Preliminary Thesis Defence

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Contents

Chapter 1

Introduction

In this Preliminary Thesis Defence I present the research projects that I intend to use for my PhD dissertation. These projects are titled:

- Additional South African Evidence on Pensions and Child Growth (chapter 2)
- Risk and Uncertainty in Unique Equilibria in Currency Attacks (chapter 3)
- Bitcoin and Remittances: The Potential of 'Stupid Phones' (chapter 4)

These project are in various stages of completion. Below I will briefly describe the research idea, the current state, and the potential for each project.

Firstly, the paper Additional South African Evidence of Pensions and Child Growth builds upon Duflo (2000, 2003). These papers look at the effect of the gender of grandparents on the growth metrics of their grandchildren. A problem in this comparison lies in the fact that pension eligibility of men was at 65 years, whereas it was 60 for women. This paper makes use of a Household Survey from 2008, 2012 and 2013. The urvey is especially of interest, because the pension eligibility age for men was lowered from 65 to 60 in 2009. As it stands now I have analysed the data from 2008 and 2012. The 2013 data was released several weeks ago, I will incorporate these data in future versions of my analysis. I will discuss this in chapter 2.

Morris and Shin (1998) claims that introducing a measure of risk in a model of currency attacks, leads to a unique equilibrium. It thus solves the previous multiple-equilibrium zone called 'ripe for attack' for a unique equilibrium. I believe that this is a result of the fact that the risk factor introduces replaces uncertainty, not certainty. We thus gain information. I want to discuss MS1998 in light of the distinction between Knightian uncertainty and quantified risk. This is done in chapter 3.

Lastly, Bitcoin is the first of a new breed of currencies, commonly referred to as a cryptocurrencies. Bitcoin transactions are conducted using an electronic process called signing. I would like to study the role of Bitcoin in remittances. For this I would like to participate in building Bitcoin applications for the type of simple phones common in developing economies (sometimes referred to a stupid phones). We could study the spread of bitcoin by looking at the downloads of the apps from regions, as well looking at how releasing the app in different languages evolves.

After this the papers follow, in the order listed above. A separate citations section is included for each chapter. For ease of reference, the titles of the citations in the bibliography link to the online articles using DOIs and URLs. In the end notes (chapter 6) I present a brief discussion of my dissertation, as it stands now, a whole. I also mention some very preliminary ideas.

Recently there has been a shift towards more replication and further analysis of previously published results. E.g. Ioannidis (2005).

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Chapter 2

Pensions and Child Growth in South Africa

Abstract

In this paper we look at variation in the health of young children driven by the gender of the household income recipient. We do this by comparing z-scores of anthropometrics of South-African children living in the same household as state pension recipients.

This paper exploits the lowering of the state-pension eligibility-age of men, to the same age as women (60, previously 65). This takes place between two waves in the South-African National Income Dynamics Survey. This enables us to perform a Difference-in-Difference estimation on the panel data set.

Our finding is that policy change had a negative effect on long-term growth metrics of young children and the general male pension income had a negative effect on young children's BMI.

These results provide support for the idea that it is preferable to use female recipients in poverty-relief projects such as CCTs.

2.1 Introduction

This paper looks at the effect of the gender of pension recipients on the growth of children in the same household. The study is based on South-African data and the approach is very similar to Duflo (2000, 2003), and orignally based on the work of Thomas (1994). The difference from international standards (Onis et al. 2006, WHO Child Growth Standards) for anthropometrics are computed as z-scores. Using these standardised metrics, we compare children living in household with pension recipients of different gender.

This study deviates from the Duflo study in several ways. The core contribution of this paper is the analyis of exogenous change in men's pension eligibility age, which is the main explanatum. The pension eligibility age for men was lowered from 65 to 60 between mid 2009 and 1-1-2011. This brought the pension eligibility age for men at par with women. We employ a Difference-in-Difference (or Fixed Effects) analysis of this change. Under then assumptions of the Difference-in-Difference model, this enables us to make a causal inference on the policy variable.

The other deviations are of a more practical nature. Firstly, the data from the Southern Africa Labour and Development Research Unit (2008, 2012) surveys contains actual information on income, including pension recipient status, whereas Duflo uses age as a proxy for recipient status. Secondly, another minor deviation is the usage of Onis et al. (2006, WHO Child Growth Standards), in stead of Kuczmarski et al. (2000, CDC Growth Charts: United States), since these have superseded the CDC charts. As long as all observations are held against the same standards, this should not be of any consequence.

The impertus for this paper lies in the optimal design of cash transfer schemes such as CCTs and UCTs. The lack Paretto optimal allocation of resources within households as discussed in i.a. Udry et al. (1995), Udry (1996), and Duflo and Udry (2004), indicates the necesity of optimal design in such schemes. Based on this lack of Paretto optimal allocation, we have to reject the idea of households acting as a unit in an economic sense. For the design of cash transfer schemes it is therefore necessary to determine the prefered recipient within the household [1].

As mentioned above, we follow Duflo (2000, 2003) general design. Looking at the gender of pension recipients gives a reasonably clean analysis, because of it's relative exogeneity. We therefore use these pension receipts as the Right-Hand Side variables, or explanata. Anthopometrics for children are used, since these capture well, the effects of both malnutrition and disease, the two most common health impediments that we are addressing.

