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"Silver Monetary Depreciation and International Relations" program
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MONETA, Hoenderstraat 22, 9230 Wetteren, Blegium, Fax (32) 93 69 59 25
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Selective adoption of mining and minting technological innovations in Habsburg colonial Mexico: Centralist policy or exchange rate management strategy?

Claudia de Lozanne Jefferies

Abstract:

Significant technological innovations in minting and mining emerged between the 16th and 17th centuries: improved technologies set new standards, which enhanced efficiency in both sectors. The reception of such innovations in Habsburg colonial Mexico was selective, however. Whilst most innovations in the mining sector were adopted and even further developed, minting activities remained centralised in the capital, Mexico City, and in accordance with medieval procedures. Although the first coin mill was adopted in Spain and installed in Segovia as early as 1583, it was only in 1732 that such device arrived in the Mexican capital, as part of the economic and political reforms carried out by Phillip V of Bourbon. Minting in Habsburg colonial Mexico, as far as technology is concerned, remained medieval throughout.

An analysis of the underlying reasons for this disparity in the embracement of technological change in the two industries will be carried out. Special focus will be placed on the characteristics of money and silver demand in different mining areas as well as on the geographical, political, social and economic factors which may have contributed towards the non- adoption of technological change. Policy changes in respect to money supply carried out by the authorities and their effects will be analysed to reveal a possible rationale behind the exchange rate system between minted coins and bullion.

Overview: Mines and Money in early modern Mexico

In his Political Essay, Alexander von Humboldt commented on the states of the mining and minting industries in the first years of the 19th century. According to his assessment, the level of technology, compared to European state of the art, was backward. In his statement, Humboldt was more sympathetic towards the mint, suggesting that it could have benefitted from better technological processes to enhance its productivity.[1] He did compliment the effective functioning of the mint, given its scale and the enormous volumes of coins that were minted. There was hardly anything commendable in the case of the mining industry, as he encountered "primitive" practices, especially in the area of extraction of ores.[2]

Humboldt's main criticism was of the digging techniques, for which he found no underlying logic. Shafts were dug randomly, following the course of a vein without any certainty as to whether or not good ores were going to be discovered. Digging was inefficient and unplanned. There were explanations for the digging practices criticized by Humboldt: since veins could be followed relatively easily by building tunnels into hillsides, design and planning was not, at least seemingly, necessary. Humboldt criticized the lack of communication between mines, given a shortage of tunneling connecting them. One further issue was the impossibility of using animal power to extract the ores, due to the absence of tunneling: human power (*tenateros*) was used to carry out ore extraction.

[1] Humboldt, 1811, vol..4:312-322.
[2] Humboldt, 1811, vol.4: 27-49; Bakewell, 1971: 134 refers to the passage in Humboldt's *Essai politique.*

Peter Bakewell[3] suggests reasons for these digging practices, one of which is related to institutional restrictions, namely article 23 of the Mining Ordinances (*Ordenanzas de Minas*) of 1584, which stipulated limits to the length and width that claims should have. There was also a limit to the number of claims that each miner could dig. This depended on whether or not the miner and the discoverer of the vein were the same person: only discoverers of veins were entitled to dig more than one claim.[4] The effect of such legislation was the production of many small claims along a vein. As pointed out by Backewell, such system obstructed cooperation and made further investment in infrastructure seem unnecessary.

An assessment of minting and mining technologies by a 16th or 17th-century observer would have delivered opposite conclusions to Humboldt's: minting techniques were medieval, whereas mines were comparable to those in Europe, in terms of technology, except digging techniques, which were bounded by institutional factors. Incremental technological innovations had emerged in New Spain, out of not only the need of adapting technological methods to geography and climate, but also the need of having to extract ores from deeper levels, as mines near the surface became exhausted. The extraction of lower quality ores, as richer ores were being exhausted, prompted Bartolomé de Medina (1497-1585) to develop his large- scale amalgamation process in 1555, which was quickly and widely adopted.

