Selling Crops Early to Pay for School: A Large-scale Natural Experiment in Malawi

Brian Dillon
Cornell University

IFPRI Malawi

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Motivation

In this paper we look at the intersection of two phenomena:

1. Crop prices exhibit predictable annual cycles
   - Crop prices in most of sub-Saharan Africa rise steadily from harvest season to lean season
   - This creates opportunities for inter-temporal arbitrage

2. Liquidity constraints bind for many agricultural households
   - Crops may represent substantial fraction of liquid assets
   - Limited recourse to coinsurance when shocks are covariant

Motivation

One implication:

Households facing expenditure requirements that cannot be deferred may have to sell crops early, when prices are lower

"Sell low, buy high"

(Stephens and Barrett, 2011; Bergquist et al., 2019)

Inter-temporal interventions

Recent interest in possible interventions to help with smoothing and inter-temporal arbitrage:

1. Commitment devices can help if present bias is a problem (Ashraf, Karlan and Yin, 2006; Duflo, Kremer and Robinson, 2011)
2. Revise timing: pay insurance premiums later; fine-tune microfinance (Field et al. 2013; Liu et al., 2013; Casaburi and Willis, 2018)
3. Reduce costs by providing credit or storage technologies (Bergquist et al., 2019; Basu and Wong, 2015; Fink, Jack, and Masiye, 2020)

This paper

A natural experiment in Malawi exogenously changed the timing of school-related expenses

I use this to:

- Measure the welfare costs associated with using crop storage as a savings device
- Empirically demonstrate one potential pitfall from changing the timing of outlays

Outline of what is to come

- In 2010, the government of Malawi moved the start of primary school from December to September
- DID estimates show that the calendar change induced households to sell crops earlier
  - Effect is limited to households in poverty
  - And it increases in the number of primary school children
  - Value of additional sales-per-child (1271 MWK) is close to average per-child school cost (1657 MWK all; 719 MWK public)
- Nominal crop prices are roughly 17.3-26.5% lower in September than in December
- Back of the envelope: impacted households lost 217-625 MWK (1.5–4.3 USD) per child in forgone revenue

Main takeaways

1. Crop price cycles + incomplete financial markets = especially detrimental to poor households

2. While there is a clear upside to harvest-time commitments (Duflo et al. 2011), the school calendar change was:
   - Not optional (no self-targeting by present-biased sophisticates)
   - Large enough to strain informal credit markets

3. Suggests a downside to moving farmer expenses to harvest time
   - We find no indication that schooling outcomes improved

4. This cautionary note applies to both agricultural and other policies

Outline of talk

1. Setting
2. Data
3. Empirical framework
4. Main results
5. Discussion and extensions

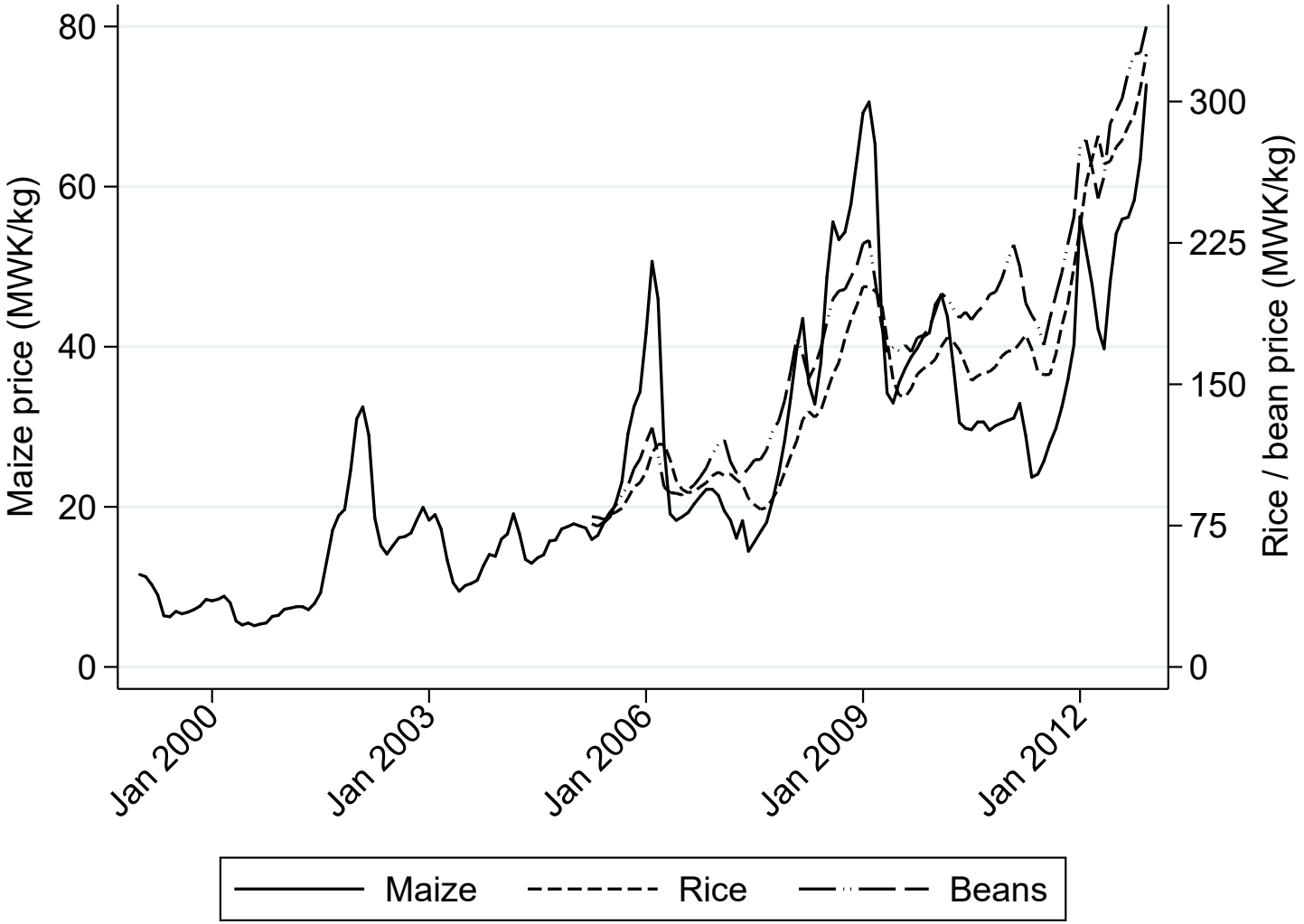
1. Setting

Setting

Two aspects of the setting to describe:

