



GALWAY-MAYO INSTITUTE OF TECHNOLOGY

Department of Computer Science & Applied Physics

Fuzzy Logic – Euro-zone Debt Dynamics

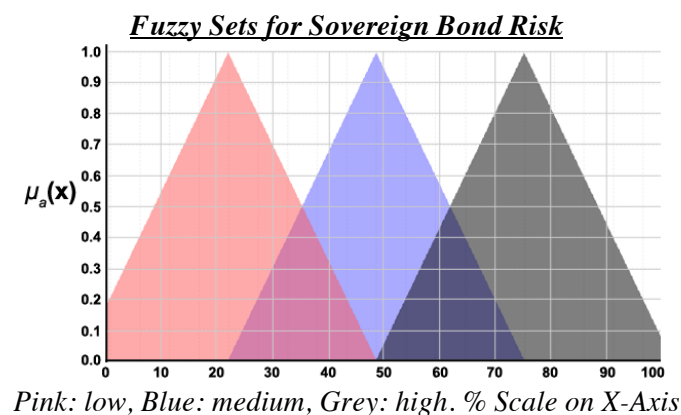
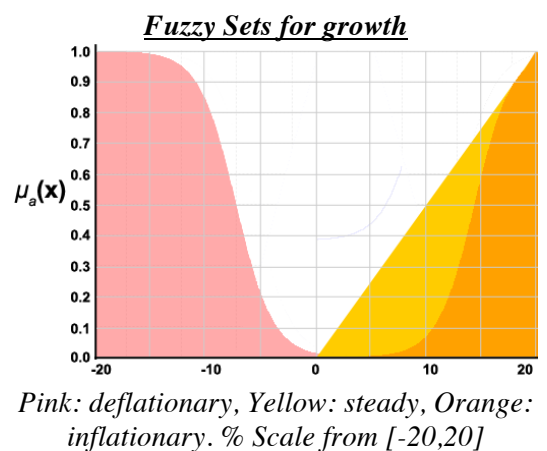
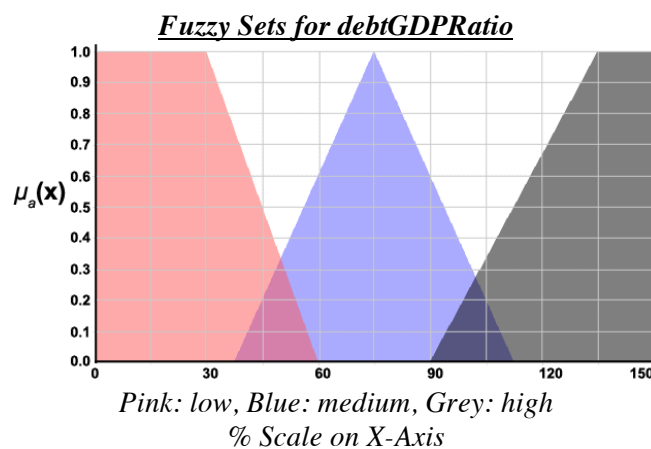
In this example, we will use fuzzy logic to determine the sovereign bond risk associated with a number of Euro-zone countries. Note that this is not an exercise in economics (thank goodness!). Other factors such as unit labour costs, general competitiveness, labour market flexibility, track record on payments and demographics all play major roles in determining how risky it is to buy sovereign debt.

Linguistic Variables

1. debtGDPRatio = {low, medium, high}
2. growth = {deflationary, steady, inflationary}
3. risk = {low, medium, high}

Fuzzy Sets and Membership Functions

Each of the linguistic variables contain fuzzy sets defined as follows:



Fuzzy Rules

The following fuzzy rules are executed to compute a result:

- IF debtGDPRatio IS high AND growth IS steady THEN risk IS LOW
- IF debtGDPRatio IS high AND growth IS MORE OR LESS low THEN risk IS high
- IF debtGDPRatio IS VERY low AND growth IS EXTREMELY inflationary THEN risk IS SOMEWHAT low
- IF debtGDPRatio IS EXTREMELY high OR growth IS VERY VERY low THEN risk IS VERY high

Question

Using the data in Tables 1 & 2, apply the fuzzy rules above to compute the risk associated with purchasing Euro-zone government bonds. As an additional, try aggregating the output of each rule and use the “Centre of Gravity” technique to generate a percentage risk.

