

**COMPLEMENTARITY NON-INTEGRABLE AMONG
MONIES IN HISTORY: NATURE OF CURRENCY AS
VISCOUS, NON-UNIFORM, AND SEPARABLE STREAM**

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I. Non-Uniform Streams of Currencies

Observing streams of liquid materials, physicists ignore neither their non-uniformity nor changes of velocity in them. Otherwise the study of fluid dynamics could not be given birth to. In contrast social scientists have rarely paid attentions to incoherent aspects in actual monetary flows. In their studying money they appear to suppose that, with no friction or no loss of energy, an ideal fluid can be in circulation uniformly and eternally.¹ That is why few of them cast a doubt to fundamental assumptions such as the velocity held constant and uniform in the quantity theory of money, $MV=PT$.

Thus economists in the main stream have no hesitation to sum up the amount of various monies in order to measure a total liquidity. Even if they admit heterogeneousness in actual circulation of currencies, the diversities have been left outside their fields and rarely considered seriously. However, a variety of characteristic performances by currencies in history should not allow students, whose loyalty is devoted not to presumption but to reality, to accept such a rough integration. The problem is that the realities were too complicated to easily answer what made currencies diverse.

The difficulty to understand did not lie in the presence of plural monies but, actually, did in fluctuating exchange rates between them. As long as fixed rates among monies were kept, monies could be summed up with little problem. Though there is a defect in possibility that falling intrinsic value in a currency caused another currency to be undervalued and consequently hoarded, the integrity among existing monies remained no problem. As Hayek suggested, the Gresham's Law, what we call, could have availability, if any, just under fixed ratios among monies (Hayek 1976,

¹ As institutional study assumes transaction costs caused by asymmetry of information as a friction (Williamson 1985, pp.18-19). Unlike the cases of making contracts among individual traders with different knowledge as above, frictions appearing in monetary circulation, which I will argue here, are caused by currencies' own movements beyond personal perceptions.

pp.35-36). In the cases that a high convertibility prevailed over monies, they could be thought to merely make up some quantity demanded by market (Kindleberger 1989, pp.58-59). Indeed, it is easy to assume that, for example, silver coins worked in order to complement gold ones whose supply alone could not meet demand for money in general. However, can we apply the same assumption so easily to the cases between copper coins (or shell monies) and gold ones? Rather, it might be safe to say, what the former was expected to function could not be the same as what the latter were expected to do. If really not, was silver also just an additional complement to insufficient gold?

Even using the same word, there is a big gap between the complementarity among things which can be summed up and the complementarity which can not be. Here, we are going to argue the issue that a money can do what another cannot do and vice versa. In spite of the differences among monies either money is money. For it can mostly serve as means of exchange, measure of value and device for accumulating wealth, but not always do all perfectly. The imperfection made it necessary to combine several monies to serve together. History tells us that some assortment of monies might be necessary to efficiently meet demand for money in actual market.

Dissimilarity in functions of monies led some scholars, typically in African studies (Lovejoy 1982), to conceiving the idea of special purpose money. Implicitly or explicitly this thought presumes a linear evolutionary path from specially functioning money to generally working one or, in more simple term, from imperfect money to perfect one. Indeed, cheap copper coins appear to be favoured with circulation from hand to hand, while glittering gold currencies look suitable to be kept in safes. However they are true, even base metal currencies could actually serve to accumulate wealth as well, while precious metal coins could be so often used hand to hand to be worn. In reality mono-functioning money rarely existed.

It is high convertibility among monies that seems us to be perfect money. Meanwhile it is incessant oscillation of exchange rates that impresses us imperfections of monetary functions. Whatever materials the monies consist of, the fixed rates ruling them makes the monetary system apparently perfect. On the other hand, even if the list of materials used for monies is the same, fluctuating rates in their relationship give us a look as though each of monies would work in different purpose. Thus we confirm again that the point is whether compatible or incompatible the monies were.

