High Discount Rates:
- An Artifact Caused by Poorly Framed Experiments or a Result of People Being Poor and Vulnerable?

By

Stein Holden

School of Economics and Business

Norwegian University of Life Sciences

Introduction: Holden, Shiferaw and Wik (1998)

- Does poverty affect time preferences?
- Are poor people poor because they have high discount rates and therefore they do not save and invest?
- Or is the causality the other way around; Poverty causes and forces them to have high discount rates and make them unable to save and invest?
- The study assessed this possible two-way causality and
- Used studies in three countries; Indonesia, Ethiopia and Zambia
- Focused on the relevance for natural resource conservation
- **Could high discount rates also explain low input use and limited technology adoption?**

Theory model

- If households face credit constraints this may affect their intertemporal decisions and the tradeoff between current and future consumption

$$v'(C_0) = Ev'(C_1)e^{-(\delta - r)} + \lambda$$

where λ is the shadow value on the credit constraint. Combined we get

$$-\frac{dC_1}{dC_0}\Big|_{U=\text{constant}} = e^r + \frac{\lambda e^{\delta}}{Ev'(C_1)}$$

- This implies that the pure rate of time preference and the shape of the utility function only matters for the rate of intertemporal substitution if the credit constraint is binding.
- A positive shadow value on the credit constraint increases the intertemporal rate of substitution (RTP)

Direction of causality? Poverty ←→ Time preferences

- If High RTP → Poverty
  - RTP is a stable preference characteristic
  - RTP is correlated with wealth
  - RTP should not respond to random or location-specific conditions
- If Poverty → High RTP
  - RTP will change with wealth
  - RTP will be influenced by liquidity constraints and location-specific conditions

Implementation of Causality Tests

- Natural experiment in Indonesia
  - Recent resettlements from Java to Sumatra
  - Compared RTPs in new settlements with good and poor market access
  - Included wealth variables in econometric analysis
- Utilized economies of scale in consumption in the household
  - With a causal relationship: Poverty → RTP and economies of scale in consumption:
  - RTP will decline with household size

Key findings

- Found very high RTPs
  - Indonesia
    - Poor market access: 132% average
    - Better market access: 64% average
  - Ethiopia
    - One location with good agroecological and market conditions: 28-79%
    - RTPs declined with household size as well as with asset endowments
  - Zambia
    - 6 Villages: 73-147 % average RTPs in villages

Weaknesses of the study

- Compared amounts today with amounts 1 year into the future (upward bias in discount rates due to present bias)
- Used hypothetical questions only (incentive compatible approaches have become the rule since then)
- Ignored risk aversion/concavity of the utility function (upward bias in discount rates

- Are the high discount rates an artifact based on poor methods?

Basic issues in elicitation of time preferences/discount rates

- **Present bias**: Higher rates when comparing current time and a future point in time than when comparing two future periods
- **Magnitude effect**: Discount rates tend to be lower for larger amounts
- **Time horizon effect**: Discount rates tend to go down with the length of the time horizon (hyperbolic discounting)
- **Market characteristics and asset integration**: Limited or partial asset integration and market imperfections such as credit constraints separates individual discount rates from market rates of interest
  - Poverty and vulnerability may affect time preferences
  - Climate risk and shocks may affect the discount rates

More credible methods for elicitation of time preferences

- **Multiple Price List** (MPL) approach introduced to elicitation of risk preferences by Holt and Laury (2002) have gained popularity and credibility (Andersen et al. 2007; 2008)
- Advantages of MPL
  - Transparency
  - With incentives; should reveal truthful responses
- Disadvantages
  - Only identifies an interval response
  - Can be sensitive to framing effects

Time preference experiments in Malawi 1

- One out of three types of experiments:
  - Risk preferences,
  - Time preferences and
  - Input demand experiments
- Varied the order of these to test whether it could affect the responses
- The choices are between amounts of money to be received with certainty at different points in the future.
- In each case the respondent chooses between two options and indicates the one he/she prefers.
- Multiple Price Lists are used
- Randomized starting point in each series

Time preference experiments in Malawi 2

- Recruited 4 enumerators (with MSc degree in agricultural economics) (one was replaced later)
- Trained them for one week, including pilot testing of experimental protocol
- Introduced the experiments in each district/village one week after the survey
  - Experiment participation seen partly as a compensation for participation in the survey (4th round panel survey of the same households)
  - Households had learnt that we are coming back
  - UMB/LUANAR(Bunda) collaboration since 2005/06
  - One day in each village with all three types of experiments
  - Minimize communication among respondents

Time preference experiments 3

- Choices between more distant future and more near future (or current) money options (in MK).
- In each series we keep the future option constant while we vary the more near future (or current) option till we identify the switch point for the respondents.
- We expect only one switch point per series for responses to be consistent in that specific series.
- The right hand side provides the implicit annual interest rate if the two options in each task had equivalent present value
  - We did not tell the implicit rates to the respondents

Time preference experiments

Time preference series 11					
Task	Receive at far future period	Choice	Receive at near future period	Choice	Implied annual interest rate
	3 months from now, MK		1 week from now, MK		
111	10000		10000		0.00
112	10000		9500		22.87
113	10000		9000		48.28
114	10000		8000		108.63
115	10000		7000		186.22
116	10000		6000		289.68
117	10000		5000		434.52
118	10000		4000		651.79
119	10000		3000		1013.89
120	10000		2000		1738.10

Time preference experiment treatments

- Far future point in time:
- 1 month, 3 months, 6 months, 1 year
- Near future point in time:
  - Today, 1 week, 1 month
- Future amounts:
  - MK 1000, MK 5000, MK 10000, MK 20000
- Randomized across households
- 10% probability that there will be a real payout for the households
  - Random selection of series and game for households that win in the lottery
  - Need to arrange for a future payment where that is relevant for the winning households (Local researchers must be able to facilitate this, must have sufficient trust among respondents)

Time preference experiment treatments (number of each in parentheses)

Treatment type	Treatment levels
Front end point in time	Current(7), 1 week delay(13), 1 month delay(7)
End point in time	1 month(5), 3 months(11), 6 months(6), 12 months(5)
Future amount level	1000MK(6), 5000MK(6), 10000MK(9), 20000MK(6)

Treatment Randomization

- To test and control for present bias, magnitude effect and time horizon
- More treatments for magnitudes and time horizons that are of interest for input use decisions in crop production
- Reduced number of treatments for 44 to 27 by dropping some combinations
- The 27 treatments were randomized across 3 and 3 households (9 TP Series per household)

Natural Experiment

- Experiments took place after a drought year when a large share of the households had experienced dry spells affecting their crops
  - Has the exposure to droughts affected the time preferences of the respondents?
  - How are their time preferences related to their wealth situation?
  - How high are the discount rates after controlling for present bias and risk aversion (curvature of utility functions)?

