

Tungsten Resilience Intelligence

Integrating Structural Supply Insight with Global Market-Price Signals

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Executive Summary

Key Findings

1 **The Western and Chinese tungsten markets have split.**

On October 26, 2026, Rotterdam APT traded at 3.74 times China ex-works APT, against an average of 1.24 times from September 2021 to June 2025.

2 **The risk index flagged the 2024–2025 tungsten case early and passed a control test.**

MetalMiner's tungsten risk index crossed 70 about 270 days before China's February 2025 export controls, while the index for molybdenum, named in the same announcement, stayed normal throughout 2025.

3 **Procurement mandates are the only tested U.S. lever with a measurable effect, and the result is borderline.**

After 11 past procurement actions, the premium for non-Chinese APT widened about 28% over 12 months, against about 7% on random dates (p=0.05). That provenance premium should be budgeted as a cost of the policy.

4 **Tariffs did not measurably move the western premium.**

After 14 tariff episodes, the premium widened about 11% over 12 months, against about 7% on random dates (p=0.31).

5 **The 2026 tungsten scrap allocation order risks reducing U.S. supply.**

Conversion capacity, not scrap, is the constraint, and the United States is a net importer of tungsten scrap, so the inbound flow at risk is more than twice the outbound flow the order retains.

Context

Tungsten resilience requires both a structural understanding of supply and a continuous view of how supply conditions are expressed in physical markets. Structural analysis establishes the foundation: supply-chain configuration, production context, concentration, bottlenecks, end-use exposure, and long-term vulnerability. MetalMiner adds a market-observation layer, its Signal Layer. Its global tungsten price portfolio tracks whether those underlying conditions may be becoming active in prices, regional premiums, product-form spreads, secondary-material markets, and risk signals.

> *Structural insight establishes the risk context; market prices monitor the risk in motion.*

As of late October 2026, tungsten market evidence points to compliance-driven market segmentation rather than a uniform, simultaneous shortage across every tungsten product. It shows persistent dislocation between China-origin and Rotterdam APT, elevated index scores in China FOB APT, Chinese FOB tungsten oxide, and African alternative-origin ore, and normal readings in several China-origin intermediate and downstream references.

The approaching January 1, 2027 U.S. defense-procurement restriction on covered China-sourced tungsten makes this segmentation more consequential. Under 10 U.S.C. §4872, DFARS 252.225-7052, and Executive Order 14415, compliance and waiver conditions increasingly elevate the importance of traceability through mining, feedstock, recycling, refining, conversion, and component production. The relevant market question is therefore no longer only “What is the tungsten price?” It is “What is the price and availability of traceable, qualifying tungsten material in the required form and delivery geography?”

This paper also examines how specific policy levers affect tungsten markets. Based on MetalMiner geopolitical disruption analyses, U.S. measures have had little measurable effect on the headline price, and at least one, the 2026 U.S. scrap allocation order, carries a risk of reducing the domestic scrap supply it was meant to protect, a risk BIS itself recognizes in its exception criteria (Section 7).

1. Tungsten and U.S. National Security

Tungsten is a national-security material because its exceptional hardness, density, high-temperature performance, and wear resistance are embedded in the industrial base that produces and sustains military capability. Tungsten carbide cutting tools are fundamental to machining the metals, superalloys, and precision components used throughout defense manufacturing. Tungsten also supports high-performance alloys, penetrator applications, wear parts, thermal-management uses, and specialized components associated with missiles, jet aircraft, naval systems, armored platforms, munitions, and other defense equipment. For the Department of War and the military departments, tungsten risk is therefore not limited to the price of a raw material. It is a question of whether traceable, qualifying tungsten can remain available to the machine shops, component manufacturers, and prime contractors that underpin readiness, production capacity, and sustained operations.

This is why market-price dislocation matters. A disruption in tungsten availability can appear first as a regional premium, a widening product-form spread, or a tightening secondary-material market, before it

becomes visible as delayed production, constrained tooling, or a reported defense supply-chain shortfall.

2. Market Prices and Structural Analysis

Structural supply analysis and market-price intelligence answer different questions and work best together. Structural analysis identifies where supply concentration, conversion bottlenecks, investment gaps, and other vulnerabilities may create risk. Market prices show whether those conditions are becoming active, through regional premiums, product-form spreads, alternative-origin feedstock repricing, and tightening secondary-material markets. A transparent price record that preserves each price's history, transaction basis, market location, and point-in-time risk reading can prompt earlier and more proportionate decisions on investment, qualification, recycling, inventory, and supplier diversification. It does not replace legal compliance review, structural analysis, supplier qualification, or policy judgment; it shows when those tools should be engaged.

Layer	Contribution	Decision question
Structural supply foundation	Maps supply configuration, production context, concentration, bottlenecks, demand exposure, and long-run resilience conditions.	Where is tungsten resilience exposed, and why?
Market-price observation	Observes physical-market prices across tungsten forms, locations, and commercial bases.	How are supply conditions appearing in markets today?
Signal layer	Scores trend, volatility, complex breadth, market dislocation, support/resistance, and persistence point-in-time.	Is observable market risk intensifying, stabilizing, or receding?
Resilience decision support	Classifies each series as normal (below 70), elevated (70 and above), or critical (85 and above) and tracks how long elevated episodes last.	When is deeper review warranted?

> *S&P-style structural analysis identifies where supply concentration, conversion bottlenecks, investment gaps, and other vulnerabilities may create risk. MetalMiner's market-price architecture monitors whether those conditions are becoming visible in actual physical-market behavior.*

3. The January 2027 Procurement Deadline and the Provenance Premium

Effective January 1, 2027, restrictions governing covered tungsten procurement for U.S. defense applications become more consequential under 10 U.S.C. §4872 and DFARS 252.225-7052. The restriction applies to covered material mined, refined, separated, melted, or produced in a covered country. Executive Order 14415 further tightens the waiver environment and reinforces supply-chain due diligence.

This creates the potential for a provenance premium: a market difference between the headline price of tungsten and the price of demonstrably traceable material that can satisfy applicable procurement, supplier, and component requirements. Market prices cannot certify compliance; that requires legal, contractual, and supplier documentation. They can show where sourcing, conversion, and delivery conditions may be separating across regions and forms.

> *For covered defense applications, the relevant tungsten price may increasingly be the price of qualifying, traceable material, not the lowest observable origin-market quote.*

Legal authorities for final citation: 10 U.S.C. §4872; DFARS 252.225-7052, *Restriction on the Acquisition of Certain Magnets, Tantalum, and Tungsten*; and Executive Order 14415. Final compliance interpretation should be reviewed by qualified counsel.

