



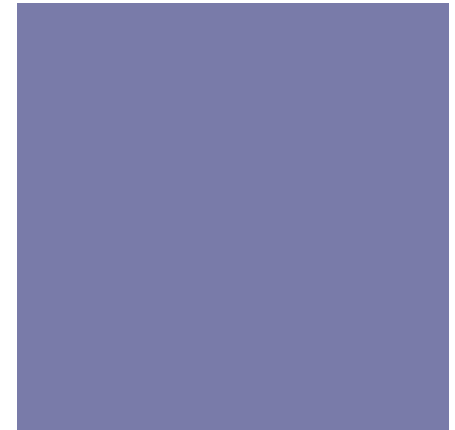
Resilient Labour Market Indicators: a fuzzy forecast approach for female unemployment rates in the Southern European Countries

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+ The structure of the presentation

- Motivation – Objectives
- Data
- Methodology
- Results – Conclusions
- Future work

+ Motivation – Objectives

■ To answer:

- How have women fared in the Southern European countries' labour market?

■ To provide:

- Forecasts for female unemployment rates for Greece, Spain and Italy for 2014, 2015 and 2016, using the methodology of fuzzy time series analysis.



Data

■ EU LFS

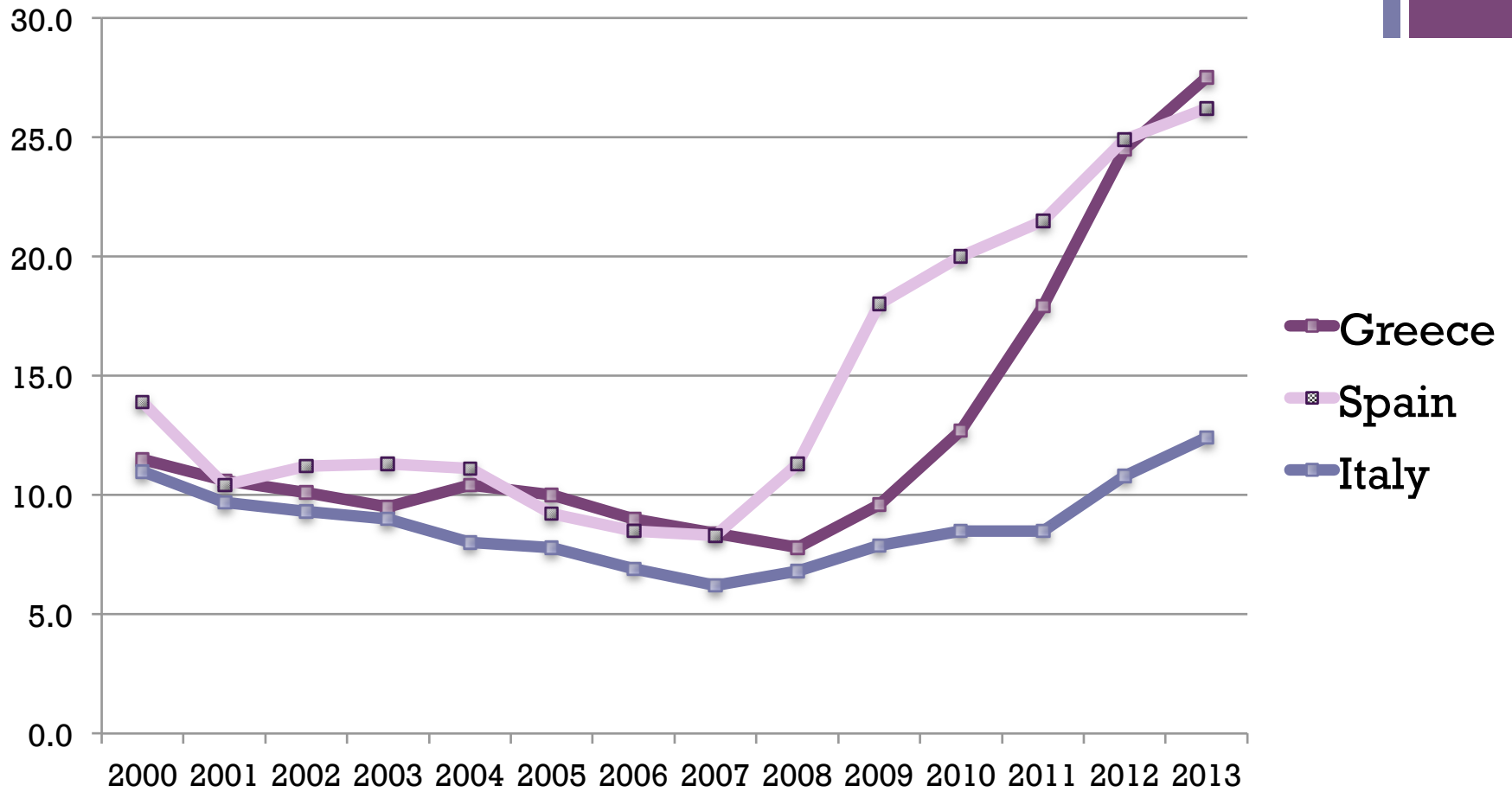
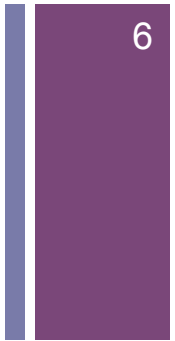
- The EU LFS is a large household sample survey providing results on labour participation of people aged 15 and over as well as on persons outside the labour force.
- All definitions apply to persons aged 15 years and over living in private households.
- Persons carrying out obligatory military or community service are not included in the target group of the survey, as is also the case for persons in institutions/collective households.

+ Data

- EU LFS
- Information about women's labour market position in Greece, Italy and Spain from 2000 to 2013.
 - 2000 to 2007 (pre-crisis)
 - 2008 to 2013 (during crisis).



