

*Mark Hup*

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Finance in Holland, 1648-1713**

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Mark Hup – 3231526

Bachelor Thesis Economics

Supervisors: Dr. P.J. Engelen & Dr. J.P.B. Jonker

Universiteit Utrecht

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# Life annuities as a resource of public finance in Holland, 1648-1713

## Demand- or supply-driven?

Abstract: This research empirically verifies adverse selection took place in Holland's market for life annuities which made life annuities relatively costly for the government. As life annuities were the government's preferred debt instrument and demand for them was slack the market was demand-driven. As long as no structural reform in the pricing mechanism was implemented the government would remain at the mercy of the market. Why said reform did not take place remains unclear.

## Introduction

Life annuities constituted an important part of public finance in 17<sup>th</sup>-century Holland, the richest and most important province of the Dutch Republic. A life annuity paid predetermined sums (the interest) to the buyer at predetermined dates until the person on whom the contract was written had died. The buyers were individuals, while the sellers were different institutions (mainly governmental ones, e.g. cities and provinces). The person on who the life annuity was written did not need to be the buyer, nor did the buyer need to know said person. This left an opportunity for arbitrage as the interest rate was not age-dependent and higher than the interest rate on redeemable annuities (*losrenten*). Presumably a large part of life annuities was written on young bodies, mainly girls of around five years old. Exactly that part of the population with the highest life expectancy. This allegedly made life annuities costly for the government. The obvious question then is: why were life annuities issued at all? The story becomes more complicated due to the analysis of Johan de Witt, Grand Pensionary of Holland from 1653 until 1672. He concluded that life annuities at the then usual interest rates were too expensive, but also judged them to be the best resource of public finance. De Witt called for a reduction in the interest rate and a transformation of the system into an age-dependent scheme. His recommendations, however, were not implemented. What kept this from happening? And why did De Witt perceive life annuities as the most suitable resource of public finance? Did adverse selection take place and were life annuities indeed costly for the government? This paper aims to answer these questions and by doing so further uncover how

financial markets worked in the Dutch Republic. A better understanding of those markets and the behavior of its actors may in turn shed more light on present financial markets.

To be able to answer said questions both the supply and the demand side of the market for life annuities should be analyzed. The main research question is embodied in the title: Life annuities as a resource of public finance in Holland, 1648-1713: Demand- or supply-driven? Three sub-questions are defined in order to structure the answer to the main question. They are: (1) What determined the supply of life annuities?; (2) What determined the demand for life annuities?; and (3) What were the specifics of Holland's market for life annuities? The historical context is very important and therefore described in the paper and incorporated in the analysis. The first section considers the historical circumstances. The second segment describes Holland's public finances at the time and the changes it did (and did not) undergo. De Witt's analysis is attended to in the third part. The value of a life annuity, and the respective up- and downsides to it as an investment, is treated in the fourth section. The main analysis comes fifth when the market for life annuities in Holland is inspected. The sixth segment examines the problem of adverse selection in the life annuity market more closely. The conclusion sums up the main findings and provides a call for further research.

The main analysis is based on original archival research. Multiple contemporary life annuity registers from the National Archive in The Hague have been sifted through to acquire relevant data on more than a thousand life annuity contracts.<sup>1</sup> Only in this way is it possible to empirically examine Holland's market for life annuities and thereby uncover its specifics. Four focus areas have been selected in order for urban-rural differences to become visible. Two urban (Amsterdam and The Hague) and two rural localities (Gorinchem and Brielle) have been chosen to represent urban and rural areas, respectively. The years between 1648 and 1713 are concentrated on as Holland and its financial markets then underwent sundry changes. The public debt expanded extremely fast, secondary markets arose, interest rates frequently changed, and Holland rose to power to subsequently decline to a moderate power once more. The historical background is considered in the next section.

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<sup>1</sup> For more on the constructed dataset see section five and the appendix.

## 1. Independence, economic growth, and war: 1648-1713

The period from 1648 to 1713 marks a remarkable and turbulent time in Dutch history.<sup>2</sup> It encompasses the zenith of Dutch power and the Dutch Golden Age and the later decline to a modest power on the European scene.<sup>3</sup> Dutch independence was officially acknowledged in 1648 with the Peace of Westphalia. This ended the Eighty Years' War with Spain and heralded the Dutch Republic as a major power. Two years later, in 1650, the First Stadtholderless Period commenced with the death of stadtholder William II, Prince of Orange. A power vacuum came into being as his son, William III, was born a week after his father's death. The vacuum was filled by an extension of the authority of the Grand Pensionary of Holland. Johan de Witt rose to the job in 1653 and effectively became the political leader of the Dutch Republic. He was immediately tested during the First Anglo-Dutch War (1652-1654) which resulted in a minor English victory.

The military defeat demonstrated the need for an expansion and better upkeep of the navy. This expansion of military power joined with commercial and diplomatic supremacy during the later 1650s and 1660s. The Republic was able to finance the navy through efficient capital markets and public finance. This was, however, lacking in England, so when the Second Anglo-Dutch War (1665-1667) came about, the Dutch accomplished a decisive victory over an England weakened by the Great Plague and the Great Fire of London. Nonetheless, peace would not rule for long. The *Rampjaar* (Disaster Year) of 1672 showed the Republic's diplomatic policy had failed as it was attacked by England, France, and the bishops of Münster and Cologne. French forces advanced quickly over the country but the main cities of Holland remained independent. Internal strife, however, was rampant and culminated in the public lynching of both Johan de Witt and his brother. Peace was finally brokered in 1678 but the economy had been dealt a severe blow and international tensions were not eased.

France kept expanding its power and encroaching on the Dutch Republic. A new war was in the making. As the Dutch had further declined in power something needed to be done to prevent a total defeat by the French. After having been invited by the English Parliament William III was sent, along with an army, to England to claim the throne. The result was the

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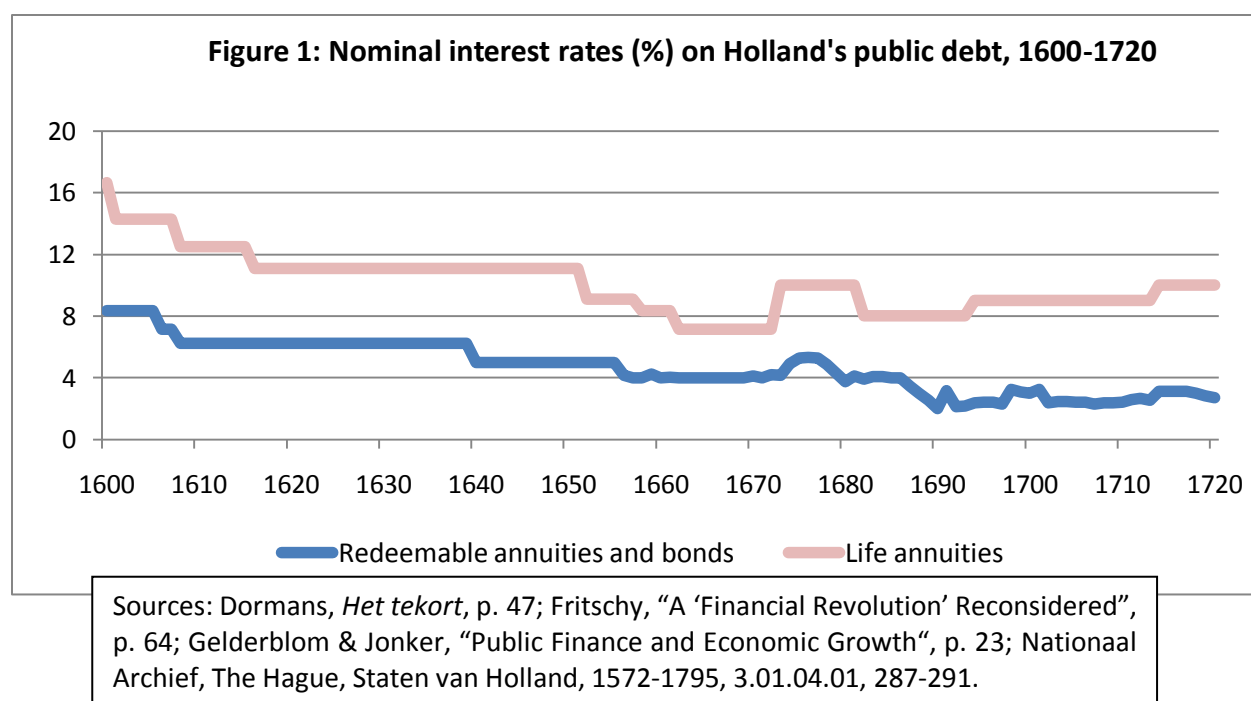
<sup>2</sup> Prak, M. (2005). *The Dutch Republic in the Seventeenth Century*. Cambridge: Cambridge University Press.

<sup>3</sup> Israel, J.I. (1995). *The Dutch Republic: Its Rise, Greatness, and Fall 1477-1806*. Oxford: Clarendon Press.

Glorious Revolution of 1688 and the crowning of William III as King of England. For the coming decades the Dutch and English cooperated to restrain the French. The Nine Years' War (1688-1697) and the War of the Spanish Succession (1701-1713) curtailed French ambitions but also rapidly increased the Dutch public debt. Furthermore, commercial and financial power gradually shifted from the Dutch Republic to England (Great Britain since 1707). The English economy became the most vibrant. The Republic left the European scene of political power play and adopted a policy of neutrality. The Dutch Golden Age was definitively over and economic growth stagnated. Holland ended its role as a major power with a remarkably high public debt. This debt is further discussed in the following section.