The South African pension system is an interesting object of study because of its eligibility criteria. The primary criterium is the age of the recipient. In adition to this there is a maximum income threshold. Outside of this, there are very few criteria. The reletive general applicablility of the program makes that there are few selection bias issues when studying this. A thorough, though a points somewhat dated, discussion can be found in Case and Deaton (1998). Although the pension system was intended as a form of poverty relief for the elder population, it has also become that for the South-African rural population(Tangwe and Gutura 2013). Average household income in rural area is much

1. For a good overview see e.g. Haddad, Hoddinott, Alderman, et al. (1997)

lower than in urban areas. Pension receipt have therefore formed a large share of household income. Upon the initial expension to include the black population, in 1991, this was a much as twice the mean monthly income.

The anthropometrics taken in the NIDS are useful for computing z-scores. We distinguish between Age Based Z-scores (ABZ) and Height-Based Z-scores (HBZ). We use two types ABZs and two types of HBZs, for a total of four types of z-scores. This is described in futher detail in subsection 2.2.2.

These z-scores are considered a good representation of short-term or long-term health issues, respectively. This relation is especially well observed for children between 6 and 60 months old. We therefore stay with the best practice and only include those observations in our analysis.

We formulate three models. One model without the treatment dummy, one model with the treatment dummy, and finally one model with the treatment dummy, and an interaction term with male pension recipient status. Each of these models is estimated with all four types of z-scores, which gives a total of twelve estimation equations. All twelve equation are estimated as fixed-effect panel models, with, where included, a time effect. We have only one data period before the policy change, which means that we cannot test for a common trend. The implicit assumption here is thus that the effects are level over the time period studied here.

Our main finding is a negative effect of the policy change on the age-based growth metrics on children (HAZ and WAZ). In the height-based metrics we find a negative effect of the state pension income of men on the body mass index (though not on the WHZ). Our results seems to indicate that the policy change had a negative impact on the long-term growth of children. Furthermore, we see a negative effect of the mens pension income on the BMI of children. These results provide support for the theory that exogenous incomes in a poverty relief context, such as CCTs and UCTs are best transfered to women in the households.

2.2 Data

In this paper we use data from two sources. The first is the South African National Income Dynamics Survey (NIDS Southern Africa Labour and Development Research Unit 2008, 2012, 2013) and the second is the World Health Organization's Child Growth Standards (Onis et al. 2006, WHO).

2.2.1 South Africa: National Income Dynamics Survey

The main source of data is the National Income Dynamics Survey of South Africa (Southern Africa Labour and Development Research Unit 2008, 2012, 2013). Like the 1993 survey used by Duflo (2000, 2003), this survey is conducted in cooperation with the World Bank. Unlike the 1993 survey, this survey does not use a random selection household, rather it collects data on a representative set of appproximately 10,000 South-African households over time. Currently three 'waves' of data are available, these waves date from 2008, 2012, and 2013 respectively.

The primary information types we use are:

- child anthropometrics,

- child age (in days)
- child gender
- adult pension recipient status
- adult gender

In addition to these variables of interest, we include a number of covariates in the analysis, these are:

- Household income
- Parent's education

Table 2.1: Z-score distributions

	HAZ	WAZ	WHZ	BMIZ
Min.	-5.972	-6.000	-4.916	-4.994
1st	-1.768	-1.110	-0.302	-0.602
Median	-0.941	-0.310	0.491	0.207
Mean	-0.956	-0.296	0.501	0.240
3rd	-0.132	0.516	1.351	1.069
Max.	5.975	4.958	4.967	4.992

For adults several variables measure the different amounts and sources of income. Among those, a variable if the adult receives a state pension, and if so, how much. This is a numeric variable, the values of which lie very close together. We observe that 22.99% of household in our dataset have a female pension recipient as part of the household. Furthermore, we observe that 9.06% of households in our dataset have a male pension recipient. This implies that, despite the fact that men are now eligible at the same age as women, the vast majority of pension recipients is female. Therefore, there is still a selection bias issue in the data we are analysing.

The income from the pension system is just above 1000 SAR. There are a number of different exact amount, which we have simplified to a dummy. Since the variation in the amount is around 5% this should not be without much loss of generality. Table 2.2 gives a description of the distribution of income as found in the NIDS data sets.

Table 2.2: NIDS Income distribution

Min.	0
1st Qu.	1,070
Median	1,870
Mean	3,939
3rd Qu.	3,150
Max.	3,413,000

Children's anthropometrics are taken, these are length/height, weight, and waist. Using these anthropometics and WHO growth standards, z-scores are calculated.

2.2.2 WHO: Child Growth Standards

In 2006 the WHO published its standards for child growth (Onis et al. 2006). These standards measure the difference between a child's anthropometrics standardised against an ideal score.

Z-score anthropometrics are used since they are considered to be a good representation of a child's health, and by extension, the household in which they grow up. With z-scores we refer to the practice of standardising the anthropometrics using an 'idea' standard (Onis et al. 2006).

For example, if we measure a height x for a child of age y (in weeks/months), then we refer the to WHO tables, find the relevant ideal height and standard deviation for a child of age y. We then substract the ideal height (μ_y) from the observed height, and divide by the standard devation (σ_y), like so:

$$z_{xy} = \frac{x - \mu_y}{\sigma_y}$$

These ideal scores are based on a sample of children from different ethnic populations, in households which observed a healthy lifestyle. Any health issues, such as malnutrition or disease will affect these metrics, by causing the child to be shorter or lighter. However, it is impossible to distinquish between the different causes of an observed slowed growth.

We stay with the best practice of using only metrics for children between the ages of 6 months and 60 months.

In general, can distinquish between two types of anthropometric z-scores, the age-based z-scores and the height-based z-scores. Whereby 'based' refers to the reference point at which anthropometrics are standardised.