Female unemployment rates for women aged 15-64 by country, 2000-2013



Unemployment rates for women 15-24 by country (%), 2000-2013

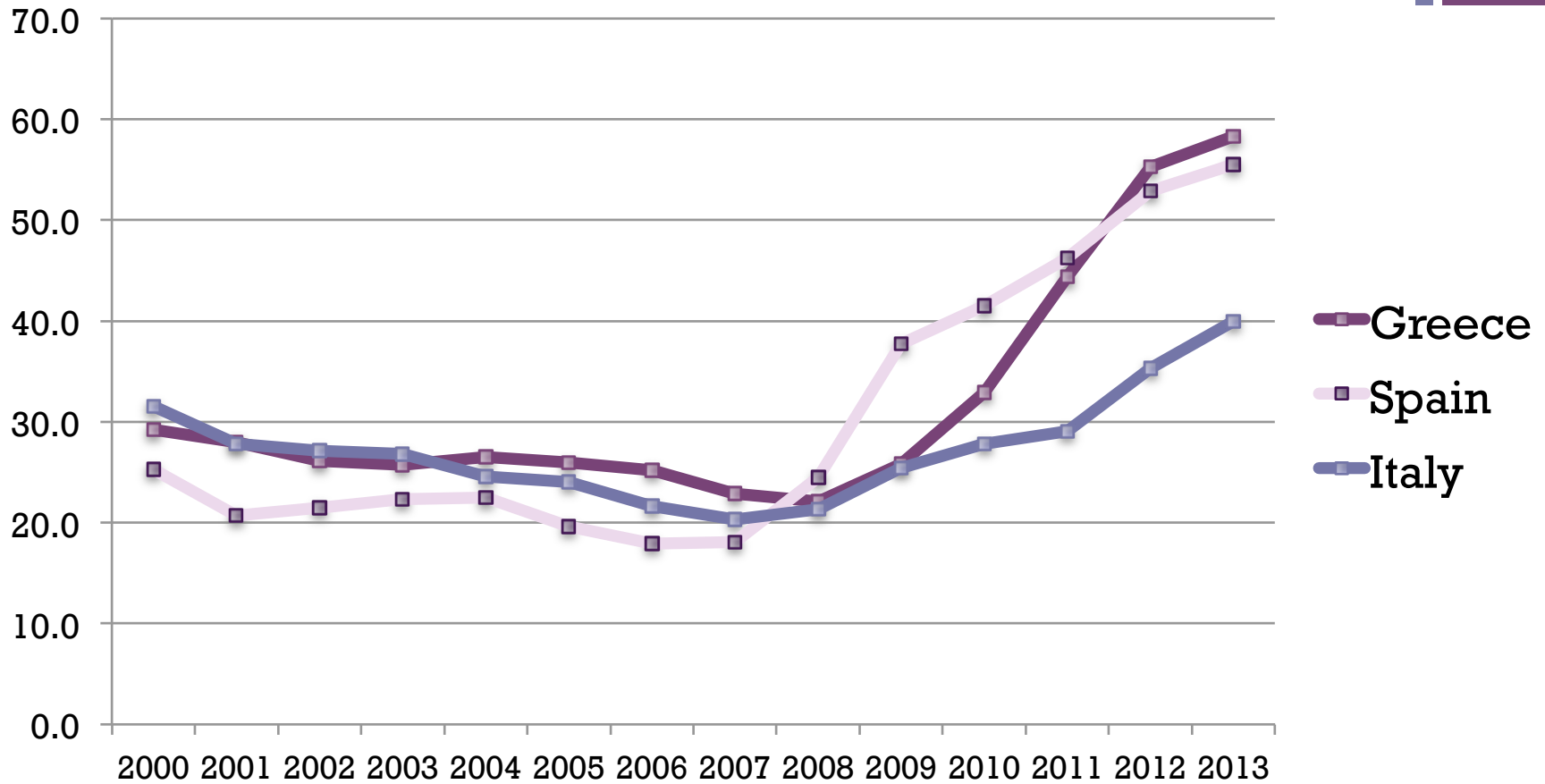
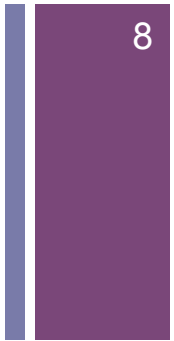
Time	Greece	Spain	Italy
2000	29.2	25.3	31.5
2001	28.0	20.7	27.8
2002	26.1	21.5	27.1
2003	25.7	22.3	26.8
2004	26.5	22.5	24.6
2005	26.0	19.6	24.0
2006	25.2	17.9	21.6
2007	22.9	18.1	20.3
2008	22.1	24.5	21.3
2009	25.8	37.7	25.4
2010	32.9	41.5	27.8
2011	44.4	46.2	29.1
2012	55.3	52.9	35.3
2013	58.3	55.5	40.0