Estimation Issues

- Exponential discounting versus alternative discounting functions (hyperbolic/quasi-hyperbolic)
- Choice of utility function versus ignoring risk aversion
  - CRRA utility function
  - Expo-power utility function
- Allowing for stochastic errors
  - Fechner error
  - Luce error
- Non-parametric estimation
- Parametric estimation
  - Variants

Theoretical framework

- The decision problem can be framed as a two-period problem choosing between one amount at a near period time and another bigger amount at a more distant point int time:

$$U_A = \left(\left(e^{-\delta(t_1-t_0)}u(y_1+M_A)\right)+\left(e^{-\delta(t_2-t_0)}u(y_2)\right)\right)$$

$$U_B = \left(\left(e^{-\delta(t_1-t_0)}u(y_1)\right)+\left(e^{-\delta(t_2-t_0)}u(y_2+M_B)\right)\right)$$

It is integrated with some background level of consumption (y): The literature is not very clear on what y should be

Structural model specification

- The Utility differential;
- 2) $\nabla U = U_A - U_B$
- may be captured by a probit (or a logistic) function such that
- 3) $prob(U_A) = \Phi(\nabla U)$
- is the cumulative density function (cdf).
- The latent index may also be written in ratio form;
- 4) $\nabla U = U_A / (U_A + U_B)$
- A further extension of the estimation of the above models is to include stochastic errors. We applied the Luce specification
- 5) $\nabla U = U_A^{1/\mu} / \left(U_A^{1/\mu} + U_B^{1/\mu}\right)$

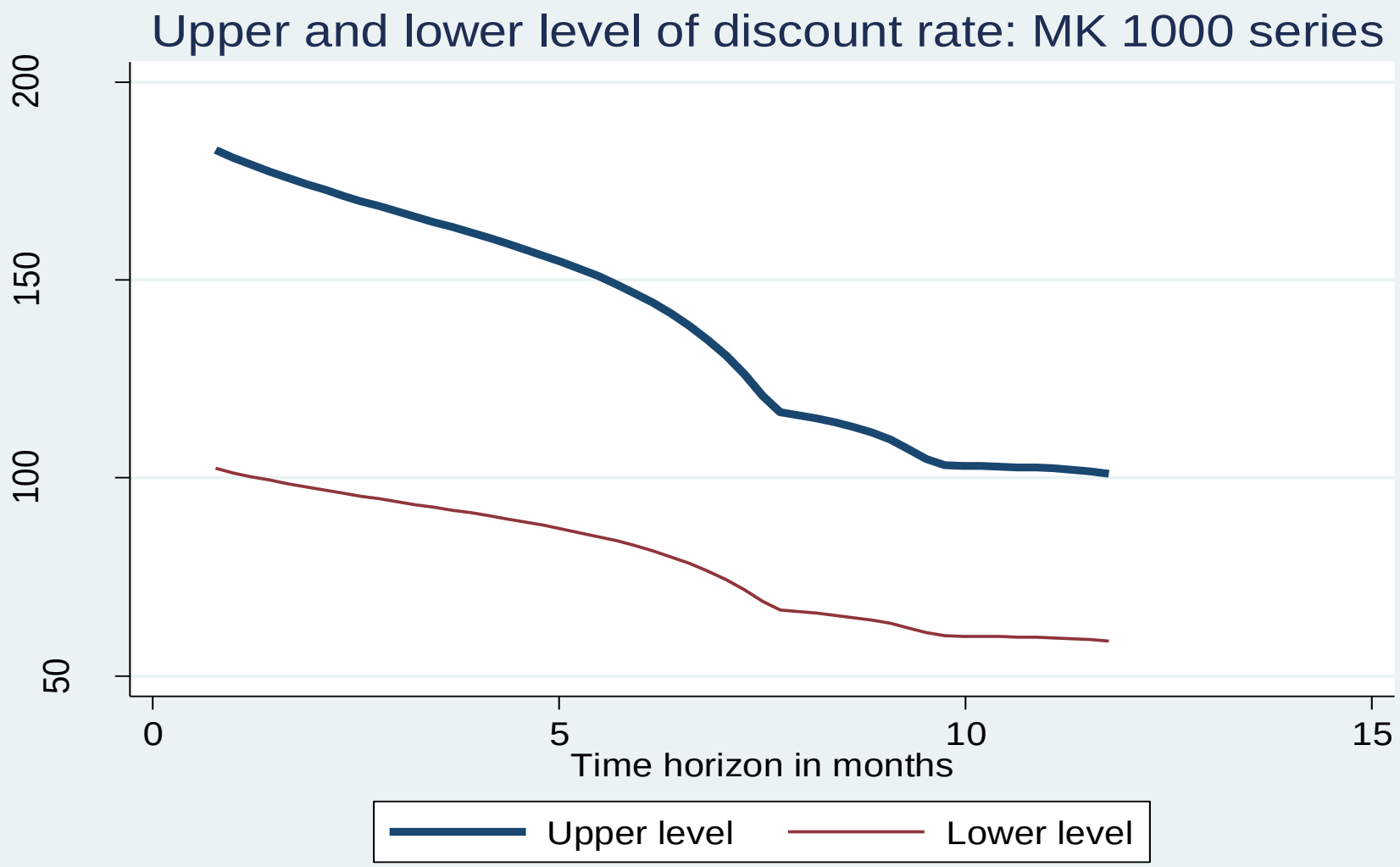
Structural model specification

- Choice of utility function: Alternatives
  - CRRA: $U(x) = (1-r)^{-1} x^{(1-r)}$
  - The problem is that the function is not continuous around r=1 and the utility becomes negative when r>1
  - Logarithmic: $U(x) = ln(x)$
  - Expo-power: $$U(x) = \frac{\left(1 - \exp\left(-\alpha x^{1-r}\right)\right)}{\alpha}$$
  - Convergence problems with this function caused me to use the logarithmic utility function (CRRA=1) but it is continuous in the relevant range

