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# The Ricardian Equivalence in the Netherlands: an Application of an Autoregressive Distributed Lag Model

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## Abstract

This research contributes to the discussion on the Ricardian equivalence theorem. Through the use of a consumption function, and several autoregressive distributed lag models, it is found that Dutch consumers have a tendency to behave in a Ricardian manner between 1999 and 2019. By working with crisis interaction terms, it is also found that during a financial crisis, the Dutch consumer still behaves according to the Ricardian equivalence. Besides empirical evidence, this research offers an overview of the economic theory regarding the Ricardian equivalence, together with a comparison of recent empirical research on the Ricardian equivalence in the Netherlands.

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# 1 Introduction

Consider a government that has no control over consumption. Fiscal policy is rendered futile because if the government starts spending more money to increase consumption, consumers start saving more rather than spending. It is difficult to wonder how such a world would work, because what basic macroeconomic theory has taught many pupils, is that Keynesian theory is what describes our consumption patterns. Many theories, many policies, many governments have based their workings on this way of thinking: if the government lowers taxes, then the people will consume more, since they have more disposable income. However, what if there are instances that the opposite is true? That is where the Ricardian equivalence comes in.

The Ricardian equivalence is a theorem that was first brought into the world by one of the grandfathers of economics, David Ricardo (1820). Even though he refuted his own theory, the Ricardian equivalence is still so captivating that many economists after him have tried to find proof to disentangle the controversy surrounding this theory. Ricardian equivalence essentially means that household consumption is affected in the same way by debt and taxes. Thus, when modifying the composition of government expenditure to not have a real effect on private consumption (Ricciuti, 2003). In this research paper, I will work through the main theory and critiques of the Ricardian equivalence. After which I will do empirical research on the Ricardian equivalence in the Netherlands. Since there is little current research surrounding this topic about the Dutch consumers, and the repercussions of this theory holding in the Netherlands could be substantial for future policymaking, it is of importance to answer the following research question:

*"Did the government's financial choices have an effect on Dutch household consumption between 1999 and 2019?"*

The methodology that will be used to answer the research question is an auto regressive distributive lag model applied on a consumption function. This consumption function is inspired by the work of Stanley (1998), and Leiderman and Bleijer (1988). To find if the Dutch consumer behaves differently during a financial crisis, interaction terms with crisis dummies will be added to the consumption function. After correcting the model for autocorrelation and other problems that come with macroeconomic research, F- and t-tests will be ran to find out if government revenue, government contribution, and government debt have an effect on Dutch consumption. If they do not, I will have found proof for Ricardian behavior among in the Netherlands. Dutch time series data will be retrieved from Statline and will be used when working with this methodology. This data will be covering quarterly data from 1999 to 2000.

This research will contribute to the current literature mainly due to its scope. Many studies research the Ricardian equivalence for multiple countries. However, these multinational studies tend to offer mixed results (Stanley, 1998). Therefore, I would like to focus my research on one country, the Netherlands. I have chosen the Netherlands since research on the Ricardian equivalence is still limited. To the best of my knowledge, there are only a few relevant papers that discuss Dutch evidence only. The first being Allers, De Haan, and De Kam (1998), who conducted a survey among Dutch consumers to see if the sample knew how high government debt and deficit was, and if they found that the country's level of debt affected their saving decisions. However, when using a survey as the main methodology, there are some flaws to consider. Since a Hawthorne effect could be affecting the answers of the people participating in the survey (Adair, 1984). For this research, I will look at data from an administrative governmental source, over which the average consumer does not have control. Other Dutch Ricardian equivalence research was, for instance, conducted by Heudra and Van Dalen (1996) who did empirical testing on the Ricardian equivalence between 1969 and 1990. But my research will have a look at more current data. Which could offer some new insights because maybe consumers are more insightful now about the relationship between current low taxes and future high taxes, since people are more educated now, or because knowledge is easier to attain due to the internet (Flynn & Flynn, 2012).

This research comprises of three sections, the first one is the theoretical framework, where both the theoretical and the empirical side of past research on the Ricardian equivalence will be touched upon. In the second section, my own empirical research will be laid out. Where consecutively the hypotheses, the specification, the data, the methodology, the results and finally the robustness checks will we discussed. The last section of this research is naturally the conclusion and discussion.

# 2 Theoretical Framework

## 2.1 What is the Ricardian Equivalence?

The Ricardian equivalence is an economic proposition that stipulates that government bonds do not create net wealth. Therefore, a government's financial choices do not affect aggregate consumption (Barro, 1974). This means that the Ricardian equivalence goes against the Keynesian belief that private consumption increases when the government decreases taxes, since it shows how taxes do not affect a household's consumption function. This theory was initially developed by David Ricardo in 1820. He ended up rejecting his own theory because he thought individuals were not sharp enough to realize what the long-term effects of a tax cut were (O'Driscoll, 1977). Nevertheless, when it comes to fiscal policy, this theory is still interesting and relevant. Barro famously extended and modelled the Ricardian equivalence in 1974. He explained that the idea behind the government not having control over aggregate consumption is that consumers incorporate the intertemporal budget constraint of the government, and thus expect future taxes to increase when current taxes decrease. Which leads them to save when there is a tax cut, rather than consume. Therefore, aggregate consumption would not be subject to taxes. Another implication is that to the consumer, government debt no longer represents net wealth as current debt indicates future tax liabilities. As a result, consumption rather depends on the financial wealth of consumers, diminished by government debt. Thus, when the government increases its deficits, one should find consumers to be saving more. Therefore, only the size of government purchases should matter, rather than the division of these purchases into taxes and bonds.

Explaining the Ricardian equivalence mathematically might further clarify the situation. According to Romer (2012), this can be easily done with the Ramsey growth model (1928), which unlike the Solow growth model (1956), endogenizes savings. And, due to the assumption of the infinite horizon of the individuals in the model, outcomes are Pareto optimal. Additional assumptions are that a household's present value of consumption cannot be higher than its wealth together with the present value of disposable income. Also, there are neither uncertainty nor market imperfections, and households and the government face the same interest rate.

This brings us to the household's budget constraint:

$$\int_{t=0}^{\infty} e^{-R(t)} C(t)\, dt \le K(0) + D(0) + \int_{t=0}^{\infty} e^{-R(t)} [W(t) - T(t)]\, dt \qquad (1)$$

Where C(t) is consumption at time t, W(t) is income, T(t) is taxes, K(0) and D(0) stand for quantities of capital and government bonds respectively, when time is equal to 0. By splitting the integral on the right-hand side of (1) we get:

$$\int_{t=0}^{\infty} e^{-R(t)}C(t)\,dt \;\leq K(0) + D(0) + \int_{t=0}^{\infty} e^{-R(t)}W(t)\,dt - \int_{t=0}^{\infty} e^{-R(t)}T(t)dt \qquad (2)$$

Then, the government's budget constraint looks like the following equation:

$$\int_{t=0}^{\infty} e^{-R(t)}G(t)\,dt \;\leq -\,D(0) + \int_{t=0}^{\infty} e^{-R(t)}T(t)\,dt \qquad (3)$$

Where G(t) is a government's real purchases at time t, T(t) is taxes, and D(0) is debt. An important assumption is that the government complies with this budget constraint. Or else, wealth would be eternally increasing. Thus, in (3) one can see that initial debt, D(0), and the present value of government purchases $\int_{t=0}^{\infty} e^{-R(t)}G(t)\,dt$ , together equal the present value of taxes, $\int_{t=0}^{\infty} e^{-R(t)}T(t)\,dt.$ Finally, substituting this into (2) gives:

$$\int_{t=0}^{\infty} e^{-R(t)}C(t)\,dt \;\leq K(0) + \int_{t=0}^{\infty} e^{-R(t)}W(t)\,dt - \int_{t=0}^{\infty} e^{-R(t)}G(t)\,dt \qquad (4)$$

In (4), the household's budget constraint is expressed in terms of the present value of government purchases, and as Barro (1974) explained, taxes and bonds are no longer part of a household's consumption equation. However, the Ramsey growth model is flawed. Because, in general, the government enjoys a lower interest rate than households to over their debt. Therefore, substitution into equation (4) should not be possible. More limitations of the Ricardian equivalence will be touched upon in section 2.2. of this research.

The Ricardian way of viewing aggregate consumption offers some interesting policy implications. For instance, according to the traditional Keynesian view, a tax cut would imply consumption growth. But, Ricardo would instead argue that a tax cut does not have an effect on consumption. Similarly, Keynes regards budget deficits as a cause for diminishing capital accumulation and growth, but Ricardo sees no relationship between these three. Therefore, if the Ricardian view is a correct one, governments have less power to influence the economy than under a Keynesian view (Barro, 1974).

Then to conclude this section, which explains what the Ricardian equivalence entails, the main assumptions of the theory are going to be described. Bernheim (1987), who evaluated the Ricardian equivalence theory by studying short- and long-run effects of government spending on aggregate demand, describes the assumptions to be the following: (1) consumers behave rationally and are farsighted; (2) capital markets work perfectly; (3) there is intergenerational altruism; (4) future tax liabilities do not change resource allocation between generations; (5) taxes are lump-sum; (6) deficits cannot cause bubbles, and; (7) using deficit financing as a fiscal tool does not change political processes.

The Ricardian equivalence is quite a controversial theory since it has some strict assumptions that are likely not to hold in the real world. It is also controversial as it explains the stark opposite of other famous theories like Keynes. Therefore it is not surprising that the theory knows some disapproval. In the following section, the main critiques of the Ricardian equivalence will be touched upon.

## 2.2 Main Critiques

### 2.2.1 Finite Horizons

The Ricardian equivalence has been criticized thoroughly by many economists. This section of the theoretical framework will lay out some of the main problems, starting with the finite horizons debate. It is argued by Diamond (1965), that a lifetime is too limited to pay off all the government debt that is owed through tax reductions. He found this by way of his overlapping-generations model. According to Pecchenino and Pollard (1995), Diamond's (1965) overlapping generations (OLG) model introduced neoclassical production to the already existing pure-exchange version by Allais (1947). Another important aspect of the Diamond OLG model is that people are constantly entering the economy by being born and exiting the economy by passing away. The main assumptions of the model, as explained by Romer (2012), are the following: each person only lives for two periods, during the first they are 'young' and during the second they are 'old'. Second, in each period $t$, $L_t$ persons are born. The growth rate of the population is $n$, therefore, $L_t = (1 + n)L_{t-1}$. Third, the number of young people during period t is: $L_t$. The number of old people is: $L_{t-1} = L_t /(1+n)$. Fourth, capital and labor markets are perfectly competitive and production has constant returns to scale. Fifth, people only work when they are young. They only consume part of what they make ($C_{1t}$) and save the rest for consumption for when they are old ($C_{2t}$). Therefore, the constant-relative-risk-aversion utility of a young person ($U_t$), depends on $C_{1t}$ and $C_{2t+1}$:

$$U_t = \frac{C_{1t}^{1-\theta}}{1-\theta} + \frac{1}{1+\rho}\frac{C_{2t+1}^{1-\theta}}{1-\theta}, \quad \theta > 0, \quad \rho > -1 \qquad (5)$$