There is evidence of the reception of Agricola's "*De re Metallica*" amongst mining circles in 16th and 17th- century Spain and its colonies.[5] Mine draining and ore refining techniques described in Agricola's work were applied in 16th and 17th- century Mexican mines. One of the greatest problems faced by miners was the need to excavate shafts at deeper levels in order to extract the ore, as mines had to be drained. In most mining areas in New Spain, there was an absence of hydraulic power to carry out this task through mechanical activation so miners were forced to resort to animal or human power. In the particular case of underground water pumps, they had to be powered by humans, as mentioned before, the absence of a tunnel system made the use of animals for this purpose impossible.

Driven by necessity, miners developed "dry" versions of mechanical methods of draining, replacing hydraulic by animal power. The need to drain mines brought miners together in collaboration for the construction of drainage shafts, although this only happened towards the second half of the 17th- century.[6]

Shortage of water in northern regions of Mexico posed also a problem for one of the stages of the amalgamation process, which involved the use of water to separate the amalgam from other minerals. Agricola describes this technique when focusing on the procedures involved in extracting gold by amalgamation.[7] The mixture of ore and mercury had to be put into containers, to which water was added. The containers were fitted with paddles, activated by hydraulic power in the case of Agricola's version (see fig. 1). The shacking paddles help the amalgam separate from the stone residues of the ore. Bakewell[8] points out that such technique was adapted to the geography of northern Mexico through the introduction of the "*tina*" (vat), which is a technique similar to the one in Agricola's book, but on a grand scale and activated by mules, harnessed to a beam, walking in circles one floor above the vats.[9] It is not known who was the author of this technological innovation. Neither is it known whose idea it was to apply antimony as a catalyst to accelerate the amalgamation process, which was used for the first time in early modern New Spain. This practice could be accounted for as a further example of incremental technological innovation.

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[3] Bakewell,1971: 136.

[4]The first claim's maximum length was set at ca. 160 yards with a width of 8 yards. Any subsequent claim had to be ca. 120 yards in length and 6 yards in width. Bakewell, 1971: 136.

[5] Bakewell found a copy in the library of Zacatecas, Bakewell, 1971: 133.

[6] Bakewell, 1971: 133.

[7] Agricola, 1556 (1912): 299.

[8] Backewell, 1971: 140.

[9] Backewell, 1971: 140-142.

If there is evidence of mechanical know- how, proven by technical innovations in the mining industry, the question arises as to why technological innovations were not adopted or developed in the area of minting. One possible answer to this question is found in institutional aspects of the origins of the Mexico City mint, which was founded, at least in theory, to enhance the efficiency of trade in a growing economy, which acted as a link between Asia and Europe.

During the first years after the conquest, gold in paste (*oro de tepezque*) circulated by weight. The name of the Mexican currency still bears reminiscence to this phenomenon.[10] It was only after 1526 that gold was cut into standard pieces to ease its circulation. Petitions from the Council of Indies to found a mint in Mexico City were presented to the Crown as early as 1531, the mint was founded 4 years later.

The first coins to be produced in Mexico City were silver reales of denomination 1/2,1,2,3 and 4 reales which were generically called "*monedas de Carlos y Juana*", after Johanna of Castile and Aragon, and her son, Charles I. The production of 3- real coins was ceased shortly after, as the Mexican Indians were confused, giving them as 2 reales and receiving them for 4 reales. Copper coins of small denomination of 2 and 4 *maravedies* were also produced, but they were rejected by indians, despite being submitted to corporal punishment as an attempt to make them accept copper coins as a means of exchange. Already at this early stage, the idiosyncrasies characterizing monetary demand in New Spain were becoming evident. Means of exchange were used in Mexico before the arrival of the Spaniards, which Mexican indians continued to use until the 19th century, as Humboldt observes.[11]It was not the lack of familiarity with means of exchange but the concept of coin which was foreign to most of them. Coins were scarce throughout the colonial period. To meet the excess of demand for currency in most urban centres, the use of pre- Hispanic means of exchange was perpetuated. Cotton sheets, gold dust held in feather quills, tin and wood tokens, jade beads and cocoa beans were some of the means of exchange circulating in colonial Mexico.[12] Barter, circulation of silver in paste and the payment of tributes in kind also helped counteract monetary scarcity.

