Leading Indicators

- Good forecasting is often determined by finding **leading indicators** – variables which reduce the MSE of multi-step forecast errors
- Leading indicators move *in advance* of the forecast variable
- Economic theory can be a good guide to help select leading indicators

Business Cycle

- Measures of the business cycle include
  - GDP growth
  - Unemployment rates
  - Production growth rates
- All of these require leading indicators of the business cycle

Common Leading Indicators

- Housing starts
- Building permits
- Orders for consumer goods
- Term spread (interest rate spread)
  - Difference between Long Rate and Short Rate
- “Junk bond” or “High Yield” spread
  - Difference between rates on low-grade and high-grade bonds, typically corporate

U.S. Treasury Bonds

- Highly liquid market
- U.S. Treasury bonds generally viewed as having very low default risk
- Relative pure term structure analysis.

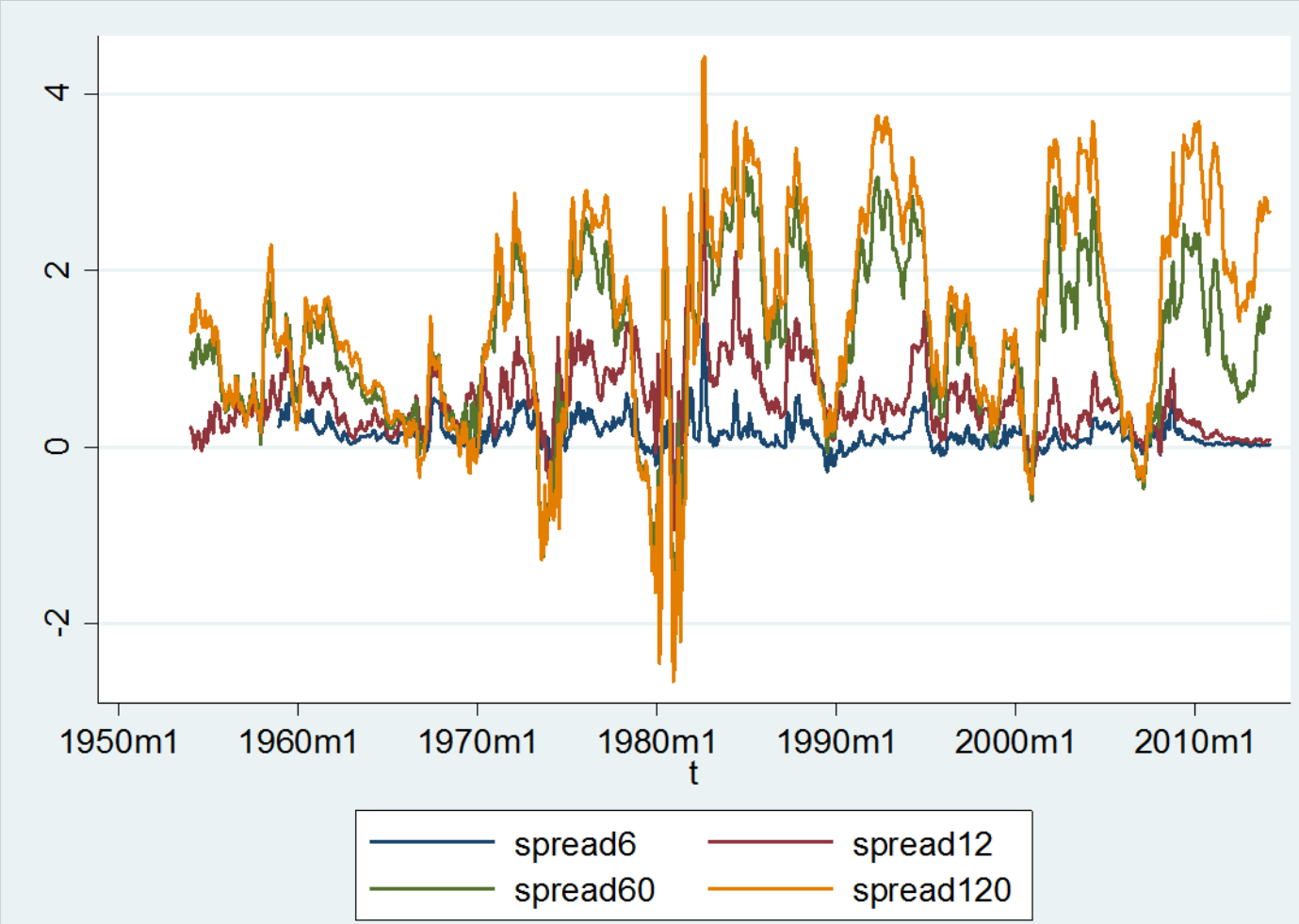
Term Spread

- Spread=Long-Short
- Term Structure theory
  - Long Rate is average of expected short rates
- Asset pricing theory
  - Long Bonds have greater risk
    - Small changes in rates imply large changes in bond price
    - Unless you hold bond until maturity the return is uncertain
  - Risky assets receive a **risk premium**: higher expected returns than low risk assets
- Together, long rates should be higher than short rates, but are forecasts of future short rates.
  - The difference – the spread – is a leading indicator

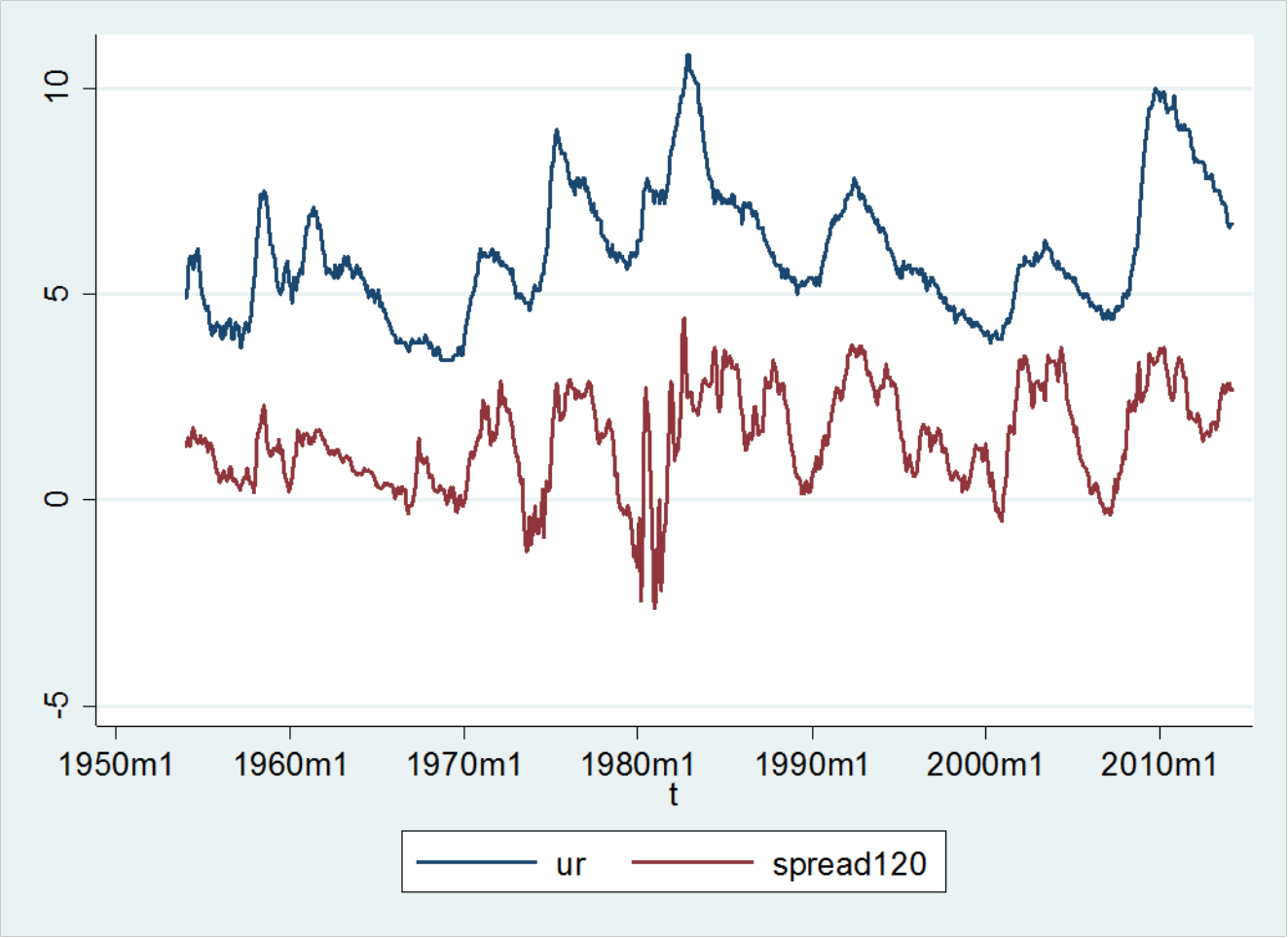
U.S. Treasuary Term Structure in March 2014