Age-Based Z-scores

The Age-Based Z-scores (ABZs) are consistituted by the Height-for-Age Z-score (HAZ) and the Weight-for-Age Z-score (WAZ). Since these metrics are age-based, they provide information about all past growth issues. Any past issues such a malnutrition and disease will have impaired growth, and these effects will still be captured by today's height. This also applies to the WAZ, as standard weight is a function of the height, which is in turn a function of the age.

The ABZs are constructed on a weekly basis up to the age of 60 months, and on a monthly basis thereafer.

Height-Based Z-scores

The Height-Based Z-scores (HBZs) are the Weight-for-Height Z-score (WHZ) and Body Mass Index Z-score (BMIZ). Where the BMI (or Quetelet) is a transformed version of the WHZ, which has a quadratic height effect. The equation for BMI is:

$$\mathbf{BMI} = \frac{\mathbf{weight(kg)}}{\mathbf{height(m)}^2}$$

These scores compare children with others of the same height, irrispective of their age. As a results we only observe the relatively short-term effect of weight. The height-based metrics thus provide is with a short-term insight.

The HBZs are available on a semi-centimeter level throughout all heights.

2.2.3 Data Structure

The NIDS uses a file and data structure which is ill suied for panel data analysis. We therefore transform the data to a format which is more conducive to our analysis. In doing so, we try to stay as close as possible to the'Tidy data' structure, as described in Wickham (submitted). This is easiest using the R package 'Reshape2' by the same author (Wickham 2007, Reshape2 implementation).

2.3 Research Design

This study focuses on a policy change in the South-African state pension system. Until mid 2009, men became eligible for pension at the age of 65. Between mid 2009 and January 1st 2011, this was gradually lowered to 60. The South-African National Income Dynamics Survey is a full-panel dataset, which contains information on household from before and after this policy change. We study the effect of the policy change, as well as the general effect on the pension system, on the health of children in the same household. The research setup in discussed in further detail below.

2.3.1 Identification Strategy

The identification strategy in this paper is based on a policy change in the pension eligibility age for men, which was introduced between mid 2009 and January 1st 2011. This policy change thus fall between waves 1 and 2 (2008 and 2012 respectively) of the NIDS data sets.

Before this policy change, the eligibility age for men was 65 years old. Post the policy change, the eligibility age is 60 years old, which bring it at par with the pension eligibility age for women.

We operationalise this natural experiment, by constructing a policy dummy. This policy dummy is called **elig.men.60**, and takes the value **1** for data after the policy change (i.e. waves 2 & 3), and the value **0** otherwise (i.e. wave 1).

2.3.2 Estimation

In order to fully exploit the available data and the policy change, we employ a 'Difference-in-Differences' estimator (DiD). This estimator operationalised by using the fixed-effects (within) estimator, with a time-effect[2].

We perform the estimations using the R package 'PLM' (see Croissant, Millo, et al. 2008). It is worth noting that questions have been raised about the Difference-in-Differences estimator being employed in certain situations, for example by (ironically) Bertrand, Duflo, and Mullainathan (2004).

Models and Variations

We define the variables for our estimation equations. The outcome variable is y_{it}, this outcome variable takes the form of the of the z-scores, such as HAZ or WAZ. Where t denotes the time and i the individual. The individual and time fixes effects are denoted by γ_i and λ_t respectively. Dummies for living in a

2. The time effect estimated here is symmetric to the individual effect. We employ the term 'time effect', since it is a more meaningful description of the policy change.

household with a female or a male pension recipient are included as P_{it}^f and P_{it}^m respectively. The dummy variable T_{it} denoted the treatment status. Lastly, ϵ_{it} is the error term, which is assumed to be distributed as:

$$\epsilon_{it} \sim N(0, \sigma)$$

We can now formally specify our base estimations as in Equation 2.1, this represents model 1.

$$y_{it} = \gamma_i + \lambda_t + \mu P_{it}^f + \nu P_{it}^m + X_{it} + \epsilon_{it} \tag{2.1}$$

In Equation 2.2 we include our policy dummy variable, this variation is denoted as model 2 in our results.

$$y_{it} = \gamma_i + \lambda_t + \mu P_{it}^f + \nu P_{it}^m + X_{it} + \delta T_{it} + \epsilon_{it} \tag{2.2}$$

Lastly, we formulate a variant of the model which includes an interaction term of the policy dummy with the male pension-recipien dummy (as well as the variables themselves). We refer to this as model 3, and the formal specification is given in Equation 2.3

$$y_{it} = \gamma_i + \lambda_t + \mu P_{it}^f + \nu P_{it}^m + X_{it} + \delta T_{it} + \rho T_{it} * P_{it}^m + \epsilon_{it} \tag{2.3}$$

These three models the are variations that we use on the Right-Hand Side (RHS) of the estimation equations.

As described above, we have a total of four z-scores available as dependent variables, Height-for-Age (HAZ), Weight-for-Age (WAZ), Weight-for-Height (WHZ), and Body Mass Index (BMI). Each of these is used in a different estimation as the Left-Hand Side (LHS). Combining these four LHSs with each of the three RHSs, gives a total of twelve estimation equations. The results of the estimation of each of these twelve equations is presented in autorefsa:results.

As we have only one time period before the treatment goes into effect, we cannot establish a common trend. The assumption here made is thus that the effects of P_{it}^f and P_{it}^m are level over time.

2.4 Results

In Table 2.3 we present our estimation results for the age-based z-scores, and in Table 2.4 we present our estimation results for the height-based z-scores.