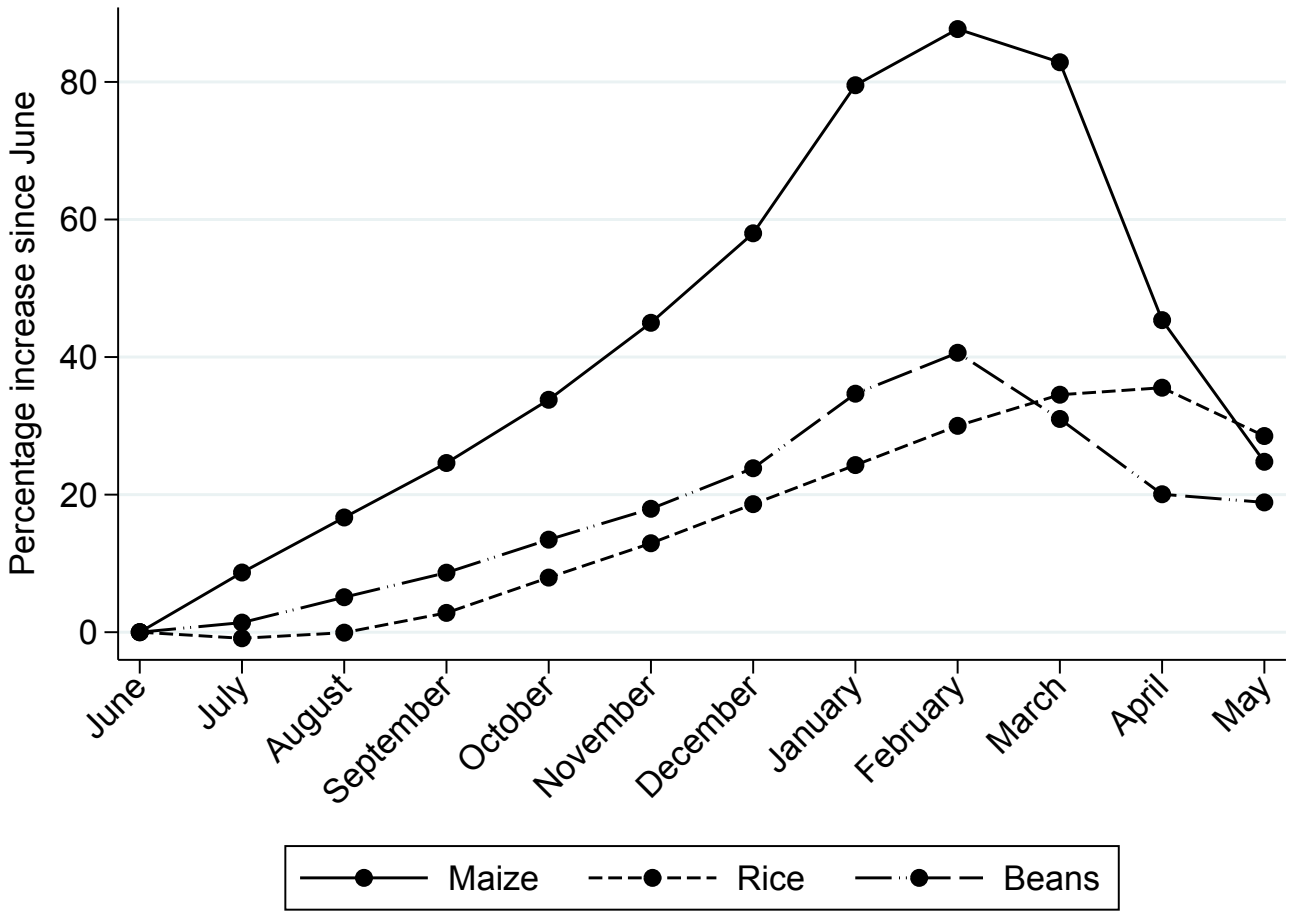
1. Crop price cycles
2. Primary education in Malawi

Maize, rice, and bean prices in Malawi



Data source: Ministry of Agriculture

Average % price increase since June, 1999-2012



Data source: Ministry of Agriculture

Primary education in Malawi

- Primary school is 7-8 years
- Language of instruction is English for standards 5-8
- 3.26 million children in primary school in 2007 (SACMEQ), which represents over 20% of the population
- Significant changes in 1994
  - Transition to multi-party democracy, election of Muluzi
  - Free Primary Education (FPE) is established, with formal tuition abolished for primary school
  - School calendar changed to run from January-November
- Why the change?
  - Persistent water shortages at boarding schools in September
  - Harmonization with neighboring states (SACMEQ III Report)

Calendar changed again in 2009-2010

- Ministry of Education decides to change the calendar back to the old schedule
- 2009 was a transition year, school began in mid December
- Then in 2010 school year began in early September
- Change accomplished by shortening the instruction period
- Why change back to a September start?
  - Water shortages at boarding schools no longer a problem
  - Harmonization with UK and Western countries
  - New calendar matches the budget cycle, which runs from July-June
  - Hope that parents will be able to pay fees if they are due closer to harvest

2. Data

Data set

Data set: 3rd Integrated Household Survey (IHS 3) collected by the Malawi National Statistics Office.

This is also the first wave of the LSMS-ISA panel data set for Malawi (IHPS).

Two subsamples: 9,024 cross-sectional households; 3,247 panel households. We use only the cross-sectional households for main analysis.

The IHS (cross-section) and IHPS (panel) now have separate but related objectives and are collected jointly every 6 years

Data set

Surveys conducted continuously from March 2010 to March 2011 (for cross-sectional households)

Timing of survey randomized within districts (village-level)

Everyone in a village surveyed at the same time

We restrict the sample to households that ran any kind of farm. Roughly half of this group are in poverty.

Data do not allow us to test impacts on enrollment, attendance, production, storage, or livestock sales using the same ID strategy

Data set

Another round of the IHS, the IHS 4, collected in 2016-2017

We can use this for falsification tests

Cannot use IHS 1 (1998-1999) or IHS 2 (2004-2005), because there is no information on timing of crop sales

Primary school expenses

Table 2: Per-student annual primary school expenses (MW Kwacha)

	All		Poor		Non-poor	
	% reporting	Mean	% reporting	Mean	% reporting	Mean
Tuition and fees	1.4	11	1.1	3	1.7	19
Tutoring	4.1	19	2.1	3	6.3	35
Books and stationary	68.3	155	67.3	117	69.4	197
Uniforms	70.1	301	65.4	244	75.1	363
Boarding fees	0.6	2	0.6	2	0.5	3
Voluntary contributions	44.5	68	40.4	48	48.9	89
Transport	0.2	4	0.2	0	0.3	7
Parent association fees	13.0	15	11.8	12	14.3	19
Other	26.8	56	24.1	33	29.8	82
Total	96.5	719	95.3	511	97.8	943
Total (including private)	96.7	1657	95.5	522	97.9	2827

