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Climate Policy Commitment and Green Metal Prices: Evidence from the Paris Agreement

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January 1, 2026

Abstract

Metal markets are an important but understudied aspect of the global energy transition. This paper demonstrates differential metal price responses to the Paris Agreement based on their role in the energy transition. We use a difference-in-differences design with daily price data from 2001 to 2024 for eight industrial metals. The treatment group distinguishes between traditional green metals (Copper, Aluminium, Nickel), which are established in renewable energy infrastructure, versus emerging green metals (Lithium), that are critical for storage. The control group includes non-green metals (Zinc, Lead, Tin, and Iron Ore). We find traditional green metals experienced 31% price decline relative to control metals following the Paris Agreement, while Lithium exhibited a 120% price increase.

Keywords: Paris Agreement, Green Transition, Metal Prices

JEL Classification: Q54, Q58, G14, L72

1 Introduction

The global transition to a low-carbon economy depends on specific industrial metals. Copper, Aluminium, and Nickel are essential for solar panels, wind turbines, and electrical grid expansion, while Lithium is essential for battery technology in electric vehicles. The Paris Agreement, adopted on December 12, 2015, represented an international commitment to climate action, with 196 parties pledging to limit global warming to below 2°C above pre-industrial levels (United Nations Framework Convention on Climate Change, 2015). This event can be expected to impact market expectations about future demand for these metals.

While there is substantial research on climate policy's effects on carbon markets, there is limited evidence on how climate agreements affect the commodity markets that underpin the green transition. Understanding these effects is critical, as metal supply constraints could impede the pace and cost of the energy transition. For instance, Hache, Seck, Simões, Bonnet, and Carcanague (2019) analyze future demand for critical metals including Lithium, Cobalt, Nickel, and Copper under the transition to electric vehicles, highlighting potential supply bottlenecks for battery production.

This paper fills this gap by examining whether the Paris Agreement led to differential price changes for metals based on their role in the green transition. The Paris Agreement is plausibly exogenous to individual metal markets: the timing and content were determined by international climate negotiations, not by conditions in specific commodity markets. While climate policy expectations have evolved over time, the agremeent represented a discrete strengthening of commitments that shifted market expectations about future green technology demand.

We employ a difference-in-differences research design using Bloomberg daily price data from 2001 to 2024 for eight industrial metals. Our treatment group distinguishes between traditional green metals essential to renewable energy infrastructure (copper, Aluminium, Nickel) and emerging green metals critical for battery production (Lithium), while the control group comprises non-green industrial metals (Zinc, Lead, tin, Iron Ore).

We find heterogeneous effects across metal markets. Traditional green metals experienced a 31.7% to 31.8% price decline relative to non-green metals following the Paris Agreement. Lithium instead exhibited a 121% to 122% price premium. These effects are statistically significant and robust to macroeconomic controls including including controls for dollar strength, oil prices, financial market volatility, interest rates, and equity market performance.

These contrasting effects appear to be driven by differential supply responses to anticipated demand increases. When futures prices exceed spot prices (contango), markets anticipate ample future supply. When spot prices exceed futures prices (backwardation), markets expect supply constraints. Examining Copper and Aluminium, we find that the 3-month futures spread showed a significant shift from backwardation to contango following the Paris Agreement. Futhermore, when examining stocks for Copper, we find that Copper stocks declined immediately and substantially following the Paris Agreement. This suggests that markets anticipated supply expansion for traditional green metals. The 121% Lithium premium possibly reflects market anticipation of exponential electric vehicle growth outpacing near-term supply expansion capabilities.

The contribution of our paper is to be the first to provide empirical evidence demonstrating that international agreements can have immediate effects on relevant metal prices, even without binding emissions constraints. Our findings inform the energy transition and green finance literature by showing that for metals associated with the green transition, international commodity markets incorporated expectations about future supply-demand imbalances well before green technology deployment.

The paper proceeds as follows. Section 2 reviews related literature. Section 3 describes our data sources and presents summary statistics. Section 4 outlines our difference-in-differences empirical strategy. Section 5 presents the main results. Section 6 explores the market expectations mechanism through futures term structure. Section 7 discusses implications of our paper and concludes.