In these tables the dependent variable used it defined on the top row. The second row defines the model used (as defined in **??**). The other rows represent the independent variables. Where **w_spen_w** represents the dummy variable for children living in a household with a state pension eligible woman. The variable **w_spen_m** is the dummy for the child living in the same household as a male state mension recipient. The policy variable **elig.men.60** is a dummy which takes the value **1** for waves 2 and 3. An interaction term of the later two is also included as **eli.men.60:w_spen_m**. Lastly, we unclude de covariate **w_h_tinc** which represents total household income.

As Table 2.3 shows both the Height-for-Age and the Weight-for-Age estimations for all three Right-Hand Side variations give similar results. For all the height-based z-score estmations, we find that the policy variable **elig.men.60**

Table 2.3: Age-Based Z-scores

	Height for Age Z-score			Weight for Age Z-score		
specification	1	2	3	1	2	3
w_spen_m	0.2366	*0.8228	0.7908	0.2366	0.2981	0.4780
w_spen_w	-0.2331	0.1053	0.1072	-0.2331	-0.3112	-0.3280
elig.men.60		**-0.3419	**-0.3465		***-0.3475	**-0.3243
w_spen_m1:elig.men.60			0.0446			-0.2545
w_h_tinc	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000

has a negative coefficient estimate, which is highly significant (where included). In all cases the estimate has a p-value of less that **0.01**. Meaning that (meta-discussion aside) the probabiliy that this coefficient represents a non-existant relation (Type II error) is less than one percent. In the model 2 specification of the Weight-for-Height dependent variable, the p-value is even less that 0.001. However, upon the inclusion of the interaction term (model 3) this falls back to below 0.01.

The fact that this outcome is consistent across different Right-Hand Side, as well as Left-Hand Side specifications, further lends credibility of there not being a Type II error. As mentioned above, the HAZ and the WAZ Z-scores capture long-term or past health issues.

Furthermore, when using Height-for-Age as the LHS, and the model 2 on the HRS, we find a positive effect of living with a male pension recipient. The coefficient output here is no longer significant when we include the interaction term in the model 3 specification.

The interpretation of the coefficients of these dummy variables is as follows. The coefficient represents the change in the expected value of a child's deviation for the standard growth anthropometics in standard deviations. A coefficient of **-0.3419** of the dummy **elig.men.60** in HAZ model 2, thus indicates that, after the lowering of the male pension eligibility age, ceteris paribus, a child's expected Height-for-Age Z-score is 0.3410 standard deviation lower than before the lowering of the eligibility age.

Table 2.4: Height-Based Z-scores

	Weight for Height Z-score			Body Mass Index Z-score		
specification	1	2	3	1	2	3
w_spen_m	-0.3532	-0.3210	-0.4303	*-0.8058	*-0.7905	*-1.0226
w_spen_w	0.0655	0.0371	0.0478	-0.1592	-0.1956	-0.1742
elig.men.60		-0.1417	-0.1574		-0.1674	-0.2049
w_spen_m1:elig.men.60			0.1484			0.3407
w_h_tinc	-0.0000	-0.0000	-0.0000	-0.0000	0.0000	0.0000

In Table 2.4 we do not find an effect of the **elig.men.60** variable. In the WHZ estimation we do not find any significant variables. However, the **BMIZ** estimation we find **w_spen_m** to be significant at a 5% level of all specifications.

We thus find a negative effect of the treatment on growth metrics. Furthermore, for one height-based z-score we also find a negative effect of male pension recipients on growth metrics. Additionaly, it is suprising that we find significant coefficients for **w_spen_m** in one height-based z-score (**BMIZ**), but not in the other **WHZ**.

The last result is surprising, considering that the coefficient estimates for **w_spen_m** in the **WHZ** estimations are all similar to each other, and roughtly half of the estimates of the **BMIZ** estimations.

For the lower coefficient estimates, it is important to note that **BMIZ** is essentially a convex mapping of **WHZ**, since height is squared in the denominator of the BMI function, as described in section 2.2.2. In other words, the fact that the estimators, which give transformed coefficient estimates can have different significance levels, can be explained as follows. The squaring of the height in the denominator of the Body-Mass Index function, makes it a non-linear mapping of the Weight-for-Height Z-scores. Furthermore, from the significance of the coefficients in the **BMIZ** estimations, we can conclude that the coefficient estimates are higher that the standard error estimates, by a factor of several times (for Degrees of Freedom ~ 380). Combining the small estimates of the standard errors, with the convex mapping, gives the results that the standard errors are scaled up to a lesser degree than the coefficient estimates. This then gives the results, that with t-testing the significance of the convexly mapped coefficients and standard errors, we can find significance at the 5% level for the convexly mapped **BMIZ** estimates of **w_spen_m**, where for the **WHZ** estimates of **w_spen_m** we could not.

Regarding the negative effect of the expansionary policy change, we need to further disseminate the change in the independent variables. Table 2.5 and Table 2.6 describe the evolution of the number of children living in a household with a pension recipient. We observe a substantial drop in both children living with male and female pension recipients. The change for the number of children living in the same household as a male pension recipient is from 612 children in 2008 to 595 children in 2012. A drop of 17 or -2.79 percent. However, if we compare the number of children living in the same household as a male pension recipient for the year 2013, the results are quite different. In the year 2013 we observe 623 children living with a male pension recipient, a rise of 1.8 percent vis-a-vis the year 2008. When comparing the number of children living in the same household as a female pension recipient, we see a different picture. In 2008 we observe 1637 children living with a female pension recipient, and in the year 2012 we observe a number of 1498, a drop of 8.49 percent. In the year 2013 we observe 1509 children living with female recipients in 2013, a drop of 8.48 oercent vis-a-vis 2008. We thus observe a drop in both the number of children living with male recipients, of children living with female recipients between the years 2008 and 2012. However, for male recipients the number rises to above 2008 levels in 2013, where as the number for female recipients remains around the lower 2012 levels.