Where $\rho > -1$ ensures that people value consumption in the second period positively. Second-period consumption of someone young in period t looks like the following:

$$C_{2t+1} = (1 + r_{t+1})(w_t A_t - C_{1t}) \qquad (6)$$

Where $w_t A_t$ is labor income, whatever is left after consumption in period one ($C_{1t}$) is saved and multiplied by the interest rate $(1 + r_{t+1})$. By dividing the left- and right- hand side by $(1 + r_{t+1})$, and adding $C_{1t}$ to the left-hand side, the person's budget constraint becomes:

$$C_{1t} + \frac{1}{1+r_{t+1}} C_{2t+1} = A_t w_t \quad (7)$$

Thus, the present value of lifetime consumption must be the same as initial wealth (which is equal to zero) together with lifetime income. The person maximizes the utility found in (5), subject to the budget constraint found in (7). This maximization problem can be solved by setting up the Lagrangian:

$$\mathcal{L} = \frac{C_{1t}^{1-\theta}}{1-\theta} + \frac{1}{1+\rho}\frac{C_{2t+1}^{1-\theta}}{1-\theta} + \lambda[A_t w_t - \left(C_{1t} + \frac{1}{1+r_{t+1}} C_{2t+1}\right)] \quad (8)$$

Where the first-order conditions for $C_{1t}$ and $C_{2t+1}$ are:

$$C_{1t}^{-\theta} = \lambda \quad (9)$$

$$\frac{1}{1+\rho} C_{2t+1}^{-\theta} = \frac{1}{1+r_{t+1}} \lambda \quad (10)$$

Then, substituting equation (9) into equation (10) gives:

$$\frac{1}{1+\rho} C_{2t+1}^{-\theta} = \frac{1}{1+r_{t+1}} C_{1t}^{-\theta} \quad (11)$$

Which can then be rearranged to find:

$$\frac{C_{2t+1}}{C_{1t}} = (\frac{1+r_{t+1}}{1+\rho})^{1/\theta} \quad (12)$$

When multiplying both sides of equation (12) with $C_{1t}$ and substituting this in the budget constraint from equation (7), $C_{1t}$ can be expressed in terms of real interest rate and labor income:

$$C_{1t} + \frac{(1+r_{t+1})^{(1-\theta)/\theta}}{(1+\rho)^{1/\theta}} C_{1t} = A_t w_t \iff C_{1t} = \frac{(1+\rho)^{1/\theta}}{(1+\rho)^{1/\theta} + (1+r_{t+1})^{(1-\theta)/\theta}} A_t w_t \quad (13)$$

Equation (13) demonstrates how interest rate $r_{t+1}$ influences the amount of income that is consumed when the person is young. When denoting *s(r)* as the portion of saved income, equation (13) suggests:

$$s(r) = \frac{(1+r)^{(1-\theta)/\theta}}{(1+\rho)^{1/\theta} + (1+r)^{(1-\theta)/\theta}} \quad (14)$$

Thus, (14) implies that a young person would save more if $(1+r)^{(1-\theta)/\theta}$ increases with r. The derivative of the latter with respect to r is $[\frac{1-\theta}{\theta}](1+r)^{\frac{1-2\theta}{\theta}}$. Therefore, $s$ increases in r if θ is smaller than one, and vice versa if θ is bigger than one. Which means that if there is an increase in *r,* there is both a substitution and an income effect. Finally, equation (13) can be rewritten as:

$$C_{1t} = [1 - s(r_{t+1})]\, A_t w_t \qquad (15)$$

Thus, Diamond's OLG model shows how people save and consume in a two-period model. According to Seater (1993), the Ricardian equivalence does not work in an OLG economy due to population turnover. If young people join the economy, a part of the future tax burden will be carried by them, even though they did not get to enjoy the full benefits of increased government debt. Thus, increased government debt serves as net wealth to those who are old enough to receive the benefits, but are too old to pay for the future taxes. However, Barro (1974) finds that this argument loses its strength when taking intergenerational links into account. People take care of their offspring by saving money for them so they can pay for the future higher taxes. This way, consumers are not limited by a single lifetime, since they behave like a household with an infinite horizon. Barro (1974) thus shows that individuals do not have to change their level of consumption when the government increases or lowers taxes.

Barro's argument regarding intergenerational links might have worked back in the day, however, demographics have changed since 1974. The United Nations (2021) found that as fertility rates have been dropping, the fraction of the population of people over 65 years old, as of 2018 is larger than the fraction of people under 5 years old. The demography of the world is changing and especially in Europe, the population will continue shrinking. In addition, the European Commission (2020) has found that households are getting smaller, as can be seen in Figure 1 below. For instance, around a third of all households are made up of a single person. This is 19% more than in 2010. In general, households in Europe nowadays mainly consist of couples who do not have children, are single parents, or simply people who live alone. Therefore, it could be more likely that households behave like in Diamond's OLG model than according to Barro's Ricardian one. Thus, consumers do not care about future tax liabilities and will consume more rather than save if current taxes decrease.

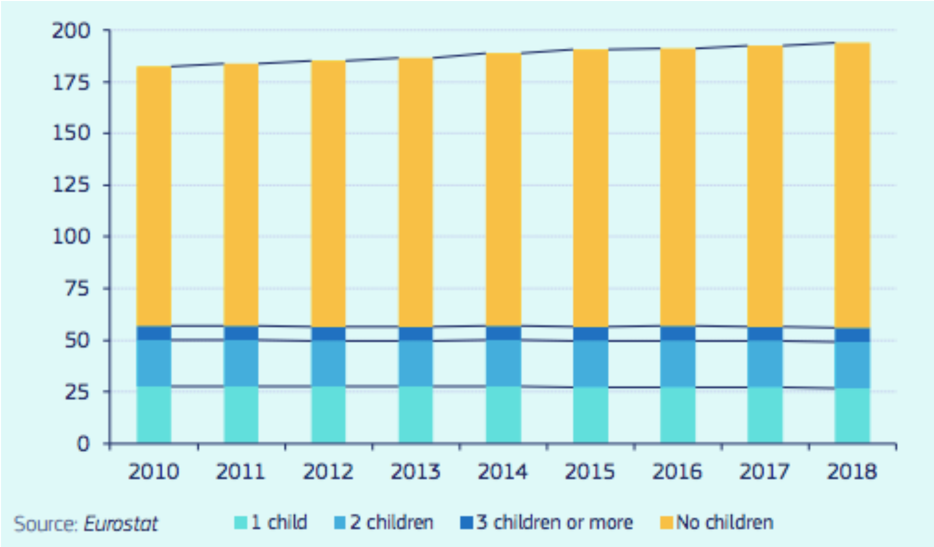


**Figure 1: Households by presence of children, EU-27, 2010-2019 (in millions)**

Another critique of the finite horizons argument is that lifetimes are sufficiently long for an individual to both enjoy tax reductions and also pay off the debt caused by these tax reductions. Poterba and Summers (1987) found this through a natural experiment concerning US tax reforms. Hubbard, Judd, Hall, and Summers (1986) similarly found that finite horizons do not significantly affect aggregate demand. But, through the use of a finite-horizon model, they do find that liquidity constraints of consumers have an important role in the Ricardian equivalence. Liquidity constraints will be discussed further in the following section.

### 2.2.2 Permanent Income Hypothesis

The second notable rejection of the Ricardian equivalence comes from its relation to Friedman's (1957) permanent-income hypothesis, in the latter, expectations play a role in consumption. For instance, it explains how consumption should not change when a temporary tax cut is superseded by an expected tax increase. The permanent-income hypothesis, which the Ricardian equivalence is based on, fails due to liquidity constraints and precautionary saving (Romer, 2012). Thus, through the transitive property, the Ricardian equivalence fails too.

Liquidity constraints offer some problems for the permanent-income hypothesis in the following way: if the government issues a bond to a household, it essentially offers a loan to liquidity-constrained consumers. But rather than paying interest, these consumers will repay the loan in the form of future higher taxes (Romer, 2012). Consumption will therefore increase when taxes decrease if the government offers a loan at a lower 'interest rate' than the household could get from the private market. Zeldes (1989) proves through micro-econometric research that liquidity-constrained households are indeed more sensitive to income fluctuations, which shows in their consumption.

The second source of failure of the permanent-income hypothesis is precautionary savings. This was found by Barsky, Mankiw, and Zeldes (1986), who found that consumers behave Keynesian rather than Ricardian when studying a world without lump-sum taxes. Since taxes depend on the height of income, and future income is uncertain, it could be that future tax liabilities turn out to be relatively low if income diminishes. Thus, experiencing a tax cut in the present, and higher taxes in the future increases the present value of a household's lifetime disposable income if future income turns out to be low. Vice versa, the present value will decrease if future income turns out to be high. As a result, a household would logically consume more today, rather than save more, because future tax liabilities will only be high if the household enjoys a high income.

## 2.3 Empirical Literature

In the last sections of the theoretical framework, the origins and critiques of the Ricardian equivalence were described. Since the Ricardian equivalence is a complex topic, it is important to look at the empirical evidence as well. Therefore, in this section, the relevant empirical literature will be laid out. This section will start by discussing work by Allers, De Haan, and De Kam (1998) and Heijdra and Van Dalen (1996) who researched the consumption behaviour of Dutch households between 1969 and 1990. Since there is little recent work on the Ricardian equivalence in the Netherlands, some papers that have incorporated Dutch consumption patterns like Röhn's (2010) research on OECD countries, and Nickel and Vansteenkiste's (2008) research on industrialized countries, will be reviewed and compared in this section.

To the best of my knowledge, there are only a few relevant papers that discuss Dutch evidence only. The first being Allers et al. (1998), who surveyed among Dutch consumers to see if the sample knew how high the government debt and deficit was and if they found that the country's level of debt affected their saving decisions. Allers et al. (1998) rejected the Ricardian equivalence based on their findings, however, there is reason to believe that the results were biased as the people taking part in the survey could have been giving politically correct answers, rather than speaking their true opinion. This effect is also known as the Hawthorne effect, which is common in surveys as people are aware that they are taking part in research (Adair, 1984). For this research, I will look at data from administrative governmental sources, over which the average consumer does not have control.

Other Dutch Ricardian equivalence research was conducted by Heijdra and Van Dalen (1996). Where intertemporal optimization is used to empirically examine Blanchard's 1985 overlapping generations model. Heijdra and Van Dalen (1996) incorporate both habit formation and durability of consumption into the model to determine private consumption. The model also controls for infinite planning horizons and the absence of liquidity constraints. The latter are necessary assumptions for the Ricardian equivalence. Findings suggest that the Dutch consumer is liquidity constrained, and plans according to finite horizons, thus, the Ricardian equivalence is rejected. However, the period under observation was 1969 to 1990 for the Heijdra and Van Dalen (1996) paper, and this research would have a look at more current data. Current data could offer some new insights because maybe consumers are more insightful now about the relationship between current low taxes and future high taxes since people are more educated now, or because knowledge is easier to attain due to the internet (Flynn & Flynn, 2012). Or perhaps the Netherlands shows a Ricardian tendency like in Spain during the global financial crisis, because both governments reached higher levels of public debt in that period (Castro & Fernández, 2013).

More recent research on the Ricardian equivalence proposition has been done by Röhn (2010), who researched the reaction of consumers to discretionary policy. Specifically how households offset fiscal policy changes through private savings. He finds that, on average, across OECD countries private savings offset is about 40%. Similar to my research, Röhn (2010) works with time series data and is also concerned with co-integration and non-stationarity issues. He resolves this by estimating private and public savings with an autoregressive distributed lag (ARDL) model. Besides this, Hansen's (1999) threshold methodology is used to control for non-linearities in the private and public saving offset.

Overall, Röhn's (2010) findings reject the strict version of the Ricardian equivalence. Nevertheless, there is heterogeneity in the savings offset levels between countries. For instance, estimates for savings offset seem to be higher in smaller countries. And, results from non-linearities suggest that discretionary policies lose their effectiveness in countries that are entering a recession with high levels of debt.

Another paper that finds that households in very high debt countries lean towards Ricardian equivalence, is an ECB paper by Nickel and Vansteenkiste (2008). Through a dynamic panel threshold model, they analyse the relation between the government balance and the current account for 22 industrialized countries. By using the first-order lag as an instrumental variable, and like Röhn (2010), applying Hansen's (1999) fixed-effects threshold model, Nickel and Vansteenkiste (2008) create an estimation where the current account and government balance can change according to a country's debt-to-GDP ratio. They ultimately find that households in a country with a debt-to-GDP ratio of around 90% reduce their consumption when the fiscal deficit increases. These findings, therefore, support the Ricardian equivalence.

