Underwater mortgages and mortgage default risk in a recourse market

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Introduction

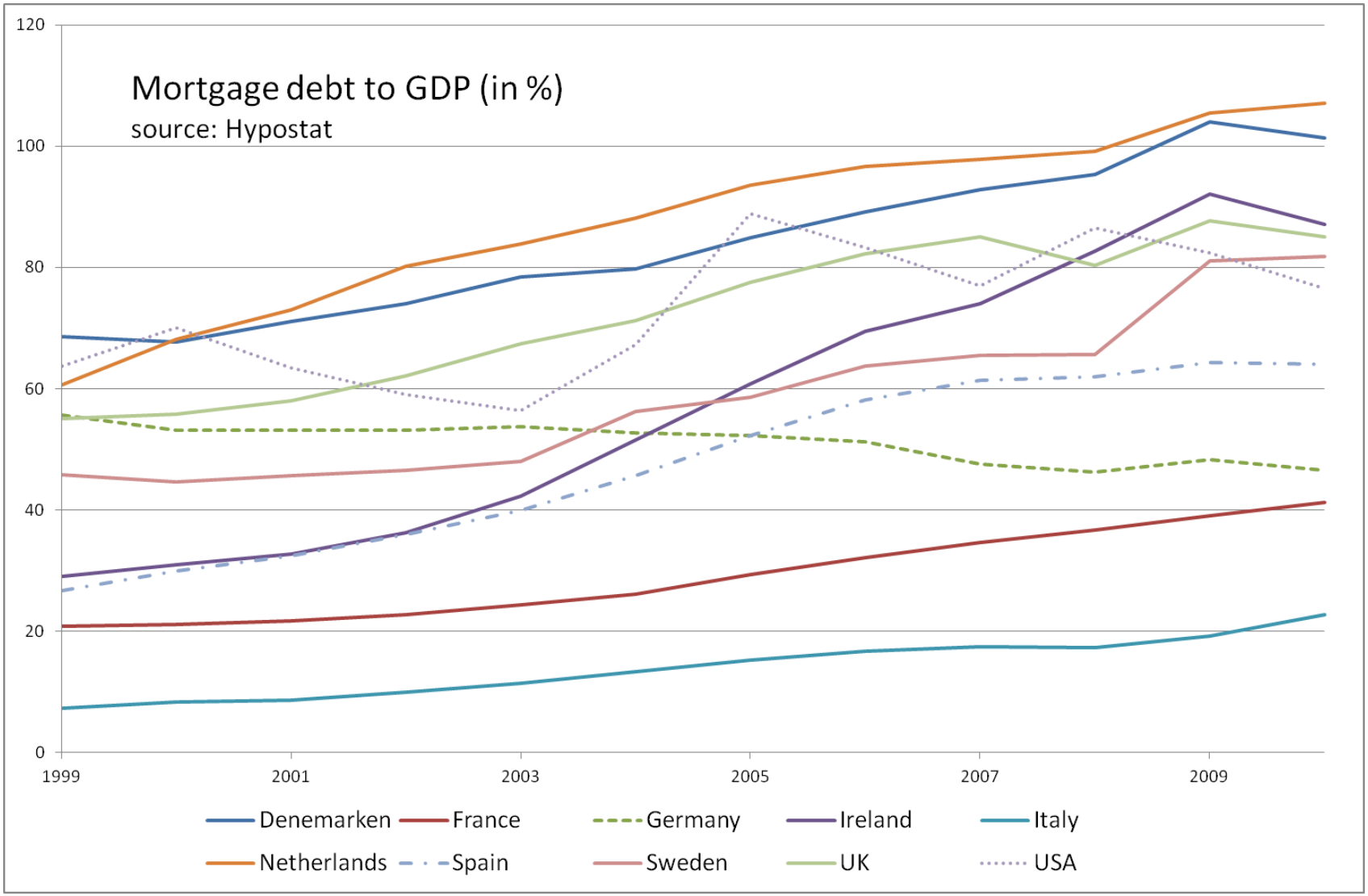
Background

- Number of households underwater: 500,000 (mid 2011)
  (number of owner-occupied homes: 4.3 mln)
- Number of defaults is increasing, however (still) relatively low

Research questions

- What makes households get underwater and
- To what extent does the prevalence of underwater households affect mortgage default risk?

Mortgage debt to GDP



Mortgage debt to value OO housing: age cohorts

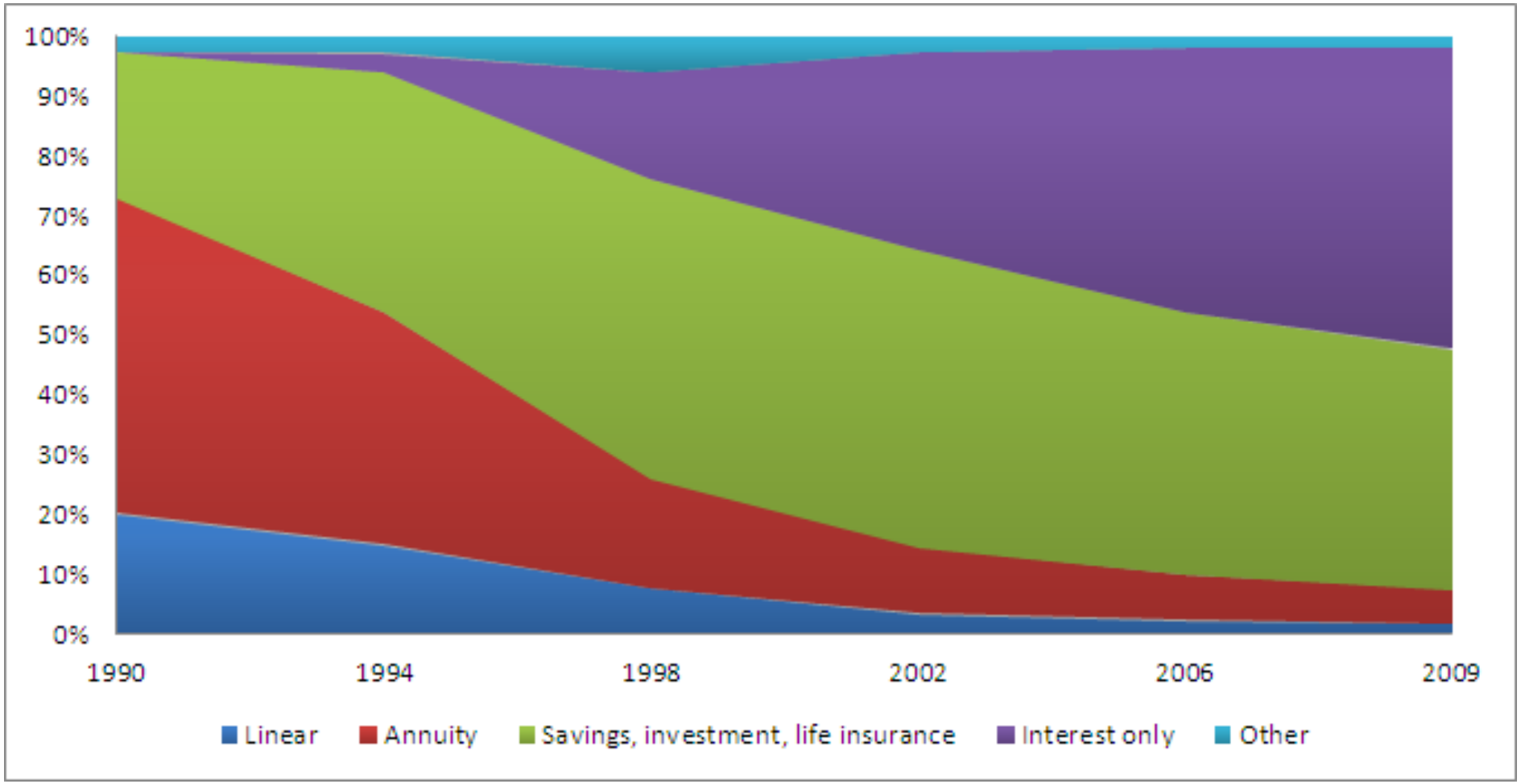
Age\Year	2006	2011*	% Owner Occupiers
<25	95.0%	104.4%	9.1%
25-30	95.4%	107.4%	39.6%
30-35	87.5%	102.7%	59.6%
35-40	73.3%	93.3%	67.3%
40-45	67.4%	78.6%	68.6%
45-50	53.1%	65.7%	67.0%
50-55	44.2%	55.6%	67.0%
55-60	38.9%	44.9%	66.3%
60-65	27.1%	35.1%	64.0%
65-70	19.9%	26.9%	61.4%
70-75	14.3%	18.6%	52.8%
>75	9.4%	9.9%	39.0%
Total	49.9%	56.5%	57.1%

Source: Statistics Netherlands
OO=Owner-Occupied

High leverage

- High leverage a problem for
  - Mortgage providers: Refinancing mortgages
    (mortgages: 640 bln, savings: 340 bln, funding gap: 300 bln)
  - Individual home owners: locked in
- Why is the Dutch housing market so leveraged?
  - Mortgage interest deduction
    (fully deduct interest payments over a period of 30 years)
  - National Mortgage Guarantee

