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Of Haircuts and Extensions: An Analysis of Greek Government Debt[1]

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Abstract

In light of the current negotiations concerning the Greek debt, this paper conducts a valuation analysis based on the Present Value (PV) method. We explain the rationale for the PV method and use it to model a simplified representation of the Greek debt situation. We illustrate the effects of changes in the variables in the PV function and show that if the Greek loan interest rate was decreased by 50 basis points and the maturity of the debt was extended from 30 to 50 years, the effect would be equivalent to a haircut of roughly 59%.

The Greek Government Debt crisis of the early 2010's has served as a microcosm of the various political, economic and social factors at play as the world emerges from the Great Recession. It has served as a battleground for future Eurozone policies, European integration and global monetary policy. Sparked by events across the Atlantic, Greece's attempts to improve its fiscal situation represent the greater challenges and decisions that sovereigns and their creditors face today.

The financial problems arising from the housing crisis were not limited to the US, as the interlinked global financial system caused many of these multinational companies to spread the problem overseas, aided by heavy investment from China and Europe into the US housing market, directly or indirectly through mortgage-backed securities (Holt, 2009). Eurozone countries were ostensibly able to weather any financial storm, with the strict restrictions of the Maastricht Treaty keeping long-term interest rates, inflation, debt-to-GDP ratios, and budget deficits within certain ranges (EC, 2014). However some countries, including Greece, had benefited from their ascension into the Eurozone with lower interest rates than they normally would have received. Taking advantage of this situation, Greece borrowed heavily in the run-up to the financial crises, limiting their borrowing capabilities during the recession. Greece ran huge budget deficits from 2004-2009, rapidly expanding the public sector and increasing government spending (Ministry of Finance, 2010). Bolstered by a steadily growing economy and low Eurozone interest rates, Greece consistently used a fiscal policy that bumped up against the edges of the Maastricht criteria, even utilizing swaps and other forms of creative accounting to artificially keep themselves within the agreed bands (Balzli, 2010).

After the financial crisis spread to Greece, its fiscal policy began to unravel. With the Greek economy quickly contracting, the European Union began to investigate as concerns grew about the need for a possible bailout. Eurostat accused Greece of manipulating data which, combined with the announcement of the Greek government that its projected 2009 budget deficit was being revised upwards from 3.7% to a staggering 12.5%, caused the bond markets to respond quickly (White, 2010). By April 2010, Greece's credit rating had dropped to junk status and its short-term borrowing costs had risen to 14%, about 1,000 basis points higher than Germany's

[1] This paper is based on a study done by DZ BANK Research. We thank the authors of the study for their valuable input that helped us develop this teaching case.

(Wachman, 2010). With Greece now breaking multiple criteria for Eurozone financial stability, the EU and IMF began to consider emergency measures. This began with a €110 billion financial aid program in May 2010 funded mainly by Eurozone countries, followed by another €130 billion package finalized in February 2012 after austerity measures were passed by the Greek Parliament (Pratley, 2012). A key portion of this package was a bond swap agreed to by the Greek government and bondholders, reducing Greece's debt by trading €200 billion of Greek sovereign debt for a mixture of cash and long-term bonds, avoiding a sovereign default by Greece (Kollowe, 2012). Further negotiations have ensued with creditors over further loan relief, including a potential extension of loan maturities from 30 years to 50 years, along with lowering the interest rate on the loans by half a percentage point (Bloomberg, 2014).

Using the present value concept, which is a common approach to value investments in finance, this case study will show that the proposed maturity extension and the reduction of the interest rate is equivalent to cutting the original outstanding loan by approximately 59%. Section I will introduce the present value formula and its derivation, and discuss the formula for a finite series of cash flows in detail. Later on, in section II , we will apply this concept by taking a simplified version of the potential Greek debt haircut as an example. We will show that the actual debt burden would be decreased considerably, should a debt extension of the discussed form be implemented. Section III will summarize the results.

I. The Present Value Of Cash Flows

A. The time value of money

The present value (PV) is a standard concept in finance that determines today's value of a stream of cash flows that occur in the future. It takes into account that 100 euros received today have a different value from 100 euros to be received in the future. The reasons for this difference in values are, for example, inflation, risk, or an attractive investment opportunity that is forgone today because of a lack of capital. The 100 euros could be invested today and yield a positive return (i.e., a future value that is greater than the 100 euros) at the end of the investment period.