# 3 Empirical Analysis

## 3.1 Hypotheses

In this section, I will summarize the findings from the theoretical framework to link past papers to my expectations for this research. Which will lead to the presentation of my hypotheses. The Ricardian equivalence has been a well-examined proposition. Barro (1974) famously supported the controversial theory even though it knows a lot of critiques. For instance, Diamond (1965) explains how through his overlapping-generations model, a lifetime would be too short to pay-off all the owed government debt by one generation. Barro (1974) rejects this by explaining that due to intergenerational links consumers behave as they exist in an infinite horizon. The failings of Friedman's (1957) permanent-income hypothesis, which the Ricardian equivalence is based on, also form some problems. Zeldes (1989) for instance proves that the permanent-income hypothesis fails due to liquidity constraints, as liquidity-constrained households are sensitive to income fluctuations, which shows in their consumption. The permanent-income hypothesis also fails due to precautionary savings. Barsky et al. (1986) found that since taxes depend on the height of income, consumers tend to spend more today when there is a tax cut, such that the future tax increase will be based on a lower income.

In addition to the previously explained criticisms about the Ricardian equivalence, it is also important to discuss the empirical literature. One of the studies is by Allers et al. (1998), they rejected the Ricardian equivalence for Dutch consumers, however, their research method was flawed. They conducted a survey amongst Dutch citizens, which suggests that results could have been biased due to the Hawthorne effect. Another research concerning the Dutch consumers was conducted by Heijdra and van Dalen (1996). They also rejected the Ricardian equivalence, nevertheless, the period they researched ran from 1969 to 1990. This research will look at more current data, namely data spanning from 1999 to 2019. Finally, Röhn (2010) also rejected the Ricardian equivalence in his study about OECD countries. Still, he finds that the saving offset as a reaction to fiscal policy changes is higher for the smaller countries. Therefore, I believe there could still be the possibility for the Ricardian equivalence to hold in the Netherlands, as throughout the years, maybe the Dutch consumer gained some insights about the workings of government expenditure. This brings me to the first hypothesis of this research:

*Hypothesis 1: The Dutch consumer behaves in a Ricardian manner.*

Another aspect of the Ricardian equivalence that was brought up in the review of the empirical literature is recession. Nickel and Vansteenkiste (2008) found that when industrialized countries were experiencing high levels of debt, households reduced their consumption when fiscal deficits increased. Also, Röhn (2010) found that discretionary policies lost their effectiveness when the government experienced high levels of debt. I therefore expect that Dutch households will be inclined to behave in a more Ricardian manner during the global financial crisis (GFC) of 2008/2009, as the Netherlands experienced higher levels of debt during that period. This brings me to the second hypothesis of this research:

*Hypothesis 2: Dutch consumers become more Ricardian during a financial crisis.*

## 3.2 Specification

A base estimation for Dutch consumption will be used as a starting point for the methodology. This base estimation is inspired by work from Stanley (1998), and Leiderman and Blejer (1988). They performed quantitative reviews of different econometric studies of the Ricardian equivalence. They explain that the common way of testing the Ricardian equivalence is by setting up an empirical model of consumption expenditure that looks like the following estimation:

$$C_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 G_t + \alpha_3 W_t + \alpha_4 Tx_t + \alpha_5 B_t + \alpha_6 Tr_t + \varepsilon_t \quad (16)$$

Where $C_t$ is household consumption in quarter $t$, $Y_t$ is household disposable income, $G_t$ is government expenditure, $W_t$ is households' net worth, $Tx_t$ is government revenue, $B_t$ is government debt, and $Tr_t$ is transfer payments by the government. All variables are expressed in real per capita terms since nominal values would be influenced by inflation. However, equation (16) might present biased results due to non-stationarity because the process is now affected by the past values of each variable. To avoid this, lags will be incorporated into the consumption function, similarly to Röhn's (2010) methodology. I would also not be able to draw causal inference through this regression since it shows a spurious relationship. A way to solve this is by taking the natural logarithm of the variables. The changes of the function will be discussed further in the methodology section. Nevertheless, the general idea of the consumption function remains, and predicts the following results: according to the Ricardian equivalence, government revenue, government debt, and government transfer payments should not affect a household's consumption choices. Thus, $\alpha_4 = \alpha_5 = \alpha_6 = 0$ (Leiderman & Blejer, 1988).

## 3.3 Data

The data for this research comes from Statline, a database of Dutch statistics which offers data on Dutch society and economy (Statline, 2021). Since I am working with data that represents the whole of the Netherlands, there will be no sample selection. All the data is available from 1999 to 2019 in quarterly periods. I have chosen quarterly data as this will offer more data points per parameter, and thus ensure a more precise estimation than if I would have used yearly data. I want to work with real, per capita values. Thus, if needed, I have transformed nominal data with the CPI price index, and then divided this value by the number of people living in the Netherlands, to get per capita terms. I chose for CPI index rather than the HICP index since the latter is generally used for comparison between different European nations. However, since this research only looks at the Netherlands, the comparison is not necessary. Finally, I have transformed the data by taking the natural logarithms of all the variables to get rid of stationarity. Besides controlling for stationarity, there are some other advantages to taking the natural logarithm of variables. For instance, interpretation will be more straightforward, and when computing with strictly positive values the distributions of variables can be heteroskedastic or skewed, logs cancel this. Besides this, the ranges of variables that take on large monetary values will be narrowed by taking the logarithm, this makes estimations less perceptive to outliers (Wooldridge, 2016). Table 1 contains the descriptive statistics of the data used in this research. All the values were in millions of euros before the natural logarithm was taken.

**Table 1: Descriptive Statistics (%)**

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Household consumption | 84 | 8.448 | 0.022 | 8.396 | 8.494 |
| Government revenue | 84 | 8.404 | 0.048 | 8.254 | 8.492 |
| Government expenditure | 84 | 8.434 | 0.059 | 8.27 | 8.539 |
| Government debt | 84 | 8.61 | 0.146 | 8.402 | 8.856 |
| Household wealth | 84 | 8.484 | 3.092 | 4.491 | 11.058 |
| Government contributions | 84 | 8.177 | 0.084 | 8.041 | 8.360 |
| Disposable income | 84 | 8.570 | 0.098 | 8.397 | 8.825 |

Note: all the values are in real per capita terms, before taking the logarithm the values were in millions of euros.

I will start my empirical analysis by building an econometric model based on equation (16). All the variables for equation (16) can be retrieved from Statline. Except for households' net worth, which was harder to find. Household net worth is the total value of a household's (including non-profit institutions that serve households) financial and non-financial assets diminished by the total value of liabilities (OECD Data, 2021). Thus, I have added the values for the non-financial assets to the balanced values of the financial assets to get the households' net worth.

For the second hypothesis regarding the effect of the GFC on the consumption behaviour of Dutch households, the exact periods of recession in the Netherlands needed to be found. According to CBS (2018), the 15th of September of 2008 was the starting point of the GFC. This is the date that the Lehman Brothers filed for bankruptcy. However, in the Netherlands, the economy did not severely contract until 2009. After which there was a brief recovery period from 2009 to 2011. Then, the Dutch economy collapsed again in 2012 due to the European Sovereign debt crisis. This whole period is also known as a 'double-dip recession'.

Since I am going to work with quarterly data, it would be fitting to know during which exact quarters the recession took place. GDP values for the Netherlands were retrieved from Statline. These values were transformed by dividing them by CPI to arrive to real terms, and then dividend by the number of people living in the Netherlands to arrive at per capita terms. After which the natural logarithms were taken and the difference between consecutive values was calculated to finally get the growth rates. As can be seen in Figure 2, the following periods are considered recessions: Q3 2008 to Q1 2009; Q4 2011 to Q1 2012; and Q3 2012 to Q4 2012. In Figure 2, it can be seen that there were some additional quarters in which the Dutch economy experienced downturns. However, since a recession is generally seen as a period of at least two consecutive quarters of negative economic growth (Claessens & Kose, 2012), these 'single' quarters will not be taken into account during my research.

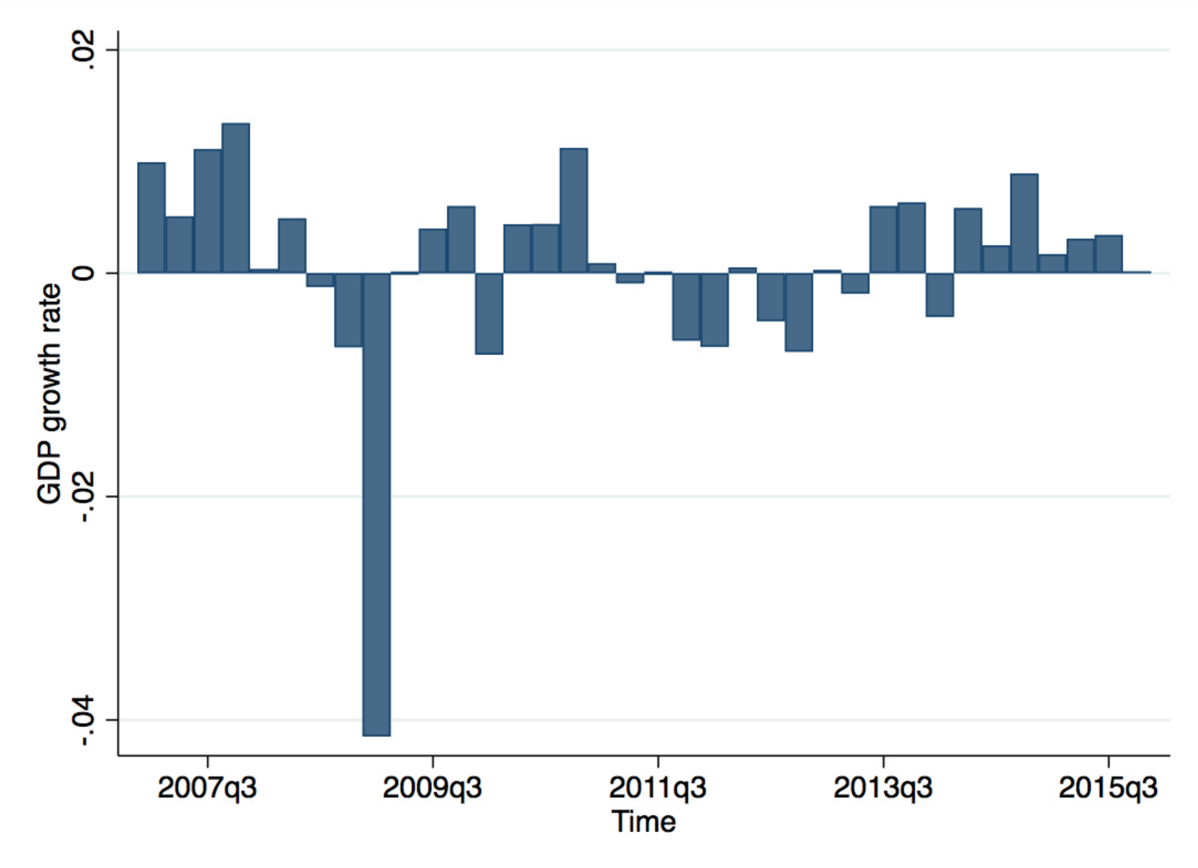


**Figure 2: Netherlands GDP growth rate 2007-2016 (quarterly)**
Note: values are in real per capita terms, and values were in millions of euros before the growth rate was calculated.

