SUPER-CYCLES OF COMMODITY PRICES SINCE THE MID-NINETEENTH CENTURY

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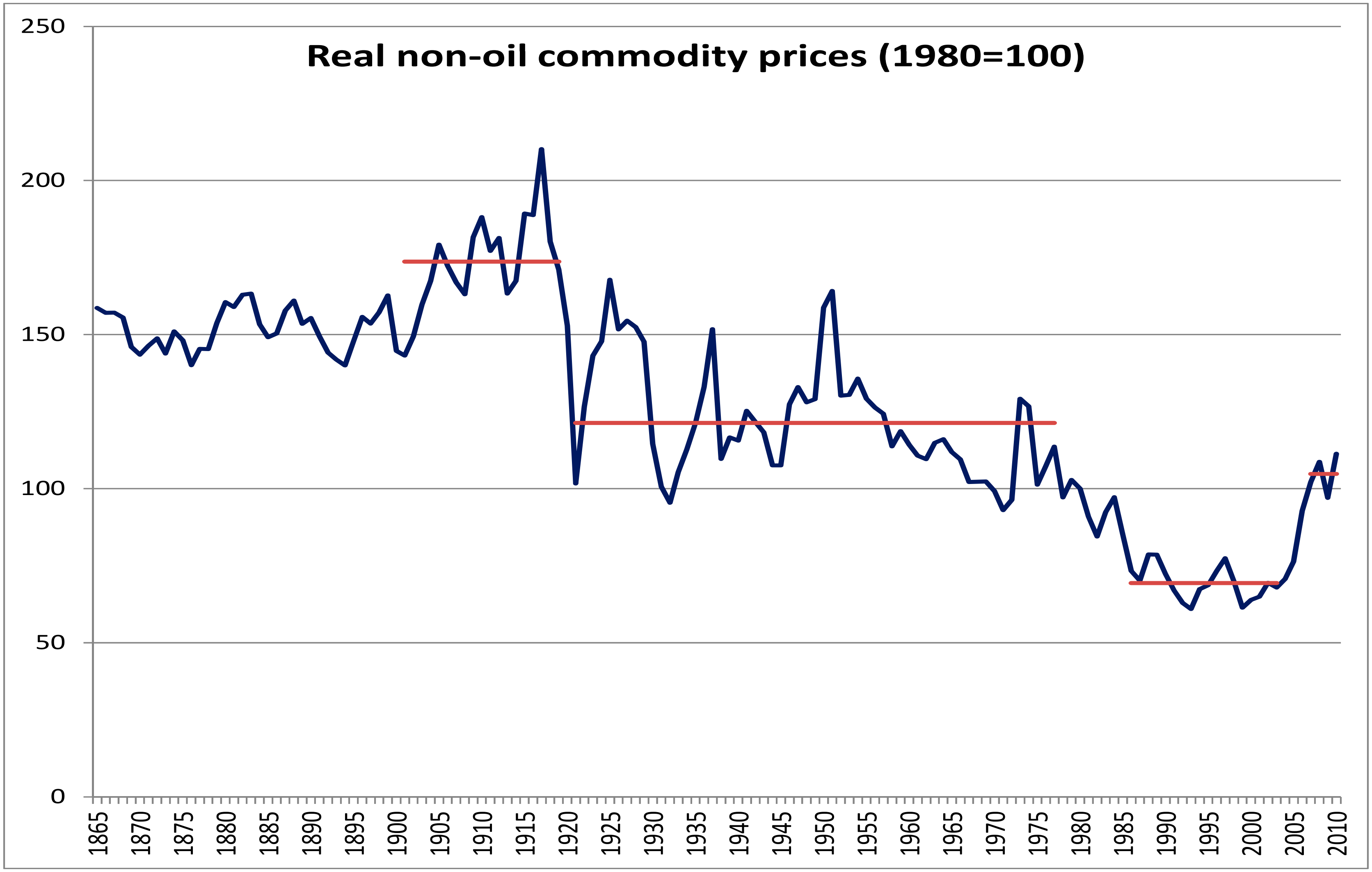
Outline

1. Introduction and Research Objectives
2. Brief Literature Review
3. Data Sources
4. Identification of Super-Cycles and Empirical Results
5. Relationship between Commodity Prices and Global Output: Short- and Long-term
6. Conclusions and Policy Implications

1. Why are trends and cycles of commodity prices important?

- Central policy issue for commodity-dependent emerging and developing countries:
  - How much resources should society allocate to commodity-dependent vs. non-commodity dependent sectors?
  - How much of the current revenues should be saved?
  - Should we tax commodity sectors, and how much?
- For monetary policy: crucial role of commodity prices on inflation trends
- For the private sector
  - Capacity expansion projects (particularly in mining sectors) depend on expected price trends
  - Hedging against risks in portfolio management

The current price boom: recovery or historic surge?



Research Objectives

- Separate long-term trends from medium and short-term cycles:
  - Do commodity prices exhibit any long-term upward or downward trends? Are there differences across different groups of commodities, and why?
  - Should changes be described as structural breaks or super-cycles?
  - Are the super-cycle components in different groups highly correlated, as would be expected if the super-cycle is demand-driven?
  - After separating the long-term trends and super-cycles, how strong are the shorter cycles?

Research Objectives (cont.)

- Investigate the relation between super cycles and global output cycles to find out whether:
  - Are they co-integrated?
  - Are global output cycles a good predictor of medium-term commodity price cycles?
  - Does the strength of the downswing or upswing in prices reflect the strength of the global economic activity?

2. Literature Review

- 19th century works of Clarke, Jevons, Tugan-Baranovski, and Wicksell
- Major analytical frameworks developed by Nikolai Kondratiev and Joseph Schumpeter:
  - Kondratiev discredited exogenous factors (wars, revolutions, gold production) in favor of endogenous factors such as technological changes as major drivers of long waves.
  - Schumpeter argued that there is tendency for the prices to exhibit cyclical behavior associated with cycles in world output growth driven by a process of creative destruction.

Literature Review (cont.)

- The Prebisch-Singer hypothesis: implications of long-term trends for developing countries:
- Post-Schumpeterian literature: Mensch, Freeman and Soete.
- Critics of Schumpeter: Kuznets, Rosenberg and Frishtak.
- Critics of long cycles: Samuelson, Becker.
- Recent interest in medium-term cycles: Blanchard, Krugman, Sargent, Solow, Comin and Gertler, Braun et al, Cuddington and Jerrett, Boshof.

