

*STATA.OUTPUT -- Chapter 12

```
. clear
. * four measurements on 20 textile workers

. infile time subject x using v.data

. centile time, centil(1,2,3,4)
```

Variable	Obs	Percentile	Centile	[95% Conf. Interval]	
time	104	1	1	1	1*
		2	1	1	1*
		3	1	1	1*
		4	1	1	1

```
. sort time
. gen time_cat = group(4)
. sort time_cat
. by time_cat: egen xbar = mean(x)
. by time_cat: gen vtemp = (x-xbar)^2/25
. by time_cat: gen v = sum(vtemp)
. by time_cat: gen upper = 25*v/invchi2(25,0.025)
. by time_cat: gen lower = 25*v/invchi2(25,0.975)

. list xbar v lower upper in 26
```

xbar	v	lower	upper
84.95538	22.52852	13.85638	42.92875

```
. list xbar v lower upper in 52
```

xbar	v	lower	upper
84.79692	19.11567	11.75728	36.42546

```
. list xbar v lower upper in 78
```

xbar	v	lower	upper
85.42423	24.93297	15.33526	47.51049

```
. list xbar v lower upper in 104
```

xbar	v	lower	upper
85.15462	21.53054	13.24257	41.02707

. clear

. *estimates of the within and between variances -- textile worker's data

. infile time subject x using v.data

. xtmixed x || subject:, var

```

Mixed-effects REML regression          Number of obs      =      104
Group variable: subject                Number of groups   =       26

                                       Obs per group: min =       4
                                       avg =           4.0
                                       max =           4

```

```

Log restricted-likelihood = -229.09151    Wald chi2(0)      =      .
                                           Prob > chi2       =      .

```

x	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_cons	85.08279	.8897887	95.62	0.000	83.33883	86.82674

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	20.1043	5.822775	11.39612	35.46672
var(Residual)	1.922087	.3077802	1.404338	2.630718

LR test vs. linear regression: chibar2(01) = 154.49 Prob >= chibar2 = 0.0000

. *alternate estimates of the within and between variances

. anova x subject

```

Number of obs = 104      R-squared      = 0.9321
Root MSE      = 1.38639  Adj R-squared = 0.9104

```

Source	Partial SS	df	MS	F	Prob > F
Model	2058.48199	25	82.3392797	42.84	0.0000
subject	2058.48199	25	82.3392797	42.84	0.0000
Residual	149.922767	78	1.92208676		
Total	2208.40476	103	21.4408229		

```
. gen ssw = 149.922767  
. gen ssb = 2208.40476-ssw  
. gen varw = ssw/78  
. gen varb = (ssb/25-varw)/4
```

```
. list varw varb in 1
```

varw	varb
1.922087	20.1043

```
. *95% confidence interval for estimated within variance
```

```
. gen lower = ssw/invchi2(78,0.975)  
. gen upper = ssw/invchi2(78,0.025)
```

```
. list lower varw upper in 1
```

lower	varw	upper
1.437199	1.922087	2.702985

```
. *95% confidence interval for estimated between variance
```

```
. gen LOWER = (ssb/invchi2(25,0.975)-varw)/4  
. gen UPPER = (ssb/invchi2(25,0.025)-varw)/4
```

```
. list LOWER varb UPPER in 1
```

LOWER	varb	UPPER
12.18037	20.1043	38.74444

```
. clear  
.*example three subjects measured three times
```

```
. input y t subjects  
      y  t subjects  
1.   4.7  1  1  
2.   5.4  2  1  
3.   8.8  3  1  
4.   5.4  1  2  
5.  10.5  2  2  
6.  10.9  3  2  
7.   8.3  1  3  
8.  11.7  2  3  
9.  11.7  3  3  
10. end
```

```
. list
```

	y	t	subjects
1.	4.7	1	1
2.	5.4	2	1
3.	8.8	3	1
4.	5.4	1	2
5.	10.5	2	2
6.	10.9	3	2
7.	8.3	1	3
8.	11.7	2	3
9.	11.7	3	3

```
. regress y t
```

Source	SS	df	MS	Number of obs =	9
Model	28.1666646	1	28.1666646	F(1, 7) =	5.51
Residual	35.7733315	7	5.11047593	Prob > F =	0.0513
Total	63.9399961	8	7.99249951	R-squared =	0.4405
				Adj R-squared =	0.3606
				Root MSE =	2.2606

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
t	2.166667	.9229009	2.35	0.051	-.0156472 4.34898
_cons	4.266667	1.993694	2.14	0.070	-.4476697 8.981003

