Statistics in meteorology without tears

Part III: Decision making from probability forecasts

9th Moscow lecture May 2016
Anders Persson, Uppsala University

Assume we are in a region with

adverse weather 30% of the time

9 days/month or 122 days/year.

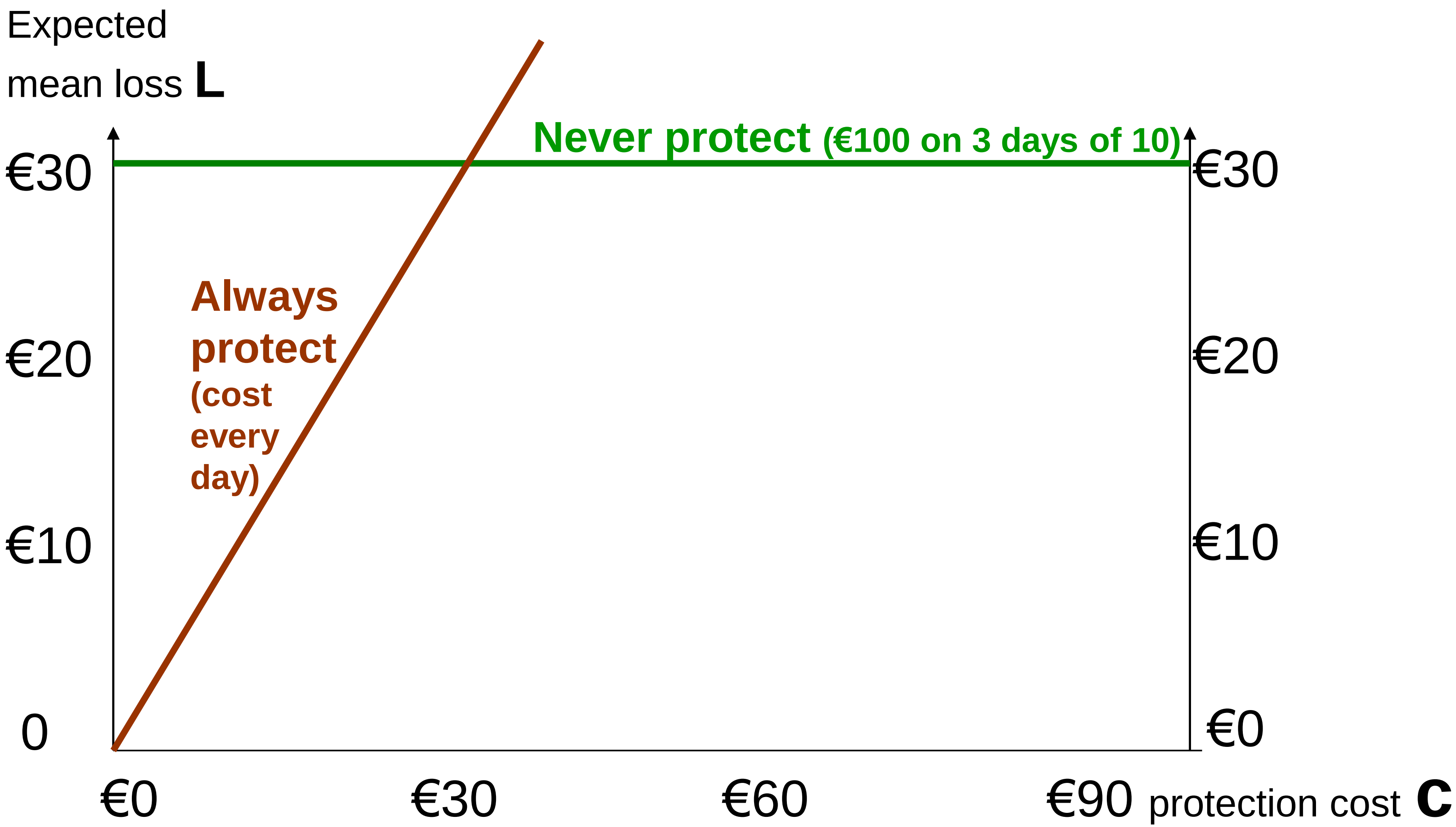
There is generally a 30% probability of rain

Assume that adverse weather will cause a loss **L = €100** per day

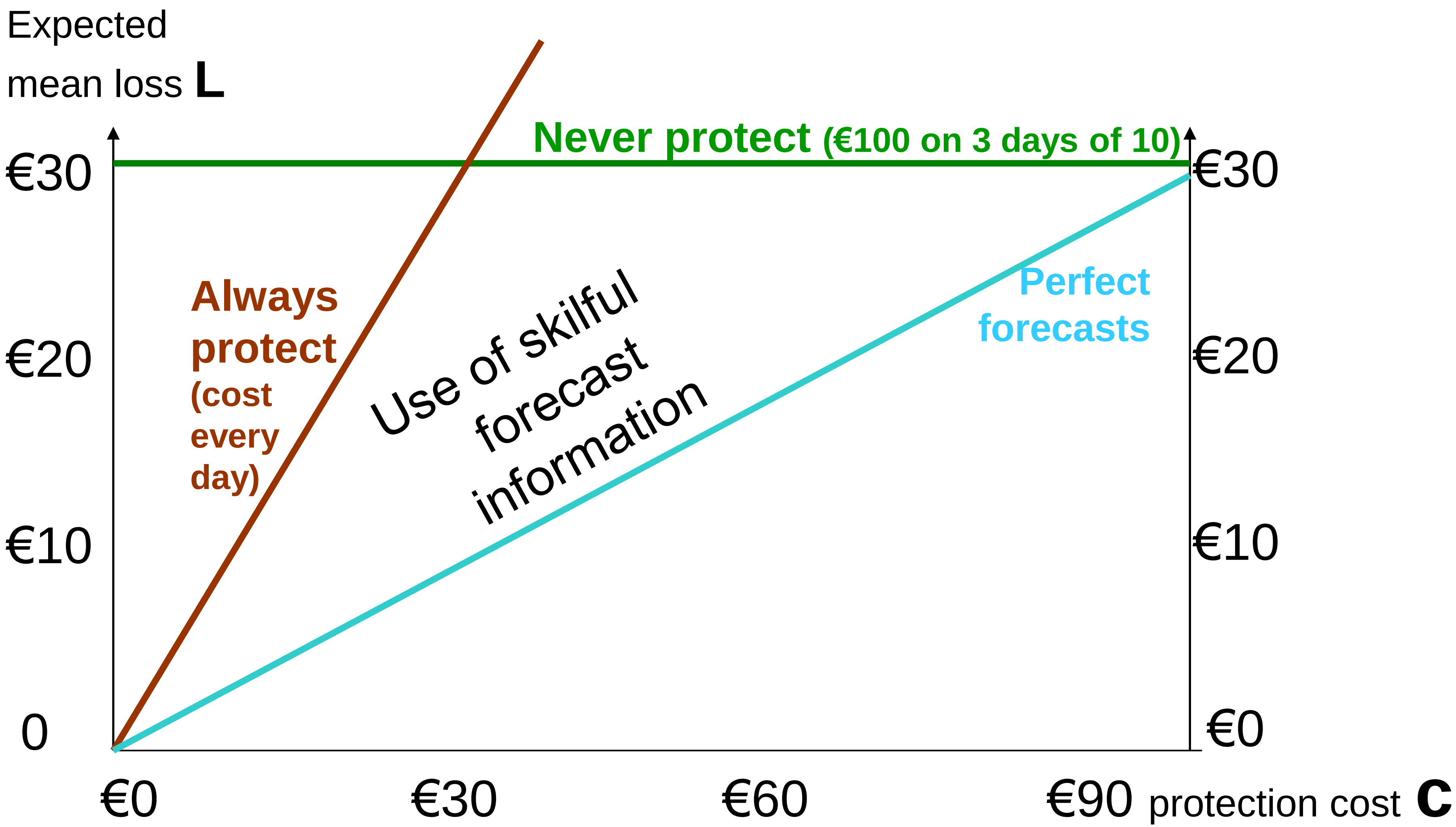
For a certain occupation the cost of protection per day may range from c = **€0** to c = **€100** **(the same as the loss)**