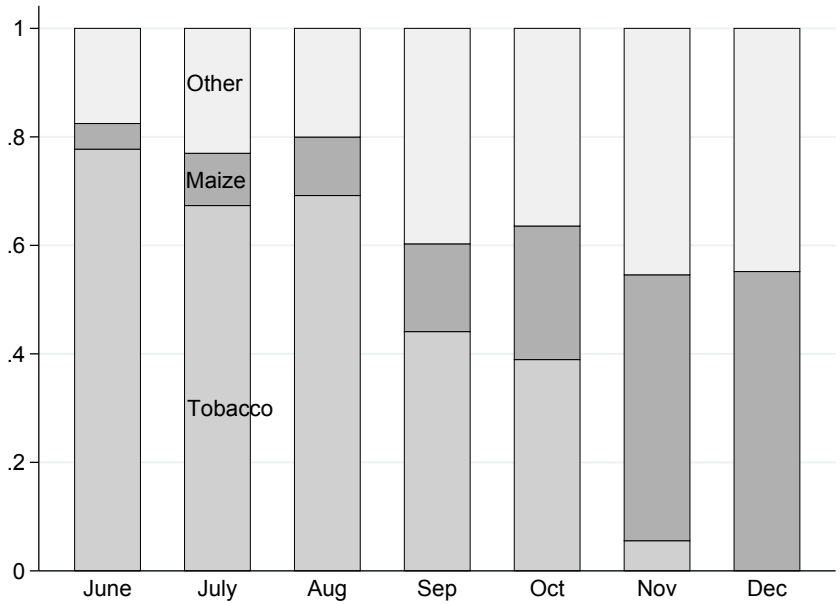
Breakdown of crops sold

Table 3: Sales breakdowns by crop and year

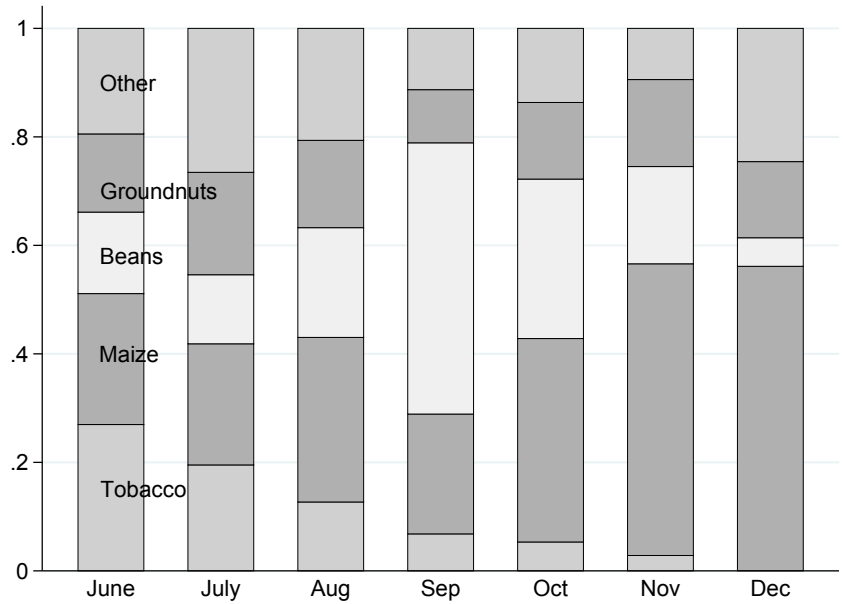
	2009		2010	
	%age of transactions	%age of total value	%age of transactions	%age of total value
	(1)	(2)	(3)	(4)
Maize	25.9	13.6	26.3	9.0
Beans	24.7	8.1	20.9	5.1
Tobacco	16.1	55.8	20.7	71.1
Groundnut	11.5	4.1	14.0	4.1
Rice	6.6	7.1	7.2	5.0
Other	15.1	11.3	11.0	5.6

Notes: Authors' calculations from IHS 3 data.

Timing of crop sales



A. Sales value



B. Number of sales

3. Empirical framework

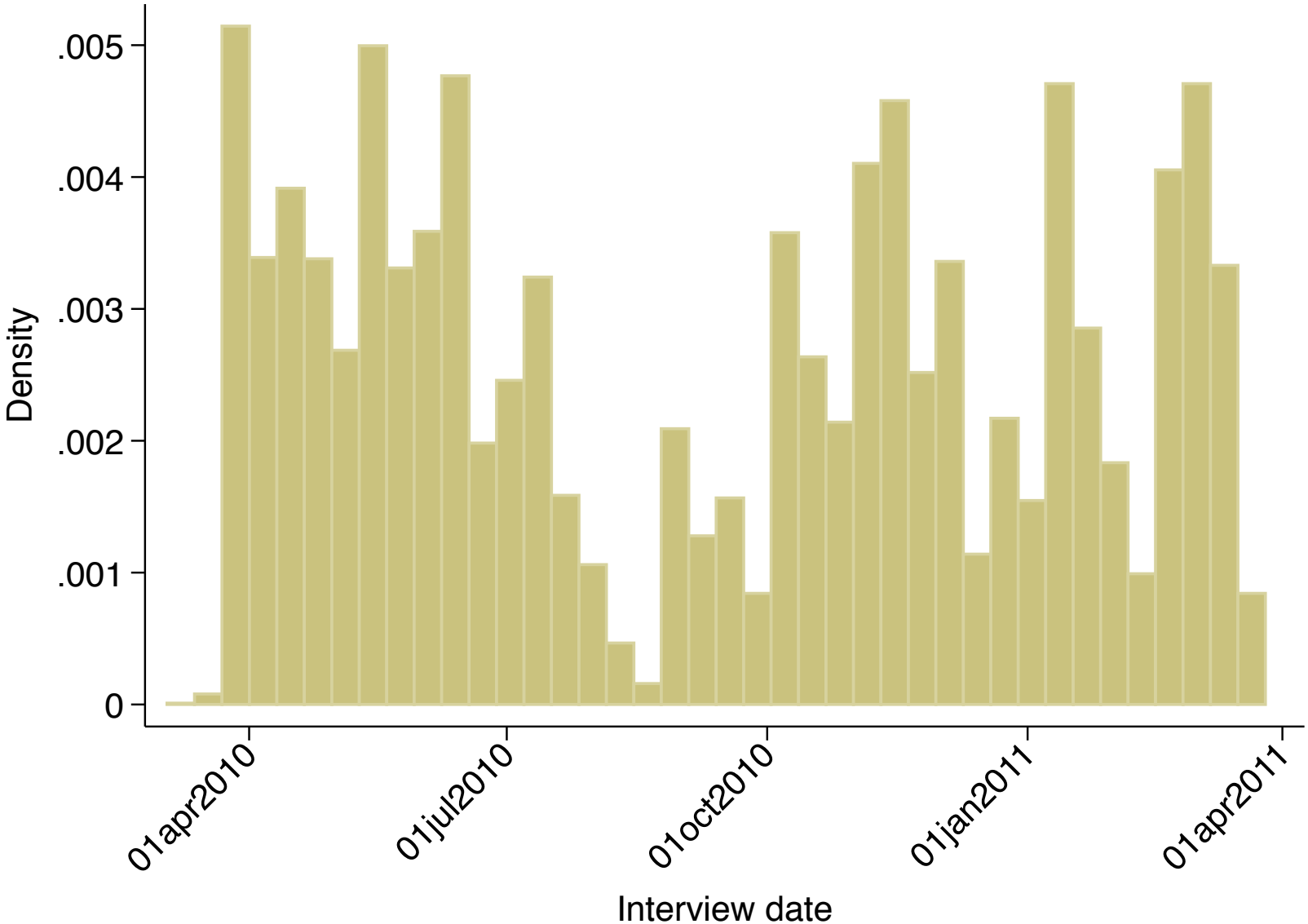
Empirical strategy

Identification:

