



Article

Plato as a Game Theorist towards an International Trade Policy

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Abstract: In the beginning of the second book of his *Politeia* (Republic) Plato in passage 2.358e–359a–c raises the issue of the administration of justice as a means of motivating people to behave fairly regarding their relationships and when cooperating with each other because, at the end, this is mutually beneficial for all of them. We argue that this particular passage could be seen as a part of a wider process of evolution and development of the institutions of the ancient Athenian economy during the Classical period (508–322 BCE) and could be interpreted through modern theoretical concepts, and more particularly, game theory. Plato argued that there are two players, each with two identical strategies, to treat the other justly or unjustly. In the beginning, each player chooses the “unjust” strategy, trying to cheat the other. In this context, which could be seen as a prisoner’s dilemma situation, both end with the worst possible outcome, that is, deceiving each other and this has severe financial consequences for both of them. Realizing this, in a repeated game situation, with increasing information on the outcome and on each other, they choose the “just” strategy so achieving the best outcome and transforming the game in a cooperative one. We analyze this, formulating a dynamic game which is related to international commercial transactions, after explaining how such a situation could really arise in Classical Athens. We argue that this is the optimal scenario for both parties because it minimizes the risk of deceiving each other and creates harmony while performing financial transactions.

Keywords: Plato; fairness; commercial transactions; international trade; game theory

JEL Classification: B11; C71; C73; D81; F33; K20; N23



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1. Introduction

During recent years, scholars have researched various aspects of the ancient Athenian economy of the Classical period (508–323 BC), showing its modern character and institutional setup in many areas, such as banking, insurance and other financial services.

Bresson (2016a, 2016b), O’Halloran (2018), Economou and Kyriazis (2019) and Bitros et al. (2020) among other authors, have analyzed the market-type of economic institutions that ensured the smooth functioning of the Athenian market while Bitros and Karayiannis (2008) have analyzed the related issue of entrepreneurship in Athens under free market economic principles. Stewart et al. (2020) focused on market specialization and division of labor in Classical Athens. Economou and Kyriazis (2017, 2019) focused on the importance of creation of an institutional setup which effectively protected private property and commercial contracts through the establishment of courts. These courts known as *Heliaia*, provided justice rapidly through highly capable and experienced jurors. Such commercial cases, known as *dikai emporikai* were judged within a month, so that justice was provided rapidly among litigants (Cohen 1992). The speed of litigation is of high importance so as to reduce significantly transaction costs (Coase 1960), and protection of commercial transactions through the law so as to become credible is a pivotal intertemporal axiom (Hodgson 2015).

Bresson (2016a, 2016b), Harris and Lewis (2016), O'Halloran (2018), Bitros et al. (2020), and Economou et al. (2021) analyze the international commercial orientation of the Athenian economy. During 478–404 BCE Athens benefited by international commerce, mainly with its 316 allied states (according to Figueira 1998, p. 52) through the Delian League and this led its economy to achieve economic growth, at least for some specific years. Thus, Athens had actually managed to integrate a large part of the Eastern Mediterranean region into a unified area of economic cooperation and security through its mighty fleet. In relation to this Halkos and Kyriazis (2010) and Bitros et al. (2020) analyzed the development of a prosperous “shipping industry” that finally led the port of Athens, Piraeus, to become, according to Cohen (1992, p. 141) an international entrepôt of antiquity. In the next section we further elaborate on the recent literature regarding the Athenian economy during the Classical period.

In this paper we argue that by trying to raise the issue of justice in human affairs, Plato, who as a citizen of Athens experienced the practice all these economic development of his times, tried to interpret the different outcomes according to whether a party deal is conducted (i) in an unfair manner (“unjust”), or (ii) in a fair manner (“just”). For Plato, the best way to ensure a mutually prosperous situation for two parties is to behave in a “just” way since this decreases the risks of wrongdoing between two parties which is important for both of them to be satisfied through their cooperation. We believe that Plato developed some ideas through which, in a wider sense, he could be considered as a pioneer “game theorist” ever as we purport to show in the next sections and this aspect of his writing has not been analyzed before. To show this, we make use of a game theoretical analysis by trying to interpret the commercial diastasis of Plato’s relative passage as a two-stage prisoners’ dilemma. This game has a sub-game perfect outcome for every outcome of the first stage, while we have an exclusive Nash equilibrium for the second stage game. Actually, to ensure perfect information, we include the state and the inspection mechanisms avoiding a sub-game perfect game with players’ strategies representing a Nash equilibrium output in every sub-game. Instead, and under the threat of inspection mechanisms, cooperation seems to be the way to limit risk in commercial transactions.

With this paper, we contribute to the international bibliography which argues that fair and honest behavior while performing commercial transactions is a key intertemporal axiom for reducing financial risks. We argue that such a behavior further sets the conditions for trade to flourish and the economy to grow in the long run, providing that the functioning of the economy is supported by a series of efficient institutions and auditing mechanisms which ensure the protection of private property, sound money, and the development of successful financial institutions such as banking, insurance, etc. Characteristic historical cases of nations which played a key economic and geopolitical role in their time, such as Medieval Venice, Early Modern Europe’s England, and the United Provinces (Dutch Republic), Great Britain, and currently the USA (Ferguson 2008; Puga and Trefler 2014; Economou and Kyriazis 2017), verify this financial axiom and with this paper we argue that we contribute to the relative discussion which should also include evidence from Athens during the Classical period and the time of Plato and later on.