Of special interest is the use of cocoa beans as mean of exchange, as there was a proper system of account for it. Arturo Giraldez[13] has reconstructed the system as described in writings of missionaries such as the Franciscan Bernardino de Shagún (1499- 1590) and the Jesuit Francisco Saverio Clavigero (1731-1787). Observations in line with the monetary theory of the School of Salamanca were made for the case of cocoa beans: the Franciscan friar Toribio de Benavente Motolinia (1482-1568), pointed out the factors determining the value of cocoa beans: The size of its crop and distance from the production area.[14]

The varying volume and elasticity of money demand

Given the extensive territory of the Viceroyalty of New Spain, distance and geographic barriers shaped regions. When focusing on monetary demand, it is therefore necessary to distinguish between two generic types of indian population: Sedentary and nomadic. Sedentary indians were subject to localities through tribute systems and debt.[15] In such communities, as Garcia Ruíz states, currency played a secondary role, as self- sufficiency prevailed. In any case, silver coins were, given their relatively high value, outside the reach of sedentary indians, who used complementary means of exchange when they needed to. The demand for currency was higher in mining regions, as miners' salaries were paid for in specie. Mining regions can also

[10] Garcia Ruiz, 1954: 21.
[11] Humboldt, 1811, vol.3: 308-309. Brevoort, 1885: 3-5.
[12] Giraldez, 2012: 158, see Brevoort, 1885: 3-5 and Humboldt, 1811, vol.3:308-309.
[13] Giraldez, 2012: 152.
[14] Giraldez, 2012: 158.
[15] Garcia Ruiz, 1954: 26.

be divided into two types, as identified by Garcia Ruíz:[16]The first one is characterized by dense populations of sedentary indians with links to nearby agricultural areas. Such areas were what corresponds to the areas of Guerrero, Morelos, Mexico (City and State), Hidalgo, Michoacan and Jalisco. A second type of area was the northern frontier: today's Nayarit, Sinaloa, Durango, Chihuahua, Zacatecas and San Luis Potosi.

The main reason behind this division lies in the characteristics of the Chihimeca tribes, which in Nahua means "barbaric". Cichimecas were nomadic hunters and warriors, who defended their territory fiercely when mining towns were established by the Spaniards. Most northern regions are dry and cultivation of land for agricultural purposes is limited. The few fertile lands in the northern regions were used to produce provisions on farms for the mining towns, in the so called "*haciendas de labranza*". As Spaniards settled in the region, the need arose to attract labour force to work in the mines and in the provisioning farms. Retention of labour force proved to be a problem, as Chichimeca indians tended to abandon sedentary life to resume their nomadic habits.

Not being familiar with means of exchange, they did not value money as highly as sedentary indians. Spaniards found it difficult to create effective incentives.

The heterogeneity of money demand within the viceroyalty appears to be very high, based on the cultural differences between indigenous groups and on the geography. It is not only the volume of money demanded which varied from region to region, but the stability as well. Volume and stability of money demand may have varied within mining regions as well.

The Mexico City mint

Garcia Ruíz compares the management of the Mexico City mint, founded in 1535, with that of a private enterprise[17], although in his view, it also had a function in centralizing viceregal power and controlling the taxing rights of the Spanish Crown on silver production. The mint was monitored by the Royal Treasury (Real Hacienda), both centrally and in every locality. Levels of tax evasion are thought to have been very high, given the impossibility to maintain control in such a vast territory.

Seigniorage was introduced only in 1620, previous to which only minting charges (*braceaje*) were applied, plus 1% for the King.

The late introduction of seigniorage may have been part of the deal between the Crown and merchants to support the latter with the setting up of the mint.

Operated by a small group from the circle of wealthiest merchants in Mexico City, who had acquired their offices by purchase from the Crown, the mint's managerial structure was vertical. The high prices of mint offices acted as a barrier to entry, as well as a barrier to innovation. The hierarchical structure of the mint may explain in part the perpetuation of medieval technology at a time when innovations in minting had been adopted in Spain: The mechanical coin mill was installed in the Segovia mint in1583, and similar technology was used in Mexico only in 1732, after a change of dynasty. Throughout the Habsburg period, minting techniques remained medieval.