Term (months)	Rate	Spread (over 3 month)
3	0.05	
6	0.08	0.03
12	0.13	0.208
60	1.64	1.59
120	2.72	2.67

Interest Rate Spreads



Spread and Unemployment Rate



Term Inversion

- Before many recessions, the long rate fell below the short rate
  - The spread became negative
  - The market prices a lower return on long term bonds than short term bonds
  - Called a “term structure inversion”
  - Signals that investors expect falling short rates
  - Negative spread predicts a future recession
    - An increase in the unemployment rate

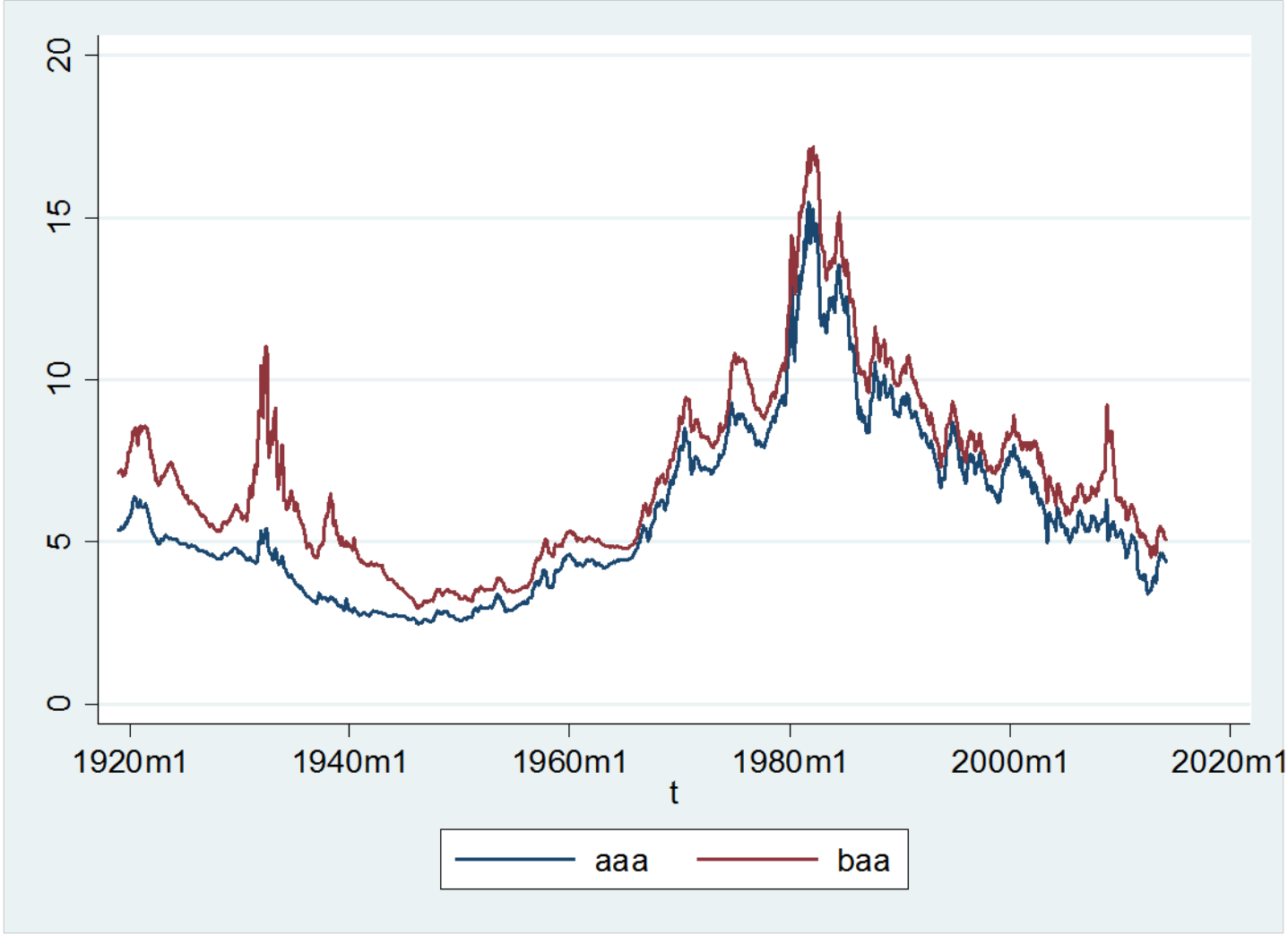
Corporate/Municipal Bonds

- Major method for corporate financing
- A promise to pay in the future
- Corporations may default on bond payments in the event of bankruptcy
- This *default risk* requires a higher interest rate
  - Relative to low risk Treasury bonds
- Not all corporations have equal default risk
  - Different interest rates

Bond Ratings

- Credit rating agencies assess default risk of corporations and other borrowers, and give each a rating:
  - AAA, AA, A, BBB, BB, B, CCC, CC, C
  - Different agencies uses different labels
- Highest rated (AAA) are viewed as near-zero default risk
- Lower rating means higher default risk
- Grade BB and lower are called
  - “Below investor grade”
  - “High-yield”
  - “Junk”
- Low grade bonds earn higher interest rates
  - Higher average returns to investors
  - Higher average costs to corporations
  - Higher risk of default

