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Western Platinum Dependence: A Risk Assessment

A Research Paper

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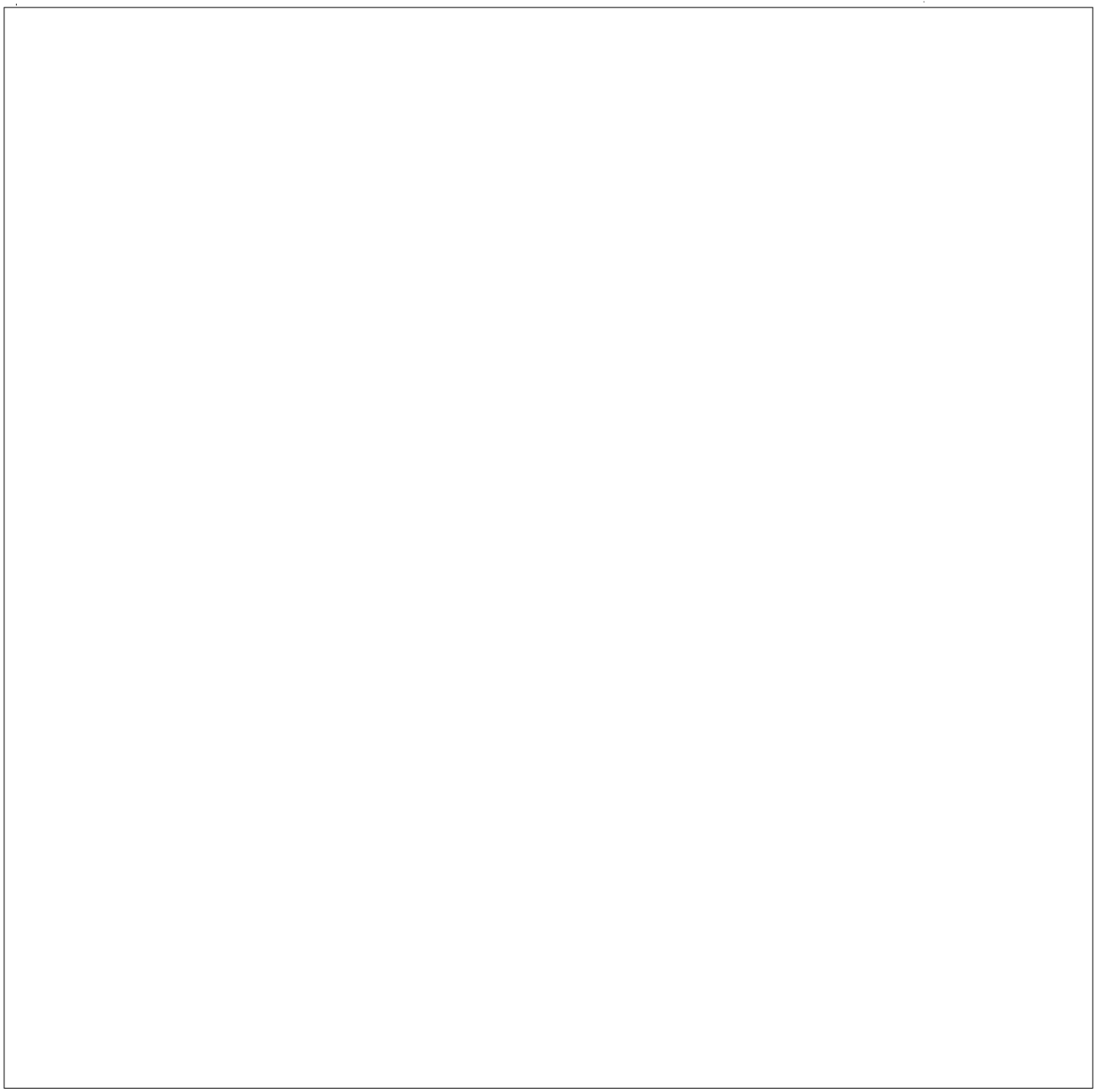

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Scope Note

The availability and dependability of strategic minerals continue to concern the United States and other import-dependent countries. Interest in strategic minerals peaked in the late 1970s when rebels twice invaded Zaire's mineral-rich Shaba region, prompting substantially higher prices. There was also concern over the concentration of many strategic minerals in southern Africa and the Soviet Union, and fear of an OPEC-like cartel. Although interest has subsided somewhat during the past several years, the United States continues to reevaluate its stockpile goals and review legislation that allows the government to subsidize domestic mineral industries, establish export controls, and set priorities for usage and allocations during emergencies. This assessment is part of a series on key strategic minerals. It follows a baseline study on important strategic mineral issues done in late 1981 and subsequent reports on Shaba cobalt and Western dependence on foreign supplies of chromium.

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Western Platinum Dependence: A Risk Assessment

Key Judgments

Information available as of 3 December 1984 was used in this report.

Platinum group metals (PGMs) are strategically important because of their use in refining petroleum, and in making chemicals, fertilizer, optical fibers, and electronic devices. In particular, they have a number of military applications in jet engines, rocket thrusters, aviation fuel, printed circuits, and lasers. The United States and most Western countries nearly totally depend on PGM imports for domestic needs. South Africa and the Soviet Union produce over 90 percent of the world's PGMs and hold a similar share of the world's reserves.

Despite this concentration, we regard a serious cutoff as unlikely. Specifically, we believe that a deliberate disruption of PGM supplies by either the USSR or South Africa or collusion between the two is improbable:

- We doubt that the South African Government would jeopardize its reputation as a reliable supplier of many minerals even if UN sanctions were imposed against apartheid. The industry generates substantial foreign exchange and employment opportunities. Likewise, the soundly managed South African PGM companies have been consistently reliable suppliers, encouraging the development of new PGM uses through secure supplies and stable prices. Strikes by black workers or bombings by the African National Congress (ANC) are more likely; however, we doubt that this type of cutoff would last longer than a few months.

- Although we cannot anticipate the Soviets' actions, it seems they would gain little by denying PGM supplies to the West. South Africa has the capacity and infrastructure to increase PGM production and replace Soviet-embargoed material. Although the Soviets are savvy traders and do attempt to manipulate prices, they have scrupulously met sales commitments. Soviet exports of PGMs to the West are lower today than a decade ago despite increased production. However, the export reduction does not appear to be part of any plan to deny critical resources to Western customers.

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A serious PGM supply disruption would sharply raise prices for individual firms such as processors and retailers. Overall, the cost to the US economy could be about $2 billion, according to one government study. In the aggregate, however, the market would make several adjustments to eliminate any strategic consequences of a cutoff. These would include:

- Contraction in nonessential PGM uses.
- Increased domestic production.
- Enhanced recycling.
- Release of PGMs from refiner, importer, dealer, and government stockpiles.
- Off-the-shelf substitution of other metals for PGMs.