The mint exerted a high degree of power over the Viceroyalty's economy, given its ability to influence money supply: it determined increases in the quantity of silver in circulation. It also monitored the distribution of silver through a large network of merchants. The mint offices were sold at very high prices, which ranged between 8000 and 130000 *pesos de a ocho* and delivered yields of between 1600 and 14000 pesos per annum.[18] Putting these numbers into perspective, the largest single producers of silver had an annual output of between 8120 and

[16] Garcia Ruiz, 1954: 26-27.
[17] Garcia Ruiz, 1954: 23.
[18] There were other offices delivering lower yields, but there is no information about their prices. See Schell Hoberman, 1991: 85.

16240 pesos. The price of mining enterprises (*haciendas de minas*) in 17th- century Zacatecas ranged between 10000 and 70000 pesos.[19]

The head of the mint was the treasurer, whose office sold at 130000 pesos, the equivalent of 2 large mining enterprises (*haciendas de minas*), and yielded between 12000 and 14000 pesos per annum. Given the fragmentary information about costs in the mining sector, it is impossible to carry out a proper comparison between profits in minting and mining, although if it is taken into consideration that costs need to be deducted from the silver output in the mining sector to obtain profits, minting is likely to have been a much more profitable activity than mining.

The mint followed a hierarchical structure. The Treasurer had an assistant, the tenant (*teniente*), who supervised the mint and the foundry. The assayer (*ensayador*), whose office was sold for 56000 pesos and yielded 7000 pesos per annum was in charge of determining the quality of the bar and its fineness. The price of his office was the equivalent to the one of a large mining enterprise and its yield was equivalent to a large mining enterprise's lower range of output.

The weigher (*balansario*) was in charge of weighing the silver bars and determining the rate of tax to be applied to them. This office was worth 7000 pesos and yielded 1600-1700 pesos pa. The yield was high as a proportion of the initial investment.

An office of great influence was that of die cutter (*tallador*), who stamped the silver bars with the royal die. The price was 80000 pesos and the annual yield between 5000 and 6000 pesos. There was scope for further internal profits for the holders of this post, which explains the lower yield as a proportion of the initial investment.

There was also a notary (*escribano*) whose office was sold at 8000 pesos and yielded 1600 pa.

Other offices lower down the hierarchy were also sold, but information about the office prices and yields is fragmentary.

Throughout the Habsburg period, mint offices remained within a small circle of wealthy merchants. Schell Hoberman[20] found that the four higher level offices were held by 14 people between 1590 and 1660. Out of those 14 people, 9 were wealthy merchants and their sons and 2 were members of the landed aristocracy. It is likely that the offices were hereditary, as they remained within the same families for decades.

Key to the proper functioning of the monetary system were the silver merchants, whose role was to deliver the silver produced in the mining regions to the mint in Mexico City. All the officials of the mint came from the silver merchants' circle, and links with them were preserved. Every mint official, regardless of his level, had links to the network of silver merchants.

The levels of yield from high mint offices were high, however, the volatile nature of silver production had repercussions on the profits that mint officials could expect to obtain. Those profits were less volatile than the individual profits of mining entrepreneurs, as the mint was a hub for the production of the whole viceroyalty.

In terms of long- run profit trends, the mint followed the trend of the mining industry, increasing during the first 3 decades of the 17th- century and declining during the second 3.

There was a high level of tax evasion and smuggling of silver in the whole network of silver trade, and mint officials were well known to engage in such illegal activities. According to some estimations, 1/3 of the silver reaching Spain was smuggled.[21] Profits of mint officials are likely to have been much higher than those registered by the fiscal authorities.

The problem of scarcity of specie in 17th-century Mexico was endemic and it affected in particular mining regions. There was an attempt to address this problem by the Viceroy,

[19] Schell Hoberman, 1991: 74-76.
[20] Schell Hoberman, 1991: 85.
[21] Schell Hoberman, 1991: 91

Count of Monterrey in 1602, who put the problem down to the small number of silver merchants, whose role was to exchange bullion for specie, which they delivered from the mint to the mining regions. For this service, they charged a "discount rate", which was normally 1 real/peso, or 8.1 reales /mark of 65 reales. The total rate of discount was about 12.5%, and fluctuated according to the level of specie abundance. The rate fluctuated between 1 and 3 reales/peso.