AAA and BAA rates



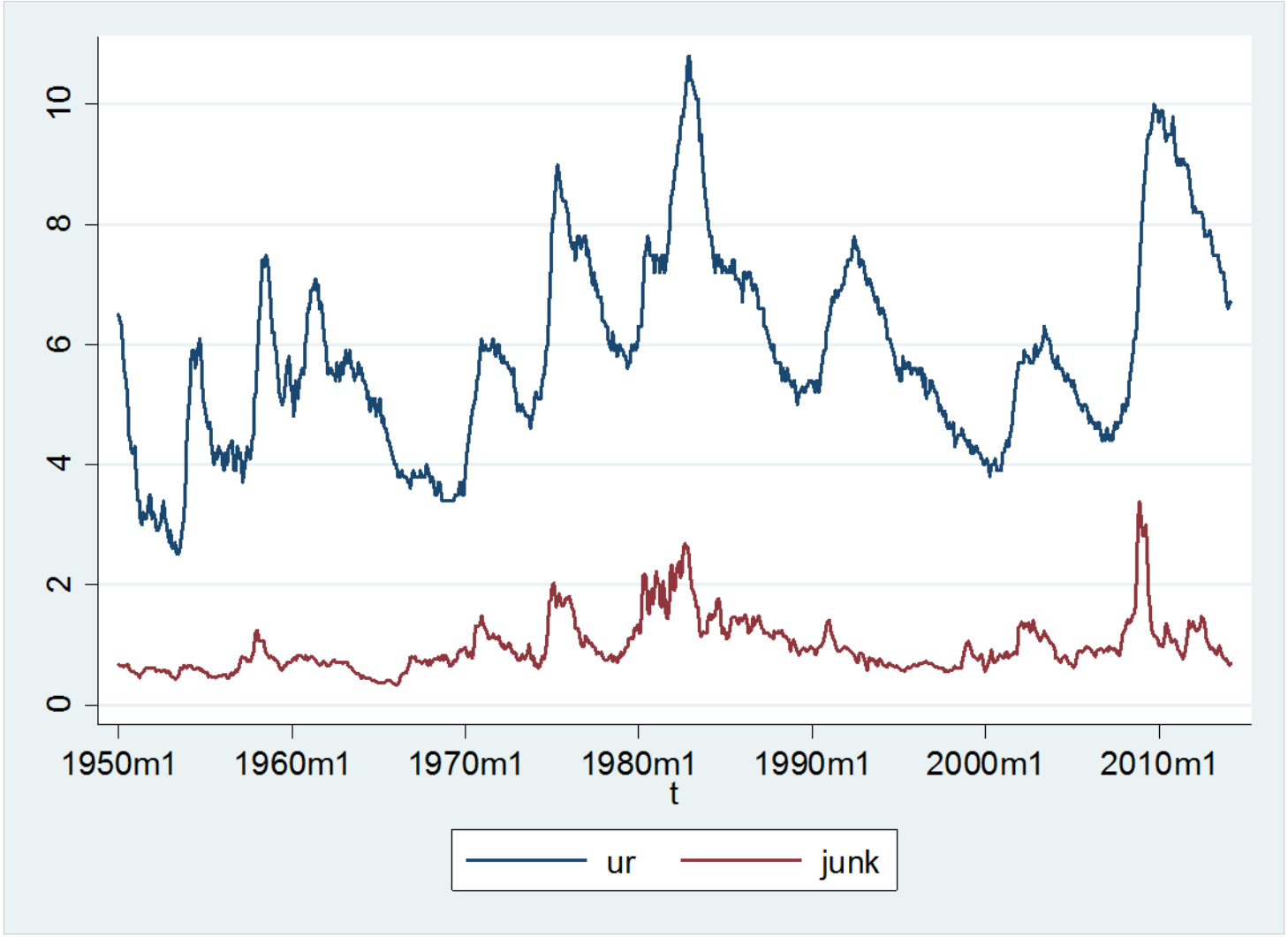
Junk Bond Spread as Leading Indicator

- Idea due to Mark Gertler and Cara Lown
  - Gertler is a 1973 UW grad, currently professor at NYU
- Increased junk bond spread is a financial symptom of the business cycle
- Useful leading indicator
- One measure = BAA - AAA

Junk Bond Spread

- Corporate bankruptcies are more common in economic downturns (recessions). Thus bond defaults are more common in recessions.
- If investors perceive the risk of recession is high, they will view high-yield (junk) bonds as high risk, and only hold such bonds if their interest rate increases
- But, high grade and low grade bond rates move up and down together as interest rates rise and fall, so the level of high-yield bond rates by itself is not a good signal concerning recession risk
- Instead, the spread (difference) between the interest rates of low grade and high grade (corporate) bonds is a good signal
- Junk bond spread = Rate on Low-Grade – Rate on High-grade
- We use: Junk = BAA – AAA
- Theory: The junk spread will be positively related with economic downturns.

High-Yield Spread and Unemployment Rate



Example: Leading Indicators for Unemployment Rate

- Interest Rate Spreads
  - Spread120=T120-T3 (10 years versus 3 month)