II. Changeable but Incompatible Currencies

Why did the exchange rate among monies fluctuate? It might be the most persuasive way to attribute the cause to the change of intrinsic value. However, on hearing the answer historians could raise a lot

of instances against it. For example, it is obviously out of question to reduce instability of paper currencies circulating in medieval China to their producing costs. But let us examine two cases of metallic currencies which should be thought to be more dependent on commodity value of materials than other forms of currencies.

First, after silver became popular in China in the sixteenth century, copper coins and silver were concurrently in circulation. Though the dynasties tried to set fixed ratio between them, they could not succeed in preventing actual rates from diverted away official ones. The silver/coins ratios were different from region to region, from time to time. However, a pattern that copper coins appreciated in autumn prevailed. Can we assume that every fall the metallic value of copper hiked or that of silver fell? Certainly it is impossible.

Second, in the latter half of the eighteenth century Bengal had a variety of currencies circulated. Even if we put a focus just on silver rupee, the sort of rupee in circulation was different region by region. For example, in Mymensingh the Arcot rupee and the Sicca rupee were in circulation side by side. There Sicca was usually quoted higher than Arcot by about 20 percent. However, every autumn the rate between them became par. Both were made of the almost same material, silver, so there is no reason we can believe only the Arcot's side of intrinsic value appreciated seasonally (Mitra 1991).

I believe it is not necessary to add more examples in order to show that fluctuations of exchange rates among monies were not so dependant on the movements of intrinsic values. No doubt, in long term, quotations between metallic currencies should have, more or less, positive relationship with the movements of the price of the materials. However, it is also doubtless that alterations of intrinsic values were not sufficient to explain what caused the quotations of monies to fluctuate more incoherently.

The two examples apparently share a characteristic: A currency appreciated in autumn. In fact, it is no astonishment that a money supplied in payment for peasant products had strong demand after harvests. Copper coins in China were so well distributed among peasants that, generally speaking, they prefer copper coins to silver in their accepting payments for their products. Unlike the Sicca rupee which was preferable in payment of taxes and in remittance to Calcutta, the Arcot rupee in Bengal had more popularity in peasants and artisans. That is why appreciations of currencies popular with peasants came seasonally in China and India.

These cases have already given us a suggestion on what caused quotations among monies to be changeable. Apparently they tell us that not money in general but particular currency was necessary to meet the demand for the payment for peasants' products. The demand had strong seasonality. Significant part among the currencies handed to small producers might be used within very limited days of the whole year. It also means that large quantities of those currencies were not so active in other seasons. Currencies are not literally current all the time.

Here may be a question. Why were not any copper coins imported or produced additionally when they appreciated so much? If they were done incessantly, the appreciation of particular currency could disappear quite soon. In reality, such a flexible additional supply had not easily occurred. As for copper coins, their cumbersome nature could be attributed to their supply's inelasticity to demand. It might not be a wrong interpretation in this case. However, we can not apply it to the case of the Arcot rupee whose physical nature was not so different from the Sicca rupee. The point was that transactions were mostly done with spot, mostly daily pace. There, any late supply of additional money was useless. Equilibrium through arbitrage can work only when the gap in quotations became so significantly large that ill adjustment of timing in transactions became trivial.

The facts also explicitly show that not only intrinsic value but also extrinsic value could not determine the exchange ratio between monies. Appreciations both of copper coins in China and the Arcot Rupee in Bengal were beyond any control by a government or a merchants' organization. However, it does not mean that no governmental activities affected the monies rates. On the contrary, both silver in China and the Sicca rupee in Bengal appreciated in the period of collecting taxes. Fiscal administration in terms of money also gave another strong seasonality to the relationship between currencies.

III. Currencies Less Assembled

We have already approached to a crucial point. For both of the peasant side and the government side money was necessary, but not all the time. The period each side demanded for money were different. So were the suitable denominations of currencies. As if water is current in streams while it is stagnant in reservoirs, a currency is also running in some time and waiting in other time. Unlike peasants or the government, possibly merchants struggled to prevent the currencies of their own from stagnancy. From a viewpoint of modern concept a unified currency would be desirable to reduce uncertainty and cut various transaction costs. However, in reality, it was extremely difficult for single currency to flexibly meet the demands from all classes of society. X wants more current currencies in one time while Y does not want release them in the same time, and vice versa in another time (Appendix 1). What made supply of currencies so inflexible?

