A Dynamic Analysis of Collusive Action: The Case of the World Copper Market, 1882-2016

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Question: What are the dynamic effects of collusive action?

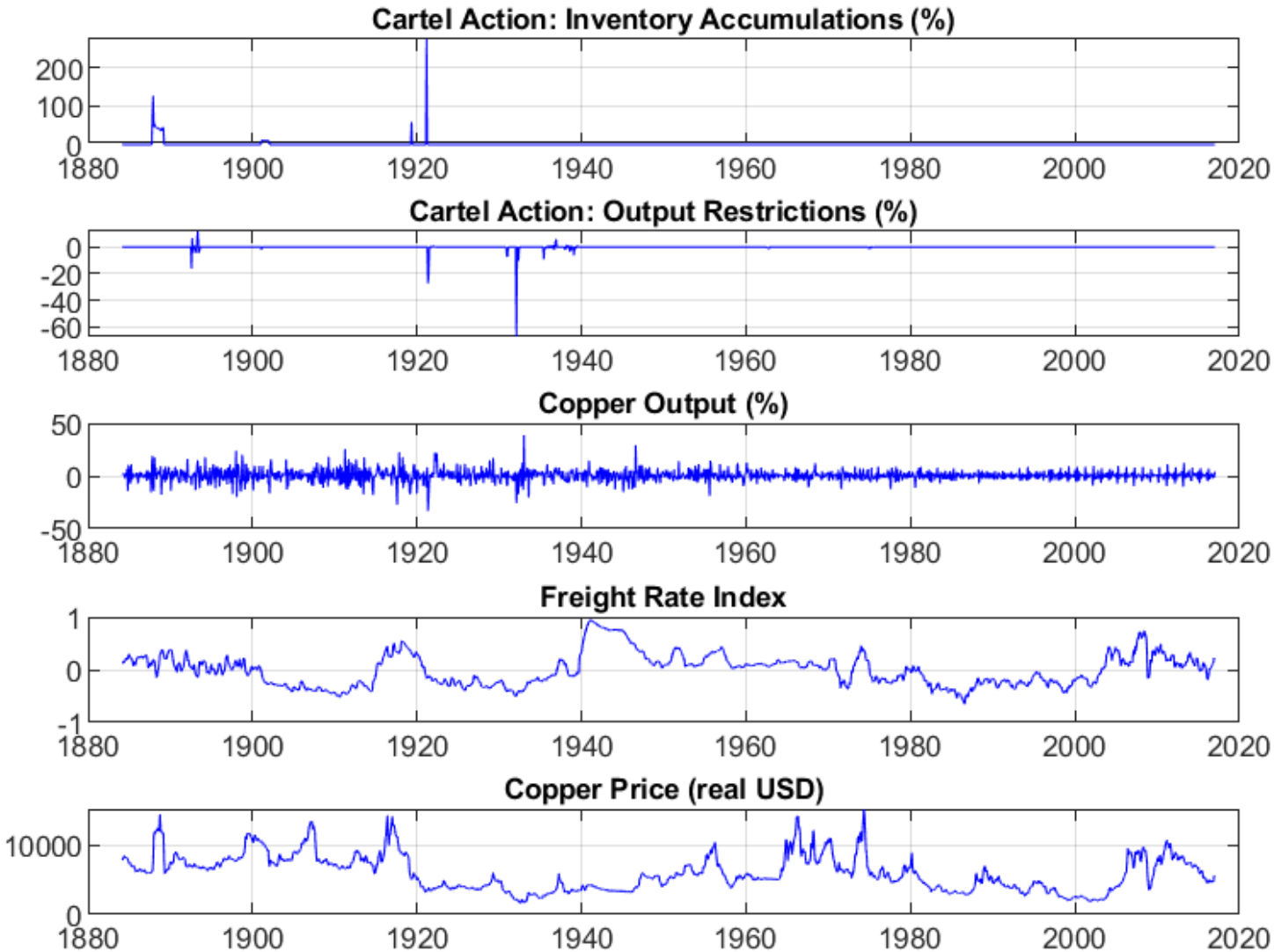
Data: Copper Market, 1882-2016, monthly.

Methodology: Structural Vector Auto-Regressive Model.

Results:

- Strong legacy effects of collusive action.
- Output damage larger than price damage.

