Cost of coexistence measures and potential adoption of GM crops by farmers

Comparison from a choice experiment in 4 EU countries

GMCC-15, Amsterdam

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PRICE
PRactical Implementation of Coexistence in Europe

Economic analysis of coexistence measures

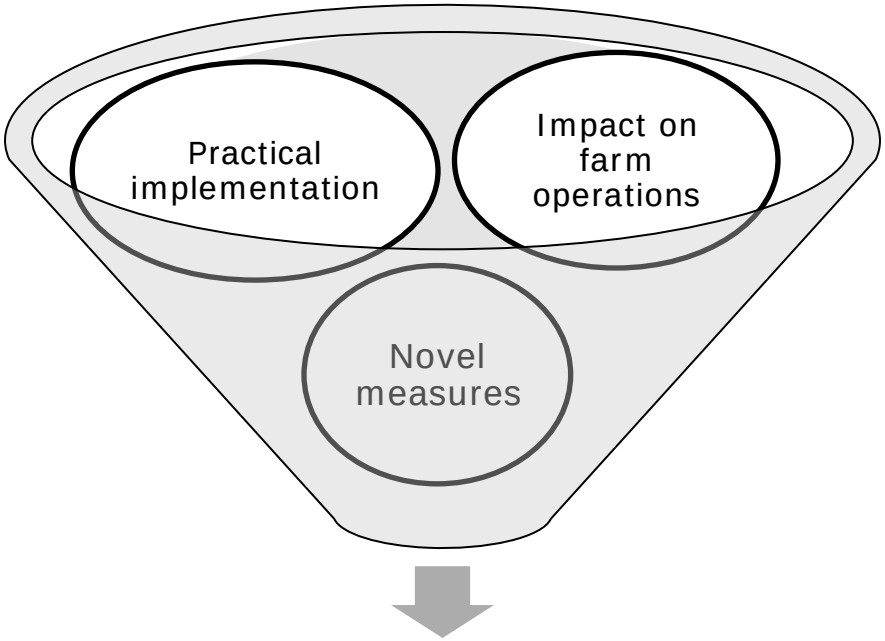
- Objective of the research
- Survey among EU farmers
- Choice model: methodology
- Results:
  - Model estimation results
  - Willingness to adopt coexistence measures (costs)
  - Potential adoption of GM maize under coexistence scenarios

PRICE FP7 project: Practical **I**mplementation of **C**oexistence in **E**urope

- 2011-2015
- Different aspects of coexistence
- 6 Partners in the EU = 6 countries in the survey

Economic analysis of coexistence measures

- Main objective: understand how coexistence measures impact adoption



Economic analysis: specific objectives

- Elicit the burden and costs of coexistence measures among EU farmers
- Estimate the costs of different measures
- Implications of coexistence measures for the adoption of new GM crops in the EU
- Welfare implications of the adoption of GM crops at national level

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Survey conducted in 4 EU MS: details

	DE	PT	ES	UK
Sample size	47	56	1,015	214
Survey method	Face-to-Face	Face-to-Face	Face-to-Face	Postal questionnaire
Crop surveyed	Maize	Maize	Maize	Maize, Oilseed rape, Sugar Beet
Current cultivation of GM crop	No	Yes	Yes	No
Previous cultivation of GM crop	Yes	Yes	Yes	No
Average farm size of respondents	1147 ha	250 ha	55 ha	350 ha

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Choice model: methodology

The theoretical framework assumes that individual indirect utility function *U* have two components $U_{in} = V_{in} + \varepsilon_{in}$

And V_{in} is a deterministic utility component that can be broken down into two elements, an individual-specific component (Z_{nk}) and a choice-specific component (X_{ina}):

$$V_{in} = \sum_{a} \beta_a X_{ina} + \sum_{k} \alpha_k Z_{nk}$$

Mixed Logit model (Random parameter) to account for heterogeneity of preferences (allow β parameters to have random distribution)

Choice model: methodology

5 attributes, 3 levels -> 3 scenarios by choice card -> 12 choices cards

An efficient design rather than an orthogonal design (better performance)

An opt-out choice (i.e. the possibility for the farmer to choose the conventional maize cultivation) included in each choice set (Louviere et al 2000)