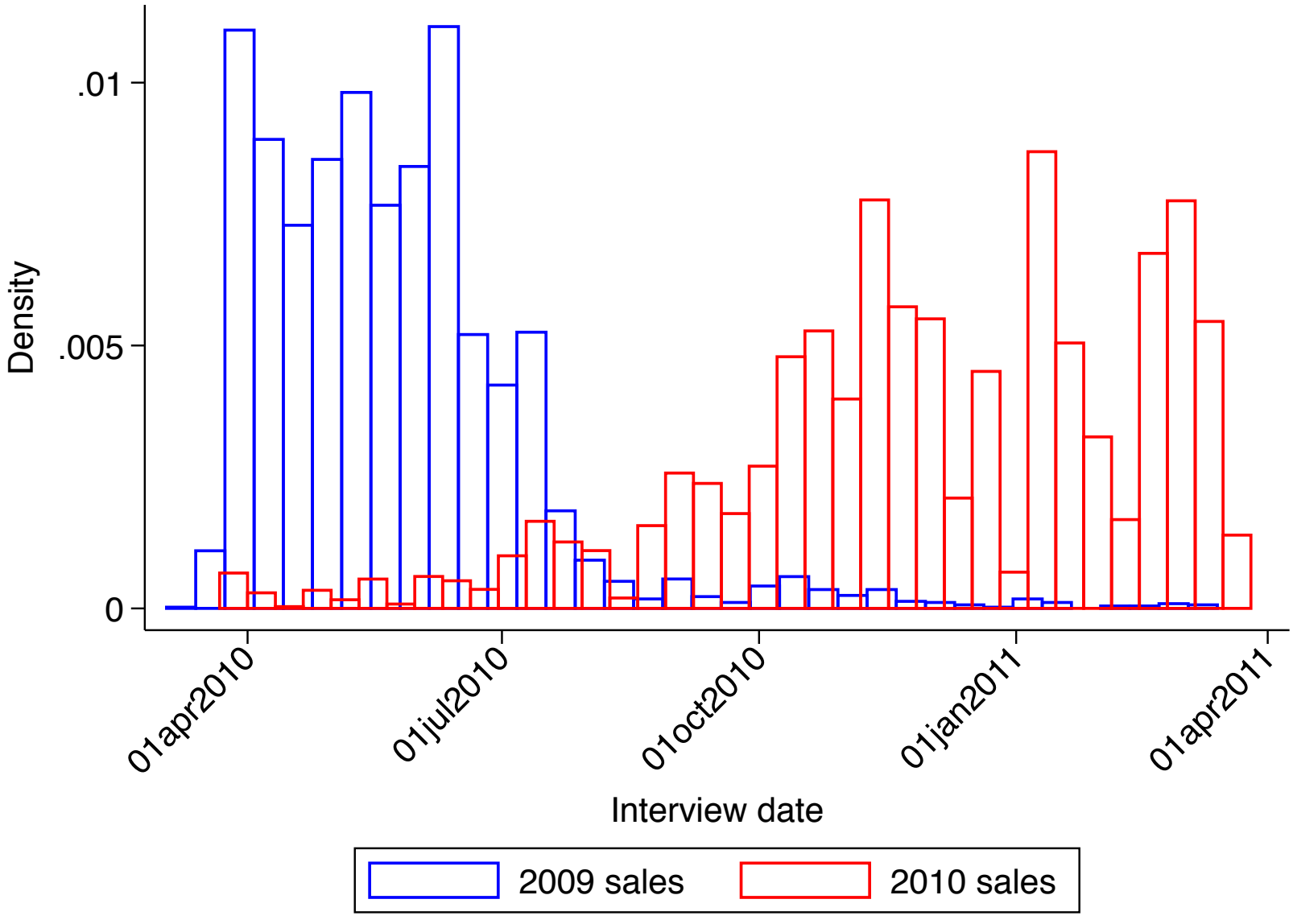
In the agriculture module, some households reported crop sales from 2009 harvest, others from 2010 harvest

Because interview dates were randomly assigned (at the village level), this provides random variation in the year of observation

Histogram of interview dates



Histogram of interview dates



Empirical strategy

We use the exogenous change in school calendar as the basis of a difference-in-difference specification between 2009 and 2010, where the second dimension of difference is the number of primary school children (treatment intensity)

Identification strategy combines elements of Card (1992) and Hammermesh and Trejo (2000)

Quasi-random assignment is clear in the summary statistics

Table 1: Summary statistics for DID control variables, by year, poor households

Variable	2009 (1)	2010 (2)	Difference (3)
Number in primary school	1.54	1.56	-0.02
Acres cultivated	1.76	1.70	0.06
Number of adult equivalents	4.44	4.38	0.06
Age of head	42.39	43.15	-0.76
Head is male (=1)	0.73	0.73	-0.01
Head education = None completed	0.87	0.86	0.01
Head eduaction = Completed primary	0.08	0.07	0.01
Head education = Completed secondary or more	0.05	0.07	-0.02*
Head marital status: married	0.74	0.75	-0.01
Head marital status: separated	0.12	0.12	0.01
Head marital status: widowed	0.13	0.13	0.00
Head marital status: never married	0.01	0.00	0.00
Num. of males: age 0-5	0.62	0.55	0.06*
Num of males: age 6-15	0.85	0.90	-0.05
Num of males: age 16-25	0.42	0.38	0.04
Num of males: age 26-45	0.46	0.48	-0.01
Num of males: age 46-65	0.19	0.19	0.00
Num of males: age 65 up	0.07	0.06	0.00
Num. of females: age 0-5	0.60	0.57	0.02
Num of females: age 6-15	0.88	0.87	0.01
Num of females: age 16-25	0.42	0.40	0.02
Num of females: age 26-45	0.56	0.57	-0.01
Num of females: age 46-65	0.18	0.19	-0.01
Num of females: age 65 up	0.09	0.09	-0.00
N	779	2686	

Empirical specification (1/2)

Difference-in-difference for households below the poverty line

$$Sales_h^m = \alpha + \beta_1 Children_h + \beta_2 2010_h + \beta_3 \{Children_h \times 2010_h\} + \gamma X_h + \epsilon_h$$

where $Sales_h^m$ is the nominal value of crop sales through end of month m for household h, and $Children_h$ is the number of children who were in enrolled in primary school in most recent year

Standard errors clustered at the village level

Hypothesis of interest (when $m = August$): $H_0 : \beta_3 \leq 0$

Empirical specification (2/2)

Triple difference including households above the poverty line

$$\begin{aligned} Sales_h^m = {} & \alpha + \beta_1 Children_h + \beta_2 2010_h + \beta_3 Poor_h \\ & + \beta_4 \{Children_h \times 2010_h\} + \beta_5 \{Poor_h \times 2010_h\} \\ & + \beta_6 \{Children_h \times Poor_h\} + \beta_7 \{Children_h \times Poor_h \times 2010_h\} \\ & + \gamma X_h + \epsilon_h \end{aligned}$$