Main Variables



Structural VAR Model with Sign Restrictions

Following Faust (1998), Rubio-Ramirez et al (2010) and others:

$$B_0 y_t = B_1 y_{t-1} + ... + B_p y_{t-p} + \Pi^* D_t + B_0 \epsilon_t \ ,$$

- Five endogenous variables $y_t = (\Delta S_t, \Delta R_t, \Delta Q_t, Y_t, P_t)'$:
  - ΔS = cartel inventories (%)
  - ΔR = cartel output (%)
  - ΔQ = world copper output (%)
  - Y = global economic activity index (freight rate index)
  - P = real copper price (2013 USD)

▸ Historical Decomposition

Identification

Shocks:	Cartel Stocks	Cartel Output	World Cu Output	Economic Activity	Real Cu Price
Cartel Stock Manip.	+		+	-	+
Cartel Output Restr.		-	-	-	+
Flow Supply	-	+	-	-	+
Flow Demand	-	+	+	+	+
Other Demand	-	+	+	-	+

Table: Sign restrictions on impact responses. We normalize the potential effects of shocks such that they have a positive impact on price.

Key assumption: Cartel action may lead to price increases; price increases discourage cartel action. ▸ Computation of Damages

Contribution of Cartel Action Shocks to Price

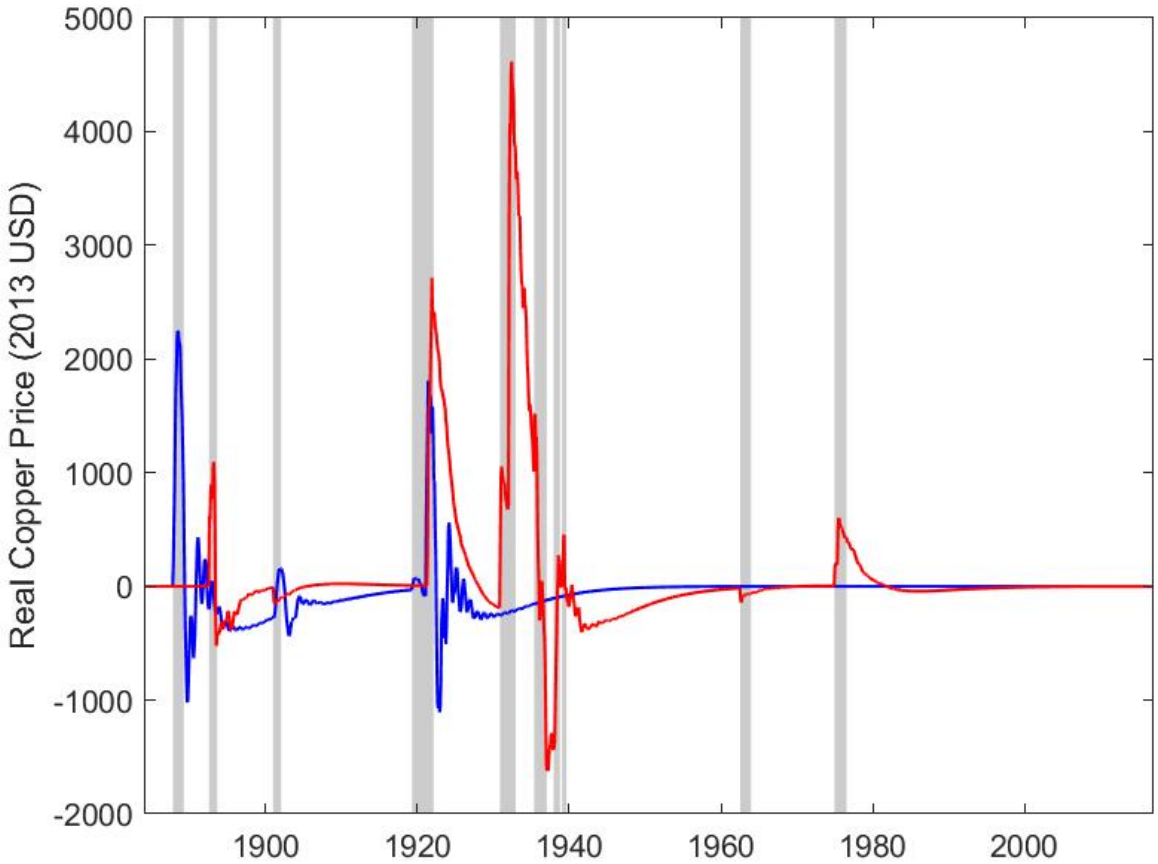


Figure: Contributions of the output restriction shock (red line) and of the stock manipulation shock (blue line) to the real copper price (modal model). ▸ Price Paths ▸ HD all variables ▸ IRFS ▸ Shock Series