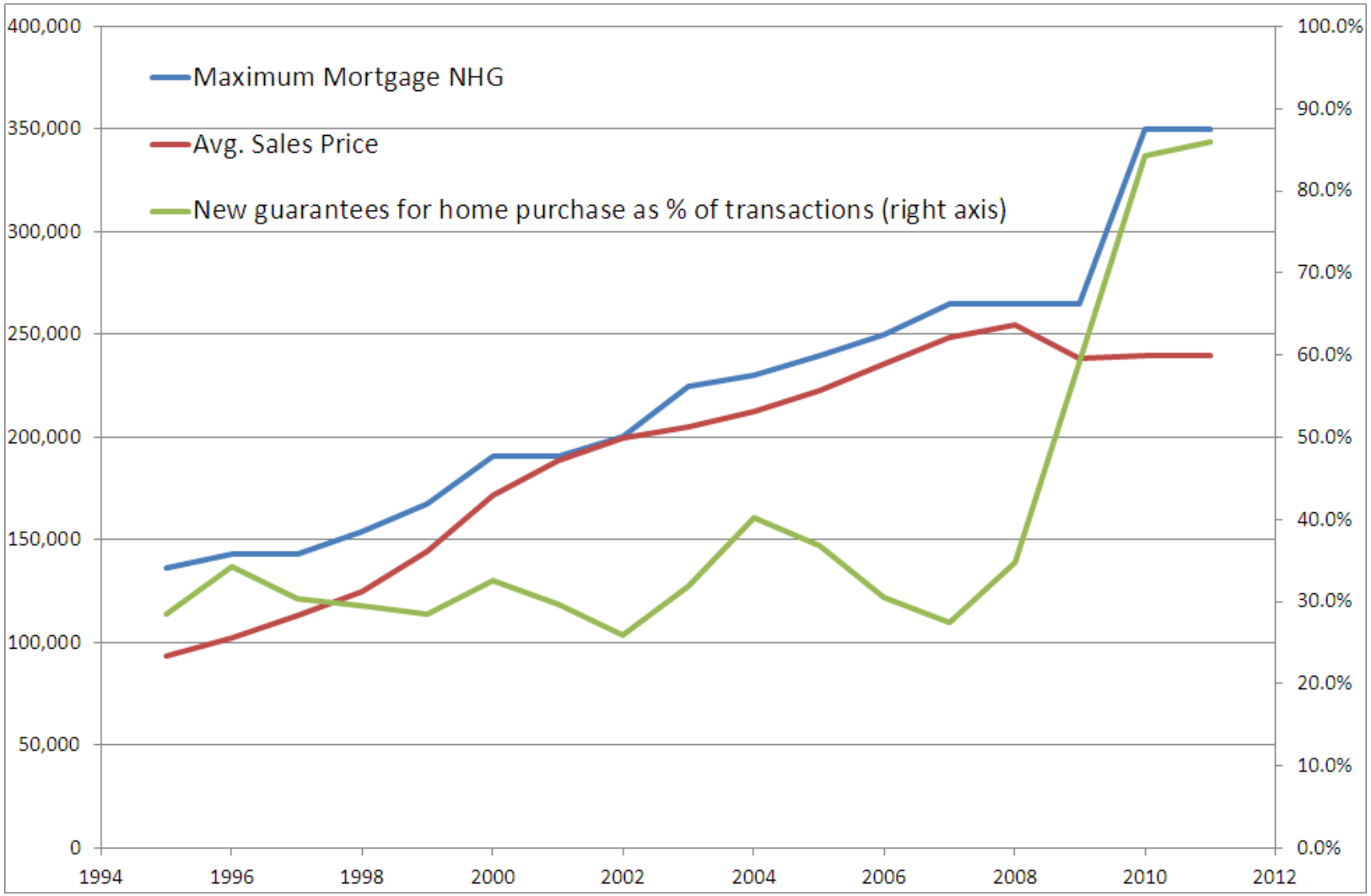
Classification of mortgages



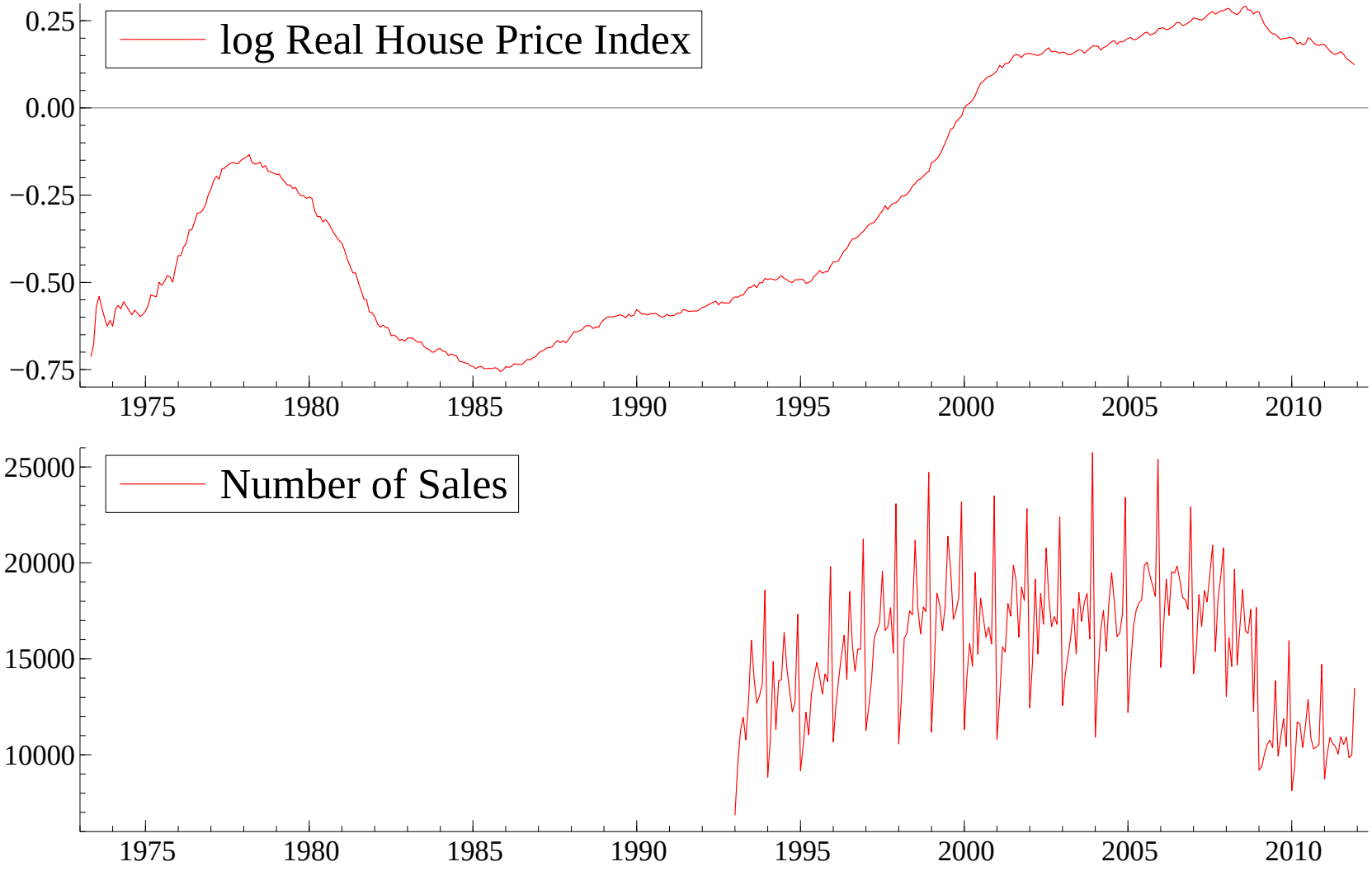
National Mortgage Guarantee

- households can insure their mortgages against losses
  (selling the home does not clear remaining outstanding mortgage)
- insurance against unfortunate events:
  divorce, illness, and unemployment
  does *not* cover losses from 'normal' housing transactions
- strict rules on LTV and LTI ratios
- maximum LTV still high: 106%
- max. loan €350,000 $\rightarrow$ €320,000 (July) $\rightarrow$ €265,000 (July 2014)
- less risk for mortgage provider
- borrower pays 0.7% of loan (in 2006: 0.28%)
- borrower has lower interest rate on loan: about 60 basis points

Maximum loan amount and proportion of guarantees



House Price Index and Number of Sales



Real Estate Literature on mortgage default

- Enormous literature on probability on mortgage default in US (decision to foreclosure)
- “Double triggers” theory: default occurs when 2 things happen
  1. the borrower has negative equity
     (house (execution) value - mortgage debt + savings)
  2. suffers an adverse life event (unemployment, divorce)
- US research (2008)
  - Negative equity is a necessary condition for foreclosure, not a sufficient one.
  - Only 6% of home-owners having estimated negative equity actually lost their homes to foreclosure.