## 2. Holland's public debt: its roots, its growth, and its parts

The roots of Holland's provincial debt lie in the Late Middle Ages.<sup>4</sup> The necessary requirements for developing a sustainable provincial public finance system originated then. The two most important are a system of collective responsibility among towns and the use of future tax revenues as securities. Both techniques are meant to attain a higher level of creditworthiness. However, they were only implemented on a provincial scale at the end of the 15<sup>th</sup> century when



<sup>4</sup> Zuiderduijn, J. (2010). "The emergence of provincial debt in the county of Holland (13<sup>th</sup>-16<sup>th</sup> centuries)", *European Review of Economic History* 14, p. 335-359.

demand for more government funding had risen.<sup>5</sup> Nevertheless, it was not enough to kick start an efficient capital market. A 'tax revolution' in the 16<sup>th</sup> century, originally aimed at directly expanding tax revenues, was needed for Holland's creditworthiness to attain acceptable levels.<sup>6</sup> This included a substantial rise in the number and level of taxes which dramatically increased tax revenue per capita.<sup>7</sup> Along with a strong increase in population it led to much higher provincial tax revenues. Around 1600 a 'financial revolution' took place which made it possible for Holland to borrow unprecedented sums on the capital market.<sup>8</sup> The earlier mentioned provincial responsibility and high tax revenues securitizing debts, along with strong economic growth and rapid wealth accumulation, were the main factors behind this.<sup>9</sup> During the 17<sup>th</sup> century Holland profited from its increased creditworthiness and vigorous economic growth, which led to huge amounts of newly created wealth looking for profitable investments, by having to pay lower interest rates on its debt (see figure 1). Interesting to note here is the rising interest rate differential between life annuities on the one hand, and redeemable annuities and bonds on the other hand. The rise of such a difference was due to multiple factors: the government's preference for life annuities, the age-independent pricing scheme of life annuities, and the particularities of a life annuity which limited its potential as a popular investment vehicle relative to the other options available to investors. All these factors are treated in more detail later in the paper.

The generally lower interest rates made possible a substantial growth of public debt (see figure 2).<sup>10</sup> Holland's public debt chiefly consisted of three different debt instruments, namely: redeemable annuities (*losrenten*), life annuities (*lijfrenten*), and bonds (*obligaties*). What distinguished these different instruments? All paid a certain fixed amount at fixed dates (usually

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<sup>5</sup> Zuiderdijjn, "The emergence of provincial debt in the county of Holland (13<sup>th</sup>-16<sup>th</sup> centuries)", p. 335-359.

<sup>6</sup> Fritschy, W. (2003). "A 'Financial Revolution' Reconsidered: Public Finance in Holland during the Dutch Revolt, 1568-1648", *The Economic History Review*, New Series 56:1, p. 57-89.

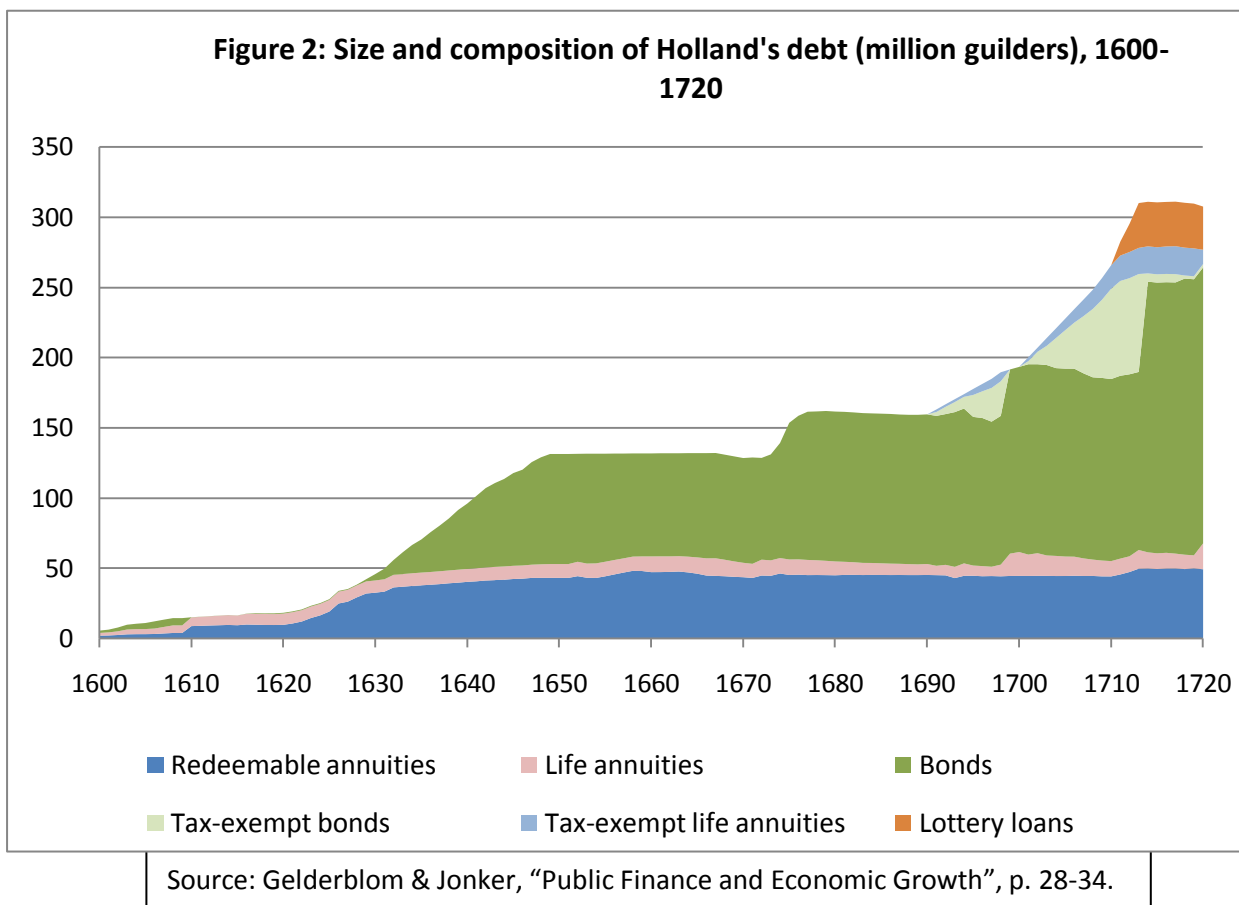
<sup>7</sup> Fritschy, "A 'Financial Revolution' Reconsidered", p. 70.

<sup>8</sup> The timing and history of this revolution is still under debate. For a treatment of the financial revolution, see Tracy, J.D. (1985). *A financial revolution in the Habsburg Netherlands: renten and renteniers in the county of Holland, 1515-1565*. Berkeley.

<sup>9</sup> Gelderblom, O. and J. Jonker. (2011). "Public Finance and Economic Growth: The Case of Holland in the Seventeenth Century", *The Journal of Economic History* 71:1, p. 1-39.

<sup>10</sup> Causality may also run the other way around: more debt and more debt-owners meant a bigger and broader market which increased liquidity. This ought to have led to a reduction in the liquidity premium charged on all three debt instruments. A lower interest rate was consequently sufficient to attract investors.

semi-annually or annually), but they differed in other respects. Redeemable annuities and life annuities were long-term debt, while bonds were short-term. A redeemable annuity could be redeemed by both investors and the province of Holland, but it tended to become perpetual.<sup>11</sup> A life annuity continued until the nominee, the person on whom the contract was written, had passed away. A bond ran for one year, but was usually rolled over on expiry. Bonds were to bearer, while both annuities were to a named person. Furthermore, the annuities were subject to a transfer tax when sold. This made annuities less liquid and therefore less attractive to the general public. Investors with a long time horizon, who had no plans of transferring the annuity any time soon, were especially attracted to annuities.<sup>12</sup> However, the biggest investors of the time, those active in commerce, required ready access to cash.<sup>13</sup> As bonds were readily redeemable at short notice they were in high demand. Nevertheless, as mentioned before, most



<sup>11</sup> Vries, J. de, and A.M. van der Woude. (1997). *The first modern economy: success, failure, and perseverance of the Dutch economy, 1500-1815*. Cambridge: Cambridge University Press, p. 114.

<sup>12</sup> Gelderblom and Jonker, "Public Finance and Economic Growth", p. 14.

<sup>13</sup> Fritschy, "A 'Financial Revolution' Reconsidered", p. 79.

bonds were rolled over on expiry. The greater part of investors, given the option of being able to quickly transform the bonds into cash, was most interested in a steady stream of interest payments. The province's bonds were a safe store of wealth and a good investment at a time when alternative avenues for private investment were limited.<sup>14</sup>

Even though bonds were the main and fastest growing debt instrument, they were not the government's favored one. Annuities were preferred because they could be taxed. Moreover, from the great increases in demand for government funding in 1672 onwards a secondary market in bonds emerged.<sup>15</sup> This emergence meant less governmental control over the market as investors began trading bonds amongst each other anonymously. Whenever the province had to tap the capital market it therefore first tried to do so by issuing annuities. Life annuities were favored over redeemable annuities because of their self-amortizing characteristic.<sup>16</sup> Once a life annuity had been issued interest was paid until the nominee had died, after which the initial capital investment definitively came into the government's coffers and any obligation to pay interest ceased to exist. It was mainly during Johan de Witt's administration that this preference took full swing.<sup>17</sup> De Witt saw the interest payments on the debt as a heavy burden and too much reliance on debt, which could be redeemed by the investor, as a liability. This last factor came to the fore during the First Anglo-Dutch War (1652-1654) when a large group of investors called on the government to pay back the principal.<sup>18</sup> Liquidity problems for the province subsequently ensued which were only solved by the end of the war and strict financial policy by De Witt. De Witt wanted both to reduce the debt and the risk of investors withdrawing capital in times when it was needed the most. Life annuities met both these wishes as they were self-amortizing and non-redeemable. Life annuities were therefore prescribed as the instrument of choice in De Witt's debt reduction plan.<sup>19</sup> The next section deals more extensively with De Witt's debt plan and analysis of life annuities.