3. Data sources

- **Non-oil commodity prices**: Annual data from 1865 to 2010 composed of prices for 24 commodities up to 1961 and 32 since 1962, grouped into five indices: total, metals, total agriculture, tropical agriculture, and non-tropical agriculture (Ocampo and Parra, 2010), updated the original price indices of Grilli and Yang (1988).
- **Oil prices**: Annual spliced series from 1875 to 2010 of West Texas International (WTI) using data from the World Economic Outlook (WEO).
- **Price deflator**: World manufacturing prices estimated by Lewis over 1860-1913, and since 1913 the Manufacturing Unit Value (MUV), developed by the United Nations and updated by the World Bank.
- **OECD and World GDP**: Angus Maddison's data, covering 1820-2003, and the version updated until 2008 by the Groningen Growth and Development Centre's Total Economy Database

4. Identification of super-cycles

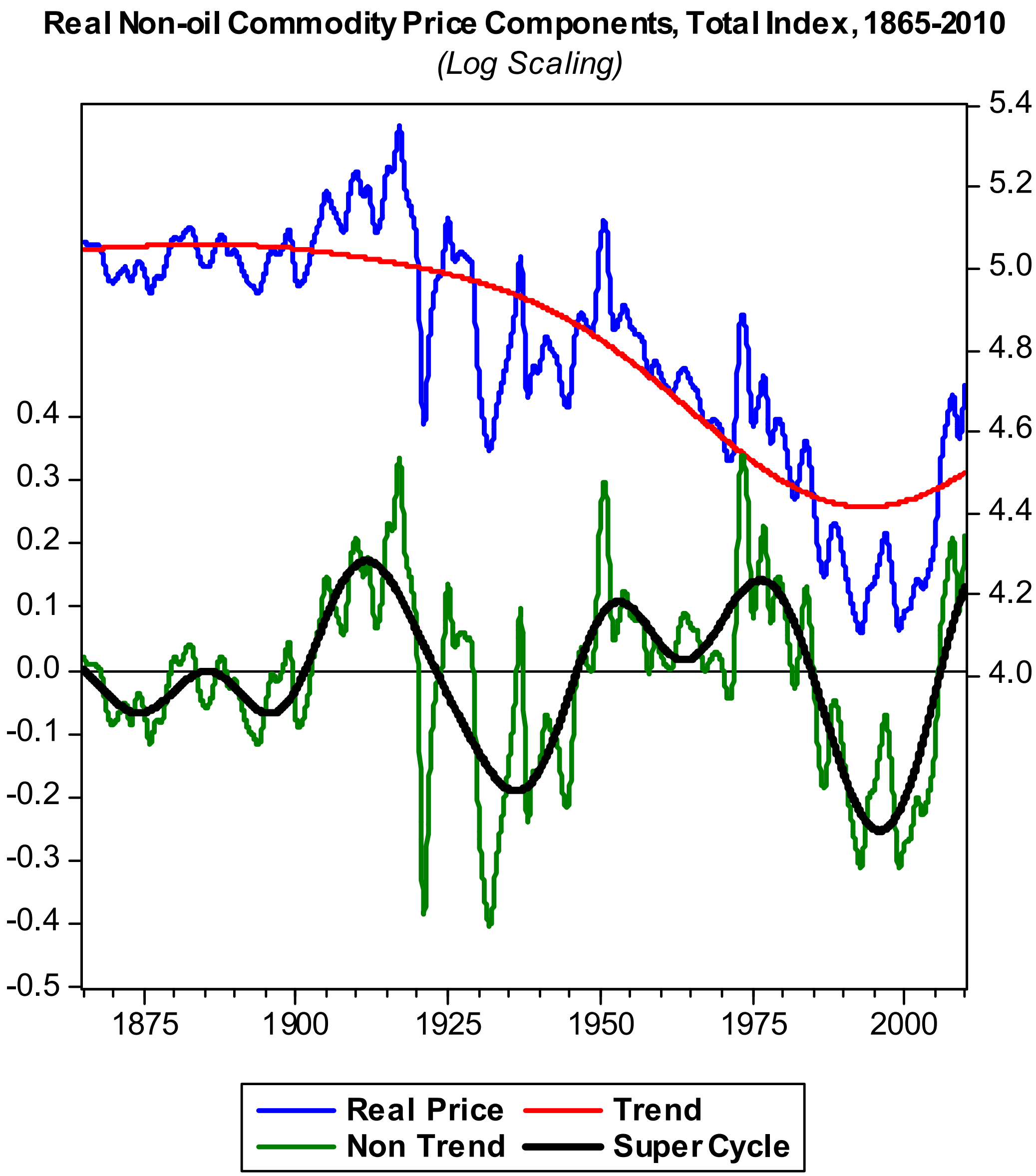
- Asymmetric Christiano and Fitzgerald (ACF) BP filters are used to extract cycles with different periodicities.
- $LP_t \equiv LP\_T_t + LP\_SC_t + LP\_O_t$ (1)
- $LP\_SC \equiv LP\_BP\,(20, 70)$ (2)
- $LP\_T \equiv LP\_BP\,(70, \infty)$ (3)
- $LP\_O \equiv LP\_BP\,(2, 20)$ (4)
- $LP\_NT \equiv LP\_BP\,(2, 20) + LP\_BP\,(20, 70)$ (5)
- $LP_t \equiv LP\_T_t + LP\_NT_t$ (6)

Long-term trends in real commodity prices

Tropical Agriculture	1865 – 1888	1888 – 2002	2002 – 2010
Annual compound growth rate	0.7%	-1.0%	0.3%
Cumulative growth rate	16.3%	-67.2%	2.5%
Duration (years)	23	114	8
Non-tropical Agriculture	**1889 – 1932**	**1932 – 1994**	**1994 – 2010**
Annual compound growth rate	0.4%	-1.0%	0.4%
Cumulative growth rate	20.2%	-46.9%	6.9%
Duration (years)	43	62	16
Metals	**1865 – 1881**	**1881 – 1974**	**1974 – 2010**
Annual compound growth rate	0.1%	-0.7%	1.0%
Cumulative growth rate	1.7%	-48.2%	43.8%
Duration (years)	16	93	36
Crude Oil	**1875 – 1925**	**1925 – 1962**	**1962 – 2010**
Annual compound growth rate	1.5%	-1.1%	2.8%
Cumulative growth rate	114.2%	-32.5%	280.0%
Duration (years)	50	37	48

Note: This table displays the descriptive statistics of long-term trends identified in the ACF BP filter decomposition analysis.