Interest in trading platinum and palladium futures contracts and acquiring bullion, bars, and coins is on the rise, but, in our view, will not create any risk for market disruption or imbalance. Although periodic investment pressures, coupled with an embargo of metal, probably would spur rapid price increases, any market disturbance would be short. The investment market tends to be both orderly and liquid, and in an emergency the US Commodities Futures Commission can force exchanges to restrict speculation.

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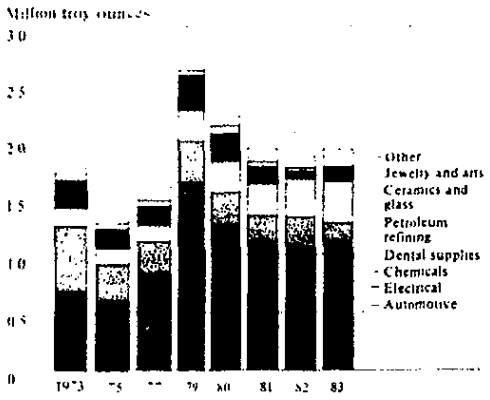
Western Platinum Dependence: A Risk Assessment

The Strategic Minerals Problem

1. Why are PGMs considered strategic minerals?
Platinum group metals (PGMs) —platinum, palladium, iridium, rhodium, ruthenium, and osmium —are among the nonfuel minerals strategic to US industry. They are valued because of their extraordinary physical and chemical properties and their use in refining petroleum, and in making chemicals, fertilizer, optical fibers, and electronic devices. Three PGMs — platinum, palladium, and iridium —are included in the National Defense Stockpile.

2. What are the major uses of PGMs?
The automotive, electrical, chemical, jewelry, petroleum, glass, and dental industries consume most PGMs, with automobile catalysts accounting for 65 percent of all platinum used (figure 1). The electronic and dental industries are the major palladium consumers, accounting for 65 percent of domestic use. In many applications, particularly in the chemical and petroleum industries, PGMs are used as capital goods—as components of plant and equipment that are recyclable rather than as production inputs that are consumed in the manufacturing process.

Figure 1
Platinum Group Metals: US Demand by Industry, 1973-83



Several of the PGMs also have important military uses, although they are not used in large quantities. The most widespread application is in electronics as switches, contacts, electrodes, and printed circuits, where a high degree of reliability is desired. PGMs are also used in jet aircraft engine magnetos, lasers, brake fluids, aviation fuel, and to improve the combustion of rocket thrusters.

The most promising growth areas in demand are:

- ***Auto sector***: As European countries begin adopting emission standards similar to those in the United States, PGM usage in catalytic converters will rise dramatically. Switzerland, Sweden, and West Germany (Federal Republic of Germany) have already enacted air-quality standards, and the EC is considering recommending Community-wide regulations. European emission controls could boost annual consumption of PGMs by 450,000 troy ounces or approximately 10 percent of 1983 world demand. Japan has been phasing in a complex set of emission standards since 1982. In addition to passenger cars, Japan's standards cover larger, diesel-burning trucks and buses. Starting in 1986, Australia will also impose regulations similar to the 1975 US standards. Although demand for PGMs will rise initially, the addition of vehicles using catalytic converters will swell the supply of PGMs available for recycling and eventually depress demand for newly mined supply.

Platinum Group Metals: Major Uses

Automotive
Used primarily in catalytic converters, where 1 troy ounce of PGMs can supply material for 64 converters. These converters transform toxic gas from automobile exhaust systems into harmless water vapor and carbon dioxide.
Substitutes: none.

Jewelry
Platinum has a high melting point and is extremely hard, making jewelry fabrication difficult and costly. A number of manufacturers have developed a new process for making platinum chains and hope to capture a share of the huge gold chain market. Market analysts believe that effective marketing and changes in consumer taste are needed to expand the appeal of platinum jewelry outside Japan, where it is most popular.

Chemicals
Used primarily for the production of fertilizers. Ammonia gas and air are pumped through sheets of wire gauze plated with platinum-rhodium alloys to produce nitric acid, a major component of fertilizers. PGMs are also used as catalysts for pharmaceutical products and in the food-processing industry.
Substitutes: rare earth elements, nickel, vanadium, and titanium in some catalytic uses.

Glass
In most glass industry applications, PGMs are used as capital goods—as bushings, spindles, or crucibles. As an example, a heated box coated with a platinum alloy is used to make fiberglass and optic fibers from molten glass. The platinum can withstand high melting temperatures without oxidizing and contaminating the glass. Glass for high-purity camera lenses is melted in nonoxidizing platinum crucibles. In new, noncommercial technologies, glass crystals formed in platinum crucibles are used in electronics and sophisticated arms systems.
Substitutes: none.

Petroleum
Catalysts in several steps of petroleum refining and reforming processes to upgrade the octane rating in gasoline.
Substitutes: molybdenum, chromium, nickel—but at a higher cost and reduced efficiency.

Electronics
Used in printed circuits, electrical furnaces, thermocouplers, and electrical contacts because they withstand corrosion while maintaining high conductivity. Recently, platinum-clad anodes have been installed on ship hulls to combat corrosion.
Substitutes: silver, gold, and tungsten.

Medical/Dental
In dental applications, PGM compounds are used in orthodontic appliances. In pacemakers, platinum electrodes are fastened to the tips of leads and wires. A platinum-based drug, cisplatin, has helped combat cancer.
Substitutes: gold and ceramics in dental applications.

New Applications
Crucibles of iridium are being used to grow synthetic gems and laser rods for medical, military, and industrial use.

- ***Commercial use of fuel cells***: PGMs are used as catalysts in fuel cells—devices that convert liquid-fuel energy directly to electricity without harmful emissions, noise, or environmental damage. Although large-scale introduction of fuel-cell technology has been delayed, industry experts predict that by the mid-1990s approximately 4 million kilowatts of capacity (or about one-third of New York City's 1982 electricity requirement) will be installed.

  Rough estimates show that, by the end of the century, fuel cells could require approximately 1 million troy ounces of PGMs or about 15 percent of current world production. PGMs are not consumed in the fuel cell, so they can eventually be recycled.

Table 1
World Production of Platinum Group Metals by Country

Thousand troy ounces

	1978	1979	1980	1981	1982	1983
Total	**6,780**	**6,887**	**7,288**	**7,382**	**7,031**	**7,182**
Australia	11	10	13	10	14	14
Canada	346	198	411	400	228	167
Colombia	13	13	14	15	20	20
South Africa	2,860	3,017	3,100	3,000	2,600	2,600
USSR	3,500	3,600	3,700	3,900	4,100	4,300
United States	8	7	3	7	8	6
Other	42	42	47	50	61	75

Sources: US Bureau of Mines, *Mineral Yearbooks*, and CIA *Handbook of Economic Statistics*.

