



# Modeling the Competition between Public Debt Creditors in Iran: An Application of Bankruptcy Games

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## Abstract

The Government in Iran plays a substantial role in the economy through financial interactions extended to various fields and many organizations. In recent years, investigation of such economic interactions indicates a considerable government debt for 2016, estimated at around 45% of GDP or two times of public budget. Given that Iran experiences tough sanctions and its oil export is restricted, many studies and experts assert that the government's income will decrease and its debt will increase even further. For creditors, this means that they are likely to face difficulties to get their money back and must compete with each other for that. The fierce competition among the government's creditors is quite understandable. The budget dedicated to paying off debts to private and public entities is only a tiny fraction of their demands. This paper tries to model the creditors' preferences using different asset allocation methods in bankruptcy games and finds a solution that may be consented. Results show that the Shapley Value dividing rule has the highest chance to be selected as social selection. Using this method, of the 450 thousand billion Rials in the public budget allocated to pay off public institutions and organizations (including private banks), the Social Security Organization (SSO) and government banks receive 137 thousand billion Rials (16.1% and 24.2% of their demands, respectively), private banks and credit institutions receive 127 thousand billion Rials (31%), public contractors receive 35 thousand billion Rials (26.3%). Other public entities receive 13 thousand billion Rials (28.3%) for their demands.

**Keywords:** Bankruptcy Games, Public Debts, Social Choice.

**JEL Classification:** H63, C71, D71.

## Introduction

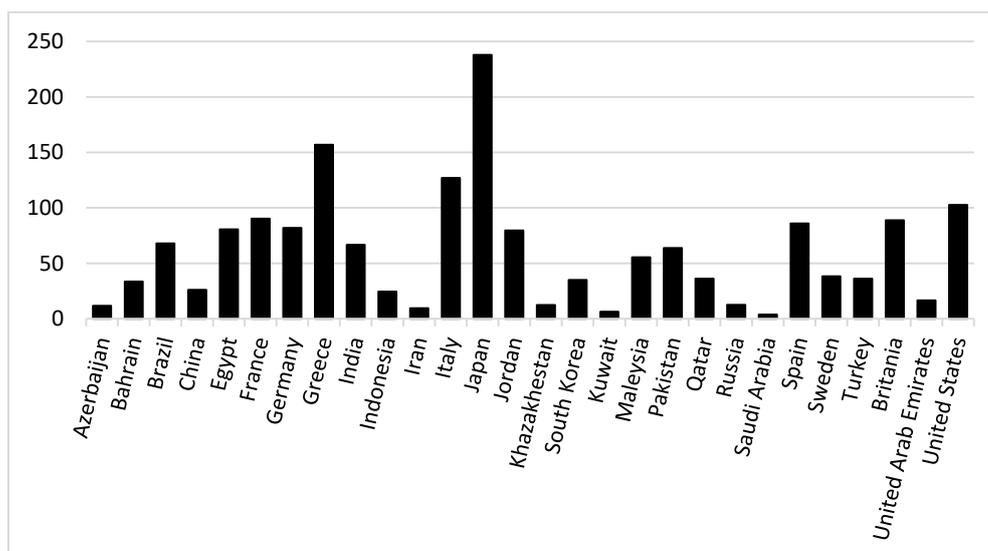
In the classical economic system, the role of government was minimal, and it was believed that private economic transactions must be free from government interventions, known as Laissez-faire. But in the last century, the perception of defects that was known as market failures eventually provided the ground for government interventions. Welfare state theories culminated the government's role, where government is recognized as responsible for welfare of the people. Today, the role and intervention of the government in Iran is very important. But implementing policies is costly to the government. Taxation is a major financing tool, which may not cover all the expenditures: a situation known as budget deficit. Public debts is in fact the accumulation of budget deficits from previous years. Bond issuance is a way for governments to finance deficits or to pay debts off. But since bonds need to be serviced and the government is required to pay their coupons and face values, in the long-run the amount borrowed must itself be paid off. Therefore, financing the deficits and paying off debts through bond issuance or any other borrowing method is deferred taxation for the next generations. Parliament research center of Iran in its new report "fixing budget deficit

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guidelines subject to policymaking constraints" published in April 2020 has characterized bond issuance to finance budget deficit as "a solution with relatively no political constraint and high income, but risky and non-sustainable" (Parliament research center 2020: 12).

Generally speaking, public debts and budget deficits may be plausible in exceptional cases like war, but in ordinary situations, non-stationary budget deficit and debt are considered the government's financial irregularity. Non-stationarity of public debt may negatively affect economics and lead to stagflation, as it is investigated by Salmani et al. (2018). Figure 1 shows the public debt ratio to GDP for some selected countries in 2012 obtained from the IMF's Historical Public Debt Database. The first point to be mentioned is the low ratio of public debt in oil-exporting countries like Bahrain, Azerbaijan, Indonesia, Kuwait, Qatar, Russia, Saudi Arabia and the United Arab Emirates. Thus, it could be expected that "as income from oil export increases, the amount of government borrowing and public debt decreases" (Ministry of Economic Affairs and Finance, 2016). Regarding oil price fall this year and its dampening effect on the government budget, hence, these countries, to achieve sustained growth, must "encourage foreign direct investment ... [and] more effort should be put to expedite the process toward decreasing the role of the government in the market and providing better incentives and institutional requirements for private investment" (Habibi and Sharif Karimi 2017: 17). The figure provided here for Iran includes only governmental debts to the banking system. The public debt office in the Ministry of Economic Affairs and Finance has reported 5600 thousand billion Rials as the total public debt for December 2016-January 2017 that is in order of 45% of GDP, 197% of budget of general government, and 59% of total public budget.<sup>1,2</sup>



**Figure 1.** Ratio of Public Debt to GDP  
**Source:** IMF, Historical Public Debt Database.

The other point is that the size of government indebtedness, around 45% of GDP is usual. This figure indicates that a 40%-50% public debt ratio to GDP is very typical. But what is problematic is that public debts in Iran are not in the form of treasury bonds to be serviced and paid off on their maturity. They are not securitized. These blocked and illiquid debts have made many of the creditors poor.

Nevertheless, the size of government indebtedness, regardless of its structure and trend, is

1. The Central Bank of Iran has reported GDP of 13151, public budget of 294, and total public budget (including budget of public corporations) of 978 thousand billion Rials at current prices for 2016.