Choice model: attributes

Attribute	Definition	Levels
Isolation distance	The separation distance needed between Bt and non Bt maize	0m; 50m; 100m
Temporal isolation	The time difference between sowing Bt maize and the neighbouring non Bt fields	0 weeks; 2 weeks; 4weeks
Information provision	The different stakeholders that should be notified or communicated to about the intention to sow Bt maize	-No information provision; -Inform your neighbouring farmers; -Inform authorities that will make it public
Liability	The situation in which a Bt maize farmer can be held liable for the economic damage of comingling	-Never; -If the farmer does not comply with the coexistence rules; -Always, even if all rules are followed
Gross margin	**The per hectare benefit from cultivating Bt maize**	**25 euro/ha; 75 euro/ha; 150 euro/ha**

Choice model: the choice cards

Below is an example of one of these sets of choices. You must choose **ONE** only of A, B or C. In option A you would always be liable to pay compensation if your GM crop contaminated a neighbour's conventional crop; you would be required to maintain a minimum 100m distance to any conventional maize crop; you would have to provide information on your GM plantings to a public database; but you would not need to alter your planned planting dates to avoid cross pollination of GM and non-GM crops. Under this option, you could expect an average increase in revenues of £60/ha from GM cultivation. If you prefer this combination of conditions to those offered in options B and C, you would select option A by circling the letter at the top of the column as shown.

Example of a set of choices	OPTION A GM	OPTION B GM	OPTION C Conventional
You are liable when your neighbour's non-GM plot is contaminated with GM	Always liable	Never liable	
Required isolation distance with non-GM neighbour	100m	100m	
Provide information on GM cultivation	To a public register	To a public register	
Temporal separation of your GM crop with neighbouring non-GM crop	Not needed	2 weeks	
Increase in output value from your production	£60 / ha	£60 / ha	

We now present 12 different scenarios or sets of choices relating to possible coexistence options for growing GM maize. Please circle **one of option A, B or C for each of the 12 scenarios that follow:**

Scenario 1	OPTION A GM	OPTION B GM	OPTION C Conventional
You are liable when your neighbour's non-GM plot is contaminated with GM	Always liable	Always liable	
Required isolation distance with non-GM neighbour	50m	No isolation	

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Choice model: results

Country	**Germany**		**UK**		**Spain**		**Portugal**	
model	RP Logit		RP Logit		RP Logit		MN Logit	
LL f	-431.26		-945.91		-7327.8		-312.68	
Chi-2	376.716		366.9		6253.27			
sig.	0		0		0			
McFadden Pseudo R-squared	0.30399		0.20243		0.29907		0.22357	
obs	**47**		**205**		**1012**		**45**	
constant	-2.8468	**	-3.171	**	-5.5829	***	-13.208	***
Attributes	β	sig.	β	sig.	β	sig.	β	sig.
gross margin	0.0153	***	0.009	***	0.00562	***	0.01372	***
partial liability	-1.2119	***	-0.1255		-0.8442	***	1.33725	***
full liability	-3.064	***	-1.9514	***	-0.276	***	-0.6663	**
distance	-0.014	***	-0.0125	***	-0.0209	***	-0.0004	
neighbour information	-0.6387	***	-0.2456	**	0.33037	***	-0.1858	
public information	-0.5538	**	-0.176		-0.3561	***	-0.0119	
temporary isolation	-1.2053	***	-0.2839	***	-0.0821	***	-0.3343	***

Choice model: results

Country	**Germany**		**UK**		**Spain**		**Portugal**	
model	RP Logit		RP Logit		RP Logit		MN Logit	
Farm characteristics	β	sig.	β	sig.	β	sig.	β	sig.
area	0.19513	*	0.00125	***	-0.1441	***	0.0029	***
maize area					0.01095	***		
share maize sold					0.00806	***		
ECB damage (%)					-0.0411	***		
constraint: pest							0.59554	***
contraint: weeds	-0.1373	**						
constraint: climate			-0.1476	***				
constraint: seed quality			0.30469	***				
nb neighbours							-0.0125	***
member cooperative			-0.5536	***	1.20115	***	3.49543	***
member association/union			-1.892	***	0.5243	***		
certification scheme					3.78536	***		