3. Are PGMs different from other strategic minerals?

Yes. Although many of the issues relevant to other strategic minerals—availability of substitutes, possibilities for recycling, and conservation—apply to PGMs, platinum and palladium differ from them in one important way. Because they are precious metals, they are used not only for industrial purposes but also for investments. Therefore, the availability of supplies depends in part on investors—both speculators and hedgers—who increasingly determine demand for the metal and its price. Although PGMs are primarily industrial materials and supply and demand factors have the most influence, the addition of investor demand is potentially important. Periodic investment pressures, coupled with an embargo of metal, could spur rapid price increases and cause spot shortages.

4. Who are the major producers of PGMs?

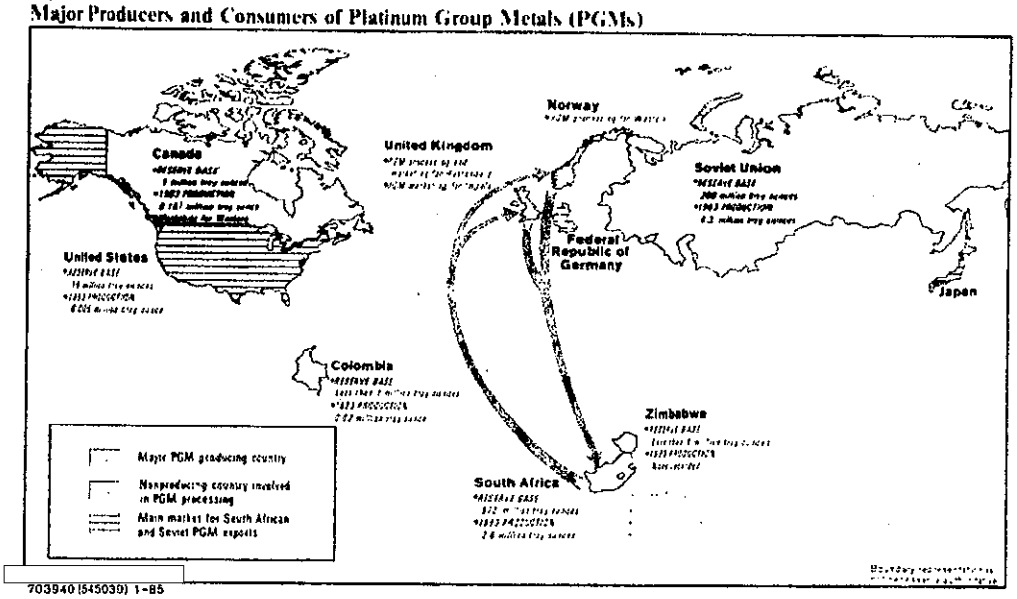
The USSR and South Africa mine over 90 percent of the world's PGMs. Canada and Colombia are also producers, and the United States recovers small amounts of PGMs as byproducts of copper mining (table 1, figures 2 and 3). Major PGM producers are unlikely to change. South Africa has the largest reserve base—970 million troy ounces; the Soviet Union, 200 million troy ounces. The United States and Canada, in comparison, have negligible reserves of 16 million and 9 million troy ounces, respectively.

The specific PGM content of the various world ore bodies differs. A typical sample taken from the Norilsk region of the USSR contains platinum and palladium in a ratio of 1:2.5. In contrast, in South African ore extracted from the Merensky Reef of the Bushveld Igneous Complex, platinum outweighs palladium by a ratio of 2.4:1. Consequently, the Soviet Union is the most important actor in the world palladium market. South Africa is the most important in the platinum market.

As for other producers:

- Canada produces PGMs as byproducts of nickel-copper production in the Sudbury District, but its annual production is low, compared with that of South Africa and the USSR. Platinum and palladium occur in roughly equal proportion.

Figure 2
Major Producers and Consumers of Platinum Group Metals (PGMs)



- Colombia is likely to remain only a minor producer of PGMs. Colombia's deposits, on the Choco coast plain, contain platinum, gold, and silver. Reserves and resources are minimal, and, according to US Bureau of Mines analysts, most of the mining equipment used for current production is obsolete.

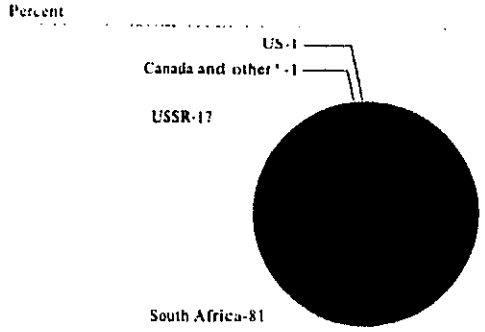
- Zimbabwe has PGM resources in the Great Dyke region, but there are no major mining operations. The ore contains significant amounts of nickel and copper. Platinum and palladium would be mined as byproducts.

5. Doesn't the United States have domestic PGM resources?

Yes, but most of them are not economical at current prices. The only primary PGMs being recovered domestically are byproducts of copper refining, and they supply less than 1 percent of annual domestic consumption. There are, however, several identified US deposits. These include three nonoperating deposits: the Stillwater Complex in Montana, controlled by Stillwater PGM Resources (a joint venture between Manville Products Corporation and Chevron Resources Corporation) and Anaconda Minerals (a division of Atlantic Richfield); INCO's Ely Spruce deposit in northeastern Minnesota; and AMAX's Minnamax deposit in the same area. A fourth deposit, along Alaska's Salmon River, had been mined between 1934 and 1975, and 1980 and 1982, but is currently out of business. The US Stillwater deposit in Montana, according to industry and government sources, holds the best potential for domestic development.

At all domestic sites, PGMs would be mined as byproducts of copper and nickel. According to US Bureau of Mines estimates, domestic resources are approximately 300 million troy ounces, 225 million of which are contained in the Stillwater Complex. Only 16 million troy ounces of the resources are considered part of the reserve base; significantly higher prices would be needed to justify development of the remaining resources.

Figure 3
Platinum Group Metals: World Reserves



[a] Includes Colombia and Zimbabwe.