Hypothesis of interest: $H_0 : \beta_7 \leq 0$

4. Results

Main results from DID

Table 4: Difference-in-difference results

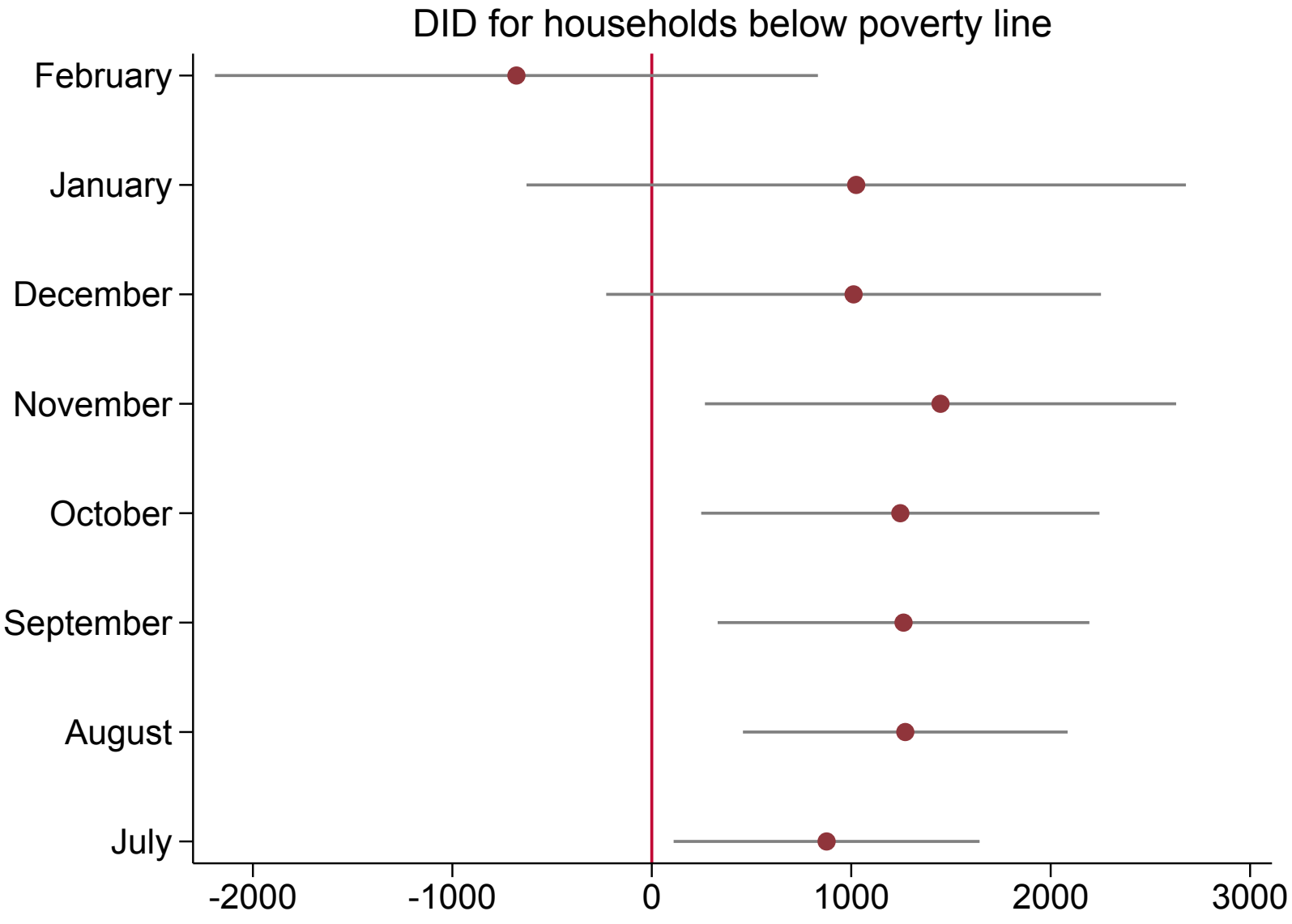
Dependent variable: Cumulative value of crop sales through August			
	(1)	(2)	(3)
Num. in primary × 2010	1180**	1301**	1271**
	(557)	(556)	(494)
2010 (=1)	1167	1368	-1495*
	(948)	(931)	(855)
Number in primary school	759**	-517	-874*
	(354)	(568)	(522)
Observations	3545	3465	3465
R-squared	0.02	0.09	0.18
Mean of dep. variable	6369	6514	6514
Test for increase (1-sided p-val)	.017	.0099	.0052
Household controls	No	Yes	Yes
District fixed effects	No	No	Yes

Triple difference estimates

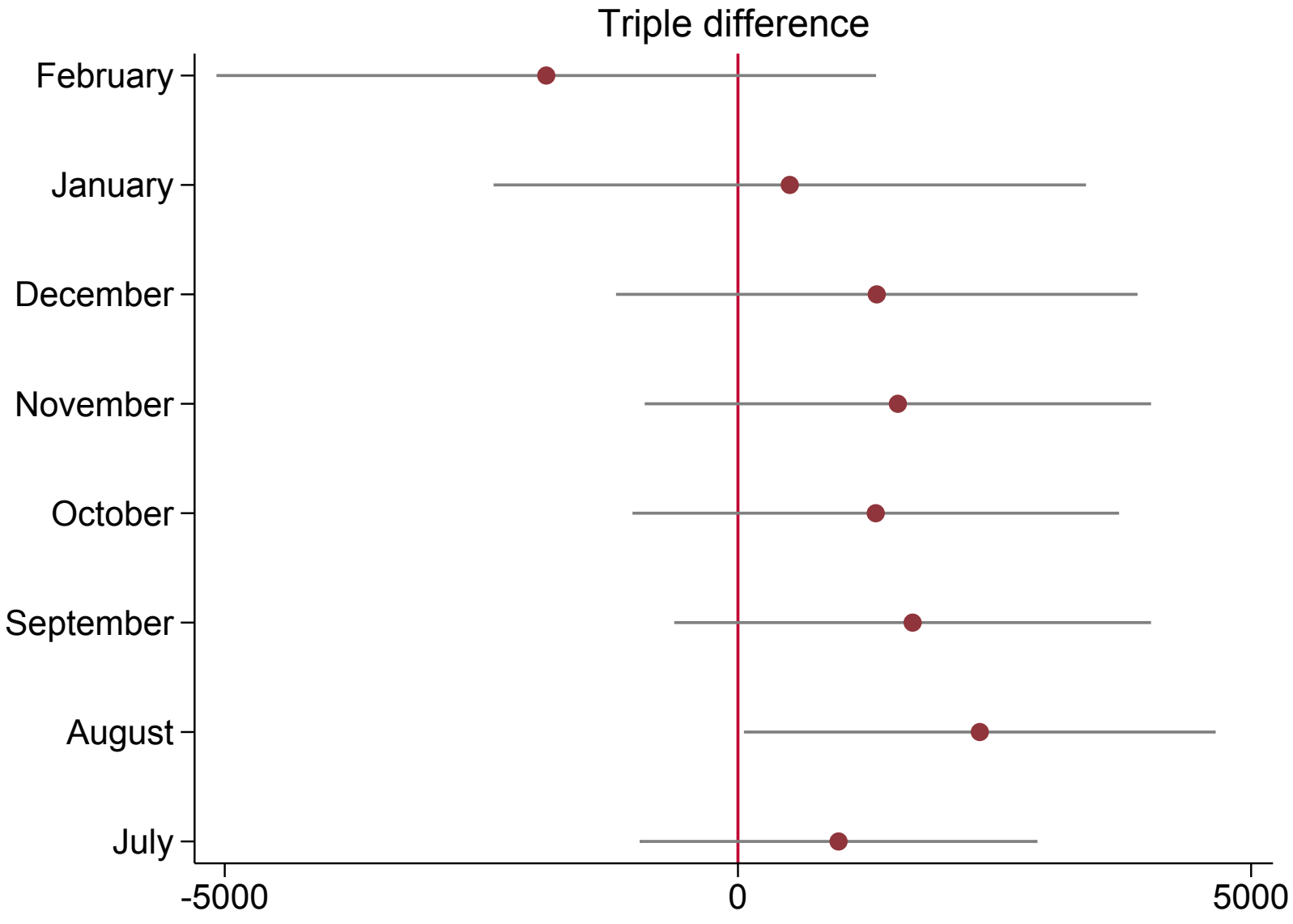
Table 5: Triple difference results

Dependent variable: Cumulative value of crop sales through August			
	(1)	(2)	(3)
Num. in primary × Poor × 2010	1940	2856*	2357*
	(1534)	(1482)	(1395)
Poor × 2010	2731	1842	33
	(2634)	(2427)	(1888)
Num. in primary × Poor	-3300**	-3404***	-2713**
	(1336)	(1305)	(1226)
Num. in primary × 2010	-760	-1473	-990
	(1503)	(1433)	(1320)
2010 (=1)	-1565	-353	-1983
	(2585)	(2342)	(1763)
Number in primary school	4059***	2170	1199
	(1350)	(1342)	(1228)
Poor (=1)	-7412***	-5304**	-2382
	(2371)	(2112)	(1589)
Observations	7063	6861	6861
R-squared	0.03	0.16	0.25
Mean of dep. variable	9402	9678	9678
Test for increase (1-sided p-val)	.1	.027	.046
Household controls	No	Yes	Yes
District fixed effects	No	No	Yes