Real Estate Literature on mortgage default

Typical research setup:

- Data on individual home-owners
  - initial purchase price,
  - transaction date,
  - mortgage (so initial loan-to-value),
  - house price development over holding period,
  - holding period
    1. the home-owner has sold his home
    2. default
    3. at the end of sample period she is still owner (censoring)
- The probability of default and sale is modelled simultaneously in a competing risk model (duration analysis) using the individual home-owner data and economic variables
- We do not have data on individual defaults, only aggregates

Data and models (1)

1. Quasi-panel: individual household characteristics
   - Housing Surveys of the Dutch Ministry of Housing
   - Years: 2002, 2006, and 2009
   - # Obs: between 65,000 and 100,000
   - Question: what are the determinants of households being underwater
     - ★ income, age, house price increase, occupancy, household composition, urbanity, recently moved, education level, non-amortizing mortgage
   - Probit model for being underwater
   - Underwater: Value of house - Mortgage debt [+ Capital insurance]
2. Aggregate NHG Default probabilities

Data and models (2)

1. Quasi-panel: individual household characteristics
2. Aggregate NHG Default (accepted claim) probabilities
   - Levels: NL, COROP, and municipality
   - From 1976 (1995) to 2011
   - Question: to what extent does the prevalence of underwater households affect mortgage default risk
     - ltv, lti, underwater and changes in price, income, unemployment
   - Models:
     1. Probit model for regional default probability
     2. Duration model

     $\Pr(T_i = j | T_i \geq j; x; \tau) = (1 + \exp(-x'\beta))^{-1}$, where
     - T_i is the duration of guarantee i to default,
     - τ is calendar time $\tau = 1976, 1997, \ldots, 2011$
     - x includes j and τ
     - missing information: duration to pay off mortgage

Guarantees and accepted claims

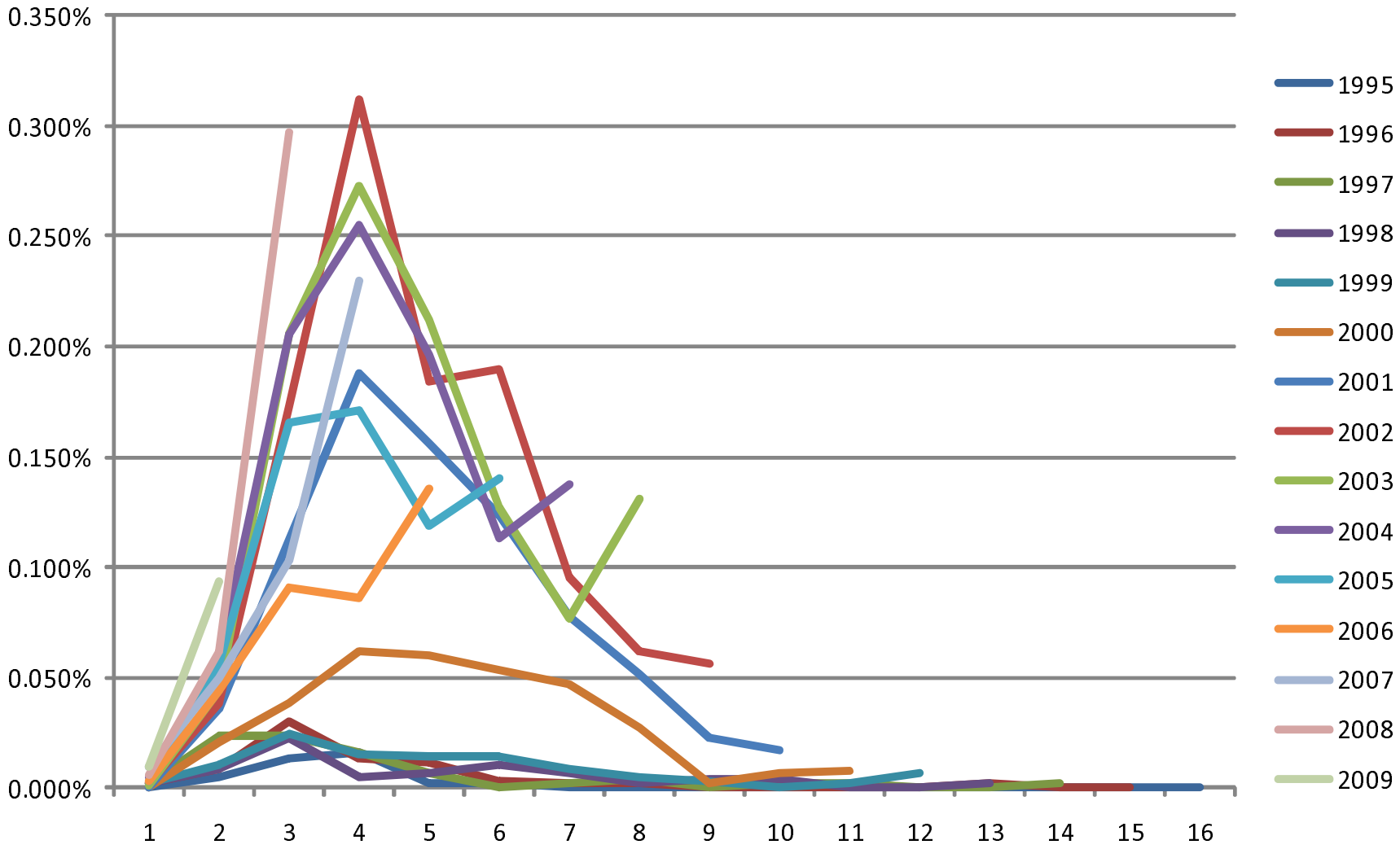
	New garuantees		Active garuantees		Accepted claims	
Year	Total	Purchase home	Number	euro (bln)	Number	euro (mln)
1995	44,025	44,025	44,025	3.53	0	0.00
1996	60,260	60,260	104,194	8.81	3	0.02
1997	56,177	56,177	159,035	13.97	12	0.18
1998	56,917	56,917	211,128	19.25	39	0.78
1999	58,292	58,243	259,334	24.63	31	0.48
2000	61,918	61,752	311,834	31.09	41	0.56
2001	58,156	57,937	353,338	36.82	39	0.50
2002	51,545	51,288	386,524	41.85	63	1.23
2003	70,122	61,636	447,395	50.82	145	3.32
2004	95,978	77,049	527,646	63.21	284	7.14
2005	111,423	75,948	618,459	77.86	494	14.83
2006	121,819	64,167	694,867	90.88	658	20.84
2007	90,337	55,685	716,113	95.68	816	25.46
2008	84,072	63,438	727,423	98.25	710	20.95
2009	97,329	75,356	807,505	108.88	606	19.09
2010	130,248	106,189	908,265	126.42	1158	38.63
2011	136,529	103,721	940,357	136.21	1734	59.56

Guarantees and accepted claims

- NHG data consists of total number of issued guarantees issued in each year (vintage), and the number of claims subsequently awarded by year

Vintage	Issued	1995	1996	1997	1998	1999	2000	2001	2002	...
1995	44025	0	2	6	7	1	1	0	0	...
1996	60260		1	5	18	8	7	2	1	...
1997	56177			1	13	13	9	4	0	...
1998	56917				1	5	13	3	4	...
1999	58292					1	6	14	9	...
2000	61918						0	13	24	...
2001	58156	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱

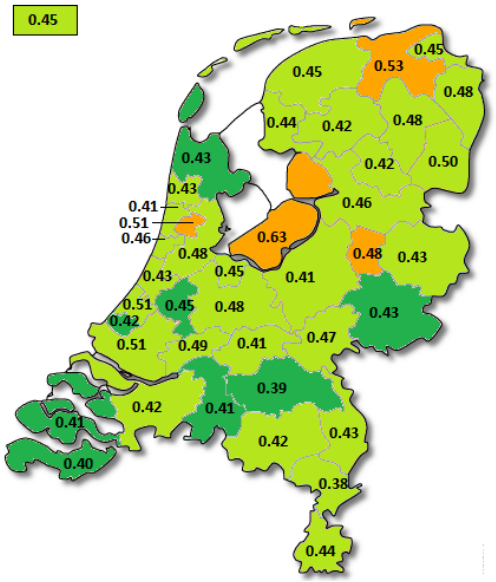
Default probability by duration



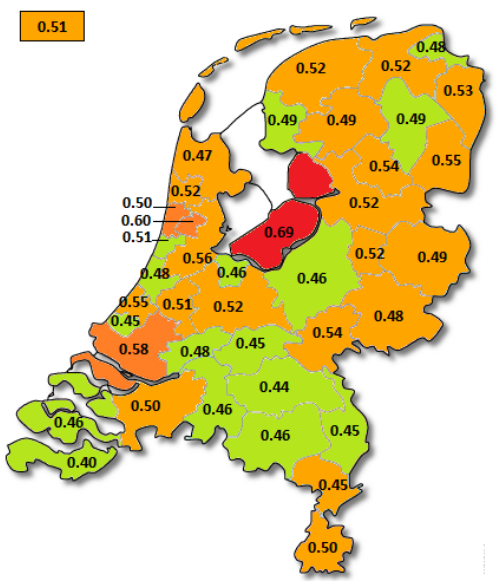
Results: determinants households being underwater

Variable	Coef	Std.Error	z	P>|z|
ln(house value)	-0.961	0.021	-45.01	0
House price change (%)	-0.912	0.413	-2.21	0.027
ln(income)	0.147	0.017	8.62	0
ln(age)	-0.662	0.039	-17	0
ln(occupancy duration)	-0.434	0.013	-32.76	0
amortizing loan	-0.190	0.032	-6.01	0
Type of income (ref. = salary)				
- Self-employed	0.178	0.024	7.49	0
- Pension	-0.040	0.034	-1.17	0.243
- Social welfare	-0.103	0.039	-2.61	0.009
Double income household	-0.025	0.030	-0.82	0.412
Education level (ref. = low)				
- Middle	-0.040	0.029	-1.37	0.17
- High	0.069	0.031	2.26	0.024
Household composition (ref. = single w/o kid)				
- Couple	0.161	0.036	4.48	0
- Couple with child(ren)	0.230	0.035	6.59	0
- Other	0.332	0.066	5.03	0
Urbanity (ref. = Strongly urban)				
- Urban	0.045	0.023	1.97	0.048
- Moderately urban	-0.008	0.024	-0.35	0.725
- Rural	-0.041	0.026	-1.59	0.113
- Strongly rural	-0.053	0.028	-1.93	0.054
Moved in past two years	0.106	0.028	3.75	0
Year (ref. = 2002)				
2006	0.436	0.032	13.77	0
2009	0.873	0.038	22.84	0
Constant	12.641	0.517	24.45	0
Obs	60,388		Pseudo R^2	0.268

