Macroeconomic Assumptions and the Rationality of USDA's Baseline Farm Income Projections: A Conditional Forecast Evaluation

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Introduction

- USDA's baseline projections play a vital role in shaping US agricultural policy:
  - Farm bill discussions,
  - Farm program costs estimation in alternative policy scenarios,
  - Long-term planning and investment decisions.
- Farm income projections are important for understanding the well-being of farming communities and the agricultural sector's future economic condition.

Introduction

- Farm income projections exhibit downward bias and barely informative for longer horizons (Bora et al., 2021; Kuethe et al.,2021; and Regmi et al., 2021).
- Sources of projection errors: assumptions used in projection and review/modeling error.
  - Farm income projections are conditional on underlying macroeconomic assumptions.
- **Gaps:** Previous studies ignore the conditional nature of baseline projections.
  - We fill this gap in agricultural forecast evaluation literature by applying a conditional forecast evaluation approach.

Introduction

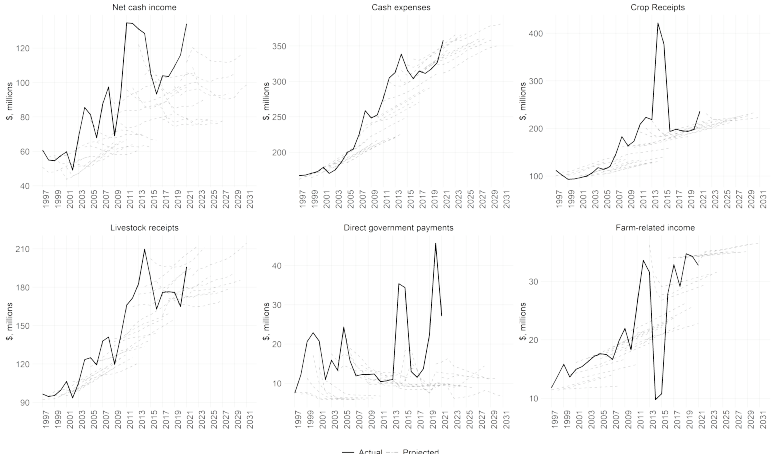
- Research questions:
  - First, are the baseline macroeconomic assumptions and net cash income projections (and its components) unbiased and efficient?
    - Mincer and Zarnowitz (1969) test,
    - Patton and Timmermann (2012) test.
  - Second, we examine the the rationality (unbiasedness and efficiency) of net cash income projections after controlling for the conditioning path.
    - Faust and Wright (2008) conditional forecast evaluation approach.

Data

- Two series of USDA baseline projections:
  - Net cash income projection and its components:
    - Crop receipts, livestock receipts, cash farm income related income, total direct government payments and cash expenses.
  - Macroeconomic assumptions:
    - Gross domestic product (GDP), consumer price index (CPI), personal disposable income, crude oil price, bank prime rate, and unemployment rate.
- 1997-2022; 26 years
  - Data set includes actual estimates of the year (t–2), nowcast, and projections for the next 9 years (compile from the Albert R. Mann Library at Cornell University's online database).

Data

Figure: 1 Net cash income and its components: projected and realized values, 1997-2031



Methods

- Unconditional forecast evaluation: Mincer and Zarnowitz (1969) test

$$Y_{t+h} = \alpha_h + \beta_h \hat{Y}_{t+h|t} + \varepsilon_{t+h}; H_0 : (\alpha_h,\ \beta_h) = (0, 1) \tag{1}$$

- Conditional forecast evaluation:

$$\hat{Y}^{c}_{t+h|t} - \ \hat{Y}^{*}_{t+h|t} = \theta_h(\hat{Z}^{\mathbf{c}}_{\mathbf{t+h|t}} - \ \hat{Z}^{*}_{\mathbf{t+h|t}}) \tag{2}$$

- Accounting this conditional nature, Equation 1 (Mincer and Zarnowitz test) becomes:

$$Y_{t+h} = \alpha_h + \beta_h \hat{Y}^{c}_{t+h|t} + \delta_h \left(\hat{Z}^{\mathbf{c}}_{\mathbf{t+h|t}} - \ \hat{Z}^{*}_{\mathbf{t+h|t}}\right) + \varepsilon_{t+h} \tag{3}$$

- Issues:
  - We do not have optimal values: $\hat{Z}^{*}_{\mathbf{t+h|t}}$,
  - Faust and Wright (2008) indicate actual/realized values can be used as optimal.

