Why did people pay taxes? Fiscal innovation in Portugal and state making in times of political struggle (1500-1680)

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Introduction:

Quantitative and comparative analyses of fiscal efficacy in early modern Europe acknowledge the coercive and compliance components of fiscal systems, as much as evasion (Bonney 1995, Hoffman and Norberg 1994, Tilly 1990). Evasion is the flipside of consent; thus taxpayer's consent is another dimension of the problem, although harder to apprehend in a historical perspective of state building. This paper takes this challenge as motivation and searches the incentives for taxpayers' consent in fiscal innovations. Frequently these innovations led to heavier tax burden (Brewer 1988, O'Brien and Hunt 1999). In a time when the scope of the centralized authority of rulers was narrowly devoted to the provision of defense and justice, any form of fiscal improvement increased the opportunity cost of a tax. We put forward the hypothesis that cooperation in paying taxes depended on taxpayers' utility in diverting a persistent threat in as much as on mechanisms of tax collection which allocated monitoring costs to local, ad hoc administrations. Ultimately, in a process of state making, we should expect cooperative behavior to need institutions diverse from key features of the strong ideal-type state underpinning high ability to collect taxes (Ardent 1975, Besley and Persson 2011, Epstein 2000, Mannn 1986, Ogilvie and Carus 2014, Tilly 1975, Tilly 1990).

Portugal in the 17th century can be an illustrative case of the political limits of taxation in early modern Europe propelling the fragmentation of large units, like the Habsburg monarchy. After a period of widespread unrest incited by several new levies, Portugal regained independence in 1640. The rule of the new king increased the state's fiscal capacity through means repudiated two years earlier. The war of independence was thus financed by an entirely new, uniform income tax, levied at 10% rate (Costa 2005, Costa e Cunha 2006, Magalhães 2004). Once the war of independence was over, the endurance of the tax implied a reduction of the rate to 4.5%, which allowed this tax to withstand the liberal revolution in 1821.

The historical events pose the question that entitles the paper: why a tax increase from around 4% to 7% to be enacted under the Habsburgs rule was deemed confiscatory and triggered a political separation, whereas a higher tax rate, of around 10%, was willingly accepted as a cost to sustain that separation ? The shifting behavior of the Portuguese taxpayers from 1638 to 1641, within four years of political contentions, supports the notion that consent was a determinant variable in the fiscal innovation success, since the legitimation of the new king's authority was not entirely hold[1] moreover, the technology could not adequately control evasion.

This paper brings about data to model taxpayer's utility function. A model derives the optimal tax rate from the standpoint of the taxpayer as a function of risk aversion, the awareness that evasion would potentially enhance war damages and the probability of war. Data on damages, contemporary assessments of the tax base, and amounts collected allow the model's calibration to test the accuracy of the hypothesis. Results point to an optimal tax rate ranging from 4.7 to 8.2 %, possibly explained by taxpayers' utility function. The model's calibration also allows finding which share of the tax collected can be attributed to administration efficacy (4- 4.7%), including a tax morale component (Luttmer and Sinnghal 2014).

The notion that high levels of destruction improved fiscal capacity is a critical inference from the model. Results also show the consistency of a lower rate, close to the optimal rate, once the war was over, which suggests the efficacy of substituting the coercive component ascribed to a centralized administration by peer monitoring and reputational constraints at the community level.

This research broadens the current view on fiscal capacity, which has been most focused on political constitutions since seminal work of North and Weingast, 1989 (North and Weingast,

[1] Political legitimacy has received scarce attention in state making literature (Greif and Rubin 2015)

1989) and tax systems (centralized versus decentralized) whereas the methods of collection and taxpayers' risk aversion are topics less covered in formalized assessments (Dincecco 2009; Van Zanden, J. L. and M. Prak 2006, Karaman and Pamuk 2010). Our conclusions point to war damages on capital as a condition to make valid a fiscal innovation, which is an inference applied either to absolutist or parliamentary regimes in early modern Europe. Besides, this study adds historical evidence of the local collection of centralized taxes curtailing moral hazard issues and regional free riding, which compensated the low enforcement capacity of the centralized administration.

(Summary: section 1 Motivation, section 2 Fiscal constitution, section 3 Tax burdens; section 4 The yields of *décima* tax. Section 5 The taxpayer, section 6: the taxpayer compliance behavior

Motivation:

Since the fall of the Roman Empire, military rivalry and political fragmentation describe the European political and financial development. Rulers took part in a winner-take-all game, whose spillovers in technological improvements underpinned Europe's ability to capture rents at a global scale after 1500. This military background challenged the integrity of large units of the sort of the Habsburg monarchy and hampered the rise of continental empires like China in Asia (Hoffman, 2015). Above all, in its long-term consequences, military mighty set up a social order based on what J. Schumpeter called the fiscal state (Schumpeter, [1918] 1991;) allowing the rulers to extract a share of the economic surplus as a means to finance such a violent environment.

An impressive body of scholarly works has addressed the history of the fiscal state and questioned the factors for growing fiscal capacity. An extended sample of studies has observed the sources of revenue, expenditure, and tax structures (Bonney, 1995; Bonney 1999; Brewer 1989, Ormrod and Bonney, 1999, O'Brien 1988, 2011; Fritschy 2003; 'T Hart, 1993; Hoffman and Norberg, 1994; Yun, 2014). Another significant strand of researchers delve into the factors for the state's financial credibility, pursuing the lead of Dickson's work (Dickson 1967) on English financial revolution and North and Weingast's (North and Weingast 1989) view on political constitution impacts on fiscal efficiency (Hoffman and Norberg 1994; Epstein 2002, Carruthers 1996, Cox 2011, Dincecco 2010; Van Zanden, J. L. and M. Prak 2006, Grafe, 2011, Grafe and Irigoin 2012, Coffaman, Leonorad and Neal, 2013). Recently, a considerable literature has grown up around the theme exploring more formalized methods to assess the

causal links between political institutions and fiscal income. Significant contributions have shown that centralized taxation (Dincecco 2009), the size of the territory and the partisan composition of parliaments mattered (Carrutheres 1996, Stasavage 2010, 2011; Dincecco and Katz 2016). Nevertheless, economic fundamentals should also be included in the list of causes, since the degree of monetization and the sectoral composition of the GDP affect the statistical significance of political constitutions. Thus, political regime mattered, but as Karaman and Pamuk demonstrated, it did in a contingent way (Karaman and Pamuk 2010).

This literature has found regularities in the process of state-making in Europe, but a few issues stand out concerning the unusual case this article addresses. Firstly, regarding tax structures, Great Britain and the United Provinces illustrate the success of indirect taxation and public debt to wage long-lasting wars (Fritschy 2003; 'T Hart, 1993; O'Brien 1988, O'Brien and Hunt, 1999). So far, no study has presented a well-succeeded case, i.e, a polity unit financing a war with an income tax which shapes the fiscal system after that, apart from Great Britain's experience during the Napoleonic wars (O'Brien, 2001). Portugal raised an income tax in 1640 and introduced it in its fiscal system once the war against the Habsburgs was over in 1668. If Portugal and United Provinces emerged victorious in their fight for political autonomy, remarkable differences would separate both cases concerning the financial solutions adopted.

There is evidence of direct taxation raising informational and negotiation costs (Bonney 1995, 434). Thus the successful cases in northwestern Europe led scholars to enhance the advantages of indirect taxes in the first stages of political development. However, a comparison between operational costs of direct versus indirect taxation is missing, so there is no demonstration that direct taxation imposed unsurmountable costs of compliance. Administrative issues have a part in the range of variables affecting the fiscal capacity of states, and well-grounded literature has consistently shown that centralization increased fiscal efficiency. However, centralized taxation is often a loosely defined concept (Summerhill 2008, 222-223) either denoting uniform tax rates or professional and centralized bureaucracy neutralizing local elites' resistance and regional free riding (Dincecco 2009). In any event, centralized tax rates and local, non-professional administrations worked together in early modern Europe. This same combination enforced the Land Tax in England and still propelled public revenue after the Glorious Revolution (Beckett 1985, Beckett and Turner 1990). Growing fiscal efficiency counted on the sovereigns' exploitation of taxpayers' local connections. Social safety nets raised reputational restraints on free riding (Greif, Iyigun, and Sasson (2013), which could make local administration as effective as a centralized bureaucracy to raise taxes. The success

of the financial innovation in Portugal rested on a universal tax rate, on the centralization of both the revenue and expenditure, while the collection was left to local, ad-hoc administration, encroached in taxpayers' nets.