The paper is structured as follows: Section 2 further analyzes in brief the institutional setup of the Athenian economy by arguing that it was export-oriented and favorable to international commerce. We do this in order to show that Plato has expressed his relevant views in an economic environment that favored, in practice, the formulation of a number of such views. We focus on two very important institutions, the *agoranomoi* and the *dokimastai*, and we argue that a key reason for the success of the internationally-oriented Athenian economy was the usage of sound money. In Section 3 we provide the relative passage of Plato in a verbatim way, followed by explanations and a further theoretical analysis. In Section 4, we present a fictional case regarding the commercial diastasis of Plato’s passage by describing a transaction between two trading parties, followed by the formulation of a two-stage repeated prisoner’s dilemma setup with complete but imperfect information.

Equally important is that such kind of transactions were the norm in the city-state of Athens during Plato's era.

We argue that in the beginning, each player chooses the "unjust" strategy, trying to cheat the other and this could be seen as a prisoner's dilemma situation, which ends in the worst possible outcome. Realizing this, in a repeated game situation, both parties choose the "just" strategy by adding auditing mechanisms in the game and they manage to achieve the best outcome by transforming the game into a cooperative one which maximizes the outcome for both.

Put it differently, being inspired by Plato's views, we argue that the success of commercial cooperation between two parties can be achieved when auditing institutional mechanisms of minimizing the risks of performing financial transactions do exist and are functional in practice. Section 5 summarizes our findings and concludes by providing some further research directions inspired by the overall analysis.

2. The Athenian Economy during the 4th Century BCE Period

As it was already mentioned in the introduction, the success of the Athenians should be attributed to the superior package of (the free market type of) economic institutions they developed, even if in a primitive form in relation to today. Bresson (2016a, 2016b), Harris and Lewis (2016), O'Halloran (2018), Bitros et al. (2020), Economou et al. (2021), among others, have analyzed the Athenian "international" trade policy through the establishment of a unified "economic area" for interstate commercial transactions between the member city-states of the Delian League while Economou et al. (2021) add that this area should be also seen as an ad hoc monetary union. According to Cohen (1992, p. 141) in the port of Piraeus, the products imported could be sold on site and directly exported to new end-user markets. The port of Piraeus had become an international entrepôt of antiquity, as was Alexandria during the Hellenistic period (323–146 BCE), Amsterdam during the 17th century AD and among others, Hong Kong, Shanghai, and Rotterdam today. Bresson (2016a, p. 414) writes:

"In the Classical period, Athens was obviously the greatest market in the Mediterranean world, the one that attracted all the merchants who wanted to sell a large cargo rapidly at a good price."

In accordance to the above, Cohen (1992) and Bitros et al. (2020), among others, have analyzed the Athenian internationally-oriented banking system. In particular, Cohen (1992) in his seminal book *Athenian Economy and Society: A Banking Perspective* analyzed exhaustively the sophisticated way banks functioned in Classical Athens. Banks' main services were: (i) the exchange of coins and foreign currencies, (ii) the acceptance of deposits, (iii) carrying out payments on behalf of their customers, (iv) providing loans to various business operations, including bottomry loans in shipping and even financing of consumer credit, (v) providing sureties, negotiated claims, and offered guarantees and personal advice to important customers, (vi) accepting documents and valuables for safekeeping but they did not act in the capacity of pawnbrokers, and (vii) facilitating export-import activities by settling payments among importers from and exporters to merchants abroad.

Cohen (1992, p. 141), Acton (2014, pp. 252–53), and Bitros et al. (2020), among others, further argue that banks also offered insurance on these maritime loans to ship-owners and merchants so as to reduce any possible negative financial consequences related to the great risks that were involved in transport journeys over sea lanes. Thus, insurance went hand in hand with the process of issuing loans with interest, so as to further promote international trade activities by minimizing the risks when performing international financial transactions.

Even primitive versions of joint stock companies were developed for various purposes such as financing maritime commerce through banks with more than one owner-shareholder, or the exploitation of the silver mines at Laurion (Cohen 1992, p. 153; Bitros et al. 2020, p. 24). Here again, these companies were the result of the attempt of the Athenian bankers or merchants to limit any negative financial consequences while

performing trade; in other words, to minimize the risk of providing loans through an international trade environment. Halkos and Kyriazis (2010) further analyzed the process of “industrialization” that made Athens the first economy in history where “services” and “industrial” (handicrafts) sectors contributed more to GDP than agriculture.

To this point it has also to be acknowledged that the literature and the references that we provide herein consist only a small part of the international bibliography in the last 30 years that revisits the older, though influential, views of Finley (see, e.g., Finley 1973, 1983) and his followers who argued that the Athenian (and by extension ancient Greek) economy was characterized by primitive structures and organization and that it was “embedded” on social, political, and religious aspects, meaning that it was not actually a market economy. Among many others Tridimas (2019, p. 12) acknowledges that, during the 1970s and 1980s, Finley’s view was the established orthodoxy but, in light of new evidence and advances in economic theory, “formalist” accounts gradually won ground. He adds that “formalism” maintains that economic actors are essentially the same in every place and in every period, so that we can treat both ancients and modern societies’ citizens as seeking to maximize profits and utility as posited by the rational choice model. It is also necessary to be mentioned at this point that for space limitation purposes we intentionally choose to provide only selected references regarding some of the most recent works available in the bibliography that are related to the specific issues we discuss in this paper.

