

Measuring Changes in the Structure of Farm Debt using Information Theory: The Role of ARMS

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Introduction

- The Farm Credit Crisis of the 1980s highlighted several potential difficulties in the farm credit system. The sector as a whole remained exceedingly solvent throughout the crisis.
 - The debt to asset for the sector reached a maximum of 22.2 % in 1985 (Table 4).
- The Farm Credit Crisis of the 1980s reinforced the fact that the concentration of lending across lenders matters.
 - The share of agricultural real estate debt held by the Farm Credit System reached a high of 43.7 % in 1984.
 - The share of agricultural real estate debt held by the farm credit system during the 1980s started at its highest point of 25.3 in 1980s (Table 5).

Overall Debt and Equity for U.S. Agriculture

Year	Farm	Real	Non-Real	Debt to	
	Farm Debt	Estate Debt	Estate Debt	Equity	Asset
1980	162,431,968	85,272,367	77,159,601	837,990,158	0.1624
1981	177,687,478	93,905,270	83,782,208	820,209,991	0.1781
1982	183,962,996	96,769,083	87,193,913	778,525,420	0.1911
1983	186,178,117	98,071,338	88,106,779	773,122,345	0.1941
1984	188,813,336	101,393,312	87,420,023	708,997,897	0.2103
1985	172,154,536	94,089,977	78,064,559	603,753,369	0.2219
1986	151,307,822	84,087,662	67,220,161	570,709,437	0.2096
1987	138,507,402	75,809,859	62,697,543	617,971,250	0.1831
1988	133,138,349	70,829,423	62,308,927	655,387,312	0.1688
1989	131,030,402	68,761,420	62,268,982	682,700,656	0.1610
1990	131,115,795	67,632,973	63,482,823	709,492,710	0.1560
1992	131,565,813	67,879,337	63,686,475	736,197,006	0.1516
1994	138,929,055	69,911,852	69,017,203	795,795,242	0.1486
1996	148,572,756	74,422,235	74,150,521	854,343,471	0.1481
1998	164,626,313	83,100,263	81,526,050	918,728,583	0.1520
2000	163,929,823	84,723,763	79,206,060	1,039,284,942	0.1362
2001	170,664,446	88,541,011	82,123,435	1,085,261,963	0.1359
2002	177,223,663	95,422,895	81,800,769	1,082,490,661	0.1407
2003	164,201,798	83,186,922	81,014,876	1,219,229,192	0.1187
2004	181,917,147	95,652,577	86,264,570	1,406,115,493	0.1146
2005	196,377,032	104,768,020	91,609,012	1,582,998,973	0.1104
2006	203,580,898	108,047,863	95,533,035	1,720,014,704	0.1058
2007	214,063,370	112,681,794	101,381,577	1,841,212,160	0.1042
2008	241,611,418	134,667,144	106,944,274	1,781,690,599	0.1194
2009	241,882,298	131,313,508	110,568,790	1,812,496,043	0.1177
2010	251,600,000	141,023,254	110,596,334	2,039,256,516	0.1098
2011	254,100,000	145,968,424	108,100,000	2,129,839,663	0.1066

Shares of Real Estate and Non-Real Estate Debt in the United States

Year	Real Estate Shares						Non-Real Estate Shares			
	Farm Credit System	Farm Service Agency	Com. Banks	Life Ins. Co.	Indiv. and Others	CCC Storage & Drying	Farm Credit System	Farm Services Agency	Com. Banks	Indiv. and Others
1980	37.0	8.3	8.7	13.3	30.9	1.7	25.3	14.0	38.9	21.8
1982	42.9	8.2	7.5	11.5	28.7	1.2	23.3	16.1	39.4	21.3
1984	43.7	8.9	9.0	11.1	26.6	0.6	20.4	17.0	43.0	19.6
1986	39.4	10.7	13.2	11.5	25.1	0.1	15.2	23.2	44.2	17.5
1988	36.5	11.5	18.5	11.6	21.7	0.0	13.9	22.3	45.4	18.3
1990	34.7	10.2	21.8	13.0	20.3	0.0	15.4	15.9	49.3	19.5
1992	33.7	8.5	24.9	11.6	21.3	0.0	16.1	12.1	51.7	20.1
1994	31.7	7.0	27.1	11.6	22.5	0.0	16.0	9.4	53.2	21.3
1996	31.5	5.8	28.5	11.6	22.6	0.0	18.7	6.7	51.7	22.8
1998	32.2	4.5	30.3	12.0	20.9	0.0	20.1	5.2	51.7	22.9
2000	35.0	4.0	35.1	13.0	12.8	0.0	21.1	5.3	56.6	17.0
2001	37.1	3.8	35.1	12.7	11.4	0.0	24.4	5.1	54.8	15.8
2002	39.6	3.3	34.6	12.0	10.4	0.0	25.0	4.9	54.2	15.9
2003	39.9	2.6	34.9	12.1	10.3	0.2	24.9	4.5	53.8	16.8
2004	38.8	2.5	36.2	11.2	11.1	0.2	25.5	3.8	53.1	17.5
2005	39.3	2.3	36.2	10.8	11.2	0.2	26.5	3.3	52.8	17.4
2006	40.2	2.2	37.2	11.1	9.1	0.3	29.1	2.9	53.6	14.4
2007	41.5	2.0	37.2	11.3	7.7	0.3	31.2	2.8	53.4	12.6
2008	42.8	1.7	37.5	11.1	6.6	0.1	34.9	2.5	53.6	9.1
2009	43.5	1.8	38.1	10.3	5.9	0.4	36.1	2.6	51.6	9.8
2010	45.2	1.9	38.2	9.4	5.1	0.2	36.6	3.0	51.2	9.2
2011	46.0	2.0	37.6	9.3	5.0	0.1	38.4	3.1	51.2	7.3