2 Literature Review

Research on climate policy evaluation has primarily focused on carbon pricing mechanisms and their effects on emissions and innovation. Comprehensive reviews of carbon pricing policies worldwide document substantial heterogeneity in design and effectiveness (Dechezleprêtre, Nachtigall, and Venmans, 2025). California's cap-and-trade program achieved significant emissions reductions with modest economic costs (Fowlie, Reguant, and Ryan, 2016). The EU Emissions Trading System had positive effects on low-carbon innovation, increasing green patents among regulated firms by 10% (Calel and Dechezleprêtre, 2016). This literature establishes that carbon pricing can reduce emissions and stimulate green innovation, but has not examined effects on commodity markets that supply inputs for green technologies.

Financial markets' responses to climate events and policies have also received substantial attention. Surveys of institutional investors reveal that climate risk is an important consideration in investment decisions, with over 70% of respondents reporting integration of climate considerations into their portfolios (Krueger, Sautner, and Starks, 2020). Climate news risk measures based on textual analysis show that the climate policy factor is priced in the US stock market, with evidence more pronounced over 2012-2018 (Faccini, Matin, and Skiadopoulos, 2023).

Reviews of theoretical and empirical evidence on environmental policy and innovation establish the conceptual foundation for understanding how regulations stimulate R&D expenditures (Jaffe and Palmer, 1997). Germany's feed-in tariff scheme significantly increased innovation in solar and wind technologies, though questions remain about cost-effectiveness (Böhringer, Cuntz, Harhoff, and Asane-Otoo, 2017). Seminal evidence using patent data shows that energy prices induce energy-saving innovation, with innovation responding to price signals across multiple technologies (Popp, 2002). Carbon taxes redirect innovation toward clean technologies, with firm-level evidence from the auto industry showing substitution from dirty to clean patents and path dependence in innovation trajectories (Aghion, Dechezleprêtre, Hémous, Martin, and Van Reenen, 2016). Both energy prices and regulatory standards drive technological change in energy efficiency, with about one-quarter to one-half of improvements associated with rising energy prices since 1973 (Newell, Jaffe, and Stavins, 1999). This strand of the literature establishes that policy induces green innovation, creating demand for metals essential to new technologies.

Our paper contributes to the literature examining how climate policy commitments affect prices for metals essential to the green transition. While previous studies analyze carbon markets, equity returns, and green bonds, no study has examined differential price responses in commodity markets based on metals' roles in renewable energy and electric vehicles.

3 Data

We obtain daily metal price data, from Bloomberg for eight industrial metals. Our treatment group comprises four green transition metals: Copper, Aluminium, Nickel, and Lithium. The control group includes four non-green industrial metals: Zinc, Lead, Tin, and Iron Ore. We also obtain macroeconomic control variables, specifically the USD Index, WTI crude oil prices, the VIX volatility index, the US 10-year Treasury yield, and the S&P 500 index. Finally, we obtain futures prices for Copper and Aluminium, and LME Copper warehouse stocks for the mechanism analysis.

We use London Metal Exchange (LME) daily official settlement prices for traditional green metals—Copper (LMCADY Comdty), Aluminium (LMAHDY Comdty), and Nickel (LMNIDY Comdty)—and for control metals Zinc (LMZSDY Comdty), Lead (LMPBDY Comdty), and Tin (LMSNDY Comdty). For Lithium, we use Lithium carbonate spot prices (L4CNMJGO AMTL Index). For iron ore, we use 62% Fe spot prices (TIO1 COMB Comdty). All metal prices represent spot prices in USD per metric ton. Lithium prices are originally quoted in CNY per ton in the Bloomberg data and are converted to USD per ton using daily CNY/USD exchange rates. All price series are transformed to natural logarithms for the regression analysis.

We construct an unbalanced panel to maximize sample coverage, retaining all available observations for each metal. To address non-trading days and different market calendars across metals, we employ a forward-fill procedure: when a metal market is closed but other markets are open, we carry forward the last available price. This approach ensures temporal alignment across all series while preserving actual price movements when markets are active.