Contribution of Cartel Action Shocks to Output

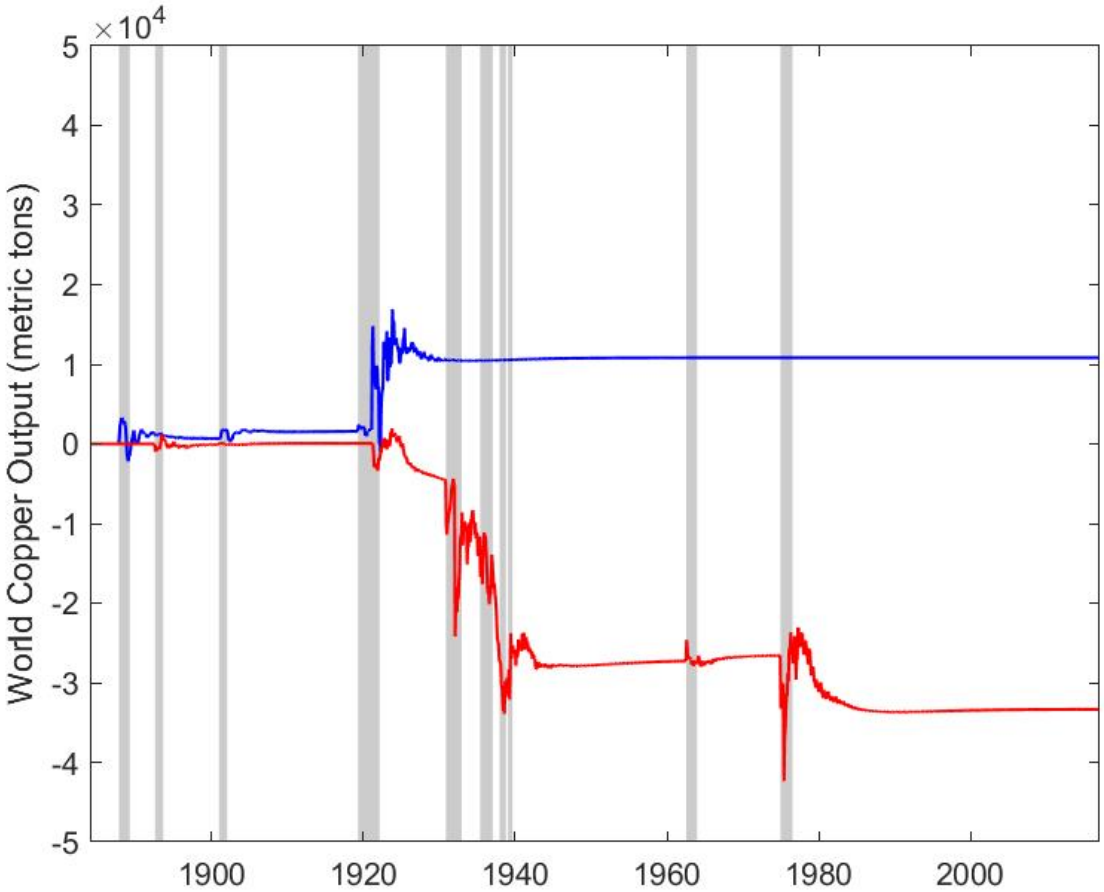


Figure: Contributions of the output restriction shock (red line) and the stock manipulation shock (blue line) to the level of copper output (modal model).

Price Damages

	Output Restr.	Stock Manipul.
Action Periods	-10.3	-3.3
(in bn 2013 $)	[-11.7, -6.6]	[-4.2, -2.3]
Unwinding Periods	-20.3	-5.7
(in bn 2013 $)	[-38.2, -4.0]	[-17.4, 4.0]

Table: Median damage computed based on all admissible models. 68% quantiles in square brackets.

Output Damages

	Output Restr.	Stock Accum.
Action Periods	-1.7	0.9
(in bn 2013 $)	[-2.5, -1.0]	[0.5, 1.4]
Unwinding Periods	-177.7	80.5
(in bn 2013 $)	[-253.5, -98.5]	[3.0, 134.9]

Table: Median damage computed based on all admissible models. 68% quantiles in square brackets

▸ Sensitivity Analysis

Conclusion

- Output damage much larger than price damage.
- Strong legacy effects of collusive action.
- Output-restrictions damage consumers, while collusive stock manipulations benefit consumers over the long run.