Results: Unconditional evaluation

Table: 1 Rationality of USDA farm income projections: Unconditional evaluation

	Horizon									
	h=0	h=1	h=2	h=3	h=4	h=5	h=6	h=7	h=8	h=9
Net cash income	1.020***	0.873***	0.893***	0.914***	0.808***	0.752****	0.659***	0.296***	0.156***	0.070***
	(0.085)	(0.147)	(0.203)	(0.233)	(0.230)	(0.216)	(0.197)	(0.273)	(0.328)	(0.222)
Crop receipts	1.212*	1.305*	1.335*	1.322*	1.208	1.079	0.945	0.668	0.259*	-0.396**
	(0.153)	(0.219)	(0.283)	(0.334)	(0.356)	(0.362)	(0.319)	(0.331)	(0.408)	(0.446)
Livestock receipts	0.947	0.922*	0.914**	0.865**	0.803**	0.790*	0.723**	0.641**	0.605**	0.522***
	(0.064)	(0.094)	(0.111)	(0.142)	(0.170)	(0.201)	(0.216)	(0.206)	(0.241)	(0.319)
Govt. payments	0.484**	-0.038***	-0.101***	-0.426***	-0.340***	-0.150***	-0.157***	0.062***	0.301***	0.511***
	(0.312)	(0.240)	(0.257)	(0.210)	(0.266)	(0.300)	(0.288)	(0.374)	(0.461)	(0.346)
Farm-rel.income	0.587**	0.568**	0.701***	0.791**	0.681***	0.739***	0.750***	0.611***	0.665***	0.607**
	(0.188)	(0.238)	(0.131)	(0.101)	(0.198)	(0.206)	(0.217)	(0.304)	(0.350)	(0.329)
Cash expenses	0.969	0.985	0.977	0.962	0.934	0.931***	0.882***	0.837***	0.767***	0.561***
	(0.030)	(0.059)	(0.083)	(0.111)	(0.148)	(0.149)	(0.190)	(0.178)	(0.200)	(0.185)

Coefficients are estimated from $Y_{t+h} = \alpha_h + \beta_h \hat{Y}_{t+h|t} + \varepsilon_{t+h}$; $H_0 : (\alpha_h,\ \beta_h) = (0, 1)$.*** ,**, and * denote 1%, 5%, and 10% significance levels, respectively for the joint test; $H_0 : (\alpha_h,\ \beta_h) = (0, 1)$. For brevity, we only report β_h. Figures in parenthesis indicate heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Results: Conditional evaluation

Table: 2 Rationality of USDA farm income projections: Conditional evaluation

	Horizon									
	h=0	h=1	h=2	h=3	h=4	h=5	h=6	h=7	h=8	h=9
Net cash income	1.002***	0.988*	1.172	1.083	1.083	1.186	0.948*	0.263	-0.137**	0.511
	(0.077)	(0.117)	(0.209)	(0.277)	(0.269)	(0.404)	(0.314)	(0.381)	(0.284)	(0.228)
Crop receipts	1.220	1.292	1.354	1.199	1.171	1.798	2.255**	2.590	-0.598	-1.663
	(0.158)	(0.216)	(0.250)	(0.221)	(0.158)	(0.372)	(0.453)	(1.033)	(2.419)	(1.252)
Livestock receipts	0.994	1.012	1.180**	0.953	0.896	1.109	0.970	0.600	0.789	1.059
	(0.042)	(0.061)	(0.073)	(0.081)	(0.141)	(0.154)	(0.116)	(0.216)	(0.268)	(0.271)
Govt. payments	0.551	0.312***	0.363	-0.624***	-1.264***	0.107	0.227*	-0.215**	0.242***	-0.085
	(0.360)	(0.330)	(0.401)	(0.348)	(0.400)	(0.504)	(0.548)	(0.543)	(0.707)	(1.043)
Farm-rel.income	0.605	0.629	0.712	1.252	1.392*	0.487	0.182	0.540	1.255	1.545
	(0.205)	(0.302)	(0.342)	(0.219)	(0.164)	(0.338)	(0.684)	(0.705)	(1.2420)	(1.190)
Cash expenses	0.975	1.005	1.0297	1.040	1.086	1.267**	1.243*	1.232**	1.353	0.876
	(0.029)	(0.056)	(0.096)	(0.136)	(0.105)	(0.098)	(0.112)	(0.168)	(0.281)	(0.309)

Coefficients are estimated from $Y_{t+h} = \alpha_h + \beta_h \hat{Y}^c_{t+h|t} + \delta_h \left(\hat{Z}^c_{t+h|t} - Z_{t+h|t} \right) + \mu_{t+h}$.*** ,**, and * denote 1%, 5%, and 10% significance levels, respectively for the joint test; $H_0 : (\alpha_h,\ \beta_h) = (0, 1)$. For brevity, we only report β_h. Figures in parenthesis indicate heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Results: Unconditional Vs Conditional evaluation