We classify green transition metals into two categories. Traditional green metals (Copper, Aluminium, and Nickel) have been used in renewable energy infrastructure for decades, with established supply chains and production capacity. Copper is essential for electrical wiring in solar panels and wind turbines. Aluminium is used in solar panel frames and transmission lines. Nickel is a key component in rechargeable batteries. Emerging green metals, represented by Lithium, experienced demand growth from electric vehicle adoption, with supply chains still developing to meet battery production needs.

For the mechanism analysis in Section 6, we supplement spot prices with 3-month futures prices for Copper (LMCADS03 Comdty) and Aluminium (LMAHDS03 Comdty) from the London Metal Exchange. The futures term structure provides forward-looking evidence of

Table 1: Summary Statistics

Series	Mean	SD	Min	Max	Observations
Copper	6126.47	2429.85	1318.25	11299.50	6261
Aluminium	2013.16	449.82	1242.50	3877.50	6261
Nickel	16581.26	7607.22	4346.00	54050.00	6261
Lithium	18083.93	18675.44	5538.59	94457.44	3696
Zinc	2163.76	833.78	722.75	4603.00	6261
Lead	1767.35	676.83	402.00	3989.00	6261
Tin	17748.48	8649.81	3601.00	48865.00	6261
Iron Ore	107.36	38.49	38.54	219.77	3696
Dollar Index	91.84	11.00	71.33	120.90	6261
WTI Crude Oil	68.61	28.04	17.68	146.08	6261
VIX	19.70	8.55	9.14	82.69	6261
10Y Treasury	3.16	1.20	0.51	5.51	6261
S&P 500	2140.62	1261.14	676.53	6090.27	6261

Notes: Metal prices are in USD per metric ton. Data sourced from Bloomberg.

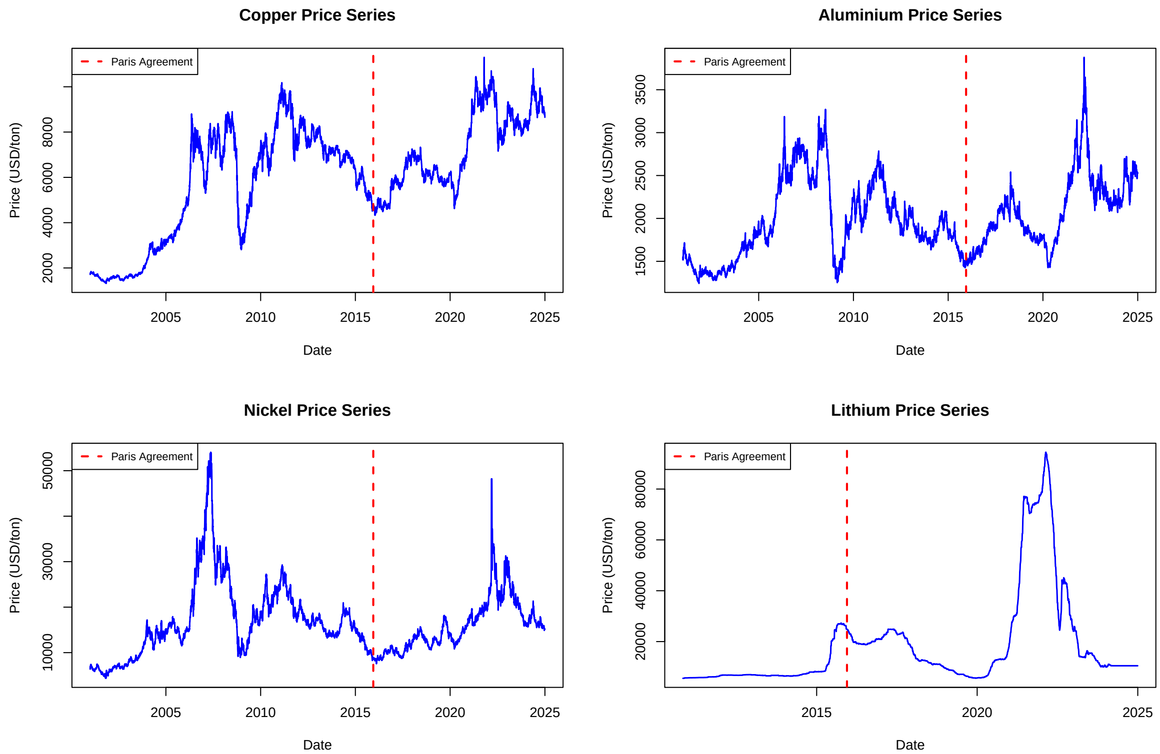
market expectations about future supply-demand balance. We obtain daily LME Copper warehouse stocks (LSCABT Index).