Money must be accepted by anyone other than its holders. Otherwise we can not call it money. A series of its acceptances are called a circulation. The circulation must start from an issuer. Currency is thought to return to the issuer after some interval. That is what social scientists have assumed as monetary circulation. However, in reality, currencies rarely returned to the issuers.

Rather, more precisely, they could not return without some enforcement.

The highest mark in the capability of assembling to the issuer might be found in the cases of precious metal coins with the re-minting system under regional authorities. Medieval archaeological findings in England shows that most hoards consist of less than five years old silver penny, and two thirds of coins were issued from the nearest mint (Blackburn 2005). It might be safe to say, as far as northwest Europe is concerned, responding the order of re-mint by kings, princes and barons, significant part of precious metal coins assembled to the mint where they had been issued from. Without strong commitments to monetary circulation by authorities possessing the right of issuance, we cannot explain this high return tendency.

Such a high propensity to assemble in silver penny has a clear contrast with unidirectional tendency in the movements of copper cash in East Asia. Though taxation in terms of copper cash prompted some part of the small denomination coins to return to the official treasure, the majority of them continued to stay after accomplishing their journeys from mints. The ruling Chinese dynasty had rarely challenged to uselessly replace own coins for those issued by former dynasties. Consequently it became rather common that a long time-span of copper coins were in circulation side by side. Thus, it may astonish Japanese (or Chinese) historians, who got accustomed to see hoards including coins whose inscriptions range from 7th century to 15th century (though not always reflect a real period of issuance) , that, in medieval England, the most hoards of the period comprise coins that are no more than five years old, at most twenty years. This contrast between high propensity to assemble and strong tendency to accumulate accompanied with another distinction.

In spite that Western Europe and East Asia share a point of having metal coins, before the 13th Century people in both regions appeared to live in another world. In England during the thirteenth to fourteenth century, loaves of bread varied in size according to the price of wheat. According to P. Spufford's explanation, 'It would have been impossible to charge a variable price for a fixed size of loaf, since there were no coins in circulation sufficiently small to accommodate the gradations in price involved'. Wages of construction workers in Southern England in the 1280s under King Edward I were only nine pennies per week. At the end of the thirteenth century the mint in England issued the highest amount of silver coins prior to the eighteenth century (Spufford 1988). Thus, well assembling propensity of currency often accompanied with its ill distribution among ordinary people, in which commodity currencies such as grains, cloths served as medium of exchange.

In contrast, in 1480 when the Ming dynasty had issued very little currency for half a century, vegetable sellers or transport workers in Beijing were said to spend twenty to thirty copper cash coins to feed their families for one day. However, leaving official paper currencies (which were another sort of currency relatively well assembled) aside now, due to the difficulty of assembling and the heavy cost of transportation, the system depending on cumbersome coins of fractional value did

not suit to encourage long-distant trades (Kuroda 2000). We may call the contrast appeared in both ends of the Eurasian continent as copper for the commoners in the eastern end and silver for the privileged in the western one.

The contrasts mentioned above reveal that currencies could not expect to be returned to issuers with no condition. In this sense, annual additional supply did not mean the increase of actual circulation of currency. Rather, leaving the portion of wear and tear aside, we might say that it just made up the amount failing to return. If so, what made currencies fail to return to the issuers or what caused currencies to be kept in the household? The fluctuating ratio among monies will give us a crucial hint again.

IV. Asymmetry in the Flow of Currencies

In late nineteenth century China, some Japanese commercial firms suffered from the shortage of copper coins in their purchasing peasant products such as raw cotton. It was serious for them, because bringing silver was no available to collect the commodities from small households who preferred the fractional coins. Abrupt surge of demand for the small changes hiked the rate of copper coins to silver, consequently hampered their businesses. Similar situations had been already reported in late eighteenth century Bengal. The Residents of the British East Indian Company found that silver rupees were too expensive to collect goods in rural markets where small denomination currencies, such as copper coins and shell monies *cowries*, were preferable.