Source: Eurostat, Labour Force Survey (lfsa_urgan),

http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_urgan&lang=en



Unemployment rates for women aged 15-24 by country (%), from 2000 to 2013



Unemployment rates for women, 25-49 by country (%), 2000-2013



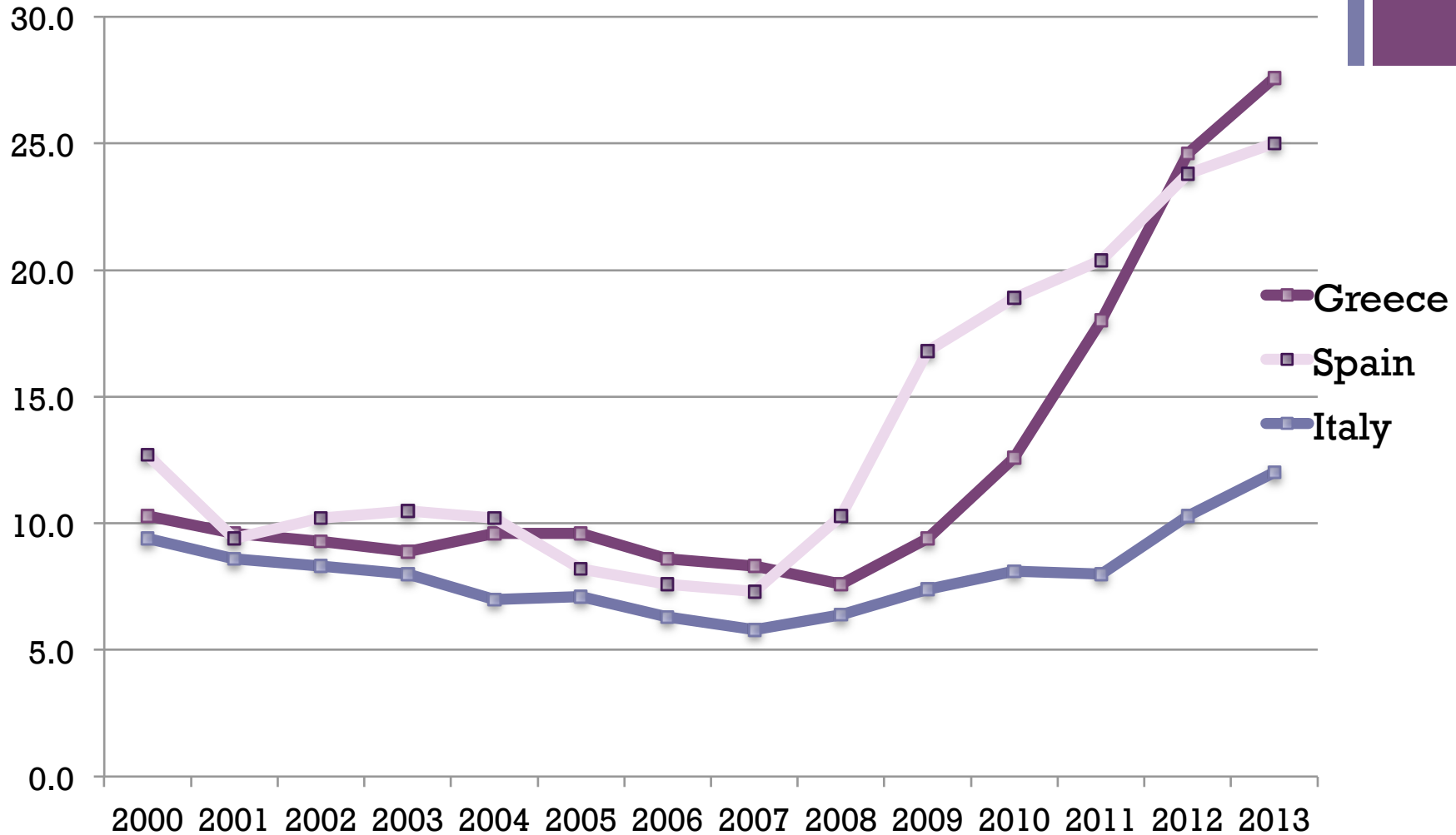
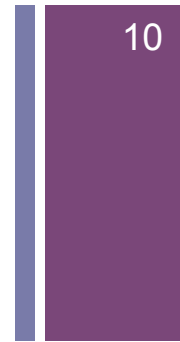
Time	Greece	Spain	Italy
2000	10.3	12.7	9.4
2001	9.6	9.4	8.6
2002	9.3	10.2	8.3
2003	8.9	10.5	8.0
2004	9.6	10.2	7.0
2005	9.6	8.2	7.1
2006	8.6	7.6	6.3
2007	8.3	7.3	5.8
2008	7.6	10.3	6.4
2009	9.4	16.8	7.4
2010	12.6	18.9	8.1
2011	18.0	20.4	8.0
2012	24.6	23.8	10.3
2013	27.6	25.0	12.0

Source: Eurostat, Labour Force Survey (lfsa_urgan),

http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_urgan&lang=en



Female unemployment rates for women aged 25-49 by country, 2000-2013



Unemployment rates for women 50-74 by country (%), 2000-2013

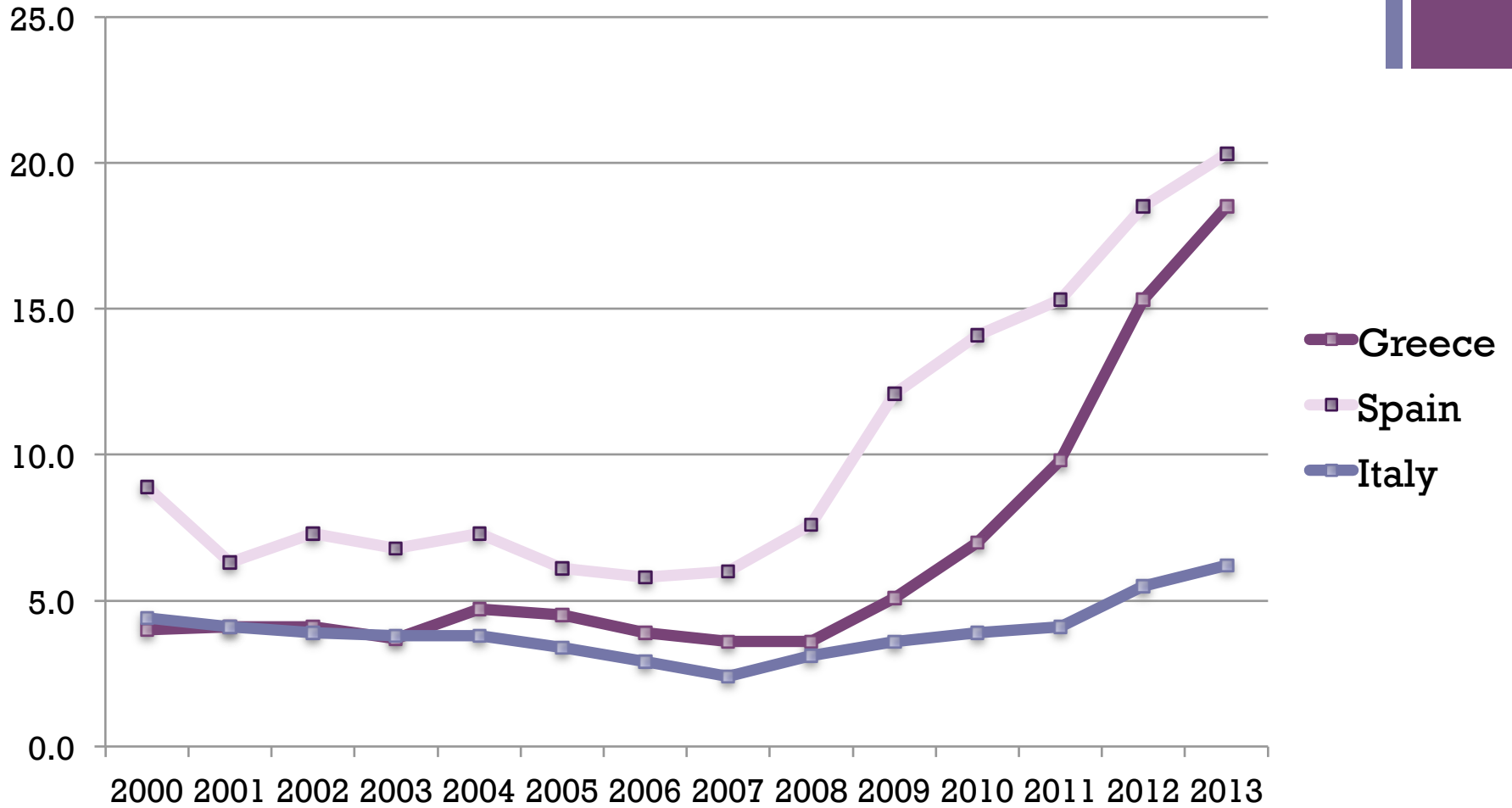
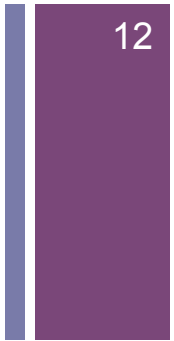
Time	Greece	Spain	Italy
2000	4.0	8.9	4.4
2001	4.1	6.3	4.1
2002	4.1	7.3	3.9
2003	3.7	6.8	3.8
2004	4.7	7.3	3.8
2005	4.5	6.1	3.4
2006	3.9	5.8	2.9
2007	3.6	6.0	2.4
2008	3.6	7.6	3.1
2009	5.1	12.1	3.6
2010	7.0	14.1	3.9
2011	9.8	15.3	4.1
2012	15.3	18.5	5.5
2013	18.5	20.3	6.2