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<sup>14</sup> Gelderblom and Jonker, "Public Finance and Economic Growth", p. 26-27.

<sup>15</sup> Gelderblom and Jonker, "Public Finance and Economic Growth", p. 19-20.

<sup>16</sup> Dormans, E.H.M. (1991). *Het tekort: staatsschuld in de tijd der Republiek*. Amsterdam: NEHA, p. 58-60.

<sup>17</sup> Dormans, *Het tekort*, p. 59.

<sup>18</sup> Dormans, *Het tekort*, p. 50.

<sup>19</sup> Houtzager, D. (1950). *Hollands lijf- en losrenteleningen vóór 1672*. Schiedam, p. 74-76.

### 3. Johan de Witt: his life, the debt reduction plan, and the *Waerdye*

De Witt was born in the town of Dordrecht in 1625.<sup>20</sup> After excelling in local schools he went on to study law and mathematics at the University of Leiden. In 1650, at the young age of 25, De Witt was appointed Dordrecht's representative to the States of Holland, basically the government of Holland. Three years later he had already risen to the highest political position available, that of Grand Pensionary of the States of Holland. This effectively made De Witt the most powerful man in the country. In his capacity as Grand Pensionary he was present at many assemblies and sat in many commissions. As a result, De Witt was well-informed and could dominate the decision-making process in the States of Holland.<sup>21</sup> He combined his financial and mathematical insight with the power and information available to him to steer financial policy in his preferred way. De Witt helped keep Holland's credit up during the 1650s and 1660s, but did not see his plans come to full fruition due to his murder in 1672.

After experiencing what could happen to redeemable debt instruments during the First Anglo-Dutch War, in 1655 it was proposed to reduce the debt burden by cutting interest rates, transforming bonds into redeemable annuities, and henceforth focusing more on issuing life annuities. If carried out diligently the province would be relieved from its pressing debt requirements within 41 years, by the year 1696, and have access to liquidity in times of need.<sup>22</sup> First, the interest rate on bonds and redeemable annuities was reduced from 5% to 4%. The interest payments saved were subsequently to be only used for debt reduction.<sup>23</sup> No other destination was permitted, except in times of extreme need, in order to prevent future lengthy debates on how to spend the savings and to assure the debt burden would indeed diminish. The interest rate cut did not go without opposition as many people, especially the relatively wealthy and powerful, had invested in bonds and redeemable annuities and would thus be negatively affected. That De Witt succeeded in implementing the plan is testimony to his influence, but also to the popularity of said debt instruments. Investors could reclaim their principal, but not

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<sup>20</sup> For an extensive and very readable biography, see Panhuysen, L. (2009). *De Ware Vrijheid: De levens van Johan en Cornelis de Witt*. Amsterdam: Olympus.

<sup>21</sup> Bovers, R. (2009). *Government-Market Interaction: Holland's Loan Issuing Policy during the Dutch War*. Unpublished MA thesis, p. 13-20.

<sup>22</sup> Houtzager, *Hollands lijf- en losrenteleningen vóór 1672*, p. 79; Dormans, *Het tekort*, p. 203.

<sup>23</sup> Houtzager, *Hollands lijf- en losrenteleningen vóór 1672*, p. 76.

many made use of this option. Apparently because investing in the provincial debt at 4% was still beneficial and no myriad of alternative investment options existed.<sup>24</sup>

The first few years after the plan's execution all prescriptions were strictly complied with. For example, when the province was in need of more funding in 1659 and 1660 due to military expeditions in Scandinavia it was agreed upon to only issue annuities and no bonds.<sup>25</sup> However, a first sign of the times to come came with the commencement of the Second Anglo-Dutch War in 1665. It was agreed to spend the yearly interest savings on equipping and enlarging the navy. The same was decided in the next two years. The interest savings were partly spent on debt reduction in 1668 and 1669, but from 1670 onwards all of it went to strengthening defensive works as war was in the air. With the Disaster Year of 1672 all hope on completing the debt reduction plan was vanquished. The debt started to grow again, while interest rates went up because of the heightened risk level. It was, after all, possible the Dutch Republic would not survive the war years, which would turn investments in the government worthless. Furthermore, the biggest part of the debt increase was in bonds. It had proven difficult to sell enough annuities wherefore recourse had to be taken to bonds. Taxes were raised too.<sup>26</sup>

All this shows the government might have good intentions but need will break law. External circumstances forced the government to stop the debt reduction plan. Moreover, the demand-side of the market for debt instruments forced it to issue bonds as demand for annuities was too scant. De Witt acknowledged reform was required to design life annuities in a way both attractive to the state and investors. He reported his life annuity analysis to the government in 1671 as the *Waerdye van lyf-renten near proportie van los-renten* (Value of Life Annuities in Proportion to Redeemable Annuities) in which De Witt argues the contemporary interest rate of 7.14% on life annuities is too high relative to the rates paid on redeemable annuities and bonds and thus ought to be lowered. It was presumably too high because of adverse selection on the part of the investors who mainly picked young nominees. This adverse selection should be combated by implementing an age-dependent pricing scheme which would result in lower interest rates paid to younger, and higher interest rates to older nominees,

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<sup>24</sup> Houtzager, *Hollands lijf- en losrenteleningen vóór 1672*, p. 81.

<sup>25</sup> Houtzager, *Hollands lijf- en losrenteleningen vóór 1672*, p. 82.

<sup>26</sup> Dormans, *Het tekort*, p. 203.

respectively. Life annuities would then become more appealing for both buyers selecting older nominees and the issuer. This would align reality more with De Witt's conviction of life annuities as the most suitable debt instrument of the time.

De Witt based his analysis on data, which has been lost, gathered from life annuity registers and innovative mathematical pricing methods.<sup>27</sup> He used the interest rate on redeemable annuities as the discounting rate, and divided life into four age-intervals with nobody living beyond the age of eighty. Each interval had its own chance of survival. These assumptions about mortality patterns allowed De Witt to calculate the value of a life annuity as it requires weighting the future cash flows by the survival probability of the nominee.<sup>28</sup> As mentioned above, he concluded interest payments were too high and recommended structural reforms. Age-dependent pricing was briefly introduced in 1672 in Amsterdam, but reforms were not broadly implemented.<sup>29</sup> Why exactly there was no follow-through on De Witt's proposals is not clear.<sup>30</sup> Possible reasons are discussed at the end of the main analysis in section five. Hereafter, first an account of the up- and downsides of a life annuity from the investors' perspective is treated, next comes the main empirical analysis of Holland's market for life annuities.

#### **4. The value of a life annuity: the investor's perspective**

Investors in Holland's public debt had multiple goals in mind. Profit, security, and liquidity were foremost among these. All three aspects will be treated in turn. Life annuities paid a relatively high interest rate but this did not necessarily have to translate into a relatively high net yield. First, life annuities did not, in contrast to redeemable annuities and bonds, return the principal. Second, life annuities were subject to several taxes. The other two debt instruments were as well, but bonds were free from a transfer tax.<sup>31</sup> Third, it was up to the buyer to prove the

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<sup>27</sup> For more on his method, see: Poterba, J.M. (2005). "Annuities in Early Modern Europe", in: Goetzmann, W.N., and K.G. Rouwenhorst. (2005). *The Origins of Value: The Financial Innovations that Created Modern Capital Markets*, New York: Oxford University Press, p. 211-212; Hald, A. (1990). *A History of Probability and Statistics and Their Applications before 1750*, New York: John Wiley & Sons, p. 122-131.

<sup>28</sup> Poitras, G. (2000). *The Early History of Financial Economics, 1478-1776*. Cheltenham: Edward Elgar, p. 190.

<sup>29</sup> Hald, *A History of Probability and Statistics and Their Applications before 1750*, p. 131.

<sup>30</sup> Bovers, *Government-Market Interaction: Holland's Loan Issuing Policy during the Dutch War*, p. 52.

<sup>31</sup> Dormans, *Het tekort*, p. 60.

nominee was still alive in order to receive the interest payment. The only accepted form of proof was a life certificate (*attestatie de vita*) from the city hall for which a fee had to be paid.<sup>32</sup> Fourth, the ultimate value of a life annuity depended on the remaining years of life for the nominee. Life annuities, unlike redeemable annuities and bonds, therefore yielded a random set of payouts.<sup>33</sup> Consequently, the value of a life annuity was more uncertain. These extra costs and uncertainties related to life annuities justified a relatively higher interest rate.

In terms of default security life annuities were equal to the other public debt instruments as all were issued by the provincial government. In general, investing in the public debt was considered very safe.<sup>34+35</sup> However, in terms of providing a secure stream of income for the rest of a person's life a life annuity was very secure because it could not be redeemed by the issuer while redeemable annuities and bonds could. Therefore, if a person selected himself as nominee he was guaranteed a certain minimal income for the rest of his life. No other similar investment option, with the same level of default security, existed at the time. Consequently, a life annuity was very suitable for guaranteeing a minimum living standard for the rest of the buyer's life when the buyer himself was the nominee. A parent could, for instance, buy a life annuity on the life of his child and transfer it to the child at the moment of his own death. The child could then enjoy the interest payments until his death. Be that as it may, although redeemable annuities and bonds were redeemable by the issuer they almost never were as the government always was in need of more funding. Nonetheless, under De Witt debt reduction was an objective with bonds and redeemable annuities as targets. The chance of the return of such a policy would thus support a relative cut in the interest rate on life annuities.

