# Pulling up the Tarnished Anchor: The End of Silver as a Global Unit of Account

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# When Do Global Monetary Systems End?

- Sometimes the answer is clear
  - US closes the gold window in 1971, ending Bretton Woods
  - England embargoes gold exports and imposes exchange controls in 1914, ending classical gold standard
- In other cases, such as the demise of bimetallism, answer is less clear
  - Individual countries (even systemically important ones) can change formal rules (i.e. laws) that bind them to system, but this does not imply that the metal(s) ceases to serve as an anchor (unit of account and numeraire) for prices *globally*

# The Demise of Silver as a Global Unit of Account

- In 19th century, silver often used in conjunction with gold to fix exchange rates
  - Under bimetallism, both metals served as numeraires
  - Other goods priced relative to the mint par ratio of gold to silver
- Most countries move from bimetallism and silver standards to gold over the latter half of the 19th century
  - Eichengreen (1996), Meissner (2005)

# Previous Literature

- Was bimetallism a viable system?
  - Velde and Weber (2000)
- Focus on changes in longstanding global mint ratio of 15.5 silver ounces to one gold ounce
  - Standard story postulates that Germany's decision to demonetize silver led many countries to drop silver and switch over to gold (Friedman and Schwartz 1963, Gallarotti 1994)

# Previous Literature

- Focus on changes in longstanding global mint ratio of 15.5 silver ounces to one gold ounce
  - Flandreau (1996), however, argues that France, being the largest bimetallic country in the world, was the marginal player in the bimetallic system that kept the silver ratio at 15.5:1
    - ★ France's 1873 decision to limit the coinage of silver violated bimetallism, and led to the eventual rise of the international gold standard and to a floating silver-gold price ratio
  - Meissner (2013) builds on Flandreau (1996), arguing it would not have been sustainable after 1875 while Morys (2007) suggests an even earlier demise—the 1860s
- Silver's usage nevertheless persisted after "demise" of bimetallism

# Our Question

- Since move away from silver was gradual, we are able to examine how its declining role as a global unit of account affected its role as a price anchor
- For an individual country, once legal backing of money with silver ended (either de jure or de facto), prices were free to fluctuate relative to that metal
  - No longer a numeraire

# Our Question

- Commodity prices, however, were largely set in competitive, global markets, suggesting that correlations between precious metals and commodity prices could persist even after legal backing ends for a single country
- On the other hand, eventual widespread end to free coinage of silver at some point likely ended silver's role as a price anchor
- As that took place, were commodity prices cast adrift or did widespread gold standard adoption stabilize price movements?