Implications:

- Consider output damages and post-cartel periods in anti-trust litigation.
- Studies of output damage in other industries needed.

Collusive Action Periods in the World Copper Market

Collusive Entity	**Time**	**Actions**
Secretan Copper Syndicate	1887-1889	Stock Manipulations
U.S. and European Producers' Ass.	1892-1893	Output Restrictions
Amalgamated Copper Company	1900-1901	Both
Copper Export Association	1919-1922	Both
Copper Exporters Inc/Copper Instit.	1930-1932	Output Restrictions
The International Copper Cartel	1935-1939	Output Restrictions
Production Cuts by U.S. Producers	1962-1963	Output Restrictions
Intergovernmental Council of Copper Exporting Countries (CIPEC)	1974-1976	Output Restrictions

Historical decomposition

Each endogenous variable in y_t can be decomposed according to :

$$\tilde{y}_t = \sum_{i=0}^{t-1} \phi_i B_0^{-1} \epsilon_{t-i} + \sum_{i=0}^{t-1} \phi_i \Pi D_{t-i} + \Gamma_1^{(t)} y_0 + ... + \Gamma_p^{(t)} y_{-p+1}, \quad (1)$$

To compute the but-for paths for copper output $\Delta \tilde{Q}^{BF}$ and price $\tilde{P}^{BF}$

- Replace all unknown parameters by estimators.
- Include all terms except for the respective contributions of the collusive action shocks.

Return

Compute Economic Damages

- We use counter-factual price and output paths to compute damages to consumers.
- We derive the price damage according to:

$$D^P = \sum_{i=1}^{T} (P_t - \exp(\tilde{P}_t^{BF}))Q_t.$$

- Action periods versus unwinding periods.