In terms of liquidity life annuities were problematic.<sup>36</sup> The transfer tax played its part in this, but the main causes should be found in the required proof of life and the problem of asymmetrical information. To prove the nominee was still alive required contact in order to

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<sup>32</sup> Bovers, *Government-Market Interaction: Holland's Loan Issuing Policy during the Dutch War*, p. 52.

<sup>33</sup> Poterba, "Annuities in Early Modern Europe", p. 211.

<sup>34</sup> Dormans, *Het tekort*, p. 55.

<sup>35</sup> However, in times of trouble, like the years following the Disaster Year, credit was hard to obtain. People deemed public debt too risky wherefore the government had to raise interest rates and mainly rely on extraordinary taxes in order to procure the necessary financing.

<sup>36</sup> Weir, D.R. (1989). "Tontines, Public Finance, and Revolution in France and England, 1688-1789", *The Journal of Economic History* 49:1, p. 111.

persuade him or her to tag along to the city hall. Relatives and friends, and their families, were therefore the main candidates to function as nominee. Networks thus directly played a role in the demand for life annuities, but also indirectly through liquidity. The initial buyer might have chosen the nominee for solid reasons, like a history of healthy family members and a prudent character, but not all potential buyers in the case of a resale had access to the same information. Information was asymmetrical: the seller knew more than the buyer. The quality of the 'product', in this market the nominee, was uncertain. This would make potential buyers hesitate to purchase any life annuities on the secondary market as the presumption of the bad driving out the good might hold true. For example, sellers might want to sell specifically those life annuities which were written on a nominee who recently became seriously ill. The life annuity market thus falls prey to the problem of asymmetrical information and becomes a 'lemon market'.<sup>37</sup> No broad secondary market for life annuities could persist. As life annuities could not be redeemed they were in effect totally illiquid. This sharply contrasts with redeemable annuities and bonds which could be readily redeemed and for which a lively secondary market existed.<sup>38</sup> A liquidity premium should thus have been charged on life annuities wherefore a relatively high interest rate was justified.

All in all, a certain interest rate differential between life annuities and redeemable annuities and bonds is explainable. The question is, however, if the continuous rise of the differential in Holland between 1648 and 1713 was justifiable. In the end it comes down to empirics wherefore original archival research is called for. After his analysis, based on archival data, De Witt came to the conclusion it was not justifiable. The next section builds on a new dataset and investigates Holland's market for life annuities in order to find out if De Witt was right and to clarify how the market operated.

## **5. The market for life annuities in Holland, 1662-1713**

According to De Witt adverse selection was effectively turning life annuities into a costly debt instrument. But did adverse selection indeed take place? Were life annuities relatively costly for

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<sup>37</sup> Akerlof, G.A. (1970). "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism", *Quarterly Journal of Economics* 84:3, p. 488-500.

<sup>38</sup> Gelderblom and Jonker, "Public Finance and Economic Growth", p. 19-20.

the government? And if so, why did the government not change its issuing or pricing policy? This section draws on a manually constructed database in order to answer these questions. More than a thousand life annuity contracts extracted from contemporary life annuity registers provide the necessary information.<sup>39</sup> The year and place of sale, the interest rate, the principal, and the yearly interest payments are known for all life annuities. The gender of the buyer and nominee, the age of the nominee at purchase and death, the year of death, and if the buyer was the same as the nominee (self-nomination) is known for most life annuities, but not for all due to gaps in and illegibility of parts of the life annuity registers. From this information, combined with our knowledge about the interest rate on redeemable annuities, the following can be calculated: total years of interest payments (total years running), total interest payments, the present value (PV) of the interest payments, the net present value (NPV) of the life annuity, the NPV/principal ratio, and the interest rate differential between life and redeemable annuities. The focus is on four areas: Amsterdam, The Hague, Gorinchem, and Brielle. The former two being big cities, the latter two small villages. Distinguishing between them highlights the differences in the development of financial markets and the sophistication of its actors in urban and rural areas. The years 1662-1713 can roughly be divided into four periods according to the interest rate paid on life annuities: 1662-1671 (7.14%); 1675-1676 (10%); 1682-1693 (8%); and 1694-1713 (9%).<sup>40</sup> Table 1 displays the number of observations for each area in each period. The

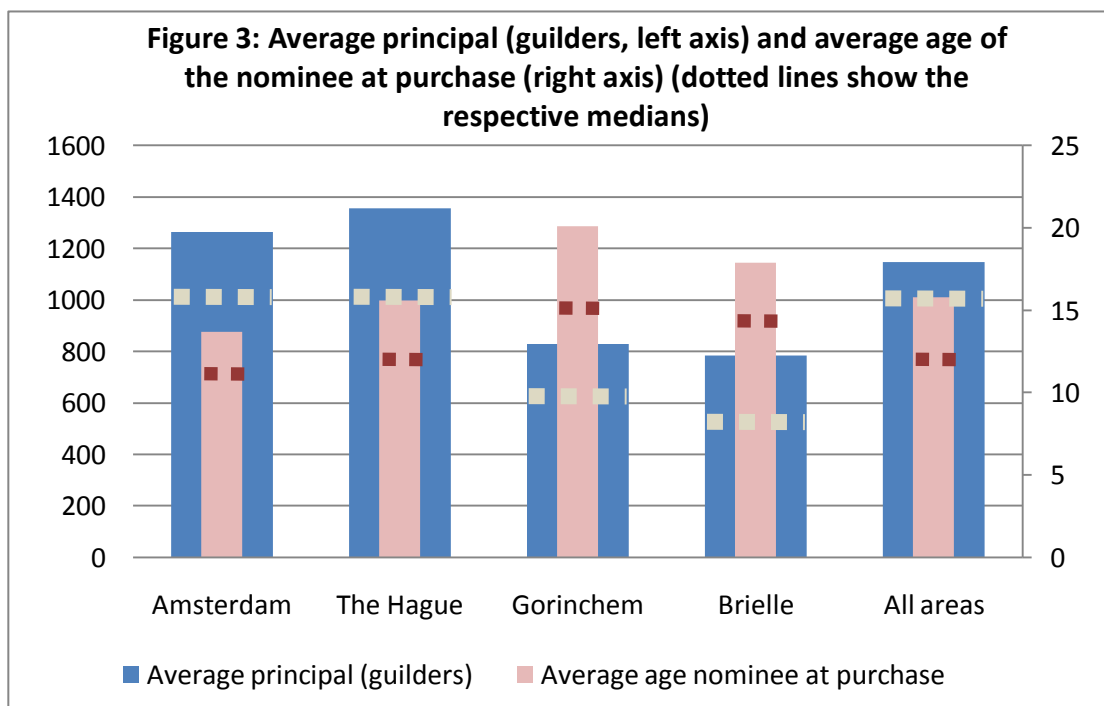
<b>Table 1: Number of observations of life annuity contracts</b>					
	<b>1662-1671</b>	<b>1675-1676</b>	<b>1682-1693</b>	<b>1694-1713</b>	<b>All years</b>
<b>Amsterdam</b>	100	75	100	100	375
<b>The Hague</b>	110	75	100	100	385
<b>Gorinchem</b>	50	0	54	100	204
<b>Brielle</b>	9	16	19	115	159
<b>All areas</b>	269	166	273	415	1,123

<sup>39</sup> All data has been extracted from Nationaal Archief, The Hague, Financie van Holland, 1575-1806, entry number 3.01.29, inventory number 337-342 (The Hague), 367-369 (Amsterdam), 380-381 (Gorinchem), and 383-384 plus 386 (Brielle).

<sup>40</sup> For more information on the terms of life annuities see the appendix.

goal was to reach around one hundred observations per area per time period but this was not always possible due to the limited availability of data. A certain level of caution is therefore recommended when using and interpreting the data as gaps do occur. As it is unclear if the life annuity registers name the buyer or beneficiary, in the following it is assumed that the buyer and the beneficiary were identical. Additionally, taxes and administrative costs (e.g. the proof of life) are left out of the analysis. Furthermore, Gorinchem had no record of any life annuity sales during 1675-1676, while both Gorinchem and Brielle only began recording the age of the nominee at purchase in 1691. These hiatuses could not be solved within the given time allowance for this research. Nevertheless, the total number of observations is substantial and the results, as discussed later, seem clear and robust.<sup>41</sup>

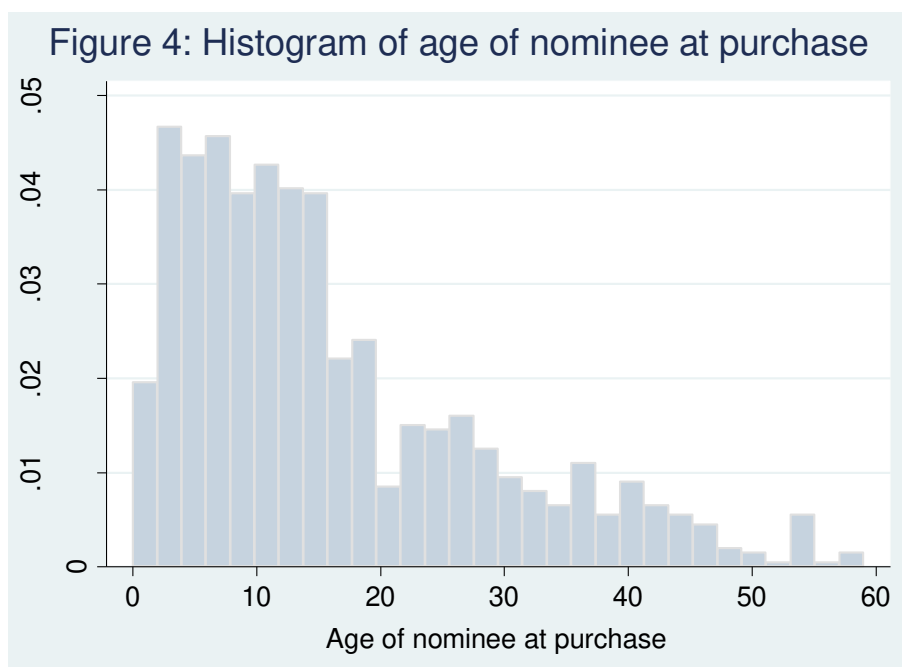
Differences between areas are clearly noticeable, but the low average age of nominees in all areas is apparent too (see figure 3).<sup>42</sup> Buyers in Amsterdam and The Hague generally buy bigger life annuities and do so on younger nominees than buyers in Gorinchem and Brielle. The differences in size can partially be explained by the urban-rural wealth gap present in Holland at



<sup>41</sup> When no mention is made, e.g. in graphs, of the specific area or time period it holds for all areas over the whole period of 1662-1713.