4. MetalMiner's Global Tungsten Market-Price Architecture

Of MetalMiner's 52 series covering materials under Executive Order 14415, 23 are tungsten-related market-price and market-trade series. The portfolio covers upstream ore, intermediates, processed material, ferro-alloys, secondary supply, China-origin markets, African feedstock, Rotterdam warehouse pricing, and China/Vietnam trade context.

Physical-market layer	Core data elements	Resilience use
Ore and concentrate	WO_3 50% FOB Africa; WO_3 55% ex-works China; China and Vietnam ores-and-concentrates indicators.	Alternative-origin feedstock and trade-flow context.
Intermediates	APT 88.5% ex-works China, FOB China, Rotterdam warehouse; tungsten oxide 99.95%; sodium tungstate.	Origin-to-delivered dislocation and conversion-stage pressure.
Processed products	Tungsten powder, tungsten carbide, W-4 tungsten bar, and thoriated tungsten electrode.	Transmission of upstream stress into industrial forms.
Ferro-tungsten	70% and 75% China references; 75% Rotterdam warehouse reference.	Alloy-market stress and China-to-Europe dislocation.
Secondary supply	Grinding swarf, drill scrap, CNC cutting-blade scrap, and high-grade THA scrap, all delivered China.	Recycling response and competition for alternative feedstock.

5. Current Market Conditions: October 2026

The following prices are reported in U.S. dollars. Prices are spot assessments as of October 26, 2026, and index readings are as of October 27, 2026. Monthly figures elsewhere in this paper are calendar-month averages, through September 2026; Figures 2, 4, and 5 show October 2026 month-to-date. Each price retains its original market specification and basis.

Index methodology and signal framework: The system evaluates individual series against historical performance on a 0–100 scale, classifying readings below 70 as normal, 70 and above as elevated, and 85 and above as critical. The status column gives that classification and, for readings of 70 and above, when the current elevated episode began. Signal outputs establish conditioning metrics rather than price forecasts.

Market reference	Current price	Risk index	Status	Interpretation
China FOB APT, 88.5%	$183.98/kg	76.8	Elevated since June 2025	The highest current reading across the tungsten complex; export-basis APT is the most acutely stressed series tracked.
China FOB tungsten oxide, WO_3 99.95%	$180.22/kg	75.9	Elevated since May 2025	Export-basis oxide pricing is tracking the APT dislocation closely.
African FOB tungsten ore, WO_3 50%	$200.77/kg	72.9	Elevated since May 2025	Alternative-origin feedstock is near the top of its recent range.
China FOB tungsten bar, W-4 99.9%	$180.47/kg	50.4	Normal	Finished tungsten reference has eased back to normal.
China drill scrap	$79.69/kg	57.9	Normal	Secondary material has eased back to normal.
China CNC cutting-blade scrap	$67.66/kg	58.3	Normal	A second scrap grade confirming the drill-scrap reading is not isolated.
Sodium tungstate, WO_3 68% ex-works	$63.53/kg	57.7	Normal	This upstream chemical intermediate has eased back to normal.
Rotterdam warehouse APT, 88.5%	$278.22/kg	53.6	Normal	Delivered APT is materially separated from China-origin APT.
China FOB tungsten carbide	$160.42/kg	60.4	Normal	Export-basis carbide has eased back to normal.
China ex-works ferro-tungsten, 70%	$72.55/kg	58.6	Normal	Eased back to normal, in line with the 75% reference below.
China ex-works tungsten oxide, WO_3 99.95%	$88.71/kg	60.3	Normal	The oxide precursor to APT and metal powder has eased back to normal.
China grinding-swarf scrap	$74.43/kg	58.6	Normal	Secondary feedstock has eased back to normal.
China ex-works ferro-tungsten, 75%	$74.80/kg	59.0	Normal	China alloy reference remains comparatively orderly.
China ex-works APT, 88.5%	$74.43/kg	59.7	Normal	China-origin intermediate market remains comparatively contained.
China ex-works tungsten powder	$114.27/kg	58.2	Normal	No equivalent elevated reading in this downstream form.
Rotterdam warehouse ferro-tungsten, 75%	$160.42/kg	57.7	Normal	Still materially above the China ex-works reference.
China ex-works tungsten carbide	$108.26/kg	58.9	Normal	No equivalent elevated reading in this downstream form.

China FOB (export-basis) APT carries the highest current risk index reading in the tracked family, at 76.8, below the system's critical threshold of 85, in an elevated episode that began on June 3, 2025, with a five-day change of -1.6. Its leading drivers are trend change and cross-market spread, both scoring 99, meaning the signal is driven less by the series' own volatility than by how far it has separated from its own history and from the rest of the complex. That separation sits specifically in the export channel: this FOB (export) reading is 17.1 index points above the China ex-works (domestic) reading of 59.7 for the same 88.5% min specification, a gap between otherwise identical material that differs only on a customs basis. For market participants sourcing outside China, that split indicates the acute stress is concentrated in the price they actually transact against, not spread evenly across the Chinese domestic market. The Signal Layer view below (Figure 1) shows how that gap has grown over the trailing three years.