To control for common macroeconomic shocks that affect all commodity markets, we include five daily control variables sourced from Bloomberg. The USD Index (DXY Curncy) captures dollar strength, which mechanically affects all dollar-denominated commodity prices. WTI crude oil prices (CO1 Comdty) control for energy costs that influence mining and processing expenses (Kilian, 2009; Hamilton, 2009). The VIX volatility index (VIX Index) measures financial market uncertainty that can drive commodity price fluctuations through safe-haven effects and risk appetite. The US 10-year Treasury yield (USGG10YR Index) captures interest rate movements that affect commodity demand through economic activity. Finally, the S&P 500 index (SPX Index) controls for equity market performance and overall economic sentiment. All control variables are transformed to natural logarithms except VIX and Treasury yields, which enter in levels.

Table 1 presents summary statistics for all metal prices and macro control variables. Traditional green metals (Copper, Aluminium, Nickel) and most control metals have data spanning the full sample from January 2001 to December 2024 (6,261 observations), while Lithium and Iron Ore have shorter samples beginning in November 2010 (3,696 observations).

Figure 1 displays the time series of green transition metal prices over the sample period. The vertical dashed line marks the Paris Agreement adoption date (December 12, 2015). The figure illustrates the substantial price variation across metals and over time, with Lithium exhibiting particularly dramatic growth in the post-Paris period, while traditional green metals show more moderate price movements.

Figure 1: Green Transition Metal Price Series



Notes: Figure shows daily price series for green transition metals from 2001 to 2024. The vertical dashed line indicates the Paris Agreement adoption date (December 12, 2015). Traditional green metals (Copper, Aluminium, Nickel) have data from January 2, 2001. Emerging green metal (Lithium) has data from November 2, 2010. All prices are in USD per metric tonnes. Data source: Bloomberg.

4 Empirical Strategy

We employ a difference-in-differences research design to identify the effect of the Paris Agreement on green transition metal prices. Our strategy exploits two sources of variation: cross-sectional variation in metals' exposure to green energy demand, and time-series variation induced by the Paris Agreement on December 12, 2015.

Our specification estimates heterogeneous treatment effects for traditional green metals and emerging green metals:

$$\begin{aligned} \ln(P_{it}) = &\beta_1 \text{TradGreen}_i \times \text{Post}_t + \beta_2 \text{EmergingGreen}_i \times \text{Post}_t \\ &+ \beta_3 \text{Post}_t + X_t' \delta + \alpha_i + \gamma_t + \varepsilon_{it} \end{aligned} \tag{1}$$

where $\ln(P_{it})$ is the natural logarithm of the price of metal i on day t. TradGreen_i equals one for traditional green metals (copper, Aluminium, Nickel) and zero otherwise. EmergingGreen_i equals one for Lithium and zero otherwise. Post_t equals one for dates on or after December 12, 2015. Metal fixed effects α_i absorb time-invariant characteristics such as production costs or geological abundance. Year fixed effects γ_t control for common annual shocks including global business cycles and macroeconomic trends.

The coefficients β_1 and β_2 capture the differential price responses of traditional and emerging green metals, respectively, relative to control metals (Zinc, Lead, Tin, Iron Ore) following the Paris Agreement. Under the parallel trends assumption, these coefficients identify the Paris Effect on green transition metal prices. We estimate specifications examining each treatment group separately to isolate individual effects, as well as specifications including both groups simultaneously.