2. Yet, it should be noted that the government's financial interactions are not unilateral, and in many cases, in fact it owes money from others. So that the government and government corporations demand 2566 thousand billion Rials.

still alarming, focused on by many studies. "How much is the optimal size of public debt" and "how much debt government can afford to pay off" are the first questions. In a report conducted by the Ministry of Economic Affairs and Finance (2016), it is attempted to specify a rule (an upper bound) for public debts in Iran. In this report that concentrates on government debts to the central bank and banking system, the optimum ratio of public debt to GDP for Iran is estimated around 20% using Generalized Method of Moments (GMM), and 32% by non-linear threshold regression. It then concludes: "experts more or less agree that there is no such a specified threshold for debt, because it depends not only on economic or social situations, but also on debt composition and market for bonds". Some other studies have focused on stationarity of public debts. Stationarity refers to a situation where the public debt growth is less than or equal to GDP growth. In other words, government income and expenditures in the future (public budget and the interest on debt of previous years) must move side by side. Otherwise, the gap between them grows infinitely. Khiabani et al. (2012), Fattahi et al. (2014), Komijani and Gudarzi Farahani (2016), Fathalizadeh (2016), and Falahati et al. (2018) are some of these studies examining stationarity of public debts and their affordability for government to pay them off. Interestingly, these studies reach almost a similar conclusion. Without income from oil export, budget deficit will increase, and no limit could be expected for public debts. Only oil income can make public debts stationary. In some of these studies, even oil income is concluded to be insufficient and, accordingly, public debt may decrease only if government's income from money supply, seignior age, is also assumed. These years, however, "sanctions and decrease of exported oil revenues, floods, epidemic of COVID-19, and again oil price fall have affected public budget seriously and has increase the budget deficit" (Parliament research center 2020: 1).

Aside from debt's size, its stationarity or affordability and the ways to finance it, this paper looking at the other side of the issue studies the behavior of creditors and their competition on debt collection, which is also interesting and important. Due to the significant weighty role of government in the Iranian economy, the domain of its financial interactions is extended to numerous public and private institutions, banks, companies, and individuals. Central bank, banking system, Social Security Organization (SSO), municipalities, contractors, and many other groups and organizations credit the government lots of money, whereas it is under tough sanction facing very restricted income from oil export, and is not able to pay its debts off in the near future. It is in such an atmosphere that a competition emerges among the creditors.

Although situations like this where the assets of a debtor is limited and not enough to honor all of the claims had been take place from remote ages, its modeling goes back to O'Neill (1982) who through historical examples describes resolutions that has been used from medieval times for this problem. O'Neill formulates this resolutions in mathematical representations and game-theoretic models and, then, derives a number of rules for division of not-enough assets between creditors. Alcalde et al. (2005) introduce a generalized form of Ibn Ezra's solution, pointing out in Alcalde et al. (2008) that "Minimal Overlap rule" proposed by O'Neill (1982) is in fact a composition of Ibn Ezra's proposal and the recommendation given by the "Constrained Equal Loss Rule" and in Alcalde et al. (2012) explore its restrictions in the complete domain of bankruptcy problems. Thomson (2015), a fascinating survey of the literature, could be referred by the reader to review all division rules, their restrictions and characteristics, and various revisions to them which are introduced by many scholars in previous decades. Recent studies have tried to bridge bankruptcy division rules to non-cooperative games which will extend its application. Ashlagi et al. (2012) show that for any claim game based on a rule satisfying efficiency, equal treatment of equals, and order preservation of awards, all Nash equilibria induce equal division. Csóka and Herings (2019) compared to standard bankruptcy games, treat debtor as a player and define a new class of transferable utility games called liability games. Tsay and Yeh (2019) show that

non-cooperative bargaining games strategically justify the constrained equal awards rule, the constrained equal losses rule, the proportional rule, and the Talmud rule.

Many other scholars also have utilized this approach to address conflicting claims. Schwartz (1993) used this framework to describe how creditors and debtors find private workouts that Pareto dominate a legal bankruptcy. Ansink (2011) integrates elements from the bankruptcy literature in a resource contest model to assess disputes on Arctic's oil and gas reserves between five coastal Arctic countries. Degefu et al. (2018) combine the bargaining theory with resource allocation and bankruptcy games to assess possible allocations of water and welfare in transboundary river basins under water scarcity.

This paper tries to model this competition using bankruptcy games. The remainder is organized as follows. Section 2 reviews the government's debts to main creditors in details, and explains the legal requirements about the repayments. The amounts of money that creditors demand and resources allocated to repayment are also discussed. Since demands are larger than dedicated budget, Section 3, using bankruptcy games, analyses various asset division rules, and accounts for what each creditor gets through these division rules. Section 4, first illustrates the creditors' preferences on the division rules, and then, assuming the same urgency or bargaining power for all creditors, specifies the most likely result to have consented among creditors based on different social choice rules. Finally, Section 5 concludes the paper.

### **Total Size of Public Debts**

According to Article 1 of the law of "resolving competitive production obstacles and improving the financial system of the country", the government has been required to provide the table of debts and credits of the state and state corporations in three classes of private individuals, private entities like cooperatives, banks, and credit institutions, and non-governmental public institutions/organizations. Detailed data on spring 2016 on the government debts and credits reported by the Ministry of Economic Affairs and Finance is shown below. Although estimations for spring 2016 shown in Table 1 indicate an amount of 4060 thousand billion Rials as public debts, the next report on autumn shows a higher amount around 560 thousand billion Rials.

As it is shown in the above table, the banking system is one of the key creditors. According to Mirbahari (2015), government debts to the Central Bank includes bank notes backing money issuance, deficit of foreign exchange reserves, securities and treasury bonds bought by the Central Bank, article 62 of "the public audit act" and other granted credits. Borrowing money from the central bank increases monetary base on which, through multiplication effect, more liquidity is created. Public debt to the central bank has been shown in Table 2. It increased from 131.6 thousand billion Rials in 2012 to more than 731.2<sup>1</sup> in 2018. Restricting the possibility of government to borrow has been investigated thoroughly, indicating that everything depends on the development of financial markets. It is in a developed financial market that the government's need for borrowing directly from the Central Bank disappears. Of course, restricting public debts to the central bank will not work if the indirect ways of getting loan is neglected. The clearest cases are the banks that may borrow from the central bank with a lower interest and lend it to the government. According to Table 2, government debt to the banks and other non-bank credit institutions amounted to 3041.3 thousand billion Rials in 2018.

