Panel Data: Dynamic Panel Data

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Version: Fall 2022

1. Dynamic panel-data (DPD) analysis

2. Acemoglu, Johnson, Robinson and Yared (2008)

Dynamic panel-data (DPD) analysis

- ✓ xtabond
- ✓ xtdpdsys
- ✓ xtdpd

xtabond

xtabond fits a linear dynamic panel-data model where the unobserved panel-level effects are correlated with the lags of the dependent variable, known as the Arellano-Bond estimator. This estimator is designed for datasets with many panels and few periods, and it requires that there be no autocorrelation in the idiosyncratic errors.

xtabond implements the Arellano and Bond estimator, which uses moment conditions in which lags of the dependent variable and first differences of the exogenous variables are instruments for the first-differenced equation.

xtabond: Arellano-Bond linear dynamic panel-data estimation

- ✓ Example: webuse abdata
- ✓ A dynamic model of labor demand to an unbalanced panel of firms located in the United Kingdom
- ✓ A panel variable and a time variable must be specified

xtabond: Arellano-Bond linear dynamic panel-data estimation

- ✓ Model employment on wages, capital stock, industry output, year dummies, and a time trend, including one lag of employment and two lags of wages and capital stock.

Basic model with two lags of dependent variable included as regressors

xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2)

```
. xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2)

Arellano-Bond dynamic panel-data estimation     Number of obs     =       611
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         4
                                                              avg =   4.364286
                                                              max =         6

Number of instruments =     41                  Wald chi2(15)     =   1624.40
                                                Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.7080866	.1456767	4.86	0.000	.4225654	.9936077
L2.	-.0886343	.0448856	-1.97	0.048	-.1766084	-.0006602
w						
--.	-.605526	.0661685	-9.15	0.000	-.7352138	-.4758382
L1.	.4096717	.1082166	3.79	0.000	.197571	.6217723
k						
--.	.3556407	.037385	9.51	0.000	.2823674	.428914
L1.	-.0599314	.0566394	-1.06	0.290	-.1709425	.0510797
L2.	-.0211709	.0418278	-0.51	0.613	-.1031519	.0608101
ys						
--.	.6264699	.1349141	4.64	0.000	.3620432	.8908967
L1.	-.7231751	.1846245	-3.92	0.000	-1.085033	-.3613177
L2.	.1179079	.1441364	0.82	0.413	-.1645943	.4004101
yr1980	.0113066	.0140743	0.80	0.422	-.0162786	.0388917
yr1981	-.0212183	.0206732	-1.03	0.305	-.0617371	.0193005
yr1982	-.034952	.0221406	-1.58	0.114	-.0783467	.0084427
yr1983	-.0287094	.0251748	-1.14	0.254	-.078051	.0206323
yr1984	-.014862	.0284833	-0.52	0.602	-.0706883	.0409642
_cons	1.03792	.6221795	1.67	0.095	-.1815295	2.257369

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        Standard: _cons
```

Basic model with two lags of dependent variable included as regressors

xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) vce(robust)

```
. xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) vce(robust)

Arellano-Bond dynamic panel-data estimation     Number of obs     =       611
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         4
                                                              avg =  4.364286
                                                              max =         6

Number of instruments =     41                  Wald chi2(15)     =   1678.80
                                                Prob > chi2       =    0.0000
One-step results
                                        (Std. Err. adjusted for clustering on id)
------------------------------------------------------------------------------
             |               Robust
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .7080866   .1455379     4.87   0.000     .4228376    .9933356
         L2. |  -.0886343   .0557558    -1.59   0.112    -.1979137     .020645
             |
           w |
         --. |   -.605526   .1796819    -3.37   0.001    -.9576962   -.2533559
         L1. |   .4096717   .1741168     2.35   0.019     .0684091    .7509343
             |
           k |
         --. |   .3556407   .0587954     6.05   0.000     .2404038    .4708775
         L1. |  -.0599314   .0717439    -0.84   0.404    -.2005469    .0806841
         L2. |  -.0211709   .0331968    -0.64   0.524    -.0862355    .0438937
             |
          ys |
         --. |   .6264699   .1705759     3.67   0.000     .2921473    .9607926
         L1. |  -.7231751   .2354623    -3.07   0.002    -1.184673   -.2616774
         L2. |   .1179079   .1440099     0.82   0.413    -.1643463    .4001621
             |
      yr1980 |   .0113066   .0135456     0.83   0.404    -.0152422    .0378554
      yr1981 |  -.0212183   .0251783    -0.84   0.399    -.0705669    .0281302
      yr1982 |   -.034952   .0255807    -1.37   0.172    -.0850892    .0151852
      yr1983 |  -.0287094   .0276914    -1.04   0.300    -.0829835    .0255648
      yr1984 |   -.014862   .0289466    -0.51   0.608    -.0715964    .0418723
       _cons |    1.03792   .6979649     1.49   0.137    -.330066     2.405906
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        Standard: _cons
```