China and India shared another important feature. In both countries those small denomination currencies appreciated so much after harvest. It looked quite natural, if we consider the strong seasonal biases of monetary distributions in peasant dominating economies. An investigation of peasant household in the early twentieth century China explicitly show that most of monetary income was obtained in a few months during and after harvest. The same tendency could be confirmed in other peasant economy such as Java (Wolters 2005). Considering such high a seasonal demand for money in rural area, it would not be surprising that the issuing amount of coins by the Reserve Bank of India surged every autumn and the interest rates of cities in China hiked after harvest seasons as well (Kuroda 2002).

The distribution of currencies from urban market to rural one, or from merchants to peasants, were concentrated in a few months. In other words currencies poured into small householders in a short term. On the other hand, monthly movements of their expenditures were rather flat than biased. It means that the velocity in the return flow of currency from rural market to urban one, or from peasants to merchants, were more constant than in the downward flow from city to village.

In addition, we may assume that, while large denomination currencies were necessary so much in urban markets, small ones were in demand in rural markets. Naturally downward flow of money need, more or less, accompany the exchange into fractional currencies, while return-up flow must prepare for the reversal changes. Considering the transport, exchange and other expense costs per unit, distributing currencies could be easier than collecting the same currencies to return.

Thus, the above two factors given, the relationship between the distribute flow of currencies to the lower market and the return flow to the upper market can be thought to be asymmetrical. Even if the annual amount of purchases by peasants from merchants in city would have been equivalent to that of sales in the opposite direction, components of currency flows would be different. Remind the tendency that spot transactions prevailed in rural market after harvest. Then, small denomination currencies were preferable to distribute among peasants for their agricultural products. However, merchants' side in upper level market had no strong wish to re-collect the small changes and transport them back. That is why, though they were exchangeable, the streams of large denomination currencies and small ones could be separable.

Trade must be bilateral. Value handed to opposite side should be thought to be the same as that obtained. However, compositions of monetary flow were not always in symmetry. Rather, as far as its flow between urban and rural markets is concerned, the current down to the rural markets did not match that up to the urban markets. Thus the stream appeared to be unidirectional like below.

Not Urban Market \square Rural Market

But Urban Market \square Rural Market \rightarrow Urban Market

As if a vortex appears from a stream, parting from currents of currencies among merchants, and between cities, the flow entering into a seasonal cycle of a rural market could make a round trajectory with few exits. At this stage the entire flow of currencies could be no longer in uniformity (Appendix 2).

Currency flows separated from main stream appear to be 'hoarded' because of their less connection with business activities in upper level markets. However, we must distinguish such an involuntary 'hoard' from voluntary hoard based on holder's choice, such as Keynes assumed (Keynes 1971b p.130). In fact the former was not in stagnancy but in action, though not easily integrated into main current.

V. Multiple Layers of Currencies' Circuits and Imaginary Money

Currencies' stream of non-uniformity did not always confine itself with just a dual structure like

Urban and Rural, or for long-distant trade and for local usage. It could be in triple or more multiple layers according to circumstances.

Take a look at an example in the case of the Maria Theresa dollar's circulation in early twentieth century Red Sea region. There we can find, at least, three layers of monetary circulation inserting the layer of the silver dollar of Austrian origin. Above the layer of the dollar's circulation the Pound Sterling or its compatible Indian rupee was in flow in the international or inter-regional circuits. At the boundaries between the two layers, depending on fluctuating exchange rates, native exchangers like shroffs and traders engaging in inter-regional trade were competing for making profits through speculation. On the other hand, below the dollar's flow a variety of smaller monies, such as the Italian 10 lira note, copper coin, cartridge, cloth, salt bar and beads, were in circulation with great regional favours. At the borders between lower two layers, though in smaller sizes, the business interchanging currencies were also common and prosperous.