Under such a context, below we focus only on two key importance institutions which are linked with what we call as Plato’s theory of justice and the commercial diastasis of his views which we further elaborate through a game theoretical analysis. These were the *agoranomoi* and the *dokimastai*. The first was a group of 10 public magistrates, elected by the Athenian Assembly of citizens under direct democracy procedures, responsible to ensure that the prices of goods in the market were not excessive. These actions were important so as to combat profiteering (Elliot 2018; Bitros et al. 2020). The *agoranomoi* also had to ensure that the quality of the products met their specifications. If this was not the case, they put fines to the sellers. They further solved disputes among merchants or between buyers and sellers in the market. This intervention could result in transactions without fear of violence or intimidation according to Harris and Lewis (2016, p. 30). The second and equally important institution were the so-called *dokimastai* (*dokimastes* in singular) which are related to the introduction of reliable currencies for the exchange of goods and services and the impressive increase of the volume of commerce between Athens and its allies (Economou et al. 2021).

Figueira (1998), van Alfen (2011), and Bitros et al. (2020), among others, argued that the so-called Athenian silver drachma became the universal coin in the Eastern Mediterranean because of its purity of silver content, which minimized the risks of performing reliable financial-commercial transactions between Athens and its allies or every other state. The most famous of these series of drachmae issued by the Athenian state silver mint, known as *Argurocopeion*, was the Athenian *tetradrachm* (four drachmae) which rapidly became the internationally-accepted leading currency throughout the Mediterranean (Scheme 1).



Scheme 1. An Athenian *tetradrachm*. Source: <http://www.wildwinds.com/coins/greece/attica/athens/sg2526.jpg> (accessed on 2 January 2021).

The reliability of these coins was safeguarded through the introduction by the Athenian Assembly of so-called *Monetary Law of Nicophon* (being the lawgiver who proposed the law). Under its provisions, all “good” (meaning of correct silver content) foreign coins and all “good” imitations of the Athenian drachma issued in mints outside Athens could circulate in the Athenian economy together with Athenian drachmae. Thus, foreign traders, etc., could use the coins of their preference for their transactions without having to change them into Athenian providing that they were not counterfeits.

In cases of doubt about the “purity” of the content of the foreign coins (and as a state guarantee against fraud) the office of the “testers” (known as *dokimastai*) was introduced. The “testers”, being themselves public slaves who acted as state officials, had an office, a bench in the Agora (the marketplace) of Athens and at the harbor of Piraeus. If one of the private contracting parties had doubts regarding the purity of the foreign coins, he could bring them to the “tester” who examined their purity. If found impure (e.g., in the case of fraud) the coins were confiscated, then cut and next, became sacred property of the treasury-temple of the Mother of the Gods. If found to be authentic imitations of the Athenian drachma, (meaning that they were of the proper silver content) they were returned to their owners, who then had the right to use them legally in order to perform commercial transactions in the market (Figueira 1998; Engen 2005). Having the above in mind (Ober 2008, pp. 222–25), Bitros et al. (2020) and Economou et al. (2021) argue that the Law of Nicophon reduced transaction costs and generated, by its existence and provisions, trust between the parties.

As a general comment, both the *agoranomoi* and the *dokimastai* were institutions introduced by the Athenian state so as to limit to the minimum any kind of risk regarding the reliability of performing financial transactions in the Athenian market.

3. Plato’s Game Theory of Justice: The Concept

Except the above brief description regarding the commercial orientation of the Athenian economy, what is also important is that by analyzing the ancient evidence in books, speeches, extant decrees, etc., it becomes clear that Greek thinkers/philosophers had anticipated many theoretical aspects of the working of the economy, such as the importance of efficient and fair administration of public economics (Xenophon Memorabilia, 3.4.7–12), the crucial issue of property and property rights protection (Aristotle, Politics, 1262b. 23–25, 1263a, 1278a; Demosthenes Against Timocrates, 149), the issue of the specialization of professions (Lysias Against Eratosthenes, 19), and the importance and the benefits of commercial exchange in order to establish viable international markets Pseudo-Xenophon (Constitution of the Athenians, 2.11–12; Plato Republic 2.370e–2.371a, 2.373d–e; Isocrates Panegyricus, 4.42).

Furthermore, the issues of division of labor and labor productivity were discussed by Xenophon (Cyropaedia, VII, 2.5), almost 21 centuries before Adam Smith raises this issue in Book I. 1.17–18 of his *Wealth of Nations*. In addition, the market mechanism, and the adjustment of prices of goods through the forces of demand and supply were also discussed by Xenophon (Ways and Means, IV). The benefits of free circulation of good currencies and the need to withdraw counterfeited coins from the market as a means of minimizing the risks when performing commercial transactions were discussed by Aristophanes (Frogs, 718–733). Even what we call today “marginalist” thinking was, to some extent, discussed by Plato (Republic 2.369b–e, 370–372, 373b–c).

We have to acknowledge that the evidence we provide here regarding the economic thinking of ancient Greek philosophers needs more clarification, however, this exceeds the scope of our paper. Detailed analysis regarding the ancient Greek philosophical thinking regarding economic matters are provided, among others, by Amemiya (2004), Baloglou (2012), and Stewart et al. (2020).

It is also to be clarified that the above philosophical views regarding economic institutions were not just the outcome of philosophical thinking or logical deductions of the philosophers regarding the theoretical foundations of economic principles but, more

importantly, it was the description of how the Athenian economy of the time worked in practice on a daily basis. What we mean is that when Plato wrote *The Republic* in 375 BCE he was experiencing the daily working of the functioning of the institutions as described in Section 2 in practice. We believe that through such an economic environment Plato developed some ideas through which, in a wider sense, he could be considered as the first “game theorist” ever, and this aspect of his writing has not been analyzed before.