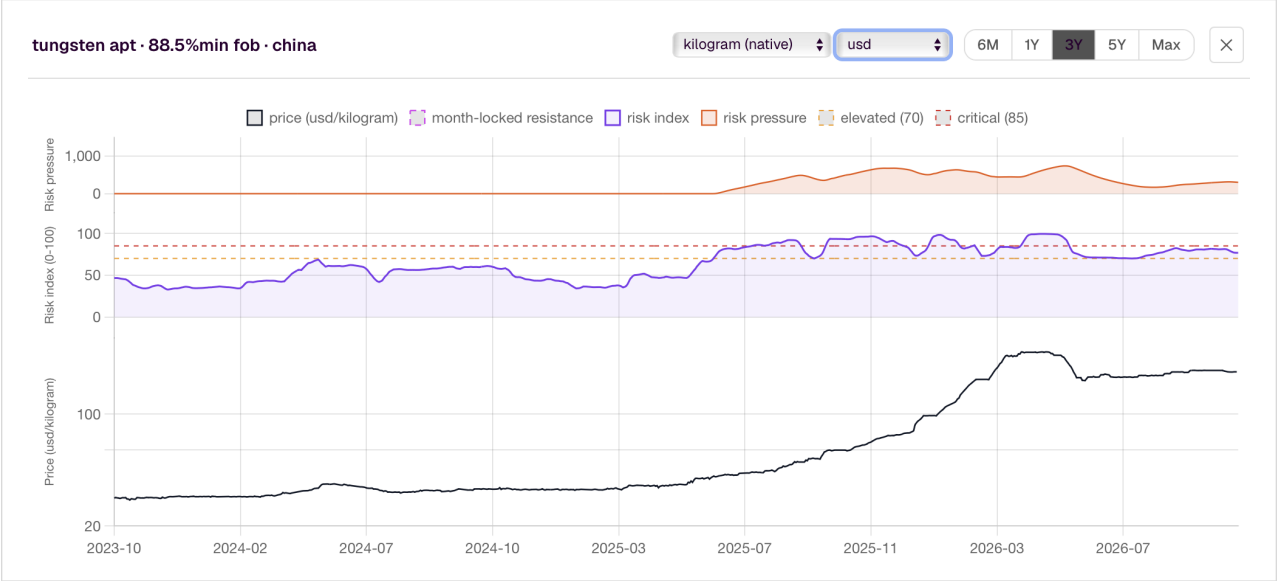


Figure 1. Signal Layer view, China FOB tungsten APT (88.5% min), the highest-scoring series in the tracked family (index 76.8). Top: risk pressure (accumulated, experimental). Middle: risk index (0–100) with elevated and critical thresholds. Bottom: price (USD/kilogram). Source: MetalMiner Market Signal, Signal Layer Series Explorer.

The strongest current cross-region indicator is the APT relationship. On October 26, Rotterdam warehouse APT at $278.22/kg was $203.79/kg above China ex-works APT at $74.43/kg, a 274% premium and a 3.74x Rotterdam-to-China multiple. That multiple averaged 1.24 times from September 2021 to June 2025 and did not break out until April 2026: between March and September 2026, using monthly averages, China ex-works APT fell 58% while Rotterdam APT rose 39%. This is not proof of a compliance premium, shortage, or single causal mechanism. It is strong evidence that the China-origin and delivered-European APT markets are not behaving as one integrated market. The single highest current reading in the tracked family, however, is China FOB APT at 76.8, the export-basis price rather than the domestic ex-works reference, consistent with the export-channel stress the rest of this paper addresses.

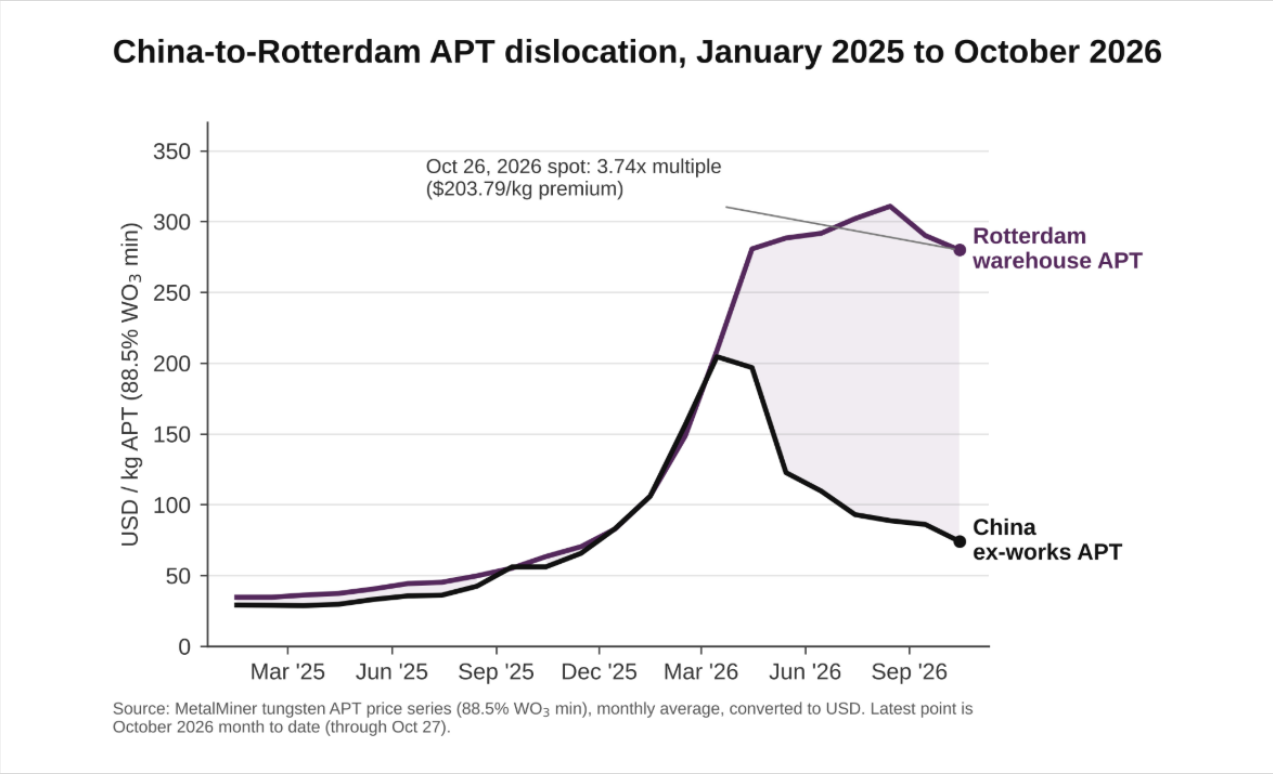


Figure 2. China-to-Rotterdam APT dislocation, January 2025–October 2026. Source: MetalMiner tungsten APT price series (88.5% WO_3 min), monthly average.

6. Historical Validation: The 2024–2025 Tungsten Case

MetalMiner's tungsten market-risk index crossed the elevated threshold of 70 on May 10, 2024, approximately 270 days before the February 4, 2025 export-control announcement. The early signal reflected coherent movement across ore, powder, carbide, ferro-alloy, and bar markets. Complex breadth and three-month trend appeared first; volatility and cross-market spread measures confirmed the condition; and a support-and-resistance breach arrived later as a discrete escalation point. In the 12 months after the announcement, China ex-works APT rose about 374%, China FOB oxide about 345%, and Rotterdam APT about 294%.