<sup>42</sup> Three outliers have been removed from the dataset. These three purchases had a principal of more than 10,000 guilders. Remarkably, they all occurred in The Hague.

the time.<sup>43</sup> The age differences might point to urban investors better understanding the valuation of a life annuity, but rural investors did understand it insofar that most of their life annuities were written on young nominees as well. A more plausible explanation can be found in urban investors often buying several life annuities at the same time and writing them on below-average aged nominees.<sup>44</sup> This points to big investors being able to reap above-average profits and significantly decreasing the average age of nominees. Different urban and rural investment opportunities play their part in this too. Financial markets in urban areas, especially in Amsterdam, were more developed and complex.<sup>45</sup> A wider range of investment opportunities existed which especially pulled those investors with a relatively lower expected net yield, thus those selecting relatively older nominees, out of the market for life annuities. Competition between a range of investment alternatives therefore made life annuities more costly for the government. In short, adverse selection seems to have taken place and more so in urban areas with richer investors and more competitive financial markets. De Witt was right in stating that life annuities were mostly written on young nominees (see figure 4).

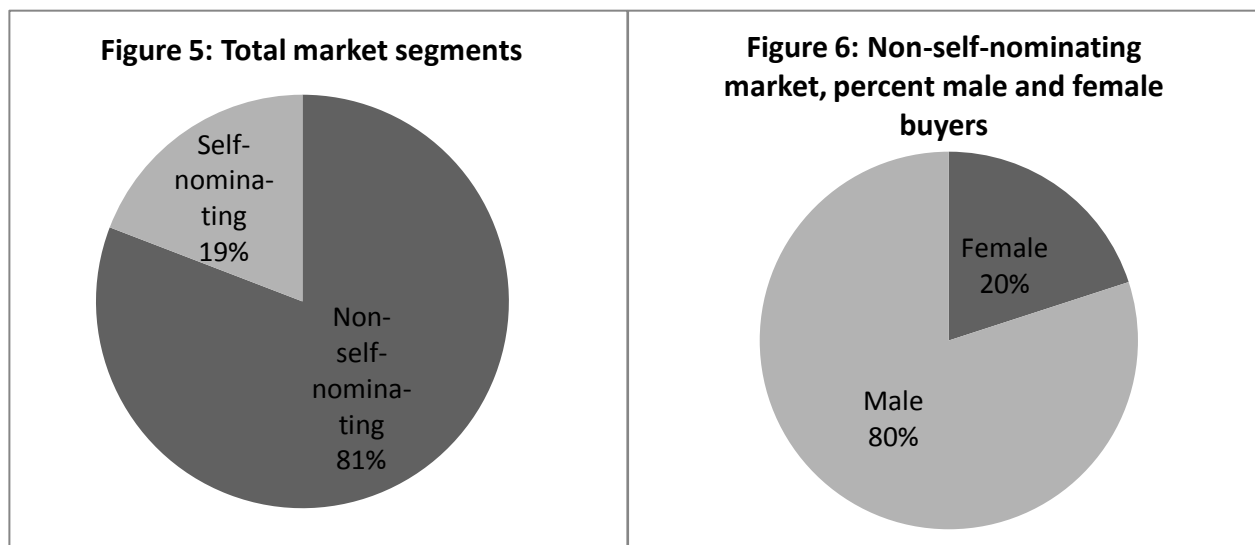


<sup>43</sup> Vries, de and Van der Woude, *The first modern economy*, p. 702.

<sup>44</sup> Unfortunately, I did not document this in my dataset. However, I strongly got this notion while extracting the other information from the life annuity registers.

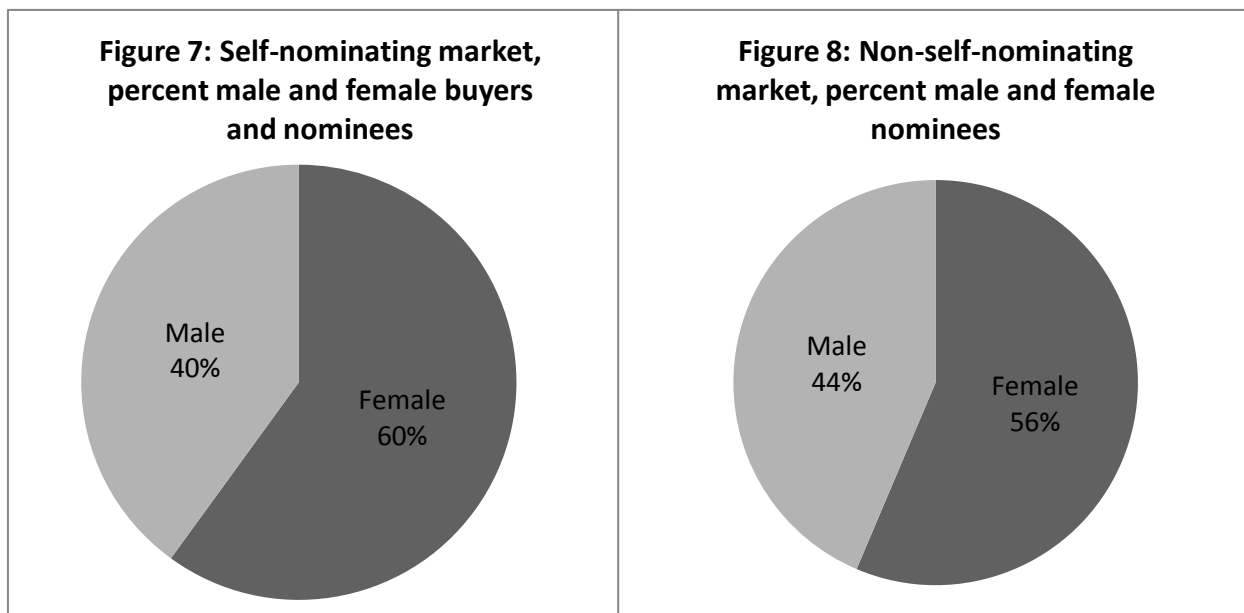
<sup>45</sup> Gelderblom, O. and J. Jonker. (2005). "Amsterdam as the Cradle of Modern Futures and Options Trading, 1550-1650", in: Goetzmann, W.N., and K.G. Rouwenhorst. (2005). *The Origins of Value: The Financial Innovations that Created Modern Capital Markets*, New York: Oxford University Press, p. 189-205.

However, life annuities served another class of demanders next to profit-seeking investors as well. Buyers could write the life annuity on themselves, thereby ensuring themselves of a fixed annual income until their death. These self-nominating buyers were looking for an income stream with an insurance component.<sup>46</sup> They preferred a totally certain income stream until their death over a higher expected total value of the life annuity attained by writing it on a younger person. These purchases can be assumed to be non-adversely selected. Overall, 18% of the market is constituted by this class of buyers (see figure 5). Remarkably, most self-nominating buyers were women which contrasts with the general market (see figure 6 and 7).<sup>47</sup> It could be that a substantial part of these women were widows, but this remains unclear as it is unknown if it was always noted down in the life annuity registers if the female buyer was a widow or not. The share of women as nominees, however, is in alignment with the general market (see figure 7 and 8). This might point to investors understanding the higher life expectancy of women, but it could also be that said life annuities were intended to be transferred to the nominee at the death of the buyer. It would then serve as a guaranteed source of income for those, e.g. women, in a worse position on the labour market. However, what exactly the buyers had in mind for the life annuities after their own death remains unclear. Still, it is clear that the self-nominating section of the market differs from the general market.



<sup>46</sup> Rothschild, C.G. (2003). "Adverse selection in Public Finance: Life-contingent Contracts in Early Modern Europe", *M.I.T. Department of Economics*, p. 17.

<sup>47</sup> Problematic with respect to the amount of individual buyers is that the same buyer could buy multiple life annuities. This is not reflected in my database. The exact share of men in the total amount of individual buyers would probably be lower as mainly men bought several life annuities at a time.