B. From compounding to discounting

The starting point for the PV is compound computation of interest. The 100 euros invested today at a rate of, say, 5% lead to a future value (FV) of 105 euros in one year's time:

$$FV = 100\,(1.05)^{1} = 105 \qquad (1)$$

Conversely today's value, the so-called present value (PV) of the 105 euros is

$$PV = \frac{105}{(1.05)^{1}} = 100 \qquad (2)$$

That is, the calculation of a present value is just undoing a compound interest calculation. This is called discounting. All other things equal, it is not hard to imagine how to compute the present value of a cash flow of 105 euros that occurs not in one but in two years' time:

$$PV = \frac{105}{(1.05)^2} = 95.24 \qquad (3)$$

The general formula for the present value of a cash flow in the future is thus

$$PV = \frac{CF_t}{(1+i_t)^t}, \qquad (4)$$

where PV: Present value of a future cash flow
CF_t: Cash flow occurring in time t
i_t: Interest rate applicable to period t, so-called discount factor

Please note the subscript *t* in the interest rate i, since interest rates might not be constant over the investment period. The choice of the applicable discount factor depends on the risk of the investment. For low-risk investments, the rates of return on government bonds can be used. If the risk is comparable to the risk of a portfolio of shares, stock market returns like that of the S&P 500 can be used. In either case, the risk of the investment which should be valued must be adequately captured by the discount factors.

The usage of the PV is not limited to the valuation of single cash flows. If we think of a whole series of future cash flows, we can add up all the individual present values and aggregate them into a single present value:

$$PV = \frac{CF_1}{(1+i_1)^1} + \frac{CF_2}{(1+i_2)^2} + \ldots + \frac{CF_T}{(1+i_T)^T} = \sum_{t=1}^{T} \frac{CF_t}{(1+i_t)^t} \qquad (5)$$

This present value gives us the value of all the cash flows that occur at different points in time in the future. In a nutshell, the PV helps to make cash flows from different points in time comparable to each other.

Let us now assume that we have taken out a 10-year loan of 10,000 euros with a yearly 5% interest rate. That means that we have to pay 500 euros in interest every year and redeem the borrowed amount of 10,000 euros in 10 years:

Table I: Interest payments and principal of a loan with maturity in 10 years

t	1	2	3	4	5	6	7	8	9	10
Interest	500	500	500	500	500	500	500	500	500	500
Redemption										10,000

Assume a constant interest rate of 10%. We can use the PV formula in Equation (5) to determine the total amount of money that we would have to set aside today for 10 years at a 10% interest rate in order to pay off the entire loan without further action:

$$PV = \frac{500}{(1.1)} + \frac{500}{(1.1)^2} + \ldots + \frac{500}{(1.1)^9} + \frac{10{,}500}{(1.1)^{10}} = 6{,}927.72 \qquad (6)$$

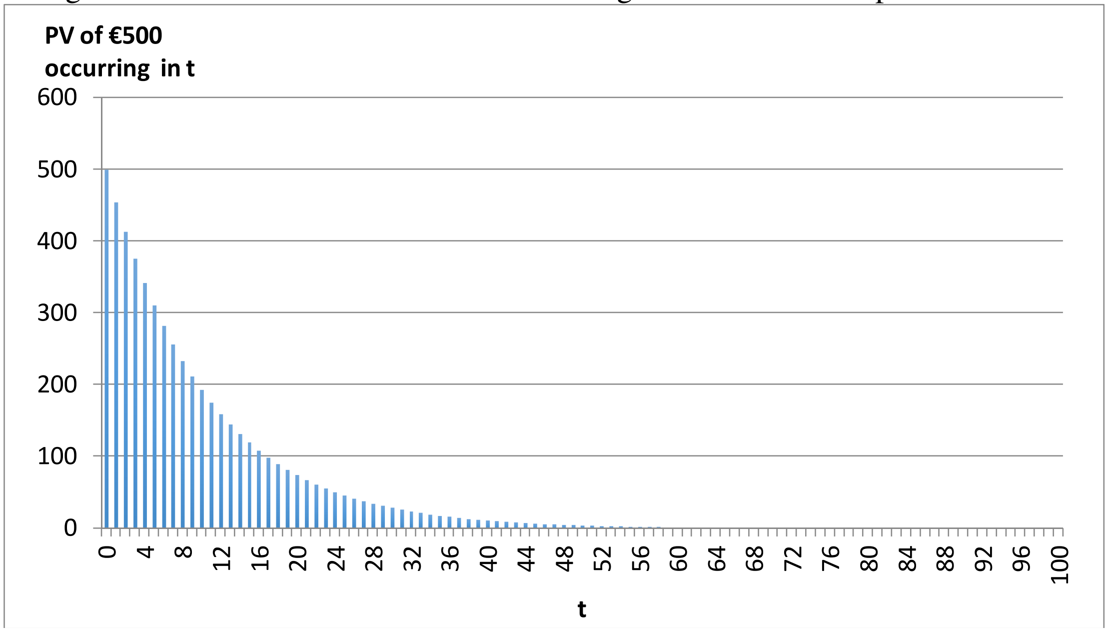
That is, if today we deposited an amount of 6,927.72 euros in an account that yields a 10% interest rate per year, we could entirely pay off the interest payments and the principal. To put it differently, we can say that the present value of 6,927.27 euros is the actual credit burden of the debtor.