Controls for macroeconomic conditions include five daily variable series sourced from Bloomberg as described in Section 3: the USD Index controls, WTI crude oil prices, the VIX volatility index, the US 10-year Treasury yield, and the S&P 500 index.

Standard errors are clustered at the Metal×Year level to account for two sources of correlation in the error term ε_{it}. First, prices for the same metal are likely serially correlated over time due to persistent supply and demand shocks. Second, prices across different metals may be contemporaneously correlated due to common macroeconomic shocks and general commodity market conditions. Clustering at the Metal×Year level allows for arbitrary correlation within each metal-year combination while assuming independence across these clusters.

Our DiD design requires the assumption of parallel trends, i.e. without the Paris Agreement, green and non-green metals would have experienced similar price trends. We test this assumption by estimating differential pre-trends in the period before December 12, 2015. Specifically, we regress log prices on treatment indicators interacted with a linear time trend for the pre-Paris period. For traditional green metals, we do not find statistically significant divergence from control metals. For Lithium, we find a significant positive pre-trend of 0.287. q

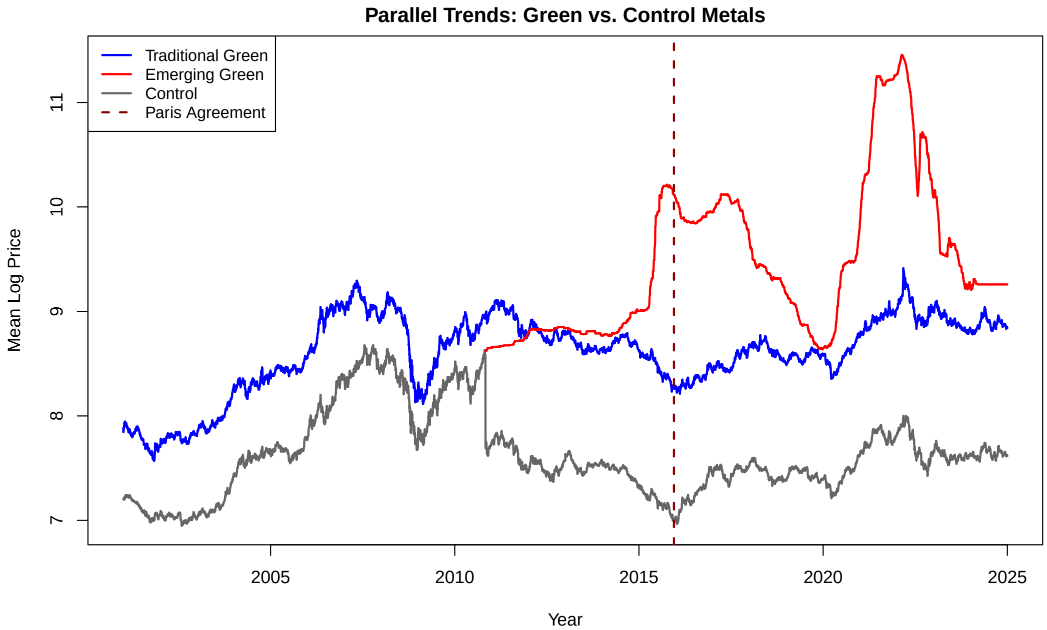
Figure 2 plots the price series, here we can see that traditional green and control metals moved in parallel before 2015, while Lithium exhibited sustained growth throughout the pre-period. The pre-trend for Lithium suggests our DiD estimate may capture both the effect of the Paris Agreement and pre-existing dynamics from early electric vehicle adoption. However, the dramatic acceleration after December 2015 visible in Figure 2 indicates a substantial Paris-Agreement specific component. For traditional green metals, the absence of differential pre-trends supports our interpretation of the estimates.

5 Results

Table 2 presents our main results. We estimate six specifications that separately identify effects for traditional green metals (Copper, Aluminium, Nickel) and emerging green metals (Lithium), with and without macroeconomic controls.