We thus observe a drop even in the number of children living with female pension recipients, despite the fact that female pension recipients were unaffected by the policy change.

One of the reason for this drop in life expectancy in South Africa. The predominant reason for the this drop in life expectancy is taken to be HIV/AIDS.

Table 2.5: Children in Households with and without Male Pension Recipients

Year	2008	2012	2013	Overall
Male Recipient	612	595	623	1830
No Male Recipient	6121	6138	6110	18369
Ratio of Male Recipients	0.0909	0.0884	0.0925	0.0906

Table 2.6: Children in Households with and without Female Pension Recipients

Year	2008	2012	2013	Overall
Female Recipient	1637	1498	1509	4644
No Female Recipient	5096	5235	5224	15555
Ratio	0.2431	0.2225	0.2241	0.2299

2.5 Conclusions and Limitations

We find two results from out estimations. Firstly, we find that there is a significant and consistant negative effect of the policy variable **elig.men.60** on the age-based z-scores (i.e. Height for Age and Weight for Height). Secondly, we find a consistent and negative effect of the men's pension variable (**w_spen_m**) on the Body-Mass-Index Z-scores. Both of these effect are consistent across the different specifications used in our estimations.

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Chapter 3

Risk and Uncertainty in Unique Equilibria in Currency Attacks

Abstract

Morris and Shin (1998) finds that the introduction of a risk factor leads to a unique equilibrium in their model of self-fulfilling currency attacks. The currency attack model thus has the surprising feature, with the introduction of perception distortion, the multiple equilibria region seems to solve to a single equilibrium. It is our contention that this is not a surpising result, it a consequence of the second-order effect, where the risk factor replaces a previous existent, Knightian uncertainty. Previously, speculators had no expectations on other speculators expectations. Here, the risk factor replaces uncertainty, this is the main driver of the surprising result of the paper. Also, the new quantified-risk region only solves a certain part of the multiple equilibria region, not the whole of it. Lastly, if we replace the somewhat strange assumption of a bounded uniform distribution of risk perceptions, with the more orthodox, normal distribution, we cannot derive the same result.

3.1 The Paper

Morris and Shin (1998) addresses the issue of multiple equilibria in models of currency attacks. In situations of a currency peg, there is the possibility of a currency attack. Speculators are able to short the pegged currency, hoping the government will release the peg. If a sufficiently large proportion of the market participates in this, the cost of maintaining the peg for the government becomes too high, which will lead to the government releasing the peg. Currency attacks thus have a self-fulling nature, which leads to a situation of multiple equilibria, as described in Obstfeld (1986, 1995, 1996).

In Morris and Shin (1998) the authors describe such a model. This model is characterised by a situation where there is a stable, unstable, and a 'ripe for attack' region (based on the underlying economic fundamentals). The authors expand on the standard model by introducting second-order expectations. Hereby speculators do not only look at the economics fundamentals of a currency, but also at other speculators' perceptions of these fundamentals.

The authors proceed by introducing a measure of risk around perceptions of the fundamentals by investors. Investors do not know the actual state of the fundamentals, but rather a distored form of it. As a result, the investors' perception of other investors' perceptions are even more distorted. Paradoxically, the leads to model being solvable to a unique equilibrium.

3.2 The Model

I will give a brief description of the model as it is defined, and some it features. There is a state of economic fundamentals θ which is distributed as $\theta \sim U[0,1]$. The exchange rate is the hypothetical situation of no government intervention is a function only of these fundamental ($f(\theta)$), it is assumed that $\frac{\partial f}{\partial \theta} > 0$. The currency is pegged at a level larger than that derived from the fundamentals ($e* \geq f(\theta)$). Speculators can short the currency at a cost t, their payoff is described by:

$$e^* - f(\theta) - t \tag{3.1}$$

The government derives a positive value $\nu > 0$ from defending the peg. The cost of the peg is determined by the economic fundamentals and the proportion of the speculators (α) that attack the currency. The payoff the government is thus:

$$\nu - c(\alpha, \theta) \tag{3.2}$$

Lastly, the following, assumptions are imposed: $c(0,0) > \nu$ (with worst fundamtentals the peg always has to be released), $c(1,1) > \nu$ (with all speculators attacking, the peg always has to be released), $e^* - f(1) < t$ (with best fundamentals, it is inopportune for speculators to attack).

3.2.1 The Possible Outcomes

When we set Equation 3.1 and Equation 3.2 equal to zero, we derive the two turning points in the model. We define $\underline{\theta}$ which solves $c(0,\theta) = \nu$. Also, $\bar{\theta}$ solves $f(\theta) = e^* - t$.

Using the turning points described above, we can define three possible outcome intervals:

1. $[0, \underline{\theta}]$, the cost is always too high, this is the unstable region.
2. $[\underline{\theta}, \bar{\theta}]$, if enough speculators attack, the cost of defending the peg becomes too high, this is the 'ripe for attack' region.
3. $[\bar{\theta}, 1]$, the cost of shorting the currency will always outway the possible gains, this is the stable region.

The two corner intervals have unique equilibria, however, the middle interval, does not. This is thus the multiple equilibria region.