Such a less regulated system given, it would be a great challenge to establish any monetary principle with fixed rates among concurrent currencies. For example, in Aden, May 1942, the Bank of Aden exchanged 140 rupees for 100 dollars (MTD) according to the British government's regulation, but 100 dollars were traded for 175 rupees in the black market. The truth was that, in purchasing vegetables for the British navy from Yemen, the payment had to be made in Maria Theresa dollars, or the rate in the black market had to be adopted if paid in rupees.

In the multiple set of currencies, the Maria Theresa dollar performed as a device switching local markets on or off the international one according to favourable or unfavourable conditions for the exporter side. The movement of annual issuance of the Maria Theresa dollar suggests that the currency became more necessary after the 1890s than before, as demands for agricultural products such as coffee, hides in the Red Sea region increased. The role as a buffering device in multiple markets made the Maria Theresa dollar survive with an overvalued privilege.

Besides the vertical movements interfacing between peasant households and international market, the dollar also worked well to combine urban cities through a grand circuit of their long journeys. The Maria Theresa dollars had left Aden continued to make their ways rather than returned the same route, and some of them finally destined Aden after one-way trips. Thus, the horizontal movements between cities as well as the vertical ones between urban and rural markets were also rather unidirectional than bilateral (Kuroda unpublished). Here we find a clear example of complementary relationship among currencies, in which any single money could not represent actual liquidity, but an assortment of monies could do.

Similar combination of currencies could be found in other areas and other periods including early twentieth century China and late eighteenth century India. Even more complicated assortments had not been so rare. The coexistence of numerous currencies, each of all behaving independently, made the merchants invent a device measuring them neutrally.

The most stable neutrality could be attained through abandoning its own substance. That is, what we call, the imaginary money. A typical case is found in some silver *taels* in Modern Chinese cities such as Ningbo, where various currencies, a number of silver ingots, silver coins, copper cash, private paper currencies etc were concurrently in circulation with no fixed quotation, but merchants made their trades among them in terms of a particular silver *tael*. The *tael* had no substance, in other words, nothing representing the unit of account did circulate. The unit was alive only in the account books of local merchants. The important is that such an imaginary unit of account had been found across the world and over the time. We can notice a similar system in keeping bills of exchange among late medieval European merchants (Boyer-Xambeu, Deleplace, Gillard).

So far I deliberately used the word, currency, only as money physically circulating. In this sense the ghost money, which was working only as a unit of account with no substance, cannot be classified into currency. I agree with Einaudi in his insisting that imaginary money should not be considered money (Einaudi 1953, p.237). It was secondary structure with no substantial presence. However, we can take it a part of complementary monetary system, as far as it worked to maintain assortments of currencies. Surely the imaginary money could work only in association with coexisting currencies.

Note that a monetary unit of account without substance, the imaginary money I defined above, must not be confused with a governmental paper currency or a central bank note of which value appears to be independent from any material substance. Their face value look imaginary, but they have substances of paper and are geographically in circulation across the nations. The imaginary money without substance could not be beyond some particular merchant circuit. There is a big difference between the monetary unit of account with substance and without it, which even Einaudi failed to clearly tell.

VI. How to Synchronise Concurrent Currencies

Finally I must be required to show how anyone could mould a variety of monies into a single monetary system. As far as I found, in some West European countries, typically England, the east coast of the United States, and, to less extent, Japan a sort of compatibility among monies appeared until around 1800, that is, before industrialization. As far as financial situations are concerned, those societies shared two characteristics: firstly the presence of a remittance system involving a public finance, in which a centre for offsetting worked well, secondly the prevalence of local credits institutions which could substantially save the usage of cash.² A well centred remittance system

² The case studies of rural finance in pre-industrial ages in England, France and Japan show that lending within a narrow community relationship substituted ready cash even in not so large sum transactions

could replace unidirectional round circuits connecting cities by some particular trade currencies such as the Maria Theresa dollar, while flexible credit supplies in local market could ease the tension between demand and supply of money, and consequently made easier to fix the local monetary unit of account to that of the upper level one.