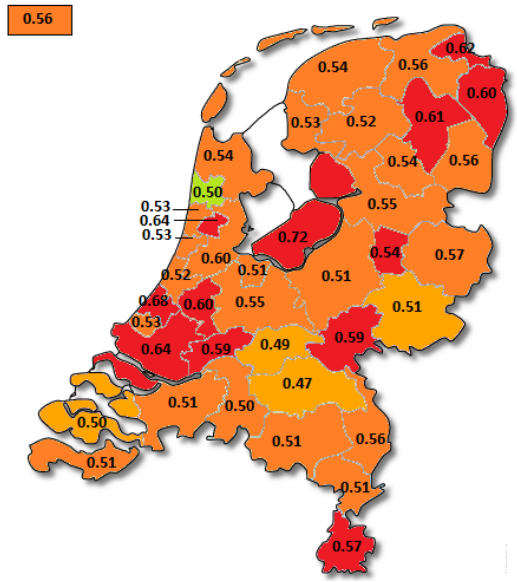
% households underwater and avg. LTV per region



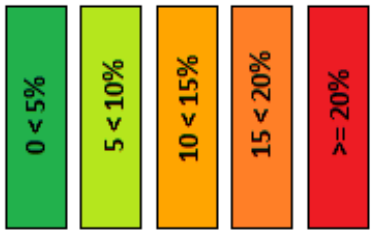
(a) 2002



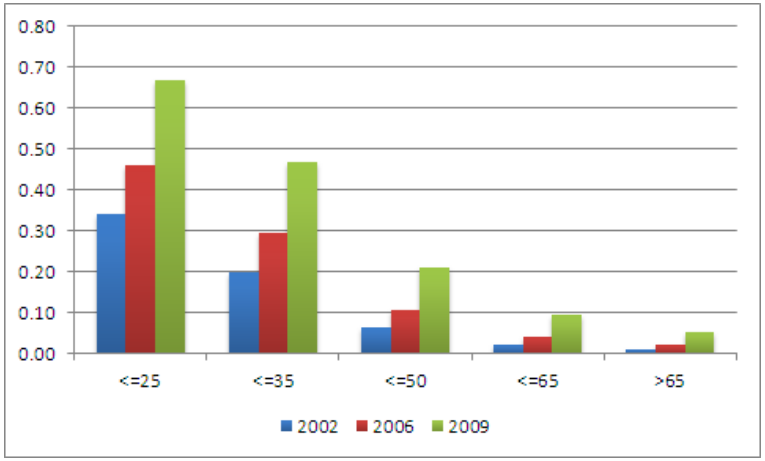
(b) 2006



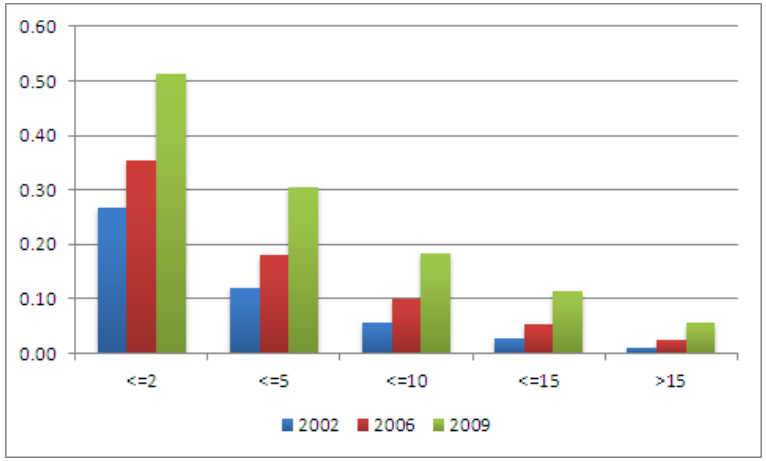
(c) 2009



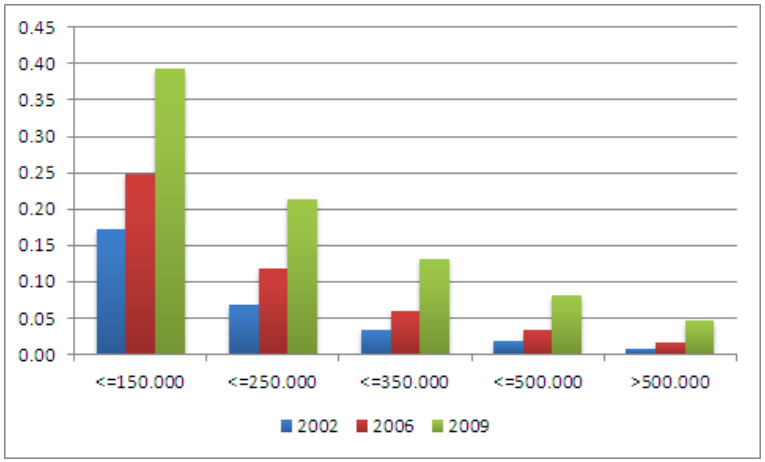
Probability underwater by age, occupancy, value



(a) age



(b) occupancy



(c) value

Default probabilities: probit model (40 regions)

	Coefficient	Std. Error	p-value
Δ(households)	25.081	12.032	0.037
Δ(price)	4.84	4.308	0.261
Δ(income)	30.54	21.985	0.165
Δ(unemployment)	-1.656	2.023	0.413
Time (ref. 2002)			
2006	1.869	1.683	0.267
2009	5.369	1.857	0.004
Time to maturity	0.754	0.367	0.04
LTV overall	-8.68	6.025	0.15
LTV recent mover	0.249	3.006	0.934
LTI overall	0.873	1.211	0.471
LTI recent mover	0.406	0.6	0.499
Non-amortizing	-7.893	8.429	0.349
Underwater	-2.303	11.693	0.844
Pseudo R^2	0.343		
n	120		

‘Underwater’ coefficient insignificant, however in duration model equity coefficient is highly significant

Default probabilities: duration model

Explanatory variables

- **Equity**: (relative) value of the house minus loan balance
- **UnemL2**: unemployment rate, 2 years lagged
- **cWPI**: cumulative wage price index
- **dCPI**: current inflation
- **Duration**: years since guarantee issuance, up to 3rd degree polynomial

Equity

As we have no individual observations on equity, we construct an aggregate measure as follows:

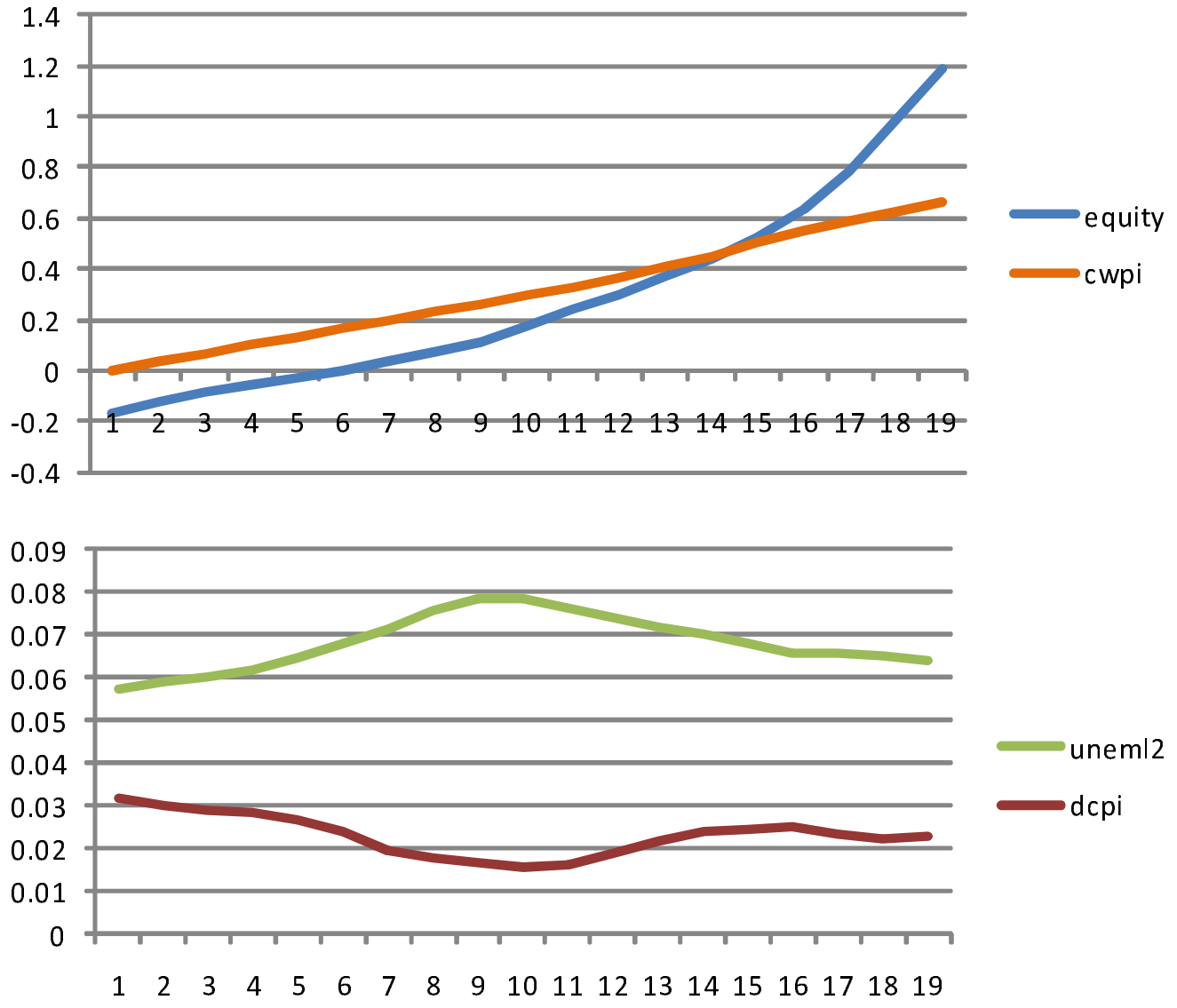
$$E_{t+s} = \frac{eP_{t+s} - L_t + K_{t+s}}{L_t},$$

where

- E_{t+s} = equity in current year $t + s$ for a house purchased in t
- P = house price
- L = loan amount
- K = capital accumulation

Using house price index data, interest rate data, and assumptions on the down-payment scheme and initial loan-to-value, we can estimate the equity per duration.