Basic model with two lags of dependent variable included as regressors

xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep

```
. xtabond n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep

Arellano-Bond dynamic panel-data estimation     Number of obs     =       611
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         4
                                                              avg =  4.364286
                                                              max =         6

Number of instruments =     41                  Wald chi2(15)     =   2282.22
                                                Prob > chi2       =    0.0000
Two-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.6559667	.090028	7.29	0.000	.479515	.8324184
L2.	-.0729992	.0270121	-2.70	0.007	-.1259419	-.0200566
w						
--.	-.5132088	.0537642	-9.55	0.000	-.6185847	-.4078329
L1.	.3289685	.0961446	3.42	0.001	.1405285	.5174085
k						
--.	.2694384	.0438193	6.15	0.000	.1835541	.3553226
L1.	.0216493	.050406	0.43	0.668	-.0771447	.1204432
L2.	-.0409021	.0258317	-1.58	0.113	-.0915314	.0097271
ys						
--.	.5917429	.1152412	5.13	0.000	.3658743	.8176115
L1.	-.572021	.1396141	-4.10	0.000	-.8456596	-.2983825
L2.	.1172642	.1136713	1.03	0.302	-.1055273	.3400558
yr1980	.0092621	.0107871	0.86	0.391	-.0118802	.0304044
yr1981	-.0347086	.0198697	-1.75	0.081	-.0736524	.0042352
yr1982	-.0432807	.0210895	-2.05	0.040	-.0846155	-.001946
yr1983	-.0277604	.0214655	-1.29	0.196	-.069832	.0143112
yr1984	-.0335613	.0224111	-1.50	0.134	-.0774862	.0103636
_cons	.4939961	.4692208	1.05	0.292	-.4256597	1.413652

```
Warning: gmm two-step standard errors are biased; robust standard
         errors are recommended.
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        Standard: _cons
```

Treat w and k as predetermined and include w, L.w, k, L.k, and L2.k as additional regressors

xtabond n l(0/2).ys yr1980-yr1984, lags(2) pre(w, lag(1,.)) pre(k, lag(2,.))

```
. xtabond n l(0/2).ys yr1980-yr1984, lags(2) pre(w, lag(1,.)) pre(k, lag(2,.))

Arellano-Bond dynamic panel-data estimation     Number of obs     =       611
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         4
                                                              avg =   4.364286
                                                              max =         6

Number of instruments =     84                  Wald chi2(15)     =   1411.83
                                                Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.7937668	.0872834	9.09	0.000	.6226944	.9648392
L2.	-.0843626	.0607867	-1.39	0.165	-.2035024	.0347772
w						
--.	-.6974494	.1279892	-5.45	0.000	-.9483037	-.4465951
L1.	.6244379	.137217	4.55	0.000	.3554976	.8933782
k						
--.	.3771336	.1159306	3.25	0.001	.1499137	.6043534
L1.	-.1323513	.0954641	-1.39	0.166	-.3194575	.0547549
L2.	-.083734	.0752791	-1.11	0.266	-.2312784	.0638104
ys						
--.	.6022657	.1529172	3.94	0.000	.3025534	.901978
L1.	-.8989964	.2069333	-4.34	0.000	-1.304578	-.4934145
L2.	.2965608	.1668582	1.78	0.076	-.0304752	.6235968
yr1980	.0179943	.014664	1.23	0.220	-.0107466	.0467352
yr1981	-.0205353	.0238296	-0.86	0.389	-.0672404	.0261698
yr1982	-.0370638	.0299283	-1.24	0.216	-.0957221	.0215946
yr1983	-.0283482	.0361302	-0.78	0.433	-.0991621	.0424658
yr1984	-.0204669	.0426329	-0.48	0.631	-.1040258	.063092
_cons	.6076893	.8817026	0.69	0.491	-1.120416	2.335795

```
Instruments for differenced equation
        GMM-type: L(2/.).n L(1/.).L.w L(1/.).L2.k
        Standard: D.ys LD.ys L2D.ys D.yr1980 D.yr1981 D.yr1982 D.yr1983
                  D.yr1984
Instruments for level equation
        Standard: _cons
```