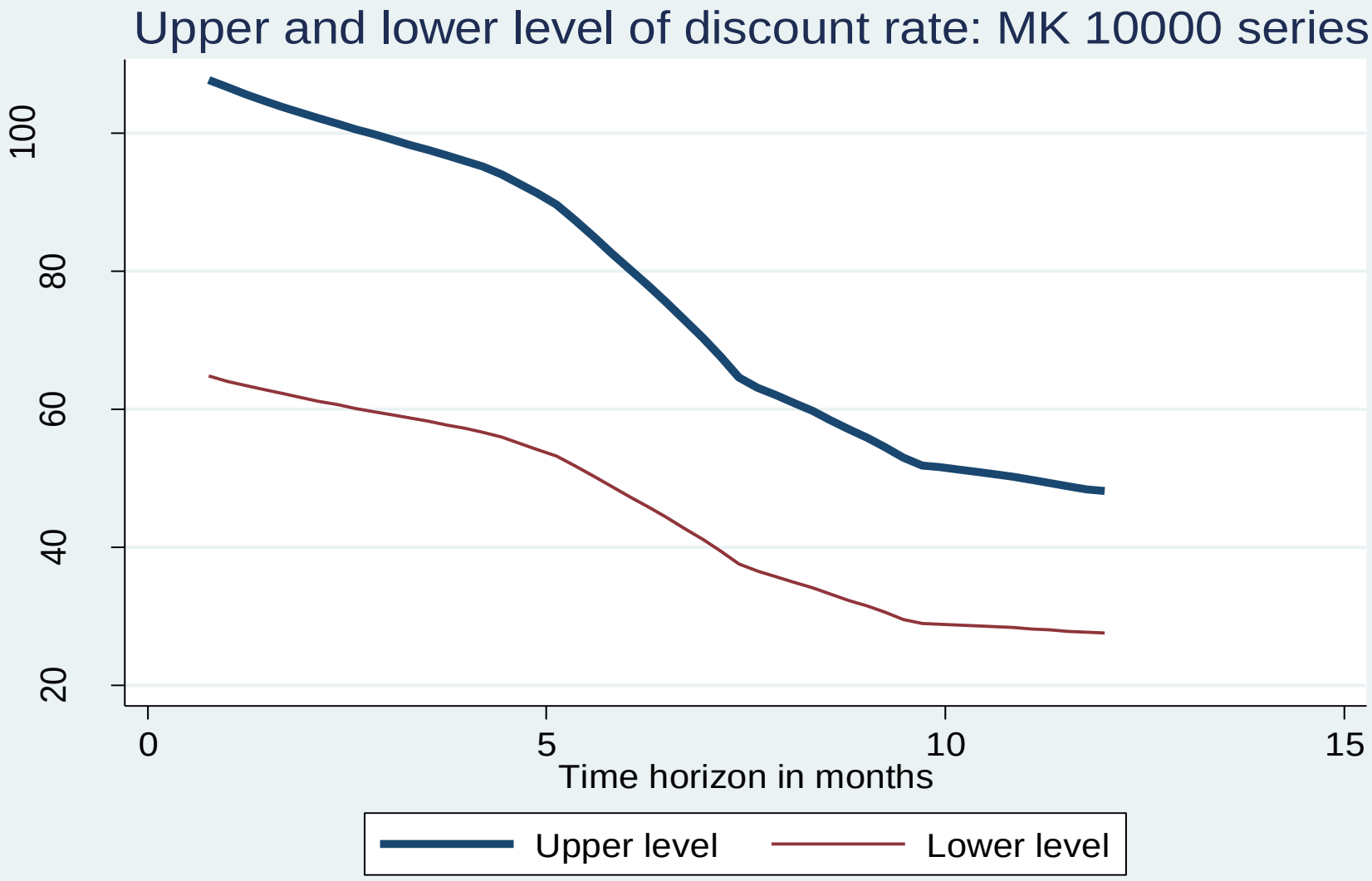
Hypotheses

- H1. Respondents possess **present bias** such that their discount rates are higher if comparison is made between now and a future date than if the comparison is between to future dates (quasi-hyperbolic discounting).
- H2. Discount rates decline with size of the future prospect (**magnitude effect**).
- H3. Discount rates decline with the length of the period between the two offers (duration effect or **hyperbolic discounting**)
- H4. **Previous high discount rates** estimated for poor people are **caused by** poor quality experimental methods and **ignorance of their risk aversion/concave utility functions**
- H5. Discount rates of poor people remain high after having controlled for present bias and concavity of the utility function; such **high discount rates reflect their limited market access, poverty, vulnerability and exposure to shocks**

Findings: Non-parametric regressions based on exponential discounting and risk neutrality 1



Findings: Non-parametric regressions based on exponential discounting and risk neutrality 2