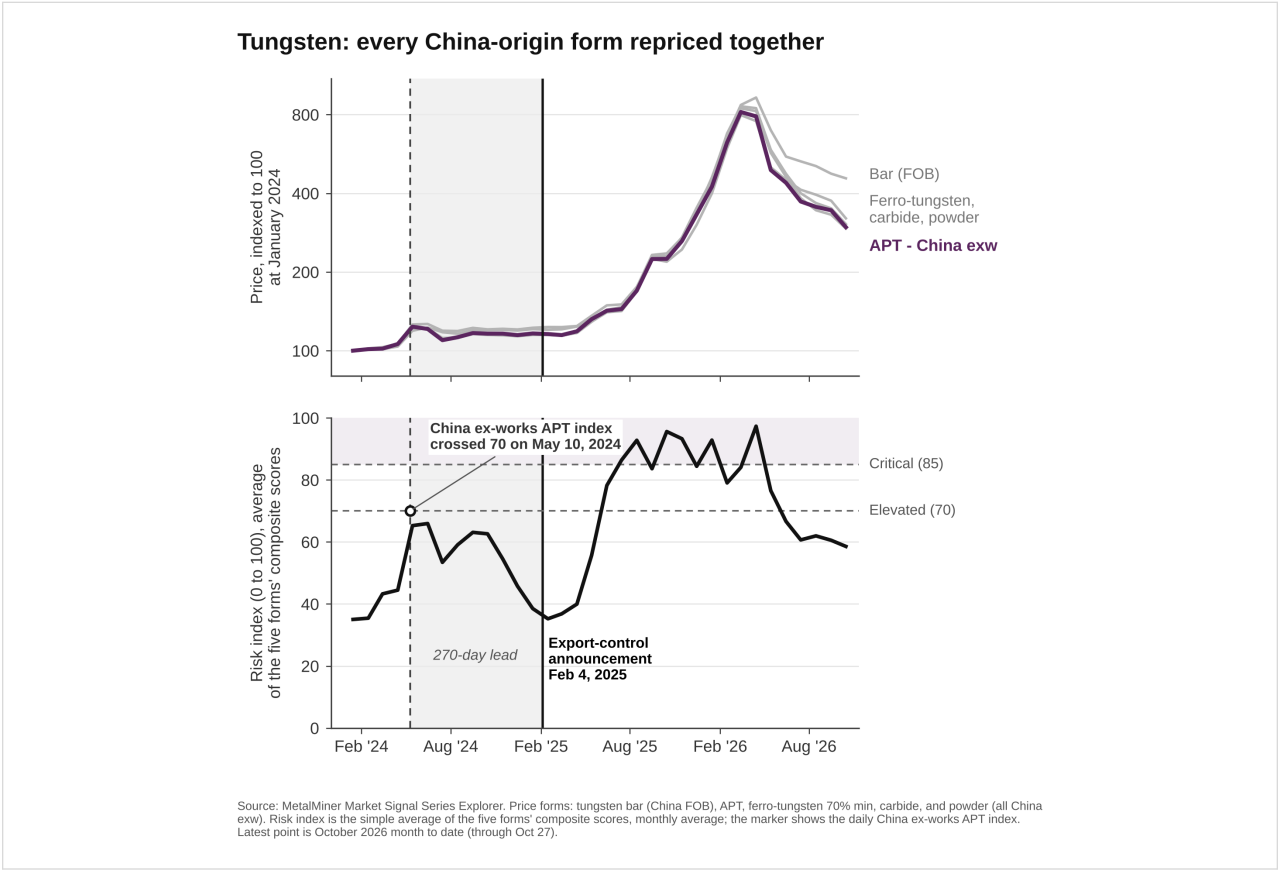


Figure 3. Tungsten price signal and the 2024–2025 export-control case, five China-origin forms (bar, APT, ferro-tungsten, carbide, powder) indexed to 100 at January 2024, with the family risk index (average of the five forms' composite scores) below. Source: MetalMiner Market Signal Series Explorer, monthly average.

A control case matters. Molybdenum was named in the same policy announcement but its index stayed below the elevated threshold throughout 2025, while China ex-works molybdenum oxide rose about 20% in the 12 months after the announcement, against 374% for China ex-works APT. Molybdenum's index did open an elevated episode later, from February to May 2026, and a brief one in June 2026, both outside the test window. This supports the conclusion that the methodology responds to market-specific evidence rather than merely to a policy headline.

One validated case and one control are persuasive but thin, so MetalMiner also measured how often the index raises a false alarm. Across 11 material families covered by 10 U.S.C. §4872 or used in the magnets it covers, from tungsten and tantalum to the magnet rare earths, gallium, and germanium, family indexes opened 32 elevated episodes between November 2021 and March 2026 that have at least six months of follow-up. In 22 of them (69%), the family's benchmark price moved 20% or more, up or down, within the next six months; in 10 (31%) it did not. Over the same period, a move that large followed 44% of all months. An elevated reading therefore raised the odds of a large move by about half, but nearly one episode in three was a false alarm. The sample is small, covers five years, and is weighted toward the 2025–2026 cycle; Appendix B describes the test.

7. Policy Levers and Their Market Effects

Policy makers have several levers for tungsten: import tariffs under Section 232 or Section 301, export bans and licensing requirements, quotas, domestic allocation orders, and procurement restrictions. MetalMiner's event study of past U.S. measures finds they do little to the headline tungsten price, which in 2025 and 2026 was driven by a global spike. The clearer U.S.-specific signal is the premium for tungsten bought outside China, which has risen from about 1.2 to 3.7 times the Chinese price. To separate policy effects from that broader rise, the study checked whether the premium grew faster after each U.S. measure than it did on random dates. Export bans had too few cases to test, and export-licensing records proved not to concern tungsten. The table sets out the evidence for the four levers most relevant to tungsten today, and the last column states what kind of evidence each row rests on. Appendix A lists every U.S. policy tool reviewed.