  - Spread60=T60-T3 (5 years versus 3 month)
  - Spread12=T12-T3 (1 year versus 3 month)
- High-Yield Bond Spread
  - Junk=AAA-BAA
- All available starting 1953m4

Leading Indicator Model

- Y = unemployment rate
  - p autoregressive lags
- X = interest rate spread
  - q distributed lags

$$y_t = \mu + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \beta_1 x_{t-1} + \cdots + \beta_q x_{t-q} + e_t$$

Baseline

- To start, we need a baseline AR model for the unemployment rate
- Estimate AR models, order 1 to 12

$$y_t = \mu + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + e_t$$

AR Model Selection

- Lowest AIC attained by AR(6), with
  - AIC = -445.5

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar1	720	-1355.375	175.5266	2	-347.0533	-337.8948
ar2	720	-1355.375	187.0141	3	-368.0283	-354.2905
ar3	720	-1355.375	215.369	4	-422.738	-404.421
ar4	720	-1355.375	220.9074	5	-431.8148	-408.9185
ar5	720	-1355.375	227.0515	6	-442.1029	-414.6274
ar6	720	-1355.375	229.7378	7	-445.4755	-413.4208
ar7	720	-1355.375	229.8255	8	-443.6509	-407.0169
ar8	720	-1355.375	229.8701	9	-441.7402	-400.5269
ar9	720	-1355.375	229.9139	10	-439.8277	-394.0352
ar10	720	-1355.375	230.0015	11	-438.003	-387.6312
ar11	720	-1355.375	234.0596	12	-444.1192	-389.1681
ar12	720	-1355.375	234.8581	13	-443.7162	-384.1859