▸ Computation of output damage ▸ Return

Counterfactual Price Paths

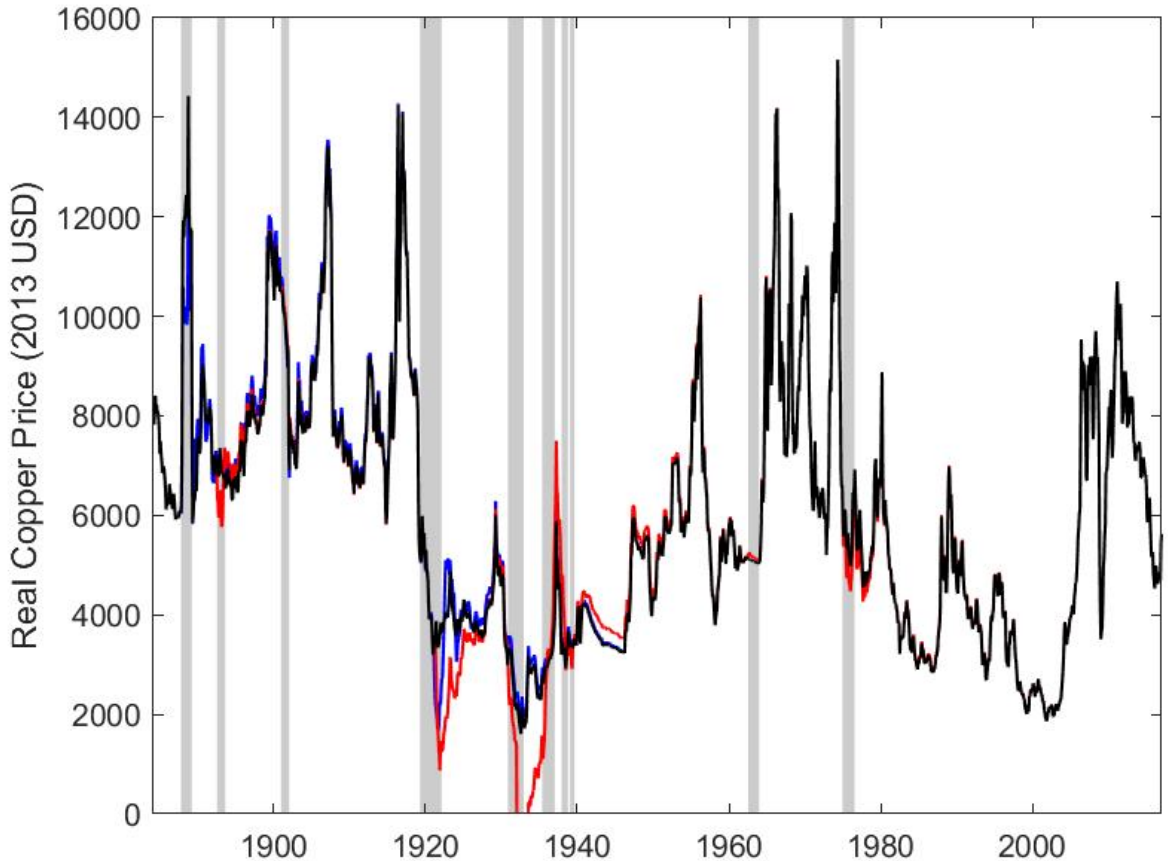