Purpose

- At the same time these changes in occurred, significant changes in the way data on agricultural debt is gathered occurred.
- The primary dataset for the collection of agricultural debt data changed from lender reported data (Stam et al. 2003) to primary farmer data provided by the Agricultural Resource Management Survey.
- Harl (1990) suggests that such farm level data would provide more relevant information about potential for farm level financial difficulties.
- However, the shift toward using the farm level data to infer the distribution of debt across lenders may have risks.
- This study examines whether this change in data source effects the share of each lender using information measures.

Empirical Model

- As a starting point, consider the information statistic proposed by Kullback (1968)

$$I(1 : 2; E) = \int_E f_1(x) \ln \left[\frac{f_1(x)}{f_2(x)} \right] dx \geq 0 \quad (1)$$

with $I(1 : 2; E) = 0$ only if $f_1(x) = f_2(x) \forall x$

- $f_1(x)$ and $f_2(x)$ are two density functions.
- We assume that the distributions are defined on parameters $\alpha \Rightarrow f_i(x) = f_i(x, \alpha)$.
- The hypothesis $H_1 : f_1(x) = f(x, \alpha)$ versus $H_2 : f_2(x) = f(x; \hat{\alpha}) \ni (\alpha \neq \hat{\alpha})$ can be tested with the informational measure.
- If $H_1 \Rightarrow I(1 : 2, E) \rightarrow 0$.

Two Measures Used in the Text

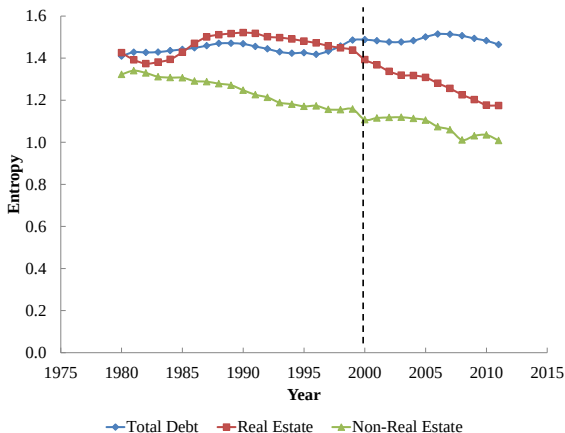
- We start by computing the entropy measure suggested by Shannon (1948)

$$J = - \sum_{j=1}^N p_i (r_i, z_i, \mu_t, \sigma_t^2) \ln [p_i (r_i, z_i, \mu_t, \sigma_t^2)] . \quad (2)$$

- The dynamic version of the information inequality is a slight modification of Moss, Mishra and Erickson (2007)

$$\Delta_k l_t = \sum_i p_{it} (r_i, z_i, \mu_t, \sigma_t^2) \ln \left[\frac{p_{it} (r_i, z_i, \mu_t, \sigma_t^2)}{p_{i,t+k} (r_i, z_i, \mu_{t+k}, \sigma_{t+k}^2)} \right] . \quad (3)$$