Our main aim in this paper is to focus and analyze in more detail Plato’s 2.358e–359a–c passage. In *The Republic* (2.373d) Plato writes that two neighboring city states try to permanently acquire things (land in this case) in competition with one another, thus “undertaking the marginal point of their needs”. Then, in *The Republic* (2.358e–359a–c) he writes the following (We follow the translation of the ancient Greek text as is provided by the Perseus Digital Library of the University of Tufts):

“By nature, they say, to commit injustice is a good and to suffer it is an evil, but that the excess of evil in being wronged is greater than the excess of good in doing wrong. So that when men do wrong and are wronged by one another and taste of both, those who lack the power to avoid the one and take the other determine that it is for their profit to make a compact with one another neither to commit nor to suffer injustice; and that this is the beginning of legislation and covenants between men, and that they name the commandment of the law the lawful and the just, and that this is the genesis and essential nature of justice—a compromise between the best, which is to do wrong with impunity, and the worst, which is to be wronged and be impotent to get one’s revenge. Justice, they tell us, being mid-way between the two, is accepted and approved, not as a real good, but as a thing honored in the lack of vigor to do injustice, since anyone who had the power to do it and was in reality ‘a man’ would never make a compact with anybody either to wrong nor to be wronged; for he would be mad. The nature, then, of justice is this and such as this, Socrates, and such are the conditions in which it originates, according to the theory. If we grant to each, the just and the unjust, license and power to do whatever he pleases, and then accompany them in imagination and see whither his desire will conduct each. We should then catch the just man in the very act of resorting to the same conduct as the unjust man because of the self-advantage which every creature by its nature pursues as a good, while by the convention of law it is forcibly diverted to paying honor to equality . . . ”

Plato proposes here an underlying utility approach to justice. Justice is not “loved” per se, but because, if applied equally, increases utility in that it prohibits wrongdoing, which, for the person receiving it, reduces his utility. The “biggest good”, for a person, would be if he could do wrong without punishment, which would increase his potential utility. The “biggest bad” is if he receives wrong without being able to retaliate, so that justice equilibrates or is an intermediation between those two extremes, balancing positive and negative potential effects of the two persons.

Further, it becomes clear that Plato, known as a moral philosopher, here perceives persons as “pure” utility maximizers. A person does not refrain from doing wrong due to his morals, etc., but because this could potentially harm his utility if the other person retaliates, or if the law prohibits it and he faces consequences if caught. Thus, in 2.359c Plato calls for establishing an environment of commonly acceptable values as rules of behavior regarding justice since this will be the way to ensure equality between individuals, the people themselves, in the society. In actuality, Plato calls for common protocols of behavior which minimize the risk of fraud and ensure the establishment of a prosperous financial environment for international trade.

Such protocols of behavior are related to the set of institutions as mentioned above in Sections 1 and 2 in brief. However, the success of the international economic-commercial networks that Athens introduced with her allies, especially in the 4th century BCE, should be attributed to some further institutions that were introduced, such as *proxeny* (a system

of developing diplomatic relationships between states), *asylia* (exemption from reprisals from one city-state to another), *isopoliteia* (political equality), *enktesis* (rewarding citizenship and property rights to own land to foreigners), and *symbola* (interstate monetary union and bilateral commercial-diplomatic agreements (Harris and Lewis 2016; Economou 2020).

The connection between the rule of law and equality as a prerequisite for establishing a prosperous society, meaning a fair and just society, is also verified by modern literature (see among others, Bingham (2011) and Gowder (2016)). Epistemic disciplines in social sciences, such as the New Institutional Economics school of thought, consider justice and the rule of law mainly from the institutional point of view: Equality in justice is seen as a highly important prerequisite which guarantees responsible governance and contributes to economic growth (Acemoglu and Robinson 2013; Hodgson 2015). Plato's call for commonly accepted rules of behavior that are related to justice is also verified by modern scholars such as Greif (2006, p. 30), who concludes at the same wavelength that institutions are a system of rules, beliefs, patterns of behavior, and organizations that together create a regularity of social behavior.

In the following section we present a scenario with fictional characters regarding how Plato's theory of justice functioned in practice, through a game theoretical analysis. It is worth to be mentioned that the following game is not just a fictional scenario but a way to bring to life how the financial institutions of *agoranomoi* and the *dokimastai* functioned in practice in Classical Athens in the time of Plato. A description on how the institution of the *dokimastai* further functioned is provided by various ancient authors such as Aristotle (*Athenian Constitution* 51.2.).

4. Plato's Game Theory of Justice. A Fictional Scenario Based on Real Life Practices

As it has already been argued, in Plato's time, Piraeus, Athens twin city and harbor, was the Mediterranean's entrepot. Merchants from all over the world could find in Piraeus all goods (even rare ones like silk and spices) without having to travel to their sources.

4.1. A Fictional Case: Apollonius; A Merchant from Emporium

A merchant from distant Emporium (today's Ampurias in Southeastern Spain) Apollonius, arrives in Athens in order to buy Athenian jewelry, reputed for its artistic quality and craftsmanship. There, he meets the Athenian trader and jewelry merchant Heraiphon. They agree on the transaction, the jewelry to be bought, and the price to be paid.