Treat L.w and L2.k as endogenous and include w, L.w, k, L.k, and L2.k as additional regressors

xtabond n l(0/2).ys yr1980-yr1984, lags(2) endogenous(w, lag(1,.)) endogenous(k, lag(2,.))

```
. xtabond n l(0/2).ys yr1980-yr1984, lags(2) endogenous(w, lag(1,.)) endogenous(k, lag(2,.))

Arellano-Bond dynamic panel-data estimation     Number of obs     =       611
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         4
                                                              avg =   4.364286
                                                              max =         6

Number of instruments =     72                  Wald chi2(15)     =   1424.46
                                                Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.6960552	.0913928	7.62	0.000	.5169286	.8751819
L2.	-.0761309	.0610322	-1.25	0.212	-.1957519	.0434901
w						
--.	-.7806016	.1400408	-5.57	0.000	-1.055076	-.5061267
L1.	.4956248	.1403399	3.53	0.000	.2205637	.7706859
k						
--.	.3744889	.1200512	3.12	0.002	.1391928	.609785
L1.	-.1443116	.100143	-1.44	0.150	-.3405884	.0519651
L2.	-.0362278	.0770196	-0.47	0.638	-.1871835	.1147279
ys						
--.	.6390589	.1512662	4.22	0.000	.3425825	.9355353
L1.	-.830853	.2088936	-3.98	0.000	-1.240277	-.421429
L2.	.2549044	.1665737	1.53	0.126	-.071574	.5813828
yr1980	.0187231	.0145504	1.29	0.198	-.0097953	.0472414
yr1981	-.01523	.0241264	-0.63	0.528	-.062517	.032057
yr1982	-.0316143	.0310578	-1.02	0.309	-.0924864	.0292578
yr1983	-.0214901	.0379517	-0.57	0.571	-.095874	.0528937
yr1984	-.0146253	.0452039	-0.32	0.746	-.1032233	.0739728
_cons	1.084412	.9429195	1.15	0.250	-.7636758	2.932501

```
Instruments for differenced equation
        GMM-type: L(2/.).n L(2/.).L.w L(2/.).L2.k
        Standard: D.ys LD.ys L2D.ys D.yr1980 D.yr1981 D.yr1982 D.yr1983
                  D.yr1984
Instruments for level equation
        Standard: _cons
```

xtdpdsys

xtdpdsys fits a linear dynamic panel-data model where the unobserved panel-level effects are correlated with the lags of the dependent variable. This model is an extension of the Arellano-Bond estimator that accommodates large autoregressive parameters and a large ratio of the variance of the panel-level effect to the variance of idiosyncratic error. This is known as the Arellano-Bover/Blundell-Bond system estimator. This estimator is designed for datasets with many panels and few periods. This method assumes that there is no autocorrelation in the idiosyncratic errors and requires that the panel-level effects be uncorrelated with the first difference of the first observation of the dependent variable.

xtdpdsys implements the Arellano and Bover/Blundell and Bond system estimator, which uses the xtabond moment conditions and moment conditions in which lagged first differences of the dependent variable are instruments for the level equation.

Basic model with strictly exogenous covariates and two lags of the dependent variable

xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2)

```
. xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2)

System dynamic panel-data estimation            Number of obs     =       751
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         5
                                                              avg =   5.364286
                                                              max =         7