The silver merchants were at the top of a wide network of merchants, linking the markets of credit and goods. Such links evolved from the needs of the mining industry. Originally, merchants were *aviadores*, supplying provisions to mining towns. Given the needs of mining entrepreneurs, goods merchants' activities diversified into the supply of currency and credit. *Aviadores* turned into *rescatadores* (rescuers), whose role was to supply the miner with currency, which the miner was due to repay in addition to the charge of 1 real/peso or 1 peso/mark, plus 5% interest within a time frame of 40-50 days.[22] Through this type of transaction, the merchant would receive silver with a higher degree of purity as a payment. The legal price of the silver mark was set at 65 reales, regardless of its purity. As silver produced by amalgamation was purer than silver produced by smelting, a mark of amalgamated silver was worth 67-68 reales and not 65. This meant that for every 65 reales of minted silver, the merchant or *rescatador* received the equivalent of 75 or 76 reales (taking into consideration transport costs and minting charges).[23]

There was a large discrepancy between the prices of bullion and of minted silver. Coined silver tended to flow out of circulation, serving as payment for imported goods and Crown taxes. The shortage of specie was partially covered by unminted smelted silver (*plata de rescate*), which circulated regionally. There were however legal restrictions on the use of unminted silver as a means of exchange.

Supply of specie and mercury in frontier mining towns

Frontier towns in colonial Mexico were typically newly-founded urban centres, whose raison d'être was the presence of rich silver ores in their vicinity. Provisioning farms were founded on the few fertile spots that could be found in mostly arid regions, and they produced food for the mining towns. The small number of suppliers of agricultural goods prevented the formation of markets such as the ones in areas where lands were more fertile and crops more abundant.

Goods prices were higher than in other regions,[24] as in addition to being in short supply, they had to be transported into towns from afar. Salaries were high, as labour was scarce and miners faced difficulties retaining nomadic indians as part of their labour force. As a whole, the frontier economy was subject to "ups and downs"[25], periods of scarcity and abundance of goods and silver, which did not always coincide with each other.

Demand for specie was higher in mining regions than in predominantly agrarian regions, as money was needed to pay for miner salaries. In order to obtain specie, the miners had to choose between taking the silver they produced to Mexico City to be minted, or buying coins from a merchant. The dependency of miners on merchants increased, as the option of contracting merchant services proved to be more convenient than having to transport their silver to the mint themselves. Merchants exchanged coins for bullion at a profit, and miners regarded this as unfair, so complaints were made to the Viceroy regarding merchants' profits and scarcity of specie, which were regarded as interlinked. There were other causes for miner dissatisfaction, related to the supply of mercury, a key input in the amalgamation process.

[22] Bakewell, 1971: 211.
[23] The risk factor has not been taken into consideration.
[24] Borah, 1994:68.
[25] Garcia Ruiz, 1954: 28.

The provision of mercury was a Crown monopoly, and there were three sources of the metal available to Spain: The mines of Almadén (near Cordoba), Huancavelica (in Peru) and Idria (in Slovenia). Most of the mercury consumed in 16th and 17th- century Mexico came from Almaden, although it was insufficient and mercury from Idria had to cover shortages, at least partially. Peru was suffering shortage problems of its own, as mercury production in Huancavelica was declining.

At a district level, mercury was distributed by "*alcaldes mayores*", who were a type of district majors who represented the Crown. The criterion behind the quantities of mercury granted to each miner was based upon previous levels of production. The Crown expected 1 *quintal* (101 pounds) of mercury to produce 100 marks of silver. "*Depósito* y *Consumido*" was the name of a system of credit through which a miner received a certain volume of mercury as a loan from the Treasury, and was expected to produce silver at the rate mentioned previously. The Treasury expected a settlement at the moment that the miner declared the silver for taxation purposes. As the distribution of mercury was based on level of previous production, the system favoured mines with high productivity at the expense of the less productive ones. Consequence of this practice was the bankruptcy of the latter and an increase in levels of industry concentration. From the miners' point of view, not only merchants (*rescatadores*), but also district majors (*alcaldes mayores*) were authors of trading abuses, as recorded in official documents.[26]

There was increasing indebtedness of miners towards merchants and towards the Treasury, via district majors. The inherent volatility of levels of silver output was one of the factors contributing towards the increase in miner indebtedness. This situation exacerbated towards the 1630's when the supply of mercury from Almadén was deviated to Peru, in order to counteract the effects of the declining output of mercury in Huancavelica.