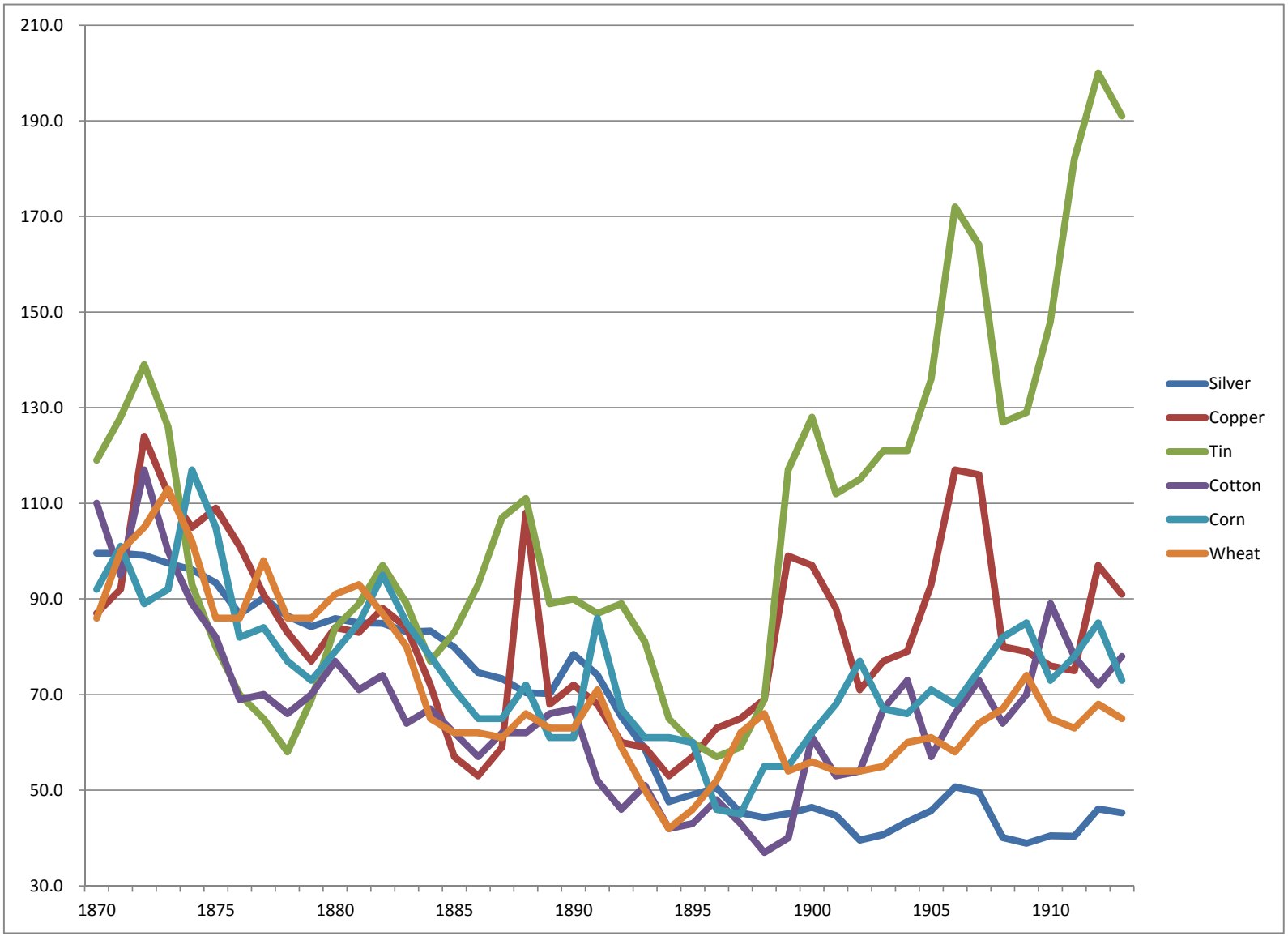
# A Dynamic Bimetallic Monetary Model

- Multiple goods in a dynamic, general equilibrium model
  - Model nests both bimetallic and monometallic monetary systems
  - Allows for easy comparison of different monetary systems
- Model calibrated using historical data on global commodity prices
  - Can the model match key features of the data?
  - What does the transition away from silver look like?
  - What distinguishes bimetallic and monometallic systems?

# Price Dynamics

- Silver ceased functioning as a global price anchor in the mid-1890s
  - High correlation between price of silver and price of agricultural commodities through the mid-1890s, but not so thereafter
  - Nearly two decades after many key countries abandoned bimetallism
- Model matches different patterns in data before and after mid-1890s
  - Lower correlation between silver and commodity prices after mid-1890s
  - Lower volatility of commodity prices after mid-1890s
- Model provides simple, clear intuition behind these changes

# Commodity Prices 1870-1913



# Outline

1. Introduction
   - Motivation
   - Preview of Results
2. A Dynamic Bimetallic Monetary Model
3. Simulations
4. Conclusion

# Key Elements of the Model

1. Four goods in the economy
   - Silver, gold, agricultural commodity, metallic commodity
   - Non-monetary demand for gold and silver

2. Constant-elasticity-of-substitution (CES) utility function
   - General and tractable: Rotemberg (1987), Flandreau (1996)

3. Cash-in-advance constraint
   - Goods must be purchased with monetary gold or silver
   - Positive relationship between money and nominal output

# Setup

- Overlapping generations of agents maximize utility over consumption:

$$u(Y_{ct}, Y_{at}, Y_{st}, Y_{gt}) = \left(\mu_c^{\frac{1}{\theta}} Y_{ct}^{\frac{\theta-1}{\theta}} + \mu_a^{\frac{1}{\theta}} Y_{at}^{\frac{\theta-1}{\theta}} + \mu_s^{\frac{1}{\theta}} Y_{st}^{\frac{\theta-1}{\theta}} + (1-\mu_c-\mu_a-\mu_s)^{\frac{1}{\theta}} Y_{gt}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}$$

  - $Y_{ct}, Y_{at}, Y_{st}, Y_{gt}$ : Consumption of each good (non-monetary)
  - $\mu_c, \mu_a, \mu_s$ : Shares of each good in total consumption
  - $\theta$ : Elasticity of substitution between goods

- Model is simple and tractable, and can be extended and generalized
  - Monopolistic competition: Rotemberg (1987)
  - Intertemporal considerations, monetary uncertainty: Svensson (1985)