Number of instruments =     48                  Wald chi2(15)     =   4001.38
                                                Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.9159204	.0853873	10.73	0.000	.7485644	1.083276
L2.	-.065795	.0369882	-1.78	0.075	-.1382905	.0067006
w						
--.	-.6467303	.0684371	-9.45	0.000	-.7808646	-.512596
L1.	.5298655	.0918694	5.77	0.000	.3498048	.7099262
k						
--.	.3360997	.0338606	9.93	0.000	.2697342	.4024652
L1.	-.1415277	.0444765	-3.18	0.001	-.2287001	-.0543553
L2.	-.0615284	.0366908	-1.68	0.094	-.133441	.0103843
ys						
--.	.6678713	.1461438	4.57	0.000	.3814348	.9543079
L1.	-.8346481	.1766848	-4.72	0.000	-1.180944	-.4883521
L2.	.1311835	.1492504	0.88	0.379	-.161342	.4237089
yr1980	.0165223	.0151769	1.09	0.276	-.0132238	.0462684
yr1981	-.0174472	.0223515	-0.78	0.435	-.0612552	.0263609
yr1982	-.0191043	.0229068	-0.83	0.404	-.0640008	.0257922
yr1983	-.0128877	.0255229	-0.50	0.614	-.0629116	.0371362
yr1984	-.005388	.029233	-0.18	0.854	-.0626837	.0519076
_cons	.743272	.6208666	1.20	0.231	-.4736042	1.960148

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        GMM-type: LD.n
        Standard: _cons
```

Same model with a robust VCE

xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) vce(robust)

```
. xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) vce(robust)

System dynamic panel-data estimation            Number of obs     =       751
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         5
                                                              avg =  5.364286
                                                              max =         7

Number of instruments =     48                  Wald chi2(15)     =   2762.87
                                                Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.9159204	.1278178	7.17	0.000	.6654022	1.166439
L2.	-.065795	.0548045	-1.20	0.230	-.1732097	.0416198
w						
--.	-.6467303	.1822369	-3.55	0.000	-1.003908	-.2895525
L1.	.5298655	.1709089	3.10	0.002	.1948903	.8648408
k						
--.	.3360997	.0609879	5.51	0.000	.2165655	.4556339
L1.	-.1415277	.0757751	-1.87	0.062	-.2900442	.0069888
L2.	-.0615284	.0385949	-1.59	0.111	-.1371729	.0141162
ys						
--.	.6678713	.1773062	3.77	0.000	.3203575	1.015385
L1.	-.8346481	.2351319	-3.55	0.000	-1.295498	-.3737981
L2.	.1311835	.1583734	0.83	0.407	-.1792227	.4415896
yr1980	.0165223	.0145901	1.13	0.257	-.0120738	.0451184
yr1981	-.0174472	.0259113	-0.67	0.501	-.0682325	.0333381
yr1982	-.0191043	.0273028	-0.70	0.484	-.0726168	.0344082
yr1983	-.0128877	.0284472	-0.45	0.651	-.0686432	.0428678
yr1984	-.005388	.0278262	-0.19	0.846	-.0599264	.0491503
_cons	.743272	.6133379	1.21	0.226	-.4588481	1.945392

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        GMM-type: LD.n
        Standard: _cons
```

Two-step estimator of the same model

xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep vce(robust)

```
. xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep vce(robust)

System dynamic panel-data estimation            Number of obs     =       751
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         5
                                                              avg =   5.364286
                                                              max =         7

Number of instruments =     48                  Wald chi2(15)     =   1449.65
                                                Prob > chi2       =    0.0000
Two-step results
```

n	Coef.	WC-Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.9767449	.1418081	6.89	0.000	.6988061	1.254684
L2.	-.0836652	.0419231	-2.00	0.046	-.165833	-.0014975
w						
--.	-.5631217	.151118	-3.73	0.000	-.8593075	-.2669358
L1.	.5673231	.2123546	2.67	0.008	.1511158	.9835304
k						
--.	.2849277	.0668521	4.26	0.000	.1539001	.4159554
L1.	-.0876075	.0871276	-1.01	0.315	-.2583744	.0831595
L2.	-.0961451	.0433443	-2.22	0.027	-.1810984	-.0111919
ys						
--.	.6138593	.1781104	3.45	0.001	.2647694	.9629491
L1.	-.765499	.2470081	-3.10	0.002	-1.249626	-.2813719
L2.	.1140538	.1725595	0.66	0.509	-.2241566	.4522641
yr1980	.009473	.0168233	0.56	0.573	-.0235001	.0424461
yr1981	-.0248051	.0296342	-0.84	0.403	-.0828871	.0332768
yr1982	-.0303709	.0327228	-0.93	0.353	-.0945064	.0337646
yr1983	-.0097145	.0363711	-0.27	0.789	-.0810005	.0615715
yr1984	-.0214451	.0348021	-0.62	0.538	-.089656	.0467658
_cons	.3246957	.6640236	0.49	0.625	-.9767666	1.626158

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.k LD.k L2D.k D.ys LD.ys L2D.ys D.yr1980
                  D.yr1981 D.yr1982 D.yr1983 D.yr1984
Instruments for level equation
        GMM-type: LD.n
        Standard: _cons
```