. *one regression analysis for each subject
. sort subjects
. by subjects: regress y t

-> subjects = 1

Source	SS	df	MS	Number of obs =	3
Model	8.40500156	1	8.40500156	F(1, 1) =	6.92
Residual	1.21499983	1	1.21499983	Prob > F =	0.2313
				R-squared =	0.8737
				Adj R-squared =	0.7474
Total	9.62000139	2	4.8100007	Root MSE =	1.1023

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
t	2.05	.7794228	2.63	0.231	-7.853506 11.95351
_cons	2.2	1.683746	1.31	0.416	-19.19402 23.59402

-> subjects = 2

Source	SS	df	MS	Number of obs =	3
Model	15.1249974	1	15.1249974	F(1, 1) =	4.11
Residual	3.68166711	1	3.68166711	Prob > F =	0.2918
				R-squared =	0.8042
				Adj R-squared =	0.6085
Total	18.8066645	2	9.40333225	Root MSE =	1.9188

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
t	2.75	1.356773	2.03	0.292	-14.48944 19.98944
_cons	3.433334	2.930965	1.17	0.450	-33.80811 40.67478

-> subjects = 3

Source	SS	df	MS	Number of obs =	3
Model	5.7799987	1	5.7799987	F(1, 1) =	3.00
Residual	1.92666623	1	1.92666623	Prob > F =	0.3333
				R-squared =	0.7500
				Adj R-squared =	0.5000
Total	7.70666494	2	3.85333247	Root MSE =	1.388

y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
t	1.7	.9814953	1.73	0.333	-10.77108 14.17108
_cons	7.166667	2.120272	3.38	0.183	-19.77395 34.10728

. *additive model (also: xi: regress y t i.s)

. xtmixed y t || subjects:, cov(unstr) var

```
Mixed-effects REML regression          Number of obs      =          9
Group variable: subjects                Number of groups   =          3
                                         Obs per group: min =          3
                                         avg              =         3.0
                                         max              =          3
                                         Wald chi2(1)     =         17.68
Log restricted-likelihood = -15.723761   Prob > chi2        =         0.0000
```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
t	2.166667	.5153208	4.20	0.000	1.156656 3.176677
_cons	4.266667	1.614632	2.64	0.008	1.102046 7.431288

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]
var(_cons)	4.103333	4.646602	.4459014 37.76024
var(Residual)	1.593333	1.007712	.4612746 5.503687

. predict Y, fitted

. list y Y

	y	Y
1.	4.7	4.396915
2.	5.4	6.563582
3.	8.8	8.730248
4.	5.4	6.728467
5.	10.5	8.895133
6.	10.9	11.0618
7.	8.3	8.174619
8.	11.7	10.34128
9.	11.7	12.50795

```
. clear  
. *weight gained during pregnancy (linear)  
  
. infile subject bmi time gain using wtgain.data
```

```
. xtmixed gain time bmi || subject:, var
```

```
Mixed-effects REML regression  
Group variable: subject  
  
Number of obs = 1870  
Number of groups = 110  
Obs per group: min = 16  
                  avg = 17.0  
                  max = 28  
Wald chi2(2) = 1787.38  
Prob > chi2 = 0.0000  
  
Log restricted-likelihood = -6558.9969
```

gain	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0685139	.0020838	32.88	0.000	.0644297	.0725981
bmi	20.53394	.7828689	26.23	0.000	18.99955	22.06834
_cons	64.06088	1.109329	57.75	0.000	61.88663	66.23512

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	111.4861	15.5909	84.75853	146.6419
var(Residual)	52.59912	1.774486	49.23368	56.19461

```
. *weight gained during pregnancy (linear and nonadditive)
```

```
. gen bmibytime = bmi*time  
. xtmixed gain time bmi bmibytime || subject:, var
```

```
Mixed-effects REML regression  
Group variable: subject  
  
Number of obs = 1870  
Number of groups = 110  
Obs per group: min = 16  
                  avg = 17.0  
                  max = 28  
Wald chi2(3) = 1818.45  
Prob > chi2 = 0.0000  
  
Log restricted-likelihood = -6555.2507
```

gain	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0736862	.0024376	30.23	0.000	.0689085	.0784638
bmi	24.22898	1.201743	20.16	0.000	21.87361	26.58435
bmibytime	-.0198762	.0049157	-4.04	0.000	-.0295109	-.0102416
_cons	63.07541	1.13342	55.65	0.000	60.85395	65.29687