Apollonius suggests paying in his own currency, Emporium drachmae, instead of changing in Athenian drachmae, in order to avoid the banking fee, something legally possible under Nicophon's Decree which permits the free circulation of all goods, thus reducing transaction costs. Heraiphon agrees and asks about the silver content of Emporium drachmae, Apollonius answering that it is exactly the same as Athenian drachmae (which would give as an exchange rate of one to one and the same price in both currencies). Still, Heraiphon has some doubts about the silver content of the Emporium drachma (with which he has never traded up till now) and decides to bring them in front of the official tester (*dokimastes*), provided by the city under Nicophon's Decree in order to be sure that the coins are indeed pure. The tester takes one at random, tests it, and discovers that Apollonius tried to cheat: His drachmae are not of pure silver content, but silver plated. The tester, as the Decree provides, confiscates all of the coins, and Apollonius suffers a substantial financial loss.

Angry, Apollonius wishes to retaliate and calls an *agoranomos*, one of those officials of the city being responsible for the good functioning of the market, protection against quality fraud, profiteering, etc. He accuses Heraiphon that he tried to cheat him selling him jewelry, alleged to be of pure gold, while in fact they are gold plated. The *agoranomos* tests the jewelry and vindicates Apollonius. Heraiphon tried to cheat him offering him gold plated jewelry instead of pure gold. Now, Heraiphon has to pay a fine, which corresponds to a financial loss. This is exactly a situation portrayed by Plato in the first part of the game: Both try to cheat, are found out, and in the end are worse off.

After some years, Apollonius comes back to Athens and meets Heraiphon. In view of their previous experience, negative for both, this time they are both honest and conclude their exchange. This is the second situation described by Plato; they agree “neither to do wrong”. What the Athenian institutional setup and, in particular, Nicophon’s Law provided for, was to transform asymmetrical information to symmetrical. Thus, market exchanges were facilitated, since information gathering is part of the transaction cost. Symmetrical information lowers transaction costs. By contrast, the existence of asymmetric information is well known and has been analyzed by many prominent economists such as [Akerlof \(1970\)](#) as one of the main problems of the functioning of markets.

The Athenian institutional setup achieved two particular aims: it gave symmetrical information on the quality-purity of the different currencies, and information on the character of the market participants, if they were honest or dishonest. In the first period of the exchange (or game) the two participants have asymmetric or even non-existent information on both issues. The Athenian does not know if the foreign currency is good, and the citizen from Ampurias does not know if the jewelry is original, and both participants do not know each other’s character. The element of trust is not present. The office of the tester provides the solution. The tester gives his verdict on the quality of the currency, so that both acquire symmetrical information. Both know then if the currency is good or not. Further, they acquire symmetrical information on each other’s character: They know if they are honest or not. Building upon this acquired information, in the next period they can modify their strategy, thus breaking out of the prisoner’s dilemma and transforming the game into a cooperative one.

Cooperative games are based on trust and shared symmetrical information. A vast bibliography of modern literature in economics and organizational theory verifies the view that trust is a lubricant enabling organizations and societies to achieve Pareto superior outcomes (i.e., [Arrow 1974](#); [Fukuyama 1995](#); [Kramer 1999](#)). For example, [Adler \(2001\)](#) argues that trust itself is a coordination mechanism that lowers transaction costs between firms. By contrast, if uncertainty increases this has financial consequences which may jeopardize the smooth functioning of an economy ([Halkos and Zisiadou 2020](#)). Nowadays, trust and reliability of commercial transactions through digital money is ensured through consumer protection laws and through specific practical norms and procedures regarding using machines for money transferring, such as ATMs, e-banking through authorized web-pages, money transfers from account to account, etc. In Classical Athens, this was ensured by auditing mechanisms such as the *agoranomoi* and the *dokimastai*.

4.2. The Game

We set up the non-zero sum prisoners’ dilemma in the normal form representation with each player simultaneously selecting a possible strategy. If we denote the strategy space of the set of possible strategies for player i as Ω_i then ω_i is an arbitrary element of this strategy space with $\omega_i \in \Omega_i$, that is each element is part of the strategy space Ω_i .

If $(\omega_1, \omega_2, \dots, \omega_n)$ is the combination of strategies one for each player and w_i the payoff function then:

$$w_i(\omega_1, \omega_2, \dots, \omega_n)$$

and the game may be expressed as:

$$G = \{\Omega_1, \Omega_2, \dots, \Omega_n; w_1, w_2, \dots, w_n\} \tag{1}$$

In our game the players choose their strategies simultaneously having complete information as if they will/may have the help of the authorities.

In the normal-form game (1) if ω'_i and ω''_i are elements of the strategy space and feasible strategies for player i then strategy ω'_i will be strictly dominated by ω''_i if:

$$w_i(\omega_1, \omega_2, \dots, \omega_{i-1}, \omega'_i, \omega_{i+1}, \dots, \omega_n) < w_i(\omega_1, \omega_2, \dots, \omega_{i-1}, \omega''_i, \omega_{i+1}, \dots, \omega_n)$$