Policy lever	Intended effect	What the market evidence shows	Evidence basis
China export licensing (February 4, 2025)	Restrict tungsten exports from China and strengthen China's pricing position.	The family risk index crossed 70 about 270 days before the announcement (Section 6). Since then the two APT markets have split: Rotterdam APT rose from a February 2025 average of $34.60/kg to a September 2026 average of $290.06/kg, while China ex-works APT rose from $28.92/kg to $86.02/kg on the same basis. Rotterdam now trades at 3.74 times China ex-works, against 1.24 times before mid-2025, and China FOB APT carries the family's highest risk reading, 76.8.	Measured in MetalMiner APT price series.
U.S. import tariff (Section 232 or 301)	Raise the cost of imported material and favor domestic supply.	The effective U.S. tariff on the tungsten product chain rose from about 4% (2015 to 2024) to 16.2% in December 2025. Across 14 tariff episodes, the premium widened about 11% over 12 months against about 7% for random dates (p=0.31), a difference indistinguishable from noise. Copper in 2025 shows where tariffs do register, in the regional premium: tariff expectations pushed COMEX about 30% above LME on July 25, and the gap closed on August 1 when refined cathode was exempted.	MetalMiner event study; Census duty data; copper case measured.
U.S. scrap allocation order (BIS, effective August 27, 2026)	Keep tungsten scrap covered by HTS / Schedule B code 8101.97.00.00 in the United States for domestic and defense use.	Before the order, U.S. scrap import values rose 138% from the first quarter of 2026 to April through July, as the western premium broke out, but only to about one quarter of the Rotterdam APT price, half the 2024 ratio (Figure 5). About 80% of January–July 2026 U.S. scrap exports went to Japan, Germany, and South Korea, and none went directly to China. Operators report processors at capacity and discounts widening.	U.S. trade data; operator interviews; industry submissions. Post-order data due November.
DFARS procurement restriction (January 1, 2027)	Remove covered-country tungsten from U.S. defense supply chains.	Procurement mandates are the one tested U.S. lever with a measurable signal. Across 11 past U.S. procurement actions, including Buy American provisions and Defense Production Act designations that cover tungsten customs classifications along with other critical minerals, the spread between Rotterdam and China APT (88.5% min) widened about 28% over 12 months, compared with about 7% on random dates in the same period (p=0.05). The result is borderline, it rests largely on a single 2025 episode, and procurement responds to the same China tightening, so it shows association rather than cause. China FOB APT now reads 17.1 index points above China ex-works APT, consistent with a premium for traceable material forming ahead of the deadline (Section 3).	MetalMiner event study; measured dislocation. Association, not cause.

The Scrap Case: When Retention Reduces Supply

On August 6, 2026, the Bureau of Industry and Security published a Defense Priorities and Allocations System order requiring U.S. sellers of HTS / Schedule B code 8101.97.00.00 (tungsten waste and scrap) to allocate 100% of monthly sales to U.S. persons from August 27, 2026 through August 27, 2027, unless BIS grants an adjustment or exception. The order covers all material under that code, with no limit by grade or tungsten content. Tungsten in other forms, such as tool-steel scrap, tungsten carbide powder, tungsten chemicals, and ores, is classified elsewhere and falls outside it. Among the grounds BIS lists for an exception are material exported for processing and returned to the United States, and cases where compliance would reduce domestic supply. The aim is to keep scrap available to domestic and defense users. The question is whether domestic processors can use it.

MetalMiner's confidential interviews with three U.S. operators, a recycler, a scrap processor, and a converter, point to conversion capacity rather than scrap supply as the constraint. Operators put total U.S. tungsten consumption at roughly 22,000 to 30,000 metric tons a year against processing capacity of roughly 16,000 to 18,000. The largest of the three estimates that U.S. oxidation capacity covers only 60% to 70% of domestically generated scrap; another notes that typical refiners can take only about 20% of their feed as scrap. All three said scrap can accumulate unless conversion capacity grows. They differ on how far prices have fallen: the smallest reports scrap at about one quarter of virgin intermediate prices, while the largest sees only a slight decline.

Greystone Alloys, a U.S. scrap processor, describes the feedback loop in August 2026 briefing papers prepared for BIS and the Department of War. When domestic outlets are full, inventory builds, U.S. bids fall, and foreign suppliers that now ship scrap into the United States send it elsewhere. The United States is a net importer of tungsten waste and scrap: in 2025 it imported 5,042 metric tons and exported 2,160, by product weight. If that redirection occurs, the inbound flow at risk is more than twice the outbound flow the order retains.

In China, drill scrap fell to 0.47 of the virgin carbide price in May 2026 as virgin material spiked, and has since recovered to 0.75, just above its 2023 to 2024 range (Figure 4). The recovery began in June, before the U.S. order was published, so it cannot be attributed to the order, but it shows that scrap in China is not in surplus. For the U.S. market, this paper relies on U.S. customs data.