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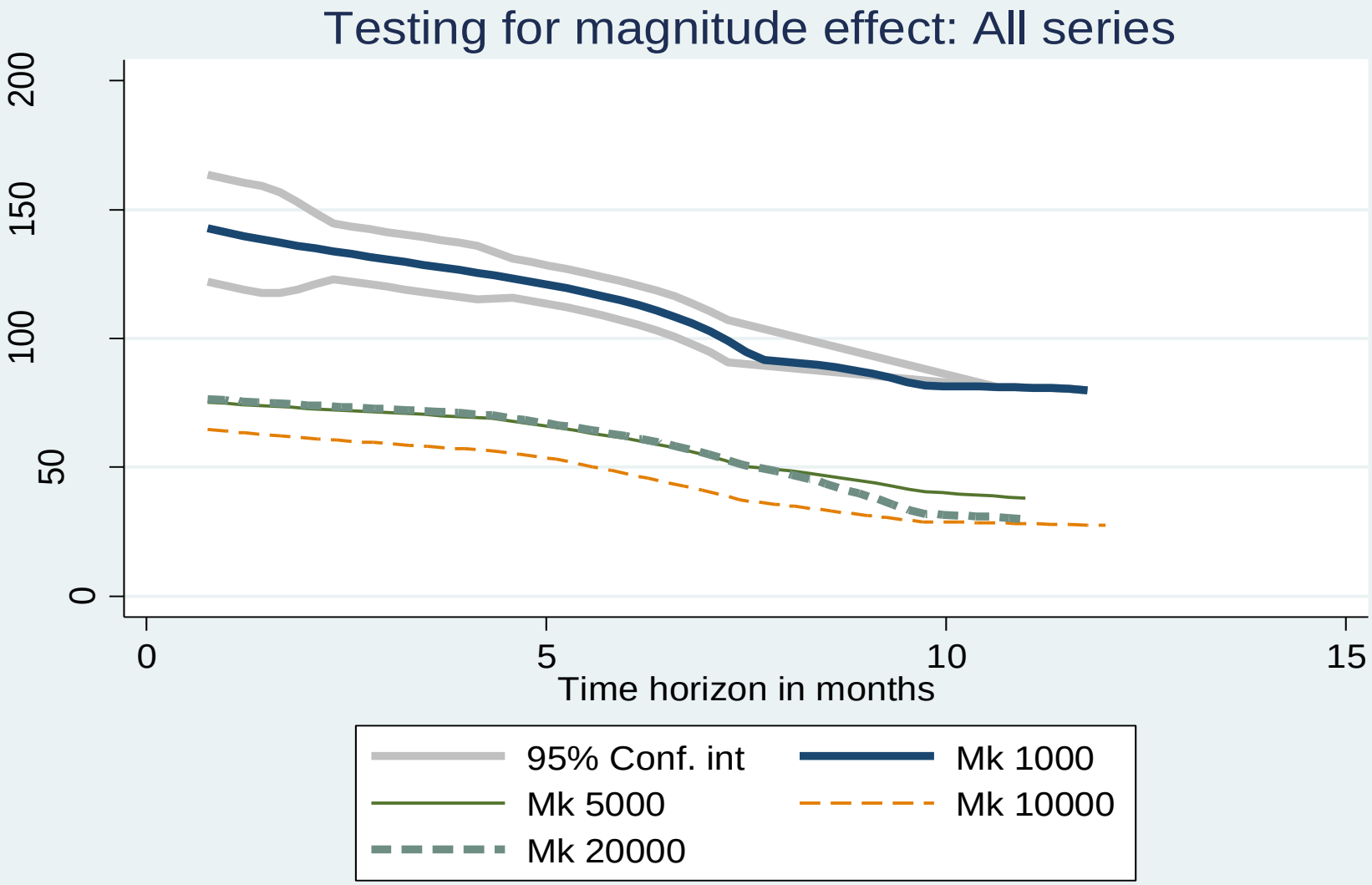
Findings: Non-parametric regressions based on exponential discounting and risk neutrality 3



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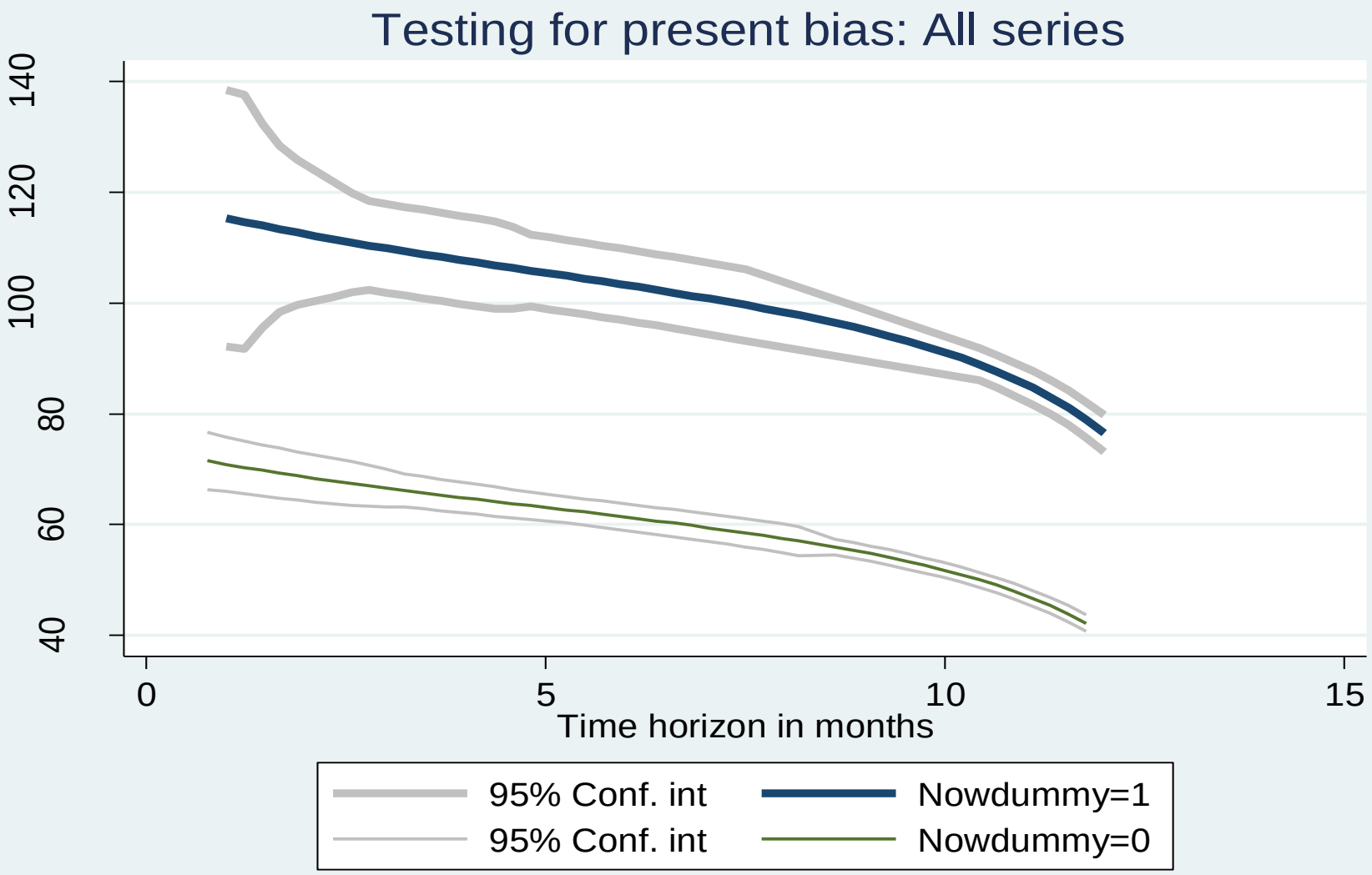
Findings: Non-parametric regressions based on exponential discounting and risk neutrality 4