The point does not lie in whether either factor existed but in the combination of the two factors. On one hand, a sort of exchange bill system was developed in the Mughal India (Habib 1967). China also had long history of transferring money in the long distance through paper bills. On the other hand, local credit supply like mutual credits was found in various ways in many societies. However, few societies before the twentieth century had knitted both threads to form a structure synchronising them. Any adaptor was necessary to adjust monetary circuits with different dispositions into single unit. The three regions mentioned above shared the experiences of the developments of local banks who could supply credits which were compatible with currencies circulated nationwide. Under a mutual dependence between the two conditions the space in which currencies bilaterally moved along both vertical and horizontal axes appeared. In China and India exchangers could make profits both in urban and rural markets, but they did not develop indigenous local banks. However, important is the difference of institutional structure behind the superficial issue of whether bank or exchanger. The different paths among China and Japan after the 18th century proves that, as for how to synchronise currencies, some combination of socio-political factors rather than the degree of commercialisation in peasant household happened to bring the different results (Kuroda 2006).

Another point is that the system moulding multiple monies into single one emerged in rather ahead than behind of any technological innovations, such as mechanization, using fossil energies etc. Unlike the emphasis by Sargent and Velde on the introduction of mechanised minting in transforming small changes into mere subsidiary coins in Western Europe, the tendencies decreasing independencies of lower denomination currencies in the Tokugawa Japan began without any technological alteration. Rather we must pay attentions to that the turn of the tide accompanied with the fall of rural markets where small denomination currencies could be indispensable in transactions (Kuroda 2002). The changes must be recognised to occur in institutions.

However, in considering the rolls of these institutions, we can not always take them what to reduce uncertainties as commonly believed.³ Complementary relationships among monies with no fixed rate appear to be full of uncertainty. Consequently successful legalization of a fixed rate among monies allures scholars to easily conclude that, by reducing uncertainties in monetary exchanges, *institutionalizing* monies into single domestic currency enable to decrease transaction costs significantly. Thus the story of triumphant national currency conceals other characteristics of

(Britnell 1986, Hoffman 1996, Ohtsuka 1996).

³ For example, see North 1990, pp.3-4.

institution held with human societies. In contrast, complementarity non-integral among monies in history reveals us that some assortments of monies with moving exchange rates could offer flexibilities to make supply meet demand in actual markets. Careful insights make us notice that such flexibility could work well enough to stabilize market activities. The diverse between bank and exchanger mentioned above must be interpreted along this context, not from any angle measuring how advanced or backward.⁴ Recognising broader senses of frameworks in human activities, we can free ourselves from a linear interpretation that a society should evolve merely from unpredictable to predictable or a market should develop from segmented to integrated.⁵

So far this paper argues about complementary relationship among currencies which were incompatible each other. Compatible relationship among monies can rarely avoid the discrimination between a standard money and others. The latter can be classified into subsidiary money, regardless of large or small denomination. There, what we call, a standard formula rules transactions. In this sense, under non-integral complementary monetary system, no subsidiary currency existed.

However, even the system compatibly consisting of plural currencies might not be the same as the system of single money. In the cases that non-official or informal currencies compatible with standard one are accepted without discount/premium their circulations must make up for something that official/formal one cannot supply. In other words, integral complementary relationship among monies also must be able to supply what cannot be given with substitutive monies. The principle, a money can do what another cannot do, may be applicable to this integral cases as well. Regardless of integral or non-integral, disarticulation between monies does mean some division of labour among them. Thus complementarity among monies gives us a clue to find a framework of real market, not of presumed one.

⁴ The business of local banks in early nineteenth century New England depended on discounting commercial papers rather than issuing banknotes or receiving deposits. The narrow sphere of commercial papers' circuits shows that bank did not develop on the basement of anonymous market activities (Lamoreaux 1994).