If we consider a game of complete (due to the feasibility of using the appropriate state inspection mechanisms) but with imperfect information as both players select their strategies simultaneously, player 1 selects action ω_1 from feasible set Ω_1 and player 2 observing ω_1 selects action ω_2 from feasible set Ω_2 with payoffs $u_1(\omega_1, \omega_2)$ and $u_2(\omega_1, \omega_2)$. In a two-stage game of complete but imperfect information players 1 and 2 select at the same time actions ω_1 and ω_2 from feasible sets Ω_1 and Ω_2 , respectively. Players 1 and 2 observe the first stage (ω_1, ω_2) and select at the same time ω_3 and ω_4 from feasible sets Ω_3 and Ω_4 respectively with payoffs:

$$u_i(\omega_1, \omega_2, \omega_3, \omega_4) \quad \text{for } i = 1, 2$$

For each feasible outcome of the first stage (ω_1, ω_2) we assume the second stage of the players has a unique Nash equilibrium as:

$$\omega_3^*(\omega_1, \omega_2), \omega_4^*(\omega_1, \omega_2)$$

Expecting these payoffs for players 1 and 2 in the first stage then if (ω_1^*, ω_2^*) is the unique Nash equilibrium outcome of this simultaneous game then $(\omega_1^*, \omega_2^*, \omega_3^*(\omega_1^*, \omega_2^*), \omega_4^*(\omega_1^*, \omega_2^*))$ is the sub-game perfect outcome of this two-stage game. If player 1 does not play α_1^* in the first stage player 2 may think about the expectation (assumption) that player 1 will play $\omega_1^*(\omega_1, \omega_2)$ in the second stage.

We can create our analysis regarding Plato’s passage 2.373d through a two-stage prisoners’ dilemma and for each possible outcome of the first stage of the game (α_1, α_2) the second stage prisoners’ dilemma gives a unique Nash equilibrium represented as $(\omega_3^*(\omega_1, \omega_2), \omega_4^*(\omega_1, \omega_2))$.

In Table 1 we present the game payoffs matrix described in the fictional case as analyzed above. In this first stage of the game both players trust each other and there is no need for state intervention through its auditing mechanisms (the *agoranomoi* and the *dokimastai*). The fact that there is no state auditing intervention increases the risk of both parties to be cheated and, thus, suffer inferior financial outcomes.

Table 1. First stage payoffs with players trusting each other—no need for state intervention.

		Strategies		
		Apollonius	Unjust (dishonest)	Just (honest)
Heraiphon	Unjust (dishonest)		(2, 2)	(15, 5)
	Just (honest)		(5, 15)	(10, 10)

In the first case described by Plato, (both “unjust”) the outcome is negative for both and this is akin to a prisoner’s dilemma situation. Both Apollonius and Heraiphon face a loss. Apollonius has been deceived since he accepts jewelry of inferior quality while Heraiphon accepts fraudulent money. Based on the procedures as described by Bitros et al. (2020) and Economou et al. (2021) regarding currency issuing and the role of the Athenian silver mint we assume that at least both Apollonius and Heraiphon do not face a total loss (0,0). The jewelry that Apollonius accepts has at least a small value, while, on the other hand, Heraiphon can apply to the silver mint, and ask from the staff to melt the fraudulent coins, then receiving back a small percentage of silver bullion, and then asking the staff to produce (unadulterated) silver coins for him under a small *seignorage* cost in favor of the state. Thus, we assume that the two players achieve a very small gain, that is (2, 2). On their part, the pairs (5, 15) and (15, 5) denote that, in both cases, one of the two players is cheated while the other player benefits more than the legal gain due to deceiving the other

party. Finally, in this game both players gain when, from the beginning, they wish to play fair (10, 10).

If the game is repeated (as Plato presumes) both players “learn”, by incorporating their past experience and, thus, choose the alternative “just” strategy, which maximizes the outcome for both. It is to their benefit to agree and behave in a “just” way. The game is transformed into a cooperation game. We symbolize “just” as “J” and “unjust” as “U”.

The pure strategy payoffs are (2, 2) (5, 15) (15, 5), and (10, 10). Other possible payoffs include the pairs (x,x) for (2 < x < 10) which come from weighted averages of (2, 2) and (10, 10) and the pairs (y, z) for y + z = 15 and 5 < y < 15 as weighted averages of (5, 15) and (15,5). The other pairs on the interior of the shaded region are weighted averages of more than two pure strategy payoffs. These are shown in Figure 1 inspired from Gibbons (1992).

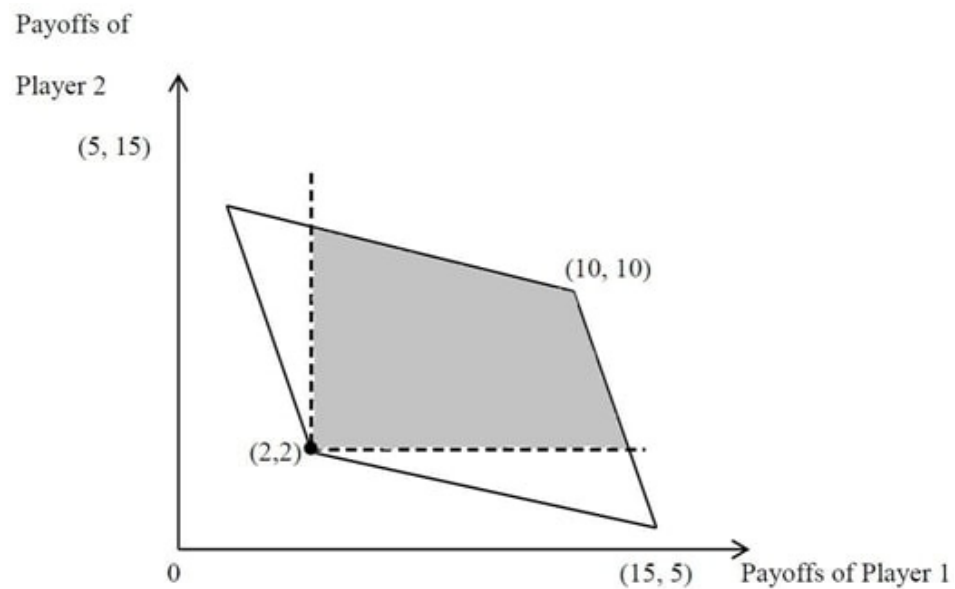


Figure 1. Graphical presentation of potential payoffs.