Unemployment Rate on Interest Rate Spreads

- All regressions include 6 autoregressive lags
- Consider 1 to 4 lags on interest rate spreads
- X = Long Rate minus Short (3 month) Rate
  - 10-year
  - 5-year
  - 1-year

$$y_t = \mu + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \beta_1 x_{t-1} + \cdots + \beta_q x_{t-q} + e_t$$

10-year spread

```
. estimates stats ar6 sp120ar1 sp120ar2  sp120ar3  sp120ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar6	720	-1355.375	229.7378	7	-445.4755	-413.4208
sp120ar1	720	-1355.375	230.6495	8	-445.299	-408.665
sp120ar2	720	-1355.375	230.7251	9	-443.4502	-402.2369
sp120ar3	720	-1355.375	234.2475	10	-448.495	-402.7025
sp120ar4	720	-1355.375	234.3718	11	-446.7435	-396.3718

- All models include 6 autoregressive lags
- Lowest AIC has 3 interest rate spread lags
  - AIC=-448.5
- Lower AIC than AR(6) alone

10-year spread

```
. reg ur L(1/6).ur L(1/3).spread120 if t>=tm(1954m4), r
```

spread120						
L1.	-.0301786	.0252864	-1.19	0.233	-.0798236	.0194665
L2.	.0706844	.0437677	1.61	0.107	-.0152452	.1566141
L3.	-.053506	.0276891	-1.93	0.054	-.1078683	.0008562

- Include 6 autoregressive lags
- Lag2 coefficient positive, Lag 1&3 negative
  - Increase in spread predicts short-term changes in unemployment, but not in long-term

5-Year (60 month) spread

```
. estimates stats ar6 sp60ar1 sp60ar2  sp60ar3  sp60ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar6	720	-1355.375	229.7378	7	-445.4755	-413.4208
sp60ar1	720	-1355.375	230.4495	8	-444.8991	-408.2651
sp60ar2	720	-1355.375	230.7174	9	-443.4349	-402.2216
sp60ar3	720	-1355.375	234.1742	10	-448.3484	-402.5558
sp60ar4	720	-1355.375	234.2637	11	-446.5275	-396.1557

- Not as low AIC as 10-year spread

1-year (12 month) spread

```
. estimates stats ar6 sp12ar1 sp12ar2  sp12ar3  sp12ar4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar6	720	-1355.375	229.7378	7	-445.4755	-413.4208
sp12ar1	720	-1355.375	230.4374	8	-444.8747	-408.2407
sp12ar2	720	-1355.375	233.3513	9	-448.7026	-407.4894
sp12ar3	720	-1355.375	235.5195	10	-451.0391	-405.2466
sp12ar4	720	-1355.375	235.5799	11	-449.1599	-398.7881

- Slightly lower AIC than 10-year spread regression (AIC=-451 instead of AIC=-448.5)
- Again low obtained by model with 3 lags

1-year spread

```
. reg ur L(1/6).ur L(1/3).spread12 if t>=tm(1954m4), r
```

spread12						
L1.	-.0678888	.0397533	-1.71	0.088	-.1459368	.0101592
L2.	.16225	.0602773	2.69	0.007	.0439069	.2805932
L3.	-.0748702	.0453971	-1.65	0.100	-.1639989	.0142584

- Include 6 autoregressive lags
- Lag2 positive, Lag1 and Lag3 negative
  - Increase in spread predicts short-term changes in unemployment, but not in long-term

High Yield Spread

```
. estimates stats ar6 junk1 junk2  junk3  junk4

Akaike's information criterion and Bayesian information criterion
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
ar6	720	-1355.375	229.7378	7	-445.4755	-413.4208
junk1	720	-1355.375	249.6867	8	-483.3735	-446.7394
junk2	720	-1355.375	250.984	9	-483.968	-442.7547
junk3	720	-1355.375	252.1005	10	-484.2011	-438.4085
junk4	720	-1355.375	252.2616	11	-482.5231	-432.1514

- Considerably Lower AIC
  - AIC=-484 instead of AIC=-451
- Lowest AIC with 3 distributed lags