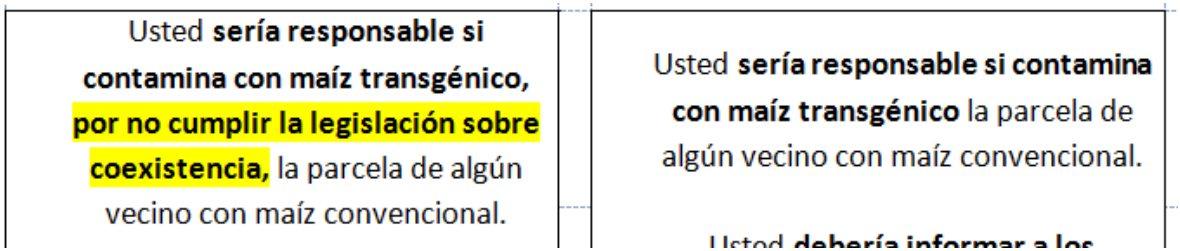
Choice model: results

Country	**Germany**		**UK**		**Spain**		**Portugal**	
model	RP Logit		RP Logit		RP Logit		MN Logit	
Biotech var	*β*	*sig.*	*β*	*sig.*	*β*	*sig.*	*β*	*sig.*
share bt 2008/2012	1.33371	*			0.0427	***		
bt test					-0.3594	**		
progress	-0.44494	*	0.7423	***			1.92909	***
gm attitude	1.84297	***	0.61134	*	1.02058	***	1.22947	**
Socio-demographic var								
only agri activities					1.40486	***		
age	-0.02414	*					-0.03055	**
experience			-0.01477	*	-0.02673	***		
education			0.64625	***	-0.40077	***	-0.17156	*
income			-0.11035	*			-0.17133	**

Choice model: limitations

Most of signs and values are consistent with expectations, but:

Order of liability attributes in Spain: a wording issue?



Informing neighbour in Spain: not considered as costly since relationships are good (pleasant discussion for 61% of respondents, none had to change growing plans)

Positive partial liability in Portugal: small sample for choice experiment

Possible improvement to the model: consider attribute non-attendance of respondents

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Coexistence costs in 4 EU countries

The WTA for attributes is given by ratio of marginal utility of attributes and marginal utility of the price vehicle (i.e. gross margin):

$$Cost = \frac{\frac{\partial V_i}{\partial X_i}}{\frac{\partial V_i}{\partial gross_i}}$$

It is the cost at which a farmer is indifferent between adopting or not the technology = coexistence cost

Coexistence costs in 4 EU countries

Country	Germany	UK	Spain	Portugal
Estimated cost of coexistence measure (€)				
Liable only if not compliant	-79.2 ***	-8.5	-108.2 ***	97.4 ***
Liable anyway	-200.4 ***	-131.7 ***	-37.5 ***	-48.6 **
Distance (€/m)	-0.91 ***	-0.84 ***	-4.43 ***	-0.03
Informing neighbours	-41.8 ***	-16.6 **	52.3 ***	-13.5
Informing public	-36.4 *	-11.9	-51.1 ***	-0.9
Sowing difference (€/week)	-78.8 ***	-19.2 ***	-22.8 ***	-24.4 ***

Coexistence costs: first lessons

Liability is considered a high cost by farmers, especially in Germany and UK

Minimum distance of 100m costs about 90€ in Germany and UK, but more than 400€ in Spain (see farm size)

One week of sowing difference costs 80€ in Germany, vs. 20€ in UK, Spain and Portugal

Informing neighbours is not a cost in Spain, but is more costly than informing the public in Germany