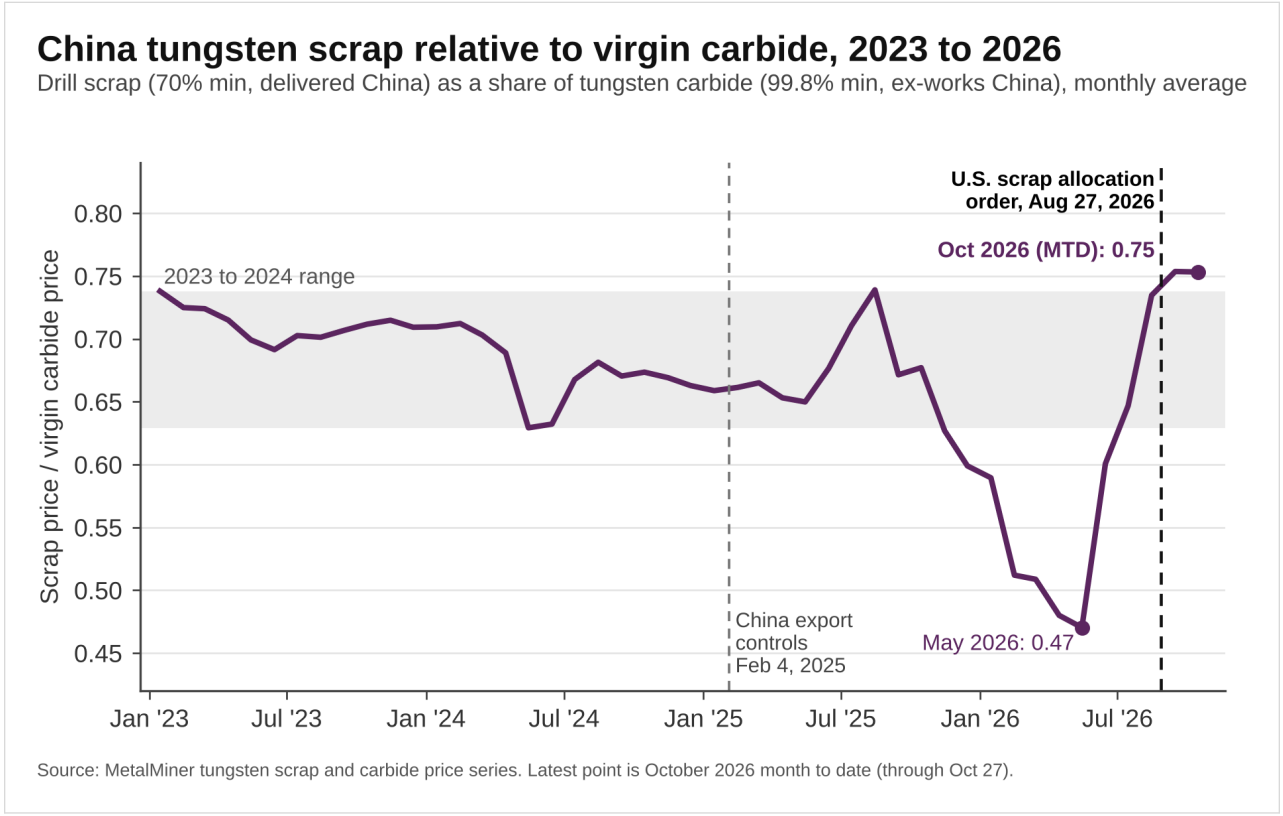


Figure 4. China tungsten drill scrap as a share of virgin tungsten carbide, January 2023 to October 2026. Source: MetalMiner tungsten scrap (drills, 70% min, delivered China) and tungsten carbide (99.8% min, ex-works China) price series, monthly average.

Dividing the customs value of U.S. imports of tungsten waste and scrap (HS 8101.97) by their weight gives an average U.S. import value per kilogram. Through August 2026, the latest month available and almost entirely before the order took effect, that value rose from $30.84/kg in the first quarter to $73.35/kg from April to July, an increase of 138% that began in the same month the western premium broke out, and reached $90.43/kg in August. Values from Germany, Mexico, and Canada, the three largest suppliers, each more than doubled, so the move is not simply a change in grade mix. Between March and August 2026, the months the trade data cover, monthly average China ex-works APT fell 57% while Rotterdam APT rose 49%. U.S. scrap was being priced off the western market, not China's (Figure 5).

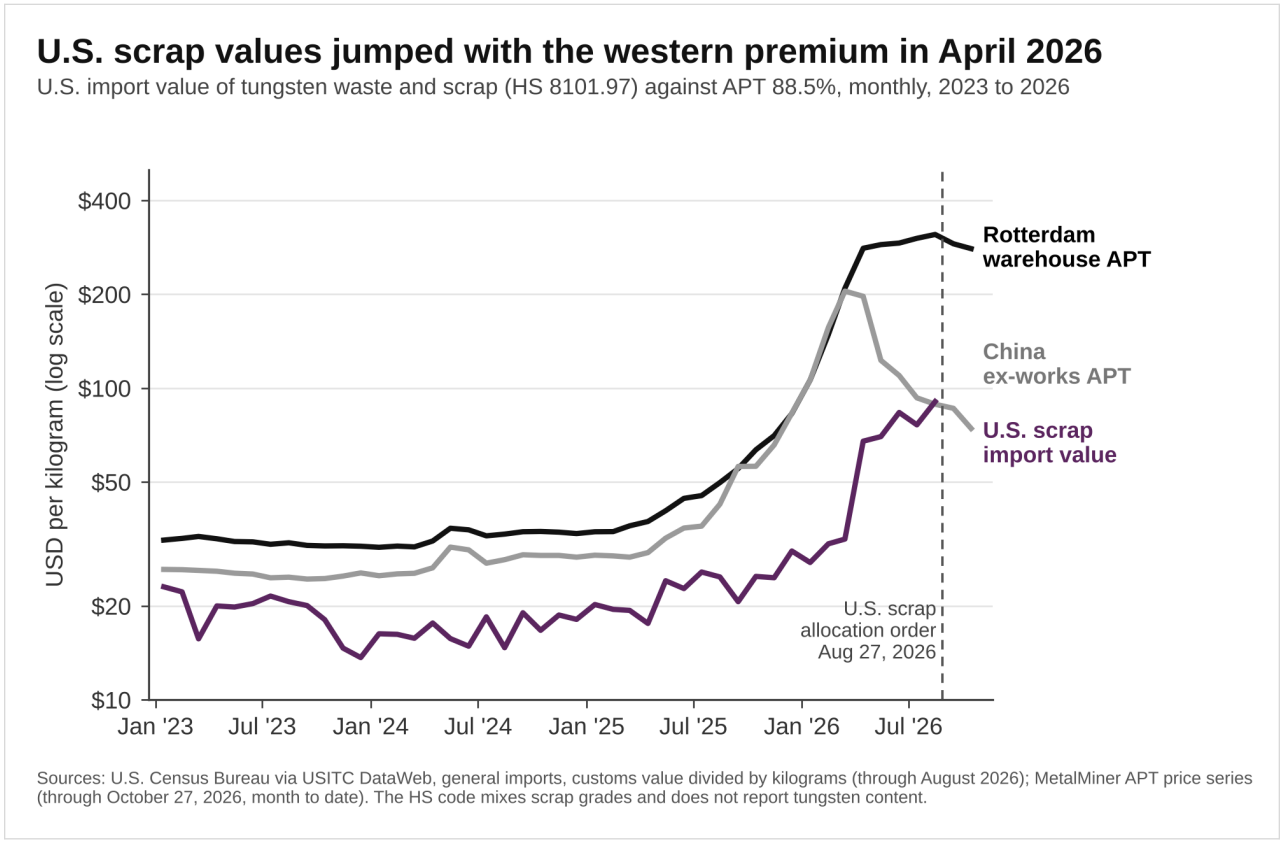


Figure 5. U.S. import value of tungsten waste and scrap against Rotterdam and China ex-works APT, January 2023 to October 2026, log scale. Sources: U.S. Census Bureau via USITC DataWeb, general imports, customs value divided by kilograms, through August 2026; MetalMiner APT price series.

It was not priced one for one. Relative to Rotterdam APT prices, U.S. import scrap values fell from 62% in 2023 and 50% in 2024 to about 25% from April to July 2026 and 29% in August, as virgin prices ran ahead of what scrap could command. The wide discount operators described was therefore already present before the order, which is consistent with conversion capacity, not export access, being the binding constraint. Whether the order widens the discount further is the test. September data, the first full month under the order, are expected in early November; August data, which cover only the order's first days, show no widening yet. Because the HS code mixes high- and low-grade material and does not report tungsten content, the measure is best read as a trend rather than a price level.

