higher socioeconomic class”. Their analysis contemplated only two socioeconomic classes, possibly for simplification purposes, but their analysis can be easily extended to more than two classes resulting suggesting something similar to figure 9.

The references, in these cases, would be increasingly distant, as those in the Fixed Term Certificates market. Markowitz (1952), in his utility function with three inflections, presented an analogous intuition. He speculated that, comparing different socioeconomic classes, “the rich would act essentially the same, in some situations, as someone with more moderate wealth, except that his first and third inflection point would be farther from the origin. Conversely, if the chooser were rather poor, I should expect him to act as if his first and third inflection points were closer to the origin.”

If the references are increasingly distant, the referenced behaviors will be, on one hand, most frequent on the households with the lower incomes and on the other hand, the existence of multiple references means that if the stakes are high enough, the number of jumps influencing the observed decision can be more than one increasing the effect in some cases or resulting in mixed effects.

For example, this means that most households, whenever facing an opportunity to increase its socioeconomic class, will be willing to bear extra risks; however, it will only do this if the extra risk does not mean that their actual level can be compromised.

V. EXPERIMENTAL ANALYSIS

In order to test the hypothesis, we conducted an experiment of risk decisions using modifications of exercises previously used in the literature. The participants represented poor and extremely households so they were expected to be deciding over the income reference of the income that ensured the consumption of minimum calories.

126 households were visited in the week previous to the experimental session. In the visit, they responded a survey with basic socio-economical variables and were invited to send one household member, of legal age, to participate in the activity. To maximize participation, they were told, at the time of the survey, that the activity could have monetary gains. As this could create anticipatory effects, they were not told the size of those possible gains; they were also instructed to go alone and bring a document to prove legal age. 92 household representatives participated in the experiment. Out of the 92 surveys made, 3 of them turned out to be incomplete.

A. Experimental Design

One reference, proposed in this paper, is the income that ensures that the household can buy the food requirements to have a healthy life. Deciding over large gains extremely poor and poor households, who are close to this reference, are expected to present the referenced behaviors predicted by the theory proposed.

1. Sample

We chose the neighborhoods of Bella Flor and El Paraíso in the locality of Ciudad Bolívar in Bogotá as we wanted to see how being near to the reference of the extremely poor could affect the behavior. The households of those neighborhoods had a high probability to have an income that oscillated around the reference. In the year 2007, the Colombian's Bureau of Statistics (DANE) conducted the Life Quality Survey for Bogotá and found that the localities of Ciudad Bolívar and Soacha have the worst income conditions. Penning (2005) found that Bella Flor's conditions, in multiple aspects, were precarious and worse than those of the locality. He also finds that between 2000 and 2003 such conditions were actually deteriorating including the incidence of extreme poverty. The latter, added to the

fact that those neighborhoods are located in a marginal area of the city that combines rural and urban sectors, suggests that the conditions of these two neighborhoods are best described by the conditions of the households in the locality of Soacha.

We approached the community through an NGO called *Fundación Bella Flor* that had been in 6 years in the community by the date of the experiments. The cooperation agreement achieved consisted on inviting all of their 86 households and they would provide assistance with one community leader. Including only the families of the foundation could potentially include selection issues so we expanded the sample by randomly inviting 22 households from each neighborhood.

The experiment was conducted, in two sessions, with 92 household's members of the 128 invited. The invitations were originally made so we would have 63 household representatives in each session: 51 from the foundation for the first session and 35 for the second session. Nevertheless, the sessions were ran in cohorts of 49 participants in session 1, 16 were from the control group, and 37 participants in session 2, 31 were from the control group. The treatments were not designed to depend on the sessions. Instead, the treatments were determined by the closeness of the household per-cápita income to the reference point: with the options given, some households could change their position around the reference level while other households could not. See table 1 for a summary on the household's characteristics.

2. Exercises

a) Determining the Reference

To be able to determine the reference value in this case of the minimum income to be able to buy the minimum food requirements, in terms of income per capita, we use the value of the extreme poverty line (price of a food basket that provides 2,100 calories and basic vitamins that takes into account the tastes and available food) that was calculated for Colombia in 2005 by the DNP. However, we have to be very careful not to restrict the value of the reference only to the value of this basket as it has been shown that even the extremely poor households do not spend all their money in food (Banerjee & Duflo 2006).