Now allow some of the covariates to be predetermined

xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep pre(w, lag(1,.)) pre(k,lag(2,.))

```
. xtdpdsys n l(0/1).w l(0/2).(k ys) yr1980-yr1984, lags(2) twostep pre(w, lag(1,.)) pre(k,lag(2,.))
note: w dropped because of collinearity
note: L.w dropped because of collinearity
note: k dropped because of collinearity
note: L.k dropped because of collinearity
note: L2.k dropped because of collinearity

System dynamic panel-data estimation            Number of obs     =       751
Group variable: id                              Number of groups  =       140
Time variable: year
                                                Obs per group:
                                                              min =         5
                                                              avg =  5.364286
                                                              max =         7

Number of instruments =    109                  Wald chi2(15)     =  653324.06
                                                Prob > chi2       =    0.0000
Two-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.9359334	.0139049	67.31	0.000	.9086803	.9631864
L2.	-.0472394	.0082023	-5.76	0.000	-.0633156	-.0311632
w						
L1.	.4786433	.0178005	26.89	0.000	.4437549	.5135316
k						
--.	.3381439	.0142908	23.66	0.000	.3101345	.3661533
L1.	-.1459764	.0159113	-9.17	0.000	-.1771621	-.1147907
L2.	-.1004765	.0097268	-10.33	0.000	-.1195407	-.0814124
w	-.6657839	.0103548	-64.30	0.000	-.686079	-.6454888
ys						
--.	.6242184	.0504538	12.37	0.000	.5253307	.723106
L1.	-.8042974	.0601264	-13.38	0.000	-.9221429	-.6864518
L2.	.1608649	.0502753	3.20	0.001	.0623271	.2594027
yr1980	.0200349	.0035604	5.63	0.000	.0130567	.027013
yr1981	-.0131416	.007338	-1.79	0.073	-.0275238	.0012407
yr1982	-.0093636	.006827	-1.37	0.170	-.0227442	.004017
yr1983	.0206735	.0073879	2.80	0.005	.0061934	.0351535
yr1984	.0154074	.0063745	2.42	0.016	.0029137	.0279011
_cons	.8210641	.1623048	5.06	0.000	.5029525	1.139176

Now allow some of the covariates to be endogenous

xtdpdsys n l(0/1).ys yr1980-yr1984, lags(2) twostep endogenous(w, lag(1,.)) endogenous(k,lag(2,.))

```
. xtdpdsys n l(0/1).ys yr1980-yr1984, lags(2) twostep endogenous(w, lag(1,.)) endogenous(k,lag(2,.))

System dynamic panel-data estimation            Number of obs      =       751
Group variable: id                              Number of groups   =       140
Time variable: year
                                                Obs per group:
                                                              min =         5
                                                              avg =   5.364286
                                                              max =         7