We can now calculate the average Expected Mean Loss per day, i.e. the average cost and loss per day if there is no forecast information

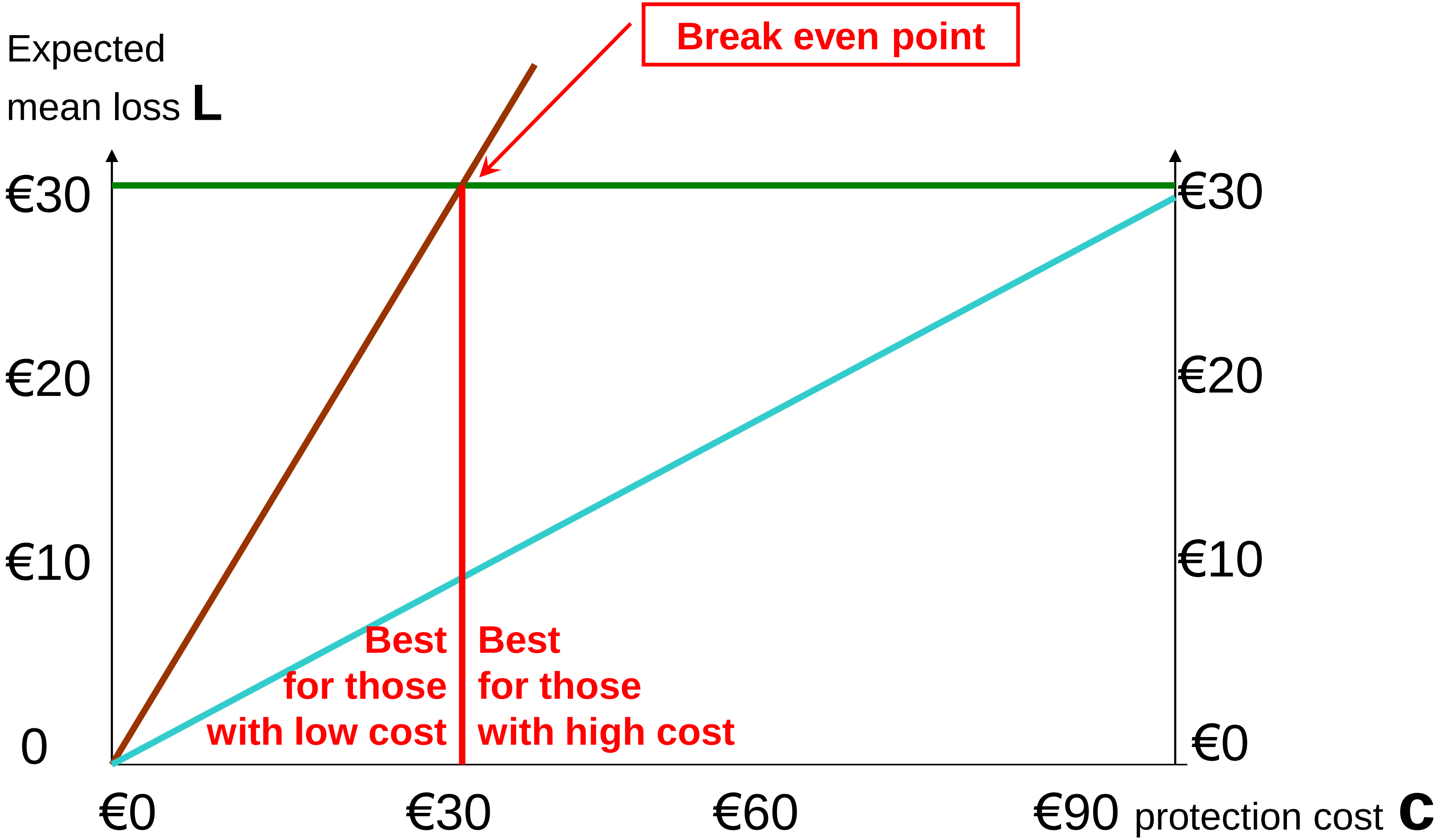
With no forecast information you can chose to a) protect every day or b) never protect



With forecast information we may minimize our costs, but not escape themcompletely



The cost/Loss at the break even point is the same as the climatological probability (p=30%)



The local weather forecasters make very good forecasts with 80% being correct.

All forecasts were well tuned:

The number of rain forecasts (30) over 100 days matches the number of observed rain days (30)