Let us now assume a yearly interest payment of 500 euros over 100 years to understand the contribution that a single future cash flow makes to the whole PV: the further in the future a payment occurs, the less value it has today. Economically, this means that we have to save very little today to end up with 500 in the far future due to interest on interest over a long period of time. Mathematically, this is because we discount the 500 euros over many periods, which makes the denominator of the PV formula bigger and thus the whole fraction smaller the later the cash flow occurs. Equation (7) reports the amounts of money that would have to be deposited today to reach 500 euros in t years, e.g. 3.628 cents saved today will accumulate to 500 euros over a period of 100 years at an interest rate of 10%.

$$\begin{aligned} PV &= \frac{500}{(1.1)^1} = 454.55 \\ PV &= \frac{500}{(1.1)^2} = 413.22 \\ &\ldots \\ PV &= \frac{500}{(1.1)^{10}} = 192.77 \\ &\ldots \\ PV &= \frac{500}{(1.1)^{100}} = 0.03628 \end{aligned} \qquad (7)$$

Figure 1 shows the present values of 500 euros that occur at different future points in time t=1,…,100.

Figure 1: Present value of 500 euros occurring at different future points in time t



The present values of payments diminish quickly the further in the future they occur. These considerations help understand the effect of a longer term to maturity on the present value of the Greek debt, assuming for simplicity that the coupon that is to be discounted remains fixed.

II. Valuing THE Greek Debt

In this section, several scenarios of a potential loan relief are discussed, and their effects on the credit burden are analyzed. The debt burden – computed as the present value of all interest payments and the redemption of the principal of a loan – is a function of three variables: the cash flows, CF_t; the applicable discount factors, i_t; and the points in time, t, in which the payments occur. A change in any of these variables alters the present value, or, in our example, the amount of money that Greece would have to save today in order to service its loans. The effect on the credit burden will be discussed in the following subsections.

A. Valuing the Greek debt: The status quo

At the time of discussing the above mentioned debt reliefs, Greece had several loans with different maturities outstanding. For the sake of simplicity, we assume that the bailout loans have a principal of €240 billion, as reported by Reuters (2014), which mature in 30 years. In order to show the effects of a change in variables, we should keep our assumptions as simple as possible. We therefore assume the interest rate on the Greek debt to be 3%, which corresponds to a yearly interest payment of €240 billion x 0.03 = €7.2 billion. We modeled a curve of discount factors which is illustrated in Figure 2[2] and follow the common assumption of an upward-sloping yield curve of interest rates, as returns on securities normally tend to increase with maturities[3]. This assumption is discussed further in section II. B.2.