Number of instruments =     89                  Wald chi2(14)      =  76216.28
                                                Prob > chi2        =    0.0000
Two-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.9281504	.0229639	40.42	0.000	.883142	.9731587
L2.	-.0295319	.0174011	-1.70	0.090	-.0636374	.0045735
w						
--.	-.7406288	.0154004	-48.09	0.000	-.770813	-.7104445
L1.	.6325302	.0229018	27.62	0.000	.5876435	.6774169
k						
--.	.4033359	.0240761	16.75	0.000	.3561475	.4505242
L1.	-.1770388	.0284268	-6.23	0.000	-.2327543	-.1213233
L2.	-.1544337	.0219597	-7.03	0.000	-.197474	-.1113934
ys						
--.	.6508306	.062621	10.39	0.000	.5280956	.7735656
L1.	-.8954249	.0675184	-13.26	0.000	-1.027759	-.7630912
yr1980	.0266106	.0062777	4.24	0.000	.0143065	.0389148
yr1981	-.0049436	.0116563	-0.42	0.671	-.0277895	.0179023
yr1982	-.018397	.0127608	-1.44	0.149	-.0434078	.0066138
yr1983	-.0120134	.0127249	-0.94	0.345	-.0369537	.0129269
yr1984	-.0304533	.0096511	-3.16	0.002	-.0493691	-.0115375
_cons	1.619706	.2654796	6.10	0.000	1.099376	2.140036

```
Warning: gmm two-step standard errors are biased; robust standard
         errors are recommended.
Instruments for differenced equation
        GMM-type: L(2/.).n L(2/.).L.w L(2/.).L2.k
        Standard: D.ys LD.ys D.yr1980 D.yr1981 D.yr1982 D.yr1983 D.yr1984
```

xtdpd

xtdpd fits a linear dynamic panel-data model where the unobserved panel-level effects are correlated with the lags of the dependent variable. The command can fit Arellano-Bond and Arellano-Bover/Blundell-Bond models like those fit by xtabond and xtdpdsys.

xtdpd, for advanced users, is a more flexible alternative that can fit models with low-order moving-average correlations in the idiosyncratic errors and predetermined variables with a more complicated structure than allowed with xtabond and xtdpdsys.

Arellano-Bond estimator with two lags of dependent variable included as regressors and strictly exogenous covariates

xtdpd l(0/2).n l(0/1).(w ys) k, dgmmiv(n) div(l(0/1).(w ys) k)

```
. xtdpd l(0/2).n l(0/1).(w ys) k, dgmmiv(n) div(l(0/1).(w ys) k)

Dynamic panel-data estimation                 Number of obs     =       751
Group variable: id                            Number of groups  =       140
Time variable: year
                                              Obs per group:
                                                           min =         5
                                                           avg =   5.364286
                                                           max =         7

Number of instruments =     33                Wald chi2(7)      =   1434.37
                                              Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.5779025	.1351405	4.28	0.000	.3130319	.8427731
L2.	-.0920163	.0462129	-1.99	0.046	-.1825919	-.0014407
w						
--.	-.6100184	.0605643	-10.07	0.000	-.7287223	-.4913146
L1.	.2930618	.101849	2.88	0.004	.0934413	.4926822
ys						
--.	.6849995	.0839359	8.16	0.000	.5204882	.8495108
L1.	-.4868203	.1503792	-3.24	0.001	-.7815581	-.1920824
k	.3623754	.0355449	10.19	0.000	.2927087	.432042
_cons	.7667895	.4707679	1.63	0.103	-.1558987	1.689478

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.ys LD.ys D.k
Instruments for level equation
        Standard: _cons
```

Arellano-Bond estimator with two lags of dependent variable included as regressors and strictly exogenous covariates

xtdpd l(0/2).n l(0/1).(w ys) k year yr1980-yr1984, dgmmiv(n) div(l(0/1).(w ys) k year) div(yr1980-yr1984) nocons hascons

```
. xtdpd l(0/2).n l(0/1).(w ys) k year yr1980-yr1984, dgmmiv(n) div(l(0/1).(w ys) k year) div(yr1980-yr1984) nocons hascons

Dynamic panel-data estimation                 Number of obs      =       611
Group variable: id                            Number of groups   =       140
Time variable: year
                                              Obs per group:
                                                           min =         4
                                                           avg =  4.364286
                                                           max =         6

Number of instruments =     38                Wald chi2(13)      =   1776.19
                                              Prob > chi2        =    0.0000
One-step results
------------------------------------------------------------------------------
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .5346138   .1274182     4.20   0.000     .2848787    .784349
         L2. |  -.0750693   .0434409    -1.73   0.084    -.1602118   .0100732
             |
           w |
         --. |  -.5915733   .0619073    -9.56   0.000    -.7129093  -.4702372
         L1. |   .2915102   .0955581     3.05   0.002     .1042198   .4788006
             |
          ys |
         --. |      .5972   .1273263     4.69   0.000      .347645    .846755
         L1. |  -.6117057   .1679471    -3.64   0.000     -.940876  -.2825354
             |
           k |   .3585025   .0348679    10.28   0.000     .2901627   .4268423
        year |   .0054272   .0128135     0.42   0.672    -.0196868   .0305413
      yr1980 |   .0056078   .0200751     0.28   0.780    -.0337388   .0449543
      yr1981 |  -.0326971   .0328505    -1.00   0.320    -.0970828   .0316887
      yr1982 |  -.0604824    .045103    -1.34   0.180    -.1488827   .0279179
      yr1983 |  -.0673326   .0582333    -1.16   0.248    -.1814677   .0468025
      yr1984 |  -.0610189   .0714438    -0.85   0.393    -.2010463   .0790084
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.ys LD.ys D.k D.year D.yr1980 D.yr1981 D.yr1982
                  D.yr1983 D.yr1984
```