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	111.085	15.52828	84.46334	146.0975
var(Residual)	52.15586	1.759998	48.81793	55.72203

```
. *weight gained during pregnancy (quadratic)
.gen time2 = time^2
```

```
. xtmixed gain time time2 bmi || subject:, var
```

```
Mixed-effects REML regression      Number of obs      =      1870
Group variable: subject            Number of groups   =      110
                                   Obs per group: min =       16
                                   avg      =      17.0
                                   max      =       28
                                   Wald chi2(3)   =     1924.49
Log restricted-likelihood = -6534.1384 Prob > chi2        =      0.0000
```

gain	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0028583	.0080864	0.35	0.724	-.0129908	.0187074
time2	.0002127	.0000253	8.39	0.000	.000163	.0002623
bmi	20.40099	.7694857	26.51	0.000	18.89283	21.90916
_cons	67.57959	1.186144	56.97	0.000	65.25479	69.90439

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	112.5111	15.71937	85.56002	147.9518
var(Residual)	50.57757	1.706812	47.34052	54.03598

```
. *weight gained during pregnancy (quadratic and nonadditive)
.gen bmibytime2 = bmi*time
```

```
. xtmixed gain time time2 bmi bmibytime bmibytime2 ||subject:, var
```

```
Mixed-effects REML regression      Number of obs      =      1870
Group variable: subject            Number of groups   =      110
                                   Obs per group: min =       16
                                   avg      =      17.0
                                   max      =       28
                                   Wald chi2(5)   =     1971.94
Log restricted-likelihood = -6535.3221 Prob > chi2        =      0.0000
```

gain	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.022557	.0093367	2.42	0.016	.0042574	.0408565
time2	.0001645	.0000291	5.65	0.000	.0001075	.0002216
bmi	26.35162	1.434524	18.37	0.000	23.54001	29.16324
bmibytime	-.074308	.0187652	-3.96	0.000	-.1110871	-.0375288
bmibytime2	.0001836	.0000597	3.08	0.002	.0000667	.0003005
_cons	65.99408	1.230397	53.64	0.000	63.58254	68.40561

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	113.3498	15.84062	86.19175	149.0652
var(Residual)	49.92452	1.685808	46.72737	53.34044


```
. clear
. *spline model: weight loss post-partum
. infile subject loss time race using race.data
. gen time0 = time-270
. gen time1 = time-270
. replace time1 = 0 if time1<30
. replace time1 = time1-30 if time1!=0
. xtmixed loss time0 time1 || subject:, var
```

```
Mixed-effects REML regression          Number of obs      =      2432
Group variable: subject                Number of groups   =      344
                                       avg                =       7.1
                                       max                =       12
                                       Wald chi2(2)       =    4197.92
Log restricted-likelihood = -7433.5435  Prob > chi2       =     0.0000
```

loss	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time0	-.4233009	.009428	-44.90	0.000	-.4417795	-.4048223
time1	.4169468	.009882	42.19	0.000	.3975784	.4363152
_cons	83.93738	.8218979	102.13	0.000	82.32649	85.54827

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	219.9419	16.94632	189.114	255.7951
var(Residual)	13.42055	.4155667	12.63028	14.26027

```
. *spline model: weight loss post-partum for four race/ethnic groups
. xtmixed loss time0 time1 i.race || subject:, var
```

```
Mixed-effects REML regression          Number of obs      =      2432
Group variable: subject                Number of groups   =      344
                                       Obs per group: min =       6
                                       avg                =       7.1
                                       max                =       12
                                       Wald chi2(5)       =    4223.69
Log restricted-likelihood = -7415.9389  Prob > chi2       =     0.0000
```

loss	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time0	-.4233676	.0094279	-44.91	0.000	-.4418459	-.4048892
time1	.4170199	.0098819	42.20	0.000	.3976517	.436388
_Irace_2	2.679121	2.483722	1.08	0.281	-2.188884	7.547126
_Irace_3	-12.12922	2.597825	-4.67	0.000	-17.22087	-7.037577
_Irace_4	-1.748445	2.263703	-0.77	0.440	-6.185221	2.68833
_cons	85.14976	.9933348	85.72	0.000	83.20285	87.09666