3.3 The Introduction of Risk

The authors expand the model by introducing a measure of risk for fundamentals:

$$x \sim U[\theta - \epsilon, \theta + \epsilon] \tag{3.3}$$

Where is the x is the state of the fundamentas *observed* by the speculators. A speculators observation can thus *at most* deviate from the true value of the fundamentals by ϵ. The speculators are also aware of the nature of the distortion. This means that they are also aware of the fact that other speculators' perceived value of the fundatmentals can at most, deviate from their own with a magnitude of 2ϵ.

3.3.1 The Outcomes with Risk

Having established the new model, the authors state:

> The unique optimal strategy for the government is then to abandon the exchange rate only if the observed fraction of deviators, α, is greater than or equal to the critical mass $a(\theta)$ in the prevailing state θ. (Morris and Shin 1998, p. 591)

By solving out this government 'optimal' strategy, the speculators can ensure themselves of a certain abandonment of the peg, for a sufficiently low observed x. The authors proceed to derivde from this the main result of the paper, which is:

> THEOREM 1: The is a unique θ^* such that, in any equilibrium of the game with imperfect information, the government abandons the currency peg if and only if $\theta \leq \theta^*$. (Morris and Shin 1998, p. 592)

We will now discuss the issues we find in the derivation of this result.

3.4 The Issues

By introduction the idea of perceptions of other speculators' perceptions, the authors state a more realistic model of such a currency attack. It is thus very surprising that the outcome of their more realistic model corresponds less to reality, than the more incomplete models do. After all, in reality, currency attacks do seem to be characterised by multiple equilibria. This is also explicitly expressed by the authors in their introduction, with the mentioning of Eichengreen et al. (1993) and Dornbusch et al. (1994).

We believe that this is due to a number of issues in the derivation of the results, we itentify three issues with this model:

1. The unique equilibrium does not apply to the entire 'ripe for attack' region.
2. The measure of risk replaces uncertainty, since previously there were no second-order perceptions.
3. The model has the unrealistic assumption that distortion would be on a bounded uniform distribution.

In the following subsections, we will describe these problems in more detail.

3.4.1 The 'Ripe for Attack' Region

We can summarise the first problem with the model as follows:

1. Multiple equilibria exist in the interval $(\underline{\theta}, \bar{\theta})$.
2. The introduction of quantief risk, removes uncertainty with 2ϵ of x.
3. Here $u(x, \theta) > 0$ leads to $\pi(x) = 1$.
4. Authors claim that i.f.f. $x < k$ (the quantified-risk region) speculators will attack.
5. This is assumption does not follow from the model.
6. Outside the quantified-risk area the previously existing uncertainty remains.
7. Multiple equilibria remain possible here.

Consider the statement of the authors:

> For the next step, consider the strategy profile where every speculator attacks the currency if and only if the message x is less than some fixed number k. (Morris and Shin 1998, p. 592)

The risk profile of the speculator is being redefined here. In the first iteration of the model, speculators might decide to the attack the currency without knowing what other investors would do. In this second iteration, speculators will only attack if they believe that there is a sufficient number of other speculators doing the same. Yet in the first model, attacks were possible, in absense of this certainty. It thus follows that speculators should be willing to attack the currency, even in outside the quantified-risk region (which now provides certainty).

To illustrate this, consider the following. The risk factor has a magnitude ϵ, where it is assumed that $\epsilon > 0$. However, if in stead we state that $\epsilon = 0$, we have eliminated the risk factor. By eliminating the risk factor, we return to a state of perfect information. Therefore, solving the second iteration of the model, with $\epsilon = 0$ should give us the same result as the first iteration. In stead, we find that we end again in a situation of unique equilibria.

As a consequence of this we have the previously mentioned:

> The unique optimal strategy for the government is then to abandon the exchange rate only if the observed fraction of deviators, α, is greater than or equal to the critical mass $a(\theta)$ in the prevailing state θ. (Morris and Shin 1998, p. 591)

This should say "...abandon the exchange rate *always* if the observed fraction is great than or equal to...". Since quantified-risk region now gives the speculators certainty about the other speculators behavious, this will now always lead to an sustainable attack.

However, as described above, outside of the new quantied-risk region, the old 'ripe for attack region' remains. In this region of multiple equilibria, currency attacks may be successful, or they may not be.

The condition the governments action is thus a sufficient, but not a necesarry one.

3.4.2 Risk and Uncertainty

The second problem is the most fundamental. The distortion measure is presented as a function that adds uncertainty. If we differenciate between Knightian uncertainty and risk, then this is not true.

In relation to the first order effect, the model introduces a quantifiable risk. (which is not the same as uncertainty)

What is more important, is the effect of this risk on the second-order expectations, that is to say, a speculator's perception of other speculators perceptions. In the first iteration of the model, there is no second-order expectation, we are thus in a situation of Knightian uncertainty. By introducing the quantifiable risk into the second iteration, **and making speculators aware of the maximum magnitude of the distortion**, speculators can quantify second-order expectations.

Summierly, the introduction of the distortion, has two effects, the first-order effect is moving from perfect information to risk, the second-order effect is moving from uncertainty to risk. It is this second order effect which leads to the surprising outcome of this model.

3.4.3 A Bounded Uniform Distortion

The third problem is relatively straightforward. The assumption of a uniform distortion is unorthodox. We would normally expect that these distortion would take the shape of e.g. a normal distribution. The effect of this is extremely relevant. A uniform distribution is bounded, which allows the distortion to the quantied with absolute certainty. An unbounded distribution, such as the normal distribution, would not allow a speculator to know the limit of other speculators perception, with absolute certainty.

3.5 Conclusion

Morris and Shin (1998) presents a model for self-fulfilling currency attacks. Under perfect information in the first order (and uncertainty in the second order), this leads to a region of the state of economic fundamentals, where multiple equilibria are possible. With a introduction of a quantified measure of distortion on the perception of this risk, the authors claim that the model solves for a unique equilibrium.