	Obs rain	Obs dry
Fc rain	20	10
Fc dry	10	60

This matrix also reflects the actions and their consequences

	Obs rain	Obs dry
Fc rain	**20**	**10**
Fc dry	**10**	**60**

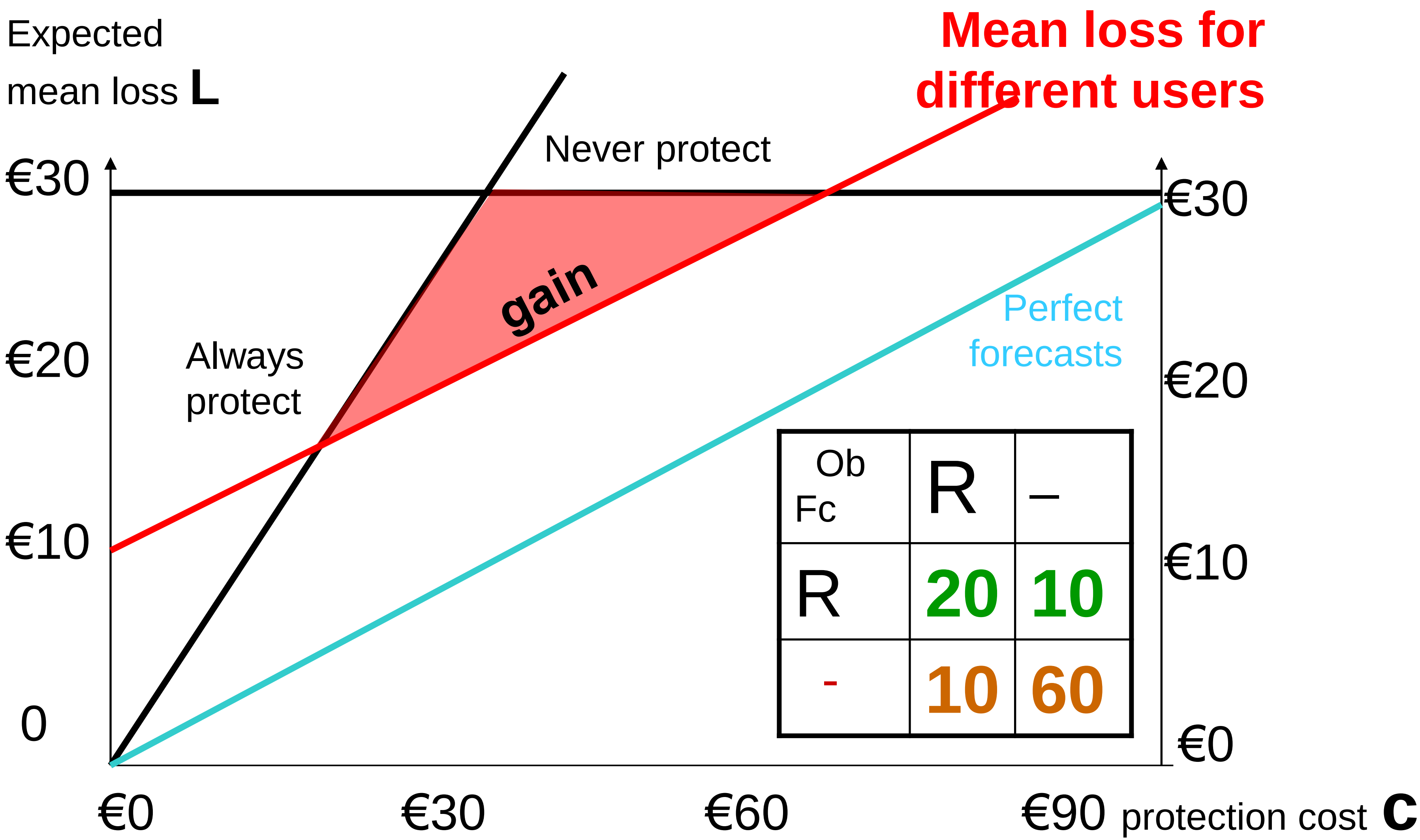
Actions were taken

No actions were taken

Losses

From this it is possible to calculate the Expected mean loss

The expected loss per day for different protection costs c



Ob / Fc	R	–
R	20	10
-	10	60

If the forecasters had chosen to become less categorical it could also have served *both* low and high cost-loss customers

	Obs rain	Obs dry
Fc rain	20	10
Fc dry	10	60

	Obs rain	Obs dry
Fc rain	10	0
???	20	20
Fc dry	0	50

50-50%

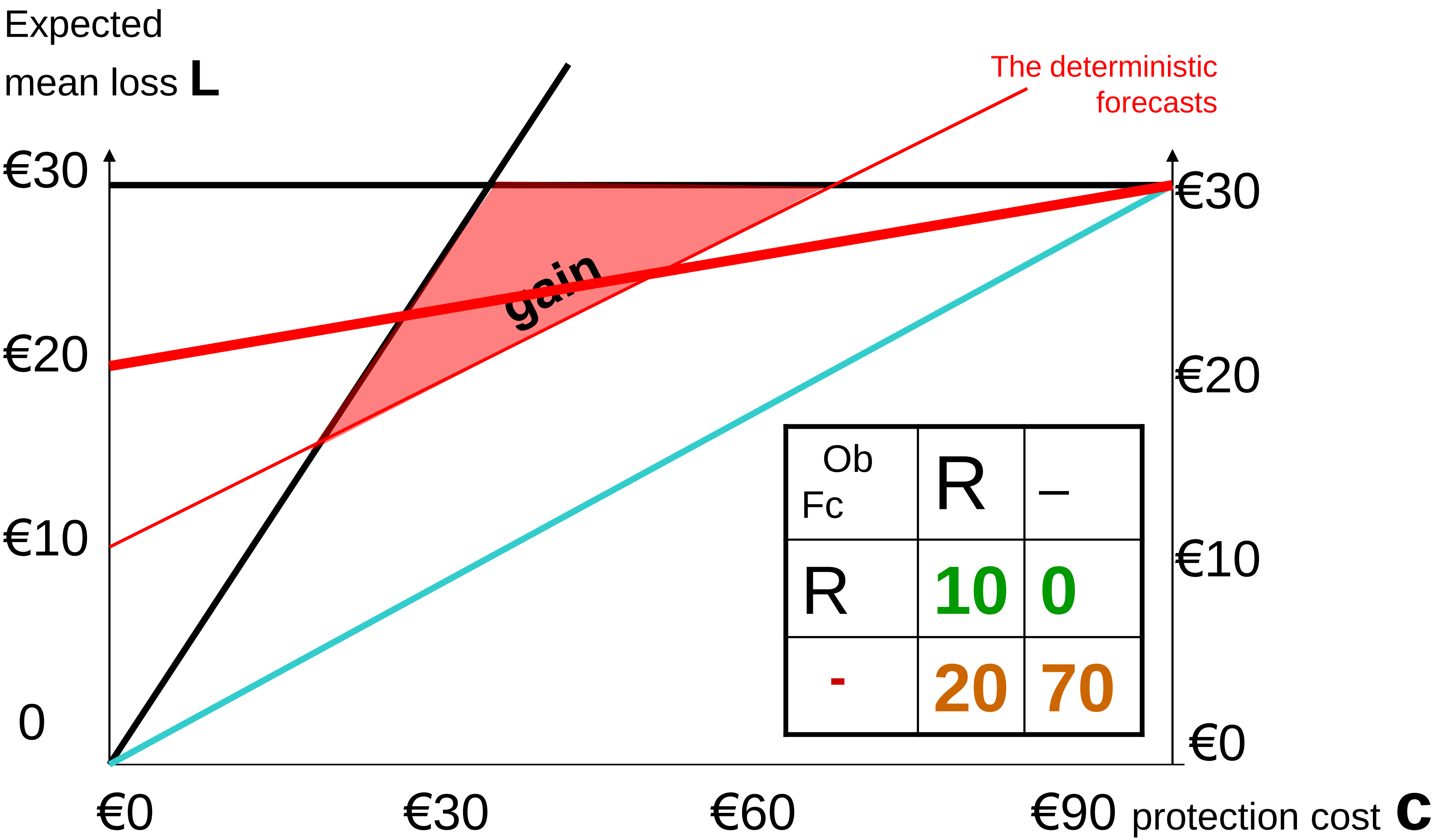
It allows those who are <u>not</u> sensitive to rain to interpret the ??? as "it might <u>not</u> rain"

	Obs rain	Obs dry
Fc rain	10	0
???	20	20
Fc dry	0	50

→

	Obs rain	Obs dry
Fc rain	10	0
Fc dry	20	70

These are the expected mean loss for those who interpreted ??? as "it might not rain"



Ob / Fc	R	–
R	10	0
-	20	70

It allows those who are sensitive to rain to interpret the ??? as "it might rain"