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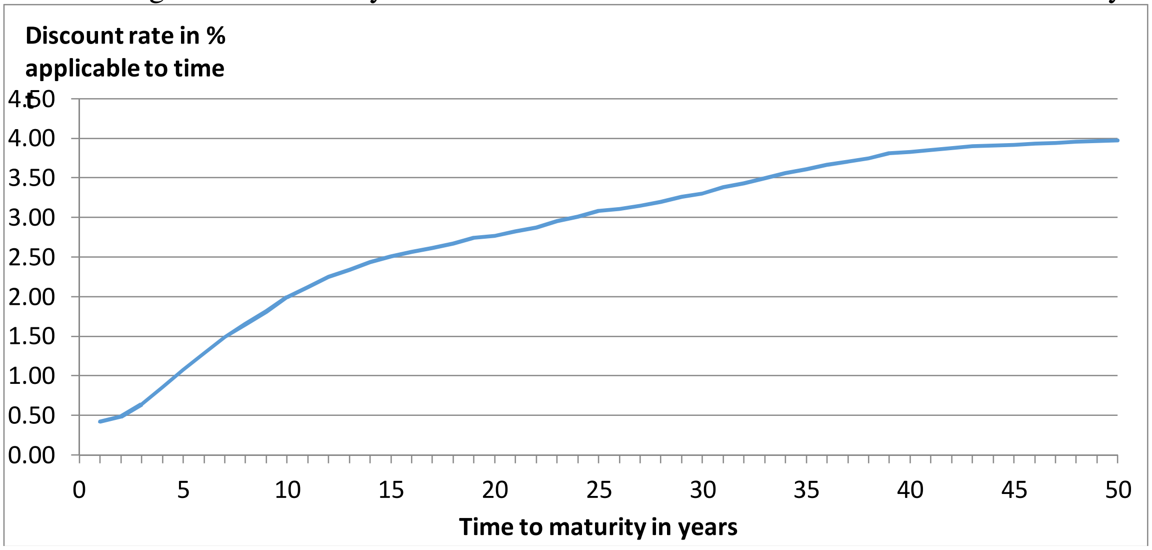
[2] Data and spreadsheet calculations available on request.

[3] This is often justified by the fact that investors require a so-called term premium for holding longer-term securities (e.g., Cox et al. (1985)).

Figure 2: Modeled yield curve of discount rates for different terms to maturity



These data define the base case. The present value, or the debt burden, of this loan is (in billions of euros):

$$PV = \frac{7.2}{(1.00420)} + \frac{7.2}{(1.00485)^2} + \frac{7.2}{(1.00640)^3} + \ldots + \frac{7.2 + 240}{(1.03300)^{30}} = 239.7 \quad (8)$$

If Greece saved €239.7 billion today, it could pay off its entire debt within 30 years.

B. Valuing the Greek debt: Scenario analysis

In this section, two effects should be analyzed: first, a decrease of 50 bps in the yearly coupon that Greece has to pay on the loan; second, a maturity extension of the Greek debt from 30 to 50 years. We will first show the separate effects in the following subsections, and combine them in a final subsection to show the overall effect. Table 2 summarizes the assumptions made in the scenarios.

Table 2: Summary of the assumptions made in each scenario

	N: Face value [billions of euros]	**c: Coupon rate** [percent]	**C: Coupon** [billions of euros]	**T: Maturity** [years]
Base case	240	3.00	7.20	30
Scenario 1 (II. B.1)	240	2.50	6.00	30
Scenario 2 (II. B.3)	240	3.00	7.20	50
Scenario 3 (II. B.4)	240	2.50	6.00	50