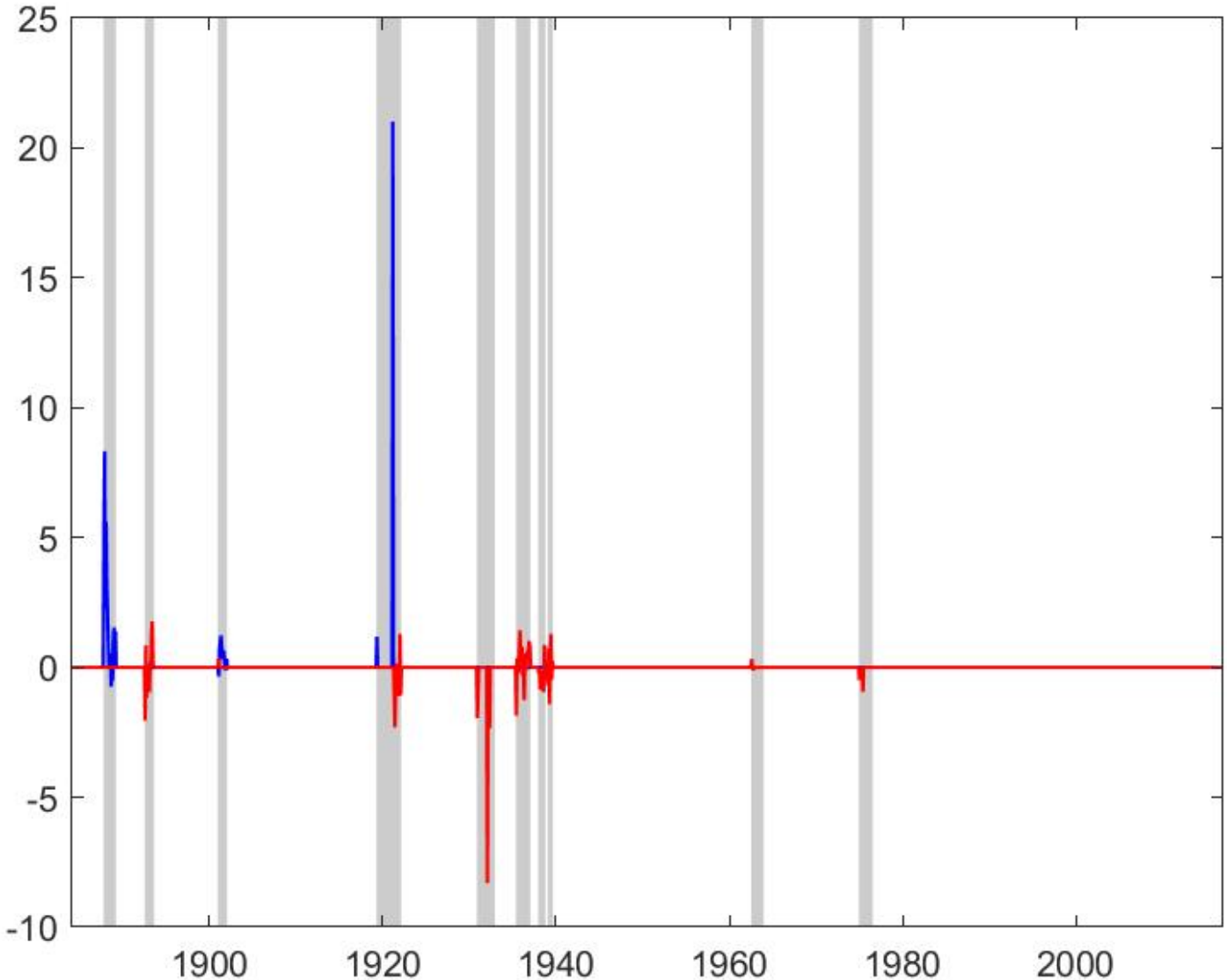
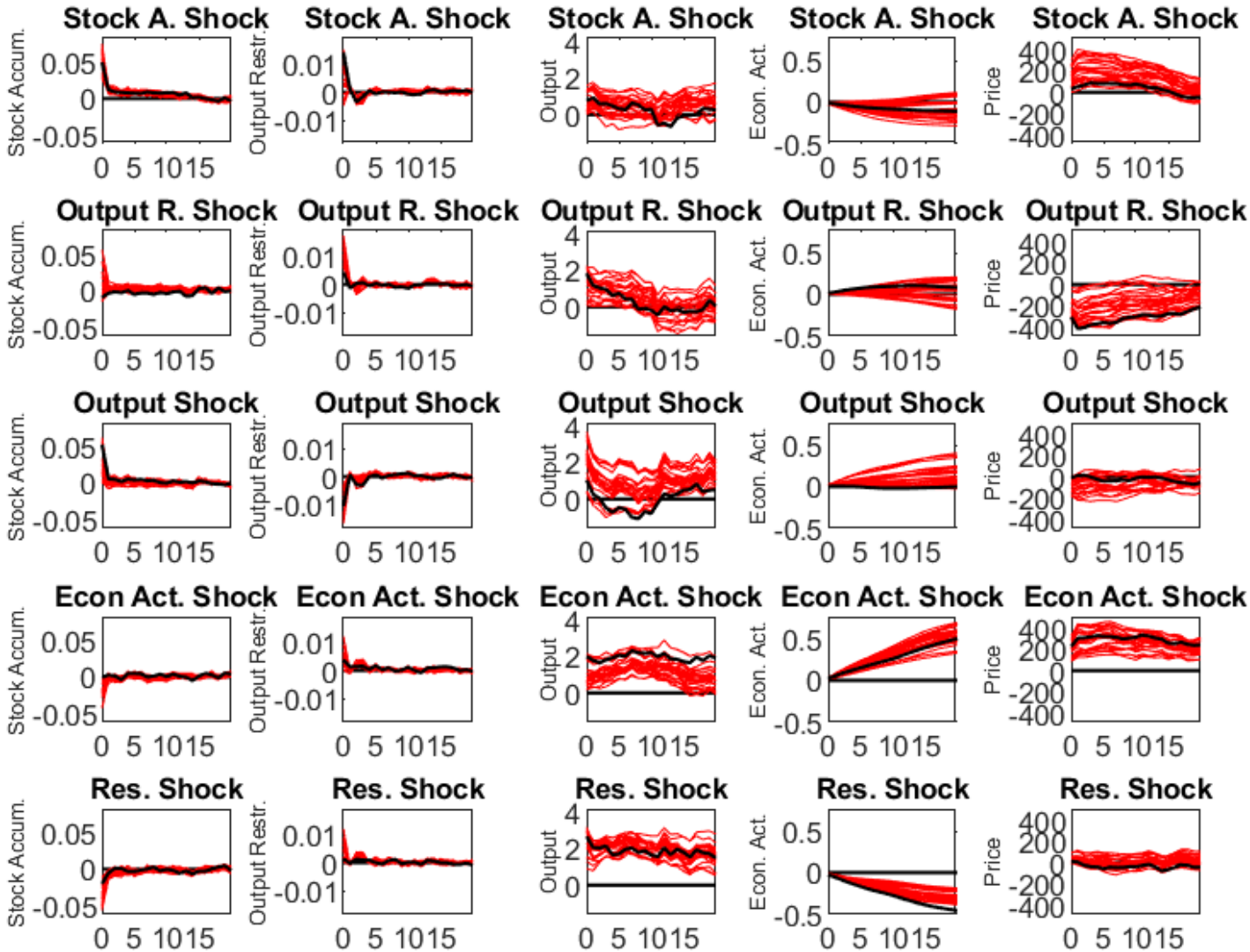