Considering the political constitution which proved better in improving fiscal capacity, parliamentary representation is deemed more effective because it monitored government's expenditure and made it easier to authorize more funds to wage wars. The benefits of this institutional arrangement rely on consent rather than coercion. Still, any other means of informing the taxpayer's decisions as it happened when the quartering of troops affected the daily life of villages and households may eventually incite consent on higher tax burden and improve the state's fiscal capacity as much as political representation did. The literature concerned with state's capacity has thus not carefully examined the diversity of mechanisms which could frame taxpayers' rationale.

Finally, since Schumpeter's foundational paper, taxes and public debt are thought a consequence of the rulers' monopoly of violence, meaning that protection (to property and people's physical integrity) was the public good at stake in any process of state making (Besley and Persson 2009). However, war could be in many respects a "private good for princes in their search for glory and personal power, with financing often meeting the resistance of taxpayers" (Gennaioli and Voth 2015). In that case, the question turns out to be: how did a private war of princes become a taxpayer's private concern? We take this issue into account and concede that legitimation of expenditure and information asymmetry severely constrained early modern states' capacity. Still, political representation and tax centralization (the ideal-type of a modern state) were means among others of releasing these constraints.

In the next section, we describe Portuguese state's revenues in the early modern period, which will tell us whether the new income tax consistently changed the state's fiscal capacity.

Fiscal constitution

In this section, we discuss the institutionally distinct role of colonial resources in state budgets and present the uniform and centralized taxes that characterized the Portuguese fiscal history since medieval times. The institutional arrangement regulating main sources of the Crown's revenue clarifies the scope of the innovation we are dealing with, based on an enduring income tax.

In the ranking of state's sources of income, the empire stood out in the 16th century (table 1) granting 57 percent of total revenues. Conversely, the impact of colonial trade on Portugal's GDP was almost insignificant. In the golden age of Brazil (1700-1780), colonial rents stood at 31- 33 percent, although then, the trade in the colonial system boosted the kingdom's GDP per capita significantly (Costa, Palma Reis, 2015). The contribution of the empire to the state's income did not necessarily go in tandem with its contribution to the macroeconomic performance of the mother country. A significant part of these revenues were domain rights of the crown, regularly farmed out to private investors, which endorses historians' view on this case as an entrepreneurial variant of a domain State (Ormrod and Bonney 1999, 12-15). Besides, the economy overseas afforded revenues not transferred to Portugal, respecting the principle of the colonies' self-sufficiency. Hence, ruling the empire did not demand financial outflows to enforce royal power overseas (Pedreira 2007)

Table 1- Government's sources of revenu

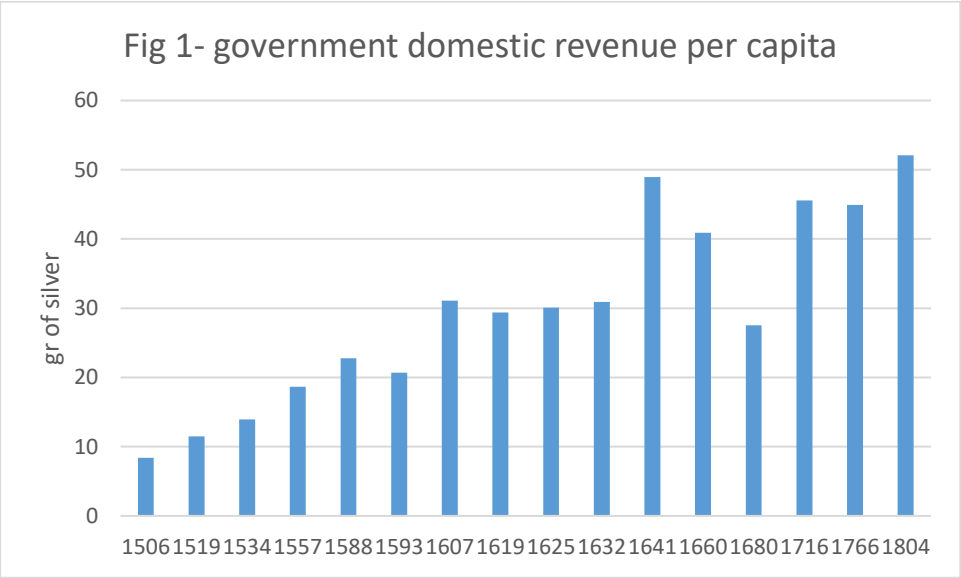
	empire (percentage of total revenue)	kingdom (annual average in **tons of silver**)
1500-1549	57	12
1550-1599	42	34
1600-1639	35	59
1640-1699	8,2	82
1716	14	106
1765	34	114
1804	32	152

Source in Appendix 1

If state making meant increasing fiscal efficacy together with a territorialized system of coordination of local forms of political order (Esptein, 2000), there were periods in which the growing size of Portuguese budgets did not reflect higher efficacy in tax collection. Income

could rise just because the empire offered additional domain sources, as it happens with dyewood, gold or diamonds in Brazil. Such an institutional framework imposes an analytical distinction between sources resting on the exploitation of the empire and those depending on the domestic economy. When leasing property rights over colonial resources, the kings underwrote a contract, incurring the risk of the other party's moral hazard or default. Differently, taxes collected in the kingdom had implementation costs due to both parties' risk of moral hazard. Taxpayers could breach the fiscal pact, because of either they free ride as a strategy or suspect the ruler's default if expenditure did not meet the alleged cause for collecting more money. Therefore, to find how much the fiscal innovation during the war of restoration heightened state's capacity, we must focus on domestic taxation only and reassess the values in column 2.

Figure 1 displays values after deducting colonial rents. It appears that the restoration boosted revenues and lost momentum afterwards, so that 1680 capitation was below any other observation in the 17th century. This decline stemmed both from the lower rate of the Decima tax, now enforced at a 4,5% rates in times of peace, and economic contraction.



Source: appendix 1

Taxation had social implications, and comparison using daily wages broadens the view on the Decima impact (Table 2) gives a different picture of the impact of the income tax in the long run, which international comparisons further reinforce. Portugal, Spain and The Netherlands were belligerents in the same wars. England and France are worth mention for their divergent

paths. The former for its early-centralized tax system assisted by representative institutions; the latter for its absolutist regime low fiscal capacity (Dincecco 2009, Hoffman and Norberg 1994).

Table 2 - Per capita government revenue in day's wages for unskilled workers.

	Portugal	Spain	Dutch Republic	England	France
1500-1549	2.6	3		1.5	2.6
1550-1599	3.8	4		2.7	3.2
1600-1649	4.5	7.2	12	2.6	3
1650-1699	7.2	7.7	13.6	4.2	8
1700-1749	7.1	4.6	24.1	8.9	6.7
1750-1799	8	10	22.8	12.6	11.4
1800-1849	9.1	8.6		13.5	14.3

Sources: Portugal (data from 1500-1810, appendix 1), Portugal 1800-1849 and other cases Palma and Reis 2016, based on Karaman and Pamuk (2010).

According to data in table 2, the political autonomy in 1640 is a landmark in Portugal's fiscal history. After a period (1600-1649) marked by a significant gap relatively to Castile, Portugal's war of restoration pushed the tax load up to the levels of its military. The Dutch case, also fighting the Habsburgs, stands out for heavy taxation already in the first decades of the 17th century, the reason why scholars have referred to a tax revolution (Fritschy 2003). Finally, Portugal reached a fiscal capacity higher than England still in the second half of the 17th century and fell definitely behind only from 1750 onwards.

The country's fiscal performance after 1640 owed much to an income tax that heightened at an unprecedented level the importance of direct taxation for the royal treasury. The tax base of the Decima tax (wages, rents, interests, and profits) became legitimate in Cortes from 1641, which enforced a 10% rate . In peace time it went down to 4.5%. Portuguese taxpayers' liability for an income tax had a long-lasting tradition in the nineteenth century when the liberal regime reformed the operational costs of this source of revenue

Before this enduring innovation, the kingdoms' fiscal system had rested on indirect taxation since medieval times. The prior statements on resources from the Empire demanding an

institutionally clear framework, go without saying that the colonial extension of the Portuguese economy was marginal to fiscal income collected in the kingdom. Portugal's foreign trade comprised the imports and re-exports of exotic commodities, which drove up customs duties right from the turn of the 15th century to the 16th century. (Godinho 1978, pp. 31-74; Pereira 2003). In the last decade of the 16th-century customs and other fiscal revenues exacted from maritime sectors hovered around 33- 35% of the totals in the domestic market. There were no constitutional constraints to the crown's alteration on tariffs, although they were not uniform taxes.