## 3.4 Methodology

### 3.4.1 Model 1

When analysing time series in the social sciences, it is important to take into account that the past may affect the current and future values of variables. Through his research on the unit root hypothesis, Perron (1988) proved that most macroeconomic variables suffer from stochastic non-stationarity. This means that random shocks that affect the variables have a lasting effect on future values, rather than a deterministic effect, where random shocks merely have a vanishing effect on future values. Therefore, I expect equation (16) to present biased results. A way to solve this problem is by adding lags, this way controlling for past effects. Since both the dependent and independent variables in equation (16) are assumed to be affected by past values, an autoregressive distributed lag (ARDL) model is viewed to be the most appropriate model for this research. ARDL incorporates both lagged values for the dependent variables, but also the present and lagged values of the independent variables (Moore, McCabe, Alwan & Craig, 2016). An additional benefit of the ARDL approach is that once the appropriate assumptions have been met, estimations can be made through an ordinary least squares (OLS) regression.

The reason behind the use of lags is to get rid of autocorrelation. Autocorrelation, or serial correlation, means that previous values are correlated to present ones (Wooldridge, 2016). Since the error term has to be independent, the present error term is not allowed to correlate with the values of past error terms. The optimal number of lags will be found by using the Akaike Information Criterion (AIC). Besides the AIC I also want to perform an autocorrelation test in the form of a Breusch-Godfrey LM test. I have chosen to perform both AIC and Breusch-Godfrey to be certain that the number of lags is appropriate and to leave no room for autocorrelation so as to be able to work with a dynamically complete model. Thus, enough lags have to be included for each variable such that adding more lags would not matter for explaining Dutch consumption.

As already mentioned in the first paragraph, one of the main assumptions of ARDL is that it requires all variables to be stationary. Stationarity means that the joint probability distribution of the variables is unchanged when shifting ahead or backward in time (Wooldridge, 2016). If there is non-stationarity, the estimated coefficients are regarded as spurious. I will solve this by taking the natural logarithm of the variables. According to Sims (1980), taking the natural logarithm of the variables offers consistent estimates when there is non-stationarity. When taking logarithms and lags into account, the original equation (16) is transformed into equation (17):

$$lnC_t = \alpha_0 + \sum_{s=1}^{p} \alpha_{1s} lnC_{t-s} + \sum_{s=0}^{p} \alpha_{2s} lnY_{t-s} + \sum_{s=0}^{p} \alpha_{3s} lnG_{t-s} + \sum_{s=0}^{p} \alpha_{4s} lnW_{t-s} + \sum_{s=0}^{p} \alpha_{5s} lnTx_{t-s} + \sum_{s=0}^{p} \alpha_{6s} lnB_{t-s} + \sum_{s=0}^{p} \alpha_{7s} lnTr_{t-s} + \varepsilon_t \quad (17)$$

Another important assumption of the ARDL model is that there should be no heteroskedasticity. Thus, the mean and variance of the error term have to be constant throughout the entire model. Since OLS standard errors are known to be biased when residuals are correlated with other observations, an adaptation needs to be made. A way to cluster standard errors when working with time series is by using Newey-West standard errors. These do not only control for heteroskedasticity but also serial correlation (Petersen, 2009).

As discussed in sub-section 2.2 about the general specification that will be used for this research; according to the Ricardian equivalence, government revenue, government debt, and government transfer payments should have not affect a household's consumption choices, therefore, $\alpha_{5s} = \alpha_{6s} = \alpha_{7s} = 0$ (Leiderman & Blejer, 1988). Since I am testing multiple linear restrictions, and since the Newey-West standard errors correct for heteroskedasticity, the first test that will be run is the F-test to test the joint significance of $\alpha_{5s}$, $\alpha_{6s}$, and $\alpha_{7s}$. Finally, one sample t-tests will be run for government revenue, government debt, and government contributions to find if any of the three variables singularly does not influence on Dutch consumption.

To conclude this section about the methodology, a topic that is worth mentioning when working with an ARDL model is cointegration. Economic analysis has proven that even when working with non-stationary variables, there are still ways to find a correct long-run equilibrium (Nkoro & Uko, 2016). One of these ways is through the ARDL cointegration technique. This is very useful for forecasting, and therefore an important property of ARDL analyses. However, I will not be looking into cointegration for this research. The main reason I am using ARDL is to transform equation (16) such that I can get unbiased estimations when performing the F- and t-tests. Nevertheless, for the sake of completeness, I wanted to mention this important part of ARDL research.

### 3.4.2 Model 2

As discussed in the theoretical framework and the hypothesis subsection, there are some reasons to believe that consumers behave in a more Ricardian manner during a financial crisis. To find out whether this is also the case for the Dutch consumers during the GFC, a crisis dummy variable is going to be added to estimation (17). I have chosen to add this dummy as a part of three interaction terms with the following three variables: government revenue, government debt, and government contributions. This way, allowing the three variables to depend on the financial crisis and see if they are now not affecting Dutch consumption. Therefore, estimation (17) is going to transform into estimation (18):

$$lnC_t = \alpha_0 + \sum_{s=1}^{p} \alpha_{1s} lnC_{t-s} + \sum_{s=0}^{p} \alpha_{2s} lnY_{t-s} + \sum_{s=0}^{p} \alpha_{3s} lnG_{t-s} + \sum_{s=0}^{p} \alpha_{4s} lnW_{t-s} + \sum_{s=0}^{p} \alpha_5 s lnTx_{t-s} + \sum_{s=0}^{p} \alpha_{6s} lnB_{t-s} + \sum_{s=0}^{p} \alpha_{7s} lnTr_{t-s} + \alpha_8 lnTx_t * dummy_t + \alpha_9 lnB_t * dummy_t + \alpha_{10} lnTr_t * dummy_t + \varepsilon_t \quad (18)$$

Where all the variables mean the same as in equation (17), but with the addition of *dummy*, which is the GFC dummy. The dummy takes on the value of one in the quarters that the Netherlands went through a recession. These recession quarters were found in Figure 2. Before running this new regression, it is of importance to follow the same steps as I did for Model 1 to make sure the results are not biased. Thus, to find out if there is no autocorrelation in the new estimation, first the appropriate number of lags will be found through studying the AIC levels and the Breusch-Godfrey test for autocorrelation. After that the appropriate lag length is established, standard errors will be clustered through the Newey-West method, such that the mean and the variance of the errors remain constant also throughout this model. Then, the F-test for joint significance will test if $\alpha_8 = \alpha_9 = \alpha_{10} = 0$ for equation (18). This way, I will be able to find out whether the consumption of Dutch households is not affected by government revenue, government debt, and government contributions during a recession. Finally, like for hypothesis 1, one-sample t-tests will be run for the new interaction terms. I will do this to find out whether the different variables on their own do not affect Dutch consumption during a recession.

## 3.5 Results

### 3.5.1 Results Model 1

In this section, the results that will answer the hypotheses of this research will be presented. This will start with the results of the AIC and Breusch-Godfrey autocorrelation tests. After finding the appropriate lag length for Model 1, the OLS regression output will be discussed. Then, the results of the F- and t-tests will be presented. In Table 2 below, the AIC and autocorrelation test results are shown for different lag lengths of Model 1. Since the model containing four lags has the lowest AIC value, and the highest p-value for the autocorrelation test, I have chosen to continue working with this lag length. By working with four lags for all the variables, I am assured that I will be working with a dynamically complete model. Thus, enough lags are included for each variable such that adding more lags would not matter for explaining Dutch consumption.

**Table 2: Test results for different lag lengths Model 1**

| Number of lags | AIC | BG |
|---|---|---|
| 1 | -551.434 | 0.180 |
| 2 | -550.570 | 0.556 |
| 3 | -558.118 | 0.000 |
| 4 | -592.697 | 0.601 |

Note: AIC stands for the Akaike Information Criterion and BG shows the test result for the Breusch-Godfrey LM test for autocorrelation.

To be sure that the mean and variance of the error term were constant throughout the entire model, the ARDL model was run with Newey-West standard errors. For Model 1, the appropriate lag length was chosen to be four. The results of the regression including all the lags can be found in Table A1 of the appendix. Table 4 shows the main results, containing only the current value coefficients, and they can be interpreted as follows. First, if disposable income increases by one percentage point, then the current household consumption decreases insignificantly by 0.03 percentage points. This result is both statistically and economically insignificant. As the p-value is bigger than the 0.01 threshold, and logically, if disposable income increases, so should consumption. Second, if government expenditure increases by one percentage point, then the current household consumption decreases significantly by 0.074 percentage points. This value is statistically significant based on the 10% significance level. This value is also economically significant since according to the Ricardian equivalence, if government expenditure increases, consumption decreases because consumers want to save for a future tax increase. Third, if household wealth increases by one percentage point, then the current household consumption will increase significantly by 0.004 percentage points. This coefficient is both statistically significant at a level of 1%, and economically significant. As households become wealthier, they will consume more. Fourth, if government revenue increases by one percentage point, household consumption will insignificantly increase with 0.015 percentage points. This coefficient is also economically insignificant because government revenue increases when the government receives more taxes, thus consumption should decrease when taxes increase. Fifth, if government debt increases with one percentage point, household consumption will significantly decrease with 0.046 percentage points, based on the 5% significance level. In a Keynesian world, increasing government debt should help increase consumption, this is called expansionary monetary policy. Thus, the coefficient being negative should be economically insignificant. However, I am studying the Ricardian model here, thus there should be no effect of government debt on consumption. This will be tested in the following step of this research. Finally, if government contributions increases with one percentage point, then the current household consumption insignificantly decreases with 0.15 percentage points. As with government debt, these government contributions should also be economically insignificant according to the Keynesian world. But again, a Ricardian model is studied here, and there should be no effect of government contributions on consumption, this will be tested in the next step of the research.

Besides the coefficients, it is also interesting to look at the model as a whole. According to the probability value of the F-statistic, the model itself is significant, since the probability of the F-statistic is 0.000, which is lower than the 1% significance level. The adjusted R-squared explains how much of the variance in the dependent variable, in this case, household consumption is explained by the model. The value for this model is 93.54%. I have chosen the adjusted R-squared since it only increases in value when additional variables improve the predictive power. Therefore, the value of the adjusted R-squared is a bit smaller than the value of the R-squared, the latter is 96.32%.

**Table 3: Model 1 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 10.321*** | 10.38 | 0.000 |
| Disposable income | -0.030<br>(0.031) | -0.96 | 0.342 |
| Government expenditure | -0.074*<br>(0.042) | -1.75 | 0.086 |
| Household wealth | 0.004***<br>(0.001) | 6.59 | 0.000 |
| Government revenue | 0.015<br>(0.052) | 0.29 | 0.774 |
| Government debt | -0.046**<br>(0.021) | -2.21 | 0.033 |
| Government contributions | -0.150<br>(0.137) | -1.09 | 0.28 |
| R-squared | | | 0.9632 |
| Adjusted R-squared | | | 0.9354 |
| F-test | | | 1226.480 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -592.697 |
| Number of observations | | | 80 |

*Notes: these results are based on an ARDL model with four lags. The ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are in brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms.*

To find out whether the Ricardian equivalence holds for this model, the F-test for joint significance was run. The results can be found in Table 4. Since the p-value is bigger than 0.05, I cannot reject the null hypothesis at the 5% significance level. This means that the three variables are jointly 0, and do not influence Dutch consumption. Thus, this could be evidence of the Ricardian equivalence holding for this subset of the Dutch population.