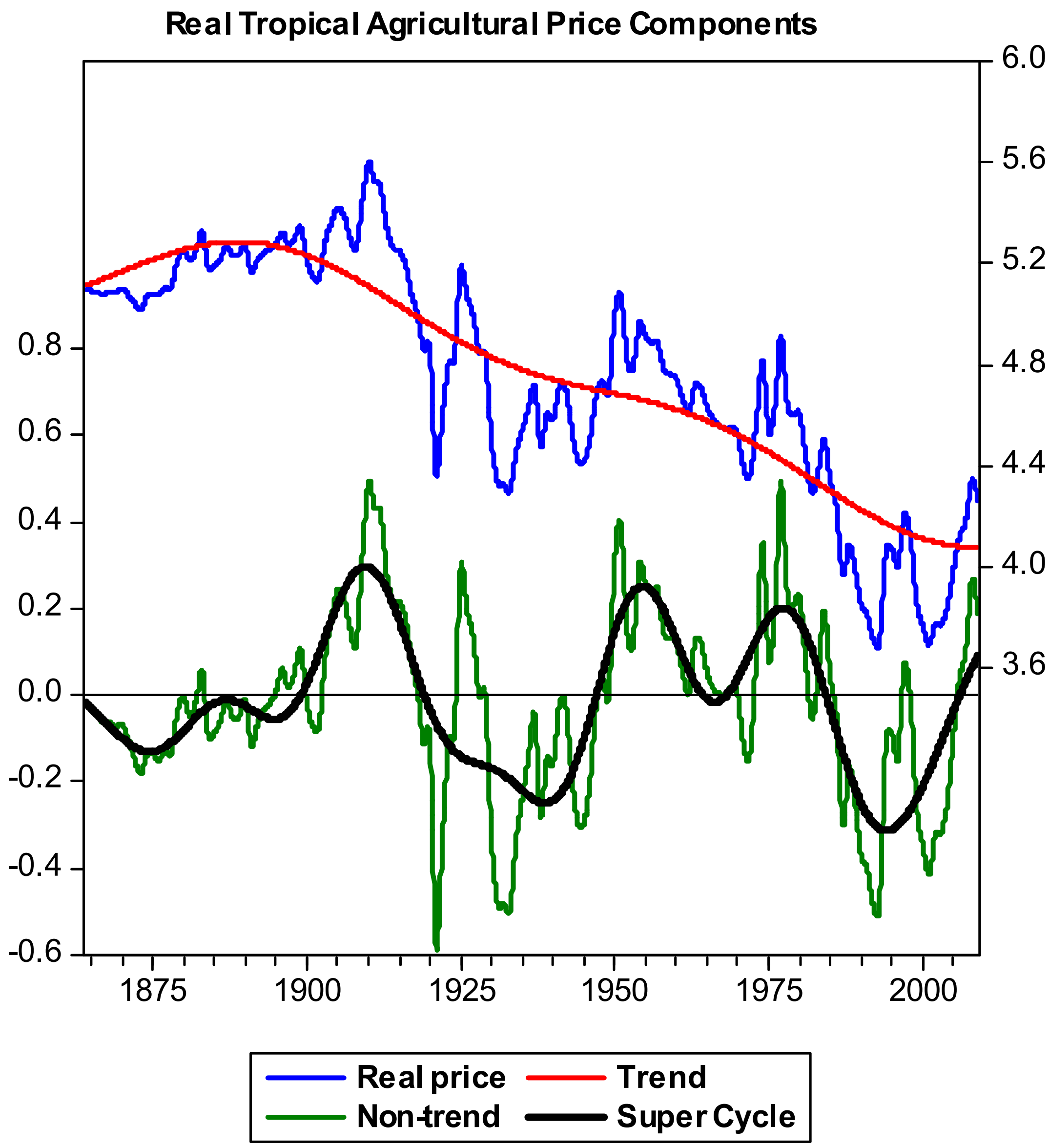
Price Decomposition for Total Non-Fuel Index