The role of indirect taxation was a feature of the Iberian kingdoms, altogether distinct in this respect from other European political units at the outset of the colonial expansion. Elsewhere in Europe, direct taxation (mainly based on land) performed the bulk of the crown's revenues. In Portugal, market-oriented production granted the base of a sales tax called sisa, the equivalent to the alcabala enforced in Castile (Tortella and Comín, p. 146.). Dominguez Ortiz 1983 p. 195.). It was administrated by six Almoxarifados (fiscal and administrative regions), contributing approximately 90% to the receipts collected in these fiscal agencies. Revenues from Almoxarifados tended to equal customs, both sources performing two-thirds of the domestic fiscal revenue.

The sisa molded the Portuguese fiscal system. Firstly, it allowed the Crown to leave the land to the aristocracy and the church to tax. As a legacy of the extended period of the war of Reconquista to the Muslims, those two political bodies, and leading contenders of the kings' power had their means of extracting an economic surplus from direct taxation. Secondly, the sisa was in its origins a local tax, consigned to local expenditure under the management of municipal assemblies. It turned out to be a uniform, centralized tax in a war against Castile in 1383. The alteration was approved in Courts and determined a first and vital step towards fiscal centralization. Thirdly, the transfer of rights over the sisa from local assemblies to the crown was legitimized as a donation, which was more than symbolic procedure. It meant that this tax yields never contributed to the rewards the kings granted the nobility. Finally, this medieval innovation demonstrated the capacity of the crown to make uniform taxes to endure further the particular context that had legitimized it. The complaints of the Third Estate (commoners) in later Courts insisting on the sisa regaining its county characteristics had never deserved a positive response from sovereigns (Oliveira 1972, pp. 298-320).

All in all, in 1565 the crown gave back the administration of collection to the municipalities but kept the yields centralized. The reform implied the delivery of lump sums to the royal treasury, the amounts being renegotiated every three to six years. The contract allowed some degree of freedom to handle tax bases, so no wonder the amounts lost their first tie to sales. The so-called "encabeçamento" (fixed amount) of the sisa may have halted the path towards fiscal centralization, as some historians have claimed. (SILVA 2004, p. 244). However, negotiation with local powers did not necessarily penalize the political core, since fiscal decentralization assigned the risk to local powers. There is evidence of municipal authorities creating new tax bases to raise enough money to accomplish the sums contracted. Thus, 30 to 60% of the value of the lump-sum ("cabeção") needed occasional levies on wealth (Oliveira, p. 308, tables pp. 348 and 359).

The new administration of the sisa made it similar to any system of quotas commonly practiced in European political units. The scheme of quotas, in Portugal as elsewhere, could solve operational costs, as it happened in England with the Monthly Assessment taxes. It also respected better the principle of a fiscal federation, as it happened in the Dutch Republic, wherein the assignment of quotas to each Province went together with the centralized decision over expenditures. (Beckett, 1985, pp. 285-308; T' Hart, 1993, p. 79.).

In fact, centralized decision over expenditure and collection assigned to local powers rooted the process of state-making in Europe. It occurred in the absolutist Castile, as well as in parliamentary regimes, like England or the Dutch Republic (Dincecco 2009, 2011; Yun, 2004). Thus, it is worth mentioning that improvements everywhere rested on institutional arrangements that involved local powers, including non-professional administrations, as it happened in England with the Land Tax, still in 18th-century.

Considering the case of Portugal, the fiscal contract ruling the *sisa* contributed to smooth thee coercive character inherent to centralized taxation, but it also prevented its use for raising extraordinary money. Philip IV experienced the limitations of the system. In the 1630s, multiple fronts of war in Asia asked for increasing funds, whereas the war in Flanders diverted Castilian resources. Portuguese taxpayers did not handle well the Hapsburg's claim for more money to wage wars in places the majority of the people had not heard about. Colonial endeavors were in far distant territories overseas, usually associated to the origin of riches, not to the need of higher taxes. The military campaigns in North Africa had been an exception when they forced the kings John III and Sebastião to ask for money in the 16th century. Such

requests faced no resistance from Catholic subjects convinced that the Crusade was worthy of a subsidy. Hence, Philip IV determination to increase the "encabeçamento" of sisa in 25% in the 1630s, to outfit military protection to possessions in Asia caused the first wave of discontentment. In 1638, the king's orders to introduce an income tax faced the most severe resistance triggering the coup d'État in 1640. The same taxpayer who repudiated Philip IV's needs endorsed the rights of John Duke of Braganza to the throne of Portugal on December the 1st, 1640. The new king eventually asked for one third more than the amount the Spanish king demanded and met no resistance at all.

Portugal's revolt against the Hapsburg was not an extraordinary event in the European history of state-making. Royal levies caused popular uprisings and often not because of economic constraints, rater due to fiscal constitutional principles. However, it had long-lasting consequences, for it threw the seeds of political fragmentation in the Iberian peninsula. We ask why did Philip IV face such stiff resistance from taxpayers. Tax load could be already too heavy by late 1630s, as it was almost two times that in England, but on the other hand, it was under the Castilian threshold. Hence, the riots that paved the way for the coup d'état in 1640 may indicate the unwillingness to pay for withdrawing a threat in too far-distant territories, where the majority of taxpayers had no capital or interest. Besides, there were no constitutional means of monitoring the expenditure of the money raised in Portugal. Thus constitutional constraints could have framed the events of 1640, but there is no doubt that taxpayers showed sympathy for John IV own war, inside the Portuguese borders.

In the next section, we estimate the tax burden implied in Philip IV's demands and compare it to that brought about by John IV's after the takeover of the throne.

Tax Burdens

Philip IV's purpose of raising the quota of the sisa (encabeçamento) in 25% went together with the demand for other subsidies, one based on income and the other on excises on wine and meat. The budget dated from 1632 is the best archive evidence available to assess how much these requests aggravated the current tax burden. The domestic revenue totaled 822.5 million réis, of which 175.5 million came from Almoxarifados and depended on more than 90% on the yields of the sisa. If this source were set to rise by 25%, it would add 43.9 million réis. To this amount, impositions on wine and meat in the municipalities of the whole kingdom would add-on more 160 million réis. In short, Philip IV was counting on raising further 200 million réis.

To estimate the impact of the additional 200 million over 822.5 million réis forecasted in the budget we use prices of wheat, which also allows estimating the impact of the financial request on the tax load. For a lower and upper bound, we take the average price of the bushel in Lisbon, the largest urban center (220 réis), and in Évora, the town in the southern area of Alentejo, where wheat took the most significant share of the agrarian output (196 réis).[2] We thus estimate a tax receipt between 62,949,949 kg and 56,082,682 kg. The population at the time was close to 2,000,000 inhabitants (Palma and Reis, Tabl A7 2016), pointing to a capitation 33- 30 kg (table 3). Scholars have found a similar capitation in Ancient Rome (Bonney 1999, p. 9) so that our estimation point to a capitation common to other agrarian economies. The ratio capitation/consumption of wheat gives a measure of the tax load. Assuming the annual consumption per person could vary from 547 kg to 730 kg of wheat (Oliveira 1980), 33 kg per capita was a tax burden hovering around 4.5- 6%. The additional 200 million réis that Philip IV requested would set the capitation at 40 to 45 kg, meaning a 1% increase.

Philip IV and John IV fiscal demands (in kg of wheat at Lisbon prices)

capitation in 1633	30
capitation in 1635	40
capitation in 1641	55

capitation/annual consumption (547 kg)	
tax load in 1633	4.5%
tax load in 1635	7.3%
tax load after 1641	10.0%

[2] Price per bushel in 1636: 196 réis (5 years moving average. Each bushel = 15 kg. See data on prices in SANTOS 2003, Appendixes; and http://pwr-portugal.ics.ul.pt/ (Price, wages, and rents in Portugal, PWR project).