Lastly, one-sample t-tests were run to find out whether government revenue, government debt, and government contributions singularly do not influence Dutch consumption. The results in Table 4 show that both government revenue and government contribution have p-values that are higher than the 5% significance level. Thus, the null hypothesis cannot be rejected, the two variables are equal to zero and thus do not affect Dutch consumption. However, for government debt the p-value is smaller than the significance level of 5%. Thus, the null hypotheses has to be rejected, government debt is statistically significantly different from 0. Therefore it does affect Dutch consumption. These results suggest some contradiction with the results from the F-test for joint significance. According to Wooldridge (2016), it could be that the three variables are correlated, multicollinearity makes it harder to find partial effects of the variables separately. Or, the data is not precise enough, which makes it appear like the coefficients are persistently zero, causing the F-test to be significant.

**Table 4: Results for the statistics of Model 1**

| Variables | F-value | t-value | p-value |
|---|---|---|---|
| Joint significance | 1.73 | | 0.18 |
| Government revenue | | 0.29 | 0.77 |
| Government debt | | -2.21 | 0.03 |
| Government contributions | | -1.09 | 0.28 |

*Note: the joint significance F-test was run only for the following three variables: government revenue, government debt, and government contributions.*

### 3.5.2 Results Model 2

In this section, the results regarding the second hypothesis of this research, whether Dutch consumers will tend to Ricardian behaviour during the GFC, will be presented. The methodology is very similar to the methodology that was used to answer the first hypothesis of this research. The only difference is the introduction of interaction terms between government debt, government revenue, and government contributions, and a GFC dummy variable. Therefore, the order of the result presentation is going to be the same as before. First, the results of the AIC and Breusch-Godfrey autocorrelation test. Second, the results of the ARDL model with Newey-West standard errors, after which the results of the F- and t-tests will be presented. Thus, starting with the AIC and Breusch-Godfrey autocorrelation test results, which can be found in Table 5 below, which presents the different outcomes for the different lag lengths. Since the fourth lag shows the lowest AIC value and has a significant p-value for the autocorrelation test, this will be the number of lags for Model 2.

**Table 5: Test results for different lag lengths for Model 2**

| Number of Lags | AIC | BG |
|---|---|---|
| 1 | -551.534 | 0.195 |
| 2 | -548.929 | 0.916 |
| 3 | -558.829 | 0.000 |
| 4 | -587.509 | 0.361 |

Note: AIC stands for the Akaike Information Criterion and BG shows the test result for the Breusch-Godfrey LM test for autocorrelation.

In Table 6, the main results for Model 2 can be found. For the complete results, which include all the coefficients for all the lags, Table A2 in the appendix can be utilized. The results in Table 6 are not that different from the ones in Table 3. For instance, the coefficients for disposable income and household wealth remain the same. Second, government expenditure is no longer statistically significant, but the magnitude only decreased slightly from 0.074 to 0.070. Third, government revenue also only decreased slightly in magnitude, it went from 0.015 in Table 3 to 0.012 in Table 6. Similarly, government debt slightly increased in magnitude from -0.046 to -0.045. However, government contributions increased from -0.150 to -0.128, therefore the crisis interaction term has picked up some of the relationship between household consumption and government contributions. Finally, the added interaction terms, all three of them are statistically insignificant. First, a one percentage point increase in government revenue insignificantly decreases household consumption by 0.071 percentage points during the GFC. Second, government debt interacted with crisis increases by one percentage point, it insignificantly decreases household consumption by 0.005 percentage points during the GFC. Third, government contributions interacted with the GFC dummy increases consumption by 0.068 percentage points. Besides the coefficients, it is also interesting to compare the models as a whole. The adjusted R-squared has slightly decreased from 93.54% to 93.20%. Therefore, adding the interaction terms did little to improve the predictive power of the model. Nevertheless, according to the probability value, which is 0.000, the new model itself is significant.

**Table 6: Model 2 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 10.603*** (1.109) | 9.56 | 0.000 |
| Disposable income | -0.030 (0.033) | -0.90 | 0.371 |
| Government expenditure | -0.070 (0.045) | -1.53 | 0.133 |
| Household wealth | 0.004*** (0.001) | 3.55 | 0.001 |
| Government revenue | 0.012 (0.056) | 0.21 | 0.831 |
| Government debt | -0.045 (0.073) | -0.61 | 0.546 |
| Government contributions | -0.128 (0.143) | -0.90 | 0.375 |
| Crisis * Government revenue | -0.071 (0.321) | -0.22 | 0.827 |
| Crisis * Government debt | 0.005 (0.011) | 0.41 | 0.682 |
| Crisis * Government contributions | 0.068 (0.334) | 0.20 | 0.839 |
| R-squared | | | 0.964 |
| Adjusted R-squared | | | 0.932 |
| F-test | | | 6119.79 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -587.509 |
| Number of Observations | | | 80 |

*Notes: these results are based on an ARDL model with four lags. The ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms.*

The F-test results for Model 2 can be found in Table 7. Since the p-value is bigger than the 5% significance threshold, I cannot reject the null hypothesis. This means that the three variables are jointly 0, and do not affect Dutch consumption during the GFC. This could be evidence supporting the Ricardian equivalence for this subset of the

Dutch population. Lastly, like for the first hypothesis, one-sample t-tests were run for the new interaction terms. I did this to find out whether the different variables on their own do not affect Dutch consumption during a recession. The results in Table 7 show that for all the three interaction terms the p-values are bigger than the 5% significance level, thus the null hypotheses cannot be rejected. This means that the three interaction terms on their own do not affect Dutch consumption during the GFC.

**Table 7: Results for the test statistics of Model 2**

| Variables | F-value | t-value | p-value |
|---|---|---|---|
| Joint significance | 0.13 | | 0.87 |
| Government revenue * crisis | | -0.22 | 0.83 |
| Government debt * crisis | | 0.41 | 0.68 |
| Government contributions * crisis | | 0.20 | 0.84 |

*Note: the joint significance F-test was run only for the following three variables: government revenue, government debt, and government contributions.*

## 3.6 Robustness Checks

### 3.6.1 First-Differencing

In this section, I will be performing alternative methodologies to test the two models that I was working with in the last sections. This way making sure that the findings were not coincidental. I will start by analysing the first differences of my coefficients, and in the next section a different definition of 'financial crisis' will be touched upon. There is a possibility that the models studied up until now are still non-stationary. A way to solve this is by computing the first differences between successive data points. This is also known as differencing. Differencing helps to detrend data by getting rid of changes in the level of a time series, this way, stabilizing the mean (Hyndman & Athanasopoulos, 2018). Additionally, taking the first difference from time series data at a lag that is equal to the period will control for seasonality issues (Holmes, Scheuerell & Ward, 2019). I will start by first-differencing Model 1. To estimate the optimal number of lags for this new Model 3, the AIC level and the autocorrelation tests of different lag lenghts will be compared. The results can be found in Table 8. The optimal number of lags for Model 3 is three since it shows no autocorrelation and has a low AIC value.

**Table 8: Test results for different lag lengths for Model 3**

| Lags | AIC | BG |
|---|---|---|
| 1 | -510.258 | 0.098 |
| 2 | -516.497 | 0.004 |
| 3 | -517.947 | 0.769 |
| 4 | -550.669 | 0.001 |

Note: AIC stands for the Akaike Information Criterion and BG shows the test result for the Breusch-Godfrey LM test for autocorrelation.

The results for the OLS regression can be found below in Table 9. However, these results show only the coefficients for the current values. The results that contain the coefficients of all the lags can be found in the appendix, in Table A3. When comparing the regression results of Model 3 with the results from Model 1, it is clear that taking the first differences has made the Model 3 coefficients less statistically significant. However, disposable income has switched signs, which makes the variable economically significant since household consumption should increase when disposable income increases. Nevertheless, the variable is still not statistically significant. The magnitude of disposable income, government debt, and government contributions have increased. Government revenue also switched signs, however this is not as relevant, since we expect this variable to be zero in a Ricardian economy. Meanwhile, government expenditure, household wealth, government debt and government contributions have all decreased in magnitude. With regards to the model in general, the adjusted R-squared has decreased from 96.32% to 69.20%, when comparing Model 1 to Model 3, respectively. Thus, taking the first difference has decreased some of the explanatory power of the model. Nevertheless, according to the F statistic's p-value, the model itself is still statistically significant as the value is below the 5% threshold.

**Table 9: Model 3 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001<br>(0.002) | 0.49 | .623 |
| Disposable income$_t$ | 0.036<br>(0.043) | 0.85 | .397 |
| Government expenditure$_t$ | -0.048<br>(0.080) | -0.59 | .556 |
| Household wealth$_t$ | 0.003***<br>(0.001) | 4.39 | 0 |
| Government revenue$_t$ | -0.028<br>(0.076) | -0.36 | .717 |
| Governement debt$_t$ | -0.050<br>(0.032) | -1.57 | .123 |
| Government contributions$_t$ | -0.115<br>(0.199) | -0.58 | .566 |
| R-squared | | | 0.797 |
| Adjusted R-squared | | | 0.692 |
| F-test | | | 246.51 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -517.947 |
| Number of observations | | | 80.000 |

*Notes: these results are based on an ARDL model with three lags. The ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*

Finally, the results of the F- and t-test are shown below in Table 10. Interestingly, taking the first differences has changed some of the results. Like before, the F-test for joint significance still offers a p-value that is high enough such that the null-hypothesis can still not be rejected. The one-sample t-tests that test whether the variables on their own affect the dependent variables show similar results. For the three variables, the null hypothesis cannot be rejected at the 5% significance level. Thus, these three variables indeed do not affect Dutch consumption. This way proving Ricardian equivalence. However, it could still be the case that the data is not precise enough to tell us what exactly is going on in the Dutch population, therefore making it seem like the data is consistently equal to zero.

**Table 10: Results of the test statistics for Model 3**

| Variable | F-value | t-value | p-value |
|---|---|---|---|
| Joint significance | 0.06 | | 0.94 |
| Government revenue | | -0.36 | 0.72 |
| Government debt | | -1.57 | 0.12 |
| Government contributions | | -0.58 | 0.57 |

*Note: the joint significance F-test was run only for the following three variables: government revenue, government debt, and government contributions.*

To finalize this section about first-differencing, I am going to take the first differences for Model 2 as well. To find the optimal lag length for this new Model 4, the AIC levels and the autocorrelation tests for different lag lengths will be compared. The results can be found in Table 11. The optimal lag length for Model 4 is three.

**Table 11: Test results for different lag lengths for Model 4**

| Lags | AIC | BG |
|---|---|---|
| 1 | -511.085 | 0.108 |
| 2 | -520.348 | 0.010 |
| 3 | -518.880 | 0.881 |
| 4 | -548.865 | 0.001 |

Note: AIC stands for the Akaike Information Criterion and BG shows the test result for the Breusch-Godfrey LM test for autocorrelation.

Model 4's OLS regression is then run with Newey-West standard errors. The results with all the lags can be found in the appendix, Table A4. The most important results, the ones presenting the current value coefficients, are shown below in Table 12. When taking the first differences, the Model 4 results show some different results than Model 2 did. For instance, disposable income has switched signs, which makes it economically significant. The variable has also increased in magnitude, however, it is still statistically insignificant. The other variables have remained similar to their old values. However, the interaction terms have changed. Government revenue during the GFC is now statistically significant at the 5% level. It has also increased in magnitude. Therefore, if government revenue increases by one percentage point during the GFC, household consumption decreases by 0.475 percentage points. Lastly, the interaction terms of the GFC dummy and government debt, and the GFC dummy and government contributions have also increased in magnitude. Regardless, the two interaction terms are both still statistically insignificant. In general, the p-value of the F-statistic is still 0.000, making the model statistically significant at the 1% level. The adjusted R-squared has decreased from 93.20% to 69.68% when comparing Model 2 to Model 4.