Table: 3 Rationality of net cash income projection and its components

	Unbiased and efficient horizons		Improvement (% horizons)
	Unconditional	Conditional	%
Net cash income	None	h=2,3,4,5,7,9	60
Crop receipts	h=4,5,7,8	h=0,1,2,3,4,5,7,8,9	50
Livestock receipts	Only nowcast	h=0,1,3,4,5,6,7,8,9	80
Govt. payments	None	h=0,2,5,9	40
Farm-rel. income	None	h=0,1,2,3,5,6,7,8,9	90
Cash expenses	h=0,1,2,3,4	h=0,1,2,3,4,8,9	20
	16.67%	73.33%	

Conclusions

- Most of the irrationality (bias and inefficiency) of net cash income projection and its components are driven by underlying macroeconomic assumptions.
  - The projection of net cash income and macroeconomic assumptions are biased and evolved inefficiently for a majority of horizons (83.3% and 81.67% of the horizons, respectively).
  - Once we control the underlying macroeconomic assumptions, the projection of net cash income and its components are unbiased and efficient for 73.3% of the horizons in total.
- Our findings help users of farm income projections to adjust expectations and informed decisions, as well as for USDA to improve the baseline projection process and selection of appropriate macroeconomic assumptions.

Thank you!

Questions and suggestions?

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Results:

Table: 1 Rationality of USDA macroeconomic projections (83.33% horizons are irrational)

	Horizon									
	h=0	h=1	h=2	h=3	h=4	h=5	h=6	h=7	h=8	h=9
GDP	0.955**	0.919***	0.885***	0.872***	0.856***	0.837****	0.815***	0.841***	0.791***	0.738***
	(0.041)	(0.048)	(0.046)	(0.040)	(0.033)	(0.043)	(0.049)	(0.066)	(0.058)	(0.089)
CPI	0.996	0.9885*	0.978***	0.957***	0.936***	0.911***	0.880***	0.849***	0.805***	0.741***
	(0.011)	(0.023)	(0.031)	(0.043)	(0.056)	(0.055)	(0.068)	(0.071)	(0.075)	(0.070)
Disposable income	1.001	0.990	0.967	0.950	0.930	0.904	0.880*	0.850*	0.812**	0.762**
	(0.022)	(0.031)	(0.033)	(0.038)	(0.045)	(0.054)	(0.062)	(0.075)	(0.079)	(0.099)
Crude oil price	0.926	0.744	0.579***	0.394***	0.287***	0.125***	-0.039***	-0.163***	-0.303***	-0.456***
	(0.100)	(0.166)	(0.159)	(0.181)	(0.184)	(0.179)	(0.161)	(0.141)	(0.116)	(0.124)
Bank prime rate	0.937*	0.739**	0.463***	0.264***	0.011***	-0.979***	0.465***	3.474***	6.419***	6.241**
	(0.067)	(0.182)	(0.343)	(0.425)	(0.672)	(0.671)	(0.613)	(0.964)	(1.250)	(2.096)
Unemployment rate	0.743	0.468**	0.259***	-0.224***	-0.684***	-0.839*	-1.045*	-0.652**	-1.478**	-1.339*
	(0.159)	(0.203)	(0.145)	(0.154)	(0.364)	(0.716)	(0.911)	(0.504)	(0.718)	(1.019)

Coefficients are estimated from $Y_{t+h} = \alpha_h + \beta_h \hat{Y}_{t+h|t} + \varepsilon_{t+h}$; $H_0 : (\alpha_h,\ \beta_h) = (0, 1)$.*** ,**, and * denote 1%, 5%, and 10% significance levels, respectively for the joint test; $H_0 : (\alpha_h,\ \beta_h) = (0, 1)$. For brevity, we only report β_h. Figures in parenthesis indicate heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Methods: PT test

- Patton and Timmermann (2012) test: powerful to detect bias and inefficiency in path forecasts.

$$\ln Y_{t+h} = \alpha + \beta_1 ln\hat{Y}_{t+h|t} + \sum_{k=1}^{j} \gamma_k \; r_{t+h|t+k-1,t+k} + \varepsilon_{t+h} \tag{4}$$

- Where, we define forecast revision between t and t+j as, $r_{t+h|t,t+j} = ln\hat{Y}_{t+h|t+j} - ln\hat{Y}_{t+h|t}$, *and* j $(0 < j < h)$.

- Joint test of unbiasedness and efficiency:

$$H_0 : \; (\alpha, \; \beta_h, \gamma_1, \ldots\ldots, \gamma_j) = (0, 1, 1, \ldots\ldots, 1) \tag{5}$$