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1. The huge increase in government debt to central bank in 2018 was mainly an accounting issue transferring the debt of banks and other depository institutions into government debt as explicated Note 5, Clause 6 of Article 1397 of Annual Budget Act.

**Table 1.** Debts of Iran's State and State Corporations, Spring 2016 (Billion Rials)

		Government's debts	Government corporations' debts	Total
<b>Private sector</b>	Private contractors and consultants (due to prioritization of capital projects)	125367	0	125367
	Private banks and credit institutions	410395	301540	711925
	Other private entities	284669	715762	1000431
	Staff	124820	77747	202567
	Other individuals	8266	18584	26850
	<b>Sum of debts to private sector</b>	<b>953516</b>	<b>1113633</b>	<b>2067150</b>
<b>State sector</b>	Public contractors and consultants (due to prioritization of capital projects)	1333	0	1333
	Public banks and credit institutions	565869	402608	968477
	Other entities	46004	1841454	1887458
	<b>Sum of debts to state sector</b>	<b>613207</b>	<b>2244061</b>	<b>2857268</b>
<b>Non-governmental public sector</b>	<b>Non-governmental public institutions</b>	<b>639312</b>	<b>13424</b>	<b>652735</b>
<b>Cooperatives</b>	<b>Cooperative entities</b>	<b>16</b>	<b>981</b>	<b>997</b>
<b>Foreigners</b>	Foreign entities	32573	338367	370940
	Foreign individuals	25	13	38
	<b>Sum of debts to foreigners</b>	<b>32599</b>	<b>338379</b>	<b>370978</b>
Total sum before deduction of duplicates and other governmental entities		2238649	3710478	5949128
Duplicates and other governmental entities		46004	1841454	1887458
<b>Total sum after deduction of duplicates and other government entities</b>		<b>2192645</b>	<b>1869024</b>	<b>4061670</b>

**Source:** Ministry of Economic Affairs and Finance, Bureau of Managing Public Debts and Liabilities of the State.

**Table 2.** General Government's Debts (Thousand Billion Rials)

	2012	2013	2014	2015	2016	2017	2018
<b>Debt to Central Bank</b>	131.6	158.3	183.6	244.1	273.8	269.0	731.2
<b>Debt to banks and other non-bank credit institutions</b>	567.4	728.3	1004.8	1191.3	1584.1	2025.0	2310.1
<b>Total debt to banking system</b>	699	886.6	1188.4	1435.4	1857.9	2294.0	3041.3

**Source:** Central Bank of Iran.

SSO is another key creditor of the government. Article 1 of the "comprehensive system of welfare and social security act" explicitly states that "entitlement of social security such that is specified in this act is the right of all people of the country, and its financing is recognized as a government duty". Yet the form of government contribution in financing attributed policies as stated in Article 7 as follows:

- At first, it is explicitly stated that the government, in accompany of the employer and insured person, should contribute to financing required resources. The contribution of the government is specified in Article 28 of "the social security act" as 3% of the insurable earnings of the insured person.
- Secondly, "government decisions or policies that have unfavorable effects on financial resources or expenditures and liabilities of pension funds must be compensated equivalently". For example, if the government for some political or welfare purposes wants to consider contribution exemptions or discounts for some employers or employees, by this law, it is required to compensate and pay for all unfavorable financial burdens which have been imposed.
- Thirdly, "government debts to organizations or funds active in social security must be accounted for and paid off in present values with an interest equal to the rate of treasury bonds. The purpose is to preserve the debts in real terms during the time and encourage the government in paying them off annually.

The amount of government debt to SSO is reported in Table 3. As can be seen, SSO credits 2539.3 thousand billion Rials from the government. Khandan (2018) predicted that till 2021, these debts went as high as 4500 thousand billion Rials, assuming the current trend is continued and the method of accounting such as debts does not change.<sup>1</sup>

**Table 3.** Government's Debts to SSO (Thousand Billion Rials)

	2012	2013	2014	2015	2016	2017	2018
<b>Government debt to SSO</b>	472.8	631.2	857.8	1120	1426	1943.2	2539.3

**Source:** SSO Financial Statements.

It should be noted that the amount of debts reported may not be approved by each of the parties, and there may be some disputes. For example, although government debts reported by SSO for 2016 are about 1420 thousand billion Rials, the government on the other side has declared only 850 thousand billion Rials as public debts to SSO according to the autumn 2016 report by the Ministry of Economic Affairs and Finance. Differences may be due to time mismatches or result from different methods of computation or disputes about interests. In this paper, detailed data reported by the government and the Ministry of Economic Affairs and Finance for 2016 will be utilized. The reason is the emphasis of policymakers in the Annual Budget Act on repayment of only debts definitely determined.

*Note 5, Clause 6 of Article 1397 of the Annual Budget Act*

Government, using Treasury Clearing Bonds (TCBs) and up to 20 thousand billion Rials, clears definitely determined public debts to private individuals, and private or cooperative entities raised by the end of the year 2017 with its (ministries or state institutes) definitely determined demands from those entities and individuals. Definitely determined demands of the government from individuals and private or cooperative entities which under Article 2 of "resolving competitive production obstacles and improving the financial system of country" has been transferred to public corporations might also be cleared with public debt to these corporations, and demands of individuals and private or cooperatives from the government due to prioritization of capital projects might also be cleared with their debts to banks and non-bank credit institutions through clearing debts of banking system to government.

- The government will be allowed, at the applicants' request, to clear the definitive demands of natural and legal persons, private, and cooperative entities, nongovernmental institutions, and sub ministry corporations of Energy and Agriculture for the government's withholding price subsidy – that has been created within the framework of the relevant laws and regulations by the end of 2016 – with their debts owed to the banks and non-bank credit institutions up to 1 thousand billion Rials as collective-expenditure. The settlement is made by settling the debts of the banks and non-bank credit institutions to the Central Bank, which has been established within the framework of relevant laws and regulations by the end of 2016. The government does this by issuing Treasury clearance bills as follows. This amount would be recognized as government debts to the Central Bank. It should not increase the monetary base. The permitted threshold of each bank or credit institute for clearing debts to the Central Bank would be determined by the Central Bank itself.

A. The minimum debt clearance through TCBs for individuals and private or cooperative entities is 500 thousand billion Rials.