**Table 12: Model 4 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001<br>(0.001) | 0.76 | 0.452 |
| Disposable income$_t$ | 0.056<br>(0.044) | 1.26 | 0.214 |
| Government expenditure$_t$ | -0.103<br>(0.076) | -1.37 | 0.177 |
| Household wealth$_t$ | 0.004***<br>(0.001) | 4.90 | 0.000 |
| Government revenue$_t$ | 0.008<br>(0.057) | 0.14 | 0.886 |
| Government debt$_t$ | -0.027<br>(0.066) | -0.41 | 0.682 |
| Government contributions$_t$ | -0.111<br>(0.188) | -0.59 | 0.557 |
| Crisis * Government revenue | -0.475**<br>(0.197) | -2.42 | 0.019 |
| Crisis * Government debt | 0.067<br>(0.075) | 0.89 | 0.375 |
| Crisis * Government contributions | 0.370<br>(0.464) | 0.80 | 0.429 |
| R-squared | | | 0.8138 |
| Adjusted R-squared | | | 0.6998 |
| F-test | | | 477.57 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -518.880 |
| Number of Observations | | | 80 |

*Notes: these results are based on an ARDL model with three lags. The ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*

To find out if the Dutch consumers behave in a more Ricardian manner during the GFC, F- and t-tests were run for Model 4. The results can be found in Table 13. The F-test for joint significance has a p-value of 0.09, which is higher than the 5% significance level. Therefore, the null hypothesis cannot be rejected. With regards to the t-tests, for both government debt and government contributions during the crisis, the null hypothesis cannot be rejected based on a 5% significance level. This means that these results could possibly be evidence of Ricardian equivalence in the Dutch population during the GFC. However, government revenue in times of the GFC is not statistically significant based on a 5% level. Thus, this variable still has an influence on Dutch consumption.

**Table 13: Results of the test statistics for Model 4**

| Variable | F-test | t-test | p-value |
|---|---|---|---|
| Joint significance | 2.54 | | 0.09 |
| Crisis * Government revenue | | -2.42 | 0.02 |
| Crisis * Government debt | | 0.89 | 0.38 |
| Crisis * Government contributions | | 0.80 | 0.43 |

*Note: the joint significance F-test was run only for the following three variables: government revenue, government debt, and government contributions.*

### 3.6.2 A different definition of crisis

For Models 2 and 4 the GFC dummy variable was based on consecutive negative GDP growth. The chosen quarters were based on the findings from Figure 2. To control if the findings related to these dummy variables were not due to coincidence, I am going to look at a different definition of 'financial crisis' to create new dummy variables. In this section, I am going to look at the quarters in which the Netherlands had high government debt, higher than the European ceiling of 60% of GDP. The European debt ceiling is part of the excessive deficit procedure (EDP) which was launched by the European Commission to correct for excessive levels of debt and deficits (EUR-Lex, 2021). According to the Ricardian equivalence, a rational household saves to offset government borrowing. Findings by Masson, Bayoumi, and Samiei (1998), who studied data for a large sample of developing and industrialized countries found evidence for this. They found that this saving offset is around 75 percent, but it depends on whether the financial position changes because of a change in taxes or a change in government spending. Bernheim (1987) similarly found that if government deficit increases by one unit, consumption drops between 50 to 60 percent, in industrial countries. As can be seen in Figure 3, the quarters that the Netherlands experienced debt above the European ceiling level of 60% of GDP were the following: the first two quarters of 1999, and the second quarter of 2011 up until the fourth quarter of 2016.

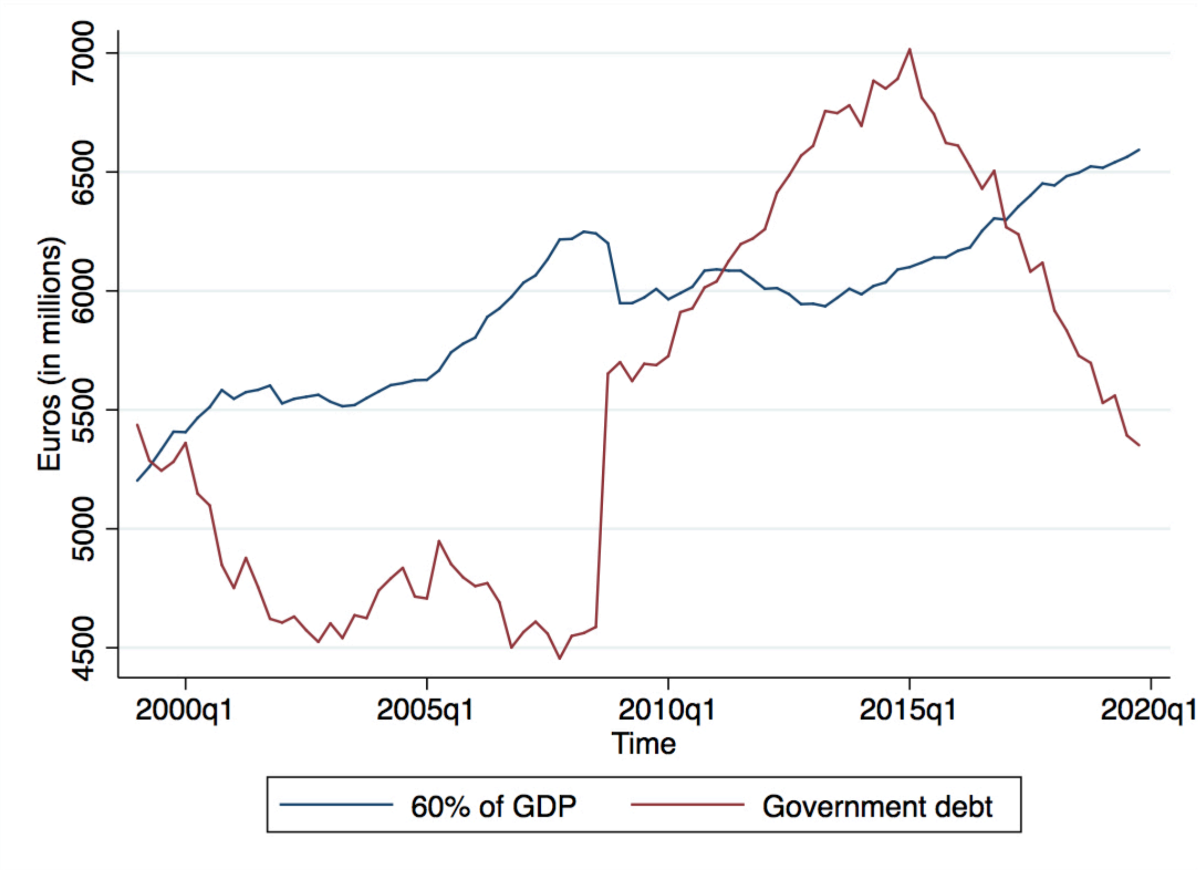


**Figure 3: Government debt against European ceiling of 60% of GDP**
*Note: GDP and government debt are in real, per capita terms, expressed in millions of euros.*

The new Model 5 is an adaptation of Model 4 since it uses a different crisis dummy. The optimal lag length will again be established by comparing the AIC level and the Breusch-Godfrey autocorrelation test values between different lag lengths. The results can be found in Table 14. Only the models with one and three lags show no autocorrelation and the AIC has the lowest value for the third lag. Therefore, the optimal lag length is three.

**Table 14: Test results for different lag lengths for Model 5**

| Lags | AIC | BG |
|---|---|---|
| 1 | -506.766 | 0.167 |
| 2 | -514.634 | 0.0312 |
| 3 | -517.266 | 0.866 |
| 4 | -545.884 | 0.000 |

Note: AIC stands for the Akaike Information Criterion and BG shows the test result for the Breusch-Godfrey LM test for autocorrelation.

To control for heteroskedasticity problems, the OLS regression of Model 5 is then run with Newey-West standard errors. The OLS regression results regarding the current value coefficients can be found in Table 15 below. The complete regression results with all the lags can be found in the appendix, Table A5. In general, the coefficients have not changed considerably from the previous models. What is interesting to consider are the interaction terms. First, government revenues in a time of crisis are no longer statistically significant, the magnitude has also decreased. Second, government debt in a time of crisis has switched signs, making the interaction term economically significant. Because, in a Ricardian world, if government debt increases, households anticipate higher future taxes and start saving more. Thus, as a consequence, they decrease consumption. The interaction terms have also increased in magnitude, but it is still not statistically significant. Third, government contributions during a crisis have slightly decreased in magnitude but are still not statistically significant. The model in general is statistically significant at the 1% level since the F-statistic's p-value is 0.000. The adjusted R-squared has decreased slightly from 69.98% to 69.37% when comparing Model 4 to Model 5.

**Table 15: Model 5 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001 (0.002) | 0.67 | .504 |
| Disposable income$_t$ | 0.024 (0.045) | 0.54 | .593 |
| Government expenditure$_t$ | -0.062 (0.076) | -0.82 | .417 |
| Household wealth$_t$ | 0.003*** (0.001) | 3.64 | .001 |
| Government revenue$_t$ | -0.016 (0.066) | -0.24 | .814 |
| Government debt$_t$ | -0.045 (0.034) | -1.32 | .191 |
| Government contributions$_t$ | -0.193 (0.246) | -0.78 | .437 |
| Crisis * Government revenue$_t$ | -0.105 (0.147) | -0.71 | .479 |
| Crisis * Governement debt$_t$ | -0.229 (0.161) | -1.42 | .161 |
| Crisis * Government contributions$_t$ | 0.249 (0.347) | 0.72 | .477 |
| R-squared | | | 0.8100 |
| Adjusted R-squared | | | 0.6937 |
| F-test | | | 368.37 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -517.267 |
| Number of Observations | | | 80 |

*Notes: these results are based on an ARDL model with three lags. The ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*

To find out whether the Dutch consumers behave in a more Ricardian manner when government debt is above the European ceiling, F- and t-test has been performed for Model 5. The results are presented below in Table 16. The F-test for joint significance has a p-value of 0.313, which is higher than the 5% significance level. Therefore, the null hypothesis cannot be rejected. This might be evidence of Ricardian behaviour among Dutch consumers. Regarding the t-tests, for all three interaction terms, the p-values are above the 5% significance level. Thus, the null hypotheses of the t-tests cannot be rejected either. Together with the findings of the F-test, it could be argued that the Dutch consumer behaves in a Ricardian manner when government debt is higher than 60% of the GDP. However, since all the variables tested were not significant when running the OLS regression, it could also be that the lack of data makes it seem like the data is consistently zero.

**Table 16: Results of the test statistics for Model 5**

| Variable | F-test | t-test | p-value |
|---|---|---|---|
| Joint significance | 1.19 | | 0.31 |
| Crisis * Government revenue | | -0.71 | 0.48 |
| Crisis * Government debt | | 1.42 | 0.16 |
| Crisis * Government contributions | | 0.72 | 0.48 |

*Note: the joint significance F-test was run only for the following three variables: government revenue, government debt, and government contributions.*

# 4 Conclusion and Discussion

To conclude and discuss my research, I am going to start by summarizing the main findings of the five models that I have worked with. Model 1 introduced the basic estimation of consumption in the Netherlands. Even though three of the six coefficients were not statistically significant, the model itself was significant and the adjusted R-squared had a value of 93.54%, which can be considered high. The p-value of the F-test for joint significance was above the 5% significance threshold, therefore the null hypothesis could not be rejected. The p-values of the t-tests for government revenue and government contributions were above the 5% significance level as well. However, the p-value for the t-test of government debt was below the 5% significance value, thus, the null hypotheses was rejected. Indicating that this variable still has an effect on Dutch consumption. Model 2 introduced the basic estimation with GFC dummy interaction terms. The three dummy variables were not statistically significant. The p-value of the T-test was above the 5% significance threshold, thus, the null hypothesis could not be rejected. The results of the t-tests were above the 5% significance level for the three interaction terms, indicating proof of Ricardian behavior among Dutch consumers during the GFC.