Historical explanatory variable avg. by duration



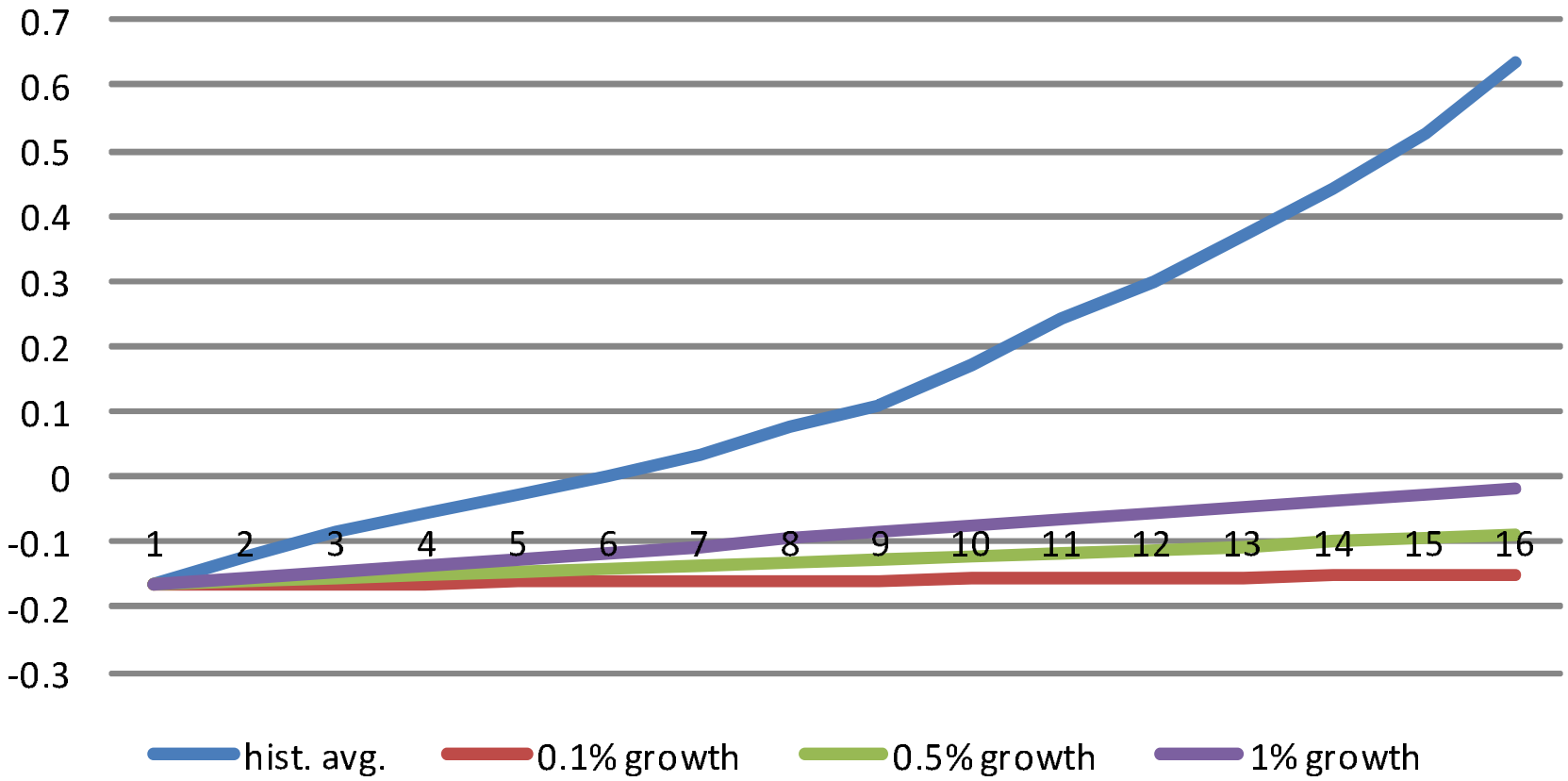
Estimation results

Variabele	Coef.	Std. Error	z
Equity	-5.573	0.068	-81.44
dCPI	-7.478	0.721	-10.37
cWPI	-9.849	0.268	-36.8
UnemL2	23.61	0.504	46.9
Duration=1	-2.353	0.111	-21.19
Duration	1.152	0.019	59.2
Duration^2	-0.086	0.002	-44.58
Duration^3	0.0027	0.0001	47.21
Constante	-11.45	0.075	-153.6
Number of observations	34519041		
Wald chi2(8)	16283.52		
Prob $>$ chi 2	0		
Pseudo R 2	0.1201		
Log-likelihood	-123401.06		

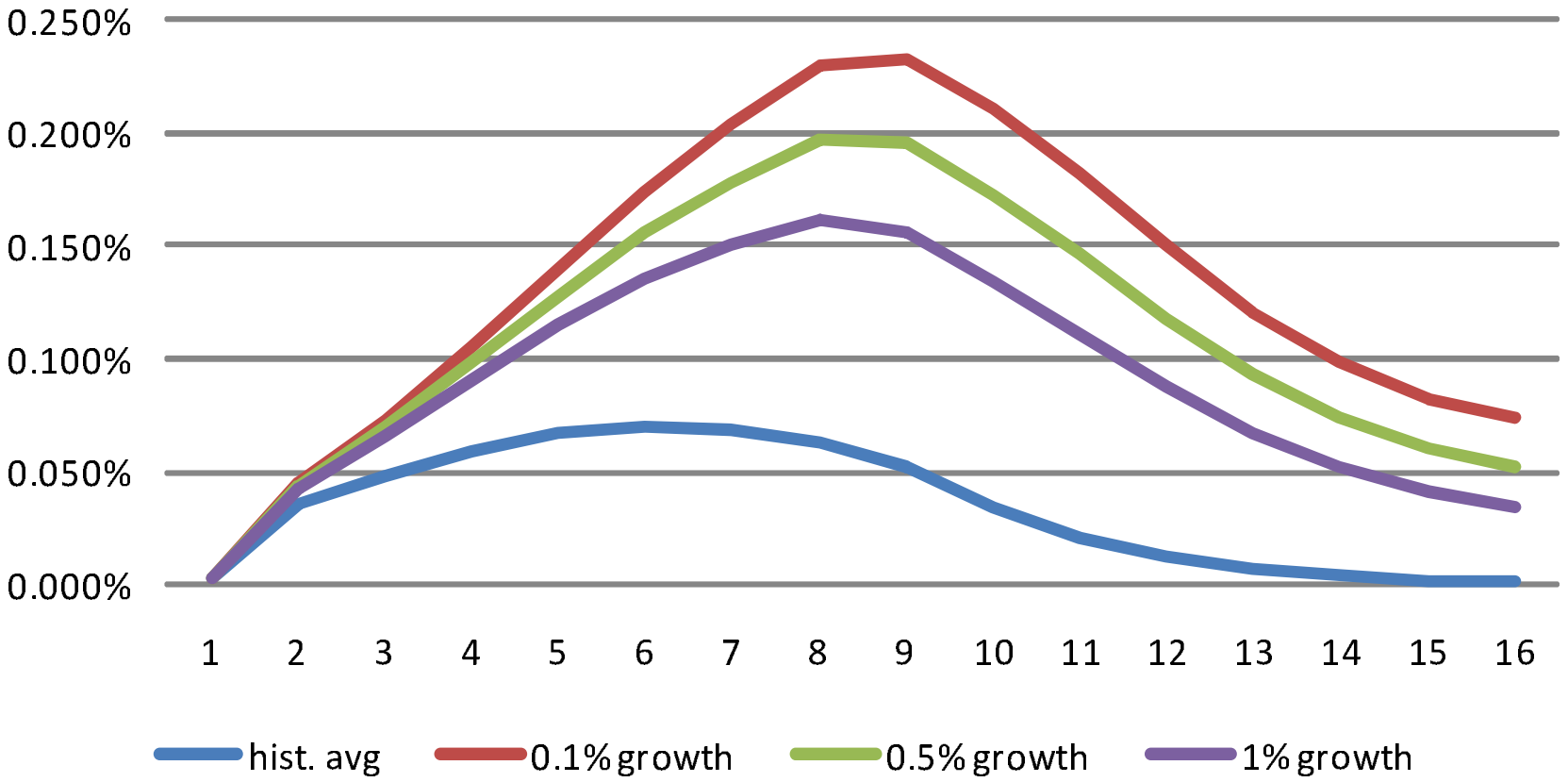
Marginal effects on default probabilities