The trade data also show where outbound scrap goes. U.S. exports from January to July 2026 reached 2,235 metric tons, already more than in all of 2025, largely because of a March surge of 1,167 tons. About 80% of January–July 2026 exports went to Japan, Germany, and South Korea, and the data record no direct exports to China from 2023 onward. Unless BIS grants exceptions, such as for processing abroad with the material returned, the order therefore mainly restricts sales to allied converters, the outcome the industry warned about. Trade data cannot show where material goes after it arrives. Imports rose 24% from a year earlier from January to August, to 4,139 tons, so the inbound flow at risk was larger than a year earlier when the order took effect.

The policy test this evidence points to is conversion, not location. The useful measure is tons of tungsten converted each year into qualified, non-Chinese intermediates and products, not tons of scrap

held inside U.S. borders. BIS can already grant company-specific adjustments under the order, and industry has proposed an approved list of trusted allied manufacturers. Choosing the mechanism is a policy judgment. Whatever is chosen, monthly trade data can track whether U.S. scrap import values and inbound flows respond, and MetalMiner's price series can track whether the western premium does.

What to Watch

November 4, 2026.	Comments are due to BIS on the scrap allocation order, the first formal chance to propose changes such as an exception for allied processing with material returned.
Early November 2026.	U.S. trade data for September, the order's first full month, will show whether U.S. scrap import values and volumes fall.
January 1, 2027.	The Department of War stops issuing waivers under 10 U.S.C. §4872 for covered material from covered countries unless a formal mitigation plan has been accepted.
January 16, 2027.	The deadline, 180 days after Executive Order 14415, for Department of War guidance requiring contractors to map critical supply chains, which will set how much traceability qualifying material must carry.
DLA stockpile deliveries.	Deliveries of ores, concentrates, and sodium tungstate under the September 2026 contract, and the restart of APT conversion in Nevada, will show whether new qualifying supply reaches the market.
The market signal.	Whether China FOB APT moves back toward the critical threshold of 85 and the Rotterdam-to-China APT multiple keeps widening as the waiver cutoff approaches.

Conclusion

The United States needs transparent, market-based evidence to support secure, resilient, and diversified critical-mineral supply chains. Structural analysis can identify where long-term vulnerability may exist. Market-price intelligence can identify when that vulnerability may be becoming active.

The tungsten framework demonstrates how a global, multi-product market-price architecture can provide this continuous observation capability. It connects ore, intermediates, processed products, ferro-alloys, secondary material, origin markets, alternative-origin feedstock, and delivered-market pricing into a single resilience-monitoring system. Used together, structural supply insight and market-price signals can help public and private stakeholders move from static risk awareness toward timely, evidence-based resilience monitoring, before market stress becomes industrial disruption.

Next Steps: Extending the Method to Other Materials

The tungsten report is intended as the first implementation of a broader MetalMiner Critical-Mineral Price and Availability Monitor. The same steps apply to any material with concentrated supply, multiple physical forms, meaningful regional delivery premiums, long qualification cycles, limited substitution, policy sensitivity, or important recycling channels.

Reusable step	Method
Map the physical chain	Define feedstock, intermediates, processed forms, components, and secondary supply.
Build market geography	Pair origin, alternative-origin, delivered, and regional warehouse markets.
Score market behavior	Measure trend, volatility, breadth, dislocation, technical state, and persistence against each market's own history.
Add compliance overlay	Track statutory dates, regulatory implementation, waiver treatment, sanctions, export controls, and procurement restrictions.
Validate historically	Test signal behavior against known stress episodes and use control cases.
Escalate proportionately	Use signals to prompt deeper supplier, trade, inventory, qualification, and industrial-exposure review.

Appendix A. U.S. Policy Tools Reviewed for Tungsten

MetalMiner reviewed 60 U.S. metals policy tools across tariffs, import and export restrictions, procurement, financing, stockpiling, tax, allied agreements, permitting, and research. The table covers those that apply to tungsten today, how each has been used, and what the evidence in this paper shows about it.

U.S. policy tool	Use for tungsten to date	What the evidence in this paper shows	Assessment
Tariffs and import pricing			
Section 301 tariffs on China	Raised to 25% on certain Chinese tungsten products from January 1, 2025.	The effective U.S. tariff on the tungsten product chain rose from about 4% to 16.2% by December 2025, but tariff episodes did not measurably move the premium between Rotterdam and China APT (Section 7).	In force; no measurable price effect.
Section 232 on processed critical minerals	January 14, 2026 proclamation imposed no tariffs and opened negotiations, with tariffs or minimum import prices held in reserve.	Not yet applied, so not testable.	Available, held in reserve.
Minimum import prices and allied price floors	Named as a fallback in the 232 proclamation; price floors proposed for a preferential trade zone at the February 2026 Critical Minerals Ministerial.	Not yet applied. A western floor would formalize the premium that already exists in the market.	Proposed; not tested.
Export and flow controls			
DPA Title I allocation (BIS scrap order)	From August 27, 2026 to August 27, 2027, U.S. sellers of tungsten waste and scrap (HTS / Schedule B 8101.97.00.00) must allocate 100% of monthly sales to U.S. persons unless BIS grants an exception.	Before the order, U.S. scrap was already priced at about one quarter of Rotterdam APT, about 80% of January–July 2026 exports went to Japan, Germany, and South Korea, and imports were up 24% through August.	Too recent to measure; risk of reducing inbound supply.
Entity List and other U.S. export controls	Used mainly for semiconductors and technology; traded in talks with China.	The 51 export-licensing events matched to tungsten codes were not tungsten actions, so the bucket was excluded.	Not tested for tungsten.

U.S. policy tool	Use for tungsten to date	What the evidence in this paper shows	Assessment
Procurement			
NDAA and DFARS tungsten restriction; Buy American	Covered tungsten from China, Russia, Iran, and North Korea is barred from defense supply chains from January 1, 2027.	Procurement mandates are the one tested U.S. lever with a measurable signal: the premium widened about 28% over 12 months after past measures (11 episodes, p=0.05).	Borderline measurable effect; raises the cost of qualifying material.
Financing and ownership			
DPA Title III awards	Three tungsten projects since 2024, including $6.2 million for Guardian Metal Resources' Pilot Mountain project in Nevada, through its subsidiary Golden Metal Resources (July 2025).	Domestic support episodes showed no measurable 12-month effect (19 episodes, about 9% against 6% on random dates, p=0.34); operators cite 18 months to 3 years to build capacity.	Capacity tool on a multiyear clock.
Government equity stakes	September 14, 2026: Department of War committed $450 million in preferred equity and warrants in The Elmet Group, including APT conversion capacity in Nevada.	Too recent to test. It is the first federal tool aimed directly at U.S. conversion, the stage operators identify as the constraint.	New; well aligned with the bottleneck.
Allied supply deals with EXIM and DFC financing	Support discussed for the Cove Kaz Capital joint venture on Kazakhstan's Upper Kairakty deposit, announced November 2025.	No production yet, so no market effect to observe.	Long-run supply tool.
Stockpiling			
National Defense Stockpile purchases	September 14, 2026: DLA awarded a contract with a $2 billion ceiling and $150 million guaranteed for tungsten ores, concentrates, and sodium tungstate through August 2031.	Deliveries are tied to new supply coming online, so the contract adds demand for qualifying material rather than absorbing today's surplus scrap.	New; supports the provenance premium.
Tax			
Section 45X production credit	Tungsten converted to APT or ferrotungsten qualifies for a credit of 10% of production costs, with a phase-out from 2031.	Not tested. It pays directly for the conversion step where the United States is short.	Available; well aligned with the bottleneck.