B.1 Scenario 1: The effect of a decrease in the coupon rate by 50 basis points

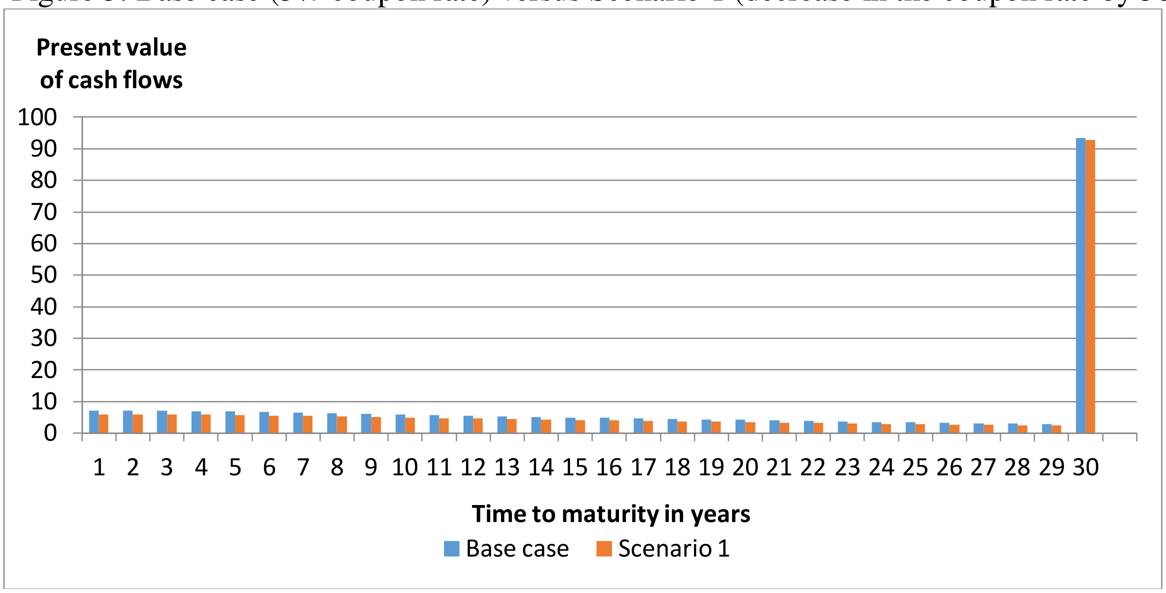
In the current debate on the extension of the Greek debt, one of the suggestions was to decrease the interest rate that Greece has to pay on the loan by 50 basis points (bps), or 0.5 percentage points.

If Greece has to pay only 2.5% interest on the outstanding loan and everything else remains unchanged, the debt burden is

$$PV = \frac{6}{(1.00420)} + \frac{6}{(1.00485)^2} + \frac{6}{(1.00640)^3} + \ldots + \frac{6+240}{(1.03300)^{30}} = 214.85. \quad (9)$$

That is, the original credit burden of €239.7 billion falls by roughly 10.37% if the yearly coupon is lowered by 50 bps. **Error! Reference source not found.** shows a comparison of the present values of the 30 coupon payments of the base case and the scenario discussed in this subsection. It is evident that the present values of the reduced payments are smaller than the original payments and that the credit burden (which is just the sum of the present values) is thus lower when less interest has to be paid.

Figure 3: Base case (3% coupon rate) versus Scenario 1 (decrease in the coupon rate by 50 bps)



B.2 The impact of the shape of the term structure of interest rates

The ideas in this subsection are not directly related to the case of Greece, since the discount rates are not affected by the potential loan extension. However, it is helpful to take a look at the shape of the term structure of interest rates, or yield curve, which is often used to value investments, in order to fully understand the effects of a loan extension on the PV of the loan.

If the interest rate for our bank account falls from 10% to 8%, then we have to save more money today in order to have a specific amount of money in the future, since the interest we receive on this amount of capital will be lower than expected. The same applies to loans and the debt burden: the lower the rate of return in the bank account, the more has to be laid aside today in order for the debtor to be able to pay back the loan in the future. Also, the later the principal has to be paid back, the higher is the interest rate at which this payment is discounted; and thus, the lower the value that has to be saved today.

The different rates of return on an investment, depending on the lifetime of the investment, are shown in the yield curve of interest rates, as depicted in Figure 2. In most cases, one can observe that interest rates increase with time (so-called 'normal' shape of the yield curve). This means that the longer our capital is tied up in an investment, the higher the returns should be. Only occasionally can a falling or 'inverse' yield curve be observed (in particular before recessions, e.g. Ang et. al, 2006; Cwik, 2005). Therefore, when there is a normal, upward-sloping yield curve, a cash flow that occurs at the so-called long end of the term structure has a lower value today than the same cash flow that occurs in the intermediate or short term because later payments are discounted at a higher interest rate.

B.3 Scenario 2: The effect of a loan extension to 50 years

In subsection B.1, the effect of a decrease in the yearly coupon that the Greek government has to pay on the loan was discussed. This of course causes a *decrease* in the credit burden. In this subsection, an extension of the loan to 50 years is discussed. Having to pay more coupon payments (namely 50 rather than 30) means an *increase* in the credit burden.