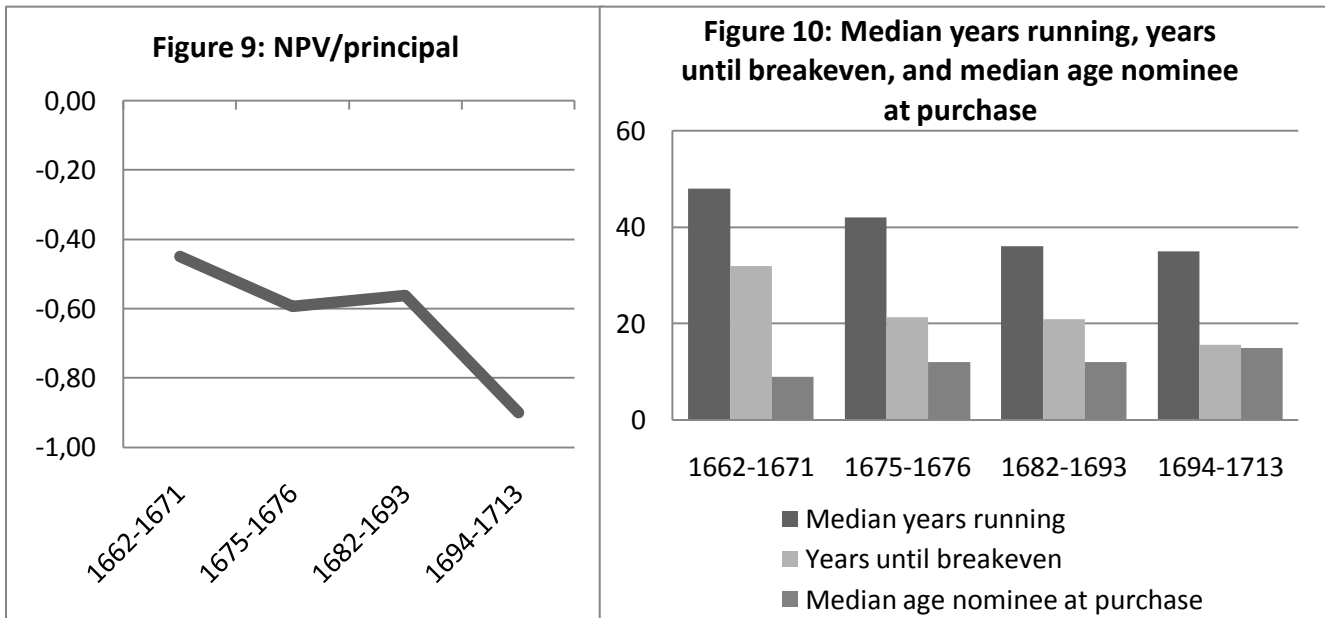


Buyers selecting themselves as nominee were on average 34 years of age, while those nominees selected by others were on average 12 years of age (the respective medians were 34 and 10). This age difference at purchase works through in the life annuities' total number of years running. The self-nominated life annuities ran on for an average of 29 years, while the others did so for an average of 42 years (the respective medians were 28 and 41).

In practice this meant that self-nominated life annuities were less costly for the government. It is therefore recommended to incorporate the division of the market into said two segments when analyzing the costliness of life annuities for the province of Holland. In order to find out the government's costs of issuing life annuities the following variables are calculated for each life annuity: total years running, the present value (PV) of all annuity payments, the net present value (NPV) of the life annuity, and the ratio NPV/principal.<sup>48</sup> To calculate the PV and NPV it is assumed that the contemporary interest rate on redeemable obligations approximates the risk-free interest rate. It is a crucial assumption affecting all the following profitability calculations.<sup>49</sup> Taking this into account, from the government's point of view most life annuities were costly: 87.35% had a negative NPV versus 12.65% with a positive NPV. Moreover, these losses were sizeable as the average NPV was -792 guilders, while the

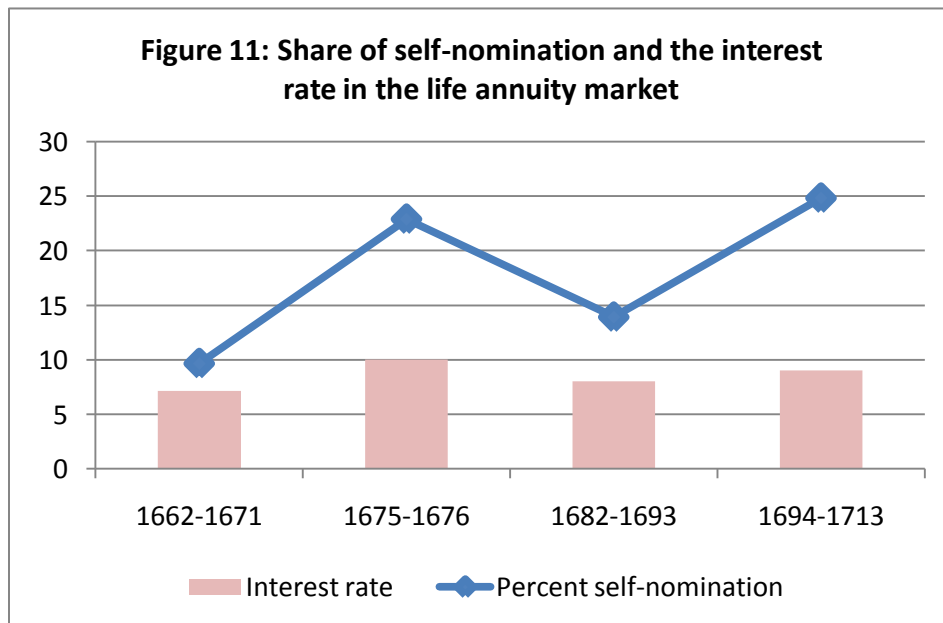
<sup>48</sup> It was only possible to do these calculations for 941 observations due to missing years of death which made calculating total years running impossible.

<sup>49</sup> Others face similar problems, e.g. Bell, A. (2010). "Valuing medieval annuities: Were corrodies underpriced?", *Explorations in Economic History*, p. 146-147.



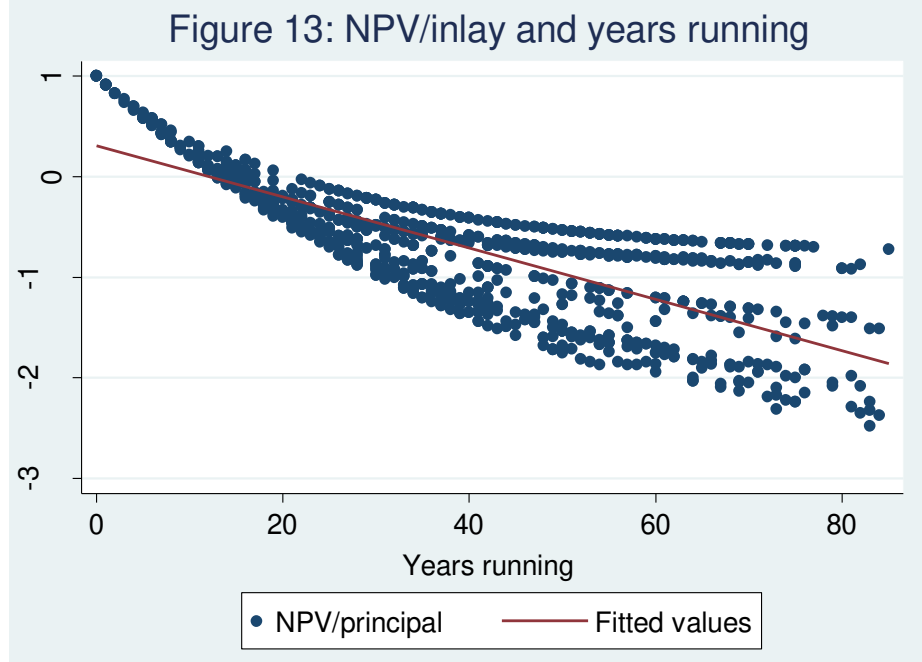
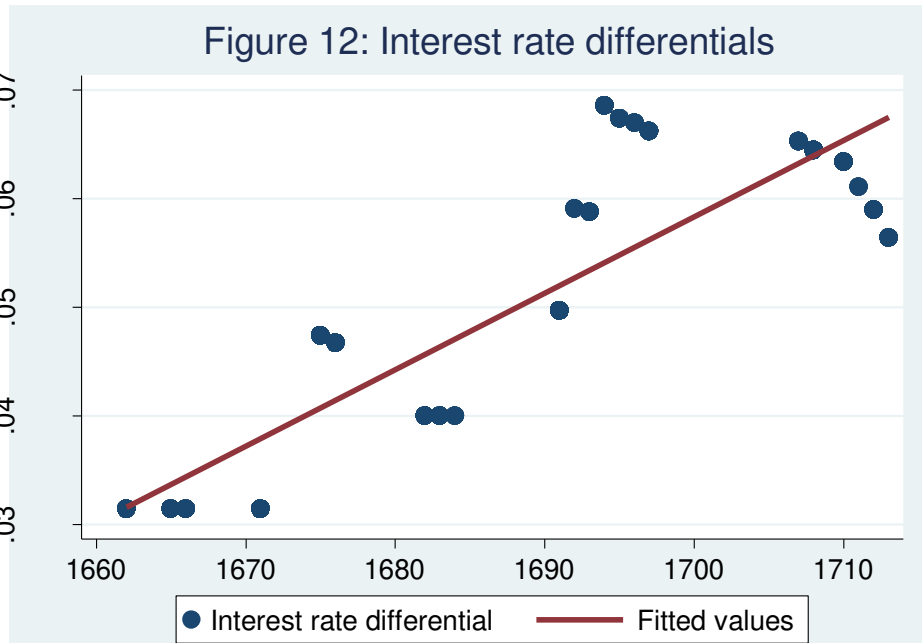
average principal was only 1,139 guilders (medians of -558 and 1,000 respectively). The average NPV/principal-ratio was therefore -0.70, meaning the government made an average loss of 70% on each life annuity (with a median loss of 66%). Notwithstanding the shorter running time, self-nominated life annuities still produced an average loss of 49% (with a median loss of 53%). Life annuities indeed were a very costly debt instrument.