Apart from the rising of the tax load, the Spanish rule looked for extra money without summoning of Cortes in Portugal which disregarded the kingdom's fiscal constitution. In the riots from 1637-1638, members of the church and the aristocracy backed the popular uprising. How the revolt unfolded is not a matter here, nor the full analysis of the political speech building up the legitimacy of the coup d'État (Costa and Cunha 2006). It is worth mention, however, that the church played an active part in the revolt. The sermons, particularly after 1630, supported the public view of a Spanish usurpation of power and extortion.

The process of political autonomy began on December, 1st of 1640 when noblemen invaded the palace where the Vice Roy (the Duchess of Mantua) resided. At the county level, local oligarchies (municipal assemblies) adhered to the secession immediately afterward. The war against the Hapsburgs' army took place in several areas of the Portuguese territory, along the borders and in the plains of Alentejo, in southern Portugal. The income tax, called décima, levied at 10% rate, waged a twenty-eight-year war and the amounts negotiated in Cortes of 1641 meant an increase in the tax burden. Between 1641 and 1642 an ambitious fiscal reform introduced a universal income tax. The tax called Decima had a 10% rate levied on rents (of urban or rural property), profits, interests, and wages. It was expected to yield 680 million réis. Still, the reminder 189 million needed should count on indirect taxation. Eventually, the people accepted levies on wine and meat, making of the riots against Philip IV a clear demonstration that taxpayers' willingness to pay was a determinant variable of fiscal capacity in absolutist regimes. According to 1641 budget, the domestic economy should support the payment equivalent to 90,308,123 kg of wheat (at Lisbon prices), that is, proximately 55 kg per capita, about 25% more than what had been refused to Philip IV.

Such an increase of the tax load did not leave archive evidence of riots or any form of political unrest after 1640. Hence, our findings trace back an innovation and a tax burden with little political costs. Moreover, Portugal won the war, which is the expected outcome considering the chance of victory depended not only on the military technology but also on the small political costs inherent to the confrontation (Hoffman 2015). However, tax evasion could have been the new king's great challenge, given the revolutionary backdrop against which the Decima was being implemented. In the next section, we ask whether evasion was an issue and if not, why taxpayers adhered to more burdensome taxation.

The Decima tax

The Decima tax was sanctioned in Cortes to pay for the costs of the political autonomy as if this was a common interest and not just the goal of a duke enthroned king. It demanded an administration specifically allocate to collect its yield. Local powers were involved in the system right from the beginning. Locally, municipalities were rules by elected senates, whose members were of the middling sort, usually in the network of aristocrats with local influence for their estates or seigniorial and jurisdictional rights in the region. The name list of the elected members of senates was sent to Lisbon for the king to underwrite formally the body of aldermen every three years. The senates administered local taxes and expenditure, as well as the collection of central taxes as happen with the sisa. As for the Decima tax, the aldermen appointed the assessors of taxable income and were under the supervision of the local agencies of a central bureau known as the Junta dos Três Estados (Council of the Three Estates). This bureau worked as royal council and gathered members from the three political bodies assembled in Cortes (the church, the nobility, and the commoners - Third Estate). The money collected locally was redistributed among the military districts by this central bureau.

Resorting to aldermen and assigning the assessment and collection to decentralized structures lowered operational costs and solved compliance issues due to closer monitoring[3] However, the tax base had also high informational costs which initially called for the expertise of agents outside the state administration. According to the law from 1642, the modes of collection followed the procedures of agents of the church (not necessarily clergies) who handled the tithe, presuming these men knew how to evaluate income from a given asset (capital or land). Hence, information delivered by the *c*hurch could check the ledgers of the Decima assessment. Such an intervention of the church seems essential. Studies in state building have seldom considered the role of religious administrations for their informational expertise[4].

The amounts assessed and collected give evidence of the administration accomplishments (table 4). The numbers from the whole decade of the 1640s point to critical times in the tax

[3] MAGALHÃES, 2004 and legislation published in J. J. Andrade e Silva, Collecção Chronologica de Legislação Portugueza, Lisboa, 1856, pp. 143-148.. also on http://www.governodosoutros.ics.ul.pt/?menu=arquivo).

[4]. The role of religion in the process of state building is usually considered for legitimation issues. See, Jared Rubin, *Rulers, Religion, and Riches: Why the West Got Rich and the Middle East Did Not*, Cambridge University Press 2017

implementation and broaden the gap between the amount negotiated in Cortes and taxable income (680 million against 397 million réis). On the other hand, in 1644 the enforcement reached extraordinary rate. It coincided with the only decisive battle fought in the first decade of war.

table 4 - The enforcement of the decima (million reis)

	tax base assessment	amount enforced	rate of enforcement (%)
1641-1649	680	397	58.4
1644	428	408	95.3
1650	628,2	502,6	80
1651	632,7	454,7	71.9
1652	635,8	296,6	46.6
1653	642,2	523,3	81.5

Sources, Hespanha 2004, 182; Lisbon Archives, Biblioteca da Ajuda 51-VI-19, fol 127 e ss; Costa, 2004b, p. 41

At the onset of the process taxpayers' evasion was the new administration main concern. The state's perception of flaws in the assessment procedures led to the enactment of legislation deciding when and how the central administration should referee the process, considering the possibility of influential taxpayers bullying local assessors. Still, figures in table 4, point to the apparent efficacy of a centralized income tax, locally collected and implemented after a revolt led by the nobility and the church. Enforcement reached an average 70% rate, which may be an impressive result. At the same token, there is no evidence of the use of violent means to exact the amounts, contrary to what happened in seventeenth France (Bonney 1995, 434-435).

The Cortes assembled every three-year created a political arena for commoners to complain about the army disturbing the daily life of households, and contend that taxes and conscription meant a double charge on taxpayers (Costa 2004a, 2004b). In 1645, protests in Cortes claimed

the money was not properly managed, and a lot was being diverted owing to military officers' bribery to relieve some men of conscription. There was, indeed, many reasons for contention. The government replied to protests with the false expectation that the war would be over by the time of the next summon of Cortes (Costa 2004b).

The summoning of the Cortes every three years helped to strengthen the bonds mentioned earlier. In Cortes, both the king and the people learned about the other party's expectations, thus Cortes worked as a Parliament for these matters. However, it lacked the constitutional fundaments to restrain the king's decision and to control expenditure effectively. Even so, this assembly must have affected taxpayers' behavior. There is no way to quantify its efficacy in promoting fiscal consent, but we know that expectations of a short-lived conflict could be a useful device to smooth resistance (Ames and Rapp 1977). In a different ground, the jurists made up the legitimacy of John IV, which convinced more sophisticated taxpayers about the integrity of the Duke and of his rights, and reinforced their aversion to the risk of expropriation if Philip IV regained the throne.

Still, other mechanisms must have made the people endorse a fiscal deal that asked for a 60% rise in the tax burden. The observed level of tax avoidance suggests an equilibrium that defined the taxpayers' optimal tax rate. We conjecture that the rate of enforcement corresponded to the amount thought as a fair price to divert the threat on daily lives of households, i.e, all the disturbances that war at home entailed, which Portuguese people have been speared to during the Habsburgs rule. Thus, the war envisioned in our model inciting taxpayers to consent in a high tax burden encompasses situations common in areas of quartering of troupes and not battlefields. This implied people's loss of capital due to well-documented requests of horses and cattle, the accommodation of soldiers for an uncertain time, robbery perpetrated by both sides of the conflict, and women victims of rape (Penim 2007). The accommodating of troupes in villages of Alentejo (Mourão), for instance, destroyed most of the housing during the military campaigns from 1659 onwards. The war also encompassed damages caused by privateering, which endangered in grate extant colonial shipping. In the next section, we analyze the factors determining the rate of execution of the Décima tax.

The taxpayer

Portugal's fiscal capacity, like that of any other political unit undergoing a process of state making, must have counted on taxpayers' self-interest in complying. Ultimately, the

equilibrium between the expected yields and enforcement owed to taxpayer's expected utility in paying taxes. So far, our argument tracks the well-grounded literature that recognizes the critical role played by warfare in state building. In our model, however, the link between war and state capacity considers the prospect of damages as the taxpayers' motivation to pay.