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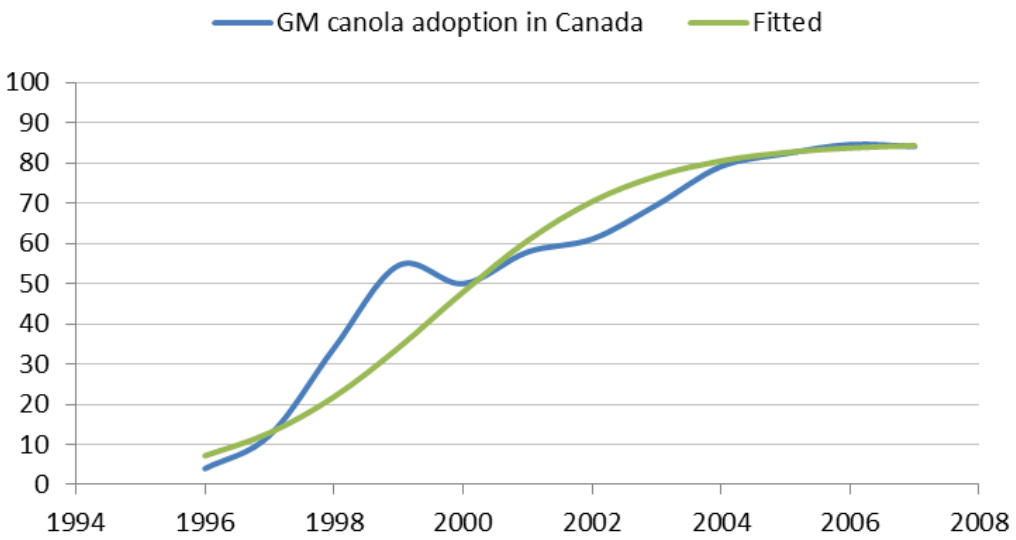
Adoption curve simulation

Griliches (1957): diffusion of innovation (hybrid maize)