Source: Eurostat, Labour Force Survey (lfsa_urgan),

http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_urgan&lang=en



Unemployment rates for women 50-74 by country (%), 2000-2013



+ Fuzzy logic

- Fuzzy logic is based on fuzzy set theory (Zadeh 1965) and is considered as a generalization of the classical logic theory.
- In fuzzy set theory, membership in a fuzzy set is not a matter of affirmation or denial but rather a matter of degree.
- When A is a fuzzy set and x is a relevant object:

x is a member of A

is not necessarily either true or false, but it may be true only to some degree, being usually a number in the interval $[0,1]$.



Like classical time series analysis, we use historical data to set up the relationship among values.

- **Step 1:** Define the universe of discourse within which the historical data are and upon which the fuzzy sets will be defined.
- **Step 2:** Partition the universe into several even lengthy intervals.
- **Step 3:** Define fuzzy sets on the universe U .
- **Step 4:** Fuzzify the historical data.
- **Step 5:** Obtain the historical knowledge about the evolution of the time series to set up the forecasting model.
- **Step 6:** Calculate the forecasted outputs.
- **Step 7:** Interpret the forecasted outputs – Defuzzify.

+ Methodology

Modeling the female unemployment rates for Greece for ages between 15-24.

- **Step 1.** Define the universe of discourse U . Since the minimum value is equal to 22.1 and the maximum value equal to 58.3 we define $U=[19,61]$.
- **Step 2.** We divide U into 5 intervals with equal lengths:
 - $u_1=[19, 27.4]$, $u_2=[27.4, 35.8]$, $u_3=[35.8, 44.2]$,
 $u_4=[44.2, 52.6]$, $u_5=[52.6, 61]$.

+ Methodology

Modeling female unemployment rates for Greece for ages between 15-24.

■ **Step 3.** Define fuzzy sets on the universe U . In this case, for the linguistic variable ‘unemployment rate’:

■ $A_1 =$ (very low), $A_2 =$ (low), $A_3 =$ (medium), $A_4 =$ (high) and $A_5 =$ (very high), where the fuzzy sets A_1, A_2, A_3, A_4 and A_5 are defined as follows:

$$A_1 = \{u_1 / 1, u_2 / 0.5, u_3 / 0, u_4 / 0, u_5 / 0\},$$

$$A_2 = \{u_1 / 0.5, u_2 / 1, u_3 / 0.5, u_4 / 0, u_5 / 0\},$$

$$A_3 = \{u_1 / 0, u_2 / 0.5, u_3 / 1, u_4 / 0.5, u_5 / 0\},$$

$$A_4 = \{u_1 / 0, u_2 / 0, u_3 / 0.5, u_4 / 1, u_5 / 0.5\},$$

$$A_5 = \{u_1 / 0, u_2 / 0, u_3 / 0, u_4 / 0.5, u_5 / 1\}.$$

- + **Step 4.** Fuzzify the historical data, i.e. find a proper fuzzy set for each year's unemployment rate.

Time	Actual Unemployment rate	Fuzzified Unemployment rate
2000	29.2	A_2
2001	28.0	A_2
2002	26.1	A_1
2003	25.7	A_1
2004	26.5	A_1
2005	26.0	A_1
2006	25.2	A_1
2007	22.9	A_1
2008	22.1	A_1
2009	25.8	A_1
2010	32.9	A_2
2011	44.4	A_4
2012	55.3	A_5
2013	58.3	A_5

+ Methodology

Step 5. Obtain the historical knowledge about the evolution of the unemployment rates to set up the forecasting model, i.e. obtain a set of logical relationships between two consequent unemployment rates:

$A_2 \rightarrow A_2, A_2 \rightarrow A_1, A_1 \rightarrow A_1, A_1 \rightarrow A_1, A_1 \rightarrow A_1,$

$A_1 \rightarrow A_1, A_1 \rightarrow A_1, A_1 \rightarrow A_1, A_1 \rightarrow A_1, A_1 \rightarrow A_2,$

$A_2 \rightarrow A_4, A_4 \rightarrow A_5, A_5 \rightarrow A_5.$

+ Methodology

Step 5

- We use the operator \times of two vectors (Song and Chissom (1993)). Suppose that \mathbf{c} and \mathbf{b} are row vectors of dimension m and $\mathbf{D}=(d_{ij})=\mathbf{c}^T \times \mathbf{b}$.
- Then the element d_{ij} of matrix \mathbf{D} is defined as $d_{ij}=\min(c_i, b_j)$, $i, j=1, 2, \dots, m$, where c_i and b_j are the i -th and the j -th element of \mathbf{c} and \mathbf{b} respectively.