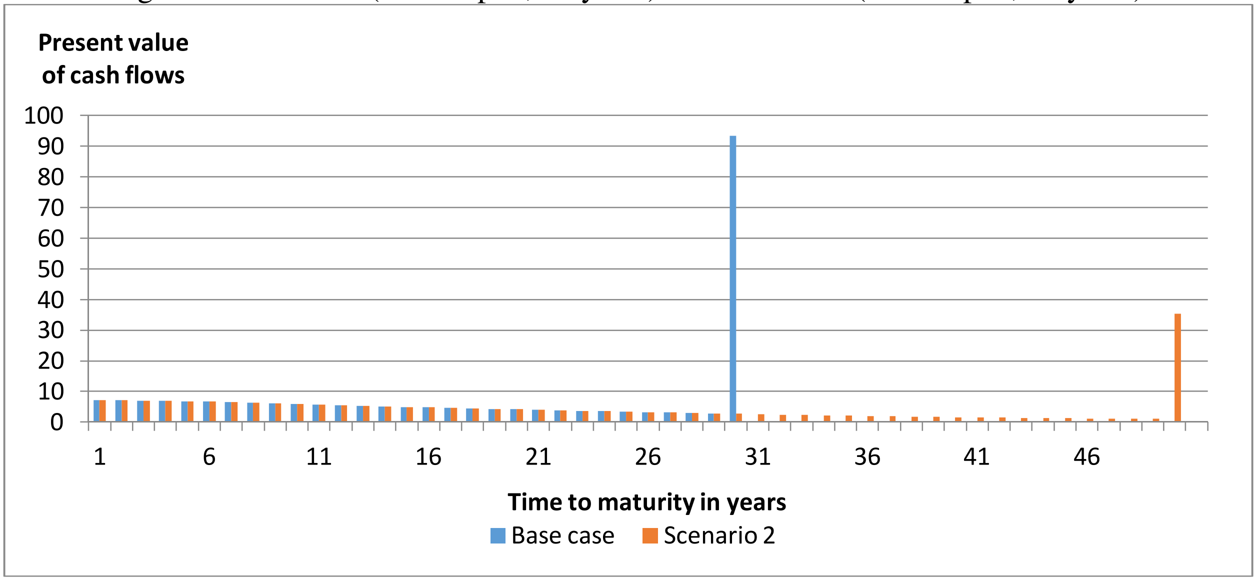
From the considerations in the previous subsection on changing discount factors (and assuming an upward-sloping yield curve) we know that longer terms to maturity come along with higher interest rates at the long end. That is, having to pay back the principal 20 years later does not only cause a decrease in the PV simply because of the fact that we discount over 20 more periods; it also decreases the PV because this very last, huge payment is discounted at a higher interest rate (3.97%) than when it was discounted in t=30 (3.3%). This additionally drives the PV down.

If we only assume that the outstanding loan is due in 50 rather than in 30 years, but leaving all other assumptions unchanged, the credit burden is

$$PV = \frac{7.2}{(1.00420)} + \frac{7.2}{(1.00485)^2} + .. + \frac{7.2}{(1.03300)^{30}} + ... + \frac{7.2 + 240}{(1.03970)^{50}} = 214.85 \quad (10)$$

That is, due to the higher number of interest payments (50 rather than 30) and more discounting, the credit burden decreased by roughly 9.7% compared to the status quo – even though 20 more interest payments have to be made. Note that an upward sloping yield curve is assumed to come to this conclusion. Figure 4 compares the present values of the coupon payments of the base case and this subsection's scenario.

Figure 4: Base case (3% coupon, 30 years) vs. Scenario 2 (3% coupon, 50 years)



The results would be different in the case of a downward-sloping yield curve. Then it would be disadvantageous for the debtor to move the face value of the loan into the future since the interest rates at which the face value was discounted would be very low. As a consequence, the discounted face value would be higher and the debtor would have to save more today in order to pay back the face value in the future. However, whether or not the sum of *all* payments would be higher than in the base case is not clear without knowing the concrete yield curve, since the NPV depends on the difference between the interest rates at the short end and the long end.