The monetary policy of 1604: Its perception and effects in Zacatecas

During his last year in office as Viceroy (1603- 1604), the Count of Monterrey tried to address miners' complaints in frontier regions about practices carried out by merchants, which in his view, contributed to the problem of the scarcity of specie in the viceroyalty. Alfonso Garcia Ruíz[27] featured this interesting episode in his article about the history of money in the mining town of Zacatecas, transcribing passages of relevant documents which portray elements of 17th- century monetary theory and policy. Garcia Ruíz's work displays the heterogeneity of money demand in 17th- century New Spain, as well as the whole scope of complementary means of exchange which circulated alongside the silver *reales*, as a context to the account of the changes in monetary policy carried out in 1604 and their effects. This provides an excellent ground for an assessment of such policies from a monetary theory standpoint.

Zacatecas was a town of 2000 inhabitants towards the end of the 16th- century, producing an annual average of 500000 silver pesos. A growing local economy was accompanied by an increasing need of specie to pay miner salaries and production inputs for the mining sector. Local businesses were prone to sudden collapses due to scarcity of specie. Already as early as 1573, proposals had been issued for the creation of a mint in Zacatecas, which the Royal Treasury (*Real Hacienda*) had opposed, arguing that the reason for scarcity of specie was money outflow as payment for imported goods.[28] As a solution to the problem of outflow, the Treasury proposed the issue of a special regional coin, which was rejected because the proposed quantity of regional money to be minted (30000 marks) was regarded a far too low. There were other petitions by the Town to establish a local mint, but no action was taken by the Treasury.

[26] Schell Hoberman, 1991: 77.
[27] Garcia Ruiz, 1954: 20-46.
[28] Garcia Ruiz, 1954: 31-32.

The Royal Assay (*Real Ensaye),* whose function was to determine which bullion was to be taxed at what rate, as depending on the way in which silver was produced, different tax rates applied. Silver produced by amalgamation or smelting in a mining enterprise was taxed at 10% and that produced outside a *hacienda* usually by smelting was taxed at 20%.

The two- rate system lead to tax evasion through informal agreements between miners and merchants: merchants would acquire silver produced through smelting and have a miner declare it as produced in his *hacienda*. This way, the merchant would benefit from a 10% profit in tax savings. Miner indebtedness towards merchants facilitated such arrangements.

Taxed silver was allowed to circulate, albeit with certain restrictions and never outside the fiscal district in question. Untaxed silver was allowed to be used as a means of payment to merchants, but merchants themselves were not supposed to use untaxed silver to carry out further payments. Untaxed silver usually would bear a stamp with the name of the miner who produced it. It could be confiscated by viceregal authorities at any time, which made it an imperfect substitute for coins.

In 1604, action was taken by the viceregal authority, which constituted an attempt to solve the problem of scarcity of specie and to eradicate abuses commited by merchants and local representatives of the authorities, *alcaldes mayores*.

The functions of the Royal Assay (*Real Ensaye)* were enhanced, as it was due to replace the function of merchants as suppliers of specie and of mayors as suppliers of mercury. The Treasury, through the Royal Assay, would then distribute specie and mercury directly to the miners. It was intended that the discrepancy between the prices of bullion and specie would disappear, as the Treasury would exchange 65 reales of bullion for 65 reales of specie. This exchange was to be carried out by a single transaction, eliminating credit. As has been pointed out in previous paragraphs, merchants would pay 65 reales worth of specie in advance to miners, who then were due to deliver bullion worth 68 reales to merchants after about two months, plus 8 reales interest. As a consequence, merchants were buying the mark at 57 reales. The gross profit was 11 reales (before deducting minting and transport costs).

Miners welcomed the Treasury taking over such functions, although it was foreseen that by eliminating the discrepancy between the prices of specie and bullion, the price level would experience increases.[29]

As was predicted, the measure carried out altered the price of bullion relative to all other commodities and relative to specie. The price of bullion increased, while the nominal value of silver reales, remained unchanged. Hence, the relative price of specie in respect to bullion decreased, and so did the purchasing power of reales. As commodity prices increased, so did the demand for nominal cash balances. To this effect must be added the absence of credit, which was previously provided by the merchants as part of the exchange procedure of bullion against silver. Credit helped cover some of the excess demand for specie. Under the new, policies, such credit arrangements had been abolished, and this exacerbated the scarcity of specie.