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Platinum Group Metals Availability

6. Are serious worldwide shortages of PGMs likely?
Judging from current production and use trends, they are not. World PGM resources are large compared with PGM demands. World resources are estimated at 3.3 billion troy ounces; the world reserve base is 1.2 million troy ounces.[1] Industry experts predict long-run growth in PGM consumption but expect total supplies—primary and secondary—to grow as well.[2] Because of the cyclical nature of PGM demand and the long leadtimes required to bring new mines onstream, new world mining capacity is unlikely to keep pace year to year with demand. However, periodic drawdowns of producer and dealer stocks and increased use of recycled PGMs should compensate for most gaps between primary production and total consumption levels

[1] According to US Bureau of Mines definitions, resources are concentrations of minerals currently or potentially economic to mine. The reserve base includes resources that are either measured or indicated. Reserves are defined as that part of the reserve base that could be economically mined under current conditions.
[2] Secondary metal is metal obtained from the processing of scrap, slime, and sludges, and other material, which contain PGM. Recycled metal also is considered secondary metal

Because PGMs are primarily industrial commodities whose use is closely tied to the business cycle, demand will continue to be the key factor driving the PGM market. The US Bureau of Mines estimates that world PGM demand will grow by an average annual rate of 1.7 percent between 1981 and 2000. According to current estimates, however, world reserves are seven times larger than cumulative demand over the period—world resources are 20 times larger.

The United States and its Western allies will continue to depend on imports from South Africa or the USSR. Rising prices are expected to spur additional US production, but, according to the same Bureau of Mines study, US output is expected to fill less than 3 percent of the forecast US cumulative demand for PGMs between 1981 and 2000. US secondary supplies will be growing but are unlikely to close the gap between domestic supply and demand. Japan and the West European countries are nearly 100 percent import dependent

South African Supplies

7. How important are South African PGM supplies to the United States and its allies?
South African supplies of PGMs are extremely important to the United States and its allies. For the **United States**, approximately two-thirds and one-half of total platinum and palladium imports, respectively, originate in South Africa. For **Japan**, South African metal represents approximately one-half and one-fifth of total platinum and palladium imports, respectively. For **West Germany**, the figures are approximately 40 percent and 20 percent of total platinum and palladium imports, respectively.

8. What short-term factors might seriously disrupt South African exports of PGMs?
Strikes by black workers or bombings by the African National Congress (ANC), in our view, are the most likely near-term threats to steady PGM exports by South Africa. We believe, however, that neither threat is great and that a cutoff of this type would be short.

The possibility of a strike by platinum mine workers extensive enough to disrupt exports remains small so long as many mineworkers are nonunion. The largest black miners' union, the National Union of

The Minor Platinum Group Metals

Markets for rhodium, iridium, ruthenium, and osmium are very small, and detailed information about mine output is not available. Output of the four metals combined accounts for approximately 12 percent of total PGM production in the market-economy countries. Platinum and palladium production account for the remaining 88 percent. Production of all the minor PGMs is relatively insensitive to changes in demand and price; they are byproducts of platinum and palladium, which themselves are often byproducts of nickel and copper production.

Of the four metals, ruthenium is the most important in terms of mine output, followed in order by rhodium, iridium, and osmium. Demand for ruthenium and rhodium has been particularly strong during the past several years, and the prices for both have advanced substantially during 1984. Ruthenium, the least expensive PGM, started the year at $25 per troy ounce and by the end of November stood at $140. Rhodium, currently the most expensive PGM, staged a similarly dramatic advance over the period, rising from $265 to $800 per troy ounce. In terms of specific applications:

- ***Ruthenium** is being substituted whenever possible for gold and more expensive PGMs in chemical and electrical applications. It is most often alloyed with platinum. Automobile manufacturers involved in catalytic converter production have experimented with ruthenium since the mid-1970s, but the metal appears unsuitable for substitution for a more expensive PGM, notably rhodium, in automobile catalysts.*
- ***Rhodium** is used in automobile catalytic converters. In the electrical, chemical, and glass industries, it is used primarily as a hardening agent in platinum and palladium alloys.*
- ***Iridium**, the only minor PGM included in the US strategic stockpile, is an extremely hard metal, most often alloyed with platinum for use in electrical contacts and as a catalyst in chemical processing and petroleum refining.*
- ***Osmium**, the least utilized PGM, is a hard, brittle metal, which gives off toxic fumes at ambient temperature. It is the heaviest known substance—six times as dense as gold. Annual consumption is often less than 1,000 troy ounces per year. The largest end use for osmium is in staining tissues for electron microscopy.*

Mineworkers (NUM), has demonstrated only limited ability to strike successfully. For example, in January 1984, the NUM struck one of Impala Platinum's refineries. In response, Impala's management dismissed 1,400 employees and kept the plant running with the remaining 600 workers. Even the effective NUM-sponsored gold miners' strike in September 1984 that won some concessions for union members did not disrupt exports in that industry, although it probably will increase union membership and leverage.

The variety of processing sites and the likelihood of stockpiles at each location would minimize the impact on exports resulting from an ANC attack on a single mine or plant. Moreover, we believe that the ANC lacks the resources to attack enough of the processing sites to disrupt platinum production significantly.

The potential for the ANC to disrupt PGM exports by attacking transportation links in South Africa also is limited. Partially processed platinum is transported by train in South Africa, and some is flown to European processing sites. In a recent internal company assessment, Rustenburg, the largest producer, judged the potential for a major transportation disruption as minimal. As a precaution, however, the company

maintains only a small stock of refined metal in South Africa and carries larger inventories in the United Kingdom.

9. What is the long-run potential for a major South African upheaval and what would be the probable impact on South African mineral trade?

We believe that the potential for serious racial unrest in South Africa is high and will remain so for the near future. Some violence may temporarily disrupt mineral production and exports. The white government in Pretoria, however, is firmly in control, and it does not hesitate to forcibly quell violent opposition. We do not foresee any time soon a prolonged civil war or a turnover of government power to black control in South Africa. Even in these events, however, incentives would be strong to maintain PGM production and exports to earn scarce foreign exchange.

10. Would the South African Government deliberately withhold supplies of PGMs?

The South African Government is unlikely to deliberately withhold supplies because of its dependence on PGM export earnings and the need to maintain its reputation as a reliable supplier of a host of minerals. Earnings from PGM exports averaged $785 million between 1978 and 1980, and PGMs are among South Africa's 10 top export products. The PGM industry also employs a large number of South African workers. One estimate shows the employment level at over 80,000 people.

In our judgment, Pretoria would be unlikely to withhold PGM exports even if UN sanctions were imposed against apartheid. Instead, Pretoria probably would take advantage of the easy transport of PGMs by air and the established futures markets in the West to earn much-needed foreign exchange to purchase embargoed imports.

11. Would South African producers deliberately withhold PGM supplies from the market?

No. The major South African producers have foreign ownership, processing, and marketing ties that probably would deter any overt actions aimed at disrupting the market. The companies also have a history of sound management. They scrupulously avoid overproduction and voice concern over the substitution, conservation, and recycling effects that accompany rapid price increases. Expansion plans are nearly always tied to large, long-term contracts.

