using significant quantities of platinum in the production of acids, as well as in hydrogenation and in the synthesis of hydrocarbons and hydroxylates. A further significant outlet was the use of PGM as catalysts during the production of high-octane petroleum from low-grade and natural crude oils. This new technique was adopted universally by the petroleum refineries. As a result, the platinum price achieved a new high of R60 per ounce in 1954.

Unfortunately, as so often happens in the PGM markets, the boom was short-lived, and a drop in demand for the metals occurred in 1955/1958. The oil industry had anticipated a large demand for platinum, but technological improvements, coupled with cutbacks in that industry and the consequent curtailment of installations, caused the industry to find itself oversupplied and overstocked with platinum metal. This excess was supplied to an already oversensitive market. This, coupled with the dumping of substantial quantities of PGM on to world markets by the USSR, contributed not only to a decline in prices to the lowest level in a decade (platinum R39 per ounce) but served to ensure, almost inevitably, the advent of the next periodic slump in the market. In 1959, the prices of platinum and palladium advanced, due to a more orderly selling policy by the USSR and palladium purchases by the USA. Early in 1963 the USSR again disrupted the PGM markets by selling large amounts of metal below market prices, but curtailed its offerings later in the year. The slump ended in 1963, at which time the South African mines could once more consider some expansion, even though from 1964 to 1968 supplies of platinum were tight. Rather unexpectedly, this expansion was to some extent foisted on RPM, and that company was compelled to mine the farm Brakspruit, adjoining its eastern border, on a tribute basis on behalf of a consortium of other major South African companies. In 1965, US suppliers allocated platinum to established customers at US $100 per ounce. US purchases of platinum increased sharply, due to the construction of new petroleum refining plants, so that in 1965, the dealer price was between 50 and 100 per cent above the producer price, increasing to two to three times in the year following. Concurrently, RPM also experienced the first competition to its previous PGM monopoly. Union Corporation announced the opening of Impala Platinum Mines in 1966, followed closely by Anglovaal's opening of the Atok mine in the eastern Bushveld in 1969 and the opening of Western Platinums by Lonrho in 1970. Prices declined, since South Africa had increased its output in each of the previous eight years.

In some respects, the South African platinum industry was lucky at that time. Increasing PGM demand in the early 1970s meant that the output of these new mines could be accommodated without causing a further market slump. New, long-term, and technologically more sophisticated outlets for the PGM promised some protection against a repetition of the periodic collapse of the market. Confidence was so strong that, by 1969, refining of the PGMs was undertaken in South Africa for the first time.

The first indication of potential new outlets was the enactment of the Clean Air Amendments Act by the USA in the early 1970s, which obliged manufacturers to introduce catalytic convertors in all motor vehicles to combat pollution. This was coupled to spiralling demand by the electronics and jewellery industries in Japan. Furthermore, the cataclysmic rise in crude-oil prices in 1973, and the rampant inflation that ensued, compelled investors to abandon paper currencies and seek refuge in hard assets. The South African PGM industry was a major beneficiary of that move. The fuel crisis and the resulting world-wide recession also brought about some delays in the PGM demand envisaged, since the anti-pollution laws were not rigidly enforced, and the introduction of catalysts, for instance, was delayed — causing some disruption of the planned production.

Nevertheless, the period after 1973 proved to be one of consolidation in the South African platinum industry, as producers struggled to repay the considerable loans raised to finance the doubling of their output capacities. In 1974, RPM acquired the holdings of the Eland Platinum Mining Co. from Amcor Mines and Mineral Holdings, in order to consolidate its future Amandelbult section. In 1975 it acquired the Atok mine from Anglovaal. The dramatic upheavals experienced in the world economy earlier in the decade had a striking effect on the markets for the precious metals, causing spectacular rises in PGM prices (the platinum price rose from US $155 per ounce in 1975 to an unprecedented US $1050 in March 1980) due to strong investor interest, chronic world inflation, and tight supply. However, in 1981/82, lower demand for the PGM resulted in lower prices.

In 1983, dealer prices for platinum and palladium increased substantially. RPM suspended its producer prices and began selling the metals at market prices, and trading activity at the New York Mercantile Exchange (NYMEX) escalated significantly. In 1984, the dealer price for rhodium almost doubled because of higher demand for rhodium in automobile three-way catalytic converters. In 1986, dealer prices for platinum increased by 60 per cent, owing to work stoppages at Impala and fears that South African supplies would be curtailed due to anti-apartheid legislation passed by the US Congress. According to Edwards and Silk, by 1985 the South African industry had milled 150 Mt of ore in its 55 years of operation, representing over 20 million ounces (622 050 kg) of platinum metal production — yet in the 5 years from 1953 to 1958, more ore was milled than in the previous 50 years.

In December 1988, the platinum market responded strongly to an announcement by the Ford Motor Company that it had developed a platinum-free automobile catalyst, and in March 1989, two scientists from the University of Utah announced that they had fused deuterium nuclei at a relatively low temperature using a platinum cathode immersed in heavy water. However, their experiment was never replicated, and remains a scientific mystery.