	Obs rain	Obs dry
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→

	Obs rain	Obs dry
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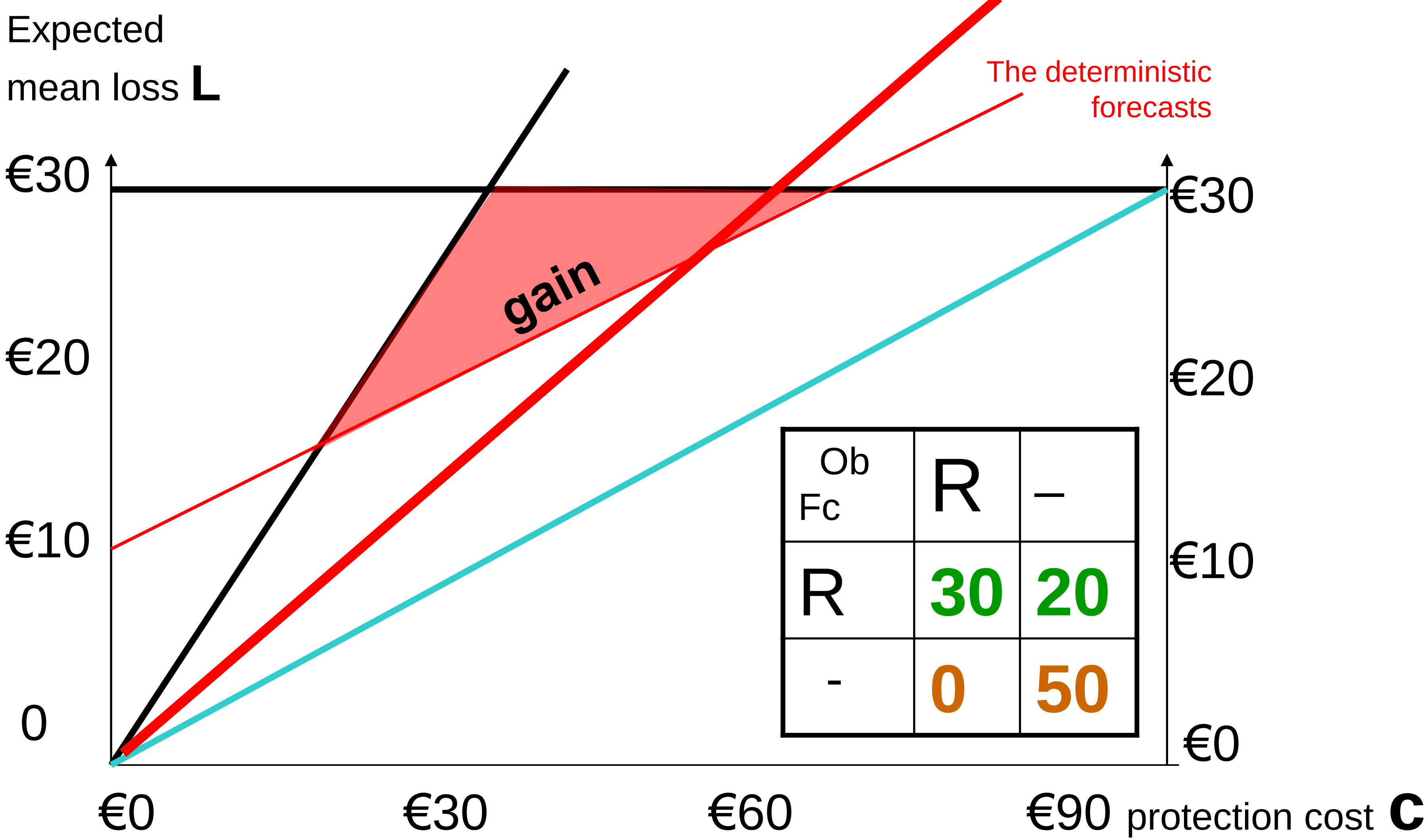
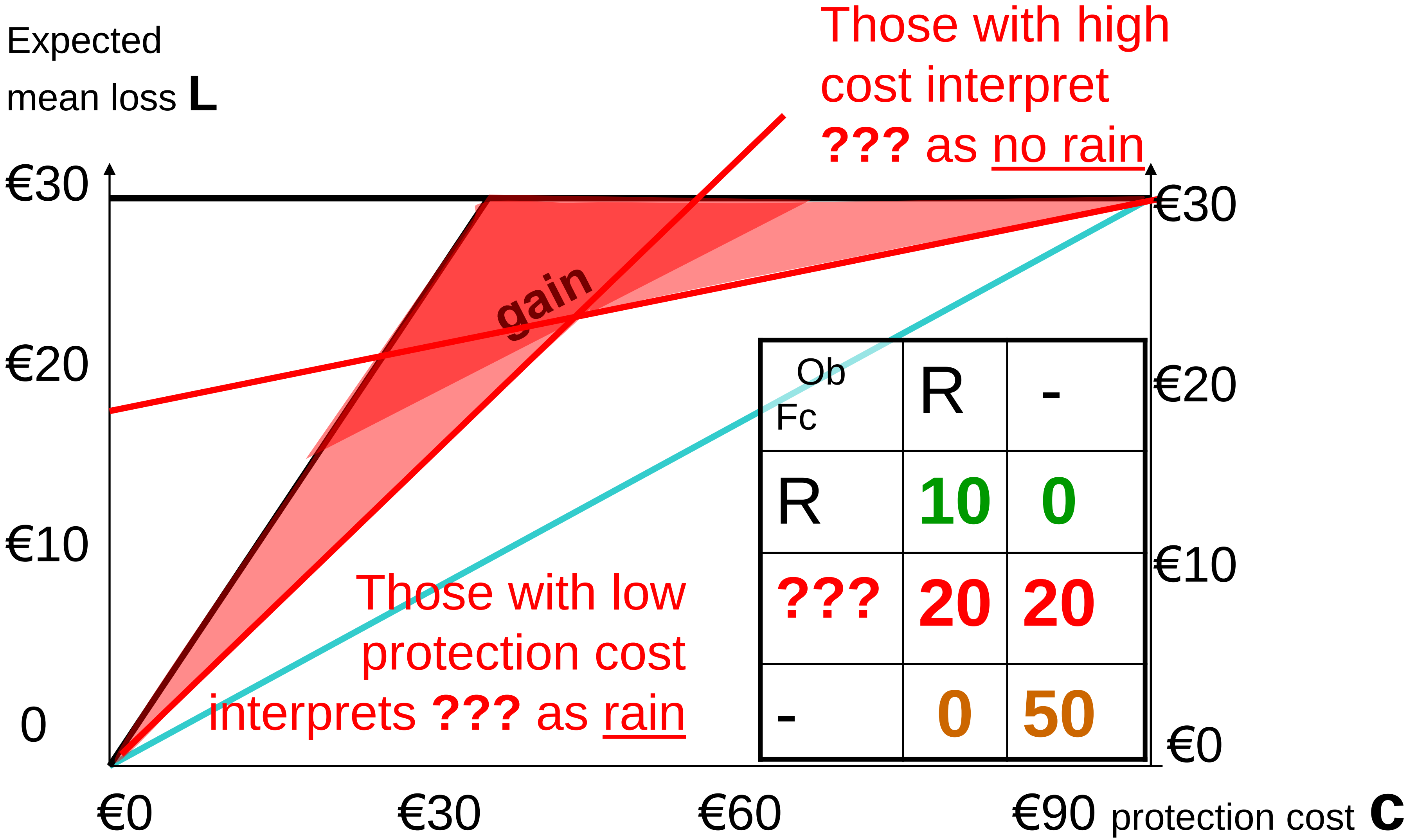
These are the expected mean loss for those who interpreted ??? as "it might rain"



And them put them together . . .



Ob / Fc	R	-
R	10	0
???	20	20
-	0	50

But not all of the 100 forecasts are certain

Categorical

Obs / Fc	R	–
R	20	10
-	10	60

Non-categorical

Obs / Fc	R	-
R	10	0
???	20	20
-	0	50

Probabilistic

Obs / Prob%	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

Can we quantify that uncertainty?

What to do with a probability **p**?