Duration	Equity	dCPI	cWPI	UnemL2
1	0.000%	0.000%	0.000%	0.000%
2	-0.020%	-0.010%	-0.010%	0.020%
3	-0.040%	-0.010%	-0.020%	0.030%
4	-0.050%	-0.010%	-0.020%	0.030%
5	-0.060%	-0.010%	-0.020%	0.030%
6	-0.060%	-0.010%	-0.020%	0.020%
7	-0.050%	0.000%	-0.020%	0.020%
8	-0.030%	0.000%	-0.010%	0.010%
9	-0.020%	0.000%	-0.010%	0.010%
10	-0.010%	0.000%	0.000%	0.000%

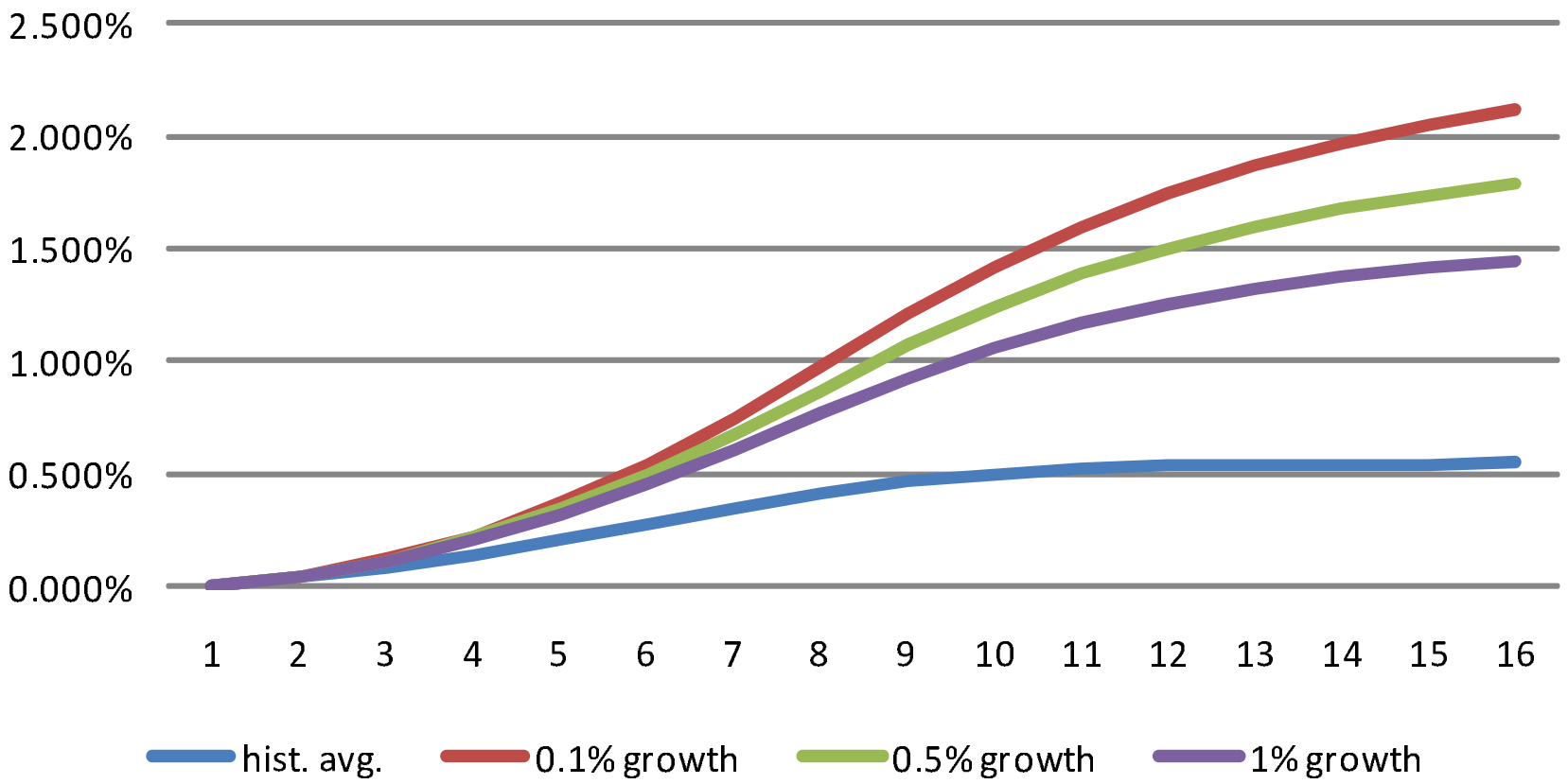
Simple equity scenarios



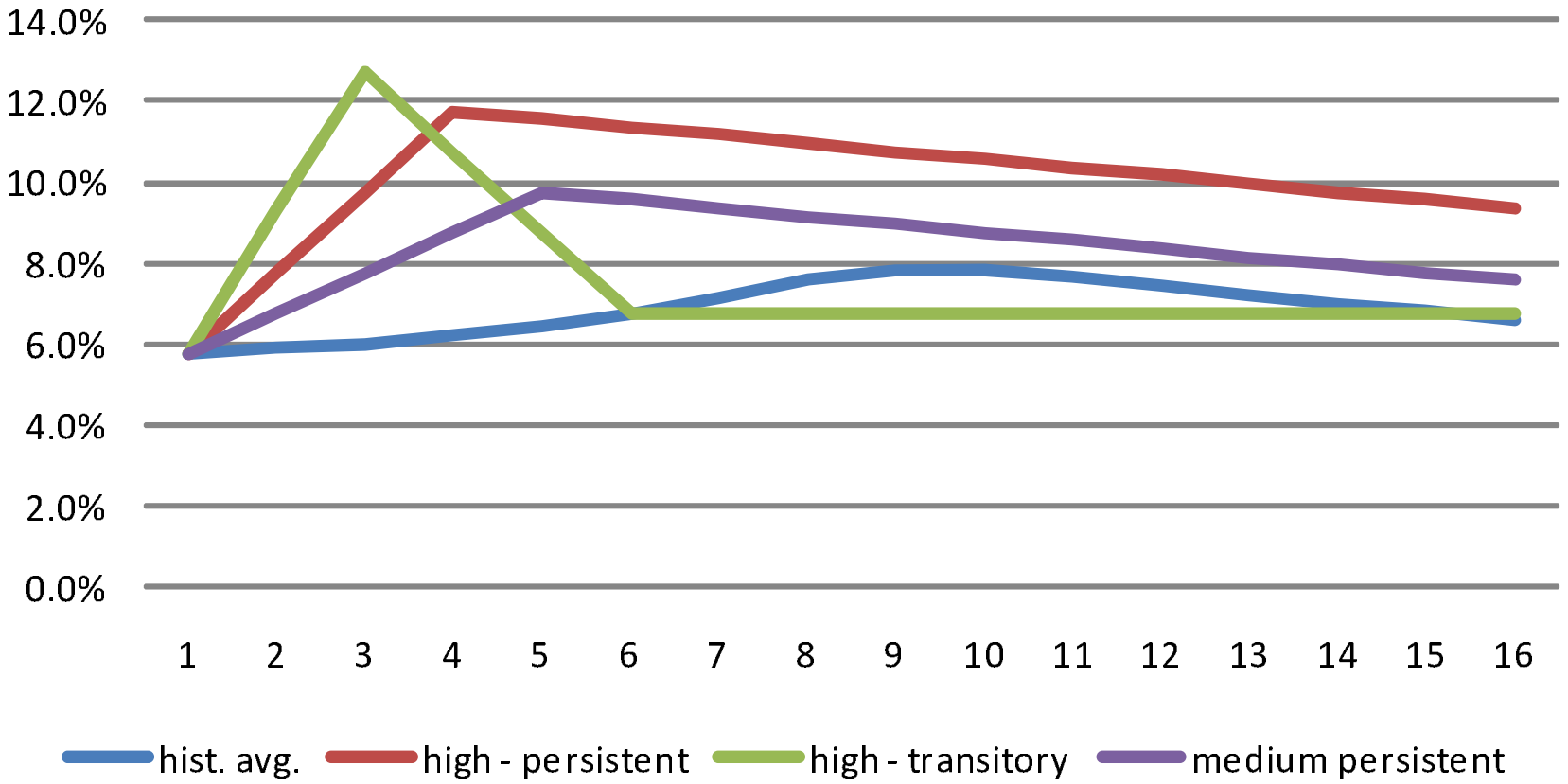
Simple equity scenarios — default prob.