Interestingly, life annuities became more costly over time (see figure 9). However, this does not seem to be due to an increase in adverse selection as the nominee's average age at purchase rose over time and the average years running fell (see figure 10). This was likely due to life annuities becoming increasingly attractive. Investors with less wealth and a smaller network,



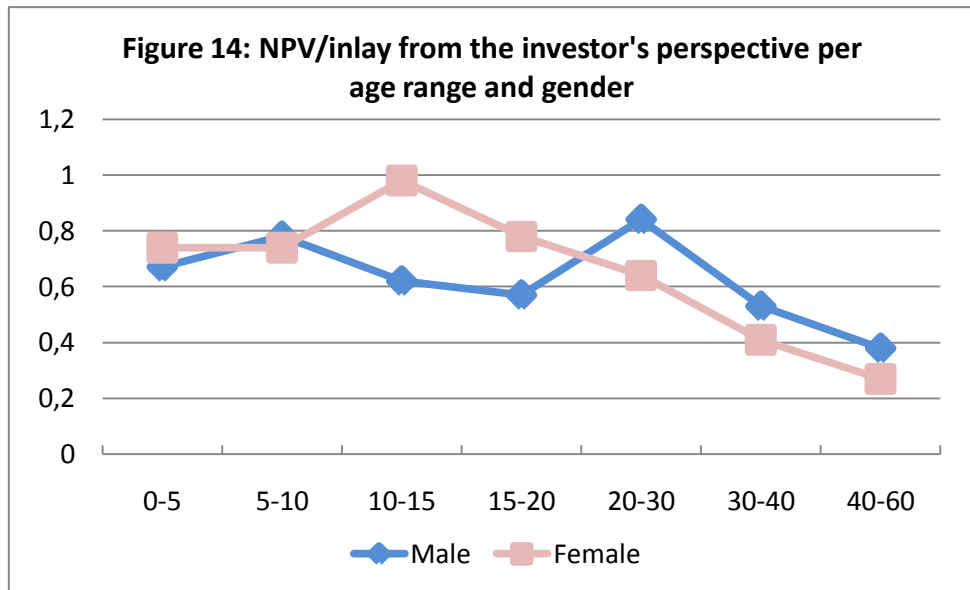
and thus faced with a more limited choice of young and healthy nominees, now entered the market too. Furthermore, the share of self-nominating buyers increased as well (see figure 11). This segment had potential to grow, but it apparently only did so when higher interest rates were offered. Investors of this kind possibly needed to be guaranteed a certain stream of income which would afford them a minimum standard of living. It seems likely self-nominating buyers were mainly looking for a way to guarantee such an income level for when they were older and less able to earn adequate wages. This meant they entered the market with a different mindset and strategy than the profit-maximizing investors. Their reference value was a certain minimum stream of income which they attempted to acquire. Once owning a life annuity would guarantee such a stream, only then would they be tempted to buy one. If not, it would be safer to keep accumulating during the working years and either find another way to invest or divide it themselves over their remaining non-working years. Therefore, the only way for a life annuity to become more attractive for these buyers would be through a higher interest rate. Liquidity criteria and interest rate differentials, basically the possibility for arbitrage, did not play as big a role as it did for the profit-maximizing investors. Life annuities paid ever higher interest rates in order to attract investors, while the interest rates on redeemable annuities and obligations initially decreased and subsequently stabilized (see figure 12). The government seemed focused on selling a certain minimum amount of life annuities. Rising interest rate differentials made life annuities relatively more costly. Nevertheless, adverse selection remained the underlying force turning life annuities into expensive debt instruments. By selecting young nominees, and thus receiving annuities for a longer period of time, buyers accomplished higher returns (see figure 13). It was most profitable to write the life annuity on a girl aged 10 to 15 years (see figure 14). That buyers understood when a life annuity's value was roughly maximized is shown by 72.7% of all contracts being written on persons of age 20 and below.

In short, life annuities were costly for the government and rewarding for investors. Adverse selection was the main driver. This held true in both urban and rural areas. Most buyers were male, while most nominees were female. The self-nominating segment of the market differed. It was dominated by older women aiming at income security. However, most actors on the market for life annuities knew how to play the market and consciously selected young



nominees in order to maximize interest payments. Rising interest rate differentials over time made life annuities an ever costlier debt instrument. Optimizing behaviour was shown in a sub-optimal market. De Witt was correct in concluding this market was in need of structural reform. Lowering the interest rates paid on life annuities would be a way to lower costs, but it would be hard to implement as the government already had trouble selling all the life annuities it intended to sell. In this respect the government was at the mercy of the demanders as a lower

interest rate would lead to less demand which would defeat the government's aim of acquiring funds. The main solution should be found in De Witt's recommendation of invoking an age-depen-



dent interest rate scheme. Implementation of this idea would combat the principal source of high costs: adverse selection. Younger nominees would be paid a lower interest rate, while older ones a higher. A diminished incentive to invest in young nominees would be the result. Moreover, selecting old nominees would be made more worthwhile which in turn would stimulate self-nomination. Life annuities on old nominees would breakeven relatively sooner with redeemable annuities wherefore it becomes more attractive to select old nominees. These older nominees were formerly driven out of the market because their expected remaining life expectancy was too low compared to the amount of years until breakeven. It would have been more profitable to invest in other debt instruments which is precisely why so few old nominees were selected. De Witt's plan would have fixed the lopsided pricing of life annuities and have made it equally profitable to invest in young and in old nominees. Big losses on life annuities written on young nominees due to uniform pricing would be prevented. Next to reducing the government's expenses, De Witt's scheme would broaden the social benefits of life annuities as relatively more older, self-nominating investors would have entered the market.

However, it remains a puzzle why exactly De Witt's recommendations were not put into practice. Perhaps his ideas lost their popularity along with his demise or maybe the government, as in France, intended to subsidize this segment of the market.<sup>50</sup> It could be vested interests

<sup>50</sup> Weir, "Tontines, Public Finance, and Revolution in France and England, 1688-1789", p. 124.

were too strong for real change to be implemented. Life annuity buyers were possibly relatively wealthy and politically powerful as in other areas and time periods.<sup>51</sup> This would prevent hurtful change to vested interests and let continue the transfer of wealth from a broad base of tax payers to a small segment of life annuity investors. Another explanation might be that Holland's government was demanding so much funding it saw no other way to acquire it except by increasing interest rates. In their attempt to tap all possible segments of the capital market they lost sight of the interaction between different debt instruments' segments and had no specific policies formulated on the basis of each segment's differing investors' demands. They might have been frightened to think about possibly losing funding from those investors who adversely selected their nominees if De Witt's plan was implemented. However, in making such a judgment the competition between life annuities, redeemable annuities, and bonds is marginalized. As De Witt aptly concluded, life annuities were too expensive relative to redeemable annuities, which also meant they were too profitable for arbitrageurs not to invest in. If the interest rate on younger nominees would be lowered, said arbitrageurs would most likely return to the market for redeemable annuities and bonds. At the same time the higher interest rate on older nominees would have attracted new investors, especially those older self-nominators previously excluded from the market. These investors had specific concerns regarding minimal income during their final years. In a time of few social safety nets life annuities could perform as a substitute providing security, but only if it was priced fairly. De Witt's age-dependent pricing would have made it fair wherefore new investors would have been attracted. Total available funding would therefore most likely have risen and the market for life annuities would be less demand-driven as the possibility of adverse selection lessened. Arbitrageurs would have had less influence on the ultimate relative costliness of life annuities for Holland's government.

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<sup>51</sup> Derycke, L. (2003). "The Public Annuity Market in Bruges at the End of the 15<sup>th</sup> Century", in: Boone, M.H., K. Davids, and P. Janssens. (2003). *Urban public debts: urban government and the market for annuities in Western Europe (14th-18th centuries)*. Turnhout: Brepols, p. 165-181; Heijden, M. van der. (2003). "Renteniers and the Public Debt of Dordrecht (1555-1572)", in: Boone, M.H., K. Davids, and P. Janssens. (2003). *Urban public debts: urban government and the market for annuities in Western Europe (14th-18th centuries)*. Turnhout: Brepols, p. 183-195.

Nonetheless, it remains unclear what the exact effect of age-dependent pricing on the demand for life annuities and other debt instruments would have been. Further research on the different capital market's segments and their interaction would be useful for this purpose. However, as adverse selection is the most important reason behind the costliness of life annuities it calls for a closer look itself. The constructed database allows for this. The next section briefly develops three models for finding out exactly what determined adverse selection.

## **6. Adverse selection: three models**

After determining adverse selection did take place and exploring its possible causes it is interesting to empirically test the determinants of adverse selection. A model has to be constructed first. In the previous sections it was supposed adverse selection showed itself in younger nominees while multiple determining factors may have played a role. As the dependent variable the age of the nominee at purchase is therefore taken as a proxy for adverse selection. The following independent variables are incorporated: size of the principal, gender of the buyer, area of purchase, self-nomination, interest rate differential, years until breakeven. Size of the principal as richer investors might be better acquainted with valuing investment vehicles and have access to a larger network of nominees, wherefore a negative relation would be postulated (the age of the nominee goes down with an increase in the principal's size). However, a richer investor would probably buy multiple life annuities on several nominees in order to reap the benefits of diversification.<sup>52</sup> The specific relation between the principal's size and adverse selection is therefore unclear. The buyer's gender is taken into account as men were generally richer and more active on the official financial markets. A negative relationship is expected. The area of purchase is considered as urban-rural differences were likely present. Urban investors were generally richer, would have had access to a larger network, and urban financial markets were more developed wherefore investors could be more financially savvy. A negative relationship is the expectation here as well. Self-nomination is taken into consideration as this is taken to be a clear case of no adverse selection. These buyers mainly aimed at the safety a life annuity would provide. A positive relationship is predicted. Interest rate

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<sup>52</sup> It is impossible to incorporate this in the analysis as it is unclear in my database how many life annuities a specific person bought.

differentials and the amount of years it took for an investment in life annuities to breakeven with an equal one in redeemable annuities are taken as proxies for the competition between the two debt instruments and the opportunity for arbitrage. As the interest rate differential increases, and the years until breakeven decreases, it is assumed more investors are attracted to the life annuity market. These investors would mainly consist of people for whom it used to be unprofitable to invest in life annuities. Those people were to a large extent relatively poorer with access to a smaller network, and older people for whom earlier it was not worth it to self-nominate. Besides, less years until breakeven meant life annuities became profitable sooner wherefore it was less risky to choose relatively older nominees. All of this leads to the expectation of a positive relationship. The variables and their definitions are shown in table 2.