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# Cash-in-Advance Economy

Agents hold monetary gold, silver in order to purchase goods consumed:

$$M_{gt} + M_{st} p_{st} \geq Y_{ct} p_{ct} + Y_{at} p_{at} + Y_{st} p_{st} + Y_{gt}$$

$M_{gt}, M_{st}$ : Quantities of monetary gold and silver

$p_{st}, p_{at}, p_{ct}$ : Prices of silver and agricultural and metallic commodities

What is the ratio of monetary silver to monetary gold?

$$\alpha M_{gt} = M_{st}$$

$\alpha > 0$ : Bimetallic monetary system

$\alpha = 0$ : Monometallic, gold-based monetary system

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# Money and Prices

- Cash-in-advance constraint is standard in monetary models
- In equilibrium, this constraint binds:

$$M_{gt} + M_{st} p_{st} = Y_{ct} p_{ct} + Y_{at} p_{at} + Y_{st} p_{st} + Y_{gt}$$

- Assuming bimetallic monetary system, what happens if $p_{st}$ increases?
  - Increase in $p_{st}$ leads to increase in money supply $M_{gt} + M_{st} p_{st}$
  - Increase in money supply leads to increase in nominal output
  - Increase in nominal output means prices of other goods also increase
- Many alternative specifications of model, but always same intuition

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# Supply Dynamics

In order to close the model, it is necessary to specify the dynamics for the supply of each good:

$$\log S_t = \bar{S} + \rho_S \log S_{t-1} + \tilde{s}_t$$
$$\log G_t = \bar{G} + \rho_G \log G_{t-1} + \tilde{g}_t$$
$$\log A_t = \bar{A} + \rho_A \log A_{t-1} + \tilde{a}_t$$
$$\log C_t = \bar{C} + \rho_C \log C_{t-1} + \tilde{c}_t,$$

$S_t, G_t, A_t, C_t$ : Total supply of each good in period $t$

$\bar{S}, \bar{G}, \bar{A}, \bar{C}, \rho_S, \rho_G, \rho_A, \rho_G$ : Constants that characterize time series

$\tilde{s}_t, \tilde{g}_t, \tilde{a}_t, \tilde{c}_t$ : Normally distributed shocks (i.i.d.)

# Equilibrium

- Two things happen in equilibrium:
  - Markets clear, so supply equals demand for each good
  - Cash-in-advance constraint binds, so income equals spending

- This implies that in equilibrium:

$$Y_{ct} = \frac{\mu_c}{p_{ct}^{\theta}} \left( Y_{ct} p_{ct}^{\theta} + Y_{at} p_{at}^{\theta} + Y_{st} p_{st}^{\theta} + Y_{gt} \right)$$

$$M_{gt} + M_{st} p_{st} = Y_{ct} p_{ct} + Y_{at} p_{at} + Y_{st} p_{st} + Y_{gt}$$

  - Demand for each good depends on price and nominal income (note that there are similar expressions for agricultural commodity and silver)

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# Model Calibration: Structural Parameters

- Elasticity of substitution between goods: $\theta$
  - Low substitutability, $\theta = 0.5$
  - Similar results for $\theta = 1$
- Shares of each good in total consumption: $\mu_c, \mu_a, \mu_s$
  - Choose $\mu_c = \mu_a = 0.4$ and $\mu_s = 0.1$
  - Similar results for alternative share values
- Ratio of monetary silver to monetary gold: $\alpha$
  - Consider several different values of $\alpha > 0$
  - Compare with $\alpha = 0$ (monometallic, gold-based monetary system)

# Model Calibration: Time-Series Parameters

- Supply of each good follows logarithmic AR-1 process:

$$\log S_t = \bar{S} + \rho_S \log S_{t-1} + \tilde{s}_t$$
$$\log G_t = \bar{G} + \rho_G \log G_{t-1} + \tilde{g}_t$$
$$\log A_t = \bar{A} + \rho_A \log A_{t-1} + \tilde{a}_t$$
$$\log C_t = \bar{C} + \rho_C \log C_{t-1} + \tilde{c}_t,$$

- Choose parameters so simulations with $\alpha = 0$ match 1897-1913 data
  - Monometallic, gold-based monetary system
- Compare results of simulations with $\alpha > 0$ with 1870-1896 data
  - Silver as a price anchor?