Also reviewed, not currently applied to tungsten: Section 232 tariffs on steel, aluminum, copper, and their derivatives; antidumping and countervailing duties; transshipment penalties; rules of origin; Section 201, 122, and 338 tariffs; IEEPA tariffs, struck down in 2026; Russian metals bans, Uyghur Forced Labor Prevention Act and Section 307 enforcement, OFAC sanctions, and import monitoring; short-supply controls on aluminum and copper scrap; controls on processing technology and outbound investment; producer-specific price floors; the Project Vault civilian reserve; tariff relief tied to allied deals; the Section 48C credit, EV battery-sourcing rules, and expensing; CFIUS review; the Minerals Security Partnership, ally tariff exemptions, and ESG standards; DOE loans and grants, the DoD Office of Strategic Capital, and DPA Title VII agreements; permitting, federal land, and seabed actions; Clean Air Act exemptions, power, tailings, and Mining Law measures; exchange rules; and USGS and DOE research programs.

What the Review Shows

> Procurement is the only tested lever with a measurable price signal. Of the three U.S. policy types with enough history to test, only procurement mandates were followed by a widening of the premium for non-Chinese tungsten beyond what random timing would produce, about 28% over 12 months. The result is borderline and shows association rather than cause, but its direction matches the policy's design: it raises what U.S. users pay for qualifying material, and that provenance premium should be budgeted as a cost of the policy.

> Tariffs barely touch tungsten pricing. China's export policy sets the price. The 2025 Section 301 increase raised the U.S. tariff wall without measurably moving the western premium.

> The newest tools target the right constraint. The September 2026 Elmet equity investment and the Section 45X credit both pay for converting tungsten into APT, the stage operators identify as the bottleneck. Their effect will show on a multiyear clock, not in the next 12 months.

> Flow restrictions act fastest and carry the most risk. The scrap order acts on trade flows directly, but evidence from before suggests conversion capacity, not export access, limited U.S. supply. BIS's exception process is the part of the order to watch.

> Several tools remain untested for tungsten. U.S. export bans and licensing, import quotas, minimum import prices, and the new stockpile contract have no measurable record yet. They are the next priorities for MetalMiner's scenario modeling.

Appendix B. Methodology

Scope

This paper complements structural supply and resilience analysis. MetalMiner's contribution uses market prices, market-trade indicators, and point-in-time market-risk signals only; it does not use or commercialize structural-price data.

Price Data

Prices are licensed daily assessments. Each series keeps its original specification, delivery basis, and location. Non-dollar assessments are converted to U.S. dollars at the daily exchange rate, and monthly figures are arithmetic averages of the assessment days in each calendar month.

Price Risk Index

For each series, the index scores current behavior against that series' own history on six components: trend change, volatility, cross-market spread against related series, breadth across the family, support-and-resistance state, and persistence. The components combine into one score from 0 to 100; the weights are not disclosed. Readings below 70 are normal, 70 and above elevated, and 85 and above critical. An elevated episode runs from the first reading of 70 or above until the reading falls back below 70, and gaps of up to 10 trading days are merged into one episode. A family index averages the scores of its member series; the tungsten index in Figure 3 averages five China-origin forms: bar, APT, ferro-tungsten, carbide, and powder. The index is a conditioning signal, not a price forecast.

False-Alarm Test

The test uses the family index for 11 materials: tungsten, tantalum, molybdenum, neodymium, praseodymium, dysprosium, terbium, samarium, cobalt, gallium, and germanium, from October 2021 to September 2026. Of 44 elevated episodes, 5 that were already underway when the data begin and 7 that opened too recently for six months of follow-up are excluded, leaving 32. An episode counts as followed by a large move if the family benchmark's monthly average price in U.S. dollars moved 20% or more, in either direction, from its level in the month the episode opened at any point in the next six months. The base rate applies the same test to every month in the period. Benchmarks are China ex-works APT, tantalum pentoxide, the four rare-earth oxides, gallium, and germanium; delivered-China cobalt metal; and European molybdenum oxide. At a 15% threshold, the hit rate is 78% against a 56% base rate, and at 25% it is 56% against 34%.

Policy Event Study

The policy test measures the western premium as Rotterdam warehouse APT divided by China ex-works APT, both 88.5% min, in monthly averages in U.S. dollars. U.S. measures come from a commercial trade-policy database, matched to tungsten through the chain of tungsten customs (HS) codes and grouped by policy type. For each type, the study takes the cumulative change in the premium over the 12 months after each measure. Measures less than three months apart count as one episode, so clustered announcements are not double-counted, and a type is reported only with eight or more episodes. Three types qualified: import tariffs (14 episodes), domestic support such as grants, loans, and equity (19), and procurement mandates (11). Export-licensing (51 events) and ban (4) records were excluded because the code matching captured measures that were not about tungsten. Because the premium drifted upward over the period, each result is compared with 3,000 sets of random dates drawn from the same period, and the p-value is the share of random sets whose average change equals or exceeds the observed one. Procurement averaged +27.6% against +6.7% for random dates (p=0.05), import tariffs +11.2% against +6.6% (p=0.31), and domestic support +9.4% against +6.3% (p=0.34).

Trade Data and Interviews

U.S. scrap values are the customs value of HS 8101.97 general imports divided by their weight in kilograms, from U.S. Census Bureau data accessed through USITC DataWeb, through August 2026. The code mixes grades and does not report tungsten content, so the series is read as a trend. Operator evidence comes from three confidential interviews with U.S. operators (a recycler, a scrap processor, and a converter) and is used for context rather than measurement.

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