+ Methodology

Step 5 and 6

$$R_1 = A_2^T \times A_2 \quad R_2 = A_2^T \times A_1 \quad R_3 = A_1^T \times A_1$$

$$R_4 = A_1^T \times A_1 \quad R_5 = A_1^T \times A_1 \quad R_6 = A_1^T \times A_1$$

$$R_7 = A_1^T \times A_1 \quad R_8 = A_1^T \times A_1 \quad R_9 = A_1^T \times A_1$$

$$R_{10} = A_1^T \times A_2 \quad R_{11} = A_1^T \times A_4 \quad R_{12} = A_4^T \times A_5$$

$$R_{13} = A_5^T \times A_5$$

$$R = \bigcup_{i=1}^{13} R_i \quad (1)$$

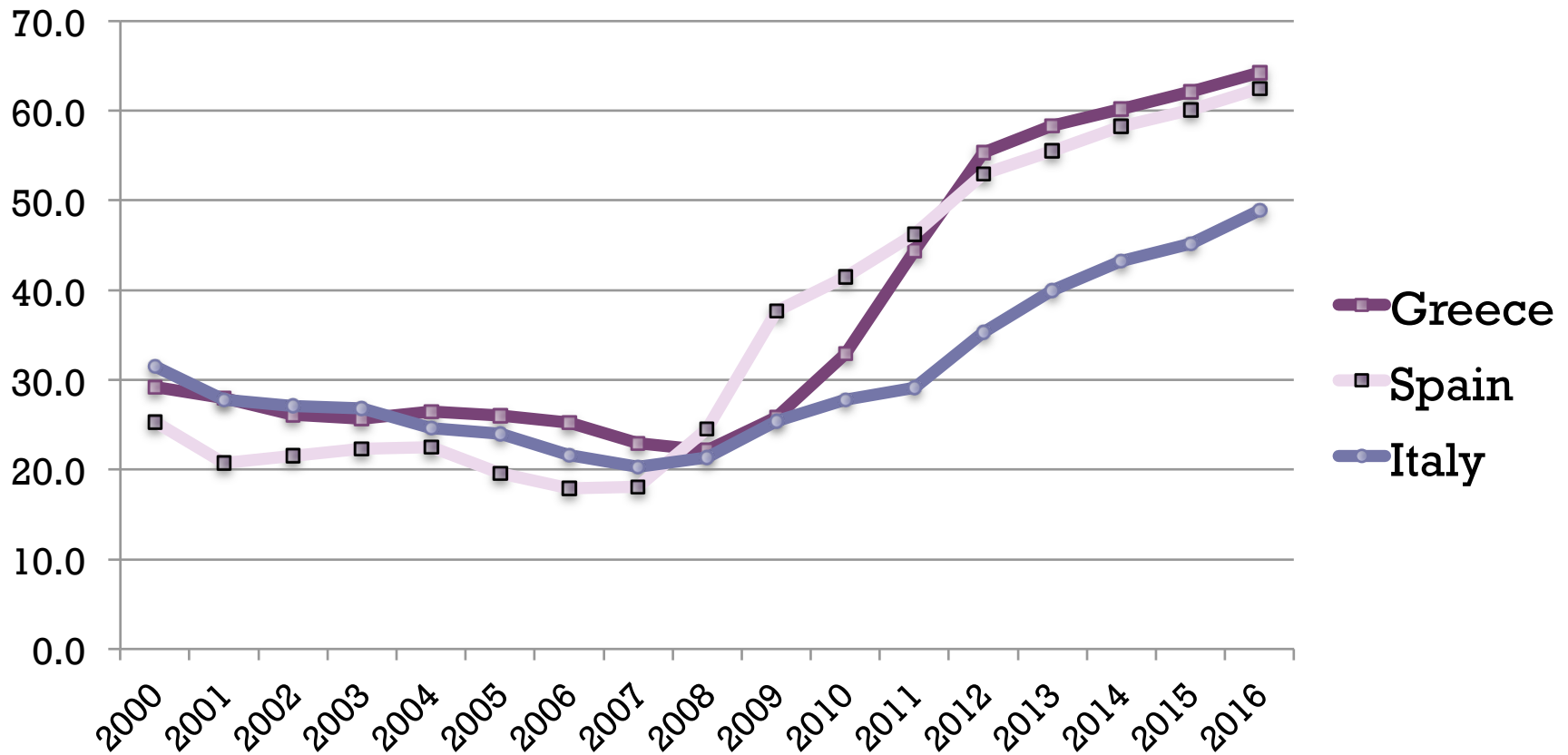
The forecasting model $A_i = A_{i-1} \circ R \quad (2)$

+ Predictions using fuzzy time series analysis

Time	Greece	Spain	Italy
Age 15-24			
2014	60.2	58.2	43.2
2015	62.1	60.1	45.2
2016	64.2	62.5	48.9
Age 25-49			
2014	29.2	27.2	14.1
2015	31.4	29.6	16.2
2016	33.2	31.1	18.0
Age 50-74			
2014	20.4	22.4	7.5
2015	22.1	24.6	8.4
2016	24.5	26.8	9.3