In column (1), we start by estimating the Paris Effect for traditional green metals without macroeconomic controls. We find a coefficient of -0.382 (t = -16.63), indicating that traditional green metals experienced a price decline of 38.2 log points relative to control metals following the Paris Agreement. To interpret the magnitude, we convert the log coefficient

Figure 2: Parallel Trends: Green versus Control Metals



Notes: Figures of mean log prices by treatment group over time. Traditional green metals (Copper, Aluminium, Nickel) and control metals (Zinc, Lead, Tin, Iron Ore) exhibit parallel trends in the pre-Paris period. Emerging green metal (Lithium) shows a significant positive pre-trend. The vertical dashed line marks the Paris Agreement date (December 12, 2015). Data source: Bloomberg.

to a level effect: $\exp(-0.382) - 1 = -0.317$, or -31.7%. This means that traditional green metal prices fell by nearly one-third relative to non-green metals after the Paris Agreement.

In column (2), we add comprehensive macroeconomic controls including the USD Index, WTI oil prices, VIX, Treasury yields, and the S&P 500. The coefficient is essentially unchanged at -0.383 (t = -16.68), confirming the effect is not driven by differential macroeconomic exposure across metals. The stability of the coefficient demonstrates that the Paris Effect operates independently of contemporaneous movements in dollar strength, energy costs, financial market volatility, interest rates, and equity markets.

Columns (3) and (4) examine Lithium. In column (3) without controls, we find a coefficient of 0.795 (t = 34.58). Converting to level effects, this is a 121% price premium. This effect is robust to macroeconomic controls in column (4): 0.798 (t = 34.71), corresponding to a 122% premium. Thus, the Lithium premium represents more than a doubling of its price relative to non-green metals.

Columns (5) and (6) include both treatment groups simultaneously, allowing direct comparison of the contrasting effects. In column (5) without controls, traditional green metals declined by 38.2 log points while Lithium increased by 79.5 log points. These effects remain stable with full macro controls in column (6): -38.3 log points for traditional green metals and 79.8 log points for Lithium. All coefficients are significant at the 1% level.

The contrast between traditional green metals and Lithium is striking. While traditional

Table 2: Difference-in-Differences Estimation: Paris Agreement Effect on Green Transition Metals

	(1)	(2)	(3)	(4)	(5)	(6)
Trad. Green × Post_Paris	-0.382***	-0.383***			-0.297***	-0.297***
	(0.073)	(0.073)			(0.066)	(0.066)
Emerging Green × Post_Paris			0.795***	0.798***	0.668***	0.670***
			(0.254)	(0.254)	(0.256)	(0.256)
log(USD Index)		-1.189***		-1.189***		-1.189***
		(0.196)		(0.196)		(0.196)
log(WTI Oil)		0.163***		0.164***		0.164***
		(0.046)		(0.047)		(0.047)
VIX		0.000		0.000		0.000
		(0.001)		(0.001)		(0.001)
US 10Y Treasury		0.007		0.006		0.006
		(0.017)		(0.017)		(0.017)
log(S&P 500)		0.657***		0.660***		0.662***
		(0.134)		(0.134)		(0.134)
Observations	44,958	44,958	44,958	44,958	44,958	44,958

Notes: Dependent variable is log price. All specifications include metal and year fixed effects with standard errors clustered at the Metal
*times*Year level. Green metals include Copper, Aluminium, Nickel (Traditional Green) and Lithium (Emerging Green). Control metals include Zinc, Lead, Tin, and Iron Ore. Post_Paris is an indicator for dates after December 12, 2015. Columns (1)-(2) focus on Traditional Green metals. Columns (3)-(4) focus on Emerging Green (Lithium). Columns (5)-(6) include both groups separately. Even-numbered columns include full macro controls: log USD Index, log WTI Oil, VIX, US 10Y Treasury, and log S&P 500. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

green metals experienced a 31-32% decline, Lithium exhibited a 121-122% increase. The combined 90-10 spread between these effects (from -32% to +122%) represents a 154 percentage point divergence in price responses. This heterogeneity suggests fundamentally different market expectations about supply responses to anticipated green technology demand.