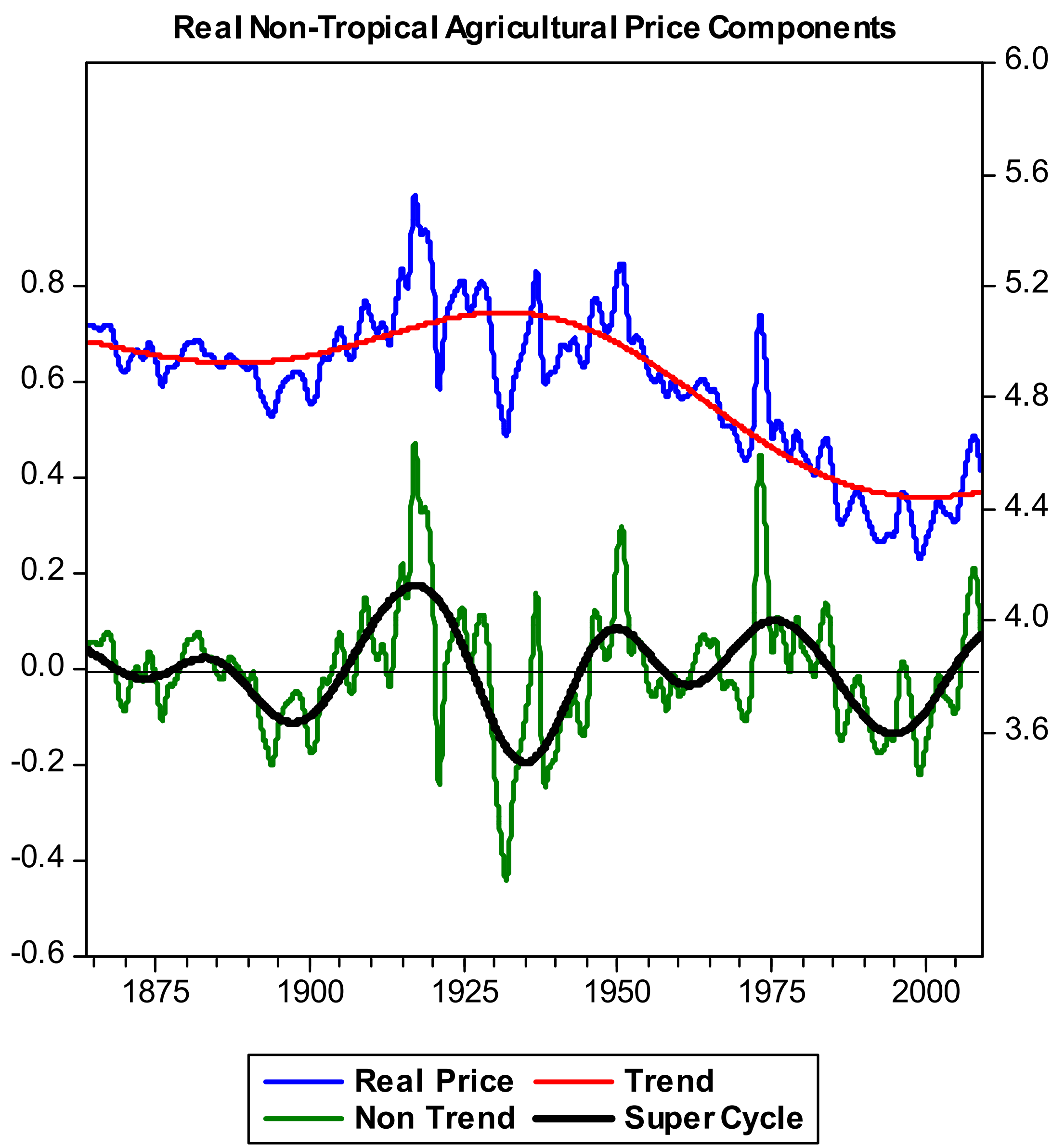
Total real non-fuel commodity prices

	1894-1932	1932-1971	1971-1999	1999-?
Peak year	1917	1951	1973	2010
Percent rise in prices during upswing	50.2%	72.0%	38.9%	81.3%
Percent fall in prices during downswing	-54.6%	-43.3%	-52.5%	-
Length of the cycle (years)	38	39	28	-
- Upswing	23	19	2	11
- Downswing	15	20	26	-
Mean (of the full cycle)	**157.3**	**119.4**	**86.2**	**82.2**
Standard deviation	24.8	15.6	18.8	17.0
Coefficient of variation	15.8	13.1	21.8	20.8

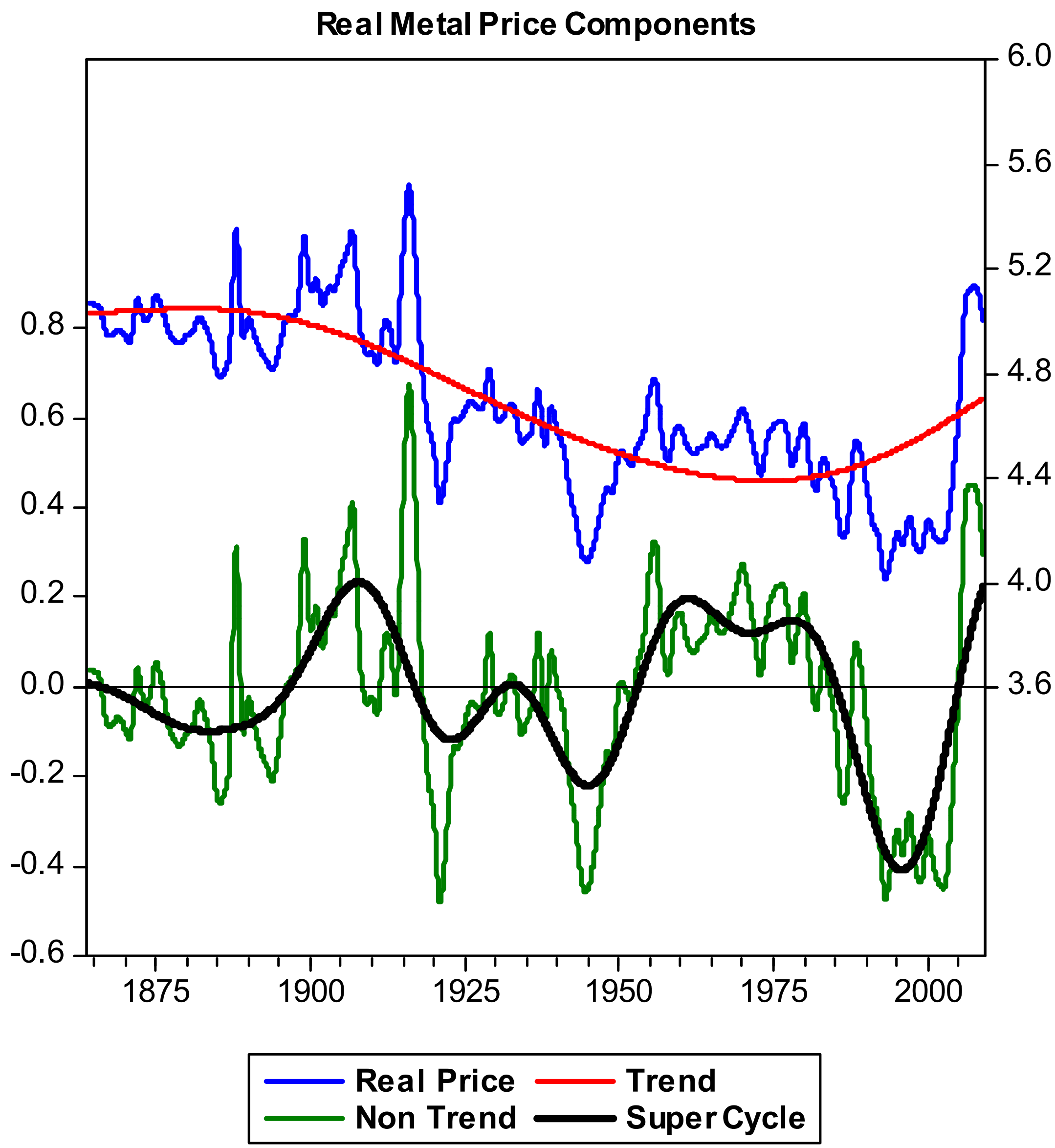
Price Decomposition for Tropical Agriculture