B.4 Scenario 3: The combined effect on the credit burden

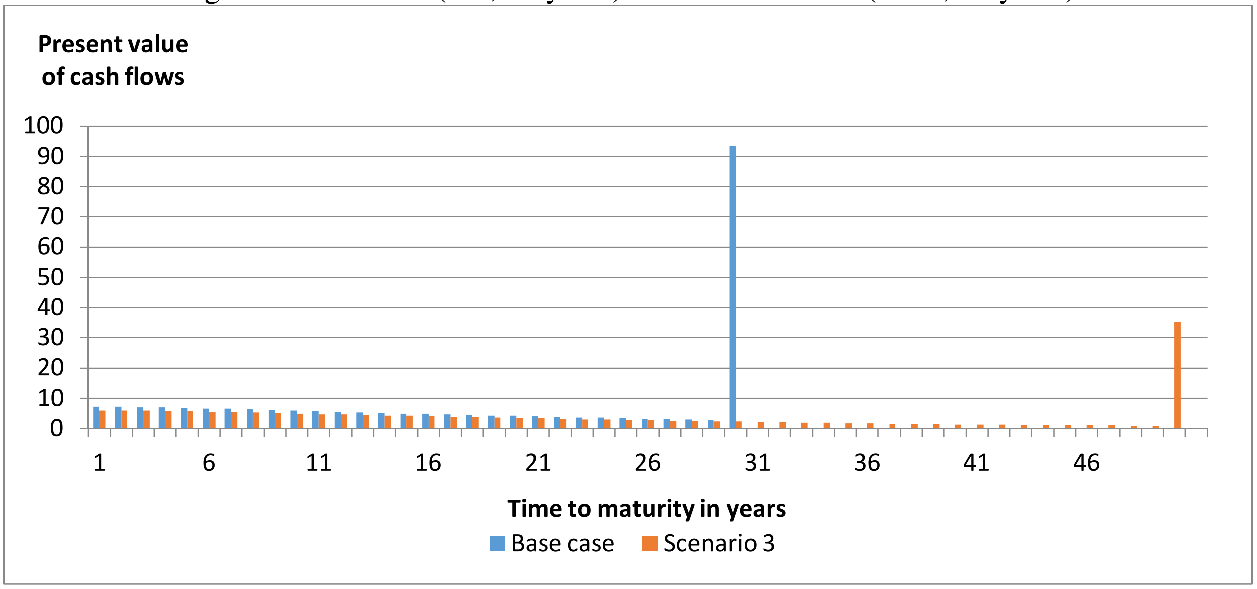
To see the full effect when the previous assumptions are combined, we compute the present value of the Greek loans, taking together all the manipulations from the previous subsections, i.e., decreasing the coupon rate by 50 bps and extending the maturity to 50 years. The debt burden for this scenario is

$$PV = \frac{6}{(1.00420)} + \frac{6}{(1.00485)^2} + .. + \frac{6}{(1.03300)^{30}} + ... + \frac{6+240}{(1.03970)^{50}} = 186.08 \qquad (11)$$

This is equivalent to a reduction of the original credit burden by more than 22%. The base case is graphically compared to this scenario in

Figure **5**.

Figure 5: Base case (3%, 30 years) versus Scenario 3 (2.5%, 50 years)



C. The haircut

In the introduction we posited that the scenario in which the coupon rate is only 2.5% and the maturity is extended to 50 years leads to the same credit burden as a haircut of the original loan of roughly 59%. To come to this conclusion, we just have to solve the following equation[4] for X:

$$186.08 = \frac{7.2}{(1.00420)} + \frac{7.2}{(1.00485)^2} + .. + \frac{7.2 + X}{(1.03300)^{30}} \quad (12)$$

Equation (12) allows us to compute the principal X that leads to the same credit burden as the combined scenario. Note that this is still the status quo except for the principal X which we are trying to compute.

Solving the above equation for X leads to a principal X of €97.994 billion. That is, if the Greek debt – as it is currently outstanding – had a principal of only €97.994 billion while the euro interest payments remained unchanged, this would be equivalent to the scenario of an interest rate decrease and a maturity extension:

$$186.08 = \frac{7.2}{(1.00420)} + \frac{7.2}{(1.00485)^2} + .. + \frac{7.2 + 97.994}{(1.03300)^{30}} \quad (13)$$

That is, these two measures together – i.e. a decrease in the coupon rate of 50 bps and a loan extension to 50 years – lead to the same loan relief as a haircut of the original principal (€240 billion) of more than 59%.

III. Conclusion

In this case study, we introduced the PV as a method to value investments and explained the general idea behind this concept. We showed that two measures that appear rather unimpressive at first sight have a considerable effect on the credit burden of Greece and that, assuming a normal shape of the yield curve, these two measures have an effect that is equivalent to a haircut of the original loan of more than 59%.

[4] Note that we assume that the coupon does not change even though the face value of the loan changes.

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