1. If you do nothing there is a chance **p** to lose **L**.

2. On average the loss will be **pL** (“risk”)

3. If you take protective action it will cost **c**

4. Only if **p·L > c** is it worth while to take action

5. The “break even” point is **p = c/L**

Decision matrix for different people when P=100%

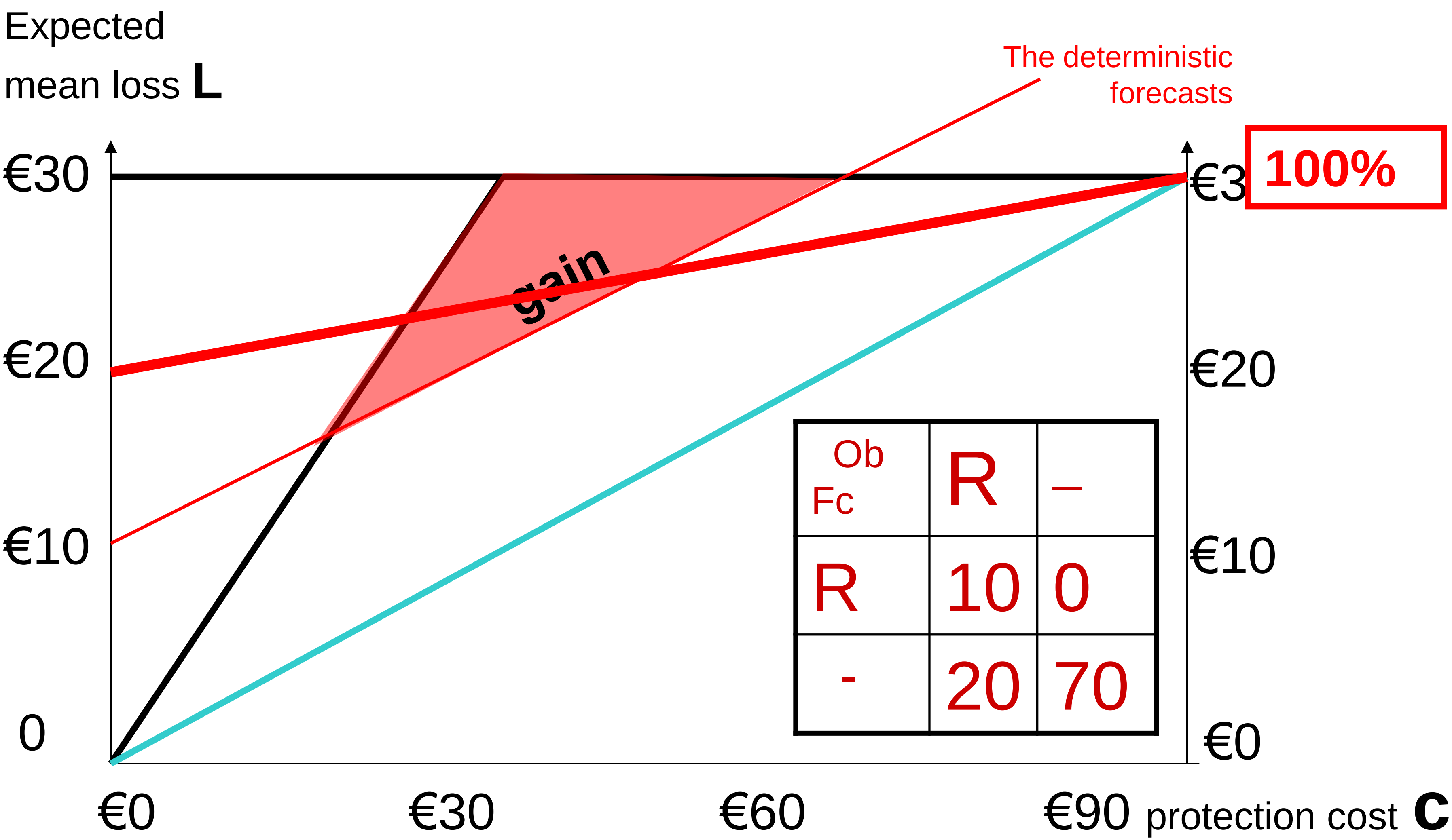
Ob Prob	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

Ob Fc	R	–
R	10	0
-	20	70

Decision matrix

Probability matrix

Gains for people with c/L almost 100%



Ob Fc	R	–
R	10	0
-	20	70

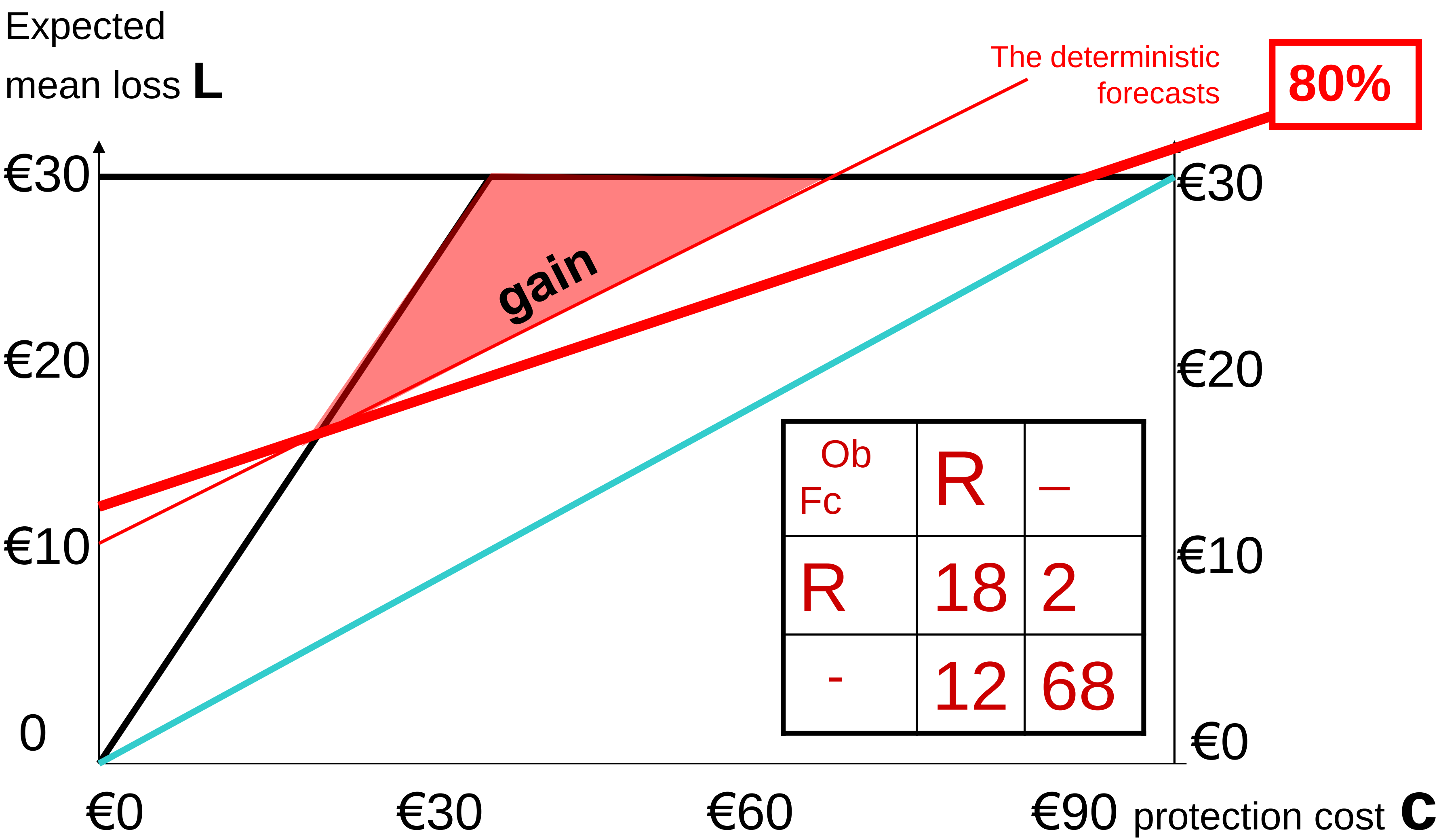
Decision matrix for people with c/L around 80%