# Results

| Good | Value of $\alpha$ | Standard Deviation (%) | Autocorrelation |
|---|---|---|---|
| Silver | 0 | 0.136 | 0.938 |
| Silver | 0.25 | 0.266 | 0.946 |
| Silver | 0.5 | 0.241 | 0.944 |
| Silver | 0.75 | 0.234 | 0.941 |
| Silver | 1.0 | 0.234 | 0.941 |
| Silver | 1.5 | 0.227 | 0.941 |
| Silver | 2.0 | 0.225 | 0.945 |
| Metallic Commodity | 0 | 0.214 | 0.965 |
| Metallic Commodity | 0.25 | 0.330 | 0.968 |
| Metallic Commodity | 0.5 | 0.313 | 0.970 |
| Metallic Commodity | 0.75 | 0.312 | 0.969 |
| Metallic Commodity | 1.0 | 0.320 | 0.968 |
| Metallic Commodity | 1.5 | 0.312 | 0.970 |
| Metallic Commodity | 2.0 | 0.280 | 0.967 |
| Agricultural Commodity | 0 | 0.211 | 0.922 |
| Agricultural Commodity | 0.25 | 0.390 | 0.925 |
| Agricultural Commodity | 0.5 | 0.363 | 0.924 |
| Agricultural Commodity | 0.75 | 0.353 | 0.918 |
| Agricultural Commodity | 1.0 | 0.349 | 0.918 |
| Agricultural Commodity | 1.5 | 0.353 | 0.926 |
| Agricultural Commodity | 2.0 | 0.355 | 0.925 |

Figure: Results from 1,000 simulations.

# Results

| Value of $\alpha$ | | Silver | Metallic Commodity |
|---|---|---|---|
| 0 | Metallic Commodity | 0.317 | 1.000 |
| 0 | Agricultural Commodity | -0.184 | -0.047 |
| 0.25 | Metallic Commodity | 0.785 | 1.000 |
| 0.25 | Agricultural Commodity | 0.900 | 0.571 |
| 0.5 | Metallic Commodity | 0.786 | 1.000 |
| 0.5 | Agricultural Commodity | 0.883 | 0.546 |
| 0.75 | Metallic Commodity | 0.767 | 1.000 |
| 0.75 | Agricultural Commodity | 0.881 | 0.543 |
| 1.0 | Metallic Commodity | 0.772 | 1.000 |
| 1.0 | Agricultural Commodity | 0.877 | 0.524 |
| 1.5 | Metallic Commodity | 0.757 | 1.000 |
| 1.5 | Agricultural Commodity | 0.882 | 0.535 |
| 2.0 | Metallic Commodity | 0.709 | 1.000 |
| 2.0 | Agricultural Commodity | 0.886 | 0.480 |

Figure: Results from 1,000 simulations.

# Data

| Good | Time Period | Standard Deviation (%) | Autocorrelation |
|---|---|---|---|
| Silver | 1870-1896 | 0.224 | 0.990 |
| Silver | 1897-1913 | 0.086 | 0.961 |
| Copper | 1870-1896 | 0.311 | 0.987 |
| Copper | 1897-1913 | 0.188 | 0.946 |
| Tin | 1870-1896 | 0.350 | 0.975 |
| Tin | 1897-1913 | 0.290 | 0.980 |
| Cotton | 1870-1896 | 0.347 | 0.972 |
| Cotton | 1897-1913 | 0.254 | 0.969 |
| Corn | 1870-1896 | 0.278 | 0.909 |
| Corn | 1897-1913 | 0.276 | 0.954 |
| Wheat | 1870-1896 | 0.232 | 0.916 |
| Wheat | 1897-1913 | 0.190 | 0.895 |

Figure: Data for 1870-1913.