Model 1 was adapted to Model 3 by taking the first differences. The F-test and the t-tests for government revenue and government contributions could not reject the null hypothesis, thus possibly showing evidence for the Ricardian equivalence. Model 2 was also adapted to Model 4 by first-differencing. As a whole, the coefficients became more economically significant than before. And, the GFC and government revenue interaction term became statistically significant. Now for both the F- and the t-tests, the null hypotheses for the interaction terms between crisis and government debt, and crisis and government contributions could not be rejected. Thus, there might be evidence of Ricardian behavior during the GFC.

Finally, Model 5 was created by changing Model 2 and Model 4's definition of 'financial crisis' to 'quarters in which the Netherlands had government debt at a higher level than the European ceiling of 60% of GDP'. The new interaction terms are not statistically significant, but in a sense, they are more economically significant, even though one would expect them to not influence in a Ricardian world. The F- and t-tests turn out to support this last statement because all the p-values were higher than the 5% significance level. Thus, like in the previously discussed models, there might be evidence of Ricardian behavior during a financial crisis. In conclusion, when taking all these findings into account, especially the ones from Models 1 and 3 one cannot reject the first hypothesis:

*Hypothesis 1: The Dutch consumer behaves in a Ricardian manner.*

However, that does not mean that the hypothesis is accepted either. Even though the results seem to lean towards Ricardian behavior among the Dutch consumers, especially the results of Model 3, the number of observations is too limited to be able to make definitive conclusions. Nevertheless, when taking the findings of models 2, 4, and 5 into account, the second hypothesis can be rejected:

*Hypothesis 2: Dutch consumers become more Ricardian during a financial crisis.*

Since the findings of Models 2 and 5 state that the interaction terms with crisis dummy variables seem to not affect Dutch consumption, one might be inclined to conclude that the Dutch consumer becomes more Ricardian during a financial crisis. But, since the first hypothesis was not rejected, I cannot conclude whether the Dutch consumer becomes *more* Ricardian or not. Because, with these results, I can merely argue that the Dutch consumer both behaves in a Ricardian manner during a financial crisis as during 'normal times'.

As mentioned before, the biggest limitation of this research is the lack of data, which caused few coefficients to be statistically significant. However, I exhausted all the data that was available to me to find the largest amount of data points, which was from 1999 to 2019. Working with data from 2020 and 2021 would have been unwise due to the covid-19 pandemic that was, and is still, taking place during these years. A pandemic has a big effect on savings and other macroeconomic factors, which would have made estimation different and possibly harder. Besides, data on 2020 and 2021 would have been predictive estimations, rather than actual data.

Another limitation has to do with the representativeness of the Dutch consumer in my research. Heijdra and Van Dalen (1996) incorporated habit formation and durability of consumption into their model, this was done because they found these to be character traits of Dutch consumers. My research did not incorporate this into the consumption functions utilized, therefore the equations might not have incorporated all the aspects that determine the Dutch consumption patterns. On the topic of missing control variables, this research did also not use instrumental variables. Therefore, there is always the possibility of omitted variable bias still being present in the equations used. Nevertheless, Modigliani (1990) researched the Ricardian equivalence by applying three different methods: instrumental variables, OLS, and first-order auto-regression, and found that the results for all three were quite similar. Therefore, I wonder whether adding an instrumental variable would have affected my findings.

When taking the limitations into account, together with the results of my empirical research, and the main findings from my literature review, I can answer the main question of my research:

*“Did the government’s financial choices have an effect on Dutch household consumption between 1999 and 2019?”*

The Dutch government’s financial choices did have an effect on Dutch private consumption between 1999 and 2019. Even though the results from my empirical research seem to lean towards the existence of Ricardian behavior among Dutch consumers, due to the lack of data points I believe my F- and t-tests were biased. The data is not precise enough, therefore coefficients could persistently appear to have been zero. Thus, suggesting that there is no affect on consumption, even though there probably is. Besides, in my empirical literature section, I found little evidence in past research for Dutch consumers to be Ricardian, rather than Keynesian. And, when researching the theoretical aspects of the Ricardian equivalence, I found that the assumptions of the theory are generally viewed as ‘too strict to hold in the real world’.

Nevertheless, as explained by Reiss (2013), even though a model does not show a perfect representation of the world it studies or explains, one can still learn from its findings. Because even though my findings know to have some serious limitations, the idea that my results suggest Ricardian behavior to be fitting in the Netherlands offers some interesting policy implications. Because, if Ricardian equivalence holds in the current Dutch population, then the government has less influence on consumption than was thought to be possible. Perhaps, the consumption stagnating during the beginning of the covid-19 pandemic, even though the government kept stimulating the economy through expansionary fiscal policies (CBS, 2021), has something to do with a Ricardian incline of Dutch consumers.

This last point brings me to the final part of my research, the suggestions for future studies. Suggestions for future research naturally flow from the main limitations of my research. Therefore the first suggestion concerns the limited number of data points that were available to me. For future studies, it would be nice to research more years, and maybe have a look at the effects of the covid-19 pandemic on Ricardian behavior, or perhaps even work with monthly instead of quarterly data. A different way to get more data points is by simply introducing more countries to the research, thus rather working with a cross-sectional than with a time series dataset. It could be interesting to compare countries with similar levels of debt to the Netherlands, like Germany, Denmark, and Sweden. Or do the opposite and comparing the Netherlands to the South-European periphery, thus countries like Spain, Portugal, and Italy. Besides this, Nickel and Vansteenkiste (2008) inspire a different avenue for future research, as they found evidence for the Ricardian equivalence when countries had a debt to GDP ratio of 90%. I only researched for levels above 60%, so it could be an idea to have a look at higher levels of debt to maybe find proof of Ricardian behavior during a crisis.

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# Appendix

**Table A1: Model 1 complete OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 10.321*** | 10.38 | 0.000 |
| Household consumption$_{t-1}$ | -0.133*<br>(0.075) | -1.77 | 0.084 |
| Household consumption$_{t-2}$ | -0.495***<br>(0.087) | -5.69 | 0.000 |
| Household consumption$_{t-3}$ | -0.237***<br>(0.088) | -2.69 | 0.010 |
| Household consumption$_{t-4}$ | 0.238***<br>(0.063) | 3.81 | 0.000 |
| Disposable income | -0.030<br>(0.031) | -0.96 | 0.342 |
| Disposable income$_{t-1}$ | 0.057***<br>(0.016) | 3.66 | 0.001 |
| Disposable income$_{t-2}$ | 0.037**<br>(0.014) | 2.67 | 0.011 |
| Disposable income$_{t-3}$ | 0.029**<br>(0.013) | 2.25 | 0.03 |
| Disposable income$_{t-4}$ | 0.097***<br>(0.036) | 2.71 | 0.009 |
| Government expenditure | -0.074*<br>(0.042) | -1.75 | 0.086 |
| Government expenditure$_{t-1}$ | -0.026<br>(0.041) | -0.62 | 0.537 |
| Government expenditure$_{t-2}$ | 0.014<br>(0.050) | 0.29 | 0.774 |
| Government expenditure$_{t-3}$ | 0.032<br>(0.029) | 1.09 | 0.283 |
| Government expenditure$_{t-4}$ | 0.058<br>(0.045) | 1.29 | 0.202 |
| Household wealth | 0.004***<br>(0.001) | 6.59 | 0.000 |
| Household wealth$_{t-1}$ | -0.002***<br>(0.001) | -2.84 | 0.007 |
| Household wealth$_{t-2}$ | 0.002**<br>(0.001) | 2.04 | 0.047 |
| Household wealth$_{t-3}$ | 0.000<br>(0.001) | -0.61 | 0.542 |
| Household wealth$_{t-4}$ | 0.003***<br>(0.000) | 5.78 | 0.000 |
| Government revenue | 0.015<br>(0.052) | 0.29 | 0.774 |
| Government revenue$_{t-1}$ | 0.034<br>(0.055) | 0.62 | 0.541 |
| Government revenue$_{t-2}$ | -0.065<br>(0.052) | -1.25 | 0.220 |
| Government revenue$_{t-3}$ | -0.053<br>(0.036) | -1.49 | 0.143 |
| Government revenue$_{t-4}$ | -0.015<br>(0.038) | -0.38 | 0.704 |
| Government debt | -0.046**<br>(0.021) | -2.21 | 0.033 |

| | | | |
|---|---|---|---|
| Government debt$_{t-1}$ | -0.068***<br>(0.021) | -3.21 | 0.002 |
| Government debt$_{t-2}$ | 0.027<br>(0.044) | 0.61 | 0.544 |
| Government debt$_{t-3}$ | -0.015<br>(0.037) | -0.40 | 0.695 |
| Government debt$_{t-4}$ | -0.031<br>(0.027) | -1.14 | 0.262 |
| Government contributions | -0.150<br>(0.137) | -1.09 | 0.28 |
| Government contributions$_{t-1}$ | 0.440***<br>(0.137) | 3.21 | 0.002 |
| Government contributions$_{t-2}$ | -0.043<br>(0.157) | -0.27 | 0.785 |
| Government contributions$_{t-3}$ | 0.166<br>(0.132) | 1.26 | 0.215 |
| Government contributions$_{t-4}$ | 0.021<br>(0.089) | 0.23 | 0.816 |
| R-squared | | | 0.9632 |
| Adjusted R-squared | | | 0.9354 |
| F-test | | | 1226.480 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -592.697 |
| Number of observations | | | 80.000 |

*Notes: the ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms.*

## Table A2: Model 2 complete OLS regression output

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 10.603***<br>(1.109) | 9.56 | 0.000 |
| Household consumption$_{t-1}$ | -0.154*<br>(0.081) | -1.89 | 0.065 |
| Household consumption$_{t-2}$ | -0.504***<br>(0.088) | -5.75 | 0.000 |
| Household consumption$_{t-3}$ | -0.254**<br>(0.112) | -2.28 | 0.028 |
| Household consumption$_{t-4}$ | 0.232***<br>(0.064) | 3.63 | 0.001 |
| Disposable income | -0.03<br>(0.033) | -0.90 | 0.371 |
| Disposable income$_{t-1}$ | 0.059***<br>(0.016) | 3.78 | 0.000 |
| Disposable income$_{t-2}$ | 0.038**<br>(0.015) | 2.51 | 0.016 |
| Disposable income$_{t-3}$ | 0.031**<br>(0.014) | 2.24 | 0.031 |
| Disposable income$_{t-4}$ | 0.099**<br>(0.040) | 2.45 | 0.018 |
| Government expenditure | -0.070<br>(0.045) | -1.53 | 0.133 |
| Government expenditure$_{t-1}$ | -0.030<br>(0.044) | -0.68 | 0.500 |