B. Debt clearance of non-government public institutions, banks and corporations

1. SSO's demands are not definitely determined yet, and there are disagreements between SSO and the government on interest rate and the accounting method.

subsidiary to the Education, Energy, and Agriculture Ministries (solely due to the imposed price subsidies) and National Iranian Oil Company is 500 thousand billion Rials—the priority is with definitely determined demands of SSO. Up to 50 thousand billion Rials of this money is devoted to the Execution of Imam Khomeini's Order and its subsidiaries.

According to the above-mentioned Clause, 1000 thousand billion Rials is dedicated for clearing public debts through TCBs. Half of this amount, 500 thousand billion Rials, is devoted to individuals and private or cooperative entities, and 50 thousand billion Rials to the Execution of Imam Khomeini's Order and its headquarters and subsidiaries. The rest, i.e 450 thousand billion Rials, is dedicated to clearing the demands of non-governmental public institutes, banks, ministries, and SSO.

### Fair Asset Division Rules in Bankruptcy Games

As discussed previously in details, there is a huge amount of public debts to the central bank, banking system, SSO, municipalities, contractors, and other institutes or organizations. In contrast, the budgetary and financial capacity of government is limited, experiencing tough sanctions with insufficient income from oil export. The government is not able to pay these debts at least in the short time. In this situation, it is very likely to observe a competition between creditors to get back a larger part of their credit.

The total budget dedicated to clear public debts, according to Clause 6, Note 5 of 1397 Annual Budget Act, is 500 thousand billion Rials for the private sector and 450 for public entities. Table 1 indicates that the government debts to the private sector are reported as 543<sup>1</sup> thousand billion Rials that is almost equal to the budget dedicated for them. In other words, the budget covers the demands. Therefore, there will be no competition, and thus, they are not the focus of this paper. Government debts to the Central Bank and foreigners are also not considered in this paper. Because there is no requirement in the aforementioned act for the government to clear its debts with them. But this is different for the public sector. According to Table 1, the money that the public sector demand from the government is:

- Debts to public banks and other credit institutes (PB) as 566 thousand billion Rials;
- Debts to public contractors (Co) equal to 133 thousand billion Rials;
- Debts to other public entities (OPE) as 46 thousand billion Rials.

To this, we must add private banks and credit institutes that are excluded from other private entities by Clause 6, Note 5 of 1397 Annual Budget Act, and are listed aside from public entities, and definitely determined debts to SSO:

- Debts to private banks and other credit institutes (B) as 410 thousand billion Rials;
- Definitely determined debts to SSO equal to 850 thousand billion Rials;

Competition here among public entities is tough. For banks, SSO, public contractors, and other public entities that demand totally 2005 thousand billion Rials, only 450 thousand billion Rials budget is devoted as resources of debt treasury clearing bonds (TCBs) in 1397 Annual Budget Act (covering only 22% of demands). This paper aims to model public sector creditors' competition for receiving their demands. Asset division rules and competition over it can be modeled properly using bankruptcy games. For modeling purposes, after then the demands of various creditors would be shown as follow:

$$C = \{A|C_{SSO}, C_{PB}, C_B, C_{CO}, C_{OPE}\} = \{450|850, 566, 410, 133, 46\}$$

1. Total debt to the private sector is about 953 thousand billion Rials, of which 410 thousand billion Rials is owed to banks and credit institutes that are explicitly separated from other private institutes by Clause 6, Note5, Article 1397 of the Annual Budget Act. Private Banks and credit institutes must compete with public institutions. Therefore, the remaining debt to the private sector is about 543, which is almost equal to the budget dedicated.

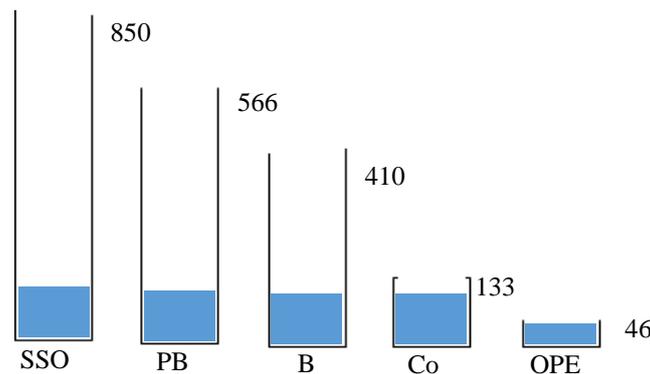
In bankruptcy and asset division among creditors literature, there are various rules or methods, which can be used. These rules would be discussed in this section as follow:

➤ Total Equity Division (TED) Rule:

This method that is shown in short as TED implies that assets must be divided equally among all creditors. Applying this method to our case, dividing the debts' clearance projected budget (450 thousand billion Rials) among five creditors, means that each creditor will get as 90 thousand billion Rials. Yet this amount is higher than the money that some creditors like other public entities (OPE) owes from the government, almost twice their demand, and thus it is not plausible. In other words, since the total dividend imputation rule only considers the number of creditors, regardless of their demand amount, some may get more than what they demand and, thus, the result may be implausible.

➤ Constrained Equity Division (CED) Rule:

This method implies that asset division is equal constrained to the fact that no one can get more than its demand. This version of equity division rule is attributed to Maimonides<sup>1</sup> at 12<sup>th</sup> century BC. To understand this rule, there is a simple geometric way without any need to complicated mathematical formulas. Suppose there are some cylindrical containers with the capacities same as the creditors' demands, and we want to fill them with an amount of water equal to total budget available. In other words, in this case, there are 450 liters of water to fill five containers with capacities equal to 850, 566, 410, 133, and 46 m<sup>3</sup> for SSO, PB, B, Co, and OPE, respectively.