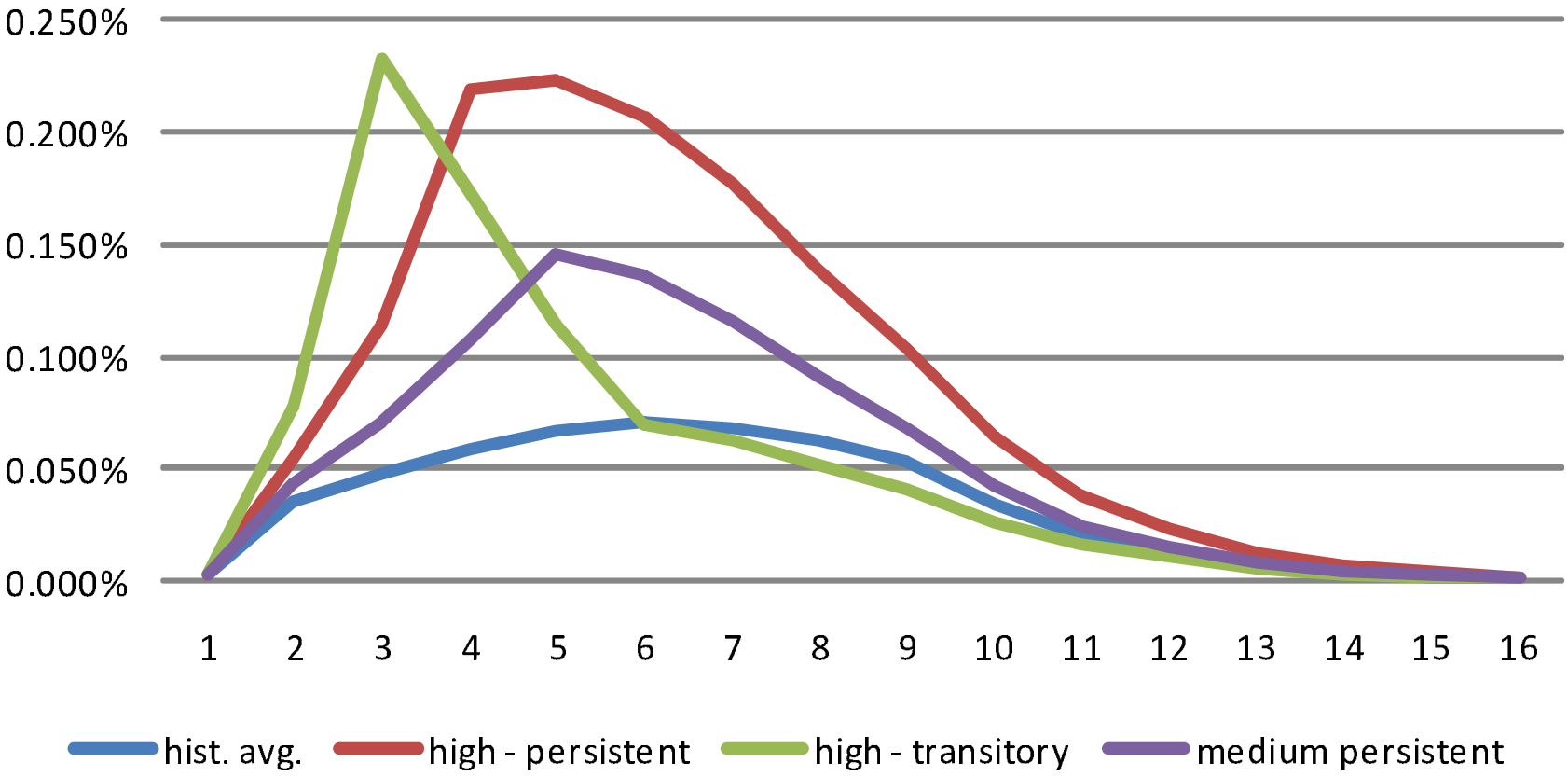
Simple equity scenarios — cum. default prob.



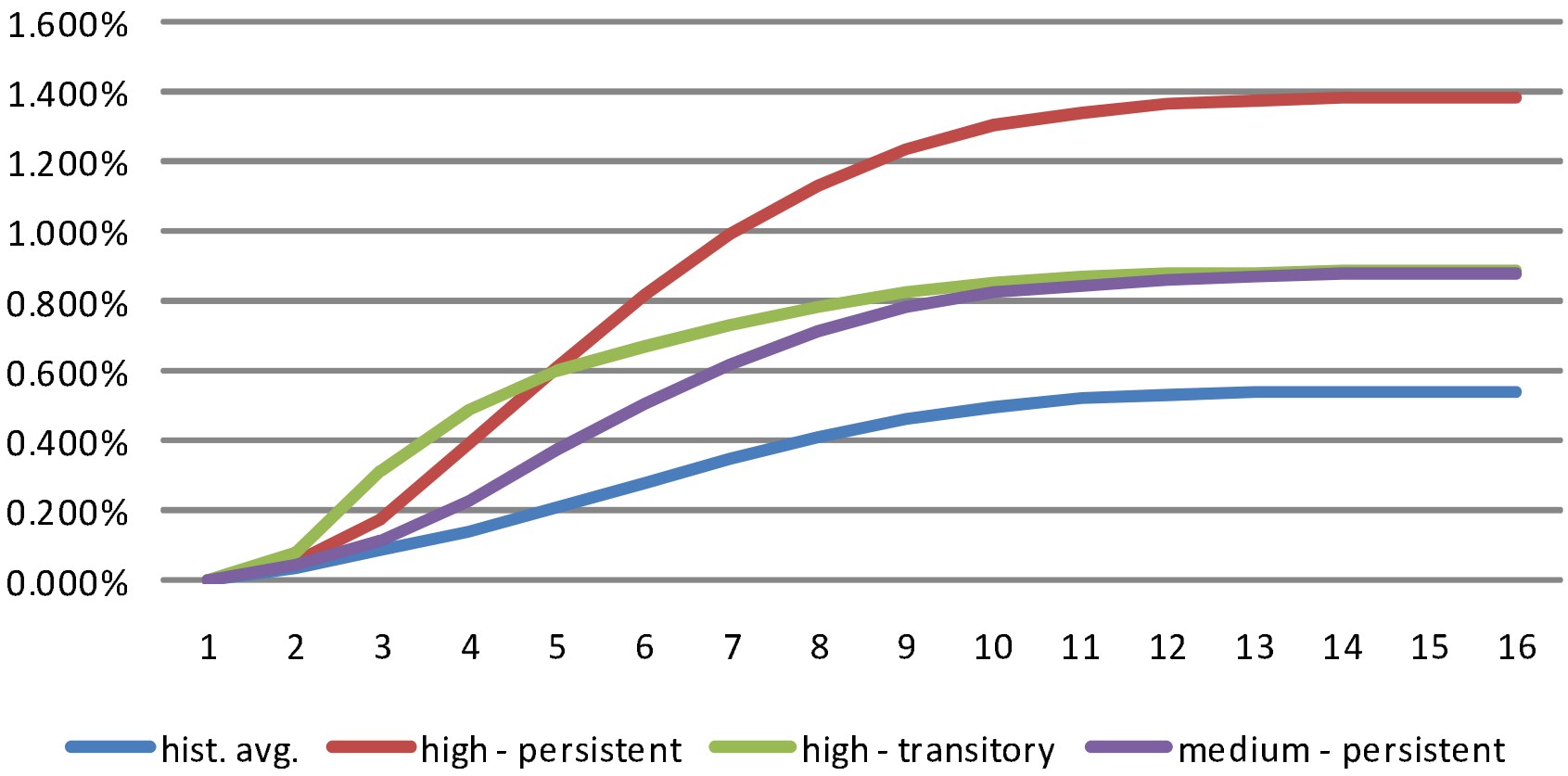
Simple unemployment scenarios



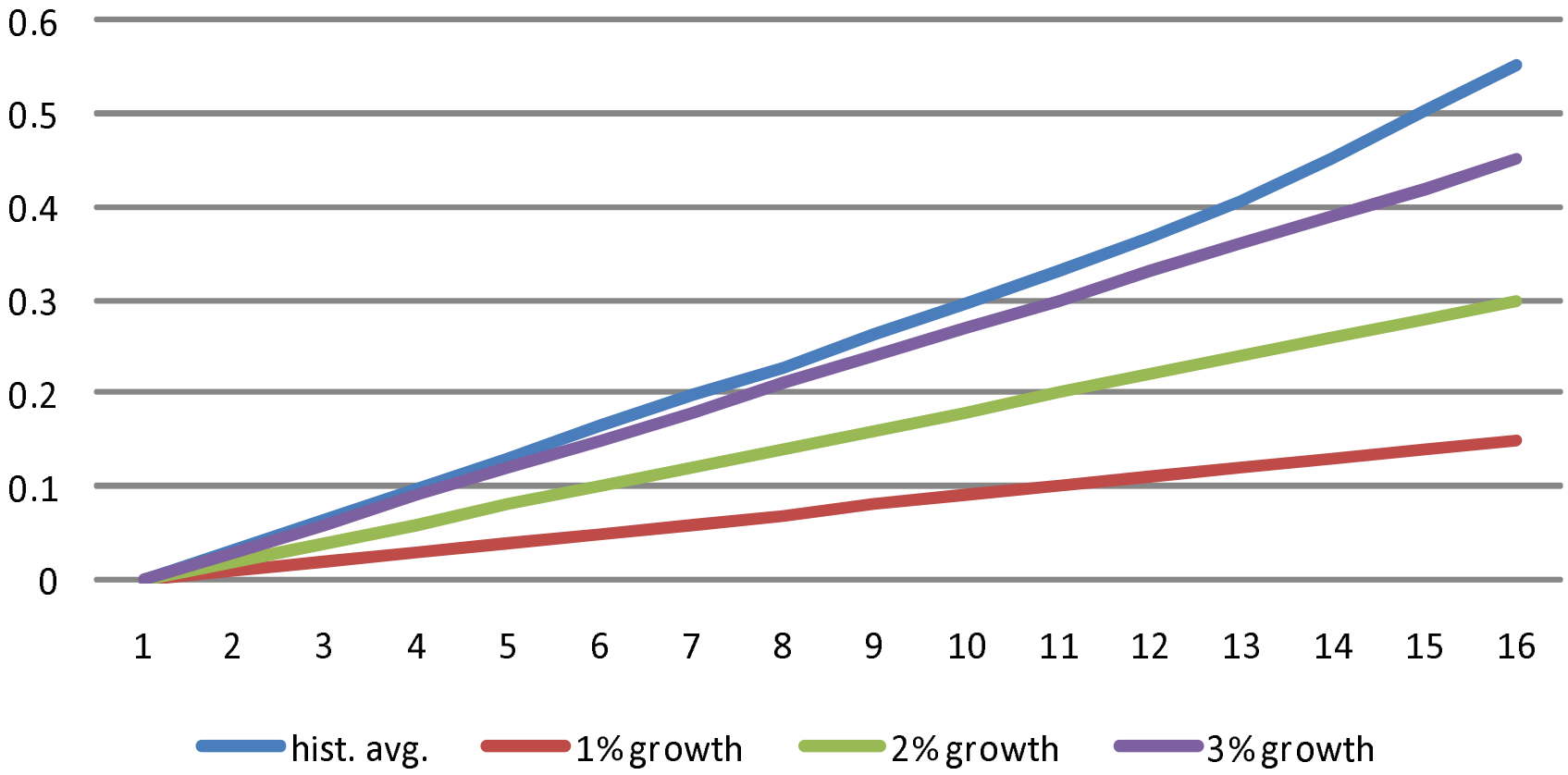
Simple unemployment scenarios — default prob.