Ob / Prob	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

→

Ob / Fc	R	–
R	18	2
-	12	68

Gains for people with c/L around 80%



Ob / Fc	R	–
R	18	2
-	12	68

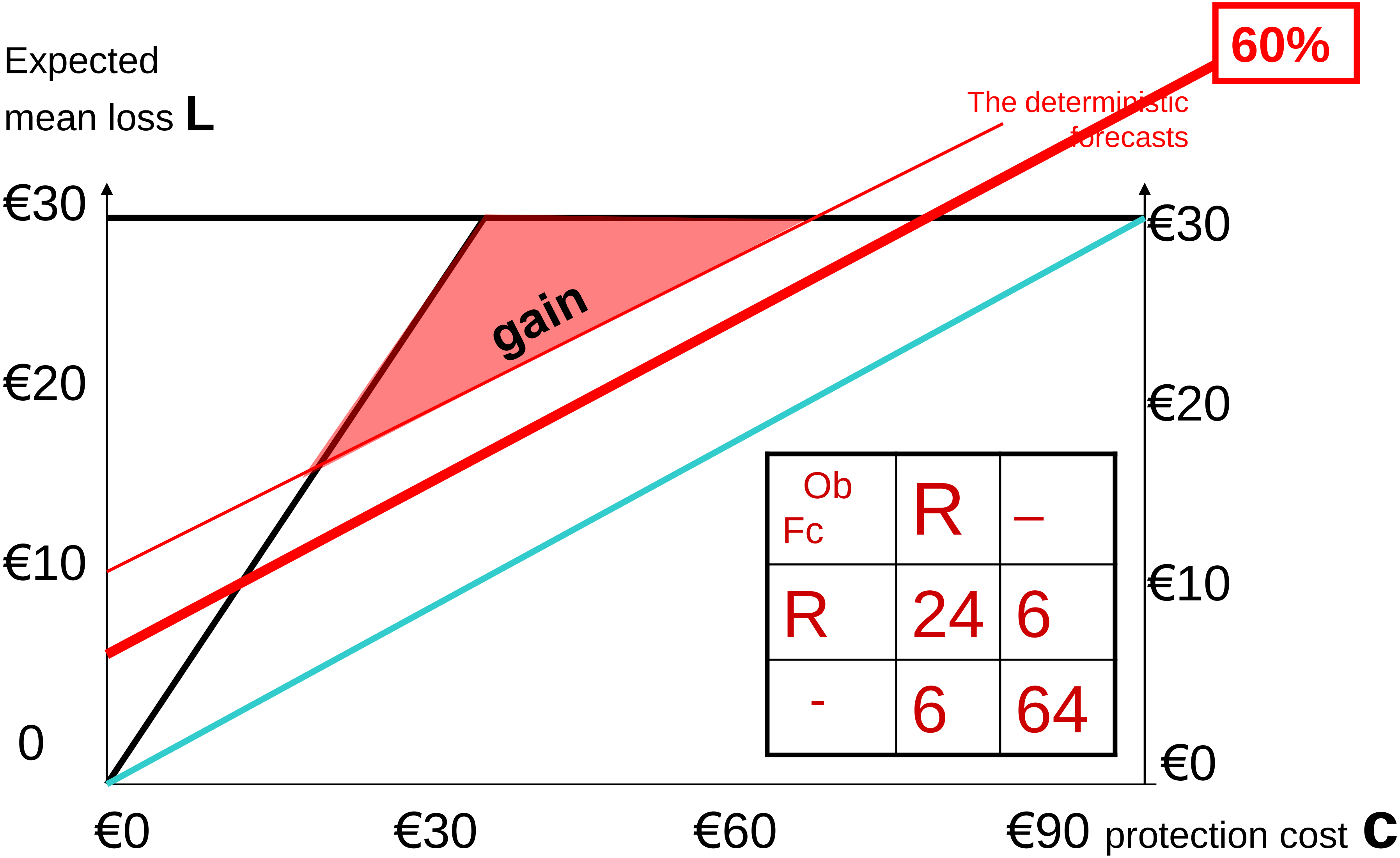
Decision matrix for people with c/L around 60%

Ob Prob	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

→

Ob Fc	R	–
R	24	6
-	6	64

Gains for different people when P = 60%



Ob / Fc	R	–
R	24	6
-	6	64

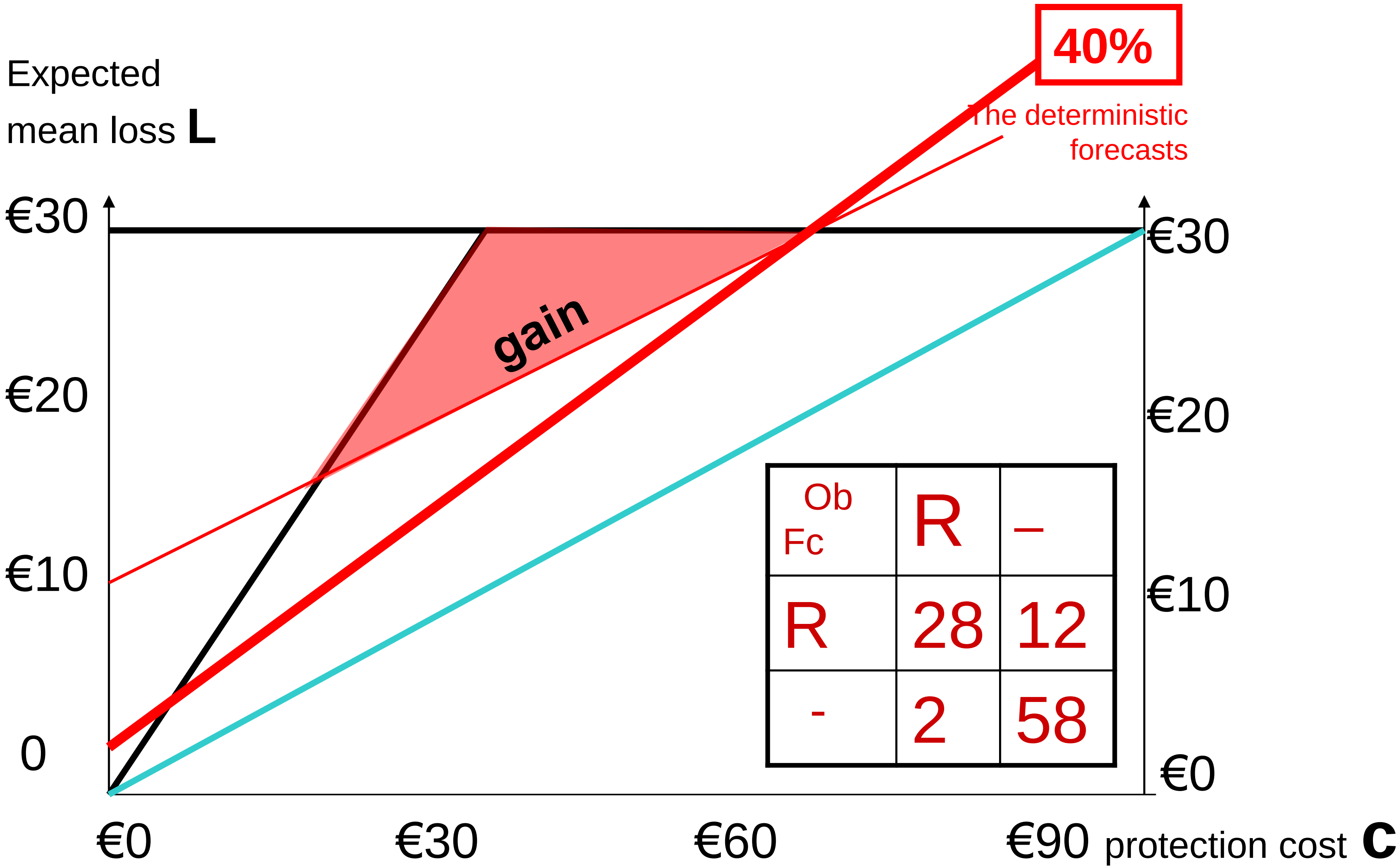
Decision matrix for people with c/L around 40%