The value of this line was calculated by the *Departamento Nacional de Planeación* in 2005 (DNP 2005) for September 2004 as COP 88,243 for a urban household, of average size of 4,45 members per HH, from Bogota. We then took this value and use the food inflation rate for the poor in Bogota²⁸ to take the value of the basket to March 2009. The resulting value of this step is COP 124,000. After that, and taking into account that, even the most poor do not use all their income in food, we used the percentage of budget used by those in Soacha in food (The locality in Bogota's LQS of 2007 with closer characteristics to the neighborhoods) that was 79% to find the expanded value of COP 157.000.

Even if this is the actual reference, we have to consider that in this exercise, choosing any of the first three options (modal responses from those far from the reference) could change the probability of treatment for those very near without the need to bear any extra risks. Because of this, we subtracted from the expanded value the high payment for the third option and we find the Reference point to be COP 148.000. Figure 10 shows the incidence of undernourishment according to the income per capita and shows that the probability decreases significantly at this level of income per capita.

b) Experimental Setup

Each session consisted on exercises on Base Risk, Loss Aversion and Risk Pooling. The exercises of Base Risk and Loss Aversion were based on those by Binswager (1980) as implemented by the IADB in the "Experiments to Measure Trust and Cooperation among Latin America" described in Candelo and Polanía (2008). Some variations were made in order to be able to test the theory proposed in a more accurate way: eight options were presented instead of six and, the layout presented to the participants was modified based on the experiment of Barr and Genicot (2007) expecting to make the exercise more clear. The Risk Pooling exercise was based in one of the treatments of the Barr and Genicot Paper. Results of the Risk Pooling exercise are presented elsewhere.

Each session lasted around 3.5 hours. Description of the location and logistic issues are described in the Methodological Annex. Preliminary data of the households of the

²⁸ This inflation rate is available monthly in the Website of the Colombian National Statistics Bureau (DANE) at www.dane.gov.co

foundation was used to determine the value of the options that could eventually made some of them to choose around the reference. The options that we needed should be sufficiently high so we could expect to incentivize the referenced behaviors in some households. This process determined that the payments had to be higher than those usually used in similar experiments.

The first exercise presented them with 8 options (in COP²⁹) that represented a bag; each bag was filled with 10 balls, 5 with a high value and 5 with a low value (see figure 11):

If we order the bags left to right and top to the bottom, bags one through seven increased in expected value and variability. The low value decreased 2,000 COP from the first bag to the second and, after that, the decreasing step increased in 1,000 COP for the following options (for example 3,000 between bags two and three, and so on). Every 1,000 COP the low value decreased meant an increase of the high value by 3,000 COP. Notice that bags seven and eight had the same expected value but the bag eight had more variability so if someone choose bag eight over bag seven would mean risk neutrality or risk attraction.

The highest possible gain of 118,000 COP (96 USD in PPP³⁰) that was around 23% of the average income they had and 24% of the monthly minimum wage. For the average household of 5 people, this payment was around 16% of the reference point proposed.

B. Data Analysis

We use an analysis of a Regression Discontinuity Design where, if there is a treatment like being undernourished, determined by a critical value of single variable as income then if all the other variables does not change around the critical value, any change in a dependent variable, for example risk aversion can be explained by the incidence of the treatment.

1. Methodological Approach: The Regression Discontinuity Design (RD)

RD has proven to be a very robust estimation strategy of treatment effects in non experimental settings when the treatment depends on an enforcing variable that cannot be perfectly controlled. Furthermore, under some feasible conditions its internal validity has

²⁹ COP=Colombian pesos. The average exchange rate in March 2009 was 2,477.21 COP/USD. For 2009 the IMF reports an implied PPP conversion rate of 1,226.41

³⁰ Using IMF World Economic Outlook Database, April 2009.

proven to be very high³¹. It is based on the assumption that the individuals very near the reference, that determines participation in the treatment, are very similar. In such way, it determines the effect of a treatment, determined by the value of single variable, around the critical value. This allows us to estimate the differences in risk aversion between those left and near to the reference of the income necessary to avoid undernourishment and those right and near to the reference.

We used the RD module for Stata³² and we chose to go with the default kernel of Local Linear Regression as for the RD it has proven to be the most reliable kernel³³.