If we allow for exchange rate differentiation other than 1:1 (Athenian drachmae and foreign drachmae from Ampurias) any point in the shaded area in Figure 1 can be attained as the average payoff in a sub-game perfect Nash equilibrium of the repeated game but with a discount rate close to 1:1. To have the payoffs for different time horizons available we recall that and the sequence becomes (Fudenberg and Tirole 1993):

$$\frac{1 - e}{1 - e^{T-1}} \sum_{t=0}^T e^t [G_1(\omega)^t] \tag{2}$$

with the use of the average discounted payoff e . If the game is played once only, the cooperation is strongly dominant and the unique equilibrium for both players is just. If the game is repeated a finite number of times sub-game perfection requires both players to defect in the last period and backward induction implies that the unique sub-game period equilibrium is for both players to be just in every time period.

If the game is played infinitely then “both just every period” remains a sub-game perfect equilibrium. If the horizon is infinite and $e > \frac{1}{2}$ then they may cooperate in the first period and continue to cooperate so long as no player ever deviates from the just:

$$(1 - e)(1 + e + \dots + e^{t-1} + 2e^t + 0 + \dots) = 1 - e^t(2e - 1) \tag{3}$$

which is less than 1 as $e > \frac{1}{2}$. With these strategies there are two classes of sub-games, class A with no player being just and class B with just i having occurred.

In the game theory setup the notions of dominance, iterated dominance, as well as Nash equilibrium stem from the hypothesis that players predict their opponents' moves by "introspection and deduction" relying on their knowledge of their opponents' rational payoffs and the simultaneous knowledge that each player knows that the other player is familiar with these matters. In this prisoners' dilemma setup it can be observed that if the game G presents a unique Nash equilibrium we may expect for any finite time horizon the repeated game G(T) to take a unique sub-game perfect result as an outcome the Nash equilibrium in each stage G. More specifically, if the game is played twice and we observe the first stage outcome before then there is a sub-game perfect outcome in this repeated game if (U,U) is played in the first stage. The two-stage prisoners' dilemma is a game with a sub-game perfect outcome as for each possible outcome of the first stage there is a unique Nash equilibrium for the second-stage game.

Allowing for state intervention leads to cooperation as the way to reduce risk in commercial transactions. That is, now the whole situation changes if we add the government and the inspection mechanisms, that is, the *agoranomoi* and the *dokimastai* as active participants in the market, who can impose fines to both parties, Heraiphon and Apollonius.

In this case, we hypothesize that both Heraiphon and Apollonius do not trust each other and before finishing their transaction they both wish to apply to the state auditing mechanisms, the *agoranomos* and the *dokimastes*. Then we have multiple Nash equilibrium situations that do not belong to this class of games. The best outcome for both Heraiphon and Apollonius will be (10, 10). They both choose to play 'just', but they still wish to turn to state auditing mechanisms, the *agoranomos* and the *dokimastes*, for an even more formal control of money and jewelry, perhaps because both of them are extremely law-abiding! It should also be noted that resorting to the two auditing mechanisms as mentioned above does not incur any costs for both Heraiphon and Apollonius. This is because a state fine can be imposed only to those who try to cheat. In other words, since no one tried to cheat the state's payoff in this case is (0, 0).

Thus, players expect that (10, 10) will be the second stage outcome if the first stage outcome was (10, 10) having now (1, 1) as a payoff if any of the other first stage outcomes takes place under complete information put forward by the inspection mechanisms. These inspection mechanisms may avoid other strategies, like trigger or tit-for-tat, in an infinitely repeated prisoners' dilemma game leading to sub-game perfect Nash equilibriums in every sub-game.

In Table 2 the pair (−1, −1) indicates that the *agoranomos* finds that the jewelry of Hairephon is of lesser value, and orders their confiscation. Additionally, counterfeit money is confiscated by the *dokimastes*. The two merchants lose everything, and, in addition, a fine is imposed on both of them by the *agoranomos* because they tried to cheat each other, which could also cause malfunction on the Athenian market in a wider sense. Thus, here there is a total loss for both of them. The state on its part receives (1, 1) because it can impose fines to both of them, because they tried to cheat each other and this behavior may cause malfunctions or erode the prestige of the Athenian market.

Table 2. Payoffs of the second stage—both players do not trust each other.