High Yield spread

```
. reg ur L(1/6).ur L(1/3).junk if t>=tm(1954m4), r
```

junk						
L1.	.1912504	.0766828	2.49	0.013	.0406982	.3418026
L2.	.0164951	.1218257	0.14	0.892	-.2226867	.2556768
L3.	-.0949606	.0750483	-1.27	0.206	-.2423037	.0523824

- Include 6 autoregressive lags
- Lag1 positive, Lag3 negative, but smaller
  - Increase in high-yield spread predicts short-term increase in unemployment which persist

Both Long/Short and HighYield Spread

- Combined model:
  - AR(6) in unemployment rate lates
  - 3 lags of Junk Spread (BAA over AAA)
  - 3 lags of Spread12 (one year over 3 month)
- AIC=-490
  - Lowest achieved

Coefficients

ur						
L1.	.9873129	.04156	23.76	0.000	.9057172	1.068909
L2.	.1469251	.0544801	2.70	0.007	.0399629	.2538872
L3.	-.1156719	.0598564	-1.93	0.054	-.2331895	.0018457
L4.	.0623987	.0584742	1.07	0.286	-.0524052	.1772026
L5.	-.0313496	.0554473	-0.57	0.572	-.1402107	.0775115
L6.	-.0806257	.0400899	-2.01	0.045	-.1593352	-.0019162
spread12						
L1.	-.0763744	.0361849	-2.11	0.035	-.1474171	-.0053318
L2.	.1697584	.0572882	2.96	0.003	.057283	.2822338
L3.	-.1067273	.0437302	-2.44	0.015	-.1925839	-.0208707
junk						
L1.	.1809977	.0750803	2.41	0.016	.0335907	.3284046
L2.	.0547323	.1165081	0.47	0.639	-.1740109	.2834755
L3.	-.1197854	.0709751	-1.69	0.092	-.2591325	.0195618

12-step Forecast Regression

```
. reg ur L(13/18).ur L(12/14).spread12 L(12/14).junk if t>=tm(1954m4), r
```

