

Interest Rates and Agricultural Debt: Estimating the Marginal Rate

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October 9, 2013

Introduction

Empirical Model

Bayesian Adaptation

Introduction

- ▶ The interest rate on farm debt is a component of several farm decisions.
 - ▶ The decision to increase or retire farm debt

$$\delta^* = 1 - \frac{\rho \sigma_A^2(t)}{\mu_A(t) - r(t)}. \quad (1)$$

- ▶ Farmland valuation

$$\ln(V_{it}) = \alpha_0 + \alpha_1 \ln(R_{it}) + \alpha_2 \ln(r_{it}) + \epsilon_{it} \quad (2)$$

- ▶ Even simple models of present value for equipment replacement or more esoteric models of investment of uncertainty and irreversibility.

- ▶ The question is then – what interest rate to use?
 - ▶ Some "market interest rate" such as the interest rate on Aaa or Baa bonds.
 - ▶ A weighted average cost of capital computed at the firm level.
 - ▶ The average interest rate paid by agriculture at the state level

$$r_{it} = \frac{\text{Interest Expense}_{it}}{D_{it}} \quad (3)$$

- ▶ Debt decision

$$D_t^* \{ = \delta_t^* A_t \} \approx \xi_0 + \xi_1 (\sigma_{A_t}^2 A_t) + \xi_2 (\mu_{A_t} A_t \{ = R_{A_t} \}) + \xi_3 (r_t A_t)$$

$$r_t = \sum_{j=1}^J \zeta_j r_{t-j}^* \left[\frac{D_{t-j} - D_{t-j-1}}{D_{t-j-1}} \right] \quad (4)$$

Empirical Model

- As a first step consider the information inequality in the amount of interest paid to the level of debt

$$J_t = \sum_{i=1}^N \left[\frac{r_{it} D_{it}}{\sum_{j=1}^N r_{jt} D_{jt}} \right] \ln \left[\frac{\frac{r_{it} D_{it}}{\sum_{j=1}^N r_{jt} D_{jt}}}{\frac{D_{it}}{\sum_{j=1}^N D_{jt}}} \right] \quad (5)$$

Inequality

Year	Average Inequality	Regional Inequality	Total Inequality
1960	25.97	12.05	38.03
1965	15.82	5.26	21.08
1970	3.33	7.10	10.43
1975	6.04	5.65	11.69
1980	8.93	7.73	16.66
1985	5.60	1.91	7.51
1990	4.35	11.93	16.27
1995	1.43	2.31	3.74
2000	1.55	1.16	2.71
2005	26.21	2.29	28.50
2009	30.82	3.03	33.85

Estimated Inequality of Interest Paid

- The concept is to use this informational inequality to estimate the underlying marginal cost of capital.

$$\hat{r}_{jt} = \alpha_{0j} + \sum_{k=0}^9 \alpha_{jk} r_{t-k}^*$$

$$\Rightarrow J_t(\theta_1) = \sum_{k=1}^K \left(\frac{\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}}}{\frac{\hat{r}_{jt} D_{kt}}{\sum_{j=1}^K \hat{r}_{jt} D_{jt}}} \right) \ln \left[\frac{\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}}}{\frac{\hat{r}_{jt} D_{kt}}{\sum_{j=1}^K \hat{r}_{jt} D_{jt}}} \right] \quad (6)$$

$$\tilde{r}_{jt} = \beta_{0j} + \sum_{k=0}^9 \beta_{jk} \ln \left(\frac{D_{j,t-k}}{D_{j,t-k-1}} \right) r_{t-k}^*$$

$$\Rightarrow J_t(\theta_2) = \sum_{k=1}^K \left(\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}} \right) \ln \left[\frac{\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}}}{\frac{\tilde{r}_{jt} D_{kt}}{\sum_{j=1}^K \tilde{r}_{jt} D_{jt}}} \right] \quad (7)$$

