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Weather & income: effect of household saving and well-being in South Africa

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Introduction and Relevance

- Increased weather variability → source of vulnerability to stable consumption, food security and **household well-being**

- Saving and consumption responses to changes in weather in SA

- Tuberculosis (TB) and HIV are major disease epidemics in South Africa
  - SA has the highest HIV epidemic in the world: 19% prevalence among adults (UNAIDS, 2015)
  - HIV: 33% of causes of death in 2012 (WHO, 2012)
  - TB incidence rate 834 per 100,000 pop. TB: leading cause of death in 2015

Research Question

- Saving and consumption responses to changes in weather in SA: test prediction of the **standard rational consumption model** and extensions
  - **Precautionary-saving** suggests that HH should save more if they experience higher variance in income
  - **Myopic consumption:** HH consume only in relation to current period's income - no consumption smoothing
- In turn, what are the impacts of saving on health behavior (HIV / TB testing & diagnosis)?

Theoretical Model (1)

- Rational consumption response to income changes for a representative HH (permanent income HP, Japelli and Pistaferri, 2010)

- Standard model: HH agent max the E(u) of consumption over some time period, subject to an inter-temporal budget constraint and a terminal condition on wealth. In each period, the HH receives $y_{it} = \overline{y_{it}} + \varepsilon_{it}$

- Predictions:
  - c_{it} responds 1-to-1 to permanent income shocks but is nearly insensitive to transitory shocks $\Delta c_{it} = \frac{r}{1+r} v_{it} + u_{it}$ $(u_{it} = P_{it} - P_{i,t-1})$
  - Saving equation (Campbell, 1987): $s_{it} = \frac{1}{1+r} v_{it}$ → s_{it} should respond to changes in v_{it}(i.e. weather-induced ones), but not permanent income (Jappelli and Pistaferri, 2010).

Theoretical Model (2)

Saving Equation (Paxon, 1992)

$$S_{irt} = \alpha_o + \alpha_1 Y_{irt}^P + \alpha_2 Y_{irt}^T + \alpha_3 VAR_{ir} + \alpha_4 W_{irt} + \varepsilon_{irt}$$

- S_{irt} saving for individual *i*, in region *r*, at time *t*.
- Y_{irt}^P permanent portion of the individual's income ; Y_{irt}^T transitory portion of the HH's income
- VAR_{ir} income variation of individual *i* in region *r*
- W_{irt} is a set of household lifecycle characteristics

Standard model's predictions:

- $\alpha_1 \approx 0$
- $\alpha_2 \approx 1$
- $\alpha_3 \approx 0$ *if* a quadratic utility function is assumed - risks and income variances do not factor into the saving equation with this U(f)

  If $\alpha_3 > 0$: indication of risk-aversion

Data

- National Income Dynamic Study (2008, 2010, 2012, 2014)
  - nationally representative across 9 provinces and 52 districts
  - includes assets, income, expenditure, health, education, well-being...
- ERA-interim climate reanalysis from ECMWF (Dee, 2011) reanalysis of global atmosphere since 1979
  - daily data at 0.75x0.75 degree resolution
  - reconstructed from actual observations, spatially complete,
  - increasingly used to study areas where weather stations are scarce
  - We use 30-years of climate data-by district

Data: variables definition

Income, consumption and saving - unit: SAR. (Source: NIDS)	
Income	Total HH income from all sources in the previous 30 days
Durable consumption	Expenditure in HH maintenance, kitchen, furniture, clothing, etc. in previous 30 days
Consumption	Total consumption, including or excluding durable consumption, in the previous 30 days
Saving	Income minus consumption, including or excluding durable consumption, for previous 30 days

Permanent income predictors. (Source: NIDS)	
Assets (in quintiles)	Market value of owned house in quintiles (rent=0)
age1-age2yo, male / female	No of HH male/female members from age1 to age2 years old

Transitory income predictors – district-specific, seasonal climatic variables. (Source: ERA-Interim)	
Rainfall, deviation from mean (mm)	Seasonal total rainfall deviation from climate normal
Rainfall, coefficient of variation (σ/μ)	Rainfall standard deviation divided by mean in the same season
Temperature, deviation from mean (mm)	Seasonal mean deviation from climate normal
Temperature, coefficient of variation	Temperature standard deviation divided by mean in the same season
Days in growing season over 34° C	No days in the growing season warmer than 34° C