Rustenburg Platinum, South Africa's largest producer, is partially owned by Anglo-American Corporation, refines part of its output in the United Kingdom, and markets platinum through a British-based firm. Impala Platinum also has non–South African ownership ties and markets its metal through a London-based firm. The third major producer, Western Platinum, nearly wholly owned by British, Canadian, and US interests, currently ships material to Kristiansand, Norway, where copper, nickel, cobalt, and a PGM concentrate are recovered. The base metals are marketed by Falconbridge, a Canadian firm, and the PGM concentrates are airshipped back to South Africa for further refining. By 1986, Western hopes to be totally independent of overseas processing. A new $10.2 million refinery is being built in South Africa and will produce PGM concentrates in six to 18 days, compared with the 100 days it currently takes to ship the ore to Norway, process it, and return it to South Africa.

Any successful embargo of PGMs would require coordination among the three South African producers because of the ease with which unused and new capacity could be brought onstream by any of the three to make up for any attempted embargo by the others:

- According to Bureau of Mines and industry estimates, Rustenburg, Impala, and Western can produce 2.1 million, 1.6 million, and 400,000 troy ounces of PGMs per year, respectively. At average 1980-83 production rates, this could create approximately 800,000, 550,000, and 150,000 troy ounces of additional PGMs that could substitute for embargoed metals.

Table 2
South African Platinum Companies: Ownership, Processing, and Marketing Ties

	Major Owners	Percent	Processing	Marketing
Rustenburg Platinum Holdings, Ltd.	Johannesburg Consolidated Investment Co., Ltd., South Africa	33	Matthey Rustenburg Refinery, Ltd., jointly owned by Rustenburg Platinum Holdings, Ltd., South Africa, and Johnson Matthey and Co., Ltd., United Kingdom Matthey Nickel, Ltd., South Africa	Johnson Matthey Public, Ltd., UK (Rustenburg and UK Divisions) (sole marketing agent)
	Anglo-American Corporation of South Africa, Ltd.	24		
	Others unknown			
Impala Platinum Holdings, Ltd.	General Mining and Finance Corp. (Gencor), South Africa	45	Own milling, concentrating, smelting, and refining in South Africa	Ayrton Metals, Ltd. (UK but wholly owned by Impala) Platinum Sales, Inc., United States
	INCO, Canada	10		
	Hambros Bank, UK	10		
	Others unknown			
Western Platinum, Ltd.	Lonrho Ltd., United Kingdom	50	Falconbridge Norwegian Refinery, Kristiansand, Norway, for copper-nickel recovery. Final PGM processing at Brakpan, South Africa	Falconbridge, Ltd., Canada
	Falconbridge Nickel Mines, Ltd., Canada	25		
	Superior Oil Company, United States	24		

- According to a US Bureau of Mines study, new capacity along the Merensky Reef could be brought onstream in less than a year. Since PGMs are mined using simple, conventional methods, production and development rates can respond quickly to changes in price and demand.

- In addition, the Bushveld Complex in South Africa contains a very rich PGM-ore body, UG2, that has not been mined because of smelting problems associated with the relatively high chromite content of the ore. Industry analysts report that South Africa's National Institute of Metallurgy has developed a successful refining process. They predict that, given the right market conditions, a major new PGM mine in that area could be operating by 1988. The UG2 area contains an estimated 600 million troy ounces of PGM. the Goldfields of South Africa Company is also considering an operation that could produce 410,000 troy ounces of PGMs per year by the end of the decade.

12. What about the possibility of natural disasters or accidents disrupting supplies?

There have been minor logistic problems associated with the mining and processing of South African PGM ore, but none seriously disturbed the market. For example, prices increased only modestly following an April fire that extensively damaged Rustenburg's refinery in Royston, England. Industry analysts say that the facility refines approximately 950,000 troy ounces of PGMs per year—or one-third of South Africa's annual output. Rustenburg responded by increasing output at its Wadesville, South Africa, refinery and by drawing down inventories. According to Rustenburg officials, the company met all contracted deliveries.

Soviet Supplies

13. How important are Soviet PGM supplies to the United States and its allies?

The USSR is the world's largest producer of PGMs, and, along with South Africa, is a major supplier to

Western markets. Industry analysts estimate that the Soviets provide slightly more than 10 percent of the West's platinum and more than 50 percent of its palladium. In recent years, Soviet metal represented approximately 2 percent of total US platinum imports and approximately 30 percent of palladium imports. Japan depends more heavily on Soviet supplies —for approximately 15 percent of platinum and over 50 percent of palladium imports. West Germany, the other major Western consumer, acquires over 50 percent of its palladium from the Soviets.

According to our estimates, Soviet PGM production has risen steadily over the past decade--from 3.0 million in 1973 to 4.1 million troy ounces in 1982. By the end of the decade, we project that production will rise to between 4.5 and 5 million troy ounces. The level of PGM exports to Western buyers, however, has declined over the period. Between 1972 and 1974, PGM sales to the United States, Japan, and West Germany averaged 2.7 million troy ounces; by 1978-80, average exports to these sources had dropped to 2.0 million.

14. Why have Soviet PGM exports declined while production has grown?

Possible explanations for reduced sales of Soviet platinum group metals include:

- Stepped-up Soviet Bloc stockpiling to deal with production and delivery bottlenecks.
- Increased domestic or Soviet Bloc demand.
- Reduced need for hard currency.
- Attempts to influence PGM prices.

The Soviets may be responding to an decree ordering enterprises to build reserves of numerous materials, including metals, during the 11th Five-Year Plan (1981-85). In addition, an industry executive maintains that unreliable deliveries from PGM manufacturing plants and poor distribution channels force Soviet Bloc platinum users generally to keep much larger stocks than their Western counterparts.

Consumption of PGMs in the Soviet Union also appears to be rising, with platinum use growing faster than palladium. For years the ratio of palladium to platinum exports was similar to the PGM content of Soviet ore—2.5:1. However, according to an industry executive, the ratio now favors palladium even more—approximately 5.5:1. Although none of the domestically consumed platinum is used for automobile catalysts and very little goes into jewelry, in all the other important industrial sectors —glass fiber, oil refining, and nitric acid manufacturing --consumption is believed, by the industry executive, to be rising. Some analysts feel that growth in palladium demand, on the other hand, is less robust.

Part of the reduction in PGM sales probably relates to price manipulation and earnings maximization goals. Palladium market specialists believe that the Soviets have restricted sales to generate higher market prices. The Soviets may be stockpiling platinum, expecting an increase in demand in the next year or two to stimulate higher prices.

15. Would the Soviets deliberately withhold surplus PGM supplies from the market?

No. The need for hard currency and the inability of the Soviet Union, alone, to totally disrupt the market—conditions similar to those limiting disruptive actions by South African producers—probably will keep Soviet PGMs flowing to Western buyers. According to our estimates, the USSR has earned between $100 million and $500 million annually from PGM sales since 1980. Their current favorable foreign exchange position may allow the Soviets to be more selective in determining both the volume and the timing of PGM sales. However, a complete supply cutoff could alienate Western buyers and lead to a long-term loss in earnings.