Comparison of Predictions

Year	Total Inequality	Inequality			Percent of Inequality		
		Interest Rate (AR)	Interest Rate (AR * $d(\ln(D))$)	Interest Rate (AR * %Debt)	Interest Rate (AR)	Interest Rate (AR * $d(\ln(D))$)	Interest Rate (AR * %Debt)
		$[J_t(\theta_1)]$	$[J_t(\theta_2)]$	$[J_t(\theta_3)]$	$[J_t(\theta_1)]$	$[J_t(\theta_2)]$	$[J_t(\theta_3)]$
1960	38.03	18.90	31.48	31.48	0.497	0.828	0.631
1965	21.08	16.05	17.35	17.35	0.761	0.823	1.260
1970	10.43	7.53	14.29	14.29	0.722	1.371	1.128
1975	11.69	9.90	16.46	16.46	0.847	1.409	1.192
1980	16.66	3.56	18.30	18.30	0.214	1.098	0.604
1985	7.51	2.32	10.06	10.06	0.309	1.340	1.602
1990	16.27	8.88	26.60	26.60	0.546	1.634	2.448
1995	3.74	5.07	17.39	17.39	1.355	4.646	10.667
2000	2.71	3.62	11.32	11.32	1.338	4.178	13.916
2005	28.50	18.72	17.63	17.63	0.657	0.619	1.709
2009	33.85	21.34	15.53	15.53	0.630	0.459	1.031

Bayesian Adaptation

- Reformulating the problem slightly, suppose that we choose the parameter vector in a way that minimizes the loss function implied by the information inequality.

$$\hat{r}_{it} = \gamma_{i0} + \gamma_{t0} + \sum_{j=0}^9 \gamma_j \ln \left(\frac{D_{it}}{D_{i,t-1}} \right) r_{t-j}^* \Rightarrow \bar{r}_{it} = \gamma_{i0} + \gamma_{t0}$$

$$J_t(\theta_4) = \sum_{k=1}^K \left(\frac{\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}}}{\frac{\hat{r}_{jt} D_{kt}}{\sum_{j=1}^K \hat{r}_{jt} D_{jt}}} \right) \ln \left[\frac{\frac{r_{kt} D_{kt}}{\sum_{j=1}^K r_{jt} D_{jt}}}{\frac{\hat{r}_{jt} D_{kt}}{\sum_{j=1}^K \hat{r}_{jt} D_{jt}}} \right] \quad (8)$$

Estimator

$$K(\theta_4) = \frac{1}{\sum_{t=1}^T J_t(\theta_4)}$$
$$\hat{\theta}_4 = \frac{\sum_{l=1}^L K(\theta_4) \times \theta_4}{\sum_{l=1}^L K(\theta_4)} \quad (9)$$

Estimated Rate

	New York	Illinois	Indiana	Iowa	Kansas	Florida	Georgia	Oklahoma	California
1960	0.0559	0.0559	0.0561	0.0563	0.0556	0.0558	0.0557	0.0558	0.0560
1965	0.0548	0.0548	0.0550	0.0552	0.0546	0.0548	0.0547	0.0547	0.0549
1970	0.0646	0.0647	0.0648	0.0650	0.0644	0.0646	0.0645	0.0645	0.0647
1975	0.0707	0.0707	0.0709	0.0711	0.0704	0.0706	0.0705	0.0706	0.0708
1980	0.0926	0.0926	0.0927	0.0930	0.0923	0.0925	0.0924	0.0925	0.0926
1985	0.0985	0.0985	0.0987	0.0989	0.0982	0.0984	0.0983	0.0984	0.0986
1990	0.0962	0.0963	0.0964	0.0967	0.0960	0.0962	0.0961	0.0961	0.0963
1995	0.0825	0.0825	0.0827	0.0829	0.0823	0.0825	0.0824	0.0824	0.0826
2000	0.0772	0.0773	0.0774	0.0777	0.0770	0.0772	0.0771	0.0771	0.0773
2005	0.0623	0.0624	0.0625	0.0627	0.0621	0.0623	0.0622	0.0622	0.0624
2009	0.0613	0.0614	0.0615	0.0618	0.0611	0.0613	0.0612	0.0612	0.0614