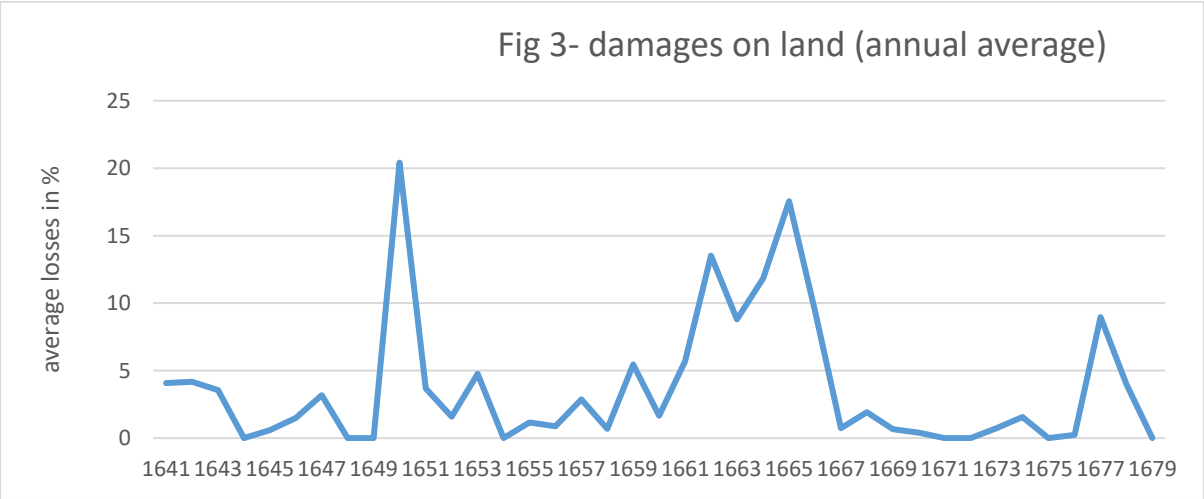
The data we use to test this hypothesis rests on the survey of the yields from the Decima edited in 1655 and referred to 14 years of experiment, which are gathered in table 3. The survey acknowledged the difference between assessments of taxable income and amounts collected. There is no evidence that the government ever attributed the flaws to official's embezzlement. Thus we may ascribe the 70% average of tax enforcement as reflecting taxpayers' ability to evade 30% . The question is, what did deter them from escaping above 30%?

A standard framework for considering individual's choice of whether and how much to evade taxes is a deterrence model first formulated by Allingham and Sandmo (1972). Accordingly, the optimal tax evasion depends on the chance of getting caught and penalized, the size of the penalty for fraud, and the individual's risk aversion. We accept some assumptions of the model, allowing for the probability of war and potential damages deter the taxpayer's utility in evasion. In our case, Portugal's defensive war is affected by taxpayers' liability which, in turn, makes noncompliance a cause of damages. Thus we adopt Allingham and Sandmo model to derive the optimal tax rate.

The model regards disorder in a context of defensive war as an incentive to taxpayers. If the model reasonably predicts taxpayers' rationale, it also will point whether damages affected the rate of enforcement. In other words, the rationale of the model implies that the higher the losses, the lower the rate of evasion. Hence, the test to the hypothesis needs the estimation of damages. We take data from the Alentejo as representative of war losses in the land. In this southward region of the country, many towns and villages were on the route of the Spanish armies in case of invasion. Here stationed 50% of the infantry and 73% of the cavalry. The military district of Alentejo demanded 71% of the war budget, which is in clear contrast with 1.7% spent with sea fortresses in the Lisbon / Cascais, Peniche and Setúbal (Lisbon Archives, Biblioteca da Ajuda, Manuscripts, 51-VI-19, FL. 359-364.). No doubt the Alentejo was the area most exposed to military pressure. It appears to be the best area to evaluate the impact of the conflict in agriculture.

The rental market in 31 properties provides data to calculate an average rate of damage. Two series are available (Santos 2003) One contains the contract specified rent; the other contains

the rents paid. The difference was the outcome of many loss-making situations; environmental factors interfered alongside war damages, inciting the tenants to renegotiate the lease with the landlord. Rui Santos' estimation of a risk index in agriculture point to 6.4% in the 1640's; 5.5% in the 1650's and 9.3% in the 1660's. Apart from the difference between nominal and actual rents, this risk index covers the turnover of tenants as reflecting the instability of the land market. In this paper, however, only the reduction in rent is significant information. We need to compare uncertainty in the agrarian economy with that in maritime contexts, affecting shipping. The shipmasters turnovers in freight contracts did not necessarily signal higher risk in the sector. Hence, for our purposes, the ratio of contracted rents and actual rents is the information we use to estimate damages in each property and an annual average of losses in the agrarian sector (Table I in appendix and figure 3…)



Source, Santos 2003

The years marked by a rate of losses below 10% largely outweigh the critical times. In peace years, between 1668 and 1680, the average fell to 1.39%, which indicates the standard risk in agriculture under normal weather. Conversely, a few peaks draw the attention to the first year of the 1650s and early 1660s. After the Treaty of Pyrenees (1659), the Castilian army concentrated in the Peninsula borders and the attacks on Portuguese territory gained momentum. The decisive battles occurred in the 1660s in the Alentejo. The fact that the 1660s depict the dangerous phase whereas tenants' default turned out to be occasional once the peace resumed, grants credibility to data to estimate war damages.

We estimate a 4.6 % average rate of losses. In such a scenario, the enforcement of a tax rate above this threshold would require taxpayer's high aversion to risk for him to consent or substantial means of coercion. However, damages were also a liability at sea. Depletion of capital in shipping and the loss of revenues depending on freights bring about a different picture. Although the Spanish navy did not perpetrate attacks to Portuguese fleets, the Dutch privateering threatened Portuguese, remaining critical issues despite Portugal different political alignment after 1640. The WIC and Zeeland privateers kept endangering Portugal's Brazilian shipping in the 1640s. In two years (1647 and 1648), about half of the fleet allocated to sugar transportation (104 ships), was lost (see the appendix for sources). The war at sea prolonged the status quo that had started in the early 1630s when the WIC conquered Pernambuco. The conflict ended in 1654 when the Portuguese chartered company, Companhia Geral do Comércio do Brasil, forced the WIC to capitulate.

Information on ships afloat and total casualties allow us to estimate a rate of damages, considering the value of the ship, outfitting costs, freights and value of cargo (Table III in the appendix). This calculation contemplates the loss of capital, while that in the agrarian sector considered income flow of tenants and landlords. So, in our estimation of losses in shipping, we included a discount factor that observed interest rates charged on bottomry loans. Results of this educated guess point to a rate of damages hovering around 11.5%, which was close to the insurance paid in Hamburg (10%) for securing Portuguese capital back and forth Lisbon and Bahia, or Lisbon and Rio de Janeiro.[5] The coincidence of values warrants the credibility of the estimation.

To sum up, considering losses at sea and on land together, the legal tax rate could have been closer to the aggregate rate of damages. If we assume the state's revenues reflected somehow the part of the maritime sector in the economy, a budget from 1660 suggest that the sea contributed around 22% to the GDP. Taking this ponderation to calculate a geometric mean (0.78 to damages in land and 0.22 at sea), we find a 6% aggregate rate of damages.

The taxpayer compliance behavior

[5] (Livro I do Governo do Brasil, J. P. SALVADO; S. M. MIRANDA, (editing and footnoting), Lisboa, CNCDP, 2002, p.52).

The literature on tax compliance (surveyed, for instance, in Andreoni and all (1998) Slemrod (2007) or Luttmer and Singhal (2014) separates the motives for paying taxes into two groups: extrinsic and intrinsic. "Extrinsic" motives are associated with rational compliance when the pecuniary penalties for evading are contingent on the action of the taxpayer (see Allingham and Sandmo (1972) and Cowell (1985). "Intrinsic" motives are related to the existence of a minimum tax that the taxpayer is willing to pay on the ground that it is "fair."