Ob / Prob	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

→

Ob / Fc	R	–
R	28	12
-	2	58

Gains for people with c/L around 40%



Ob / Fc	R	–
R	28	12
-	2	58

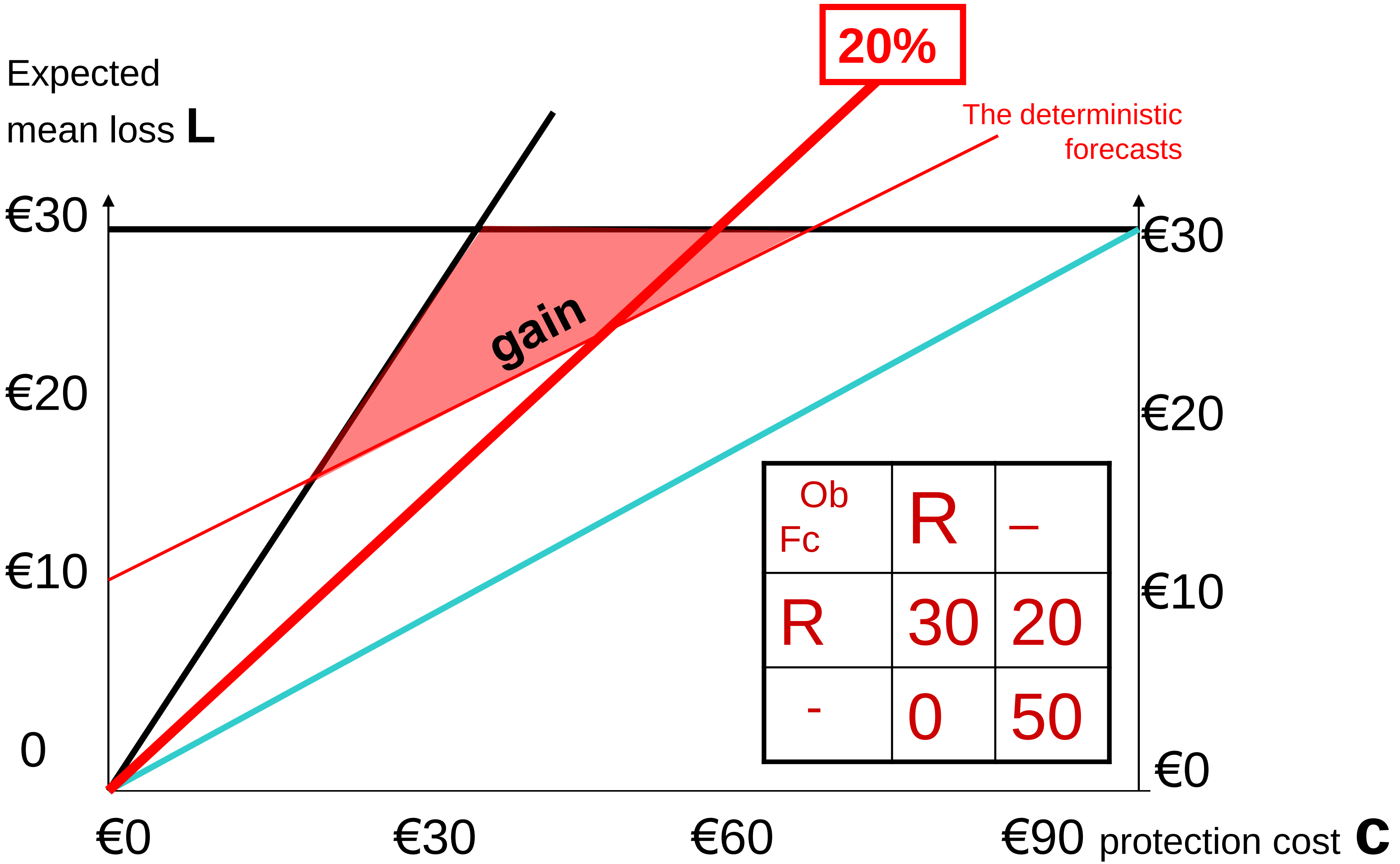
Decision matrix for people with c/L around 20%