**Figure 2.** Asset Division among Creditors by Constrained Equity Division Rule  
**Source:** Research finding.

The method is that water will be poured in the containers equally and eventually till the smallest container, the OPE, fills up. At that moment, every container has received 46 liters of water. This means that 230 thousand billion Rials from the total budget 450 has been consumed. Then, the remained budget, 220 thousand billion Rials, will be dedicated in the same manner to the containers that have still some empty space. At this step, the other four containers each get 55 thousand billion Rials more. The final result of asset division based on this rule is shown below. What creditors received has been shown in absolute amount and as a percentage of their demands.

$$CED = (SSO, PB, B, Co, OPA) = (101, 101, 101, 101, 46) = (\%11.9, \%17.8, \%24.6, \%76, \%100)$$

1. Moses ben Maimon, commonly known as Maimonides.

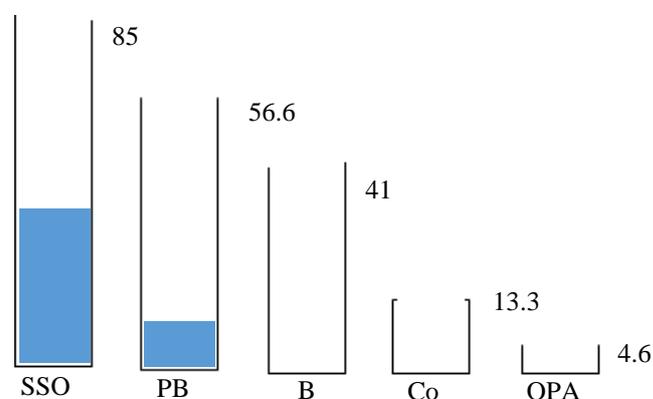
➤ Loss Equity Division (LED) Rule:

In previous methods, creditors with the least demand would get all they owed, while others underwent some loss. An alternative method is to equally divide the loss, so that all creditors lose equally. The total demands sum to 2005 thousand billion Rials, and the total budget dedicated to clear debts is only 450. Thus, the total loss (total demands less than budget available) is 1555 that if be divided equally, every creditors undergo a loss about 311 thousand billion Rials. Since other public entities (OPE) and public contractors (Co) demand less, 46 and 133 thousand billion Rials respectively, they may get nothing of the budget dedicated, but they cannot undergo even more loss. Therefore, we need to impose the same restrictions as the CED rule. The total loss is distributed equally and eventually among creditors. Other public entities (OPE) are the first group reaching their full capacity that undergo a loss of 46 thousand billion Rials, getting nothing for their demands. At this stage, others have also undergone the same loss, which means that in sum and till now 230 thousand billion Rials of total loss is distributed. But still 1325 thousand billion Rials loss is remained that should be distributed among other four creditors. The other group is public contractors that by undergoing more loss as much as 87 thousand billion Rials reach their full capacity. Public contractors (Co) like other public entities (OPE) get nothing for their demand, but they suffer more loss. At this stage, the four creditors have undergone the same loss as public contractors, but still 977 thousand billion Rials has remained to be distributed among creditors with highest demands. The next group is banks that reach their capacity, and the loss distributed raises their demands. They also get nothing from the budget. After undergoing 277 thousand billion Rials equally, the remaining loss as 146 thousand billion Rials must be distributed among SSO and Public Banks (PB). Each undergo 73 thousand billion Rials more losses.

Finally, the loss that the creditors have undergone is as follow. Other public entities (OPE) lose 46 thousand billion Rials, public contractors (Co) lose 133, and private banks and other credit institutes (B) lose 410 by receiving nothing back of their demands. Public banks (PB) lose 483, and get only 83 thousand billion Rials from the dedicated budget. SSO also lose 483, and gets back 367 thousand billion Rials. The final result is as follow:

$$LED = (SSO, PB, B, Co, OPA) = (367, 83, 0, 0, 0) = (\%43.2, \%14.7, \%0, \%0, \%0)$$

The loss is distributed equally, so that no one can lose more than what they demand for. The amount of money that these creditors receive can be obtained by subtracting their loss from their demands. Small creditors receive no part of their demand, because the loss is distributed equally as much as they had demanded. Large creditors also undergo more loss in an absolute term, but they receive part of their demands. This is also shown in Figure 3.



**Figure 3.** Asset Division by LED Rule

**Source:** Research finding.

➤ Proportional Division (PD) Rule:

Another method of asset division is that only creditors' demands be considered and, then, divide the budget available in proportion to those demands. The total budget available to extinguishment of the debts is 450 thousand billion Rials that covers 22.4% of total sum of the demands. If the budget available is divided in the same proportion of demands for all creditors, then SSO get 191 thousand billion Rials, Public banks (PB) 127, Banks and other credit institutes (B) 92, public contractors (Co) 3, and other public entities (OPE) 1. In this method, all the creditors receive money as the same proportion as the ratio of the dedicated budget to the total sum of demands.

$$LED = (SSO, PB, B, Co, OPA) = (191, 127, 92, 3, 1) = (\%22.4, \%22.4, \%22.4, \%22.4, \%22.4)$$

➤ Shapley Value (SV):

Suppose the government says to its creditors that the sooner one demands, the sooner will be paid. A rule known as first come, first serve. Different forms of queue may be formed. Since there are five creditors, number of possible arrangement in the queue is 120 (5! Permutations). Table 4 reports the different forms of queue and the amount creditors receive based on their location in the queue. In the first case, suppose SSO is the first in the queue, and because its demand exceeds the total budget, others in the queue would receive nothing and the whole 450 thousand billion Rials budget would be dedicated to SSO. Since it doesn't matter how others locate in the queue, the other 24 states (4! Different permutations generating with arrangement of others behind SSO) have the same result. These are numbered as 1 to 24 in Table 4.

In another group of possible states, public banks stand at the front of the queue, and since their demand is also greater than the total budget, a result similar to previous cases would take place. The whole 450 thousand billion Rials budget is granted to public banks (PB). Again, forms of queue behind public banks are not important and 24 arrangements have the same results that are numbered from 24 to 48 in Table 4. In the third group of possible states, private banks and credit institutes (B) stays at the front of the queue, and others locate behind it in different arrangements. In these possible arrangements, private banks receive their total