In the case of income taxes like the décima, the tax authority fixes a legal tax rate, in a context of asymmetric information as regards the tax payer: the taxpayer knows the true income but the tax authority only knowns the income reported by the taxpayer. In this environment, there is tax evasion if the taxpayer under-reports her income, which implies that her effective tax rate is smaller than the effective tax rate. Let us assume that, for "intrinsic" motives there is a minimum rate that taxpayers are willing to pay and that the legal rate is above this rate. Taxpayers can be separated into three groups: total compliers, partial compliers, and minimum compliers. Total compliers report truthfully and, therefore, their effective tax rate is equal to the legal tax rate. Minimum compliers will only be willing to pay a minimum tax rate, which they do by reporting a minimum income consistent with paying an effective tax rate which is equal to the minimum tax rate. Partial compliers/evaders will be in an intermediate situation. We can assume that there is an average degree of compliance which is related to several factors: efficiency of the tax authority, social pressure for compliance, perceived usefulness of the use of tax receipt, transparency of the tax ruling, among others. We assume that in the period in which the independence-war was latent or fought we identify the degree of tax compliance with the probability of having war with the resulting direct and indirect war damages. This allows us to adapt the Allingham and Sandmo (1972) model.

Consider there are two states of the world defensive war and no war with probabilities 1-p and p, respectively. In the event of no war, the net revenue of the taxpayer would be his income minus taxes, which are equal to the legal tax rate applied over the reported income. In the case of war, his net revenue was gross income minus taxes and destructions caused by war. The declared taxable revenue is R, where Y is the actual income and R corresponds to the reported income. For simplicity, assume that the taxpayer sees destruction (D) as a linear function of evasion $D = \delta (Y-R)$, where $\delta > 0$. The taxpayer knows that the degree of damages she can suffer increases with the shortage of resources to wage war and therefore he can recover part

of its payments as a reduction in the likelihood to suffer from war damages. If there are no savings the are two possible consumption outcomes: C(no war) = Y-tR, C(war) = Y- t R - δ (Y-R). We assume that the extrinsic motives to pay taxes are determining by maximizing a Von-Neumann- Morgenstern utility function in which the utility function (u(C)) displays risk aversion

E[u(R)] = (1-p) u(C(no war)) + p u(C(war)).

The intrinsic motives to pay taxes are also included by assuming that the taxpayer reports a minimum level of income (R(min)) consistent with paying a minimum positive effective tax rate τ(min). Therefore the tax-payer's problema is to find an optimal reporting level R that maximizes E[u(R)] such that R >= R(min).

Solving the problem (see the Appendix) we find that the optimal effective tax rate (τ) displays three branches associated with the three states: total compliance, partial compliance and "intrinsic" compliance. There are two critical values (depending on the parameters) but smaller than the damage rate (δ), $0 < t1(t,\sigma, p, \delta, \tau(min)) < t2(t,\sigma, p, \delta, \tau(min)) < \delta$ such that the optimal effective tax rate has the following values: for values of the tax rate smaller than t1 the effective tax rate is equal to the legal tax rate; for intermediate values of the legal tax rate $t1 < t < t2$ there will be partial compliance such that the effective tax rate is varying ($\tau = f(t,\sigma, p, \delta, \tau(min))$) between the legal tax rate and the minimum intrinsic tax rate, $\tau(min) < \tau < t$; and for the tax rate lower than the critical value t2 the optimal effective tax rate is equal to the minimum value $\tau = \tau(min)$.

We can apply this model to data for the years in which the rates of enforcement are known. This means that we have a measure for τ. We have other observables: t (the legal tax rate at 10%) and δ (measured by the destruction rate). Te next table reports the observables for period 1641-1649 and yearly data for the years between 1650 and 1653, in the first three lines.

The unobservable parameters are the behavioral parameters, i.e., the perceived probability of war (p) and the degree of risk aversion σ. For the period under study, it seems reasonable to assume it should be at least as high as $\sigma = 6$. This allows applying our model to determine an implicit probability of war (see line four in the Table), which in our model can be interpreted as the average proportion of compliance due to extrinsic motives unrelated to war damage. We see that in all periods, the effective tax rate is below the legal tax rate. However, while in all the years, except the year 1652, the effective tax is above the rate of damage δ, in the year 1652 it is below that rate. According to our model, taxes were paid due to extrinsic motives in the

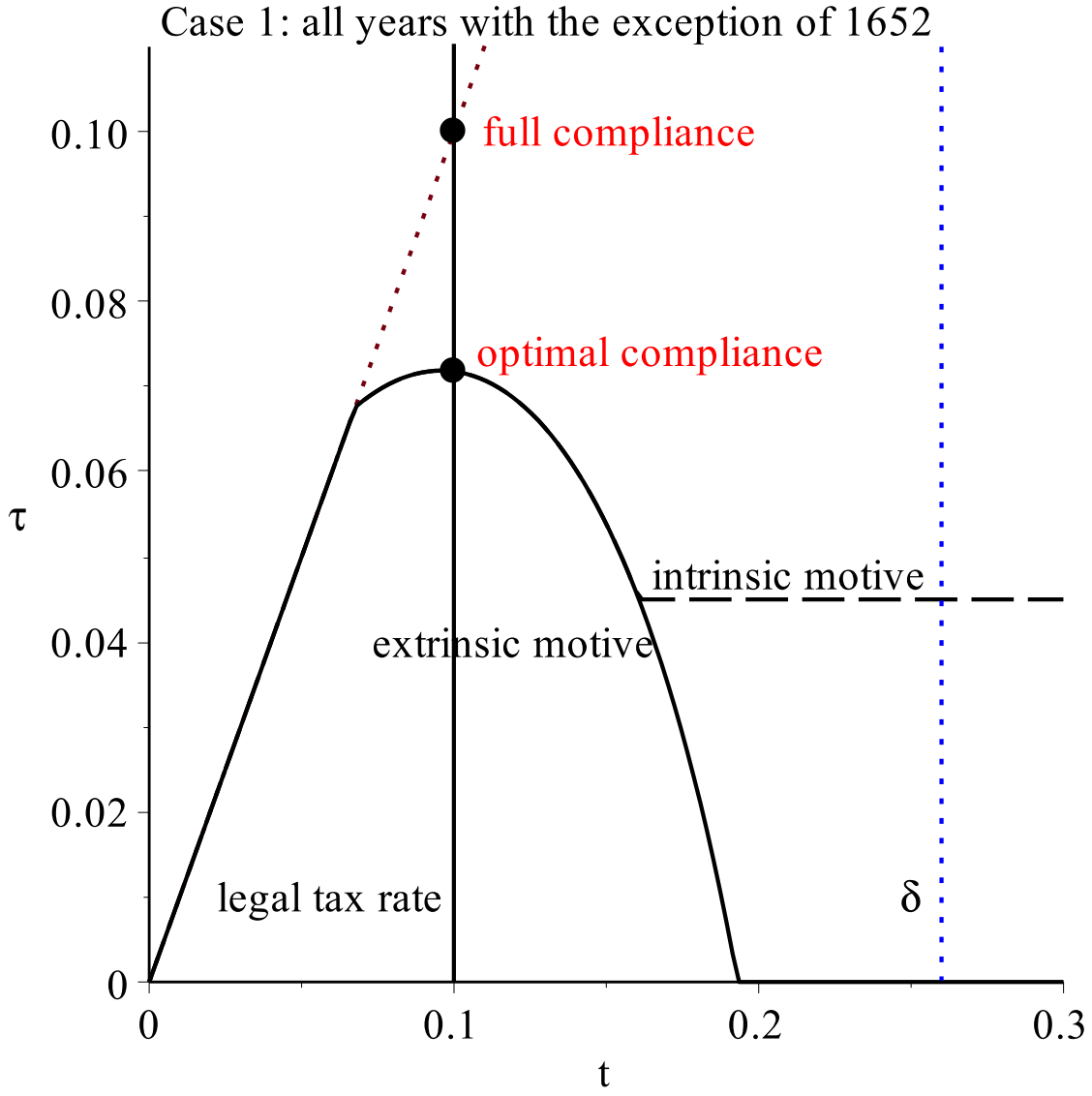
year 1652 they were paid by intrinsic motives. The two figures illustrate the two cases. In the first case, because war damages were relatively large, the two critical values t1 and t2 were relatively high which resulted that the taxpayer found optimal to pay taxes above a minimum level, while in 1652 a very low level of war damages, together with a low level of enforcement, did not provide incentives to pay more than a minimum tax rate which was observed to be 4.7 %.