Ob Prob	R	–
100	10	0
80	8	2
60	6	4
40	4	6
20	2	8
0	0	50

→

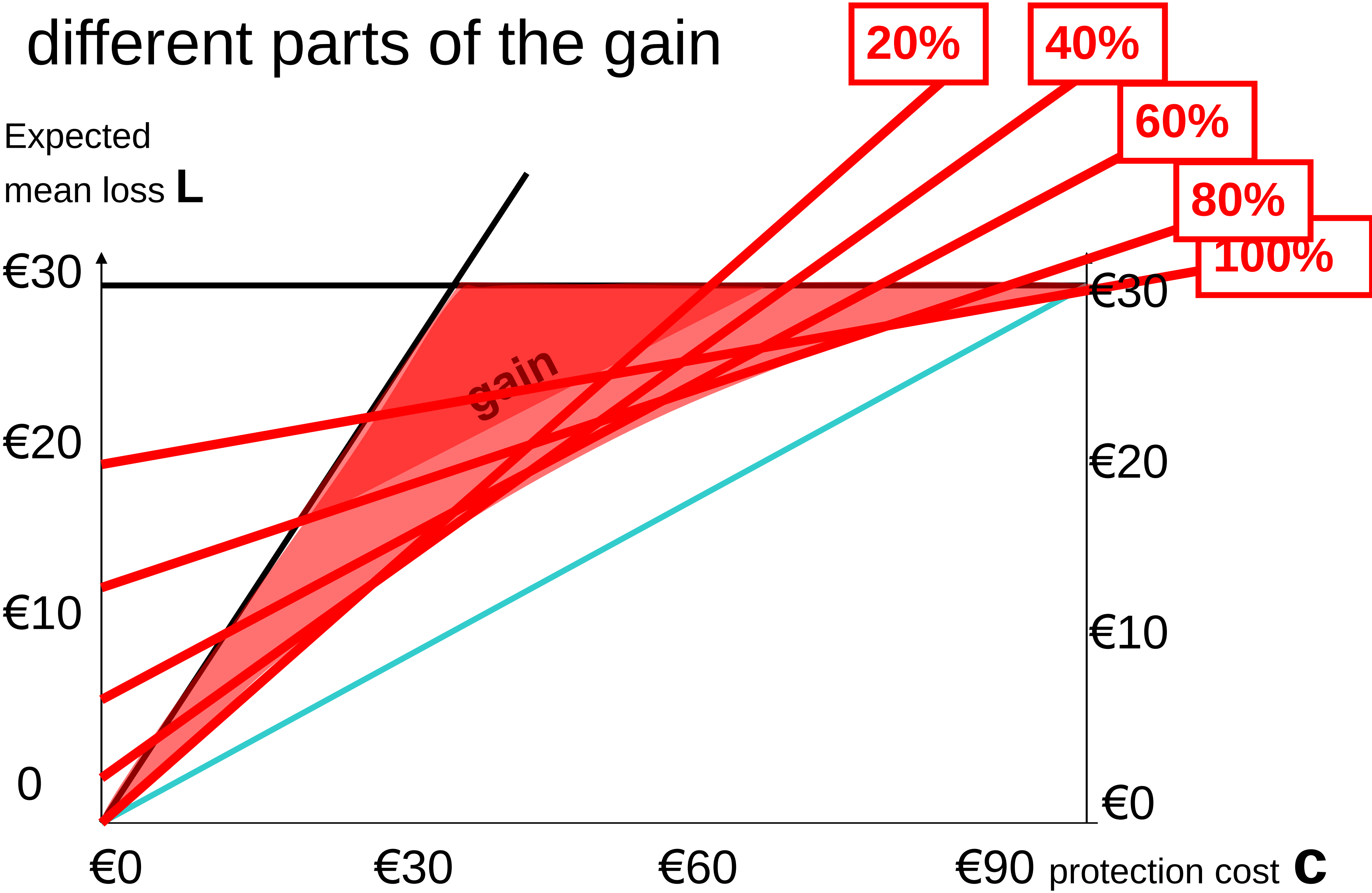
Ob Fc	R	–
R	30	20
-	0	50

Gains for people with c/L around 20%

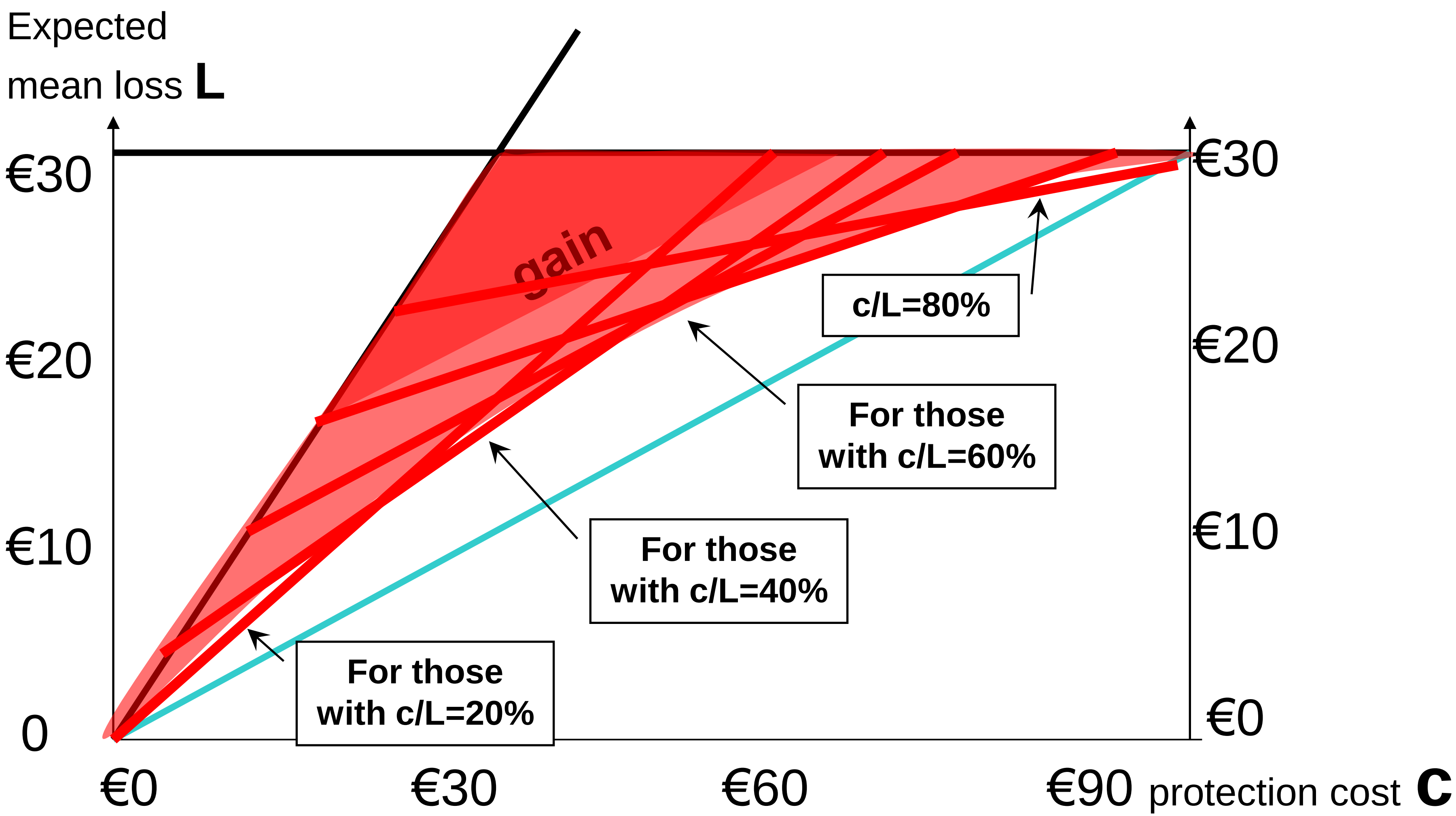


Ob / Fc	R	–
R	30	20
-	0	50

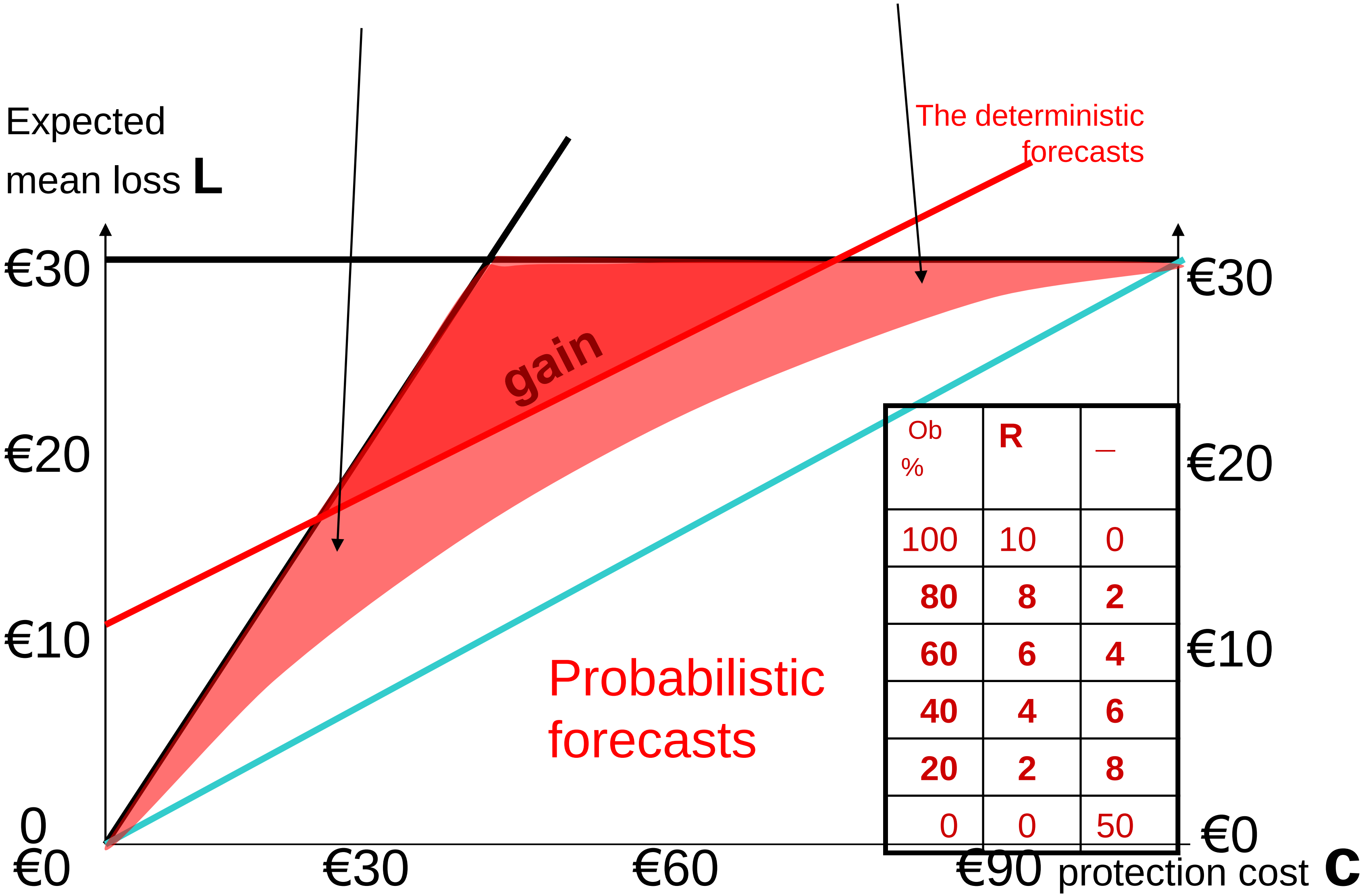
Different users benefit from different parts of the gain



Different users benefit from different parts



Probabilities yield gains for all possible protection costs



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