**Table 4.** Asset Division According to Different Forms of Queue

Arrangement	The queue form	Budget dedicated to creditors
1-24	SSO, ...	(SSO, PB, B, Co, OPA)=(450,0,0,0,0)
25-48	PB, ...	(SSO, PB, B, Co, OPA)=(0,450,0,0,0)
49-54	B, SSO, ...	(SSO, PB, B, Co, OPA)=(4,0,41,0,0)
55-60	B, PB, ...	(SSO, PB, B, Co, OPA)=(0,4,41,0,0)
61-66	B, Co, ...	(SSO, PB, B, Co, OPA)=(0,0,41,4,0)
67-72	B, OPE, ...	(SSO, PB, B, Co, OPA)=(0,0,41,0,4)
73-78	Co, SSO, ...	(SSO, PB, B, Co, OPA)=(317,0,0,133,0)
79-84	Co, PB, ...	(SSO, PB, B, Co, OPA)=(0,317,0,133,0)
85-90	Co, B, ...	(SSO, PB, B, Co, OPA)=(0,0,317,133,0)
91-92	Co, OPE, SSO, ...	(SSO, PB, B, Co, OPA)=(271,0,0,133,46)
93-94	Co, OPE, PB, ...	(SSO, PB, B, Co, OPA)=(0,271,0,133,46)
95-96	Co, OPE, B, ...	(SSO, PB, B, Co, OPA)=(0,0,271,133,46)
97-102	OPE, SSO, ...	(SSO, PB, B, Co, OPA)=(404,0,0,0,46)
103-108	OPE, PB, ...	(SSO, PB, B, Co, OPA)=(0,404,0,0,46)
109-114	OPE, B, ...	(SSO, PB, B, Co, OPA)=(0,0,404,0,46)
115-116	OPE, Co, SSO, ...	(SSO, PB, B, Co, OPA)=(271,0,0,133,46)
117-118	OPE, Co, PB, ...	(SSO, PB, B, Co, OPA)=(0,271,0,133,46)
119-120	OPE, Co, B, ...	(SSO, PB, B, Co, OPA)=(0,0,271,133,46)

**Source:** Research finding.

demand of 410 thousand billion Rials, and the remaining budget as 40 thousand billion Rials would be dedicated to the second creditor in the queue. Behind public banks, four other creditors may stand. These states are shown in Table 4 as 49 to 72. Other creditors in the third and the next locations would be ineffective. Every creditor standing in the second location has a greater demand than the remaining budget and, thus, no budget would remain after. Therefore, each subgroup labeling with the second location includes 6 (3! Different permutations) ineffective arrangements of creditors in the third and the next locations.

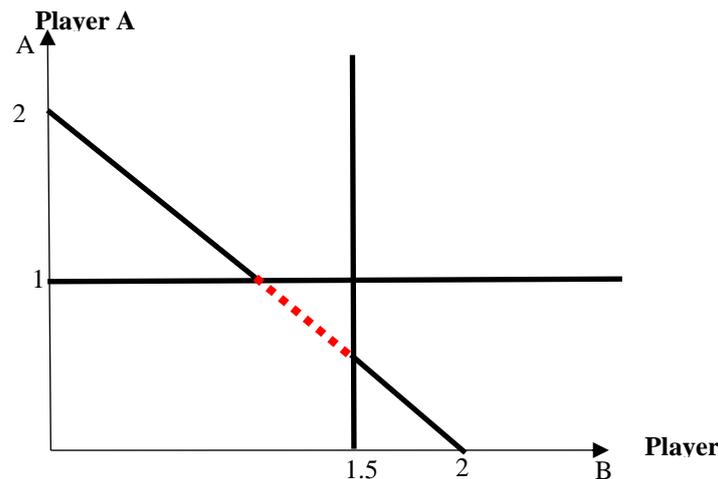
In the fourth group of arrangements, this time public contractors (Co) locate at the front of the queue, and receive all that they demand for as 133 thousand billion Rials. The rest of the budget as 317 thousand billion Rials (total budget available of 450 minus the amount received by public contractors) will be dedicated to others in the queue behind public contractors. If the second location in the queue is occupied by SSO (numbers 73-78), public banks (numbers 79-84) or private banks and other credit institutes (numbers 85-90), the whole budget remained would be consumed, and nothing would be left for the third person in the queue. But if the second location is filled by other public entities (OPE), not only they receive their 46 thousand billion Rials, but also still 271 remains for the third location in the queue. These are shown in Table 4 from 91 to 96. In the last group of arrangements, suppose other public entities (OPE) stand at the front of queue, and receive all that they were demanding—46 thousand billion Rials. If the second location in the queue is occupied by large creditors, e.g. SSO, public banks or private banks, they will receive all 404 thousand billion Rials remaining budget, and nothing would be left for the third creditor in the queue shown by arrangements from 97 to 114. But if public contractors (Co) stand at the second location, not only they will receive their demand of 133 thousand billion Rials, but also still 271 will remain for the third creditor. These arrangements were also shown in Table 4 from 115 to 120.

The Shapley Value is computed as the average amount of money that creditors get in these different possible states of queue formation. What creditors receive based on Shapley Value (SV) rule has been shown below.

$$SV = (SSO, PB, B, Co, OPE) = (137, 137, 127, 35, 13) = (\%16.1, \%24.2, \%31, \%26.3, \%28.3)$$

➤ Uncontested Demands and the Game Core:

There is another old method to resolve conflicts shown in Figure 4 for a two player case. Suppose players A and B have demands respectively equal to 1 and 1.5, while there are only 2 units of assets to be divided between them. The sloping line shows the share that each player may receive from the asset division. It indicates a constraint known as group rationality stating that the whole asset should be divided among creditors. Oppositely, there are some individual rationality constraints indicating that players cannot receive assets more than what they have demanded. For example, player A can receive maximum 1 unit of assets equal to its demand. In Figure 4, this constraint is shown for player A by the horizontal line, and for player B is shown by the vertical line.



**Figure 4.** Asset Division Based on Core of the Game  
**Source:** Research finding.

Part of the assets that conflict and would be contested is shown in Figure 4 in dashed red line and is known as the core of the game. One way of conflict resolution is to pay each player their uncontested part of the assets, because with no conflict they can be recognized as the owner of those parts. And equity division rules are applied only for the contested part of the assets, or the core of the game. For the case discussed here, the uncontested parts of the assets are shown in Table 5. For SSO and public banks (PB) whose demands are more than the budget available, there are no uncontested demands. So, the results are the same as before depending on the division rules being applied.

**Table 5.** Demands and Uncontested Demands of the Creditors

	SSO	PB	B	Co	OPE
Demands	850	566	410	133	46
Uncontested demands	-	-	40	317	404

**Source:** Research finding.

➤ Nucleolus of The Game

Nucleolus of The game is in fact simultaneous equity division of assets and loss, which were discussed before. In this method, the following algorithm is used.

- ✓ Demands are divided by two, and the assets should be dedicated to this half demand based on the rule of assets equity division. The game will be ended if the whole assets are consumed, but if some are left, we will go to the second stage.
- ✓ Using assets and demands that remained from the previous stage; the total loss could be calculated. At this stage, the total loss would be divided equally among creditors following LED rule.