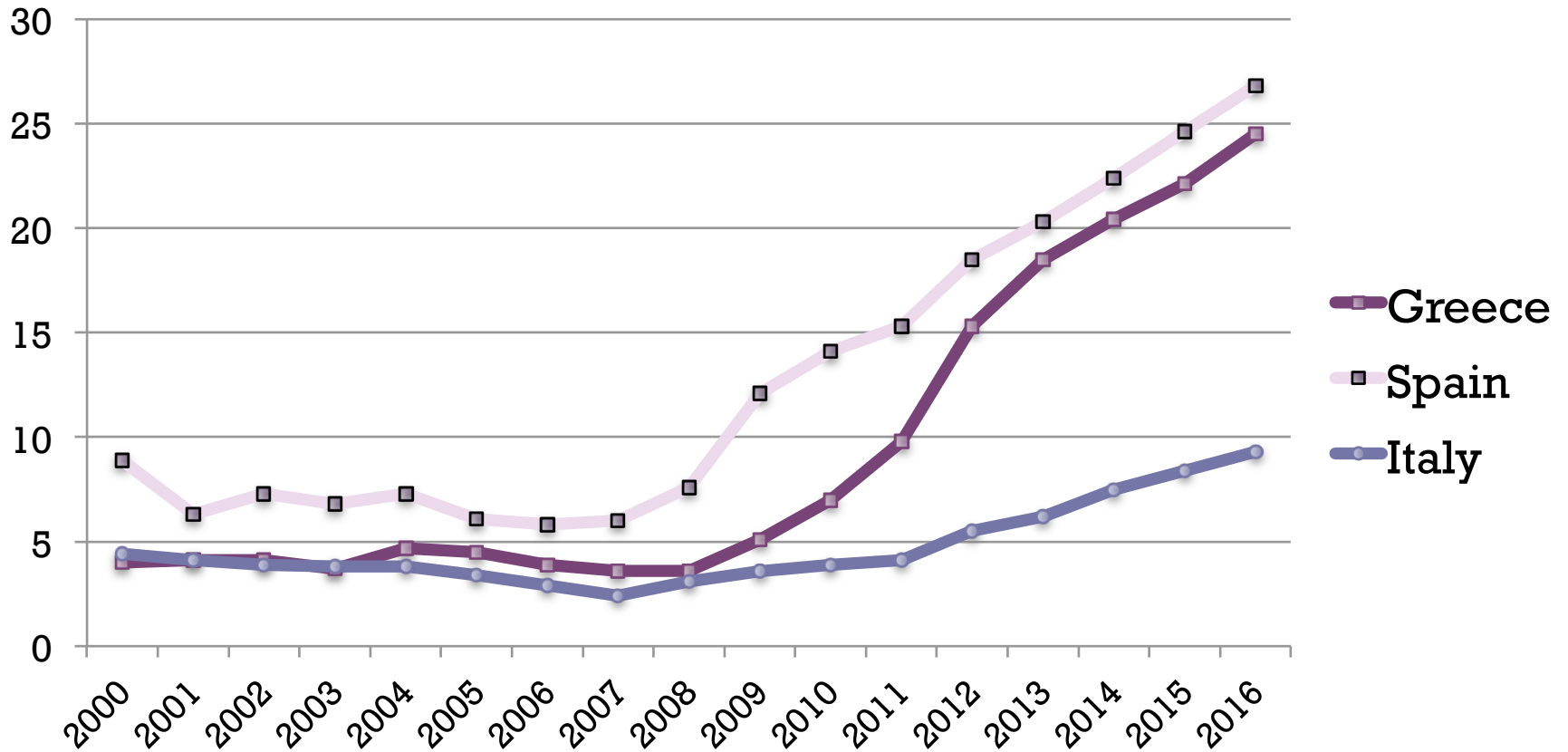


Unemployment rates for women aged 15-24 by country (%), from 2000 to 2013 and predicted values for 2014-2016



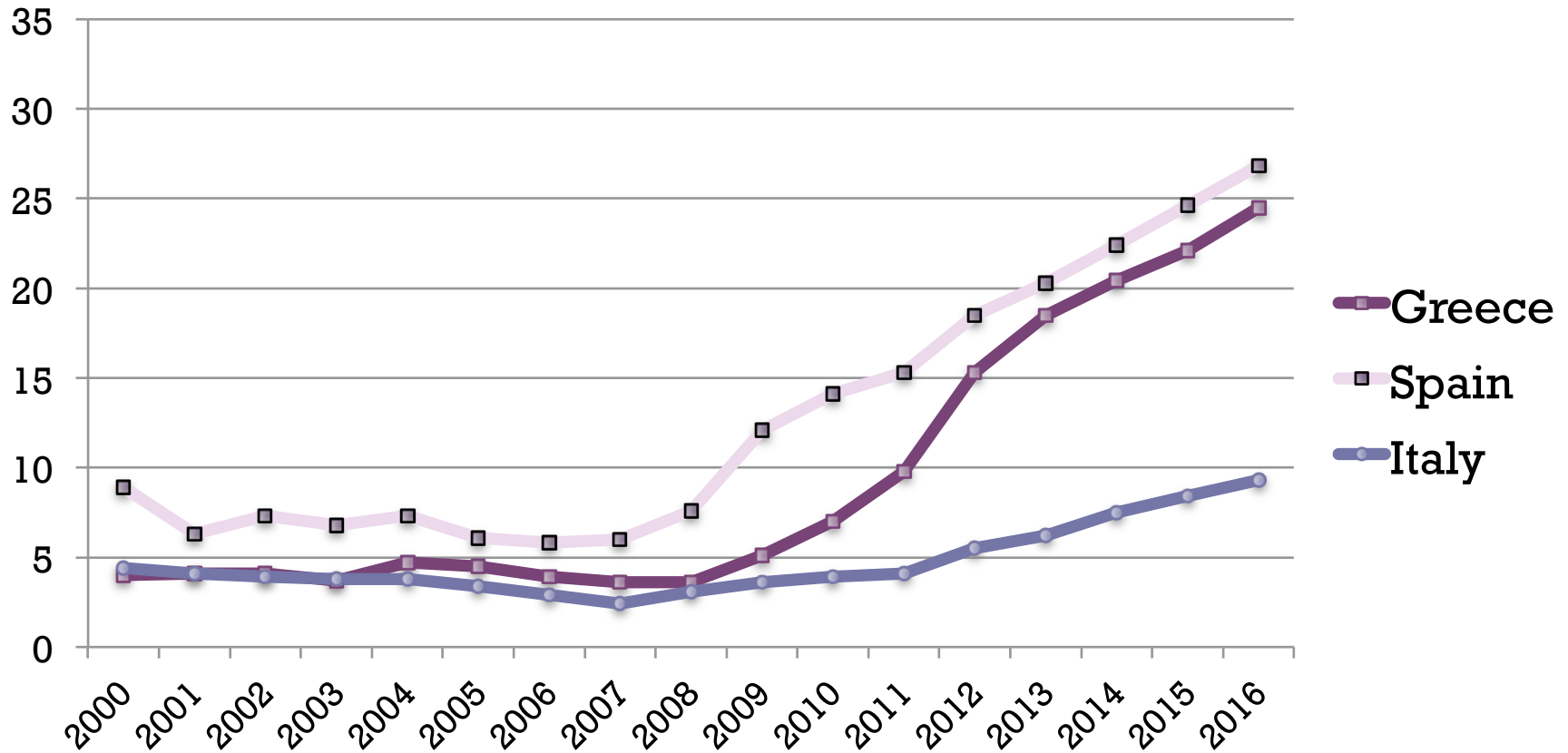


Unemployment rates for women aged 25-49 by country (%), from 2000 to 2013 and predicted values for 2014-2016