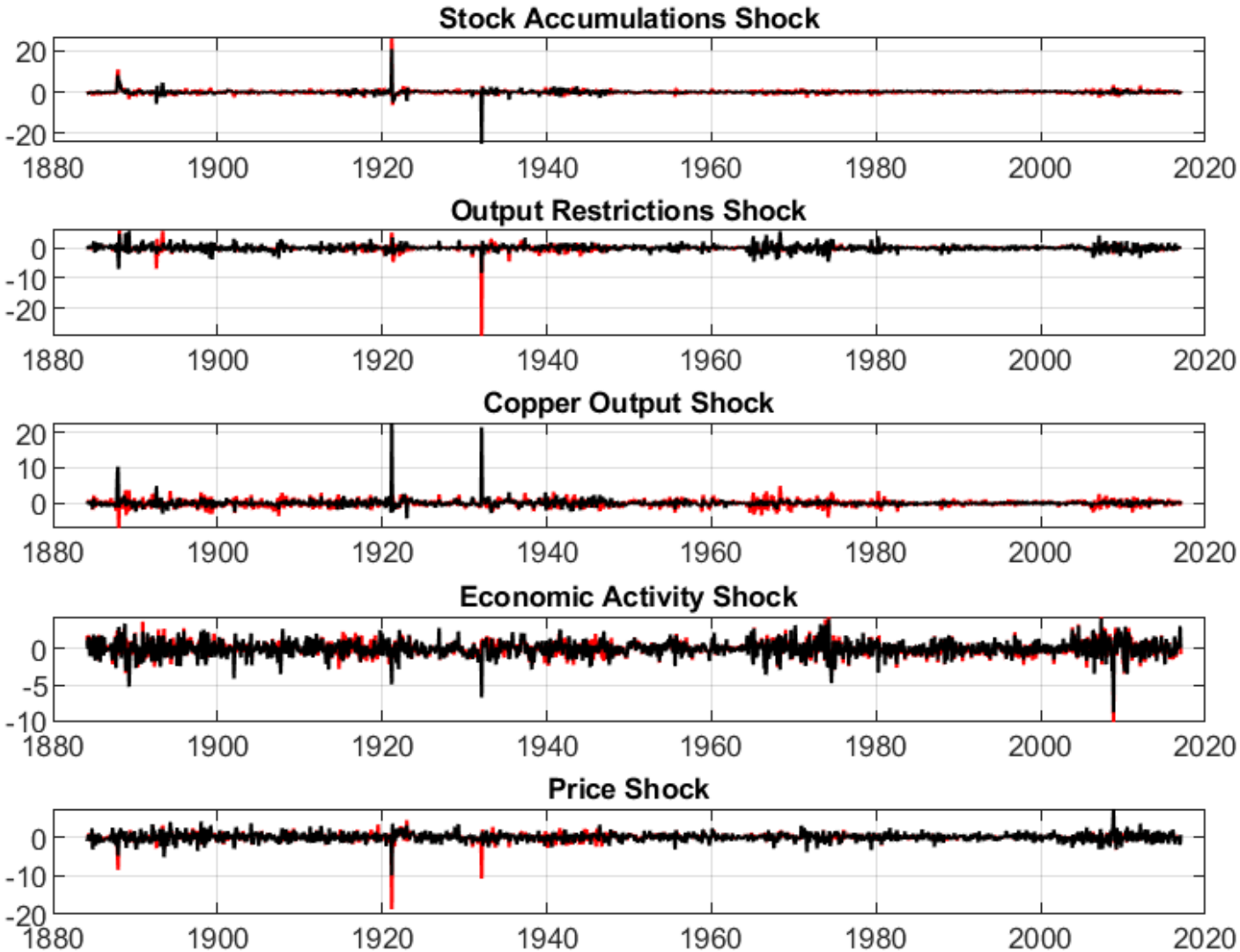
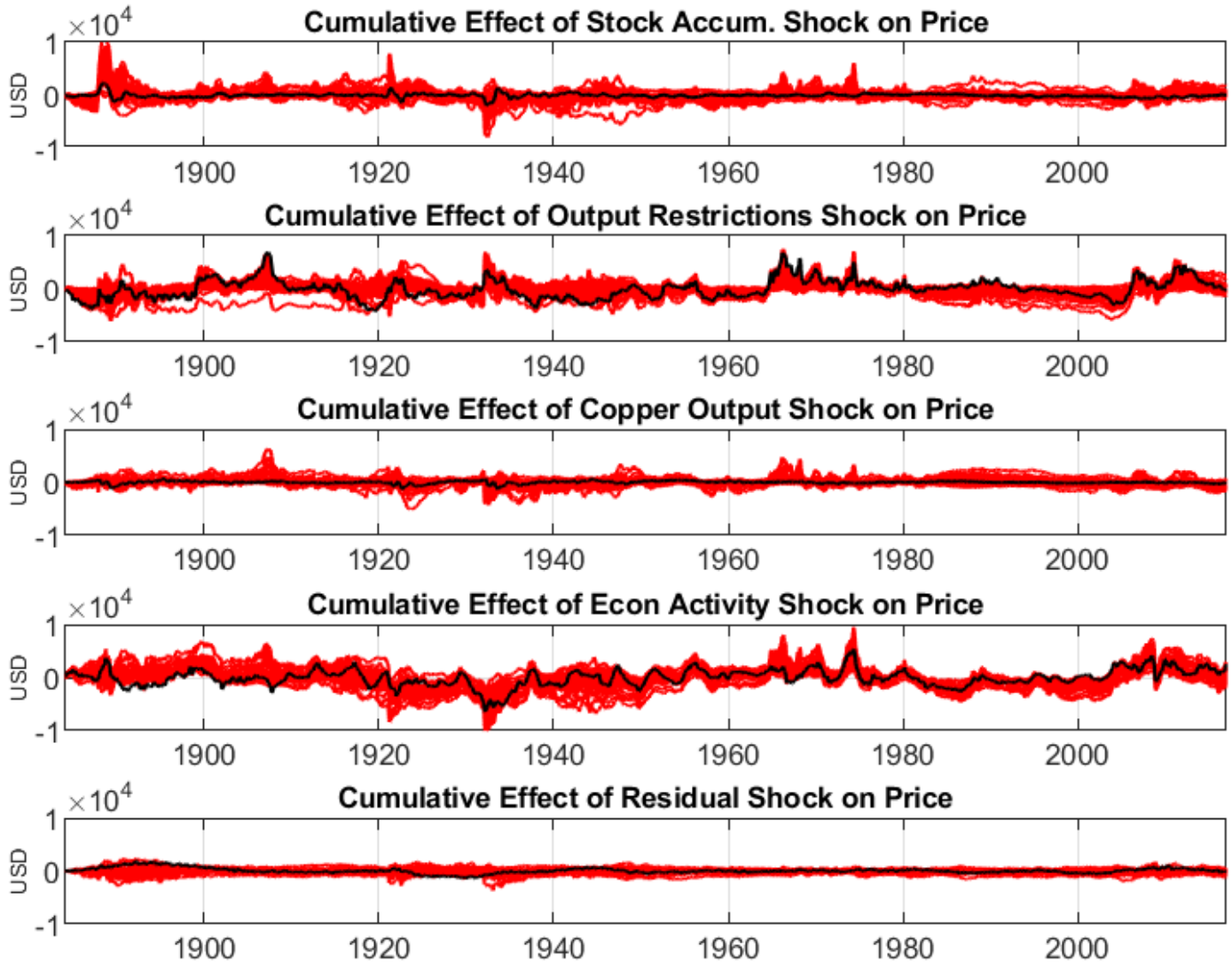