Price Decomposition for Non-tropical Agriculture



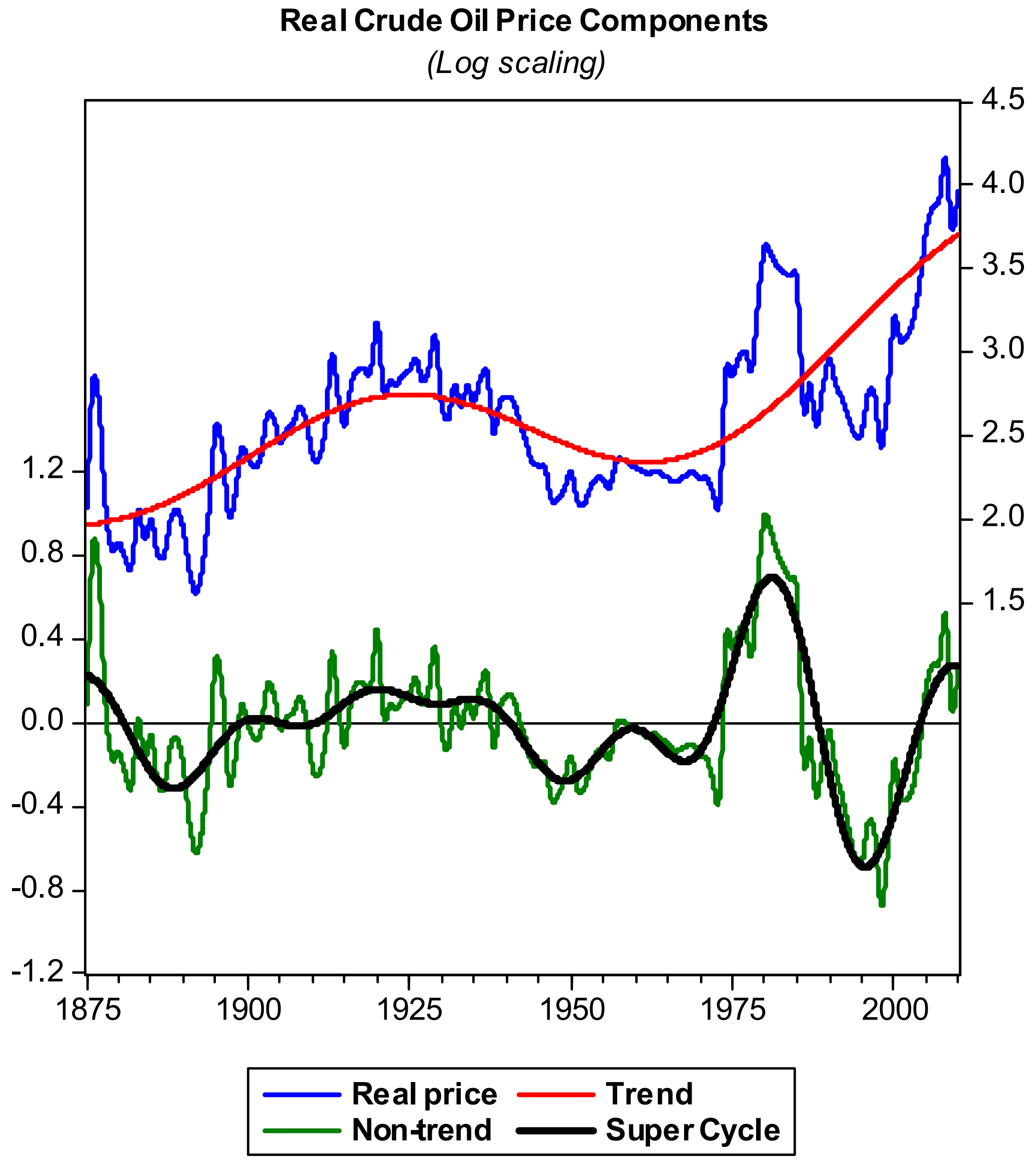
Price Decomposition for Metals



Metal prices

	1885-1921	1921-1945	1945-1999	1999-?
Peak year	1916	1929	1956	2007
Percent rise in prices during upswing	105.7%	66.6%	98.0%	202.4%
Percent fall in prices during downswing	-70.2%	-51.9%	-47.4%	-
Length of the cycle (years)	36	24	54	-
- Upswing	31	8	11	8
- Downswing	5	16	43	-
Mean	**151.6**	**95.7**	**85.2**	**109.3**
Standard deviation	35.7	16.3	14.6	45.9
Coefficient of variation	23.5	17.1	17.2	43.7