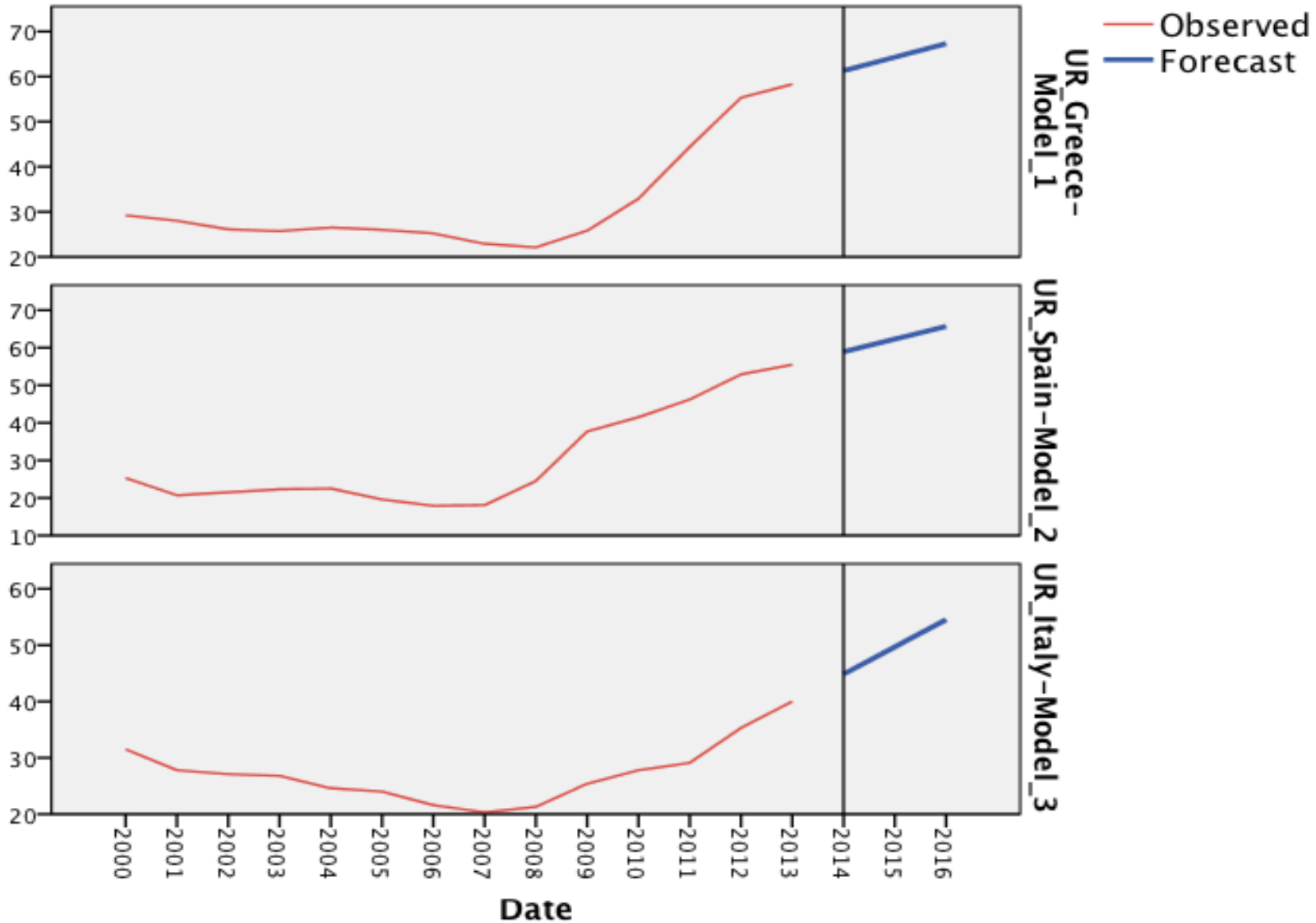
Unemployment rates for women aged 50-74 by country (%), from 2000 to 2013 and predicted values for 2014-2016



+ Predictions using time series analysis

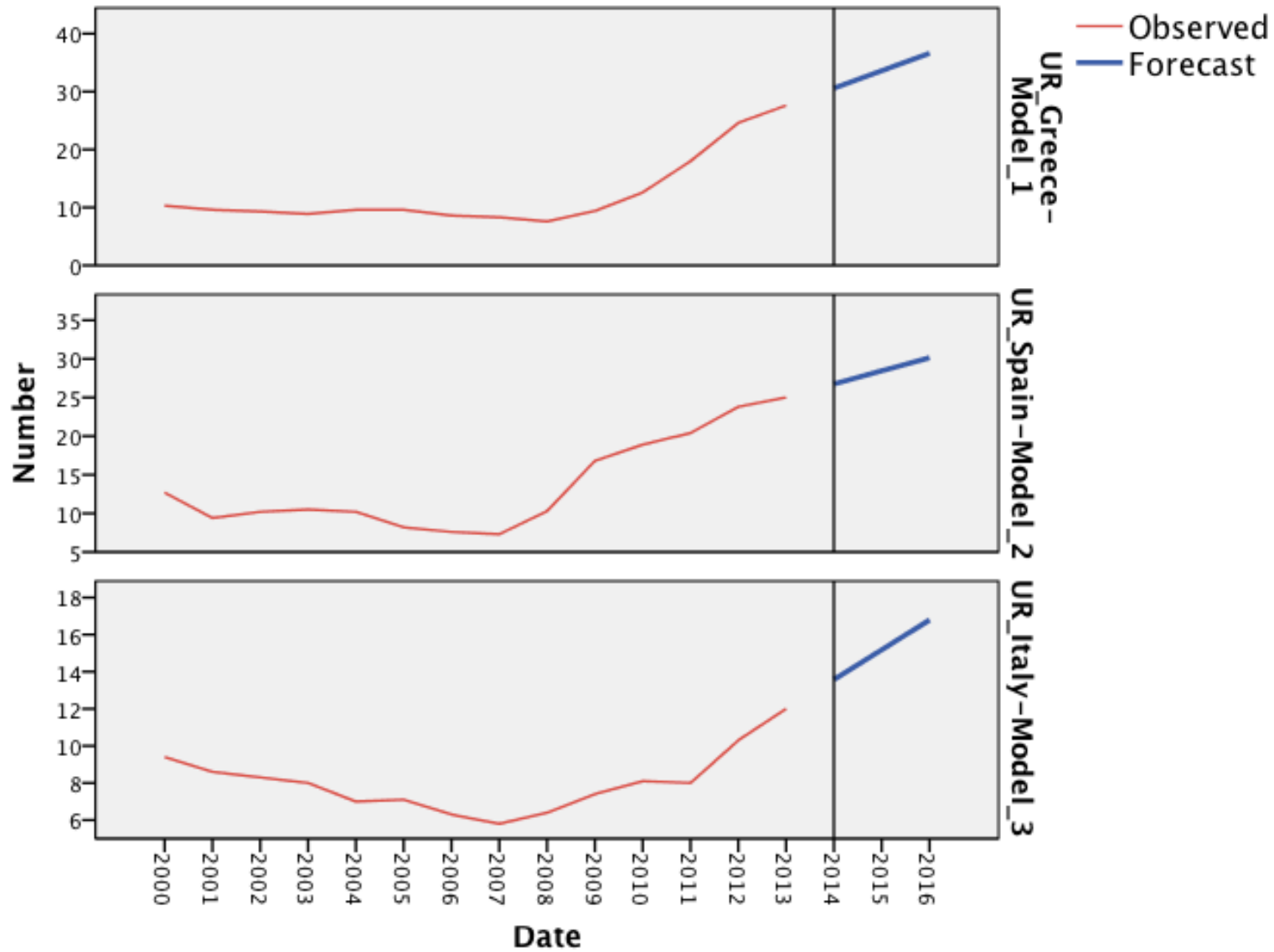
Time	Greece	Spain	Italy
Age 15-24			
2014	61.30	58.93	44.84
2015	64.30	62.31	49.69
2016	67.30	65.69	54.53
Age 25-49			
2014	30.60	26.74	13.57
2015	33.60	28.45	15.18
2016	36.60	30.15	16.79
Age 50-74			
2014	22.12	22.54	7.03
2015	25.72	24.73	7.86
2016	29.32	26.91	8.68