$$\theta(t) = \frac{\theta_{max}}{1 + e^{-(a+bt)}}$$

Parameters *a* and *b* estimated from data on adoption of GM canola in Canada

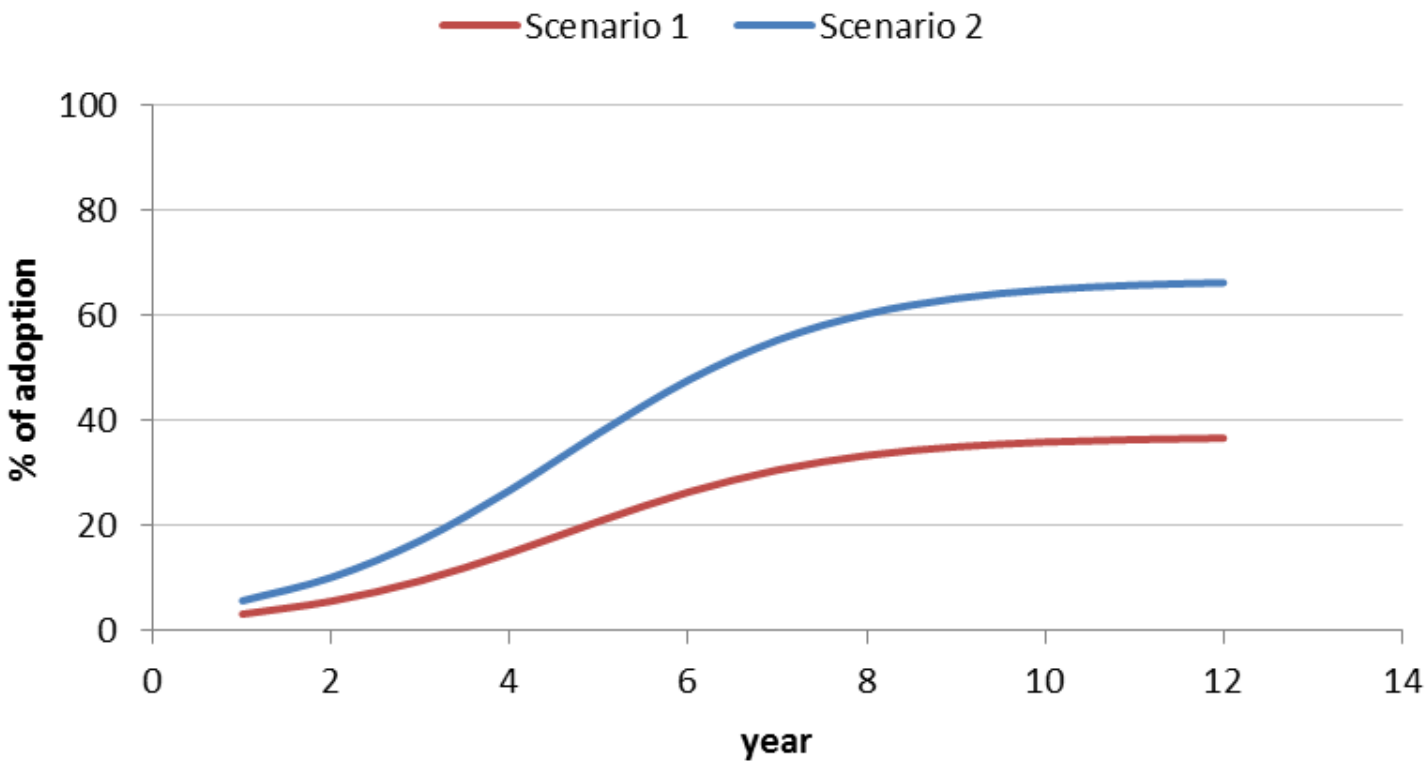


Adoption curve simulation

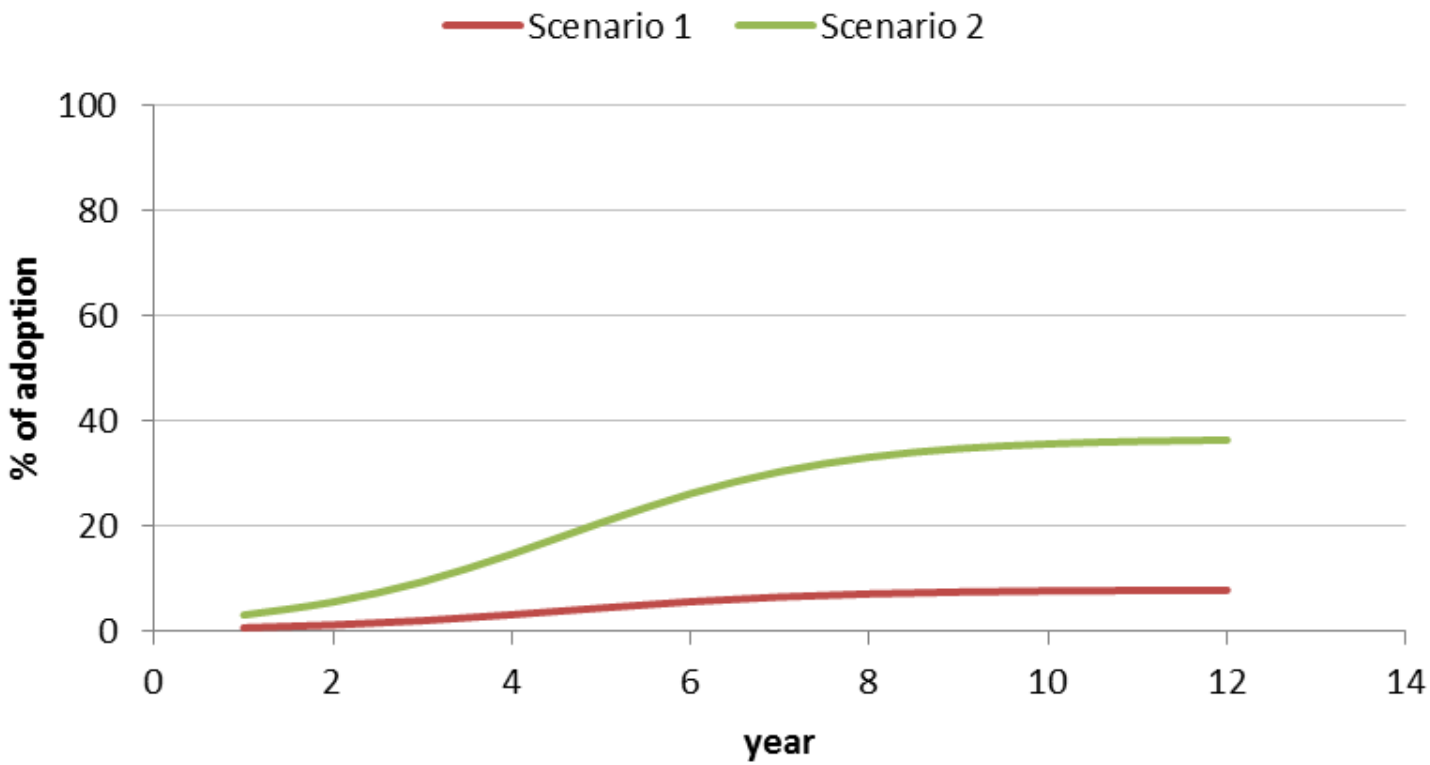
The θ_{max} is calculated from the results of the choice experiment, for different scenarios of coexistence measures