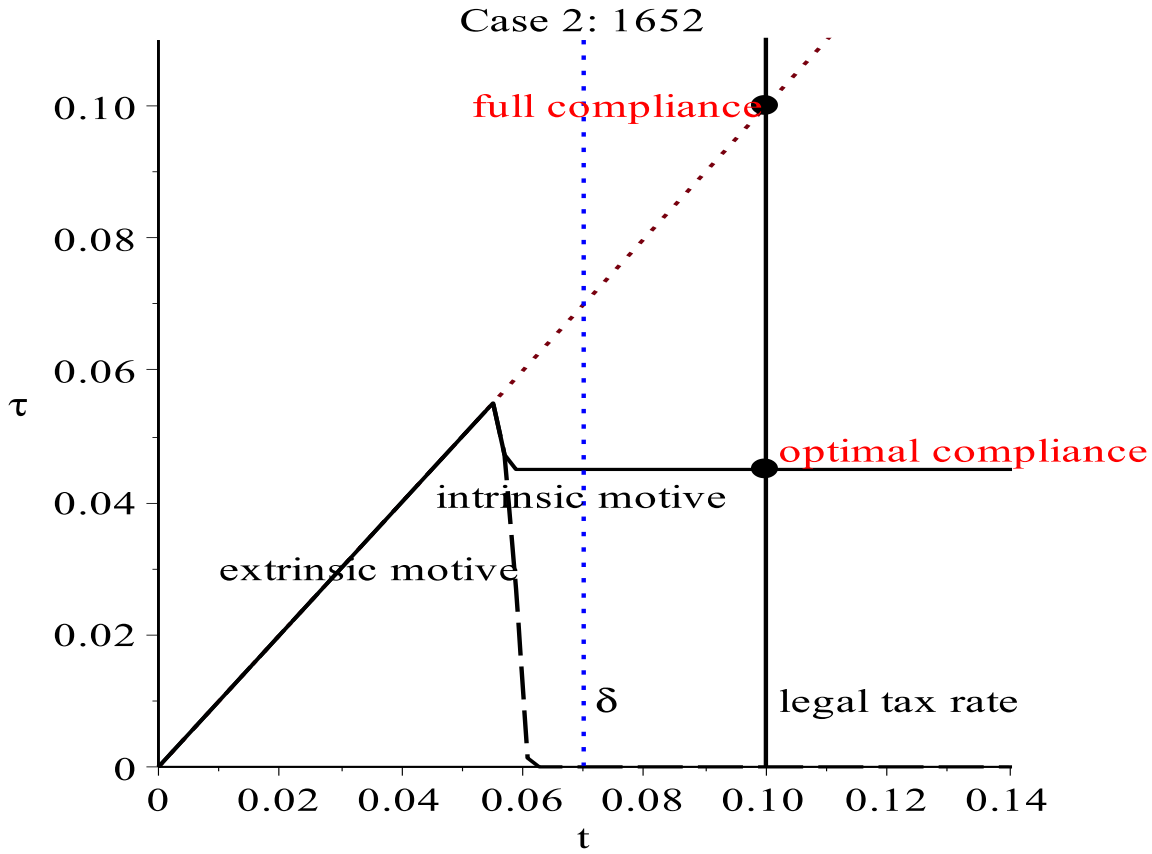
The previous model was applied under the assumption that taxpayers were homogeneous. However, the three social bodies (clergy, nobility and commoners represented in Cortes) for reasons of status, were heterogeneous taxpayers: the religious institutions paid a minimum tax and the nobles paid the maximum tax rate. Using the information from 1652 we estimate these institutions effective tax rate as 4%. Estimating the weight in total income as 12% and 10% for the first two groups, respectively, we estimate the effective tax rate for the rest of the population and the probability of war (see the last two lines on Table).

Interestingly we find that 4% is the "intrinsic" tax for the ordinary taxpayer which was the level of taxes before the change introduced by Phillip IV triggered the Independence war.

Table 1: Data and model calibration (in percentages)

	1641-1649	1650	1651	1652	1653
observed					
τ	5.8	8	7.2	4.7	8.2
t	10	10	10	10	10
δ	30.2	98.0	18.5	5.1	51.9
model calibration: homogeneous tax-payers					
$p(\sigma = 6)$	17.3	2.6	45.4		11.0
model calibration: heterogeneous tax-payers					
church	4	4	4	4	4
nobles	10	10	10	10	10
others					
τ	5.6	8.4	7.3	4	8.6
$p(\sigma = 6)$	16.6	3.4	45.8		12.5


Case 1: all years with the exception of 1652
full compliance
optimal compliance
intrinsic motive
extrinsic motive
legal tax rate
δ
τ
t
0.10
0.08
0.06
0.04
0.02
0
0
0.1
0.2
0.3



Final remarks

The exercise provides two critical results. First, when the expected damages are high, the optimal tax rate increases and gets close to the legal rate (1650). In such circumstances, the probability of war does not need to be high to deter taxpayers' evasion. It is worthy of remark that losses were most critical at sea. This exercise suggests that more capitalized economies, depending on the maritime economy, could have been assisted by higher rates of compliance. Secondly, when the expected damages were much lower than the legal rate (1652), no payment should have occurred. Nevertheless there was a 4.6% rate of enforcement (and a 4% for the common taxpayer). This is a compelling indicator of the state's fiscal capacity. It tells us the coercive potential of the tax administration in a context of extraordinary incentives to evasion. Moreover, the rate is quite close to the legal rate of the Decima in times of peace, which was 4.5%.

The model assumes that damages were the primary incentive. However, the enduring collection of the Decima poses the question of which methods assured a 4.5% rate of enforcement in times of peace. The solutions in matters of fiscal administration in Europe ranged from transferring the risk of taxpayer's moral hazard to tax farmers, to professional administration, attenuating the fiscal particularisms of counties. The literature on these topics is much extended. However, it seldom puts forward the possibility of modes of collection enhancing reputational matters. Studies in micro finance in developing countries, in contexts of critical asymmetry of information as it happened in the long-term process of state making, have stressed the significance of joint liability and peer monitoring. Stretching the similarities further, we would say that local and non-professionalized tax administration improved the reputational dimension of fiscal compliance. In any event, the information and routinized procedures during the war allowed for some useful expertise in times of peace displayed in ledgers of assessment deposited in archives. The topic asks for further research. We can only conjecture that the efficacy of the tax collection depended on the balance between local assessors' accountability and the efficacy of taxpayers' peer monitoring. The model calibration suggests that local administration of taxes already contained both conditions, pointing to the likelihood of extraction of 4.5% of the taxpayers' revenue.

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Appendix

Table I - Damages on land
(deflates values in "alqueires" of wheat)

Ano	Nominal Rents	Discouted Nominal Rent at 6,25%	Discount factor	Nominal Damages	Discounted Damages at 6,25%	Discounted Damages/ Nominal discounted rents
		68477,02			2980,66	4,35%
1640	4649,40	4649,40	1	30,00	30,00	0,65%
1641	5670,10	5336,56	0,9411765	124,40	117,08	2,19%
1642	2832,10	2508,71	0,8858131	299,80	265,57	10,59%
1643	5326,70	4440,90	0,8337065	152,30	126,97	2,86%
1644	2718,69	2133,26	0,7846649	0,00	0,00	0,00%
1645	5256,00	3881,60	0,7385082	92,90	68,61	1,77%
1646	5422,60	3769,07	0,6950665	47,80	33,22	0,88%
1647	5469,80	3578,24	0,6541803	205,90	134,70	3,76%
1648	5361,51	3301,07	0,6156991	0,00	0,00	0,00%
1649	5265,46	3051,24	0,5794815	0,00	0,00	0,00%
1650	5066,90	2763,46	0,5453943	1119,90	610,79	22,10%
1651	2927,40	1502,67	0,5133123	191,60	98,35	6,55%
1652	2831,50	1367,95	0,4831175	77,40	37,39	2,73%
1653	4808,20	2186,28	0,4546988	392,10	178,29	8,15%
1654	5596,45	2395,01	0,4279518	0,00	0,00	0,00%
1655	5352,00	2155,67	0,4027782	17,50	7,05	0,33%
1656	5709,50	2164,39	0,3790853	45,90	17,40	0,80%
1657	4941,10	1762,92	0,3567862	155,60	55,52	3,15%
1658	5179,70	1739,34	0,3357988	60,30	20,25	1,16%
1659	5481,30	1732,34	0,3160459	505,00	159,60	9,21%
1660	5681,50	1689,99	0,2974550	107,30	31,92	1,89%
1661	5029,80	1408,13	0,2799576	299,00	83,71	5,94%
1662	2215,20	583,68	0,2634895	553,90	145,95	25,00%
1663	3581,60	888,20	0,2479901	672,50	166,77	18,78%
1664	4637,40	1082,38	0,2334025	923,20	215,48	19,91%
1665	4090,80	898,64	0,2196729	921,80	202,49	22,53%
1666	4968,60	1027,26	0,2067510	143,70	29,71	2,89%
1667	5448,00	1060,12	0,1945892	45,00	8,76	0,83%
1668	5324,70	975,18	0,1831427	198,80	36,41	3,73%
1669	5238,50	902,96	0,1723696	25,40	4,38	0,48%
1670	5403,90	876,68	0,1622303	5,00	0,81	0,09%
1671	4741,55	723,97	0,1526873	0,00	0,00	0,00%
1672	4774,18	686,08	0,1437057	0,00	0,00	0,00%
1673	5224,44	706,62	0,1352524	0,00	0,00	0,00%
1674	4117,80	524,18	0,1272964	81,20	10,34	1,97%
1675	4849,56	581,02	0,1198084	0,00	0,00	0,00%
1676	5354,10	603,73	0,1127608	11,70	1,32	0,22%
1677	4945,50	524,86	0,1061278	522,70	55,47	10,57%
1678	4513,40	450,82	0,0998850	264,00	26,37	5,85%
1679	5444,66	511,85	0,0940094	0,00	0,00	0,00%