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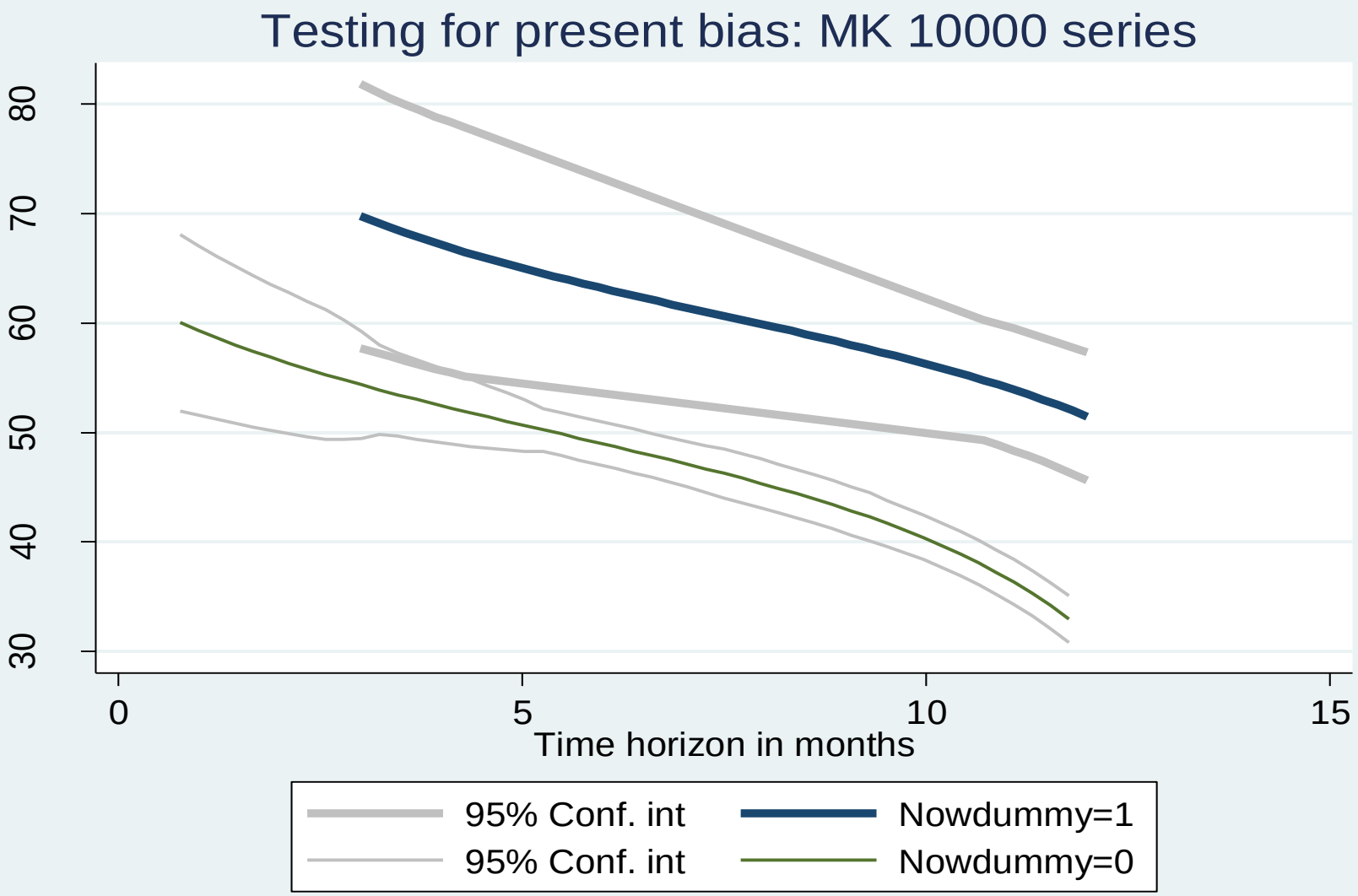
Findings: Non-parametric regressions based on exponential discounting and risk neutrality 5



ML estimates of continuous time discount rates without and with inflation correction

Models where the base consumption level=MK300	Without inflation correction	With inflation correction
Future amount: Baseline=1000MK		
Future amount: 5000MK	-0.526****	-0.569****
Future amount: 10000MK	-0.704****	-0.773****
Future amount: 20000MK	-0.749****	-0.819****
Far future point in time: Baseline=1 month		
3 months	-0.941****	-0.995****
6 months	-1.296****	-1.398****
12 months	-1.846****	-2.096****
Dummy for front end point=current	0.115***	0.122***
Dummy for front end point=1 month	0.098**	0.111**
Experienced drought shock in 2011/12, dummy	0.224*	0.259*
Random starting point dummy*Task number	-0.024****	-0.029****
Tool index	-0.012	-0.014
Farm size in ha, gps-measured	-0.050*	-0.058*

ML estimates of continuous time discount rates without and with inflation correction