	Spain		Germany		UK		Portugal	
	Scenario 1	*Scenario 2*	*Scenario 1*	*Scenario 2*	*Scenario 1*	*Scenario 2*	*Scenario 1*	*Scenario 2*
Minimum distance (m)	100	0	300	50	100	100	100	100
Sowing difference (weeks)	0	4	0	0	0	0	0	0
Liable only if non-compliant	0	0	0	0	0	1	0	1
Liable always	1	1	1	1	1	0	1	0
Informing the neighbours	1	1	1	1	1	1	1	1
Informing the public	1	0	1	1	1	0	1	0
Potential adoption (θ_{max})	**36.8**	**66.6**	**7.9**	**36.6**	**31.4**	**65.0**	**52.8**	**77.8**

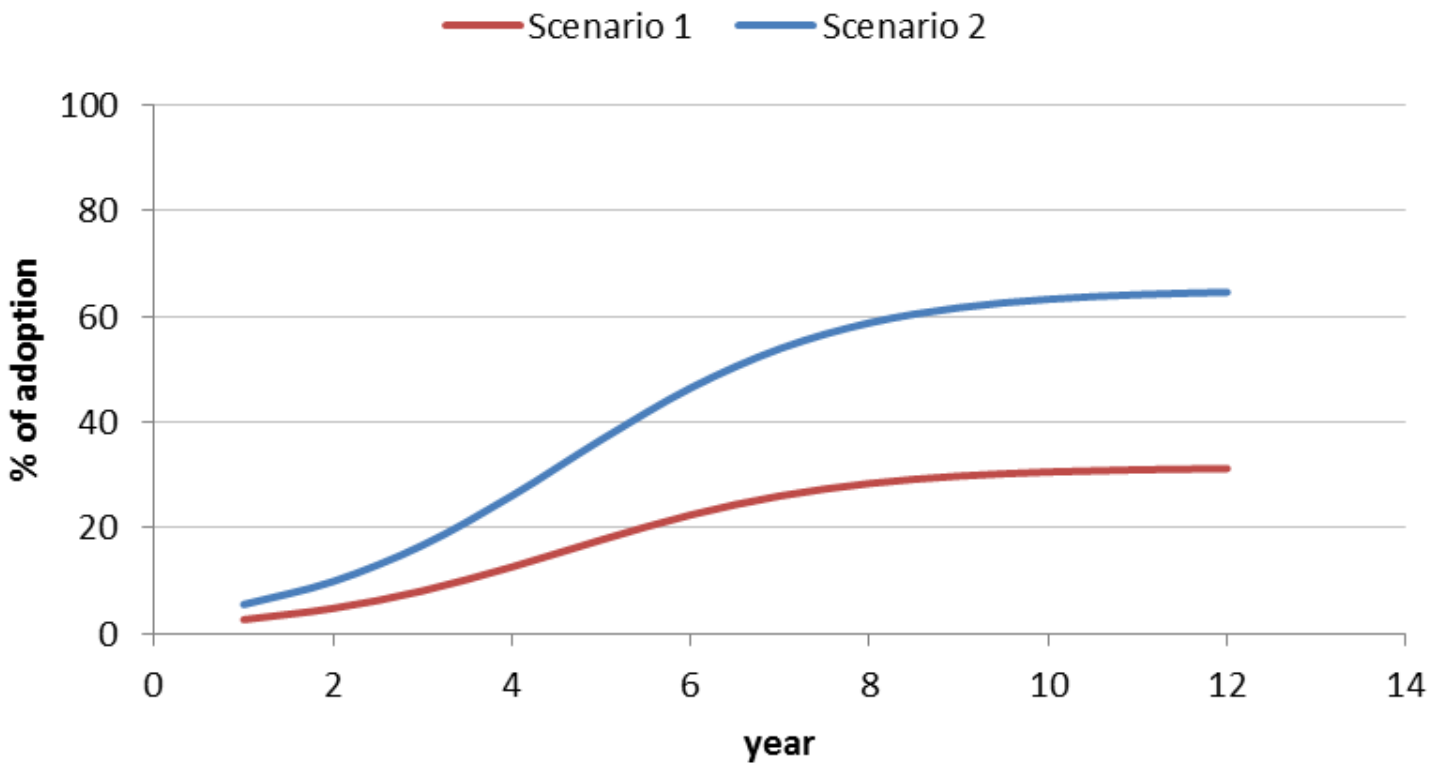
Adoption curve in Spain



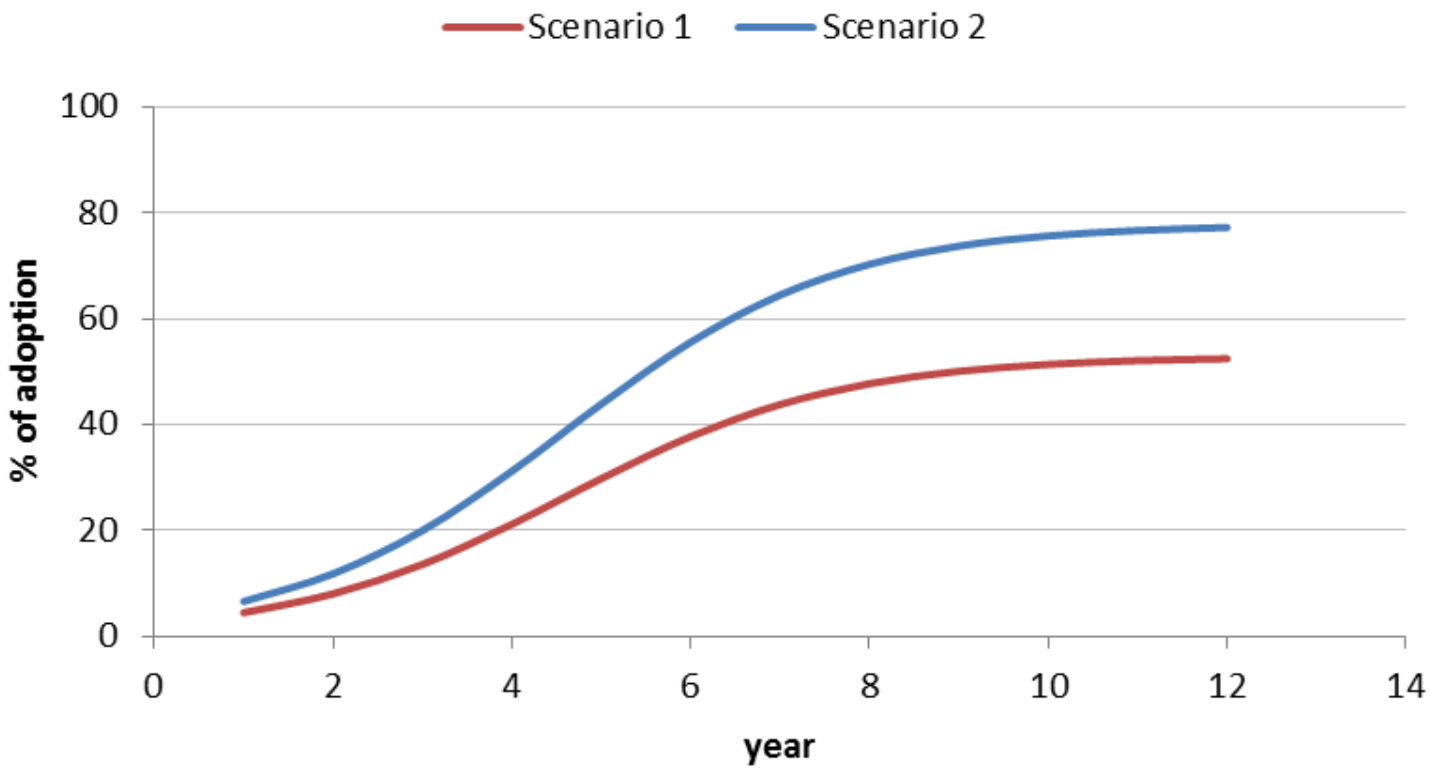
Adoption curve in Germany



Adoption curve in the UK



Adoption curve in Portugal



Thank you for your attention

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