We checked all the sufficient conditions presented by Lee and Lemieux (2009). In this case, we have a continuous enforcing variable, that is the income, and a variable that present a jump in the determined reference, the risk aversion, with an inability to perfectly control the enforcing variable. The only condition that presented some problems was the continuity in density of the enforcing variable around the reference. After analyzing the potential problems this had, we found that this was not a sign of manipulation over the enforcing variable but solely a problem of the sample. Data from the Bogota's LQS (2007) was revised finding that this variable has uniform density around the reference.

2. Econometric Estimation

First we do the estimation with an order given to the options according to the risk involved.

We find that the difference, around the reference, in the options chosen is significant for both the Base Risk and the Loss Aversion Exercise (see figure 12 and table 4).

However, these results do not capture the difference that exists when choosing between options 1 and 2 or options 7 and 8. According to this, it would be best to use measures of risk aversion. However, the experimental design of Binswager does not provide the possibility to determine the exact value of the risk aversion but only an interval. Using the widely used CRRA utility of $U(x) = x^{(1-r)} / (1-r)$, that allows us to compare with other papers, we find the values that would make an individual neutral between any two

³¹ For a “user to guide” of the Regression Discontinuity Design and the necessary conditions to be able to use it, please refer to Lee & Lemieux (2009).

³² RD: Stata module for regression discontinuity estimation.

³³ Lee and Lemieux (2009) note that “the choice of kernel typically has little impact in practice”

consecutive options. Then we propose a method where we imputed, for each decision, a risk aversion parameter that is the average between the high value and the low value of the interval. In the case of the first and the last options, we could not follow this procedure as we only had one value of the interval, the inner value, so for these cases, we imputed the value of the inner range (see table 2). The imputed values allow making comparisons between choices. The imputations in the extreme options can affect the estimation. In such way, we can drop those observations or keep the inner value as we propose. It is expected that, choosing the inner value underestimate the effects. Because the

The literature has found that, conventionally, the risk aversion is explained partially by various variables; in order to control by those variables, and following Lee and Lemieux (2009): First we run a regression of risk aversion over control variables of sex, age and age squared (see table 3). Then, we run the RD design over the unexplained portion of the risk aversion. With an assumed jump from zero to one at $Z=148000$ and find a local wald estimate of the jump of 5.207888. This is the difference in risk aversion between those near above and below.

Because the Stata module for RD assumes that the treatment is 0 before the jump and 1 after it, we have to interpret the results as the difference on risk aversion by being near the jump and above it compared to those below. Table 4 presents the results of bootstrapping the method and find that the effect is significant at a 95% confidence level³⁴. This behavior is consistent with the example developed in section IV.D. Being below and near the reference makes that, whenever one is presented with an option to go above the reference, we take higher risks.

VI. CONCLUDING REMARKS

This paper has developed a model that explains a mechanism of how, exclusion based on the income, generates referenced behaviors around certain values of income. With the inclusion of the possibility that the outcome of present decisions can affect the future access

³⁴ There seem to be slight sensibility to the bandwidth chosen by the module but only if we double or half the bandwidth.

to consumption of certain goods or productive activities, we can keep a single exponential discount rate as well as the desired characteristics of EU and still model referenced behaviors and loss aversion.

Some of the decisions we make may have consequences in our future and we take into account those consequences. In the case of the extremely poor, those consequences can be different life expectancies and exclusion. The evidence suggests that the extremely poor individuals are able to identify the income necessary to avoid undernourishment and, additionally, the individuals react to the possibility of going from one side to the other of the reference.

This theory suggests that the behaviors will depend on the existence of activities that can secure the minimums and the probability to access them. Avoiding undernourishment, in the case of the extremely poor, and avoiding income exclusion, in the case of the poor, is an incentive to take higher or lower risks depending on the position around the reference.

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ANNEX I. FIGURES

Figure 1. Utility Function Dependent on Wealth by Friedman & Savage in 1948

Source: Friedman & Savage (1948), p. 295.

Figure 2. Markowitz Utility function around current wealth with three inflection points

Source: Markowitz (1952), p. 154.

Figure 3. Prospect Theory

Source: Figure 1. Kahneman y Tversky (1979), p.279.

Figure 4. Utility Function with a Jump.