Wellbeing and health indicators. (Source: NIDS)	
Life satisfaction	Household Head's self-reported life satisfaction, on 1 (lowest) to 10 (highest) scale
HIV testing (household)	Indicator of whether any household had at least one individual over the age of 15 with HIV testing
HIV testing (individual)	Indicator of whether any individual over the age of 15 had HIV testing

Empirical Approach

- Paxson (1992)
  - $S_{irt} = \alpha_o + \alpha_1 Y_{irt}^P + \alpha_2 Y_{irt}^T + \alpha_3 VAR_{irt} + \alpha_4 W_{irt} + \varepsilon_{irt}$
- Decompose permanent and transitory income:
  - $Y_{irt}^P = \beta_{ir}^P + \beta_1 X_{irt}^P + u_{irt}^P$
  - $Y_{irt}^T = \beta_t^T + \beta_2 X_{irt}^T + u_{irt}^T$
- X_{irt}^P household's assets and demographic characteristics
- X_{irt}^T seasonal variations from normals, temperature and precipitation, extreme degrees days
- VAR_{irt} seasonal coefficients of variation, temperature and precipitation
- W_{irt} demographic categories

Empirical Approach (1): joint significance

- Re-write saving equation:

$$S_{irt} = \gamma_t + \gamma_{ir} + \gamma_1 X^P_{irt} + \gamma_2 X^T_{irt} + \gamma_3 VAR_{irt} + v_{irt}$$

- Test joint significance of permanent and transitory income in saving:
  - $H_0: \gamma_1 = 0$, $H_1: \gamma_1 \neq 0$
  - $H_0: \gamma_2 = 0$, $H_1: \gamma_2 \neq 0$

Table 4: Test of joint significance of permanent and transitory factors

Joint significance on saving (F statistic and p-value)	Durable goods as consumption	Durable goods as saving
Permanent ($Ho: \gamma_1 = 0$)	1.02 *(0.432)*	0.89 *(0.546)*
Transitory ($Ho: \gamma_2 = 0$)	3.74*** *(0.000)*	3.81*** *(0.000)*

Predictions of standard model confirmed: Saving is related to predictors of transitory income but not to predictors of permanent income

Empirical Approach (2): propensity to save (2 steps)

- $S_{irt} = \alpha_1 \widehat{Y^P_{irt}} + \alpha_2 \widehat{Y^T_{irt}} + \alpha_3 VAR_{irt} + \alpha_4 W_{irt} + \alpha_5 \widehat{u_{irt}} + w_{ir} + v_t + \varepsilon_{irt}$

- $C_{irt} = \alpha_1 \widehat{Y^P_{irt}} + \alpha_2 \widehat{Y^T_{irt}} + \alpha_3 VAR_{irt} + \alpha_4 W_{irt} + \alpha_5 \widehat{u_{irt}} + w_{ir} + v_t + \varepsilon_{irt}$

- Estimate α_1 and α_2

- Test $\alpha_1 = \alpha_2$ in saving H_0: $\alpha_1 = \alpha_2$, H_1: $\alpha_1 \neq \alpha_2$

Result: propensity to save and consume

Coefficients and standard error	Durable goods as consumption	Durable goods as saving
Propensities to save		
$\hat{y}^P$	1.06***	1.19***
	(0.140)	*(0.228)*
$\hat{y}^T$	1.83***	2.34***
	(0.313)	*(0.462)*
$\hat{\varepsilon}$	1.27***	1.35***
	(0.017)	*(0.036)*
Propensities to consume		
$\hat{y}^P$	0.78***	0.64***
	(0.147)	*(0.176)*
$\hat{y}^T$	0.34	0.44
	(0.290)	*(0.371)*
$\hat{\varepsilon}$	0.40***	0.39***
	(0.018)	*(0.023)*
Ho:(p-values)		
$\hat{y}^P = \hat{y}^T$ in saving	0.019	0.022

Predictions of standard model confirmed: Consumption co-varies with permanent income only