For the case discussed here, half of the demands of SSO, public banks (PB), private banks and other credit institutes (B), public contractors (Co), and other public entities (OPE) are equal to 425, 283, 205, 66.5, and 23 thousand billion Rials respectively. Since the whole budget available is 450 thousand billion Rials, the game would be over at the first stage, and no budget would remain unutilized. Following the constrained asset equity division (CED) rule, at first, OPE reaches its maximum capacity. At this moment, all creditors have received 23 thousand billion Rials, and 335 remains from the budget. Dividing equally this remained budget among other four creditors, public contractors (Co) reaches their maximum by a more amount of 66.5 thousand billion Rials. The rest as 161 thousand billion Rials would be divided equally among three other creditors. The final asset division result is shown below.

$$Nu = (SSO, PB, B, Co, OPA) = (12, 12, 12, 6.65, 2.3) = (\%14.1, \%21.2, \%29.3, \%50, \%50)$$

## The Social Choice of Asset Division Rule

Asset division rules among private and public banks, SSOs, public contractors, and other public entities were discussed in the previous section. Assets dedicated to each creditor were different based on various rules. In constrained asset equity division rule (ED), it was seen that the creditor with the smallest demand receives proportionally the greatest part of the money it owes from the government, or in LED, assets mainly would be dedicated to the creditors with the highest demands. Therefore, creditors are not indifferent to the division rule that would be enforced. So, their preferences for the different rules of division are defined. Here, we suppose that creditors prefer the rule that repays them a higher proportion of the money they owe or a higher proportion of what they demand. Preferences of creditors on various division rules, based on the previous section calculations, are shown below in Table 6.

**Table 6.** Preferences of Creditors on the Various Asset Division Rules

SSO	LED > PD > SV > Nu > ED
Public banks (PB)	SV > PD > Nu > ED > LED
Private banks and other credit institutes (B)	SV > Nu > ED > PD > LED
Public contractors (Co)	ED > Nu > SV > PD > LED
Other public entities (PBE)	ED > Nu > SV > PD > LED

**Source:** Research finding.

For example, SSO prefers LED rule over proportional division (PD), prefers PD over Shapley Value (SV), prefers SV to Nucleolus (Nu), and finally prefers Nu to asset equity division (ED) based on the money it receives back from the government. Assuming these different preferences, there would be no division rule that all creditors would unanimously prefer. Then, the question arises as to how creditors consent over one division rule that is called social choice in the literature. There are various ways to resolve the disagreement between the creditors for the rule to be enforced.

### ➤ Social choice Mechanisms:

Social choice is a framework to obtain social preferences from individual preferences. To specify the result of contrasting individual preferences and to obtain the social preferences, the following mechanisms can be applied.

#### ✓ Plurality Voting

In this method, creditors are asked to vote for their favorites from various options. Applying this method, public and private banks vote for Shapley Value (SV), while SSO votes for LED, and public contractors (Co) and other public entities (OPE) select asset equity division (ED). With the votes counted in this election, there is no winner in the first round because both the ED and SV win two votes. None of the rules wins more than half of the votes, and as a result, the election goes to the second round, in which creditors must elect their favorite division rule between ED and SV. In the second round, Shapley valued three votes win the election because SSO prefers it and votes for it. Thus, Shapley Value (SV) asset division rule is chosen socially.

#### ✓ Pairwise Comparison

Voting options in this method are not compared in groups, but are compared in pairs. This pairwise comparison in the literature is known as the Condorcet method. Table 7 reports the results of pairwise comparisons between different division rules.

**Table 7.** Pairwise Comparison to Determine the Condorcet Winner

	<b>ED</b>	<b>LED</b>	<b>PD</b>	<b>SV</b>	<b>Nu</b>
<b>ED</b>	-	ED	ED	SV	Nu
<b>LED</b>	ED	-	PD	SV	Nu
<b>PD</b>	ED	PD	-	SV	Nu
<b>SV</b>	SV	SV	SV	-	SV
<b>Nu</b>	Nu	Nu	Nu	SV	-

**Source:** Research finding.

For example, as presented in Table 6, by comparing equity division (ED) with LED based on the creditors' preferences, four out of five creditors prefer ED. In fact, SSO is the sole creditor that votes for the loss division rule, LED. Therefore, in Table 7, cells corresponding to the first row and second column or the reverse, first column, and second row, are filled by ED as the winner of this comparison. As another example, in a pairwise comparison between equity division (ED), the first row, and proportional division (PD), the third column, ED is placed as the winner because three of the creditors, i.e. contractors (Co), private banks (B), and other public entities (OPE), select equity division rule while only two, SSO and public banks (PB), prefer proportional division.

After filling the table and making all the pairwise comparisons, we can see that each division rule has won or failed in which combat. For example, ED in pairwise comparisons has won two of the comparisons against LED and PD, while has failed in two others against SV and Nu. Based on the results of pairwise comparisons between different division rules, reported in Table 7, it can be seen that Shapley Value (SV) is the Condorcet winner, the rule that has won all pairwise comparisons, and LED is the Condorcet loser, the rule that has failed in all pairwise comparisons. Thus, if using this method, it is the Shapley Value (SV) division rule that is selected as the social choice.

✓ Borda Count

This method is based on the ratings or scores attributed to different division rules, and the result will be the rule with the highest score. Since there are five different division rules, preferences are rated from 1 (lowest rate or least preferred) to 5 (highest score or most preferred). Previously, preferences were declared in ordinal scale, saying for example SV and ED are preferred to LED division rule by public banks, but we could not measure the interval between them or see how much SV or ED are better than LED. By rating preferences, now we know that for public banks (PB) the SV is ranked first (score 5) and ED is fourth (score 2), and thus, SV is four points higher than ED. In this way, we are able to penalize the very non-preferred division rules. Scores of each division rule obtained from creditors' preferences are summed up and reported in Table 8. For example, LED is rated as the last option for four creditors (rated as 1 by each creditor) and as the first option for SSO (rated as 5), in total earning 9 points. Based on these ratings, it could be seen again that Shapley Value (SV) obtains the highest score, and is the most preferred division rule or the social choice of creditors.