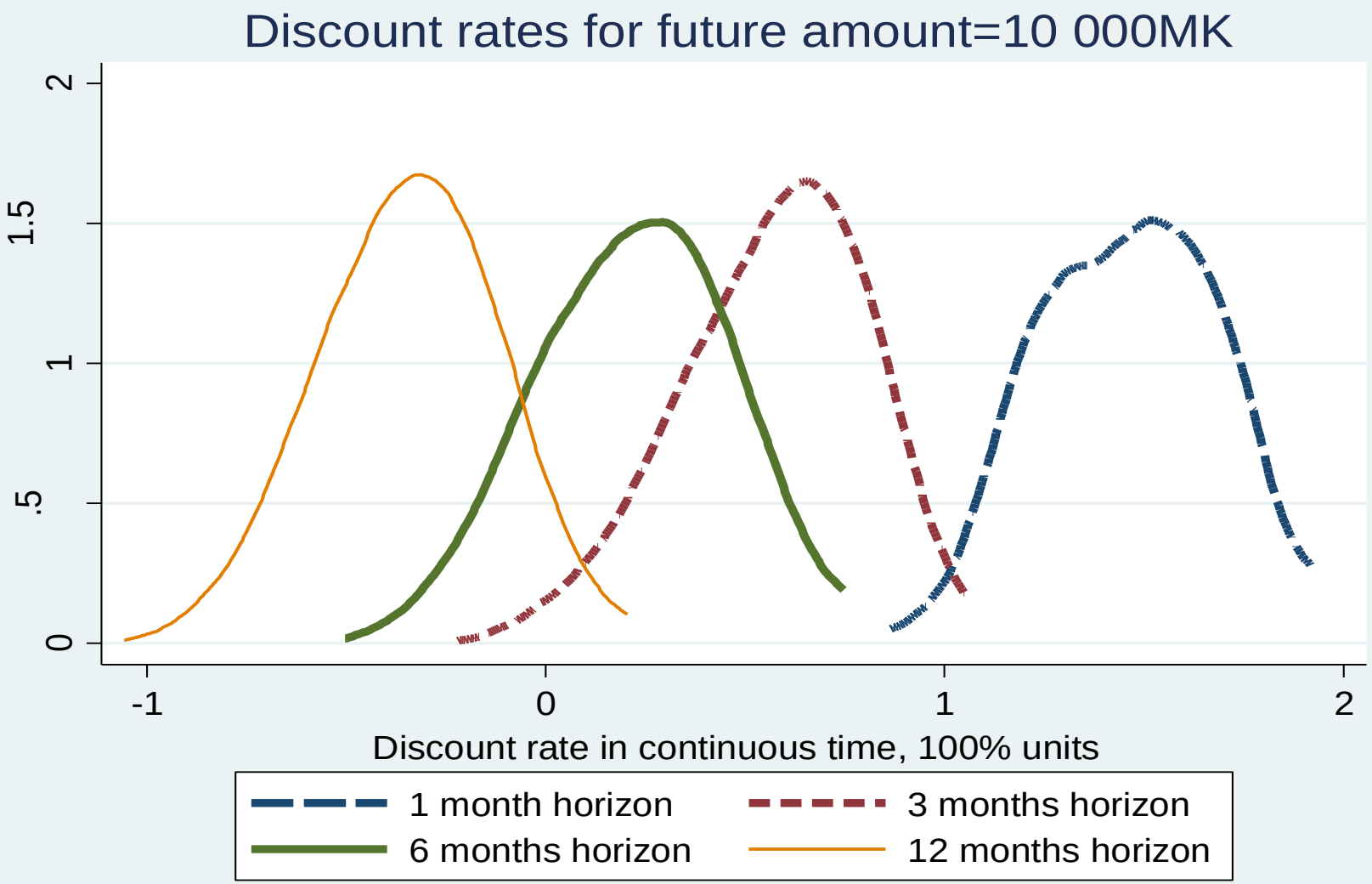
Models where the base consumption level=MK300*Months time delay	Without inflation correction	With inflation correction
Future amount: Baseline=1000MK		
Future amount: 5000MK	-0.635****	-0.666****
Future amount: 10000MK	-0.854****	-0.908****
Future amount: 20000MK	-0.958****	-1.023****
Far future point in time: Baseline=1 month		
3 months	-0.401****	-0.423****
6 months	-0.485****	-0.514****
12 months	-0.671****	-0.728****
Dummy for front end point=current	0.081**	0.083**
Dummy for front end point=1 month	0.075*	0.079*
Experienced drought shock in 2011/12, dummy	0.239*	0.261*
Random starting point dummy*Task number	-0.019****	-0.021****
Tool index	-0.019	-0.021
Farm size in ha, gps-measured	-0.057*	-0.062*

Predicted discount rate variation with variation in near and far future points in time

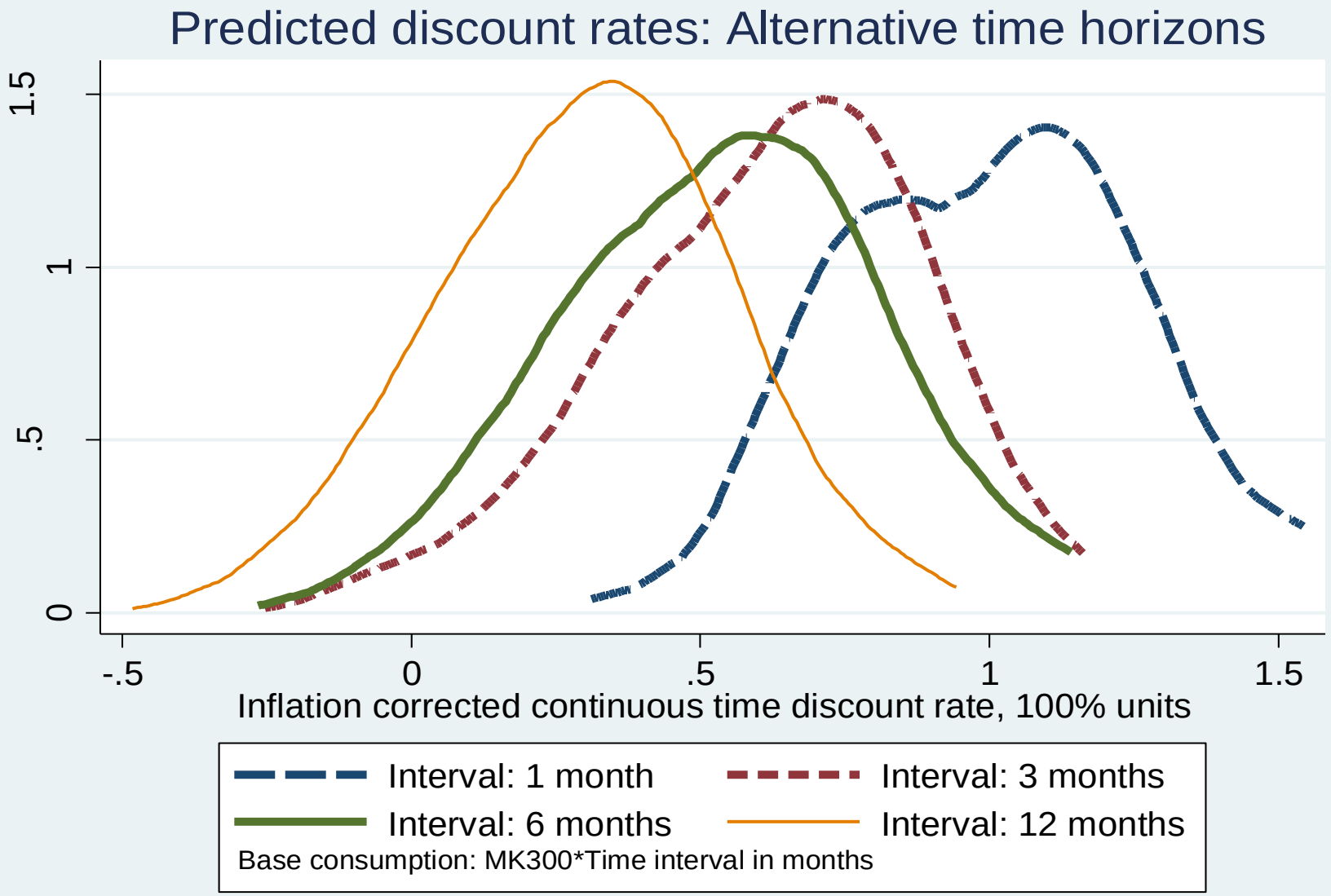
	Near point in time is 1 week or 1 month			Near point in time=Current		
Duration to far future point in time (months)	Mean, 100%	se(mean)	N	Mean	se(mean)	N
1	**1.00**	**0.007**	**1101**			
3	**0.62**	0.005	2376	**0.66**	0.007	1105
6	**0.54**	0.006	2297			
12	**0.30**	0.005	2475	**0.34**	0.007	1378