⁵ Through the study of the Atlantic African cases Guyer also insists that stabilization should be distinguished from integration (Guyer 2004, p129)

Appendix 1: The Reason Making Currencies Plural

In the case of single currency

$$M = \frac{P_u T_u}{V_u} + \frac{P_r T_r}{V_r}$$

In the case of plural currencies

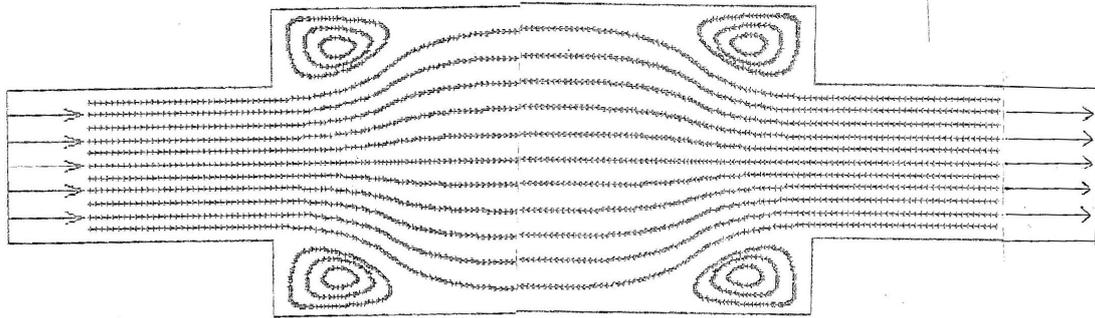
$$M_u = \frac{P_u T_u}{V_u}$$

$$M_r = \frac{P_r T_r}{V_r}$$

u indicates urban market, while r does rural one

In the case that single currency, for example, a silver coin, circulates in both urban and rural markets, if the elasticity of the currency supply is given not to be sufficiently high, the relationship between $P_u T_u$ and $P_r T_r$ must be negative. Imagine that the demand for grain in an urban market would become stronger. Without elastic additional supply of silver the trades in a rural market would have contracted. In addition, V_r can be assumed to be lower than V_u . If it is true, in order to keep the same size of trade, more silver would be necessary to hoard in the rural market. If the urban market side wish to keep the silvers, the best way is to make businesses in terms of non cash: commodity, credit, and service. Meanwhile, if different currencies, like a silver coin in an urban market and a copper coin in a rural market, circulated side by side without a fixed ratio, the actual exchange ratio between the two currencies would depend on $P_u T_u$ and $P_r T_r$ as well as on the supplies of both currencies. Both market can have more flexible monetary supply to stabilise making transactions in each market, while businesses ranging two layers of markets suffer from uncertainty due to fluctuating exchanging rate between two currencies.

Appendix 2: The Reason Making Current Unidirectional



Urban Market □ Rural Market → Urban Market

$$\rho_u v_u A_u = \rho_r v_r A_r$$

$$A = f(d, n)$$

v: velocity of currency

d : degree of spatial dispersion of traders

n : population independently engaging in trade

If the fluid is incompressible, the density (ρ) must be constant.

Assume that the size of both the purchase and the sale from urban to rural is the same in terms of a monetary unit. For example, the urban side sells a cloth of 100 dollars twice, while it purchases a bottle of wine of 20 dollars ten times. From the urban side view 200 pieces of one dollar coin appear to be paid and returned. However, in the sphere of the rural market the dollar may be converted into

another currency, such as brass penny, otherwise it would behave so differently from in the sphere of the urban market that its stream line might make a vortex. In the latter case additional supply of dollar coins must be made to keep the size of the trade. Thus we had better assume that the streamline of the currency in the sphere of the rural market has a different density from in that of the urban one.