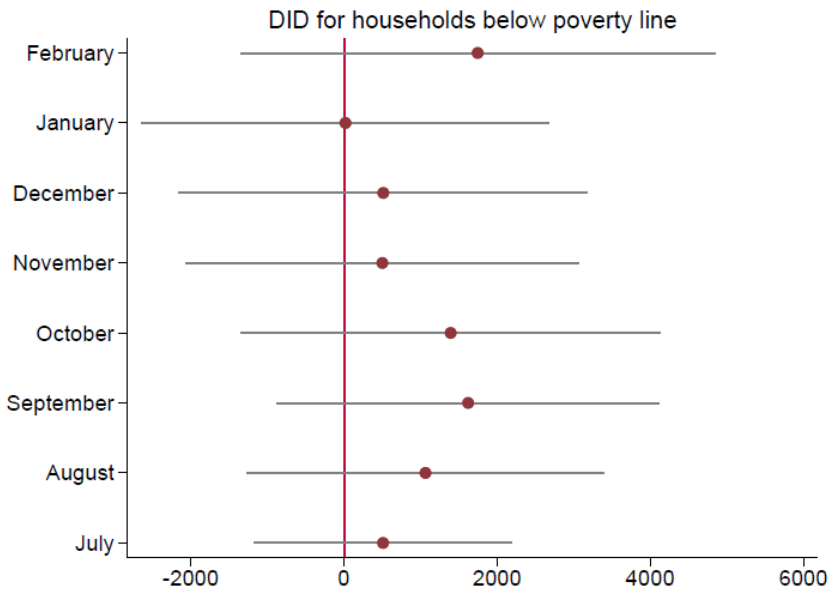
Varying the cut-off month: poor households (DID)



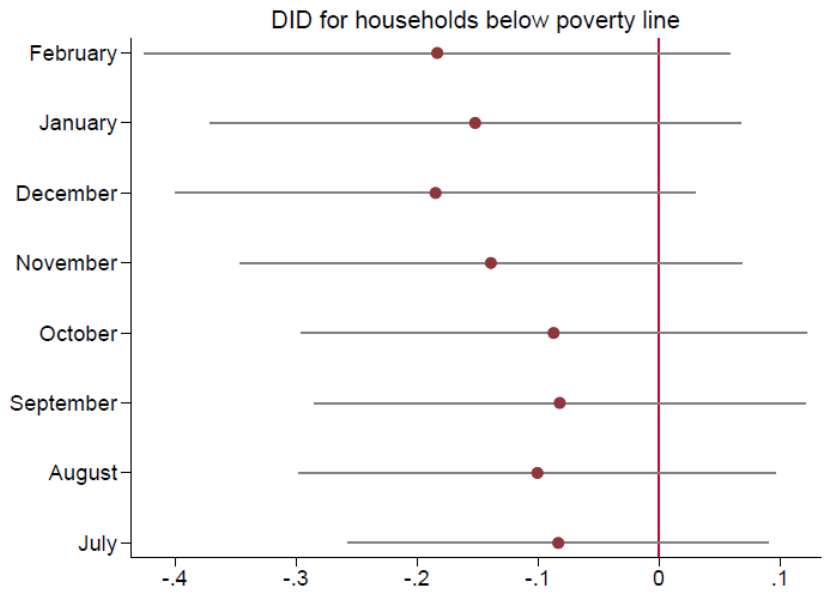
Varying the cut-off month: all households (triple diff.)



Falsification: DID using IHS 4



A. Crop sales value



B. Crop sales value after SINH^{-1} transform

Figure S3: DID coefficients with 90% confidence intervals, falsification test using IHS 4

5. Discussion

We cover the following:

1. How much do households forego by selling early? Need to consider:
   - Expected rise in market and farmgate prices
   - Possible depreciation during storage

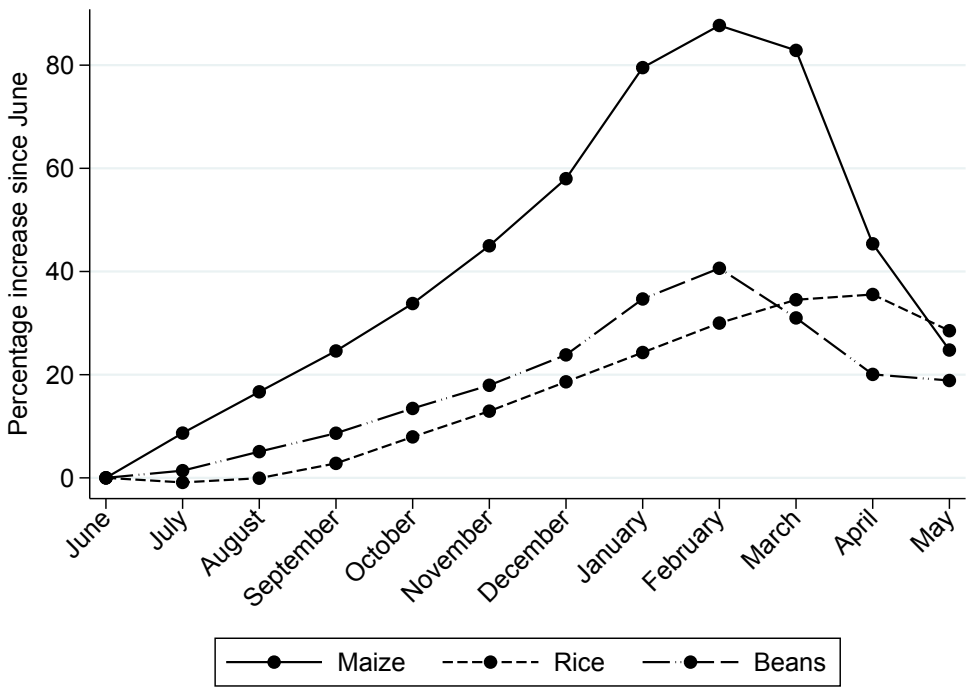
2. Did schooling outcomes improve?