Source: Masson (1974), p. 560.

Figure 5. Utility Function proposed by Zuleta.

Source: Zuleta (2002), p.3

Figure 6. Reasons for Unequal Treatment That Most Affect Population, 2008

Source: Latinbarometer (2008), p.57. Note: Figure presents responses to “Which groups do you think are the most discriminated against, or do you think that there is no discrimination?” (Here those above 2%)

Figure 7. Graphical Representation of the Value Function with a Jump.

Source: Author's

Figure 8. Preference reversals
 8.a. Generally Risk Averse household choosing to be risk lover.

8.b. Generally Risk Lover household choosing to be risk averse

Source: Author's.

Figure 9. Value function with multiple jumps.
9.a. Generally Risk Averse Household.

9.b. Generally Risk Lover Household.

Source: Author's

Figure 10. Incidence of Undernourishment vs income per capita around 157,000

Source: Author's

Figure 11. Decision Sheets.

Figure 12. RD: unexplained variance

Source: Author's. Notes: the zero corresponds to an income per capita of 148,000 COP. In the ordered options higher means more risk while in the risk aversion higher means lower risk

ANNEX II. TABLES

Table 1. Descriptive Statistics of the Households (HH)

Variable	N	Mean	Std. Dev.	Min	Max
HH members	89	5.04	2.29	2	16
HH Members with ages 15-64	89	2.34	1.32	0	9
Age of Participant	87	36.97	12.84	16	68
Missing meals per-capita in the last week (max 21)	89	1.74	3.35	0	16
Years of Education: HH Members aged 15-64	88	6.76	3.03	0	13
HH Monthly Income in COP	89	507,157	298,176	20,000	1,800,000
HH Monthly Income per-capita in COP	89	110,839	69,538	6,667	375,000

Characteristic	Percentage of HH with the Characteristic
Natives of the City	49%
Woman Participant	83%
House Ownership*	58%
Missed at least 1 meal in the last week	34%

*A private closed space is considered a house. Some of these houses are very precarious constructions.

Table 2. Risk aversion parameters used in the estimation

Options	Low gain	High Gain	Expected Gain	Risk Aversion Interval		Imputed Risk Aversion
				Lower limit	Higher limit	
1	32,000	32,000	32,000	9.99		9.99
2	30,000	38,000	34,000	2.79	9.99	6.39
3	27,000	47,000	37,000	1.47	2.79	2.13
4	23,000	59,000	41,000	0.93	1.47	1.20
5	18,000	74,000	46,000	0.64	0.93	0.79
6	12,000	92,000	52,000	0.43	0.64	0.54
7	5,000	113,000	59,000	0.00	0.43	0.22
8	-	118,000	59,000		0.00	0.00

Source: Author's

Table 3. Regressions over controls

VARIABLES	Base Risk (Ordered Options)	Loss Aversion (Ordered Options)	Base Risk (Risk Aversion)
Age	-0.132 (0.0994)	0.263** (0.110)	0.357* (0.184)
Female	-0.331 (0.570)	-0.507 (0.645)	0.126 (1.053)
Age squared	0.00155 (0.00117)	-0.00234* (0.00129)	-0.00424* (0.00216)
Constant	6.050*** (1.897)	-0.0281 (2.076)	-2.650 (3.501)
Observations	87	86	87
R-squared	0.030	0.168	0.048

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. RD estimation, bootstrapped 1,000 times to estimate standard errors

	Base Risk (Ordered Options)	Loss Aversion (Ordered Options)	Base Risk (Risk Aversion)
lwald	-3.080** (1.464)	-2.389** (1.182)	5.222** (2.314)
lwald50	-4.613 (15.99)	-1.357 (9.835)	6.816 (30.00)
lwald75	-3.397 (2.265)	-2.952 (1.908)	5.702* (3.163)
lwald125	-2.379** (1.210)	-1.899* (0.999)	3.430 (2.147)
lwald150	-1.648 (1.082)	-1.821** (0.900)	2.021 (1.993)
Observations	87	86	87

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Z0=148.000

Bandwidth=60.000

Note: lwaldX estimates the jump with alternative bandwidths used to test robustness. X is the percentage of the normal bandwidth. This table shows that the jump is significant with a bandwidth of 75% and 125% of the normal one.