16. Have the Soviets manipulated the PGM market?

No. Although the Soviets use various short-term techniques for influencing the PGM market they have been scrupulous in meeting contracted sales commitments. no active campaigns to disrupt the PGM market.

On the other hand, the Soviets are savvy metals traders and try to influence the market price of palladium, in particular, to maximize their return on export sales. According to trade analysts, examples of short-term market "manipulation" are: limiting the availability of platinum and palladium on the spot market; refusing to increase monthly allocations of the metals under long-term contracts; and, for the past several years, indicating before new contract negotiations or renewals that less metal would be available for sale to pressure prices upward.

Collusion Between Major Suppliers

17. Is there any evidence that the Soviets and South Africans have colluded or will collude in controlling the PGM market?

No. Until recently, the major South African producers have supported a stable producer price and admit to holding down prices to limit the incentive of PGM consumers to develop substitutes. However, this "collusion" involved only the South African producers. To the best of our knowledge, the Soviets and South Africans have never attempted to form a cartel or otherwise collude to control the market. Any collusion to withhold supplies could significantly boost prices and seriously disrupt the market. However, in our opinion, any joint action would be aimed at increasing the profitability of PGM operations and, therefore, would be unlikely to include a cutoff.

18. If supplies from either of the major producers were curtailed, how would the other supplier react?

If the Soviets halted PGM shipments to the West, South African producers probably would increase output until they reached capacity—both the mining and refining infrastructure are already in place. We doubt, however, that new mine shafts would be sunk or that new refineries would be built unless the South Africans anticipated an extended cutoff and believed that Soviet ore would not reach Western markets through third parties. Past expansion plans hinged on firm contracts from major consumers, and, in this case, the South African producers would undoubtedly require assurances that new capital expenditures could be recovered. PGM companies probably could find financing for increasing development either through private sources or through South Africa's sophisticated mining-house system that specializes in funding mining ventures.

Denial of South African PGM supplies to the United States and its allies is unlikely to trigger a cutoff of Soviet exports. Instead, we believe that the Soviets would continue to export PGMs to take advantage of the higher prices created by a crisis. In fact, sales probably would increase if there were an exportable surplus. A South African disruption would probably be short lived, and the Soviets, knowing this, would have little time to take advantage of their enhanced market power.

Adjustments to Supply Disruptions

19. What adjustments would the market make if PGM supplies were disrupted?

A serious and potentially long-term PGM-supply cutoff would induce various market and other adjustments aimed to minimize the strategic impact on the United States and its allies.

Increased Recycling. The level of PGM recovery from secondary sources depends on the primary supply/industrial demand imbalance, prices, and the economic feasibility of recycling. Currently, recycled material supplies 40 percent of Western PGM needs—primarily toll-refined [1] metal recovered from nitric acid and petroleum catalyst production. An estimated 85 percent of the PGM catalysts consumed by the chemical and petroleum refining industries are recovered. Jewelry scrap had represented the largest nontoll secondary supply source, but discarded catalytic converters from automobiles are likely to contribute significantly to supplies in the future. Since 1975, the automobile sector has consumed over 6 million troy ounces of PGMs. More than 80 percent of this metal is in operating vehicles and will eventually be available for recycling.

The high cost of collecting and transporting scrap is the major inhibitor of large-scale recycling. However, as converters are scrapped in larger numbers and refining technology is improved, recovery of PGMs

[1] In toll refining, scrap material is sent to a refinery, refined for a fee, and returned to the original owner without any change in ownership.

from automobile converters will become more economic; US automobiles were first fitted with pollution-control devices in 1975 and 1976 and are currently nearing the end of their life cycles. As more countries adopt automobile emissions standards, foreign supplies will grow as well. One industry analyst predicts that between 350,000 and 500,000 troy ounces of usable PGMs will be recovered from scrapped automobile catalysts, primarily in the United States, in 1985. However, by 1990, the volume could exceed 800,000 troy ounces—more than 10 percent of world output—with European and Australian supplies contributing to the total.

Increased Domestic Primary Production. According to mineral press reports, the consortium controlling the US Stillwater Complex has almost completed a mining feasibility study. The future of the project depends on both the results of that study and on completion and approval of an environmental impact statement. The consortium is expected to make a production decision during the first half of 1985. The Stillwater partners anticipate that it will take two years to bring the operation into production from the time construction begins. At capacity, annual output is estimated at 270,000 troy ounces of palladium and 80,000 troy ounces of platinum—a sizable gain in domestic production but insignificant in terms of total world production. Metal from Stillwater would satisfy less than 10 percent of average 1978-83 US platinum needs and approximately 20 percent of palladium needs.

Private Stockpile Releases. There are widely dispersed private stockpiles of PGMs. The US Bureau of Mines estimates that by June 1984 stocks of PGMs held by refiners, importers, and dealers in the United States (including metals in the depositories of the New York Mercantile Exchange [NYMEX]) stood at nearly 1.3 million troy ounces—equal to nearly nine months of domestic usage at the 1983 level of consumption or six months of consumption at 1979 levels. In addition, there are sizable stocks in PGM processing and refining plants in Norway, the United Kingdom, and Canada. Investors hold metal in bar, bullion, and coin, much of it deposited in Swiss banks, but we know of no reliable estimate of the size of these stocks.

Table 3
US Strategic Stockpile—Platinum Group Metals, Status as of 30 November 1983

Thousand troy ounces (except where noted)

Material	Goal	Total Inventory	Total Inventory as a Percent of Goal *(percent)*
Platinum	1,310	440	34
Palladium	3,000	1,253	42
Iridium	98	25	26

Technological Change. Over the longer run, technical change probably would encourage adjustments in PGM use—through substitution, increased life of PGM-bearing capital goods, and reduced usage of PGMs per unit of output. Several materials can be substituted for PGMs in the major using sectors. The high price of PGMs today compared with that of a decade ago has already spurred conservation; technology has lengthened the life of platinum catalysts, and individual electronic and glass components use smaller quantities of PGMs today than they did in the past.

20. How could Washington ease the impact of a supply disruption?

If the United States faced a serious disruption of PGMs, it could: open strategic stockpiles; encourage domestic conservation, recycling, and substitution; and initiate domestic PGM production. (C)

At 1983 levels of consumption, release of PGMs in the US defense stockpile (table 3) would satisfy six months, 18 months, and five years of domestic consumption of primary platinum, palladium, and iridium. Since the US Bureau of Mines estimates that only 2 percent of US PGM consumption is channeled to the defense industry, the current stockpile inventory is sufficient to meet the demand in this critical sector for many years.