6 Mechanism

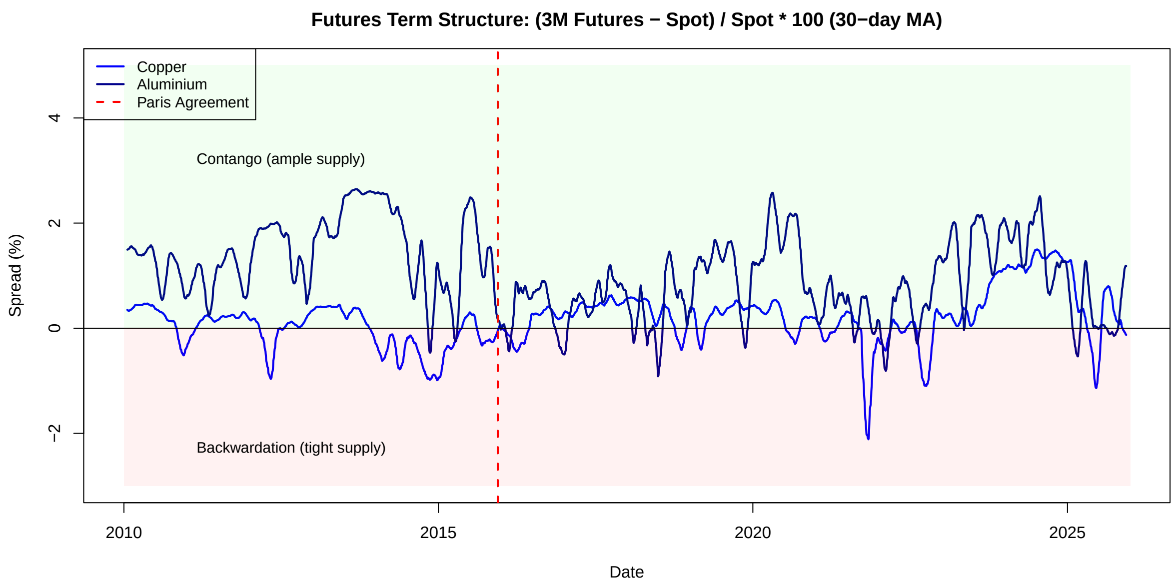
We test whether the contrasting price effects reflect differential expectations about future supply responses. Markets may have anticipated that existing producers of traditional green metals could expand capacity to meet expected demand, reducing supply-side price pressure. Lithium supply chains, being nascent, created expectations of persistent constraints.

We examine this mechanism using futures market data for Copper and Aluminium. The futures term structure provides direct evidence of market expectations about future supply-demand balance. The futures spread indicates whether markets anticipate tightness or abundance. Positive spreads (contango) signal expectations of ample future supply. Negative spreads (backwardation) indicate expectations of supply constraints.

Figure 3 displays 30-day moving averages of futures spreads from 2010 to 2024. Following the Paris Agreement, both metals shifted toward contango, consistent with markets anticipating future supply. This shift is statistically significant (t = -24.13, $p < 0.001$). Copper moved from backwardation to periods of contango.

The transition to contango confirms that markets expected supply expansion to prevent sustained price increases for traditional green metals. The futures evidence shows the post-Paris price decline incorporated rational expectations of future supply adequacy, not actual contemporaneous supply constraints. This mechanism explains why Lithium exhibited the opposite response: Lithium lacked expandable production capacity in 2015 due to nascent supply chains and geographical concentration, creating expectations of persistent supply constraints as battery demand accelerated. The contrasting price effects thus reflect differences in supply elasticity rather than differences in anticipated demand growth.

Figure 3: Futures Term Structure: Market Expectations



Notes: Futures spread calculated as (3-month futures - spot) / spot × 100. Positive values (contango) indicate expectations of ample supply. Negative values (backwardation) indicate expectations of tight supply. The vertical dashed line marks the Paris Agreement (December 12, 2015). 30-day moving average shown. Data source: Bloomberg.