3. Could there be GE effects from the increase in early sales?

Forgone revenue from selling early

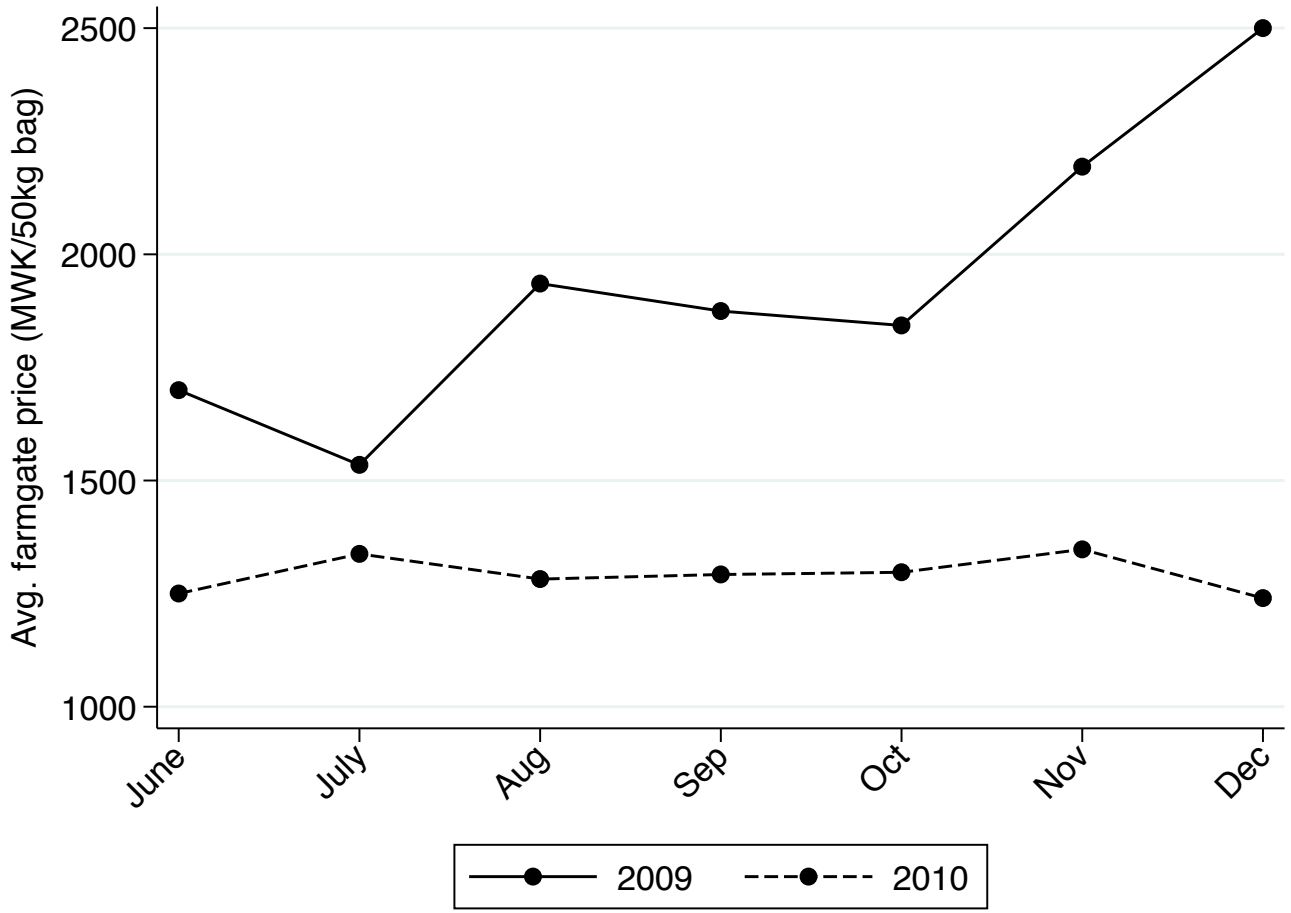
Lack the data to calculate exactly for all households

Market price data suggests roughly 25% increase in prices from September to December



Farmgate prices

Farmgate sales of maize suggest a 28% increase



Crop depreciation

- Oft-repeated stylized fact: post-harvest losses are 20-40%
- Likely true in some settings
- But that figure covers the entire post-harvest period
- Recent evidence regarding losses during on-farm storage only:
  - 2.9% over 11 months in MW, TZ, UG (Kaminski and Christiaensen 2014)
  - 1.25% in Ghana (University of Ghana 2008)
  - 8% average across Sub-Saharan Africa (FAO 2011)
- For this setting and 3-month period, we treat 25% as the expected return to storage from September to December

Financial implications of early sales

- Foregone revenue ranges from $1271 \times 0.25 = 318$ MWK to $2357 \times 0.25 = 589$ MWK (2.20-4.21 USD)
- This range includes the mean per-child 12-month school outlays by poor households (511 MWK)
- Using the DID estimate: indirect costs from early selling equal roughly 70% of the value of direct expenditures on school
- By revealed preference: cost of alternative sources of finance exceeded 25% per quarter, or 100% per year, on average
- How important is it that this was a covariant shock? We cannot test, but possibly critical

Did schooling outcomes improve?

- Cannot use the same identification strategy
- Instead: examine trends on either side of the policy change
- Two additional data sets:
  1. Panel component of the IHS 3 (IHPS)
  2. Malawi DHS

Table 6: Changes in school quality and schooling expenditures, from IHS 3 and IHPS

	2010-2011 mean	2013 mean	N	Difference
Panel A				
At the closest government school:				
Number of teachers	16.3	19.3	408	-3.0
Number of students regularly attending	1331	1549	408	-218
Student/teacher ratio	111.4	88.8	406	22.6*
All buildings brick w/ tin roof (=1)	0.75	0.57	408	0.18***
If no, number of classes not in brick building	4.02	5.87	138	-1.85
School is electrified (=1)	0.15	0.20	408	-0.05
Panel B				
For the children in this community:				
School feeding programs in community (=1)	0.32	0.36	408	-0.04
Proportion of students in school feeding:				
Almost none	0.05	0.03	137	0.02
25%	0.05	0.01	137	0.03
50%	0.03	0.00	137	0.03
75%	0.03	0.47	137	-0.43***
Almost all	0.84	0.49	137	0.35***
Panel C				
Average schooling expenditure per primary school student, panel households:				
All households	869	1738	3803	-869***
Poor	529	1163	1533	-634***
Non-poor	1159	2065	2270	-906***

Table 7: School attendance and literacy in the Malawi DHS

	2004	2010	2015-2016	χ^2 p-value
	Panel A			
Net attendance ratio				
Female	83.8	91.5	94.3	
Male	80.1	89.9	93.4	
Urban	89.2	95.4	94.7	
Rural	80.9	90.0	93.8	
Total	82.0	90.7	93.9	
	Panel B			
Demonstrated literacy	(%age of primary school graduates aged 15-16 that can read:)			
Female:				
Nothing	19.8	17.5	12.5	0.00
Part of sentence	7.9	11.0	10.6	0.03
Entire sentence	72.2	71.5	76.9	0.00
N	922	2410	2229	
Male:				
Nothing	21.2	18.4	14.3	0.02
Part of sentence	10.4	9.1	18.3	0.00
Entire sentence	68.3	72.5	67.4	0.07
N	240	826	803	

Schooling outcomes: summary

Some measures show improvement:

- More teachers
- Lower student:teacher ratio
- Slightly higher demonstrated literacy for girls
- Small increase in NAR (but slower than before change)

Others worsened:

- Less coverage of school feeding programs
- More classes in temporary structures
- Slightly lower demonstrated literacy for boys

Growth rate of school payments (inflation: 64%):