5.2. Sales of Primary PGM Production

5.2.1. *Agents for Contractual Sales of Primary Production*

As noted previously, RPM's output after refining is sold exclusively through Johnson Matthey PLC, particularly through its London and New York offices, although a part of the production is purchased by the Engelhard Corporation under a long-term agreement. Impala's output is sold worldwide exclusively by the Gencor group's marketing arm, Ayrton Metals Ltd and Endow Platinum in Japan. The production from Eastern Platinum and the enlarged Western Platinum is sold by Lonrho SA Ltd. Inco in Canada also markets its own PGM output. In Russia, the controlling body for sales of the precious metals is currently the 'State Committee for Precious Metals and Gemstones', which is attached to the Russian Ministry of Finance. This committee also has the responsibility for awardng export licences. The 'Platina' department of Almazjuvelirexport, a subsidiary of Rosalmazzoloto (the new name for Almazzoloto of Moscow, the holding company for all Russian precious-metal combines), has been responsible for the sales of the Russian PGM.

In 1955, RPM founded a platinum promotion organization called Platinum Guild International (PGI) in Germany, initially to study the jewellery market in Japan. At that time, gold imports were prohibited by the Japanese government, but imports of platinum were unaffected. Today, many organizations in the platinum industry contribute to the sales promotion of the non-profit PGI, which has its headquarters in Luzanne, Switzerland. The PGI now promotes sales of jewellery worldwide, disseminates information on the PGM, and supports all outlets (particularly those of platinum) to manufacturers, wholesalers, and retailers by offering sales training and promotional material. Since 1982, the PGI has also promoted the sale of small ingot bars. According to Cullen (1991), the mandate of the PGI has been to diversify the product range of the PGM in Japan, and to test the markets in the USA and Europe. He contends that, starting from a zero base, the PGI's efforts have been singularly successful in promoting demand: 14 000 kg (34 000 oz) in the former West Germany; 934 kg (30 000 oz) in Italy; while in Japan, the increase in demand was some 64 per cent, from 22 012 kg (505 000 oz) in 1986 to 36 023 kg (1 155 000 oz) in 1991.

Nevertheless, the PGI has not really been successful in promoting platinum jewellery in the UK, and although jewellers in Italy are certainly interested, the possibility of a significant and sustained demand for platinum in that country and the rest of Europe appears to be slight. It is possible that Hong Kong and China may become major outlets for PGM jewellery in the future.

It has been estimated that some 85 per cent of PGM trading and subsequent sales results from long-term, large-volume contracts concluded directly between mining companies and major consumers. In this way, the large producers are in a better position to defend their share of the market, as their production is secured by long-term contracts. Although such contracts bear an agreed discount of between 1 and 9 per cent (average about 3 per cent), the advantage to the producers is that they have a guaranteed source of funds to finance their capital requirements. The remaining 15 per cent of the sales remaining after the conclusion of these contracts is available for trading and sales on the open market.

Metallic platinum and palladium are available mainly as sponges (a term applied to imperfectly consolidated metal, the end product of refining), but basic forms such as powder, single crystals, sheet, ribbon, foil, bar, plate, and wire are also sold. Various sizes of coins, medallions, and ingot bars are available for investment purposes. Ruthenium, rhodium, iridium, and osmium metals are available as powders and in several compact forms, while all the PGM are available as all types of chemical salts on world markets. Purity standards for the metals have risen over the years — according to Loebenstein (1985), articles reputed to be made of platinum worldwide, as well as hallmarked platinum in the UK, must be 95 per cent pure; commercial-grade platinum must normally exceed 99,95 per cent purity, and palladium 99,9 per cent; while chemically pure platinum must be at least 99,999 per cent pure, particularly when used in thermocouples and resistance thermometers.

5.2.2. *Markets and Exchanges for Spot and Futures Contact Sales*

Daily trading at spot prices and sales of PGM futures take place at three main global markets (also called exchanges). The Tokyo Commodity Exchange (TOCOM) opens first, followed by the Platinum and Palladium Market in London, and finally the New York Mercantile Exchange (NYMEX). If major contracts between producers and consumers affect 85 per cent of the market, as implied, then the market share of these organizations is probably in the region of 15 per cent of total PGM sales.

A futures contact is a legal obligation to buy or sell a standard amount of a commodity, of a standard grade or quality, at a specified time in the future, according to formalized and strictly enforced trading rules. This hedging strategy allows the parties involved to act prudently, in order to limit the risk of fluctuations in inventory value. Futures trading is attractive to investors, since it lends itself to a variety of trading strategies. Loebenstein (1991) suggests that 'futures contracts help producers and consumers of platinum and palladium lock in prices and allow speculators an opportunity to make profits. By comparing the current price with the price for future delivery, one can surmise whether market participants expect prices to rise or fall'.