| | | | |
|---|---|---|---|
| Government expenditure$_{t-2}$ | 0.015 (0.053) | 0.29 | 0.773 |
| Government expenditure$_{t-3}$ | 0.035 (0.030) | 1.15 | 0.256 |
| Government expenditure$_{t-4}$ | 0.053 (0.051) | 1.04 | 0.306 |
| Household wealth | 0.004*** (0.001) | 3.55 | 0.001 |
| Household wealth$_{t-1}$ | -0.002** (0.001) | -2.22 | 0.032 |
| Household wealth$_{t-2}$ | 0.001 (0.001) | 0.97 | 0.340 |
| Household wealth$_{t-3}$ | 0.001 (0.002) | 0.34 | 0.734 |
| Household wealth$_{t-4}$ | 0.002 (0.002) | 1.12 | 0.271 |
| Government revenue | 0.012 (0.056) | 0.21 | 0.831 |
| Government revenue$_{t-1}$ | 0.038 (0.054) | 0.71 | 0.485 |
| Government revenue$_{t-2}$ | -0.064 (0.052) | -1.24 | 0.221 |
| Government revenue$_{t-3}$ | -0.059 (0.038) | -1.56 | 0.127 |
| Government revenue$_{t-4}$ | -0.004 (0.043) | -0.09 | 0.929 |
| Government debt | -0.045 (0.073) | -0.61 | 0.546 |
| Government debt$_{t-1}$ | -0.075* (0.038) | -1.97 | 0.056 |
| Government debt$_{t-2}$ | 0.032 (0.052) | 0.62 | 0.537 |
| Government debt$_{t-3}$ | -0.015 (0.040) | -0.36 | 0.721 |
| Government debt$_{t-4}$ | -0.031 (0.027) | -1.16 | 0.254 |
| Government contributions | -0.128 (0.143) | -0.90 | 0.375 |
| Government contributions$_{t-1}$ | 0.417*** (0.150) | 2.79 | 0.008 |
| Government contributions$_{t-2}$ | -0.035 (0.155) | -0.23 | 0.823 |
| Government contributions$_{t-3}$ | 0.166 (0.143) | 1.17 | 0.251 |
| Government contributions$_{t-4}$ | 0.023 (0.104) | 0.22 | 0.828 |
| Crisis * Government revenue | -0.071 (0.321) | -0.22 | 0.827 |
| Crisis * Government debt | 0.005 (0.011) | 0.41 | 0.682 |
| Crisis * Government contributions | 0.068 (0.334) | 0.20 | 0.839 |
| R-squared | | | 0.964 |
| Adjusted R-squared | | | 0.932 |
| F-test | | | 6119.79 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -587.509 |

| Number of Observations | 80 |
|---|---|

*Notes: the ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms.*

**Table A3: Model 3 OLS regression output**

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001<br>(0.002) | 0.49 | .623 |
| Household consumption$_{t-1}$ | -0.437***<br>(0.132) | -3.30 | .002 |
| Household consumption$_{t-2}$ | -0.676***<br>(0.111) | -6.08 | 0 |
| Household consumption$_{t-3}$ | -0.378**<br>(0.145) | -2.60 | .012 |
| Disposable income$_t$ | 0.036<br>(0.043) | 0.85 | .397 |
| Disposable income$_{t-1}$ | 0.04<br>(0.039) | 1.01 | .316 |
| Disposable income$_{t-2}$ | 0.021<br>(0.034) | 0.62 | .54 |
| Disposable income$_{t-3}$ | 0.008<br>(0.040) | 0.19 | .848 |
| Government expenditure$_t$ | -0.048<br>(0.080) | -0.59 | .556 |
| Government expenditure$_{t-1}$ | -0.038<br>(0.073) | -0.52 | .608 |
| Government expenditure$_{t-2}$ | -0.014<br>(0.087) | -0.16 | .875 |
| Government expenditure$_{t-3}$ | 0.052<br>(0.088) | 0.59 | .559 |
| Household wealth$_t$ | 0.003***<br>(0.001) | 4.39 | 0 |
| Household wealth$_{t-1}$ | -0.001<br>(0.001) | -0.87 | .386 |
| Household wealth$_{t-2}$ | 0.002*<br>(0.001) | 1.82 | .075 |
| Household wealth$_{t-3}$ | 0.000<br>(0.001) | 0.32 | .75 |
| Government revenue$_t$ | -0.028<br>(0.076) | -0.36 | .717 |
| Government revenue$_{t-1}$ | -0.002<br>(0.088) | -0.03 | .979 |
| Government revenue$_{t-2}$ | 0.020<br>(0.058) | 0.35 | .728 |
| Government revenue$_{t-3}$ | -0.03<br>(0.070) | -0.43 | .671 |
| Governement debt$_t$ | -0.050<br>(0.032) | -1.57 | .123 |
| Governement debt$_{t-1}$ | -0.091**<br>(0.039) | -2.36 | .022 |
| Governement debt$_{t-2}$ | -0.056<br>(0.035) | -1.59 | .118 |

| | | | |
|---|---|---|---|
| Governement debt$_{t-3}$ | -0.036<br>(0.038) | -0.96 | .34 |
| Government contributions$_{t}$ | -0.115<br>(0.199) | -0.58 | .566 |
| Government contributions$_{t-1}$ | 0.282*<br>(0.144) | 1.96 | .055 |
| Government contributions$_{t-2}$ | -0.06<br>(0.216) | -0.28 | .784 |
| Government contributions$_{t-3}$ | 0.377***<br>(0.129) | 2.94 | .005 |
| R-squared | | | 0.797 |
| Adjusted R-squared | | | 0.692 |
| F-test | | | 246.51 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -517.947 |
| Number of observations | | | 80.000 |

*Notes: the ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*

### Table A4: Model 4 complete OLS regression output

| Dependent: Household consumption$_{t}$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001<br>(0.001) | 0.76 | 0.452 |
| Household consumption$_{t-1}$ | -0.424***<br>(0.135) | -3.13 | 0.003 |
| Household consumption$_{t-2}$ | -0.656***<br>(0.116) | -5.65 | 0.000 |
| Household consumption$_{t-3}$ | -0.356**<br>(0.150) | -2.37 | 0.022 |
| Disposable income$_{t}$ | 0.056<br>(0.044) | 1.26 | 0.214 |
| Disposable income$_{t-1}$ | 0.062<br>(0.043) | 1.46 | 0.152 |
| Disposable income$_{t-2}$ | 0.041<br>(0.036) | 1.13 | 0.266 |
| Disposable income$_{t-3}$ | 0.025<br>(0.042) | 0.58 | 0.563 |
| Government expenditure$_{t}$ | -0.103<br>(0.076) | -1.37 | 0.177 |
| Government expenditure$_{t-1}$ | -0.063<br>(0.068) | -0.92 | 0.362 |
| Government expenditure$_{t-2}$ | -0.034<br>(0.085) | -0.40 | 0.691 |
| Government expenditure$_{t-3}$ | 0.028<br>(0.086) | 0.33 | 0.744 |
| Household wealth$_{t}$ | 0.004***<br>(0.001) | 4.90 | 0.000 |
| Household wealth$_{t-1}$ | -0.002*<br>(0.001) | -1.82 | 0.075 |
| Household wealth$_{t-2}$ | 0.002*<br>(0.001) | 1.86 | 0.068 |
| Household wealth$_{t-3}$ | 0.002*<br>(0.001) | 1.74 | 0.089 |

| | | | |
|---|---|---|---|
| Government revenue$_t$ | 0.008<br>(0.057) | 0.14 | 0.886 |
| Government revenue$_{t-1}$ | -0.007<br>(0.084) | -0.09 | 0.931 |
| Government revenue$_{t-2}$ | 0.004<br>(0.060) | 0.06 | 0.952 |
| Government revenue$_{t-3}$ | -0.022<br>(0.070) | -0.32 | 0.751 |
| Government debt$_t$ | -0.027<br>(0.066) | -0.41 | 0.682 |
| Government debt$_{t-1}$ | -0.140**<br>(0.063) | -2.20 | 0.032 |
| Government debt$_{t-2}$ | -0.050<br>(0.035) | -1.43 | 0.158 |
| Government debt$_{t-3}$ | -0.035<br>(0.039) | -0.88 | 0.385 |
| Government contributions$_t$ | -0.111<br>(0.188) | -0.59 | 0.557 |
| Government contributions$_{t-1}$ | 0.287**<br>(0.140) | 2.05 | 0.046 |
| Government contributions$_{t-2}$ | -0.055<br>(0.209) | -0.26 | 0.794 |
| Government contributions$_{t-3}$ | 0.299*<br>(0.153) | 1.95 | 0.057 |
| Crisis * Government revenue | -0.475**<br>(0.197) | -2.42 | 0.019 |
| Crisis * Government debt | 0.067<br>(0.075) | 0.89 | 0.375 |
| Crisis * Government contributions | 0.370<br>(0.464) | 0.80 | 0.429 |
| R-squared | | | 0.8138 |
| Adjusted R-squared | | | 0.6998 |
| F-test | | | 477.57 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -518.880 |
| Number of Observations | | | 80 |

*Notes: the ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*

### Table A5: Model 5 complete OLS regression output

| Dependent: Household consumption$_t$ | (1) | (2) | (3) |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-value** | **p-value** |
| Constant | 0.001<br>(0.002) | 0.67 | .504 |
| Household consumption$_{t-1}$ | -0.432***<br>(0.126) | -3.44 | .001 |
| Household consumption$_{t-2}$ | -0.677***<br>(0.117) | -5.80 | 0 |
| Household consumption$_{t-3}$ | -0.364**<br>(0.150) | -2.42 | .019 |
| Disposable income$_t$ | 0.024<br>(0.045) | 0.54 | .593 |
| Disposable income$_{t-1}$ | 0.027<br>(0.044) | 0.61 | .544 |

| | | | |
|---|---|---|---|
| Disposable income$_{t-2}$ | 0.012<br>(0.041) | 0.28 | .778 |
| Disposable income$_{t-3}$ | -0.003<br>(0.048) | -0.06 | .949 |
| Government expenditure$_{t}$ | -0.062<br>(0.076) | -0.82 | .417 |
| Government expenditure$_{t-1}$ | -0.044<br>(0.067) | -0.66 | .511 |
| Government expenditure$_{t-2}$ | -0.03<br>(0.083) | -0.36 | .723 |
| Government expenditure$_{t-3}$ | 0.053<br>(0.085) | 0.62 | .536 |
| Household wealth$_{t}$ | 0.003***<br>(0.001) | 3.64 | .001 |
| Household wealth$_{t-1}$ | -0.001<br>(0.001) | -1.37 | .176 |
| Household wealth$_{t-2}$ | 0.001<br>(0.001) | 1.24 | .22 |
| Household wealth$_{t-3}$ | 0.000<br>(0.001) | -0.36 | .723 |
| Government revenue$_{t}$ | -0.016<br>(0.066) | -0.24 | .814 |
| Government revenue$_{t-1}$ | 0.012<br>(0.084) | 0.15 | .883 |
| Government revenue$_{t-2}$ | 0.040<br>(0.056) | 0.73 | .472 |
| Government revenue$_{t-3}$ | -0.028<br>(0.067) | -0.42 | .679 |
| Government debt$_{t}$ | -0.045<br>(0.034) | -1.32 | .191 |
| Government debt$_{t-1}$ | -0.103**<br>(0.047) | -2.20 | .033 |
| Government debt$_{t-2}$ | -0.062<br>(0.041) | -1.52 | .135 |
| Government debt$_{t-3}$ | -0.03<br>(0.039) | -0.76 | .449 |
| Government contributions$_{t}$ | -0.193<br>(0.246) | -0.78 | .437 |
| Government contributions$_{t-1}$ | 0.222<br>(0.164) | 1.35 | .182 |
| Government contributions$_{t-2}$ | -0.086<br>(0.204) | -0.42 | .675 |
| Government contributions$_{t-3}$ | 0.425<br>(0.127) | 3.34 | .002 |
| Crisis * Government revenue$_{t}$ | -0.105<br>(0.147) | -0.71 | .479 |
| Crisis * Governement debt$_{t}$ | -0.229<br>(0.161) | -1.42 | .161 |
| Crisis * Government contributions$_{t}$ | 0.249<br>(0.347) | 0.72 | .477 |
| R-squared | | | 0.8100 |
| Adjusted R-squared | | | 0.6937 |
| F-test | | | 368.37 |
| Prob(F-statistic) | | | 0.000 |
| AIC | | | -517.267 |
| Number of Observations | | | 80 |

*Notes: the ARDL model is estimated with OLS using Newey-West standard errors. Standard errors are within brackets. *, **, *** represent the significance levels of 10, 5, and 1 percent respectively. All variables are in logarithms and first-differenced.*