With continuous time discount rates, logarithmic utility function, MK10 000 series, with inflation correction, and
base consumption=MK300*Length of time interval in months

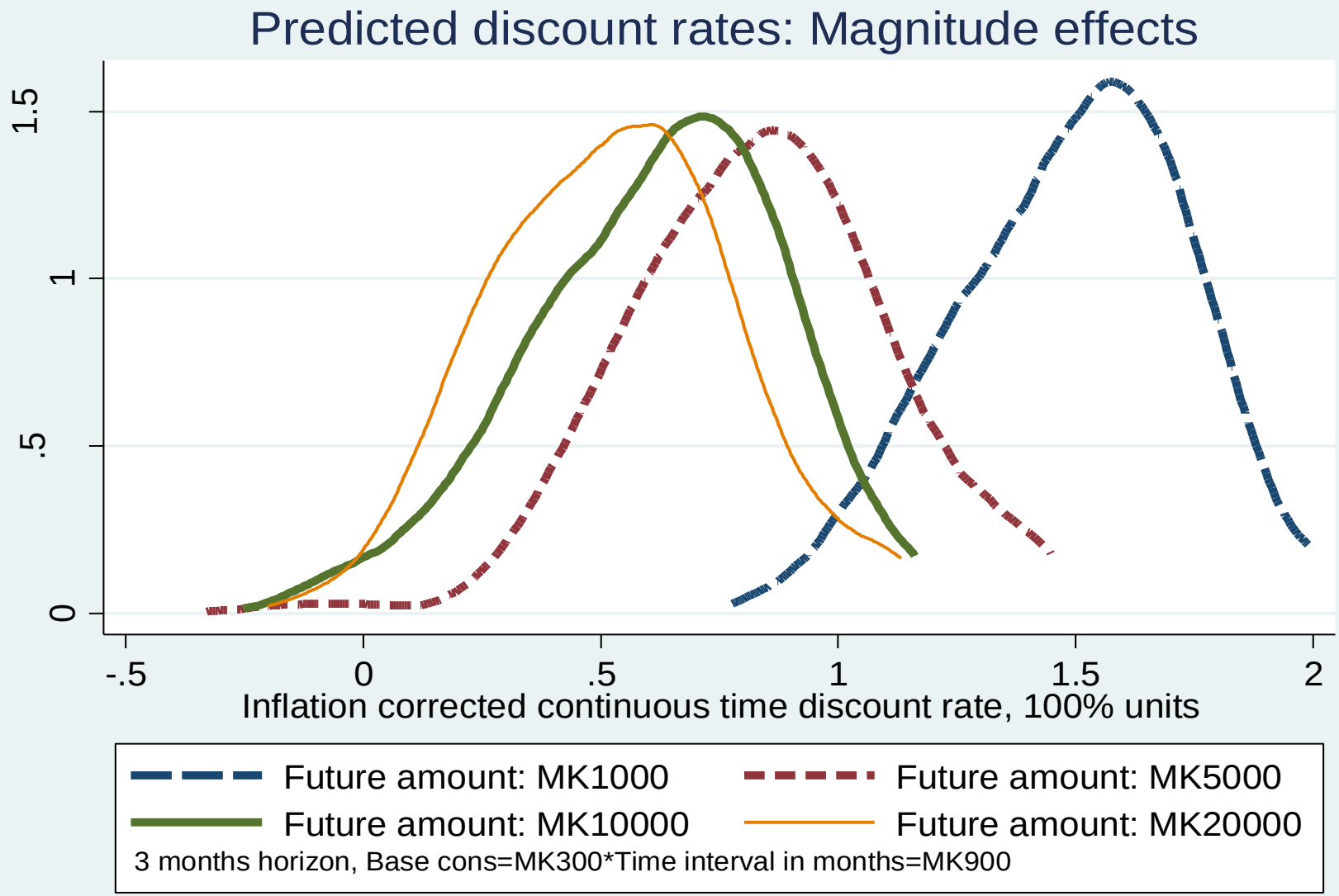
Predicted discount rate distribution with base consumption=MK300 (constant for all time horizons)



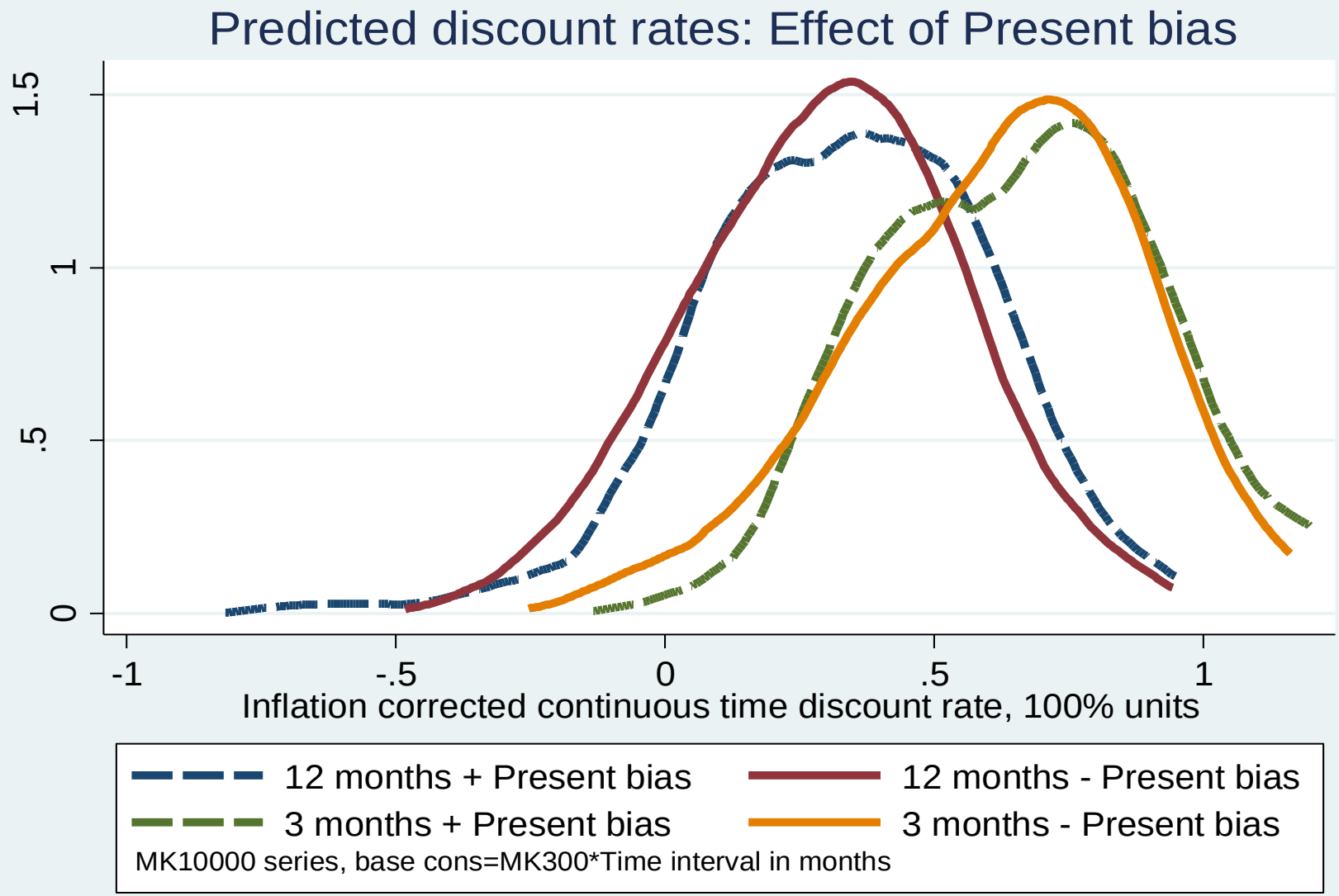
Predicted discount rate distribution with base consumption=MK300 *Number of months time horizon