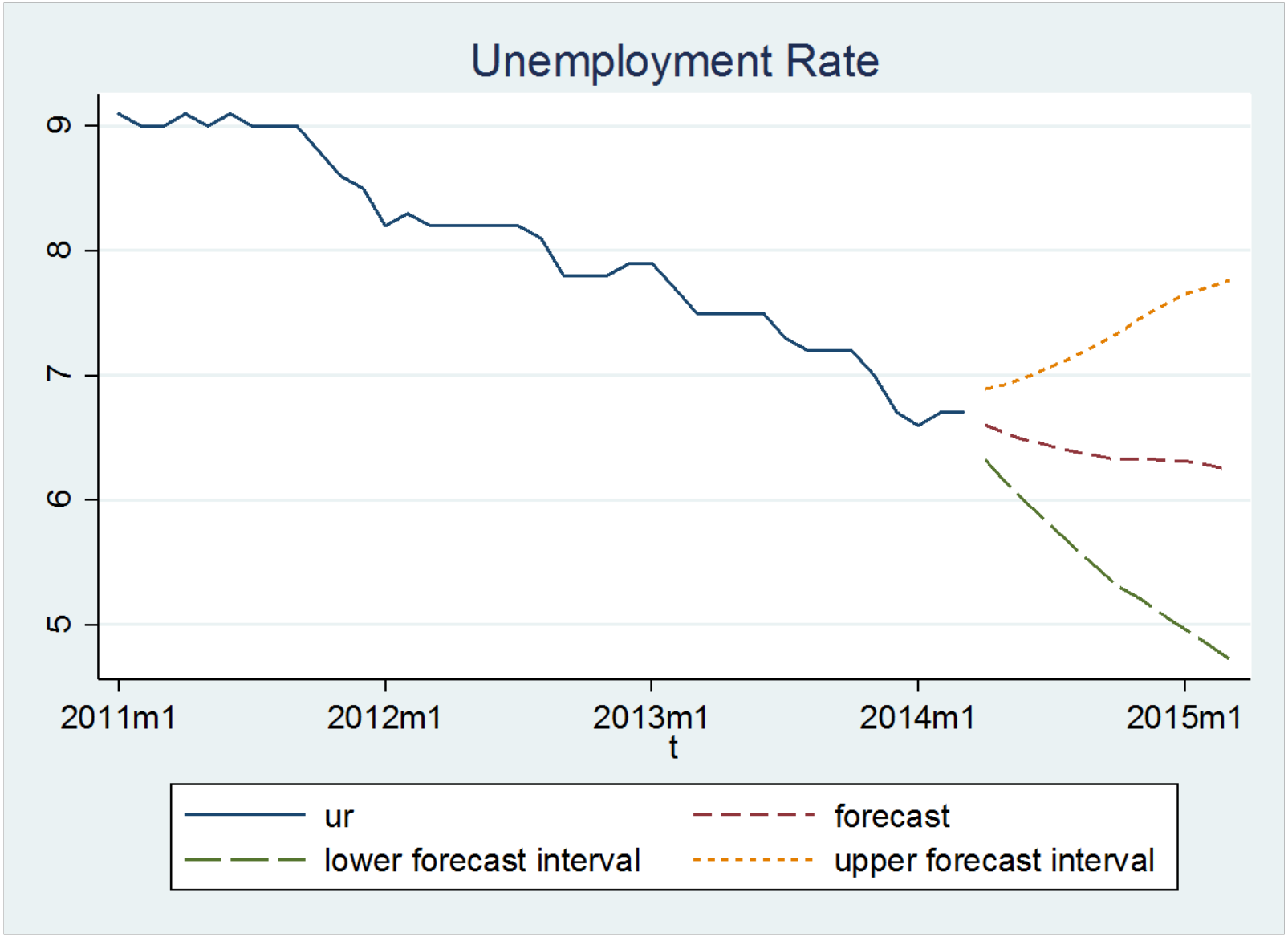
ur						
L13.	1.006277	.2230831	4.51	0.000	.5682901	1.444263
L14.	-.2181137	.2892192	-0.75	0.451	-.7859477	.3497203
L15.	-.1022191	.3024601	-0.34	0.735	-.6960494	.4916112
L16.	-.3055739	.3139874	-0.97	0.331	-.9220362	.3108884
L17.	-.1979078	.3069968	-0.64	0.519	-.8006452	.4048296
L18.	.3062866	.2139559	1.43	0.153	-.1137803	.7263536
spread12						
L12.	.1243851	.2579363	0.48	0.630	-.3820302	.6308004
L13.	.0871211	.3776913	0.23	0.818	-.6544133	.8286556
L14.	-.5362375	.2582529	-2.08	0.038	-1.043274	-.0292006
junk						
L12.	2.408352	.3737778	6.44	0.000	1.674501	3.142203
L13.	-.9698773	.6134506	-1.58	0.114	-2.174286	.2345315
L14.	.0451208	.3902766	0.12	0.908	-.7211228	.8113644

Forecast Inputs (March)

- Current Unemployment rate= 6.7%
- Junk Spread= 0.68%
- 12-month spread = 0.08%

```
reg ur L(1/6).ur L(1/3).spread12 L(1/3).junk if t>=tm(1954m4)
predict y1
predict sf1,stdf
gen y1L=y1-1.645*sf1
gen y1U=y1+1.645*sf1

reg ur L(2/7).ur L(2/4).spread12 L(2/4).junk if t>=tm(1954m4)
predict y2
predict sf2,stdf
gen y2L=y2-1.645*sf2
gen y2U=y2+1.645*sf2
…
egen p=rowfirst(y1 y2 y3 y4 y5 y6 y7 y8 y9 y10 y11 y12) if t>=tm(2014m4)
egen pL=rowfirst(y1L y2L y3L y4L y5L y6L y7L y8L y9L y10L y11L y12L) if t>=tm(2014m4)
egen pU=rowfirst(y1U y2U y3U y4U y5U y6U y7U y8U y9U y10U y11U y12U) if t>=tm(2014m4)
label variable p "forecast"
label variable pL "lower forecast interval"
label variable pU "upper forecast interval"
tsline ur p pL pU if t>=tm(2011m1), title(Unemployment Rate) lpattern (solid dash longdash
shortdash)
```


Unemployment Rate
9
8
7
6
5
2011m1
2012m1
2013m1
2014m1
2015m1
t
ur
forecast
lower forecast interval
upper forecast interval