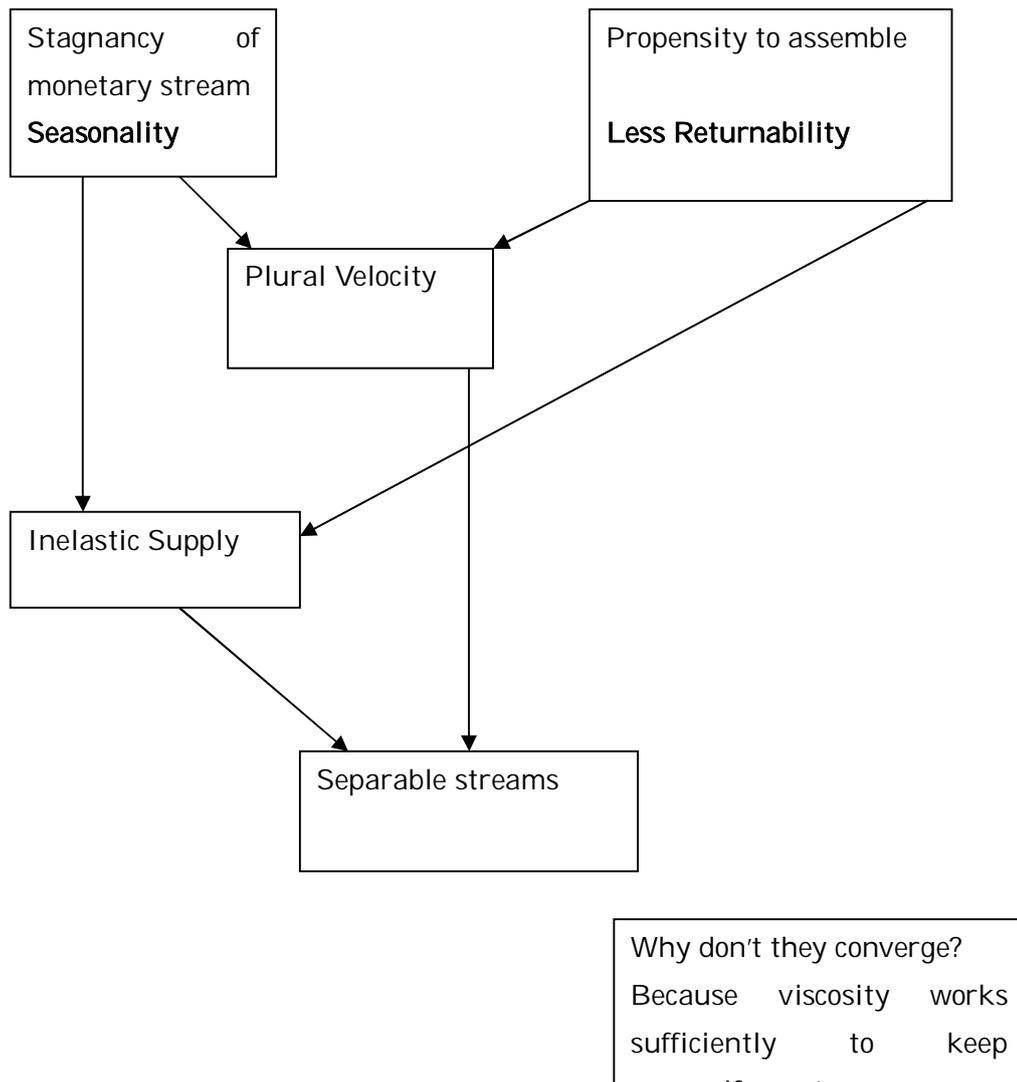
Appendix 3: The Reason Making Circuit Multiplied

$$\Delta h = \left(1 - \frac{A_u}{A_r} \right) V_u$$

h indicates the loss of head, or the size of vortex (separated stream) appear

The figure in Appendix 2 has been doubly connected: urban market and rural market. However, it can be triply connected or more times. That is, it can be thought to be n-ply connected. If the gap between A_u and A_r is so big that the so many vortexes appear, inserting the third currency layer of an intermediary size between two spheres may decrease the head of the loss. That is why the actual circulation of currencies can be in more multiple layers. The circulation of the Maria Theresa dollar in the Red Sea region was one of the cases.

Concept of Separable Streams



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