We have identified three problems with this model and its outcomes.

Firstly, the new equilibrium, does not cover the entire previously existing multiple equilibria region. Even though a larger part of the region (w.r.t. the economic fundamentals) leads to a unique equilibrium, a part of the old 'ripe for attack' region, remains subject to a situation of multiple equilibria. It is only through two assumptions which do not follow from the model, that this region also solves for a unique equilibrium.

Secondly, the most fundamental issue is the distinction between risk and uncertainty. The first-order effect of the distortion is moving from perfect knowledge to a situation of quantifiable risk. However, by making speculators aware of the maximum distortion, they can now form expectations of other speculators expectations. The second order effect, is thus moving from uncertainty to risk. This is the driving mechanism behind the new equilibrium in **part of** the 'ripe for attack' region.

Thirdly, the authors introduce a distortion which takes the form of a uniform distribution. It is only due to the bounded nature of the uniform distribution, that speculators are able to form bounded quantitative exectatations on other speculators expectations, with absolute certainty. As mentioned above, it is this absolute certainty on the bounded quantifiable second-order expectations, that drives the result.

In conclusion, we analyse the model introducted by Morris and Shin (1998) and find that the results are driven by a second-order effect, as well as certain unjustifiable assumptions.

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Chapter 4

Bitcoin and Remitances: The Potential of 'Stupid Phones'

Abstract

In this chapter I describe the basis of cryptocurrencies, particularly Bitcoin. I give an overview of what sources of data are available for analysis, and how these can be employed. I propose a project which enables simple telephones or 'stupid phones' to perform bitcoin transaction, this can provide insights into the remittances that are transacted in Bitcoin.

4.1 Introduction

In the 2009 whitepaper (Nakamoto 2009) called "Bitcoin: A Peer-to-Peer Electronic Cash System" an anonymous individual or collective referred to a Satoshi Nakamoto (the Japanese equivalent of John Smith) describes an online currency called Bitcoin (BTC). This currency -the first of a group called cryptocurrencies-has the following economics features:

- public transactions
- anonymous addresses
- fixed amount of units
- high granularity (1 Bitcoin = 100,000,000 Satoshi)
- no or low transaction costs

An addition to these economic features, the key feature of Bitcoin is decentralisation. All transactions are kept in a public ledger called the blockchain. An incentive in the form of transaction fees is provided to stimulate the creation of multiple copies of this ledger. Conflict resolution, in this system, is done through majority consensus of blockchain copy holders.

There are a number of features which make Bitcoin attractive for remittances. Firstly, the low transaction costs are a huge step up from the current facilitators, which charge high percentages. Secondly, government intervention (especially in the recipient country) is prevented by the anonymity. Thirdly, recipients can choose to keep their remittance in a currency which is not controlled by their government. Fourthly, the granularity ensures very small transactions can be conducted.

Bitcoin initially because popular in advanced economies such as those in Europe and North America. However, since mid 2013 there has been a large shift towards developing economies, in which comparative advantages of Bitcoin are more pronounced. For example, since its inception, Mt.Gox (located in Japan) was the largest Bitcoin exchange (marketplace), however in October 2013, Mt.Gox was overtaken by a Chinese exchange.

Bitcoin transactions are conducted by the electronic 'signing' of a transaction. This is a very simple electronic process. Currently many smartphone apps are available to this purpose. However, in the targeted developing economies, many phones are not smartphones, the vast majority using Nokia Operating System (Nokia OS). These phone can also run applications, using the Java Mobile App platform. Currently there are no Bitcoin apps available for this platform.

I propose to participate in the development of open-source applications which would enable the users of stupid phones. We can then exploit the temporal difference when releasing the applications in different languages at different times, as well the downloads from traceable IP addresses.

4.2 Data

Funds held at Bitcoin exchanges are not held in the owners bitcoin wallet. Rather, the exchange holds them in their wallet, and the clients have a claim on this wallet. Much like the way bank clients have a claim to their money, which is in the bank's vault.

Therefore Bitcoin purchases at exchanges do not lead to transaction being recorded in the blockchain. Since the Bitcoins remain in the Exchange's wallet, the only thing which changes is the claims of the clients.

- The blockchain (public ledger)
  - IP address
  - Language of transaction notice
  - Transaction times
- The exchanges
  - Location of exchanges
  - Transaction costs for each currency
  - The order books
  - Transaction times
  - The traded currency
- Software
  - Downloads
  - Translation contributions (?)
  - Connections to server

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Chapter 5

Bitcoin Attacks: Or How Cryptocurrencies Gain Momentum

Abstract

In this chapter I set out the idea of employing the models used for currency attacks, to analyse how cryptocurrencies gain momentum. Additionaly, I discuss how inflation in the cryptocurrency economy is possible.

5.1 Introduction

As discussed in chapter 4, there has been a new phenonemon in international finance called cryptocurrencies. The first of these was the cryptocurrency called Bitcoin (Nakamoto 2009). However, soon after Bitcoin started gaining momentum, alternative crypotcurrencies where being designed. All of these cryptocurrencies are based to a large extend on the Bitcoin protocol, but often introduce small technological innovations.

The most known of all of these alternative crypocurrencies is Litecoin. Litecoin introduces a number of small technological innovations, the most import of these is the change that the process of 'mining' coins is 4 times faster, this has two consequences, transactions are approved faster than in the bitcoin protocol. It also means that the technological limit for the total number of Litecoins ever available is 4x times higher. For Bitcoin the technical limit is around 21 million Bitcoin, which is expected to be reached in the year 2140. For Litecoin, the limit is around 84 million bitcoin, which is also expected to be reached around this time.