**Table 8.** Scores or Borda Counts of Division Rules

<b>Nu</b>	<b>SV</b>	<b>PD</b>	<b>LED</b>	<b>ED</b>
17	19	14	9	13

**Source:** Research finding.

✓ Median Voter

Political economics maintains that parties shift their slogans from extremes toward the median voter to maximize their chance of victory, under the majority voting law. In other words, if voters are sorted based on some single-peaked preferences, the median voter is in

the middle, and therefore, imitating it requires at least 50% of the vote. Here, if we sort creditors based on their demands from the government, private banks, and other credit institutes are the median voters, and therefore, their preferred division rule, i.e. Shapley Value (SV), has the greatest chance of winning.

➤ Fallback Bargaining:

Fallback bargaining is the maximization of the minimum scores or choosing the best option among division rules with the lowest refund. The process is in this way: First, creditors express their favorite choice, but then in order to reach an agreement unanimously, they are ready to back to their other options with lower payoffs. Regarding our case here, looking at creditors' preferences on various asset division rules, it can be seen that at first two of the creditors, public and private banks, will choose Shapley Value (SV) and two others, public contractors and other public entities, will choose equity division rule (ED) as their preferred options. Since no unanimous agreement can be reached at this stage, creditors have no way but to look back to their second preferred division rules. At this stage again, they cannot agree on something unanimously, because Nucleolus (Nu) as a new option comes up with three votes. So, they inevitably go back further. It is in the third stage that SSO, public contractors (Co), and other public entities (OPE) finally give consent to Shapley Value (SV). In other words, Shapley Value (SV) is the first division rule that creditors can agree on it unanimously. So, if unanimity is the criteria, and creditors are willing to look back at their lower preferences to reach unanimity, that division rule would be Shapley Value (SV).

To sum up, it can be said that using either social choice rules i.e. plurality voting, pairwise comparison and Borda count, as well as median voter, or unanimity based on fallback bargaining, it is the Shapley Value (SV) division rule that has the highest chance to be selected socially. According to this rule, assets would be divided between creditors as below:

$$SV = (SSO, PB, B, Co, OPE) = (137, 137, 127, 35, 13) = (\%16.1, \%24.2, \%31, \%26.3, \%28.3)$$

Of the 450 thousand billion Rials budget dedicated by Note 5, Article 1397 of the Annual Budget Act to pay off the government debts, SSO and public banks each receive 137 thousand billion Rials that is 16.1% and 24.2% of their demand, respectively. Private banks and other credit institutes (B) receive 127 thousand billion Rials (31%), public contractors 35 thousand billion Rials (26.3%), and other public entities (OPE) 13 thousand billion Rials (28.3%) on their demands.

## Conclusion

In the previous sections, it was stated that the government in Iran had borrowed money due to its strong presence in the economy and its extensive financial relationships, and owes to various individuals and entities. In addition, it was discussed that under this circumstance that the economy of Iran suffers from tough foreign sanctions, and as a result, its income from oil export decreases, the government is very likely to encounter tighter financial conditions, and its debts will increase even further and faster. Therefore, no outlook there could be seen for government to pay its debts at least in a short time. In this condition, creditors must compete with each other in getting their money back. This paper was aimed to model competition among creditors to get their money back from the government.

In Note 5, Article 1397 of the Annual Budget Act, a total of 1000 thousand billion Rials is dedicated to government debts. The first paragraph explicitly dedicates half of this budget to the private individuals and entities that credit money from the government. This amount is almost equal to their demands, and thus, there should not arise any competition among

creditors to get their money back. Based on the second paragraph, another half of the budget, i.e. 500 thousand billion Rials, is dedicated to paying off the government debts to public entities and banks (private and public) in general. Of this budget, 50 thousand billion Rials is set aside for the Execution of Imam Khomeini's Order, and 450 remains which is less than a quarter of the total demands of other specified creditors. Therefore, here the competition between creditors on getting their money back must be tough.

The creditors' competition to receive most of their credits from the limited budget available was modeled using bankruptcy games. Various asset division rules were examined, and it was revealed that by using them, how much money or what proportion of demands would be received by different creditors. Since division and devotion of budget are different under these different division rules, the creditors have different preferences over these asset division rules. After arranging the preferred division rules for various creditors, their social choice or the most probable division rule that might be consented among creditors was thoroughly investigated. Here, there are some implicit but important assumptions. The first assumption is that there is no dictatorship. Because in the case of dictatorship, the asset division among creditors is determined by the dictator's wishes, and there is no fair division rule to be discussed. There would not be also any place for the creditors to participate in decision making and reaching an agreement.

The second assumption is that creditors are only different in the amount of money they demand. Their urge for getting their money back and their power in bargaining over other creditors or governments are assumed as equal. Of course, getting money back is important for any individual or entity, but it is reasonable to expect that creditors' urge depends on their financial position or ease of access to other income resources. For example, in case of financial distress or liquidity deficit, banks may borrow from the Central Bank, or SSO may rely more heavily on the income of social insurance contributions that it collects from employees and employers, but contractors do not have such alternatives. However, these important factors may be investigated in other studies. Instead, this paper focused on fair division rules and creditors' consent over something, which is called social choice. Using these rules and games here to model a challenging issue as public debt is in itself of interest showing the importance of this study.

The result is interesting. Although creditors had different preferences over asset division rules, using various criteria for reaching an agreement, from social choice mechanisms as plurality voting, pairwise comparison, Borda count, or median voter to methods like fallback bargaining, all led to Shapley Value (SV) as the unique socially favorite asset division rule. According to Shapley Value, assets would be divided between creditors as below:

$$SV = (SSO, PB, B, Co, OPE) = (137, 137, 127, 35, 13) = (\%16.1, \%24.2, \%31, \%26.3, \%28.3)$$

It can be seen that creditors with greater demands such as SSO and public banks have received greater amounts, but proportionately to their demands, it can be said that they were not successful. On the other hand, small creditors as public contractors (Co) and other public entities (OPE) have received a greater proportion of their demands. Private Banks enjoying their position as median voters receive considerable budgets either in absolute or in proportion. In reality, however, a more divergent division will be expected if other factors like urgency are considered. One can expect that SSOs and public banks will not urge as much as others for two reasons: First, the accessibility of SSOs to other income resources such as social insurance contributions provide a better financial position for them than public contractors that may face liquidity distress more easily. The second reason is the agency problem. The organizations and entities are ruled by depositions that represent a large unorganized population. Therefore, in fact, the division should be more divergent, which

means SSO will receive an even smaller proportion of their demands, while private banks and contractors will be more successful.

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