# Chickens, Eggs, and Causality, or Which Came First?

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Time-series evidence from the United States indicates unidirectional causality from eggs to chickens.

*Key words:* causality, chickens, eggs.

Granger's seminal paper entitled "Investigating Causal Relations" has spawned a vast and influential literature. In macroeconomics, for example, the causal relationship between money and income has been investigated time (Sims) and again (Barth and Bennett; Williams, Goodhart, and Gowland; Ciccolo; Feige and Pearce; Hsiao). Some authors have taken exception to Granger's definition of causality *qua* causality (Zellner; Jacobs, Leamer, and Ward; Conway et al.), and even Granger has suggested "a better term might be temporally related" (Granger and Newbold, p. 225). We find ourselves in agreement with the temporal ordering interpretation of Granger causality. In fact, we believe that the most natural application of tests for Granger causality (temporal ordering) has until now been overlooked. We refer, of course, to: "Which came first, the chicken or the egg?" Our purpose in this study is to provide an empirical answer to this venerable question, which theory alone has not resolved.

## Empirical Results

We examine annual U.S. time series from 1930 to 1983 of egg production and chicken population. We count as chickens the 1 December population of all U.S. chickens except for commercial broilers. This definition is relevant in a study of the chicken-egg ordering because it includes all chickens that lay or fertilize eggs; i.e., all chickens capable of causing eggs. This measure excludes chickens raised only for meat. Eggs are measured in millions of dozens and include all eggs produced annually in the United States. All are potentially fertilizable.

The notion of Granger causality is simple: If lagged values of $X$ help predict current values of $Y$ in a forecast formed from lagged values of both $X$ and $Y$, then $X$ is said to Granger cause $Y$. We implement this notion by regressing eggs on lagged eggs and lagged chickens; if the coefficients on lagged chickens are significant as a group, then chickens cause eggs. A symmetric regression tests the reverse causality.[1] We perform the Granger causality tests using one to four lags. The number of lags in each equation is the same for eggs and chickens.

To conclude that one of the two "came first," we must find unidirectional causality from one to the other. In other words, we must reject the noncausality of the one to the other and at the same time fail to reject the noncausality of the other to the one. If either both cause each other or neither causes the other, the question will remain unanswered. The test results are presented in table 1. They indicate a clear rejection of the hypothesis that eggs do not Granger cause chickens. They provide no such rejection of the hypothesis that chickens do not Granger cause eggs. Therefore, we conclude that the egg came first.[2]

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The authors thank Paul Godek for a useful suggestion.

[1] Feige and Pearce describe and distinguish among the several Granger causality tests. The validity of our test statistic requires lack of serial correlation, homoskedasticity, and normality of the disturbances in the distributed lag equations, which we of course assume.

[2] We recognize that the annual sampling period conditions our results. In fact, the identification of a Granger causal relationship sheds no light whatsoever on chicken and egg interactions within the sampling period. While our test is agnostic regarding this

**Table 1. Granger Causality Tests**

Part 1: Did the Chicken Come First?

The following equation was estimated by OLS:

$$Eggs_t = \mu = \sum_{i=1}^{L} \alpha_i \, Eggs_{t-i} = \sum_{i=1}^{L} \beta_i \, Chickens_{t-i} + \epsilon_t;$$

$H_0 : \beta_1 = \ldots \beta_L = 0$ (chickens do not Granger cause eggs).

| $L$ = no. of lags | $F$-statistic | $P$-value | $R^2$ of the regression |
|---|---|---|---|
| 1 | .04 | .85 | .96 |
| 2 | 1.71 | .19 | .97 |
| 3 | 1.10 | .36 | .97 |
| 4 | .79 | .54 | .97 |

Part 2: Did the Egg Come First?

The following equation was estimated by OLS:

$$Chickens_t = \mu + \sum_{i=1}^{L} \alpha_i \, Chickens_{t-i} + \sum_{i=1}^{L} \beta_i \, Eggs_{t-i};$$

$H_0 : \beta_1 = \ldots = \beta_L = 0$ (eggs do not Granger cause chichens).

| $L$ = no. of lags | $F$-statistic | $P$-value | $R^2$ of the regression |
|---|---|---|---|
| 1 | 1.23 | .27 | .73 |
| 2 | 10.36 | .0002 | .81 |
| 3 | 5.85 | .0019 | .81 |
| 4 | 4.71 | .0032 | .82 |

Data source: U.S. Department of Agriculture, 1983 and others.
Note: The data are annual, 1930–83.

## Suggestions for Future Research

The structural implications of our results are not yet clear. To draw them out fully will require collaboration between economists and poultry scientists. The potential here is great. As to other questions of temporal ordering, the chicken and egg question is only the most obvious application of causality testing. Other fruitful areas of research include the testing of "He who laughs last laughs best" and the multivariate "Pride goeth before destruction, and an haughty spirit before a fall."

instantaneous causality, we suspect that eggs are endogenous in the sense that chickens cause eggs within the sampling period. A Wu-Hausman test of the predeterminedness of eggs could address the issue and would require a valid instrumental variable (correlated with eggs and uncorrelated with the chicken forecast error), perhaps bacon.

*[Received June 1987; final revision received September 1987.]*

## References


Barth, J. R., and J. T. Bennett. "The Role of Money in the Canadian Economy: An Empirical Test." *Can. J. Econ.* 7(1984):306–11.

Ciccolo, J. H., Jr. "Money, Equity Values, and Income: Tests for Exogeneity." *J. Money, Credit, and Banking* 10(1978):46–64.

Conway, Roger K., P. A. V. B. Swamy, John F. Yanagida, and Peter von zur Muehlen. "The Impossibility of Causality Testing." *Agr. Econ. Res.* 36(1984):1–19.

Feige, E. L., and D. K. Pearce. "The Casual Causal Relationship Between Money and Income: Some Caveats for Time-Series Analysis." *Rev. Econ. and Statist.* 61(1979):521–33.

Granger, Clive W. "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods." *Econometrica* 37(1969):424–38.

Granger, Clive W., and Paul Newbold. *Forecasting Economic Time Series.* New York: Academic Press, 1977.

Hsiao, C. "Autoregressive Modeling and Money-Income Causality Detection." *J. Monetary Econ.* 7(1981): 85–106.

Jacobs, R. L., E. E. Leamer, and M. P. Ward. "Difficulties with Testing for Causation." *Econ. Inquiry* 17(1979):401–13.

Sims, Christopher. "Money, Income, and Causality." *Amer. Econ. Rev.* 62(1972):540–55.

U.S. Department of Agriculture. *Agricultural Statistics.* Washington DC, various issues.

Williams, D., C. A. Goodhart, and D. H. Gowland. "Money, Income and Causality: The U.K. Experience." *Amer. Econ. Rev.* 66(1976):417–23.

Zellner, Arnold. "Causality and Econometrics." *Three Aspects of Policy and Policymaking: Knowledge, Data and Institutions* ed. K. Brunner and A. H. Meltzer, pp. 9–54. Carnegie-Rochester Conference Series on Public Policy, vol. 10, 1979.