The key thing to note here is the perspective of the new cryptocurrecy adopt. Even though the value of Bitcoin is much higher than that of Litecoin, it does not have more to offer. The lower valued new cryptocurrency is technologically superior and thus more attractive. Most new cryptocurrencies do not gain momentum and their value is only trivialy more than zero. However, some currencies have gain momentum, the previously mentioned litecoin introduces a technological innovation and build it base on that. However, recently a new cryptocurrency has arisen and become quite popular. This cryptocurrency is called 'Dogecoin' and besides it name, it does not introduce any novelty. Dogecoin is a reference to an internet phenomenon called 'Doge Meme'. Despite the fact that 'Dogecoin' does not have a real reason for being considered valuable (in the sense that crypotocurrencies are considered valuable), however, by utilising a previously existing internet phenomenon, and it's fanbase, this currencies has become valuable. We thus observe that from the perspective of economic and technological fundamentals, there is a situation of multiple equilibria.

5.2 Positive Currency Attacks

My idea is to adapt standard models of currency attacks such as in Obstfeld (1986, 1995, 1996) to model the gaining of long (v.s. currency attacks' short) momentum for cryptocurrencies. Initially we would model how a currency can gain sufficient momentum to establish itself as a stably above zero.

5.2.1 A Multi-currency Model

This could later be expended to a model with several cryptocurrencies, competing for the investment of the same new cryptocurrency adopt, who is converting his/her fiat currency into one of several cryptocurrencies.

Figure 5.1: A Doge Meme

5.3 Multi-cryptocurrency Economy and Inflation

Finally, an extension of such a multi-cryptocurrency model can provide a valuable insight into the issue of inflation.

On of the key selling points of the cryptocurrencies, and equally one of the key critisism of many economics (e.g. Paul Krugman), is that there is no inflation in a crypocurrency. The crypocurrencies are designed specifically so that inflation eventually becomes impossible (once all coines are mined).

However, it is key here to understand the economy as a multi-cryptocurrency object. Since creating a currency can be done at negligable cost, and the only value of the cryptocurrency lies in its utility as a mechanism for transactions, more cryptocurrencies will come into existance. Especially since it is very simple for a merchant to accept several cryptocurrencies as a form of payment. The effect of this will be that inflation in each cryptocurrency will remain as defined, however, the cryptocurrency economy as a whole, will be able to experience inflation.

Additionaly, this partly addresses one of social critiques of Bitcoin, namely the issue of bitcoin mining being excessively wastful. Bitcoin mining does not produce anything of any social value (not unlike gold mining), the higher value of bitcoin, the more computing power (and electricity) will be diverted to this. However, in a multi-currency model, it will be more effective to mine alternative cryptocurrencies, as these can initially be mined with relative ease.

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Chapter 6

End notes

In the previous chapters I have presented my current research projects. These projects are in various stages of completions.

I believe that my South Africa paper provides an interesting opportunity to exploit the data from the household survey, done before and after a highly relevant policy change. Especially since the methodology and location are the same as in Duflo (2000, 2003). In addition to this there is now a third data wave which has become available. This provides us with more data, and mostly the opportunity to use more interesting methodology. The text of the paper still has to be written.

The discussion of Morris and Shin (1998) is in a very early stage. I have looked at the paper in detail, I have also done a brief analysis of my main critique, namely the conflation of risk (quantifiable) and Knightian uncertainy (unquantifiable). However, I would like to presenta worked out example which demonstrates how this convolution leads to the main result of the paper. In addition to this, this example should demonstrate how only a part of the 'ripe for attack' region is solved for the unique equilibrium.

Finally, relating to Bitcoin (Nakamoto 2009), I think that there is a enormous potention for uncontrolled low-cost remintances using Bitcoin. I would like to analyse the spread of this. I propose to follow the spread of applications for platforms which are popular in developing economies.

At this point, three out of four of the previously discussed research projects are some form of a replication of prior work. As replications they are mostly critiques of others' work, rather than constructive ideas. This is mostly a result of the fact that these projects progress faster. For this reason, these research projects have progressed more than the projects which are primarily based on my own ideas. However, it is my attention to shift the focus of my thesis to include more original work. Here I present two more ideas which are too preliminary to include in the main body of the text, but are based on my own work.

Firstly, I was in charge of setting up a baseline diagnostic into security perceptions in Conakry, Guinea. This diagnostic will be used to analyse the impact of a police reform conducted here. The reform constitutes of the implementation of a model of 'police de proximitee'. The baseline consist of 4500 interviews using smartphones in the comune of Conkary as well a large number of interviews in N'Zerekore (east Guinea). Some time after the implementation of the police reform as follow up study will be conducted. I propose to conduct an impact evaluation using the results from the studies in which I have taken and will take part.

Secondly, I have previously studied philosophy of science in my bachelors in Theoretical Philosophy. I would like to write one paper about an issue relating to this. In particular I would like to at the effect of outliers. The effect how these outliers has extensively been discussed in contexts such as finance and international economics (Taleb 2010; Sornette 2009), as well as indiviual behaviour (Kahneman 2011). I would like to see how these principles affect research in development microeconomics.

In this document I have tried to give a description of my research projects. None of these projects are near completion and many are in fact in a very early stage. The purpose of this has been to describe the direction I am taking with my thesis, and to receive feedback on this. As a result of this being work in progress, the articles are still incomplete, this includes lacking the proper attribution of ideas using citations.

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