An even higher degree of scarcity was the effect of the changes to money supply carried out by the viceregal authorities in 1604. Contrary to the Authority's plans, it was necessary to keep allowing the circulation of unminted silver *plata de rescate*, which was due to be completely banned, as part of the plan. New stipulations were then issued to regulate the circulation of bullion:[30]

-Bullion produced by smelting, which had neither been assayed, nor taxed, should be stamped with an "R" and circulate within the kingdom (Nueva Galicia, in the case of Zacatecas).

-Bullion produced by amalgamation had to be assayed before circulating.

-Bullion produced by smelting, which had been taxed at 10%, should circulate with the name of the miner stamped on it.

[29] Garcia Ruiz, 1954: 34.
[30] Garcia Ruiz, 1954: 35-37.

Other types of lower quality silver which had not been essayed or taxed, were also allowed to circulate with a miner name stamp, and the miner had to assume responsibility for its future assaying and stamping.

The practical aspects of transporting silver to and from Mexico City posed difficulties, which further obstructed the original plan to transform the supply channels of specie. The viceregal authorities had assigned a number of carts to transport bullion from the periphery to Mexico City which were called "*conductas*". In the case of the Zacatecas[31] area, carts were the target of frequent attacks by Chichimeca indians, despite their slight interest in silver, attacks on *conductas* were a form of retaliation by the indigenous population against the Spanish presence in Chichimeca territory.[32]

The viceregal attempt to eliminate the service offered by merchants as intermediaries in the money market was short- lived. The need for specie and credit, especially in mining areas, weakened viceregal regulations and the merchant's role as supplier of specie and credit was eventually reinstated. The number of merchants offering these services seems to have increased over time, which made the credit market more competitive, and, as a consequence, the "rate of discount" charged by merchants for exchanging specie for bullion on credit showed a downward trend throughout the 17th- Century.[33]

Medieval minting technology, low supply of specie and the discrepancy between the prices of specie and bullion: an exchange rate manipulation strategy?

The low supply of silver coins and the reluctance to adopt technological change, could be ascribed to the monopoly status of the mint in 16th and 17th- century New Spain. Institutional barriers to entry perpetuated its unique power to alter money supply. Its exclusive presence in Mexico City was in line with viceregal intentions to keep control over its operations, in order to ensure appropriate taxation, important source of revenue for the Spanish Crown.

The question remains as to whether the Viceroyalty of New Spain needed a more productive and less centralized mint. The episode of the *Real Ensaye* of 1604 suggests that level of issuance of specie, as well as state of the art and location of the mint may have been appropriate, as far as frontier economies are concerned.

The failed attempt to eliminate the difference between the prices of bullion and specie in 1604 reveals the nature of frontier markets in 17th century Mexico. This difference acted as a "buffer zone", within which prices and bullion production could fluctuate without affecting the nominal price of specie. Silver production was volatile; volumes produced varied from year to year, and this had effects on the price of bullion. The limited negotiability of bullion, accompanied by specie being in short supply, preserved the stability of the nominal price of specie, and prevented commodity prices expressed in reales from reaching higher levels.

The medieval minting practices in the Mexico City mint may have been appropriate for the monetary situation in frontier areas, despite the pleas for increases in the quantity of specie. With short supply and the transport costs incurred in providing Zacatecas with specie, the reales acquired more real value, which justified the discrepancy between the prices of bullion and specie. Complementary means of exchange helped cover the shortage of specie. A further advantage of a overvalued currency in short supply was its higher likelihood to remain circulating domestically rather than flowing out. Silver outflow had to be kept under control, as silver was the main export commodity in colonial Mexico, and over- production was likely to have a terms of trade effect. Bakewell observes the great quantities of silver flowing into the

[31] Zacatecas and Mexico City are 603 km apart.
[32] Garcia Ruiz, 1954: 37-38.
[33] Schell Hoberman, 1991: 90.

world economy in the 16th and 17th centuries caused a steady depreciation of silver in respect to gold, in particular between 1620 and 1640. This period coincides with high levels of silver production in Zacatecas.[34] Controlling the exchange rate, monetary supply and the value of the main export commodity were all linked to one same policy.