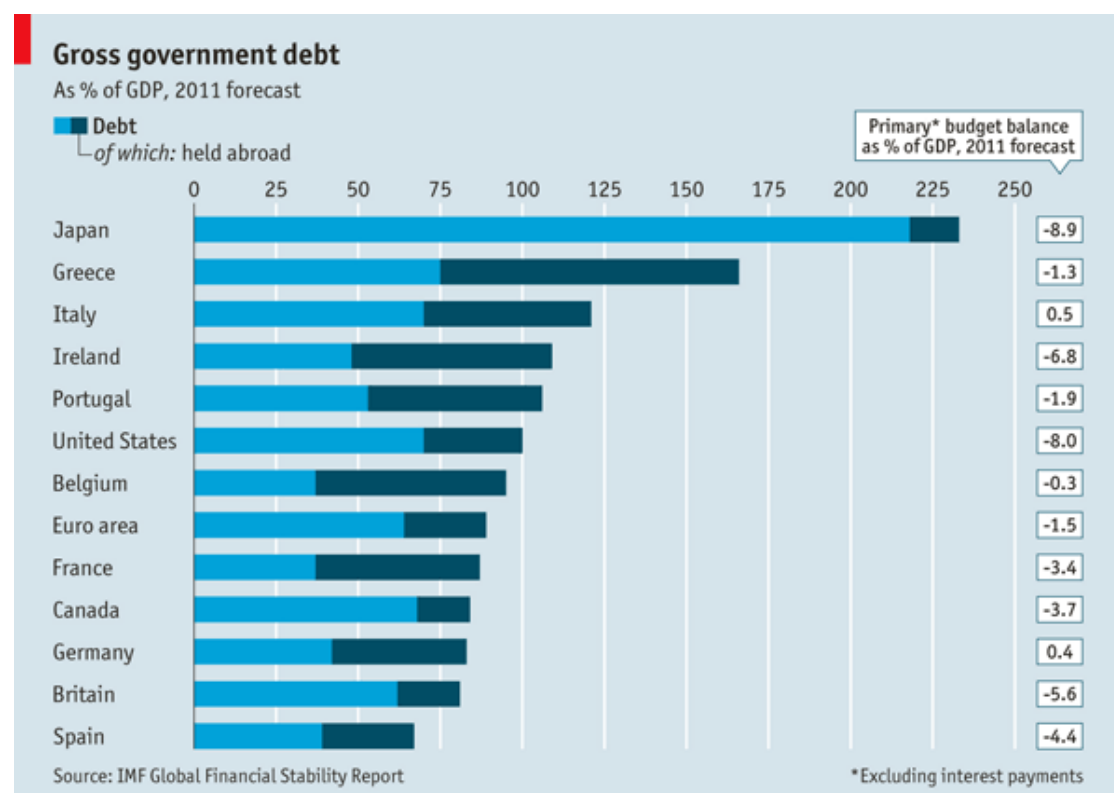


Table 1: Gross Government Debt. Source: Economist Magazine, Sep 21st 2011.

Geo\Time	2008	2009	2010	2011	2012	2013
Belgium	1	-2.8	2.3	2.2	0.9	1.5
Czech Republic	3.1	-4.7	2.7	1.8	0.7	1.7
Denmark	-0.8	-5.8	1.3	1.2	1.4	1.7
Germany	1.1	-5.1	3.7	3	0.8	1.5
Ireland	-3	-7	-0.4	1.1	1.1	2.3
Greece	-0.2	-3.3	-3.5	-5.5	-2.8	0.7
Spain	0.9	-3.7	-0.1	0.7	0.7	1.4
France	-0.1	-2.7	1.5	1.6	0.6	1.4
Italy	-1.2	-5.1	1.5	0.5	0.1	0.7

Luxembourg	0.8	-5.3	2.7	1.6	1	2.3
Netherlands	1.8	-3.5	1.7	1.8	0.5	1.3
Austria	1.4	-3.8	2.3	2.9	0.9	1.9
Portugal	0	-2.9	1.4	-1.9	-3	1.1
Finland	0.3	-8.4	3.7	3.1	1.4	1.7

Table 2: Euro-zone Real GDP Growth Rates (2008-2013). Source: Eurostat, 2012

Summary of Hedge Functions and Fuzzy Operators

Name	Operation on $\mu_a(x)$
Very	$\mu_a(x)^2$
Extremely	$\mu_a(x)^3$
Very Very	$\mu_a(x)^4$
More or Less	$\sqrt[n]{\mu_a(x)}$
Indeed	$2[\mu_a(x)]^2$ if $0 \leq \mu_a(x) \leq 0.5$ $1 - 2[1 - \mu_a(x)]^2$ if $0.5 < \mu_a(x) < 1$
AND	$\min[\mu_1(x), \mu_2(x) \dots \mu_n(x)]$
OR	$\max[\mu_1(x), \mu_2(x) \dots \mu_n(x)]$
NOT	$1 - \mu_a(x)$