The United States has a considerable range of policy options to limit the impact of PGM-supply disruptions. To meet immediate needs, the government

could relax automobile emissions standards, freeing approximately 50 percent of domestically consumed PGMs for other uses. Over the medium term, subsidization of domestic primary production and recycling, either through price supports or direct grants to producers, would be effective alternatives. Over the long run, the government could intensify its metals and materials research and development, encourage domestic exploration and production, or subsidize private stockpiles using tax or credit incentives. The Defense Production Act of 1950, which was recently extended, allows the President to undertake many of these actions to expand production of strategic minerals in the interest of national defense.

21. Would these adjustments be sufficient for the United States to weather a prolonged cutoff?
Militarily, yes, because of the limited number of defense applications and the ability to divert PGMs to these uses. A cutoff would be far more painful for the industrial sector in the short run in terms of costs and output. Even so, within several years major market changes would relieve the burden.

A US Bureau of Mines[1] study examined the impact of a hypothetical five-year PGM-supply cutoff from South Africa beginning in 1987, assuming that the Soviet Union would not increase exports of PGMs to the West to make up for the shortfall. Under one scenario, the government takes no action to relieve the effects of the cutoff. In the first year of the disruption, platinum prices increased eightfold and palladium prices fivefold. This equates to prices of $3,200 and $1,125 per troy ounce, respectively. Consumption during the year drops by 10 and 15 percent. According to the analysis, in the second year, consumers begin to substitute other materials for PGMs where possible and recycling becomes an important source of domestic supply. This trend continues throughout the disruption. In the fifth year of the cutoff, US domestic primary production enters the market in response to four years of high prices. Palladium prices drop to their predisruption level (approximately $225) because of the high percentage of palladium in domestic PGM-bearing ore. The platinum price response is less dramatic. Prices drop to $2,300 per troy ounce, still nearly five times their predisruption level. Palladium is increasingly substituted for platinum in response to the price decline. In addition, the United States becomes a small net exporter of palladium. The estimated direct economic cost of the disruption is $2.3 billion in 1980 dollars, primarily in the form of transfers to foreigners for higher priced PGMs and the costs associated with domestic production.

The study also examines the impact of several government actions under the same supply disruption: releasing material from the US strategic stockpile, relaxing automobile emissions regulations, and establishing a support price for domestically produced PGMs. All lower the expected impact of the cutoff. The stockpile-release option reduces direct economic costs the least, to $2.0 billion, or 13 percent below the baseline estimate. Relaxing emission regulations is more effective; costs are estimated at $1.4 billion. The price-guarantee option "costs" $1.5 billion. In all cases, the impact of the South African cutoff, even one that lasts five years, is not severe enough to cripple the US defense structure or US industry.

[1] *Platinum and Palladium: Effectiveness of Alternative US Policies in Reducing the Costs of a Supply Disruption*, Division of Mineral Policy Analysis, Bureau of Mines, US Department of the Interior, September 1982

Platinum Group Metals as Assets

22. Why are investors interested in PGMs?
The investor appeal of platinum and palladium is linked to the metals' uses as:

- An inflation hedge during periods of depreciating money values.
- An insurance holding against political and economic upheaval.
- A total portfolio hedge for large and sophisticated investors. Platinum prices tend to move countercyclically to prices of financial assets, thereby reducing the risk and variation in the value of the total portfolio.

- A spread partner with gold, a more heavily traded precious metal.[1]

According to trade analysts, PGM prices and investor interest tend to move positively with high inflation rates, rising gold and silver prices, low real interest rates, a relatively weak dollar, perceptions of growing political and economic instability, and improving industrial demand for the metal.

23. Do investors play an important role in the PGM markets?

Potentially, yes. Although investors represent only a small part of the total PGM market (in 1980, total investment demand was estimated at 200,000 troy ounces versus 2.5 million troy ounces of industrial demand), the following indicators point to the emerging role of investors as important PGM market participants:

- A dramatic rise in the number of contracts traded and the level of open interest on NYMEX.[2]
- The decision by the Tokyo Gold Exchange and Mid-America Commodities Exchange to begin trading platinum contracts this year.
- Increasing sophistication of investors eager to diversify their portfolios.
- Intense promotion by bullion dealers and traders to market the metal.
- The decision by Ayrton Metals—a subsidiary of Impala Platinum, the second-largest South African PGM producer—to market the Noble, a 1-ounce platinum coin similar to the Kruegerrand. To date, sales have been nearly double their expected level. During the first three months of marketing, Ayrton sold 30,000 coins, mainly to West German, Swiss, and Swedish buyers.
- Optimistic long-run price projections for PGMs.

24. How do investors participate in the PGM market?

PGM investors can be categorized as either hoarders or speculators. Hoarders purchase the physical commodity—bullion, bars, and, most recently, coins—to hold until the price is high enough to encourage sales. Speculators, on the other hand, usually trade platinum and palladium futures contracts—currently available on the NYMEX, the Mid-American Commodities Exchange in Chicago, and the Tokyo Gold Exchange. They rarely accept physical delivery of the metal but instead use paper transactions to profit through price fluctuations. Hedgers are the second part of the platinum futures market equation. They are *not* speculators, but rather producers and consumers of PGMs who use the futures market to minimize the risks associated with commodity price fluctuations.

The NYMEX is the only important platinum futures market. Daily trading has increased by more than 50 percent since 1980. In mid-September, there was an average of 2,000 daily transactions involving 100,000 troy ounces of platinum. However, since many of the trades involve platinum being sold and resold with very little platinum delivery, the figure is an aggregate. According to a trading expert, it is impossible to determine the actual amount of platinum changing hands in any one day.

There are about 12 major firms playing the PGM futures market. Half are foreign firms involved in approximately 55 percent of total futures trading. The speculator/hedger mix changes. Currently, market analysts estimate that speculators account for 25 percent of futures market activity and hedgers for 75 percent. However, between 1979 and 1981, when inflation was high and interest in precious metals was feverish, the percentages were reversed.

[1] In futures trading, spreading means simultaneously taking a long (or buy) position in one futures contract—platinum, for example—while taking a short (or sell) position in another—gold, for example. Speculators essentially "play" the price difference between the two metals. Traders claim that the financial risks associated with spreading are smaller than with simple long and short positions.

[2] That is, open interest in the number of contracts that remain to be settled in the futures market. A trader may establish a new position by buying a May contract. This contract must be settled at a later date by either selling the May contract or taking delivery of the commodity in May. As long as the contract is unsettled, it is counted as open interest.