The money market in Habsburg colonial Mexico may have had an underlying logic pointing towards a deep understanding by merchants of the factors affecting exchange rate movements. This knowledge contrasted with the more pragmatic approach of miners, whose priorities were set at a microeconomic scale, with the sole objective of maximising profits.

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[34] Bakewell, 1971: 214.

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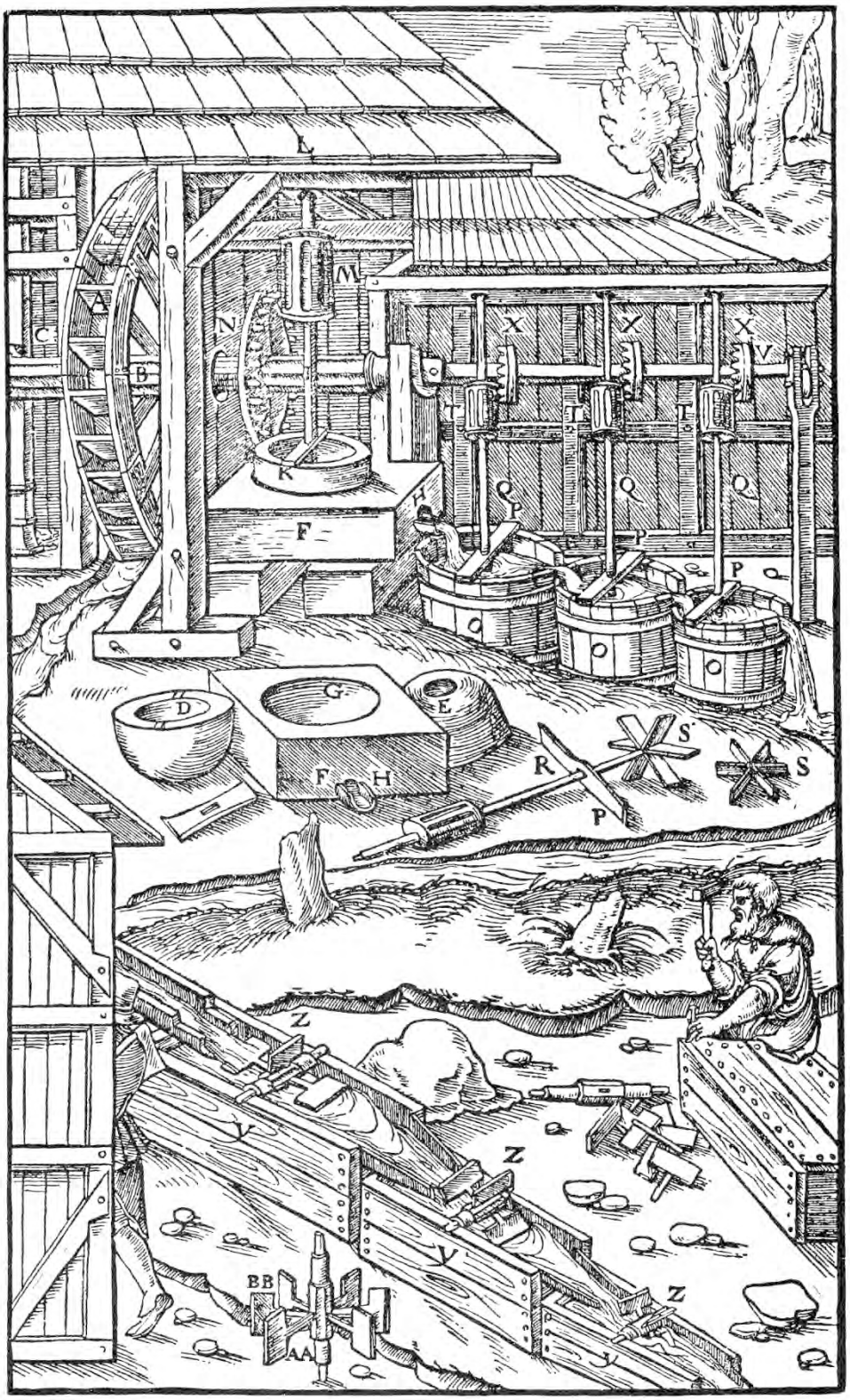

Fig.1. Source: Agricola, 1556.

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