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	206.5216	15.99124	177.4417	240.3671
var(Residual)	13.42052	.4155648	12.63025	14.26024

```
. clear  
. *random effects model: test data  
. infile s1 s2 s3 s4 s5 using vv.data  
. list
```

	s1	s2	s3	s4	s5
1.	19.1	23	20.2	35	24.3
2.	.2	17	17	21.4	33.6
3.	11.1	22.5	22.1	26.6	30.1
4.	11.9	17.1	18.4	20.9	30.6
5.	12.6	18	16.7	29.1	38.6
6.	11.8	9.6	22.3	20.4	27.9
7.	10.3	14	10.6	13.2	22.3
8.	21	21.6	29.9	29.3	26.5
9.	6.5	22.4	24.2	28	28.6
10.	11.6	12.4	22.7	17.1	9.5
11.	14.4	17.9	16.2	13.5	34.2
12.	8.4	10.8	18.4	19.2	25.8
13.	12.4	6.9	10.7	22	17.6
14.	12.2	19.5	24.4	17	34.3
15.	8.7	17.5	21	30.8	28.3
16.	8.6	13.6	9.5	16.2	23.7
17.	3.9	10.7	15.7	18.3	22.9
18.	8.9	19	17.2	39.9	25.2
19.	12.1	13.4	15.8	19.6	27.2
20.	10.8	7.2	13.6	22.5	22.4

```
. correlate s1 s2 s3 s4 s5, cov
```

(obs=20)

	s1	s2	s3	s4	s5
s1	20.8209				
s2	6.05303	25.3142			
s3	7.96184	14.7356	26.6706		
s4	6.63421	18.27	12.9589	51.1432	
s5	-1.51	16.0196	5.97537	5.68579	41.4027

. clear

. *random effects model: test data
. infile subjects t y using test.data

. xtmixed y t || subjects:, var

```

Mixed-effects REML regression          Number of obs    =      100
Group variable: subjects                Number of groups  =       20
                                         Obs per group: min =        5
                                         avg              =       5.0
                                         max              =        5
                                         Wald chi2(1)     =    131.58
Log restricted-likelihood = -308.46081   Prob > chi2      =     0.0000

```

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
t	3.9005	.3400424	11.47	0.000	3.234029	4.566971
_cons	7.2065	1.320038	5.46	0.000	4.619273	9.793727
Random-effects Parameters			Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)			9.41166	4.61322	3.60115	24.59752
var(Residual)			23.12577	3.679575	16.93013	31.58873

. clear

. *random effects model: weight gained by small mothers (linear)
. infile wt time k subjects age parity bwt ht gest using small.data
. *random intercept

. xtmixed wt time || subjects:, var

```

Mixed-effects REML regression          Number of obs    =      638
Group variable: subjects                Number of groups  =       49
                                         Obs per group: min =        9
                                         avg              =     13.0
                                         max              =       20
                                         Wald chi2(1)     =   3349.93
Log restricted-likelihood = -1552.8877   Prob > chi2      =     0.0000

```

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0659707	.0011398	57.88	0.000	.0637367	.0682047
_cons	44.26571	.6464603	68.47	0.000	42.99867	45.53275
Random-effects Parameters			Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)			17.87225	3.741627	11.85705	26.93901
var(Residual)			5.638638	.3288705	5.029541	6.321499

. *random effects model: weight gained by small mothers (quadratic)

```
. gen time2 = time^2
. xtmixed wt time time2 || subjects:, var
```

Mixed-effects REML regression	Number of obs	=	638
Group variable: subjects	Number of groups	=	49
	Obs per group: min	=	9
	avg	=	13.0
	max	=	20
Log restricted-likelihood = -1525.8124	Wald chi2(2)	=	3876.88
	Prob > chi2	=	0.0000

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0303781	.0041306	7.35	0.000	.0222823	.0384738
time2	.0001181	.0000132	8.92	0.000	.0000921	.000144
_cons	45.99289	.6706983	68.57	0.000	44.67834	47.30743

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	17.90695	3.737644	11.89471	26.95811
var(Residual)	4.974121	.2903575	4.436379	5.577044

. *random effects model: weight gained by small mothers (quadratic+age)

```
. xtmixed wt time time2 age || subjects:, var
```

Mixed-effects REML regression	Number of obs	=	638
Group variable: subjects	Number of groups	=	49
	Obs per group: min	=	9
	avg	=	13.0
	max	=	20
Log restricted-likelihood = -1527.14	Wald chi2(3)	=	3876.85
	Prob > chi2	=	0.0000

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0303783	.0041306	7.35	0.000	.0222825	.038474
time2	.0001181	.0000132	8.92	0.000	.0000921	.000144
age	-.001504	.1063129	-0.01	0.989	-.2098735	.2068655
_cons	46.0297	2.69075	17.11	0.000	40.75592	51.30347

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	18.29649	3.857556	12.10331	27.65869
var(Residual)	4.974115	.2903568	4.436374	5.577037

