Agricultural Commodity Prices and Exchange Rates under Structural Change

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Introduction

Schultz’s (1959 American Economic Review) classic article led to the widely held belief of the U.S. agricultural community that agricultural commodity prices are strongly influenced by exchange rates. During commodity booms a weak dollar typically signals price increases.

Observations during the 2006-08 “Commodity Boom”:
• U.S. Dollar weakened substantially
• Metals and energy prices rose
• Agricultural prices followed, but with a lag (see Balestra and Hacioglu, 2011 Working Paper 5347)

Currently, U.S. Dollar has strengthened since May 2014
• Agricultural commodity prices, along with metals and energy, initially declined. But agricultural prices disconnected by late 2014.

Markets Analyzed: U.S. Corn and Soybeans

Research Questions

• Why does agricultural commodity price responsiveness to exchange rate changes vary over time?

Hypotheses

• Supply use balance (e.g. stocks positions following production shortfalls or demand expansions) influence both market behavior (e.g. domestic demand elasticity) and the responsiveness of prices to exchange rates.
• Macroeconomic factors (monetary policy, inflationary expectations, or recession) also influence both market behavior (e.g. demand elasticity) and the responsiveness of prices to exchange rate changes. Downshifting (Eraker, 1999, 2000; Bovenberg, Bovenberg, and Wright, 2002, Econometrica 70(3))
• Structural changes in parameters may cause apparent series non-stationarity (Perkins, 1989, Econometrica 57(3))
• Series non-stationarity makes hard-standards estimation problematic (Granger and Newbold, 1974)
• Individually non-stationary variable series may have a long-run equilibrium relationship. The variables are then cointegrated (Engle and Granger, 1987, Econometrica 55(2)).

Research Question

• When these “structural change factors” are relevant the price responsiveness to exchange rate changes statistically significantly different?

Relevance

• Determining which factors are relatively more important for explaining price responsiveness to exchange rate changes can help explain future price movements.

Theoretical Results

• Law of One Price (LOP) Theory: full pass-through (β = unit elastic response) to agricultural prices from exchange rate changes
  • Empirical measurement finds incomplete pass-through (Goldberg and Knetter, 1997 AEJ 30(1))
  • Why?
    • U.S. is large country in many agricultural markets; less than full pass-through is expected as both domestic and world prices adjust (Abbott 2000-2004)
  • Theoretical results
    • Small country response: β < 1, but less than full pass-through (response elasticity < 1)
    • Large country response: β > 1, response elasticity increases if domestic demand becomes more inelastic

Structural Change Factors

Supply-use Factors

Low-stocks-to-use (LSU) (corn and soybeans)
• Why?
  • Domestic demand is more inelastic under low stocks (Weight, 2005 AEJ 33(1))
  • Indicator variable: value of 1 for low stocks periods, 0 otherwise

Renewable Fuel Standard (FFS) (corn only)
• Why?
  • Domestic demand is more inelastic during periods when prices are affected by regulatory policy (Abbott, Hurt, and Tyler, 2011, Agricultural Foundation)
  • Indicator variable: 1 for months following RFS relevance, 0 otherwise

Chinese Soybean Net Export Policy (EXP) (soybeans only)
• Why?
  • Similar demand shift and elasticity changes in corn due to RFS (Abbott, Hurt, and Tyler, 2011, Agricultural Foundation)
  • Indicator variable: 1 for months following change, 0 otherwise

Macroeconomic Factors

Low federal funds rate (FF) (corn and soybeans)
• Why?
  • Over/value of agricultural commodity prices due to low post-rate
  • Indicator variable: 1 for months of low monetary policy, 0 otherwise

Recession (REC) (corn and soybeans)
• Why?
  • Overshooting of agricultural commodity prices due to low time lags of manufactures prices
  • Indicator variable: 1 for months of recession, 0 otherwise

Empirical Issues Due to Structural Changes

• Domestic demand is nonlinear due to stocks demand (Weight, 2011 AEJ 33(1))
• Approximated as piecewise linear demand, which behave the structural change (when moving from elastic demand in normal stocks (NS) situation to inelastic demand with low stocks (LS))
• Piecewise linear demand can lead to non-stationarity of variable series (Bovenberg, Bovenberg, and Wright, 2002, Econometrica 70(3))
• Structural changes in parameters may cause apparent series non-stationarity (Perkins, 1989, Econometrica 57(3))
• Series non-stationarity makes hard-standards estimation problematic (Granger and Newbold, 1974)
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Empirical Method and Econometric Models

Method

• A version of the Engle and Granger (1987, Econometrica 55(2)) two-stage method was implemented

Structural change accounted for through inclusion of indicator variables (similar to Gregory and Hansen, 1996, AEJ 70(3)) for relevant factors above

Model

First stage levels models:

\[ y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 \text{EXP}_{t-1} + \alpha_3 \text{FF}_{t-1} + \alpha_4 \text{REC}_{t-1} + \epsilon_t \] (1)

where

\( y_t \) is the natural log of the commodity price
\( \text{EXP}_{t-1} \) is an binary indicator variable that represents structural change periods or conditions
\( \text{FF}_{t-1} \) is the natural log of the exchange rate index
\( \epsilon_t \) is a random-error

Second stage error correction mechanism (ECM) models for corn:

\[ \Delta \text{P}_{t} = \beta_0 + \beta_1 \Delta \text{P}_{t-1} + \beta_2 \Delta \text{EXP}_{t-1} + \beta_3 \Delta \text{FF}_{t-1} + \beta_4 \Delta \text{REC}_{t-1} + \epsilon_{t} + \gamma_0 \mu_{t-1} + \gamma_1 \mu_{t-2} \] (2)

where

\( \mu_{t-1} \) and \( \mu_{t-2} \) are the lagged estimated residuals from the associated low stocks-to-use level models
\( \Delta \text{EXP}_{t-1} \) and \( \Delta \text{FF}_{t-1} \) are the lagged indicator variables for the RFS and low federal funds rate (FF) indicator variables
\( \epsilon_{t} \) is a random-error

Empirical Results

Results for estimation of the corn levels models with a single indicator and interaction variable (equation (1)) for each of the relevant structural changes are included in table 1 below.

Summary of Results

• Results vary somewhat by exchange rate index used, but pass-through is often elastic (\( \beta_1 \) for \( \text{EXP}_{t-1} \), \( \text{FF}_{t-1} \), and \( \text{REC}_{t-1} \) is 1)
• We find the Fed FIC index to have more explanatory power, and greater pass-through, than the broader indices
• Strong statistical evidence was found for structural change in responsiveness of agricultural commodity prices to exchange rate changes (\( \text{NS} \) to \( \text{LS} \)), especially under low stocks conditions
• When stocks are large, supply-use balance dominates, explaining intertemporal disconnects in price and exchange rate movements
• Once stocks positions are taken into account, additional factors add little additional explanatory power
• Accounting for low stocks in the levels models was found to be critical for finding evidence of a long-run cointegrating relationship between these prices and exchange rates
• Evidence supporting overshooting theories is strongest in the short-run ECM models, after accounting for low stocks in the levels models

Discussion

• Estimated empirical magnitudes are higher than economic theory predicts, especially during low stocks periods
  • Because the exchange rate is correlated with other factors like global macroeconomic performance and expectations, these parameter estimates likely capture third variable effects
  • We (and others) find it difficult to identify a viable third variable to control for these correlated third variable effects, especially at monthly frequency