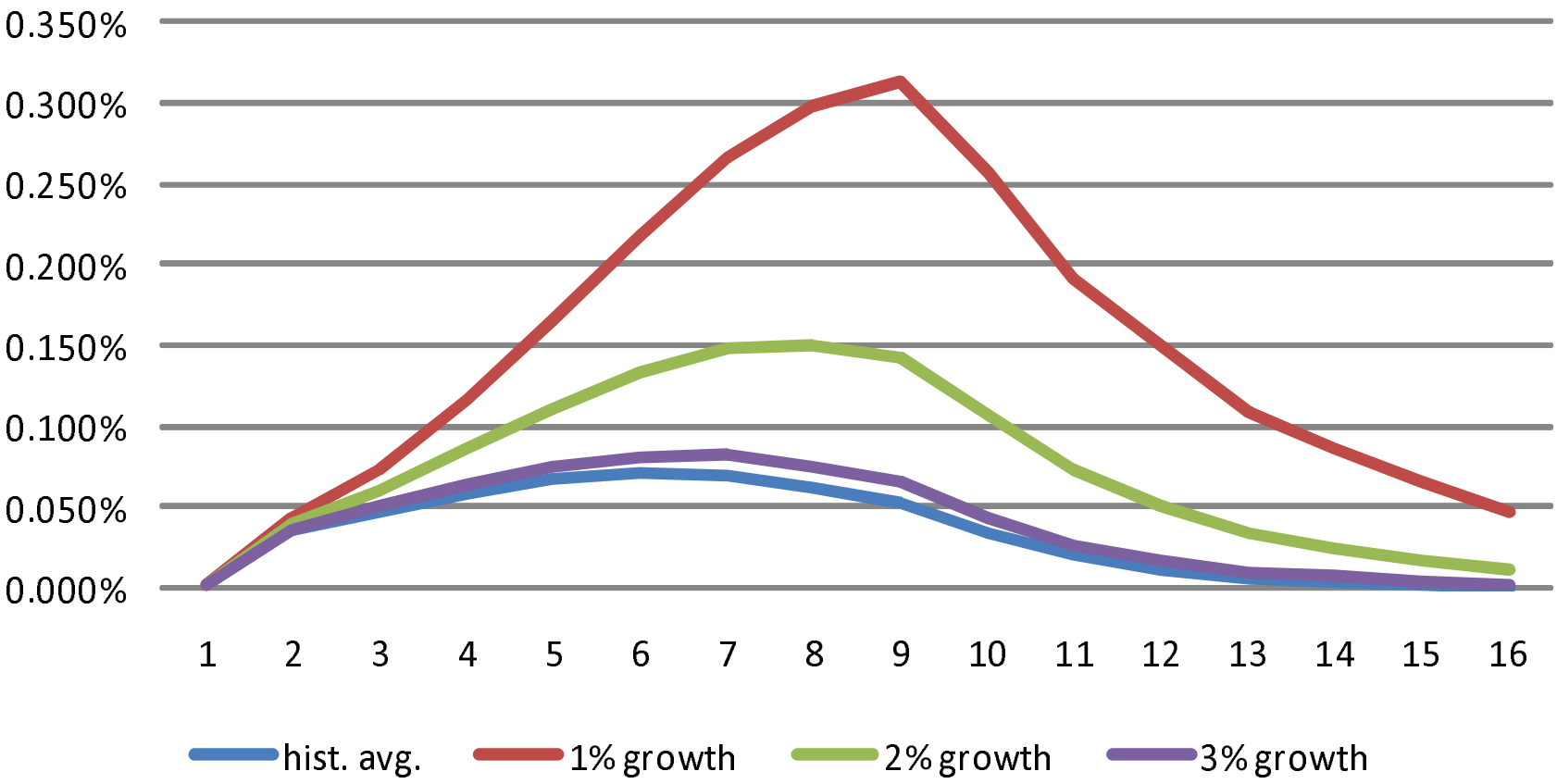
Simple unempl. scenarios — cum. default prob.



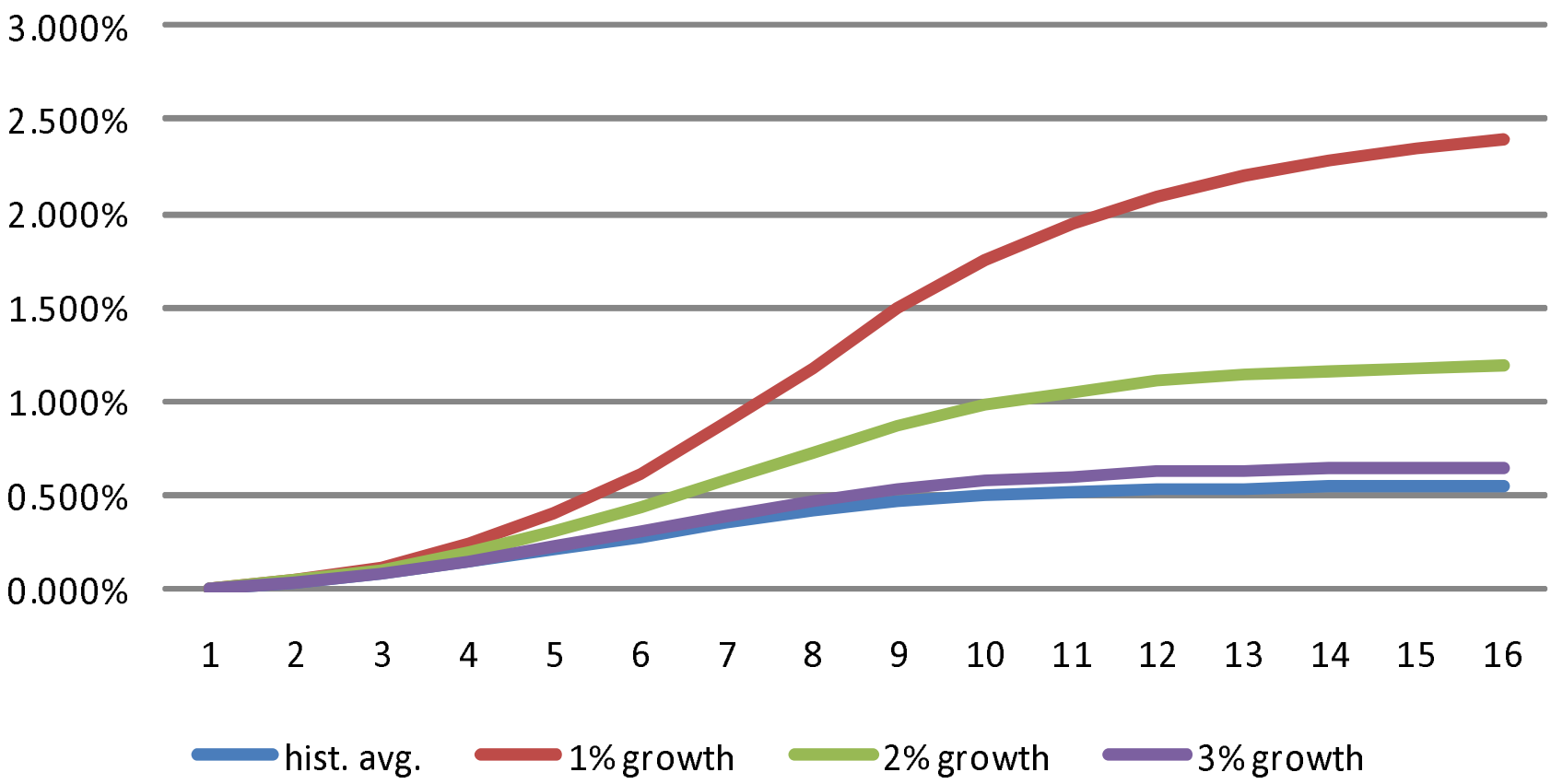
Simple wage scenarios



Simple wage scenarios — default prob.



Simple wage scenarios — cum. default prob.



Complex scenarios

Simple scenarios (and also marginal effects) assume a path for one explanatory variable, while holding others at historical averages.

- The explanatory are highly correlated
- More realistic projections, scenarios with realistic correlations
- Final caveat: some scenarios will fall far outside historical precedent. How far the estimated logit specification continues to hold is on open question.

Conclusions

- Probability of underwater affected by
  - price increase from home purchase to now,
  - age head of household,
  - occupancy duration,
  - home value
- Aggregate default probabilities
  - Negative equity not sufficient condition for default
    (in probit model the 'underwater' variable not significant)
  - Equity is most important variable in duration model
- Further research: extend the duration analysis
  - including 2011
  - regional decomposition
  - find data on number of guarantees still outstanding per vintage year (??) $\rightarrow$ competing risk model