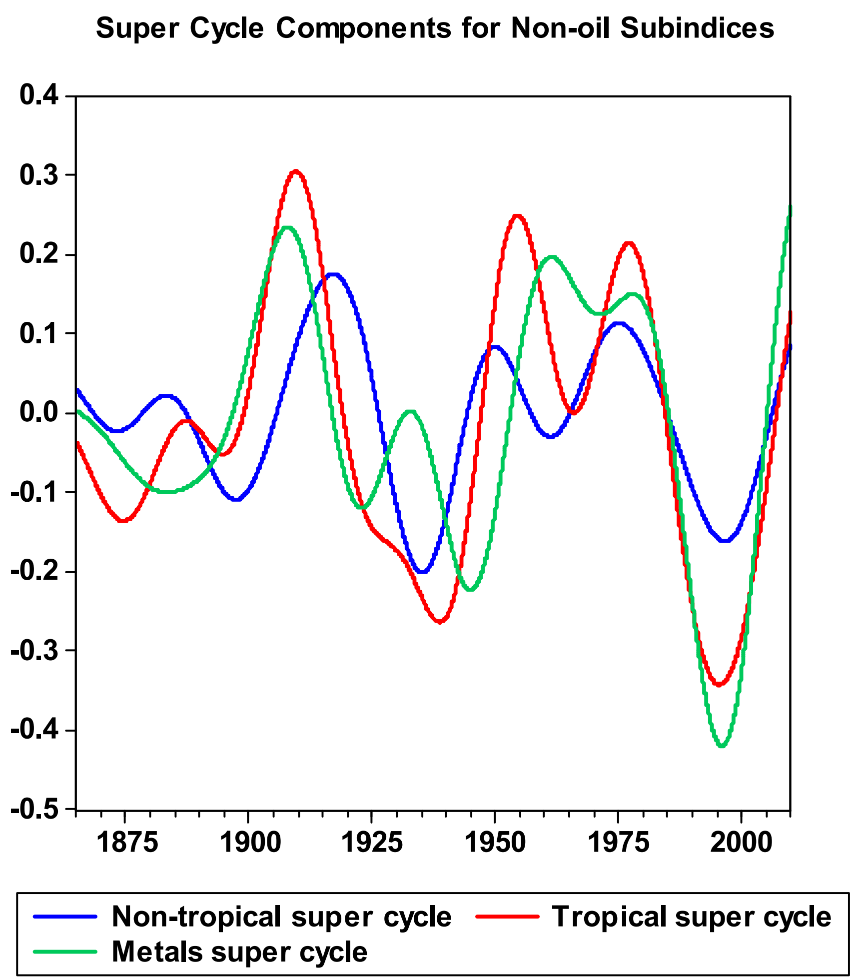
Price Decomposition for Crude Oil

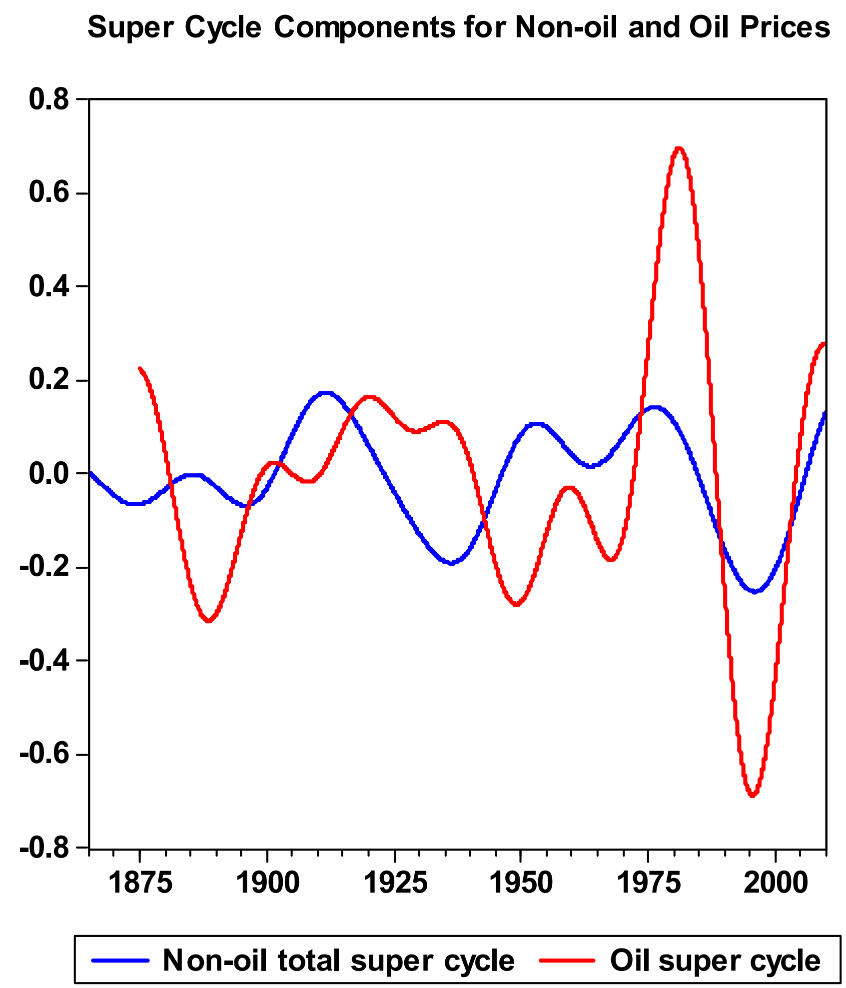


Crude oil prices

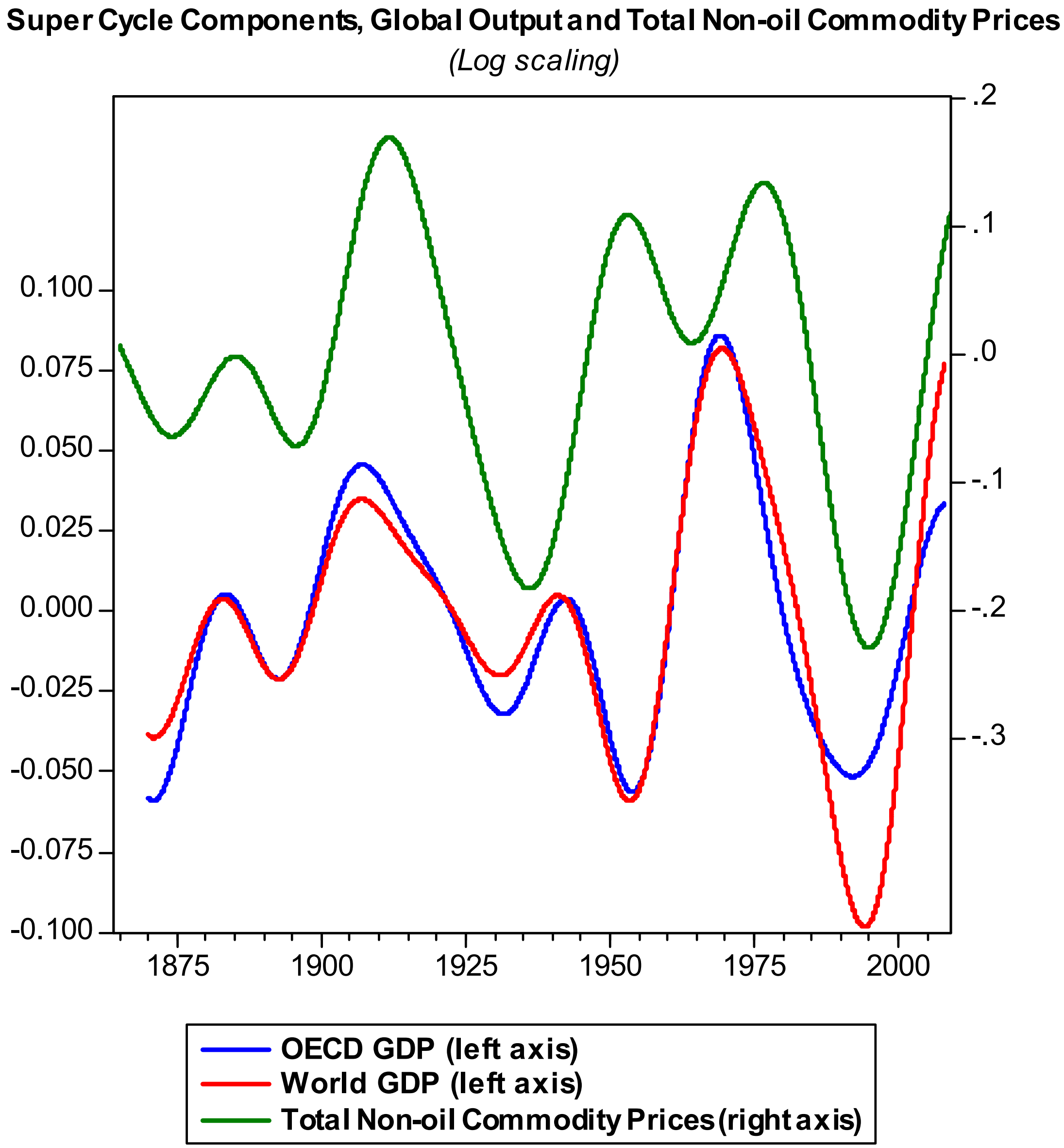
	1892-1947	1947-1973	1973-1998	1998-?
Peak year	1920	1958	1980	2008
Percent rise in prices during upswing	402.8%	27.4%	363.2%	466.5%
Percent fall in prices during downswing	-65.2%	-23.1%	-69.9%	-
Length of the cycle (years)	55	26	25	-
- Upswing	28	11	7	10
- Downswing	27	15	18	-
Mean	**36.9**	**24.8**	**53.2**	**91.2**
Standard deviation	3.9	0.7	8.5	16.4
Coefficient of variation	27.9	7.5	42.0	47.4