# Data

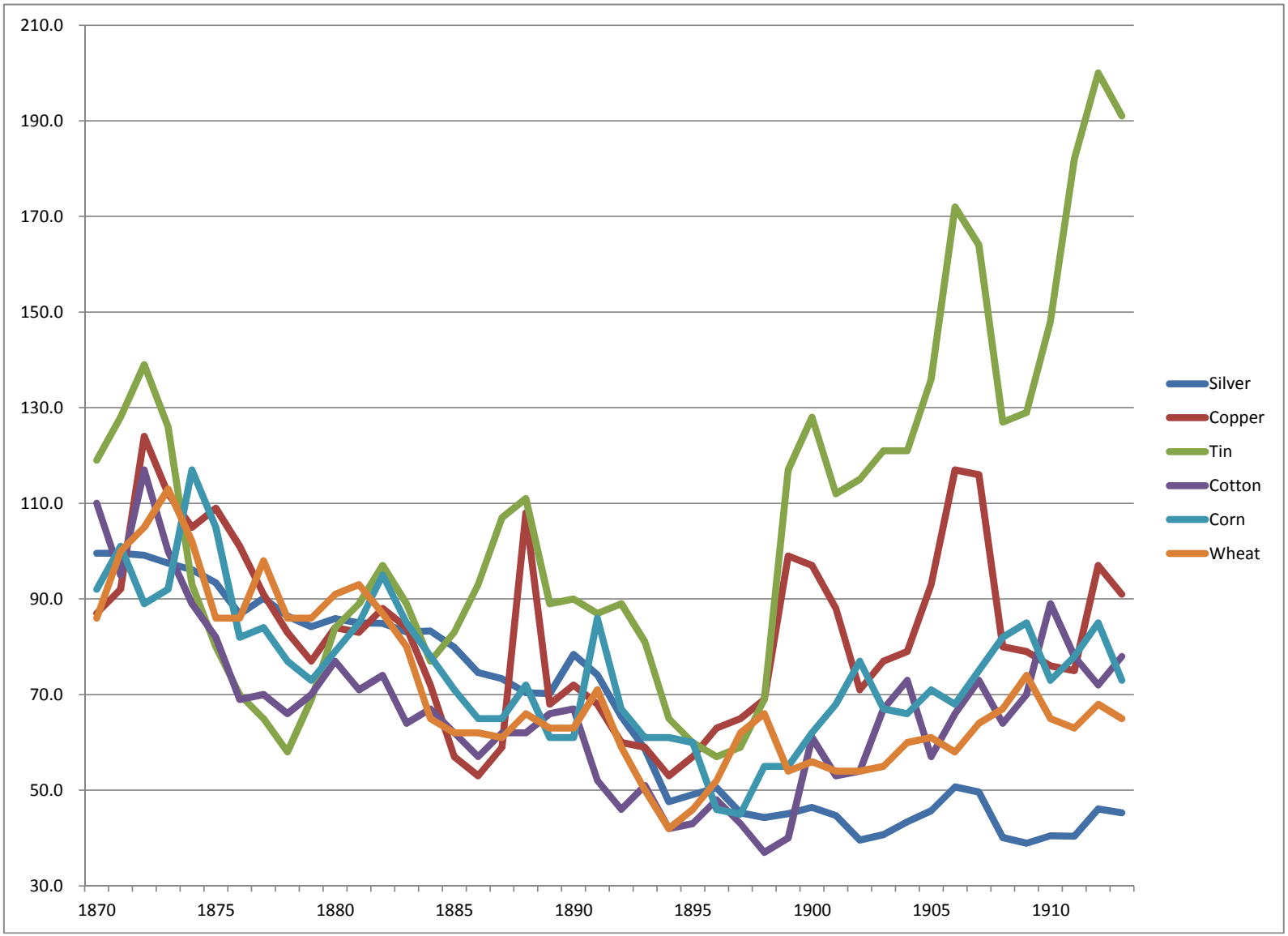
| | Silver | Copper | Tin | Cotton | Corn |
|---|---|---|---|---|---|
| Copper | 0.833 | 1.000 | | | |
| Tin | 0.662 | 0.755 | 1.000 | | |
| Cotton | 0.864 | 0.865 | 0.819 | 1.000 | |
| Corn | 0.419 | 0.170 | 0.272 | 0.317 | 1.000 |
| Wheat | 0.749 | 0.715 | 0.457 | 0.600 | 0.321 |

Table 2: Data correlations 1870-1896.

| | Silver | Copper | Tin | Cotton | Corn |
|---|---|---|---|---|---|
| Copper | 0.726 | 1.000 | | | |
| Tin | 0.168 | 0.329 | 1.000 | | |
| Cotton | -0.177 | -0.081 | 0.631 | 1.000 | |
| Corn | -0.379 | -0.185 | 0.560 | 0.547 | 1.000 |
| Wheat | -0.327 | -0.348 | 0.249 | 0.412 | 0.510 |

Table 3: Data correlations 1897-1913.

# Commodity Prices 1870-1913



# The Model and the Data

- Simulations show that model matches key characteristics of the data
- Silver as price anchor vs. unambiguously monometallic system
  - Key distinction is correlation between silver and commodity prices
- Simple intuition
  - If price of silver increases, then the quantity of money also increases
  - If quantity of money increases, then the price level also increases

# Future Directions

- Expand, sharpen the parameterization
  - Use trade based on gold (silver) or country-specific information on use of metals as money to have a time-varying alpha
- What is the best cutoff between high-correlation/high-volatility and low-correlation/low-volatility periods?

# The End

Thank You