. *random effects model: weight gained by small mothers (quadratic+age+birth weight + height)

. xtmixed wt time time2 age bwt ht || subjects:, var

```
Mixed-effects REML regression      Number of obs      =      638
Group variable: subjects           Number of groups   =       49
                                   Obs per group: min =        9
                                   avg =      13.0
                                   max =       20
                                   Wald chi2(5)      =   3884.54
                                   Prob > chi2       =    0.0000
```

Log restricted-likelihood = -1523.6362

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0304092	.0041305	7.36	0.000	.0223136	.0385048
time2	.0001179	.0000132	8.91	0.000	.000092	.0001439
age	.0966822	.1074217	0.90	0.368	-.1138604	.3072248
bwt	.6918818	1.401731	0.49	0.622	-2.055461	3.439225
ht	.2887873	.1105724	2.61	0.009	.0720693	.5055053
_cons	-3.914028	18.60061	-0.21	0.833	-40.37055	32.54249

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
var(_cons)	16.39555	3.53931	10.73933	25.03082
var(Residual)	4.973888	.2903304	4.436195	5.576753

. *random intercept and slope (linear)

. xtmixed wt time || subjects: time, var cov(unstructured)

```
Mixed-effects REML regression      Number of obs      =      638
Group variable: subjects           Number of groups   =       49
                                   Obs per group: min =        9
                                   avg =      13.0
                                   max =       20
                                   Wald chi2(1)      =   396.15
                                   Prob > chi2       =    0.0000
```

Log restricted-likelihood = -1326.6092

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0662207	.0033271	19.90	0.000	.0596997	.0727417
_cons	44.25498	.4291212	103.13	0.000	43.41391	45.09604

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
subjects: Unstructured				
var(time)	.0005172	.0001111	.0003395	.0007878
var(_cons)	7.992761	1.841772	5.088086	12.55565
cov(time,_cons)	-.0195891	.0106838	-.0405291	.0013508
var(Residual)	2.174516	.1323336	1.930018	2.449987

```
. *random intercept and slope (quadratic) u
.xtmixed wt time time2 || subjects: time, var cov(unstructured)
```

```
Mixed-effects REML regression          Number of obs      =      638
Group variable: subjects                Number of groups   =       49
                                         Obs per group: min =        9
                                         avg               =      13.0
                                         max               =       20
                                         Wald chi2(2)      =     695.61
Log restricted-likelihood = -1216.9652   Prob > chi2       =     0.0000
```

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.029226	.0039624	7.38	0.000	.0214599	.0369921
time2	.0001234	7.08e-06	17.43	0.000	.0001095	.0001372
_cons	46.03255	.4429206	103.93	0.000	45.16444	46.90066
Random-effects Parameters			Estimate	Std. Err.	[95% Conf. Interval]	
subjects: Unstructured						
	var(time)	.0005324	.0001122	.0003523	.0008046	
	var(_cons)	8.442542	1.857837	5.484799	12.99528	
	cov(time,_cons)	-.0219713	.0108116	-.0431616	-.000781	
	var(Residual)	1.392011	.0847912	1.235361	1.568526	

```
. *random intercept and slope (quadratic age + birth weight + height)
.xtmixed wt time time2 age bwt ht || subjects: time, var cov(unstructured)
```

```
Mixed-effects REML regression          Number of obs      =      638
Group variable: subjects                Number of groups   =       49
                                         Obs per group: min =        9
                                         avg               =      13.0
                                         max               =       20
                                         Wald chi2(5)      =     702.98
Log restricted-likelihood = -1216.1781   Prob > chi2       =     0.0000
```

wt	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
time	.0292327	.0039611	7.38	0.000	.021469	.0369963
time2	.0001233	7.08e-06	17.43	0.000	.0001095	.0001372
age	.1618151	.071022	2.28	0.023	.0226146	.3010157
bwt	.2944168	.9264356	0.32	0.751	-1.521364	2.110197
ht	.1453172	.0733601	1.98	0.048	.0015341	.2891003
_cons	18.33181	12.33132	1.49	0.137	-5.837129	42.50074
Random-effects Parameters			Estimate	Std. Err.	[95% Conf. Interval]	
subjects: Unstructured						
	var(time)	.0005319	.0001121	.0003519	.0008038	
	var(_cons)	7.912602	1.814808	5.047666	12.40361	
	cov(time,_cons)	-.0228791	.0109777	-.0443951	-.0013632	
	var(Residual)	1.392109	.0848029	1.235437	1.568649	