<b>Table 2: Variable definitions</b>	
Nominee's age at purchase	Dependent variable, proxy for adverse selection
Principal	Size of the principal
Male buyer	Dummy, 1 if the buyer is male
Urban	Dummy, 1 if the area is urban (The Hague and Amsterdam)
Self-nomination	Dummy, 1 if self-nominated
Interest rate differential	Difference in percentage points between the interest rate on life annuities and on redeemable annuities
Years until breakeven	Amount of years until a life annuity investment is breakeven to an equal redeemable annuity investment

Three models are constructed. The first model leaves out competition with redeemable annuities, while the second and third include it. Both interest rate differentials and years until breakeven are used separately to proxy for competition. A random error variable is included too.

$$\text{Model 1: } \text{Nominee's age at purchase} = \beta_0 + \beta_1 \text{Principal} + \beta_2 \text{Male buyer} + \beta_3 \text{Urban} + \beta_4 \text{Self-nomination} + \varepsilon_i$$

$$\text{Model 2: } \text{Nominee's age at purchase} = \beta_0 + \beta_1 \text{Principal} + \beta_2 \text{Male buyer} + \beta_3 \text{Urban} + \beta_4 \text{Self-nomination} + \beta_5 \text{Interest rate differential} + \varepsilon_i$$

Model 3: *Nominee's age at purchase* =  $\beta_0 + \beta_1 \text{Principal} + \beta_2 \text{Male buyer} + \beta_3 \text{Urban} + \beta_4 \text{Self-nomination} + \beta_5 \text{Years until breakeven} + \varepsilon_i$

For all models we hypothesize:  $H_0: \beta_1 = 0$  and  $H_1: \beta_1 \neq 0$ ;  $H_0: \beta_2 = 0$  and  $H_1: \beta_2 < 0$ ;  $H_0: \beta_3 = 0$  and  $H_1: \beta_3 < 0$ ; and  $H_0: \beta_4 = 0$  and  $H_1: \beta_4 > 0$ . For model 2 the hypothesis is  $H_0: \beta_5 = 0$  and  $H_1: \beta_5 > 0$ , while for model 3 it is  $H_0: \beta_5 = 0$  and  $H_1: \beta_5 < 0$ . The results are shown in table 3. The results are straightforward and robust. Almost 50% of the dependent variable's variance is explained by the model.  $H_0: \beta_1 = 0$  is never rejected, while  $H_0: \beta_3 = 0$  is only rejected in model 1.  $H_0: \beta_2 = 0$ ,  $H_0: \beta_4 = 0$ , and  $H_0: \beta_5 = 0$  are always rejected. Based on these results it can be concluded that the size of the principal has no significant effect on the nominee's age at purchase. It cannot be concluded that bigger life annuities were more adversely selected. Nonetheless, if richer investors did or did not select relatively young nominees remains unclear due to the earlier mentioned caveat that they might as well have bought multiple life annuities of average size. The expectation of males selecting relatively younger lives is vindicated. The average male buyer selects nominees more than two years younger compared to those selected by women. The urban-rural distinction does not seem to be very clear. It is significant and as expected in model 1 where a nominee is about three years younger when selected in an urban area, but it does not come to the fore in models 2 and 3. Self-nominating buyers are definitely shown to be non-adversely selecting. If a life annuity is self-nominated the nominee is circa twenty years older compared to no self-nomination. Lastly, competition with redeemable annuities seems to play a significant role in the market for life annuities. When the interest rate differential increases with one percentage point the average nominee's age increases with fifteen months. And when it takes one year less for life annuities to breakeven with redeemable annuities said age increases with three months. Both these effects agree with the hypothesis. In case life annuities become relatively more attractive the market broadens and older nominees are selected.

In short, manifold causes were underlying adverse selection in Holland's market for life annuities. However, it could also be impeded in manifold aspects by changing the pricing mechanism. If De Witt's age-dependent pricing scheme was adopted it would have worked through on adverse selection in multiple ways. The interest rate differential would have

increased and the years until breakeven have decreased for older nominees. This would have directly contributed to less adverse selection. Indirectly, as the market becomes more attractive for older people more self-nomination will take place. Furthermore, less wealthy people, thus relatively more women and rural inhabitants, will enter the market. De Witt's plan would have therefore had effect on multiple levels. Adverse selection would definitely have been reduced.

	Model 1	Model 2	Model 3
Principal	0.0004 (1.26)	0.0004 (1.33)	0.0004 (1.39)
Male buyer	-2.5365 (-3.13)***	-2.3466 (-2.91)***	-2.2805 (-2.83)***
Urban	-2.9642 (-3.99)***	-0.9809 (-1.11)	-1.2614 (-1.49)
Self-nomination	20.6798 (19.89)***	20.3646 (19.70)***	20.3239 (19.62)***
Interest rate differential		1.2709 (4.95)***	
Years until breakeven			-0.2560 (-5.10)***
Intercept	15.5260 (15.96)***	7.5055 (3.95)***	19.5430 (15.61)***
R-squared	0.4837	0.4954	0.4950
Number of observations	985	985	985
Note: 1) t-value is in parentheses; 2) significance at the 99% level is denoted by ***.			

## Conclusion

In short, Holland's market for life annuities between 1648 and 1713 suffered from adverse selection which made life annuities a relatively costly debt instrument. Although life annuities were the government's favored instrument, investors had plenty of reasons to prefer redeemable annuities and bonds. Higher costs, more uncertainty, and less liquidity all played a role in this. Demand for life annuities therefore did not meet supply which often forced the government to issue redeemable annuities and bonds to attain the necessary financing. Consequently, the market for life annuities was demand-driven. The main problem for both government and investors was the inadequate pricing of life annuities. Each life annuity paid the same interest rate regardless of the nominee's age, while his age would be the main determinant of the total amount of years running and therefore the life annuity's final value. De

Witt solved this problem by constructing a sound method for age-dependent pricing. If implemented De Witt's plan would have combated adverse selection, broadened the base of investors, and made life annuities relatively less costly for the government. This in turn would have led to life annuities playing a more prominent role in the total public debt which would have made the public debt safer and less inclined to continually expand as life annuities were non-redeemable and self-amortizing.

However, it remains a puzzle why exactly De Witt's recommendations were not put into practice. Perhaps his ideas lost their popularity along with his demise or maybe the government intended to subsidize this segment of the market. Vested interests might have been too strong for real change to be implemented or maybe Holland's government was simply demanding so much funding it was too scared to possibly lose a market segment if pricing changes would have been introduced. Their only solution to acquiring more funding was higher interest rates, but the necessary structural reform did not take place. To solve this puzzle more research is necessary. Internal governmental discussions and communications should be studied further, and more data should be uncovered. Especially data on the employment, networks, and income or wealth of the life annuity buyers would be useful. Possible political connections, network externalities, and income and wealth effects can then be examined more accurately. Studying the failure of Amsterdam's 1672 experiment with age-dependent pricing might uncover more too.

## **Appendix**

Over time the interest rate and terms of life annuities changed.<sup>53</sup> In 1648 life annuities were issued at an interest rate of 9.09%. By 1662 the interest rate had dropped to 7.14%. It stood at 10% in 1673, the year after the Disaster Year. By 1682 the interest rate was 8%, and by 1694 9%. The latter rate lasted until 1714 when it was increased to 10%. These high and varying rates contrast with those paid on redeemable annuities and obligations.<sup>54</sup> Those debt instruments experienced a gradual drop from 5% in 1648 to 4% in 1671. A slow increase over the next five

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<sup>53</sup> Nationaal Archief, The Hague, Staten van Holland, 1572-1795, entry number 3.01.04.01, inventory number 287-291.

<sup>54</sup> Gelderblom & Jonker, "Public Finance and Economic Growth", p. 23

years led to a rate of 5.33% in 1676. After this peak a piecemeal decrease to the 2-4% range took place. The interest rate differential therefore increased over time.

Besides the interest rates, the terms of life annuities changed as well. In 1652 life certificates were made obligatory with the intention of stemming unjust claims for interest payments. Furthermore, a reward was given to those who could report others unjustly claiming interest payment. From 1653 onwards an extra tax, the thousandth penny (0.1%), was charged on life annuities. More tax raises took place in times of (expected) trouble. In 1670 the two hundredth penny (0.5%) was imposed. Three years later, in 1673, the reward for reporting unjust interest claims was revoked. The hundredth penny (1%) was levied from 1692 onwards. However, all life annuity contracts included in the dataset used in this research were exempted from any extraordinary taxes for the first ten years after issuance.<sup>55</sup> Nevertheless, as the terms of life annuities changed quite frequently and no option of resale existed as a secondary market was not available, the value of a life annuity was made more uncertain than necessary. This probably added to the risk premium charged on life annuities wherefore the interest rate had to increase.

## Literature

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<sup>55</sup> Nationaal Archief, The Hague, Financie van Holland, 1575-1806, entry number 3.01.29, inventory number 337-342 (The Hague), 367-369 (Amsterdam), 380-381 (Gorinchem), and 383-384 plus 386 (Brielle).

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