Overlapping Super Cycles

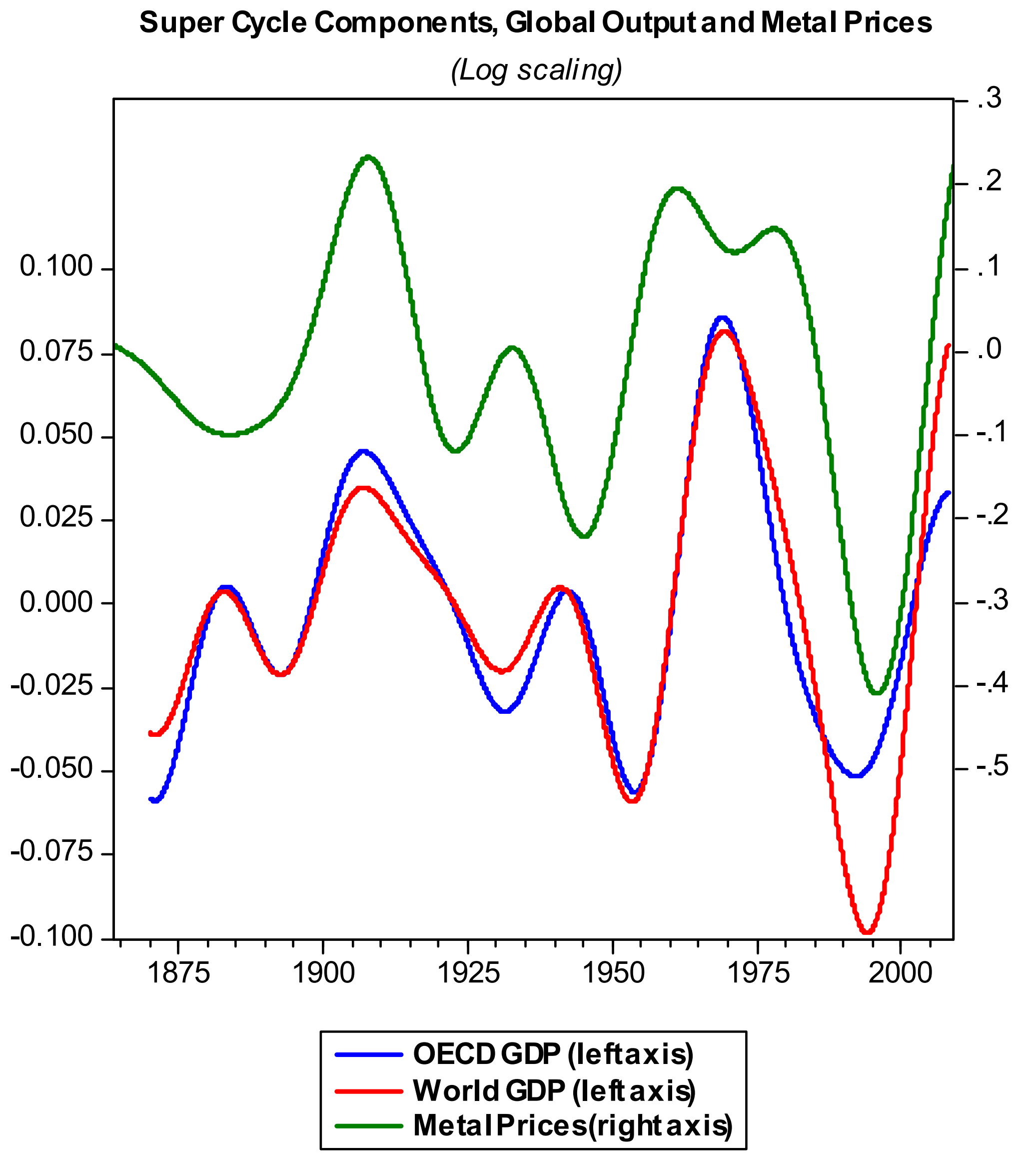




5. Global Output and Commodity Price Cycles



Global Output and Metal Prices



Correlation Coefficients for Super Cycle Comp

	Total	Metals	Total Agr.	Tropical Agr.	Nontrop. Agr.	Oil	OECD GDP	World GDP
Total	1.00							
Metals	0.73**	1.00						
Total Agriculture	0.99**	0.61**	1.00					
Tropical Agriculture	0.94**	0.78**	0.92**	1.00				
Nontropical Agriculture	0.87**	0.37**	0.91**	0.68**	1.00			
Petroleum	0.42**	0.56**	0.34**	0.33**	0.34**	1.00		
OECD GDP	0.53**	0.61**	0.46**	0.43**	0.42**	0.19*	1.00	
World GDP	0.58**	0.73**	0.49**	0.47**	0.44**	0.46**	0.93**	1.00

Cointegration Analysis

- Unit root tests show that all variables are integrated of order one, I (1).
- Johansen likelihood ratio test show that there is a strong evidence of cointegration of world GDP with total agricultural prices and metals
- There is also partial evidence of cointegration for the tropical and non-tropical agricultural prices.
  But for crude oil prices, we cannot reject the null hypothesis of no cointegrating vectors.