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Empirical Application (well being and health behaviour):

1. Well-being = self-reported life satisfaction of household head

$$W_{irt}^{*} = \alpha_o + \beta_1 SAV^P + \beta_2 SAV^T + u_i + v_t + \varepsilon_{irt}$$

- Fixed effects ordered logit (Baetschmann, 2015)

2. HIV test = whether the household / individual has taken an HIV test
   - data available for 2010, 2012 and 2014 at individual level
   - hazard (incidence) rate at household and individual level
   - households and year fixed effect

Empirical Model: well being and health behaviour

Table 9: Life satisfaction and HIV testing regression on saving behavior

	All	Agriculture	Non-agriculture
Life satisfaction (odds ratio)			
SAV^P	1.27	1.15	1.29
SAV^T	1.14***	1.14**	1.14***
HIV testing (household hazard ratio)			
SAV^P	1.05***	1.05***	1.05***
SAV^T	1.00	1.00	1.00
HIV testing (individuals hazard ratio)			
SAV^P	1.06***	1.06***	1.06***
SAV^T	0.97	0.99	0.97

- Increase in log-saving from Y^T increases the odds of a 1-unit increase in life-satisfaction by 14%
- 1-step increase in log-saving from Y^P: 5-6% increase in the incidence hazard ration of HIV testing

Main Findings

- standard model: propensity to save from transitory income close to 1 while that of permanent income close to 0
  - saving from both transitory and permanent income are significant, but
  - the proportion saved from transitory income > permanent income
- evidences of precautionary saving driven by non-agriculture HH
- strong evidences of myopic consumption for agriculture HH
- increase in log-saving from transitory income increases the odds of an increase in self-reported life-satisfaction
- increase in log-saving from **permanent income** leads to an increase in the hazard ration of having taken an HIV test

Conclusions and Policy Implications

- HH adjust for consumption of non-durable items (e.g. food) in order to cope with income changes

- Programs to encourage HIV testing - may need stronger inducement than a transitory injection of income. Focus on fundamental improvements to change behavior in the long term?

Reverse causality issue! Health shocks impact on household's saving behavior, after controlling for demographic factors (permanent income), and weather-related factors (transitory income)

Thank you very much for your attention

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Agriculture vs non agriculture

Table 7: Test of joint significance and estimation of coefficients

Joint significance on saving (F statistics and p-value)		Durable goods as consumption	Durable goods as saving
Agriculture HH	Permanent ($\gamma_1 = 0$)	1.28	1.30
		(0.215)	*(0.202)*
	Transitory ($\gamma_2 = 0$)	1.62	1.65
		(0.074)	*(0.066)*
Non-agriculture HH	Permanent ($\gamma_1 = 0$)	1.32	0.94
		(0.186)	*(0.515)*
	Transitory ($\gamma_2 = 0$)	2.32**	2.31**
		(0.004)	*(0.005)*
Propensities to save (coefficients and standard error)			
Agriculture HH	$\hat{y}^P$	0.52	1.25*
		(0.319)	*(0.517)*
	$\hat{y}^T$	1.38*	2.24*
		(0.627)	*(0.995)*
	$\hat{\varepsilon}$	1.29***	1.32***
		(0.030)	*(0.065)*
Non-agriculture HH	$\hat{y}^P$	1.18***	1.19***
		(0.157)	*(0.254)*
	$\hat{y}^T$	1.85***	2.13***
		(0.370)	*(0.535)*
	$\hat{\varepsilon}$	1.26***	1.36***
		(0.020)	*(0.042)*

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Table 8: Test for model extensions by type of households

F statistics and p-value		Durable goods as consumption	Durable goods as saving
Agriculture HH	*Precautionary saving* $(Ho: \alpha_3 = 0 \text{ in saving})$	0.63	1.12
		(0.817)	*(0.338)*
	Myopic consumption (Chow interaction test)	0.68	0.91
		(0.606)	*(0.457)*
Non-agriculture HH	*Precautionary saving* $(Ho: \alpha_3 = 0 \text{ in saving})$	4.06***	4.07***
		(0.000)	*(0.000)*
	Myopic consumption (Chow interaction test)	3.70**	1.98
		(0.005)	*(0.095)*