- 119% for poor households
- 78% for non-poor households

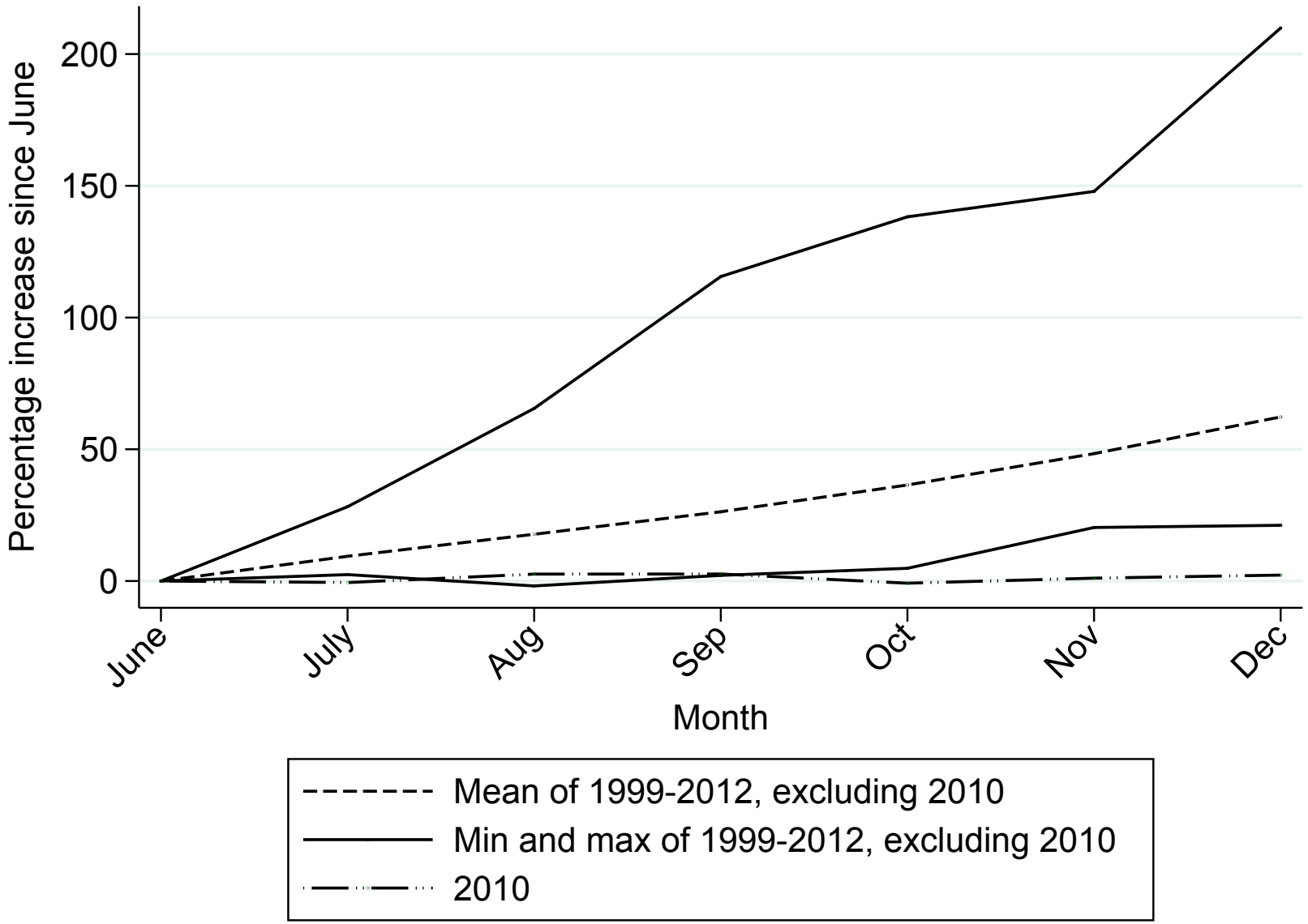
General equilibrium effects on crop prices?

Additional sales represent potentially large increase in supply early in the season

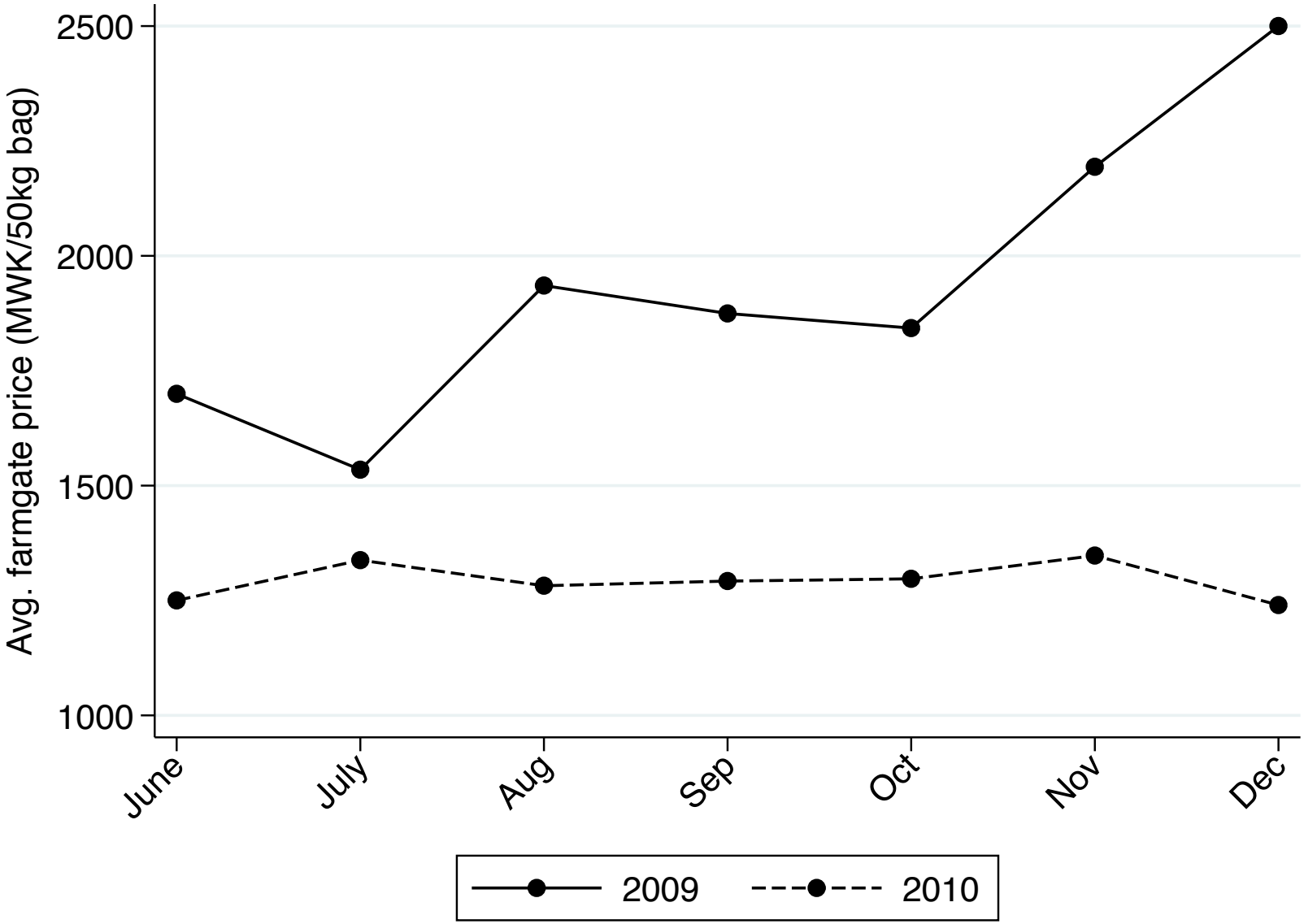
Could this have implications for the annual price cycle?

Hard to test with these data, but there is something anomalous about maize prices in 2010

2010: maize is an outlier



Also an outlier at the farmgate



Other evidence suggests that GE effect is unlikely

- 2010 not an outlier for rice or beans
- Maize prices return to normal in 2011 and 2012, but school still begins in September
- This is a time of heavy government investment in the maize sector in Malawi
- Opted to ignore the maize anomaly in calculating forgone revenues (surely not anticipated differentially by poor households based on their numbers of children)
- If there is an impact on prices, the likely mechanism is from difference in trader supply elasticity (relative to farmers)

Summary and conclusion

- Predictable change in the timing of expenditures led poor households to use crop market for liquidity
- Suggests high cost of moving wealth across time ($>100\%$ per year)
- Little indication that schooling outcomes improved
- Key takeaway: highly cyclic crop prices exacerbate the negative effects of liquidity constraints on poor households
- Policy considerations
  - Changes in timing of expenditures can have unintended consequences
  - Leap from optional commitment devices to mandated harvest-time payments should be undertaken cautiously

Thanks.

Comments welcome: bmd28@cornell.edu