LME Copper warehouse stocks provide direct measurement of physical market tightness following the Paris Agreement. Table 3 presents Copper warehouse stocks across four periods: pre-Paris baseline (2001-2015), immediate post-Paris (2016-2017), medium-term (2018-2020), and long-term (2021 onward).

From the table, we can see that Copper stocks declined immediately and substantially following the Paris Agreement. Average daily stocks fell significantly from 356,626 metric tonnes (MT) pre-Paris to 252,185 MT during 2016-2017, a 29.3% reduction. The drawdown persisted: stocks significantly declined to 216,097 MT during 2018-2020 (39.4% below baseline) and to 149,137 MT post 2021 (58.2% below baseline). We also estimate the mean inventory

Table 3: LME Copper Warehouse Stock Dynamics

Period	Mean Stocks (MT)	Change from Baseline (%)	t-statistic
Pre-Paris (2001–2015)	356,626	—	—
2016–2017 (immediate)	252,185	−29.3	−22.73
2018–2020 (medium-term)	216,097	−39.4	−30.47
2021+ (long-term)	149,137	−58.2	−48.73

Notes: Mean Stocks represents average daily LME warehouse stocks in metric tonnes. t-statistics and p-values from one-sided t-tests testing H_0: Mean stocks post-Paris $\geq$ Mean stocks pre-Paris. Paris Agreement date: December 12, 2015. *** $p < 0.001$. Data sourced from Bloomberg (LSCABT Index).

decline post-Paris Agreement in a simple regression framework with year fixed effects (not shown), and this yields an estimate $\hat{\beta} = -0.460$ (s.e. $= 0.017$), corresponding to a 37% significant level effect.

The combination of falling inventories with persistent contango in futures markets indicates forward-looking market behavior. Low inventories reflect increased physical demand, while contango signals market confidence in future supply adequacy. Had supply expansion been unanticipated, we would observe backwardation as markets scrambled for immediate delivery. The absence of backwardation despite a 29% inventory decline reveals that markets tolerated the drawdown because they anticipated supply responses, consistent with the production acceleration observed 2-3 years post the Pairs Agreement.

7 Discussion and Conclusion

This paper provides empirical evidence that the Paris Agreement triggered differential price responses across metal commodity markets based on metals' role in the energy transition. Using a difference-in-differences design with daily price data from 2001 to 2024, we find heterogeneous effects across metal markets. Traditional green metals (Copper, Aluminium, and Nickel) declined by 31.7% to 31.8% relative to control metals following the Paris Agreement. Lithium exhibited a 121% to 122% premium. These effects are statistically significant and robust to including macroeconomic controls.

The contrasting effects appear to reflect differential supply elasticities. Traditional green metals had established production capacity that could expand to meet anticipated demand, leading markets to incorporate expectations of adequate supply. Lithium supply chains were still developing in 2015, creating expectations of persistent constraints as battery demand accelerated. The large magnitudes demonstrate that commodity markets rapidly incorporated forward-looking assessments of supply-demand imbalances induced by climate policy commitments.

Our findings have three implications. First, international climate agreements can have market effects even without binding emissions constraints, as policy commitments alter expectations and induce forward-looking behavior in these metal commodity markets. Second, the heterogeneous effects highlight the importance of supply-side policies to complement demand incentives for green technologies. Lithium's 121% premium indicates that supply constraints could impede the pace and increase the cost of the energy transition, suggesting a role for policies accelerating mining capacity expansion and mineral processing infrastructure to match global emission targets. Third, the divergent price effects imply differential profit opportunities. Countries rich in Lithium resources may capture economic rents from the green transition, while traditional green metal producers face price pressures from supply expansion.

Future research could extend our analysis in several directions. First, examining whether similar effects occurred for other commodities essential to the green transition would test generalizability of our results. Second, analyzing how mining companies' equity prices responded to the Paris Agreement could reveal market expectations about which firms would benefit. Third, investigating whether previous climate policy developments induced similar metal price responses would help identify which types of policy commitments most effectively shift market expectations and to what extent.

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