Entropy for Lender Shares



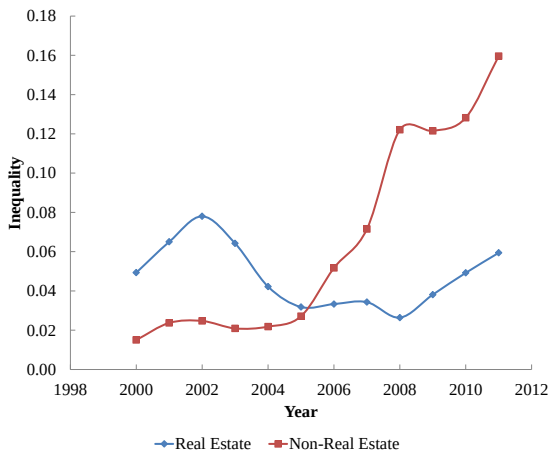
Information Inequality

Year	Total	Real Estate	Non Real-Estate
1980	0.000529	0.000006	0.000526
1982	0.000480	0.000005	0.000577
1984	0.000361	0.000000	0.000588
1986	0.000462	0.000000	0.000709
1988	0.000516	0.000000	0.000693
1990	0.000410	0.000000	0.000551
1991	0.000394	0.000000	0.000494
1992	0.000351	0.000000	0.000453
1993	0.000325	0.000000	0.000402
1994	0.000308	0.000000	0.000380
1995	0.000249	0.000000	0.000332
1996	0.000206	0.000000	0.000305
1997	0.000136	0.000000	0.000275
1998	0.000113	0.000000	0.000257
1999	0.000114	0.000000	0.000263
2000	0.014961	0.013307	0.017196
2001	0.019376	0.017512	0.022090
2002	0.020663	0.018652	0.023433

Average Rate of Change in Lending Share

	Real Estate Lenders					Non-Real Estate Lenders			
	Farm Credit System	Farm Service Agency	Com. Banks	Life Insurance Companies	Individ. and Others	Farm Credit System	Farm Services Agency	Com. Banks	Individ. and Others
2000	0.0860	-0.0184	0.1049	0.0676	-0.4457	0.0893	0.0030	0.0974	-0.3479
2001	0.0716	-0.0417	0.0522	0.0186	-0.2810	0.1171	-0.0234	0.0325	-0.2113
2002	0.0696	-0.0698	0.0304	-0.0062	-0.2158	0.0875	-0.0289	0.0179	-0.1384
2003	0.0546	-0.1121	0.0253	-0.0023	-0.1651	0.0640	-0.0407	0.0115	-0.0895
2004	0.0378	-0.0986	0.0275	-0.0163	-0.1168	0.0564	-0.0685	0.0068	-0.0632
2005	0.0338	-0.0934	0.0228	-0.0200	-0.0963	0.0531	-0.0797	0.0047	-0.0542
2006	0.0323	-0.0891	0.0234	-0.0130	-0.1121	0.0589	-0.0879	0.0062	-0.0736
2007	0.0323	-0.0881	0.0205	-0.0090	-0.1187	0.0602	-0.0811	0.0048	-0.0804
2008	0.0320	-0.0968	0.0192	-0.0100	-0.1218	0.0659	-0.0843	0.0047	-0.1085
2009	0.0307	-0.0831	0.0191	-0.0169	-0.1211	0.0627	-0.0730	0.0004	-0.0898
2010	0.0311	-0.0689	0.0173	-0.0235	-0.1236	0.0584	-0.0516	-0.0003	-0.0878
2011	0.0299	-0.0597	0.0146	-0.0228	-0.1145	0.0575	-0.0449	-0.0003	-0.0995

Time Information Inequality



The Haircut

$$\hat{l}(\alpha) = \sum_{i,k} [p_{it}(r_i, z_i, \mu_t, \sigma_k^2) + \alpha_i s_{i,t+k}] \ln \left[\frac{p_{it}(r_i, z_i, \mu_t, \sigma_k^2) + \alpha_i s_{i,t+k}}{p_{i,t+k}(r_i, z_i, \mu_{t+k}, \sigma_{t+k}^2)} \right] \quad (4)$$

- Where α_i are the estimated coefficients and $s_{i,t+k}$ are observed data (i.e., starting with the estimates from Stam (2003)).

Conclusions – Discussion

- The entropy shares for lenders provides some evidence for a break in the lender shares between 1999 and 2000.
- Information between series indicates significance differences between the Stam data and ARMS in 2000, 2001, and 2002.
- The information of the change in lender share is large for Real Estate lenders in 2000, 2001, and 2002, but then dampens out.
- The information of the change in lender share is initially small for Non-Real Estate lenders, but grows significantly after 2005.