Figure: Actual real price of copper (black line); counter-factual prices without output restriction shock (red line) and without stock manipulation shock (blue line). ▸ Return


25
20
15
10
5
0
-5
-10
1900
1920
1940
1960
1980
2000


Stock A. Shock
Output R. Shock
Output Shock
Econ Act. Shock
Res. Shock
Stock Accum.
Output Restr.
Output
Econ. Act.
Price
0 5 1015


Stock Accumulations Shock
20
0
-20
1880
1900
1920
1940
1960
1980
2000
2020
Output Restrictions Shock
0
-10
-20
Copper Output Shock
20
10
0
Economic Activity Shock
0
-5
-10
Price Shock
0
-10
-20


Cumulative Effect of Stock Accum. Shock on Price
Cumulative Effect of Output Restrictions Shock on Price
Cumulative Effect of Copper Output Shock on Price
Cumulative Effect of Econ Activity Shock on Price
Cumulative Effect of Residual Shock on Price
×10^4
USD
1
0
-1
1900
1920
1940
1960
1980
2000

Computation of Output Damage

- Derive but-for output path in levels first.
- Compute total output damage according to:

$$D^Q = \sum_{i=1}^{T} (Q_t - \tilde{Q}_t^{BF}) \tilde{P}_t.$$

Return

Sensitivity Analysis

Results are generally robust to:

- Different specifications of the cartel variables.
- Using New York instead of London copper price.
- Sub-sample period from 1882 to 1939.
- Using annual data and VARX model.

Return