ADF and PP tests for unit root

Variable	*ADF*		*PP*	
	Level	*First diff.*	*Level*	*First diff.*
LP (Log of prices)				
Total (LP)	-1.911	-10.072**	-1.643	-12.380**
Metals (LPM)	-2.499	-10.769**	-2.509	-10.976**
Total agriculture (LPA)	-1.795	-10.508**	-1.557	-14.589**
Tropical agriculture (LPT)	-1.553	-11.630**	-1.537	-11.649**
Non-tropical agriculture (LPN)	-2.314	-10.569**	-2.204	-22.031**
Oil (LPO)	-1.873	-10.456**	-1.594	-12.806**
LY (Log of output)				
OECD output (LY1)	0.168	-7.685**	0.483	-7.033**
World output (LY2)	1.626	-7.184**	2.254	-6.833**

Johansen cointegration likelihood ratio test (1)

Trace test				*Maximum eigenvalue test*			
Null hypothesis	*Alternative*	*λ_{trace} stat.*	*Prob.***	*Null hypothesis*	*Alternative*	*λ_{max} stat.*	*Prob.***
Total price and OECD GDP (LP and LY1)							
$r \leq 0$	$r = 1$	14.56	0.068	$r = 0$	$r = 1$	14.54*	0.045
$r \leq 1$	$r = 2$	0.03	0.871	$r = 1$	$r = 2$	0.03	0.871
Total price and World GDP (LP and LY2)							
$r \leq 0$	$r = 1$	18.23*	0.019	$r = 0$	$r = 1$	15.39*	0.033
$r \leq 1$	$r = 2$	2.84	0.092	$r = 1$	$r = 2$	2.84	0.092
Metals and World GDP (LPM and LY2)							
$r \leq 0$	$r = 1$	16.17*	0.040	$r = 0$	$r = 1$	16.08*	0.026
$r \leq 1$	$r = 2$	0.09	0.763	$r = 1$	$r = 2$	0.09	0.763

Johansen cointegration likelihood ratio test (2)

Trace test				*Maximum eigenvalue test*			
Null hypothesis	*Alternative*	λ_{trace} *stat.*	*Prob.***	*Null hypothesis*	*Alternative*	λ_{max} *stat.*	*Prob.***
Tropical agriculture and World GDP (LPT and LY2)							
$r \leq 0$	$r = 1$	15.90*	0.043	$r = 0$	$r = 1$	12.97	0.079
$r \leq 1$	$r = 2$	2.94	0.087	$r = 1$	$r = 2$	2.94	0.087
Non-tropical agriculture and World GDP (LPN and LY2)							
$r \leq 0$	$r = 1$	16.23*	0.039	$r = 0$	$r = 1$	13.27	0.071
$r \leq 1$	$r = 2$	2.96	0.085	$r = 1$	$r = 2$	2.96	0.085
Oil and World GDP (LPO and LY2)							
$r \leq 0$	$r = 1$	10.42	0.250	$r = 0$	$r = 1$	9.50	0.247
$r \leq 1$	$r = 2$	0.92	0.338	$r = 1$	$r = 2$	0.92	0.338

Analysis of error correction models

- The coefficients of the error correction terms indicate unidirectional causality that runs from global output to non-fuel commodity prices without any feedback effect in the long-run – implying that world GDP is a useful predictor of non-fuel prices in LR.
- The error correction term for metals shows that the real metal prices change by 26% in the first year following a deviation from long-run equilibrium. This speed of adjustment is the highest compared to other adjustment rates, implying that the metal prices are particularly sensitive to changes in economic activity in the LR.
- There is also a short-run relationship running from

Results of the Vector Error Correction Model for Non-fuel Commodity Prices and Global Output

	ΔLP_t	$\Delta LY1_t$		ΔLPA_t	$\Delta LY2_t$
ECT_{t-1}	-0.201** (-3.85)	-0.013 (-0.73)	ECT_{t-1}	-0.223** (-4.16)	-0.009 (-0.59)
ΔLP_{t-1}	0.152 (1.75)	0.026 (0.88)	ΔLPA_{t-1}	0.136 (1.58)	0.026 (1.08)
$\Delta LY1_{t-1}$	-0.093 (-0.38)	0.388** (4.66)	$\Delta LY2_{t-1}$	0.107 (0.37)	0.443** (5.49)
	ΔLP_t	$\Delta LY2_t$		ΔLPT_t	$\Delta LY2_t$
ECT_{t-1}	-0.219** (-3.97)	-0.016 (-0.97)	ECT_{t-1}	-0.157** (-3.41)	-0.001 (-0.12)
ΔLP_{t-1}	0.155 (1.77)	0.027 (1.06)	ΔLPT_{t-1}	0.092 (1.06)	0.011 (0.62)
$\Delta LY2_{t-1}$	0.047 (0.17)	0.448** (5.52)	$\Delta LY2_{t-1}$	0.180 (0.45)	0.431** (5.13)
	ΔLPM_t	$\Delta LY2_t$		ΔLPN_t	$\Delta LY2_t$
ECT_{t-1}	-0.256** (-3.91)	-0.003 (-0.24)	ECT_{t-1}	-0.185** (-3.67)	-0.009 (-0.72)
ΔLPM_{t-1}	0.257** (2.78)	0.000 (-0.02)	ΔLPN_{t-1}	0.086 (0.99)	0.026 (1.18)
$\Delta LY2_{t-1}$	-0.010 (-0.03)	0.418** (5.01)	$\Delta LY2_{t-1}$	-0.001 (-0.01)	0.443** (5.67)

Results of the Vector Autoregressive Model for Crude Oil Prices and Global Output

	ΔLPO_t	$\Delta LY2_t$			
ΔLPO_{t-1}	-0.030 (-0.35)	-0.022 ** (-2.05)			

6. Conclusions and Policy Implications

- A major characteristic of commodity prices is 30-40 year-long super-cycles, which tend to overlap significantly across sub-indices (including oil since the 1950s).
- The amplitudes vary between 20-40 percent from long-run trend: tropical agriculture exhibits super-cycles with greater amplitude relative to non-tropical agriculture.
- The mean of each super-cycle for non-fuel commodities has a tendency to be lower than that of the previous cycle, suggesting a step-wise deterioration over the entire period.
- Tropical agriculture experienced a severe long-term downward trend through most of the twentieth century, followed by non-tropical agriculture and metals.
- Real oil prices experienced a long-term upward trend, which was only interrupted during some four decades of the twentieth century

Conclusions and Policy Implications (cont.)

- Since world economic activity is a strong predictor of commodity prices, the ongoing commodity price boom could last only if China and other major developing countries are capable of delinking from slow growth expected in developed countries.
- Commodity-dependent countries should be aware of price cycles, and develop policies to take advantage of the expansionary phases while taking precautionary action against the contraction phases.
- Step-wise deterioration underlines the importance of diversification.
- Supply-side factors associated with resource depletion may have become an additional drivers of prices.
- Investments in commodity futures have also become an important determinant of short-term fluctuations in

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