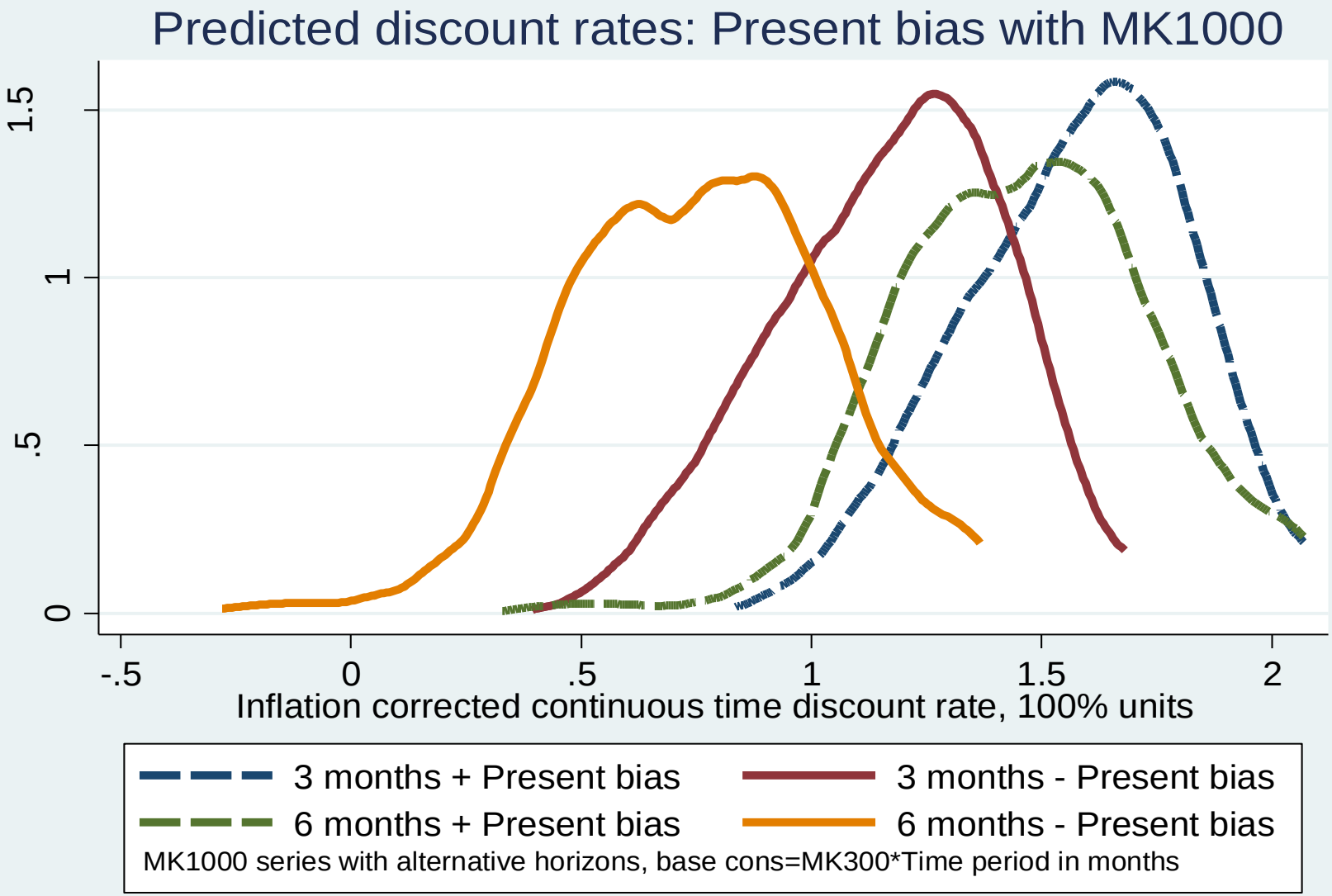
Magnitude effects: Predicted discount rates: logarithmic utility function with Luce error



Extent of present bias and time horizon in series with relatively large amounts (10000 MK)



Extent of present bias and time horizon in series with relatively small amounts (1000 MK)



Conclusions

- Credible time preference estimation requires careful and well organized fieldwork with an incentive-compatible experimental approach
- The MPL approach is probably the most tested an accepted approach used today
- The MPL is also sensitive to framing effects and requires very careful training of good enumerators
- Framing should be adjusted to the purpose for which the estimates are to be used (time horizon, magnitude, present bias)
- We found that time preferences in Malawi responded to drought shocks (+24-26% higher discount rates).
- Discount rates were negatively correlated with farm size
- Poverty/vulnerability→High discount rates