+ Forecast of unemployment rate, women 15-24, Greece, Spain, Italy, using time series analysis



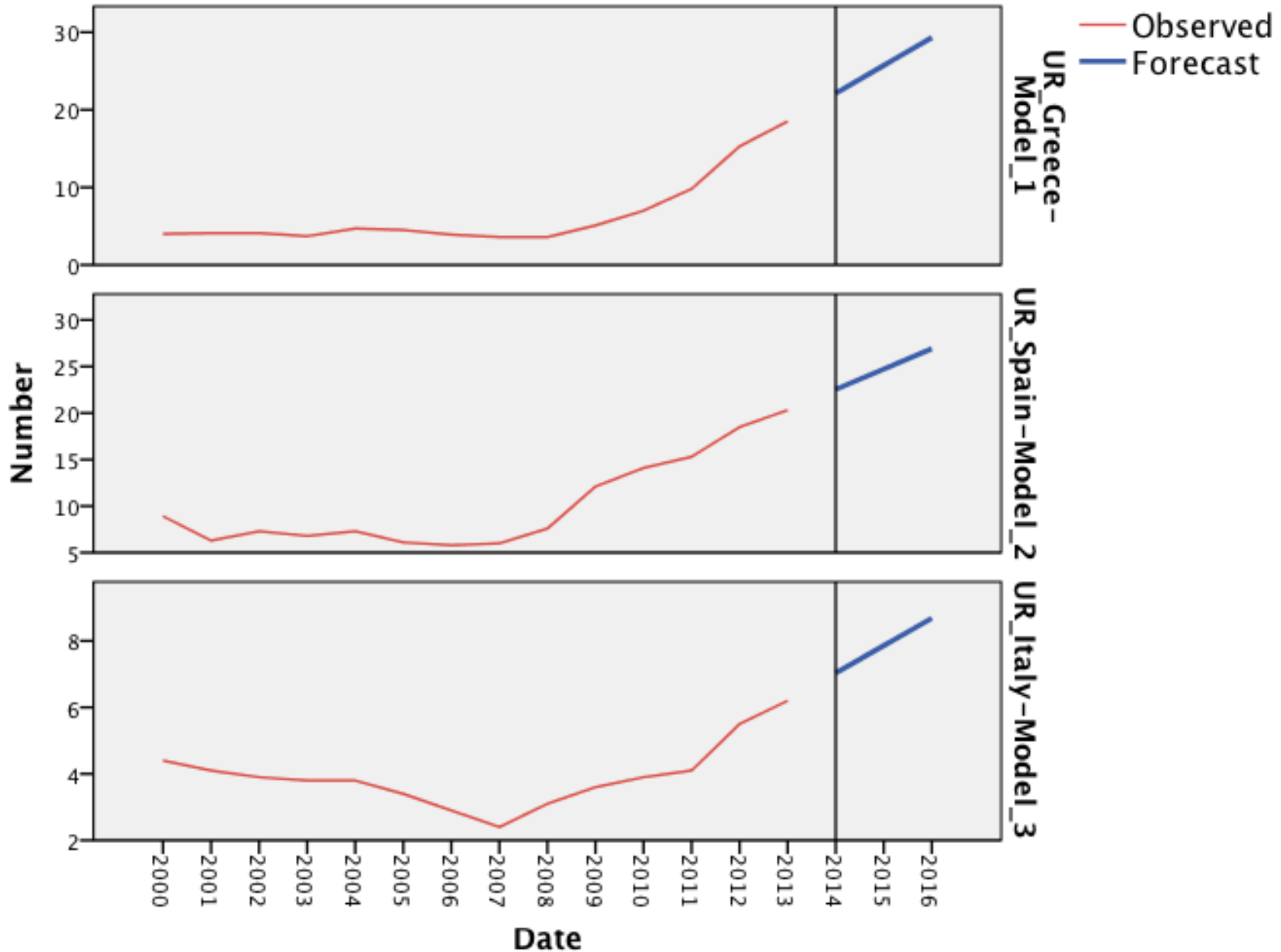


Forecast of unemployment rate, women 25-49, Greece, Spain, Italy, using time series analysis





Forecast of unemployment rate, women 50-74, Greece, Spain, Italy, using time series analysis





Conclusions

Both models predict persistently high female unemployment rates, for all three countries and for all age groups.

Fuzzy time series analysis forecasts

Greece, 15-24

60.20

62.10

64.20

Spain, 50-74

22.40

24.60

26.80

Time series analysis forecasts

Greece, 15-24

61.30

64.30

67.30

Spain, 50-74

22.54

24.73

26.91



Future work

- Develop a fuzzy system to model the unemployment rates.
- Fuzzy systems are systems in which variables have as domain fuzzy sets encoding structured, heuristic or linguistic knowledge in a numerical framework. They describe the operation of the system in natural language with the aid of human-like IF-THEN rules and provide a more reflective representation of human perception.

+ Bibliography

- Zadeh L. A., Fuzzy Sets, *Information and Control*, 8(3), 338-353, 1965.
- Song Q. and Chissom B., Fuzzy time series and its models, *Fuzzy Sets and Systems*, 54, 269-277, 1993.
- Song Q. and Chissom B., Forecasting enrollments with fuzzy time series- part I, *Fuzzy Sets and Systems*, 54, 1-9, 1993.
- Song Q. and Chissom B., Forecasting enrollments with fuzzy time series- part II, *Fuzzy Sets and Systems*, 62, 1-8, 1994.