Table II – a

Damages on land: period of war
(Deflated values in bushels of wheat)

	Rents	Discounted Rens at 6,25%	Discount factor	Damages	Discounted Damages at 6,25%	Discounted Damages/ discounted rents
		61384,26			2881,98	4,69%
1640	4649,40	4649,40	1,0000000	30,00	30,00	0,65%
1641	5670,10	5336,56	0,9411765	124,40	117,08	2,19%
1642	2832,10	2508,71	0,8858131	299,80	265,57	10,59%
1643	5326,70	4440,90	0,8337065	152,30	126,97	2,86%
1644	2718,69	2133,26	0,7846649	0,00	0,00	0,00%
1645	5256,00	3881,60	0,7385082	92,90	68,61	1,77%
1646	5422,60	3769,07	0,6950665	47,80	33,22	0,88%
1647	5469,80	3578,24	0,6541803	205,90	134,70	3,76%
1648	5361,51	3301,07	0,6156991	0,00	0,00	0,00%
1649	5265,46	3051,24	0,5794815	0,00	0,00	0,00%
1650	5066,90	2763,46	0,5453943	1119,90	610,79	22,10%
1651	2927,40	1502,67	0,5133123	191,60	98,35	6,55%
1652	2831,50	1367,95	0,4831175	77,40	37,39	2,73%
1653	4808,20	2186,28	0,4546988	392,10	178,29	8,15%
1654	5596,45	2395,01	0,4279518	0,00	0,00	0,00%
1655	5352,00	2155,67	0,4027782	17,50	7,05	0,33%
1656	5709,50	2164,39	0,3790853	45,90	17,40	0,80%
1657	4941,10	1762,92	0,3567862	155,60	55,52	3,15%
1658	5179,70	1739,34	0,3357988	60,30	20,25	1,16%
1659	5481,30	1732,34	0,3160459	505,00	159,60	9,21%
1660	5681,50	1689,99	0,2974550	107,30	31,92	1,89%
1661	5029,80	1408,13	0,2799576	299,00	83,71	5,94%
1662	2215,20	583,68	0,2634895	553,90	145,95	25,00%
1663	3581,60	888,20	0,2479901	672,50	166,77	18,78%
1664	4637,40	1082,38	0,2334025	923,20	215,48	19,91%
1665	4090,80	898,64	0,2196729	921,80	202,49	22,53%
1666	4968,60	1027,26	0,2067510	143,70	29,71	2,89%
1667	5448,00	1060,12	0,1945892	45,00	8,76	0,83%
1668	5324,70	975,18	0,1831427	198,80	36,41	3,73%

Sources:
Tables I and II (a, b): SANTOS, R., *Sociogénese do Latifúndio Moderno. Mercado, Crises e Mudança Social n a Região de Évora, século XVII a XIX*, Lisboa, Banco de Portugal, 2003.

Table III
Damages at sea: period of war
Deflated values in silver marcs

year	interest rate	deflat	capital at sea	Discount Factor	Discounted capital at sea	damages	Discaunted damages	Discounted damages/Discounted capital
					847812,78		97348,59352	11,48%
1624	50,00%	0,000357143	383049,43	0,6666667	255366,29	75123,85	50082,57	19,61%
1625	50,00%	0,000357143	451403,23	0,4444444	200623,66	12945,56	5753,58	2,87%
1626	50,00%	0,000357143	415423,44	0,2962963	123088,43	7758,58	2298,84	1,87%
1627	50,00%	0,000357143	534328,48	0,1975309	105546,37	133362,81	26343,27	24,96%
1628	70,00%	0,000357143	616500,09	0,1161946	71634,00	58065,15	6746,86	9,42%
1629	85,00%	0,000357143	829588,36	0,0628079	52104,71	22723,80	1427,23	2,74%
1630	100,00%	0,000357143	732811,83	0,0314040	23013,19	68209,48	2142,05	9,31%
1631	102,50%	0,000357143	531896,97	0,0155081	8248,72	69484,17	1077,57	13,06%
1632	105,00%	0,000357143	590801,04	0,0075649	4469,37	59682,74	451,50	10,10%
1633	107,50%	0,000357143	654678,65	0,0036458	2386,80	212971,14	776,44	32,53%
1634	110,00%	0,000357143	471306,87	0,0017361	818,22	119017,51	206,62	25,25%
1635	120,00%	0,000357143	450644,70	0,0007891	355,61	37559,27	29,64	8,33%
1636	127,50%	0,000357143	414071,97	0,0003469	143,63	20527,61	7,12	4,96%
1637				0,0001476	0,00		0,00	0,00%
1638				0,0000628	0,00		0,00	0,00%
1639				0,0000267	0,00		0,00	0,00%
1640				0,0000267	0,00		0,00	0,00%
1641				0,0000267	0,00		0,00	0,00%
1642				0,0000267	0,00		0,00	0,00%
1643				0,0000267	0,00		0,00	0,00%
1644				0,0000267	0,00		0,00	0,00%
1645				0,0000267	0,00		0,00	0,00%
1646				0,0000267	0,00		0,00	0,00%
1647	75,00%	0,00025	379578,75	0,0000153	5,80	112638,75	1,72	29,67%
1648	80,00%	0,00025	453885,00	0,0000085	3,85	234663,75	1,99	51,70%

Sources

Capital at sea: estimations based on costs of setting up a ship; freight rates per ton and the number of ships annually allocated to the sugar fleet, in Leonor F. COSTA, *O Transporte no Atlântico e a Companhia Geral do Comércio do Brasil,* Lisbon, CNCDP, 2002, pp. 175-178; p. 360.

For data on cargo (prices of sugar only): archive sources quoted in Leonor F. Costa, *O Transporte no Atlântico*…p. 241; Frédéric MAURO, *Le Portugal, le Brésil et l'Atlantique au XVII ème Siècle,* Paris, Fondation Caloust Gulbenkien, 1983, pp. 298-299; Stuart SCHWARTZ, *Sugar Plantations in the Formation of Brazilian Society Bahia, 1550-1835* (Portuguese edition), São Paulo, Companhia das Letras, 1988, pp. 400-401.

The capital estimated for each ship sailing on the Portuguese-Brazilian routes took into account a 210-day voyage (back and forth) and a rate of optimal exploitation of freight tonnage (for rates of optimal exploitation of freight tonnages, Leonor F. Costa, *O Transporte*… table in p. 319), providing the average value of a sailing ship which also enables the estimation of damages according the number of casualties.

Casualties:

Number of ships and cargo (other than sugar) for the period 1624-1636: Joannees LAET, *História ou Anais dos Feitos da Companhia Privilegiada das Índias Ocidentais, desde o seu começo até ao fim do ano de 1636*, Rio de Janeiro, Biblioteca Nacional do Rio de Janeiro, 1925, vol. II, pp. 621-636.

For the period 1647-1648: Ch. BOXER, *The Dutch in Brazil, 1624-1654*, Oxford, Clarendon Press, 1957, Appendix III.

Interest rate: Leonor F. Costa, *O Transporte no Atlântico*... Appendix V.