		Strategies		
		Apollonius		State (inspection mechanisms)
Heraiphon	Apollonius	Unjust (dishonest)	Just (honest)	
	Unjust (dishonest)		(−1, −1)	(−1, 8)
Just (honest)		(8, −1)	(10, 10)	(0, 0)
State (inspection mechanisms)		(0, 1)	(0, 0)	(1, 1)

Similarly, the pair $(-1, 8)$ means that Heraiphon tries to cheat while Apollonius tries to play justly. Thus, before finalizing their transaction, Apollonius demands that the jewelry of Heraiphon is inspected by an *agoranomos*. The later inspects the jewelry of Heraiphon, he finds that Heraiphon tried to cheat and, thus, he confiscates the jewelry of Heraiphon and also imposes upon him a fine. On their part, Apollonius does not earn 10 because he wished the transaction to be done, which it was not. Thus, although he keeps his pure (not fraudulent) coins, he scores 8 and not 10 because his utility would have been maximized if the transaction had been done, a situation that did not materialize in the end. In this case the state also earns a small profit because it imposes a fine to Hairephon because he tried to cheat Apollonius. By contrast, the state earns nothing from Apollonius since it cannot put a fine on his sound money and pure silver coins. Thus, the pair for the state in this $(1, 0)$.

On the other hand, the pair $(8, -1)$ denotes the inverse case of $(-1, 8)$, and under the same logic the state's payoff is only $(0, 1)$ since it can only receive a small profit by putting a fine (only) to Apollonius.

5. Conclusions

In this paper we approached the issue of justice in human affairs as an important parameter regarding the establishment of an institutional environment, which is beneficial to international trade. Our analysis links the issue of financial risk through a game theoretical approach regarding the famous philosopher Plato's views on trust between parties and especially while performing international commercial transactions.

Since fair and honest behavior is a key intertemporal axiom for performing efficient commercial transactions, our motivation, among others in this paper, was to trace how deeply this financial behavior goes back in the course of history. We found that elements of such an intertemporal value system for reducing risk in financial transactions dates back to the time of Plato in Athens during the Classical times.

To prove this, we chose to elaborate a famous passage from Plato's Republic by formulating a repeated game of "just" and "not just" while performing financial transactions. Essentially Plato argued that the absence of regulatory mechanisms of justice in a society causes unproductive outcomes. The opposite also applies. When two parties decide to cooperate with each other by playing fairly and this is also backed up by strong institutions, that is, efficient auditing mechanisms by the state so as to apply justice fairly, as this will be to the benefit of both parties.

We formulated a relative conceptual framework through a game theoretical analysis seeing Plato as "game theorist". We argued that, in the beginning, each player chooses the "unjust" strategy, trying to cheat the other and could be seen as a prisoner's dilemma situation, which ends to the worst possible outcome. Realizing this, in a repeated game situation, both parties choose the "just" strategy so achieving the best outcome and transforming the game into a cooperative one that maximizes the outcome for both, that is, it is to their benefit to agree and behave in a "just" way and their cooperation is transformed into a cooperation game.

We have also found that the whole situation changes if we add the government and the inspection mechanisms. In a repeated game and having the state inspection mechanisms (S_1, S_2) ensures the trust outcome of (J_1, J_2) with cooperation achieved in a complete information repeated game. The outcome of trust between the two players (J_1, J_2) is Pareto superior as both players are better off compared to unjust ones (U_1, U_2) but the situation with this strategy is unstable as each player has an incentive to unjust if he considers the other player will play just. In case both players play justly and do not cheat then the outcome (J_1, J_2) will be chosen. This is ensured with the inspection mechanisms that eventually lead to the cooperative outcome.

Our results contribute to the current knowledge regarding the world economy competitive arena by conveying the intertemporal axiom that what is important so as to ensure the establishment of an effective system of commercial transactions at a supranational level is to create an environment of robust and functional financial institutions where

trading parties behave “just”. This is a necessary, but not a sufficient, condition, though. Such a financial system, in order to be effective requires to be backed by effective auditing mechanisms and, equally important, bonds of trust between trading parties and the state institutions should be forged and be mutually reinforcing. As argued in the introduction, these prerequisites were also among the key reasons of success in later historical cases, such as Venice, the United Provinces, England, Great Britain, and the USA nowadays.

Further research directions could perhaps include focusing on the common protocols of behavior that systems, such as monetary unions, develop so as to achieve the “just” behavior among trading parties at a supranational level. As already argued, some authors consider Athens and her Delian League allies as an ad hoc monetary union. Later monetary unions include, among others, the Achaean League as one of the most advanced federations in the Hellenistic period (Economou 2020) and, in later times, the United Provinces, a federal state which also established a monetary union, the USA, the German Zollverein of 1834, the Latin Monetary Union of 1865, the Austro-Hungarian Monetary Union (AHMU) of 1867, the Scandinavian Monetary Union of 1873 (Ryan and Loughlin 2018) and, of course, the current Eurozone of the European Union (EMU) established in 1992. Further research could, for example, include a comparative analysis of the cases mentioned above with the case of Classical Athens and the Delian League as a coherent whole in terms of a monetary union institutional setting. Such research could also include commercial and customs unions, such as the Hanseatic League of 1356, the European Free Trade Association (EFTA) of 1960, or even the recent Eurasian Economic Union (EAEU) established in 2015, among others. Another possible future research direction would be to compare the scientific impact and the methods we used in this paper with the results of other studies with similar hypotheses that possibly exist. Due to space limitations we promise further research in the future in this direction.

Of course, there are also some limitations regarding the research we performed with this paper. We have no cliometric data available for the case of Classical Athens and, generally, for every ancient economy, thus, in this case we can only rely on the findings of history by using them properly through interpretative tools from disciplines such as financial history, historical (and international) political economy, and the history of economic thought as our paper does.

As a final comment, we hope that the approach we follow in this paper, which combines (i) issues of risk while performing financial transactions, (ii) game theory as an interpretative tool for financial transactions, (iii) financial history, will stimulate future interest in the academic community on related issues.

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