25. Are the major producers or consumers of PGMs active in the futures market?

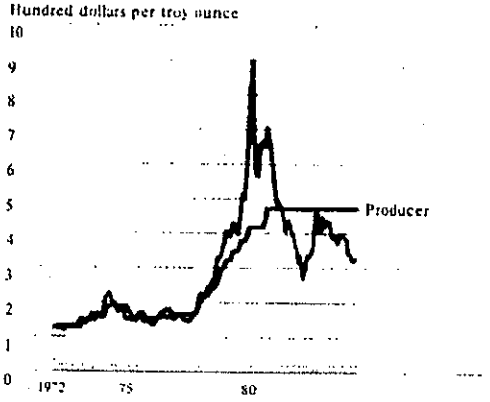
No. An industry expert reports that neither the major producers nor the major US PGM consumers are active in the futures market. [redacted] the Soviets are reluctant to enter the futures market; they prefer to work directly with dealers, previously using long-term contracts, now working with frame contracts.[1] Their lack of expertise in trading futures may also be inhibiting more active participation. South African producers likewise have avoided active market trading, but some of their output is hedged on the NYMEX by Swiss trading firms. Since US automakers had been locked into supply contracts with major South African producers at stable prices, they had little need to hedge purchases. According to a futures market executive, however, they sold surplus platinum on the futures market when automobile sales slumped. [redacted]

26. What has been the major impact of investor participation in the PGM market?

According to market experts, perhaps the most important impact of growing investor participation in the PGM market was the change in the pricing policy of the largest South African producer, Rustenburg. In January 1984, Rustenburg abandoned its fixed pricing policy and adopted a more flexible standard. For 50 years, Rustenburg's customers paid "producer" prices for PGMs—that is, relatively stable prices determined by major producers. (The producer price for platinum has been $475 per troy ounce since September 1980.) Palladium producer prices have changed a little more frequently but are far more stable than either the dealer or exchange prices.[2] The intent by producers has been to protect PGM from inroads from competition metals by lending stability and reliability to the market. Between 1979 and 1980, Rustenburg continued to sell platinum at the producer price of $475 per ounce, even though the exchange price rose as high as $1,000. However, during the past several years when free market prices dropped below producer prices, traditional buyers have refused to make large purchases at the higher prices [redacted]

Under Rustenburg's new pricing system, prices are set daily, usually within a few dollars of the NYMEX price. [redacted] Rustenburg's new strategy reflects the company's recognition that it is no longer practicable for a producer (even one as large as Rustenburg) to control PGM prices once investors become seriously involved in the market. The company's major competitor, Impala, continues to use a producer pricing system and, according to the metals press, does not anticipate a swing to exchange-linked prices. [redacted]

Figure 4
Platinum Prices, 1972-84 [a]



[a] As of November 1984.

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[1] The Soviets have been shifting away from long-term supply contracts to monthly "frame" contracts. Under the new system, dealers sign contracts for options on given monthly allocations at prices determined by the Soviets. The dealers can choose not to take the option for any particular month, but cannot roll forward their allocation, hoping to get a better price later. Under this system, the Soviets can determine the market price of sales on a monthly basis. [redacted]

[2] There are two commonly quoted prices for platinum group metals: the *producer price*—the price set by the major South African and Canadian producers and their sales agents; the *dealer price*—the price quoted by *Metals Week*, which is determined by surveying US precious metals dealers each week. In addition, the prices of platinum and palladium futures traded on the NYMEX are called *exchange prices*. In general, producer prices apply to industrial accounts and long-term purchases, while dealers' prices are charged for spot purchases. Exchange prices apply to hedging and speculative contracts traded on NYMEX. They are also used as reference prices for spot purchases and recently have been included in formulas for determining prices for contract sales. [redacted]

Investors' participation in the platinum market played a key role in changing Rustenburg's pricing policy, according to an industry executive. Ironically, the new policy is likely to lead Rustenburg into more active participation in the futures market, which would strengthen further the role of investors and futures prices in the platinum and palladium markets. Under a fixed producer price, Rustenburg had little need for hedging. However, faced with fluctuating prices, the company may have to either hedge more of its own production or intervene in the market to cushion the market against speculative interest—a net benefit to strategic users of the metal.

The price trends in the dealer and futures markets for PGMs have also been accentuated to a large extent by investor sentiment. During periods of weak fabrication demand, investor demand ebbs because investors prefer to purchase metals with strong and improving supply/demand fundamentals. Likewise, prices that are rising because of improved industrial demand are further boosted by increases in investor demand.

27. Is investor demand for PGMs likely to create a shortage of metal for fabricators?

Probably not. The PGM market and prices in particular are potentially more volatile than some other mineral markets because of the limited number of producers and the existence of an investor and speculator market. However, we doubt that growing investor demand alone would create serious material shortages. Indeed, even if the Soviet Union or South Africa disrupted supplies, triggering increased speculative hoarding and more active futures market trading, we believe that a combination of free market forces and regulatory measures would ensure that adequate supplies still found their way to the critical users.

If active investor interest were precipitated by high inflation or a rapid decline in the value of the dollar, PGM prices would rise. However, large platinum users with long-term contracts should continue to receive regular shipments, some at the contracted producer price, others at the flexible price. Users who depend on the free market for PGM supplies would be forced to pay higher prices for the material but would be unlikely, in the short run, to cut consumption dramatically. Platinum suppliers probably would increase output and draw down stocks to take advantage of higher prices, eventually moderating price increases.

28. How would investors react to an actual supply cutoff?

Under an actual supply-cutoff scenario, PGM hoarding probably would increase. In this instance, buyers of platinum and palladium futures contracts might force sellers to deliver the metal instead of accepting cash for liquidating positions. This would undoubtedly set off a scramble for metal and fuel further price increases. However, hoarders can only profit from price runups by eventually selling, and in an active market they risk holding the metal too long. If the supply cutoff suddenly ended or if significant amounts of mobile old metal [9] entered the market, their profits could shrink rapidly. We believe that PGM prices would eventually reach a level where investors would dishoard, and additional metal would find its way to fabricators. Stockpile disposals and the availability of secondary supplies of PGMs, particularly at the higher prices, would relieve any temporary supply crunch.

29. Could someone successfully corner the PGM market?

Not likely. Futures exchanges set limits on daily price movements of platinum and palladium contracts. Even with the leverage afforded by margin buying,[10] few investors are wealthy enough to buy most of the world's aboveground platinum and palladium supplies. Moreover, in the United States, the Commodities Futures Trading Commission (CFTC) regulates the futures market. In an emergency, the CFTC could force the exchanges to halt trading altogether or to restrict the volume of speculation and to diminish its effects.

[9] *Mobile old metal*—sometimes called *aboveground reserves*—is available for sale or recycling, given the right price. In the silver market, examples of *mobile old metal* are silver flatware, coins, and jewelry. When silver prices rose rapidly during 1979/80, these items reentered the market in dramatic numbers.

[10] All margins are relatively small in proportion to the total value of the contract. The current margin requirement for the NYMEX platinum contract is 7 percent. A speculator, therefore, can "buy" one contract—or 50 troy ounces, worth $19,000 at a platinum price of $380 per troy ounce—by putting up a margin of $1,330.