Arellano-Bond estimator with two lags of dependent variable included as regressors, strictly exogenous covariates and robust VCE

xtdpd l(0/2).n l(0/1).(w ys) k year yr1980-yr1984, dgmmiv(n) div(l(0/1).(w ys) k year) div(yr1980-yr1984) nocons hascons twostep vce(robust)

```
. xtdpd l(0/2).n l(0/1).(w ys) k year yr1980-yr1984, dgmmiv(n) div(l(0/1).(w ys) k year) div(yr1980-yr1984) nocons hascons twostep vce(robust)

Dynamic panel-data estimation                 Number of obs      =       611
Group variable: id                            Number of groups   =       140
Time variable: year
                                              Obs per group:
                                                           min =         4
                                                           avg =     4.364286
                                                           max =         6

Number of instruments =     38                Wald chi2(13)      =    822.28
                                              Prob > chi2        =    0.0000
Two-step results
                                        (Std. Err. adjusted for clustering on id)
------------------------------------------------------------------------------
             |              WC-Robust
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .4741506   .1853986     2.56   0.011     .1107761    .8375251
         L2. |  -.0529677   .0517491    -1.02   0.306    -.1543941    .0484587
             |
           w |
         --. |  -.5132049   .1455655    -3.53   0.000    -.7985081   -.2279017
         L1. |     .22464   .1419498     1.58   0.114    -.0535765    .5028564
             |
          ys |
         --. |    .609776   .1562628     3.90   0.000     .3035065    .9160455
         L1. |  -.4463736   .2173026    -2.05   0.040    -.8722788   -.0204684
             |
           k |   .2927232   .0626271     4.67   0.000     .1690764     .41547
        year |    .010509   .0099019     1.06   0.289    -.0088983    .0299163
     yr1980  |   .0036333   .0159636     0.23   0.819    -.0274589    .0347255
     yr1981  |  -.0473287   .0299195    -1.58   0.114    -.1059699    .0113124
     yr1982  |  -.0794778   .0415265    -1.91   0.056    -.1608682    .0019126
     yr1983  |  -.0918336   .0528334    -1.74   0.082    -.1953852    .0117179
     yr1984  |  -.1125632   .0614008    -1.83   0.067    -.2329066    .0077801
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.ys LD.ys D.k D.year D.yr1980 D.yr1981 D.yr1982
                  D.yr1983 D.yr1984
```

Arellano-Bover/Blundell-Bond system estimator with two lags of dependent variable included as regressors and strictly exogenous covariates

xtdpd l(0/2).n l(0/1).(w ys) k, dgmmiv(n) lgmmiv(n) div(l(0/1).(w ys) k)

```
. xtdpd l(0/2).n l(0/1).(w ys) k, dgmmiv(n) lgmmiv(n) div(l(0/1).(w ys) k )

Dynamic panel-data estimation                 Number of obs     =       751
Group variable: id                            Number of groups  =       140
Time variable: year
                                              Obs per group:
                                                           min =         5
                                                           avg =  5.364286
                                                           max =         7

Number of instruments =     40                Wald chi2(7)      =   4375.71
                                              Prob > chi2       =    0.0000
One-step results
```

n	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
n						
L1.	.709591	.072315	9.81	0.000	.5678563	.8513257
L2.	-.0708808	.0314552	-2.25	0.024	-.1325319	-.0092296
w						
--.	-.6495049	.0607098	-10.70	0.000	-.7684938	-.5305159
L1.	.3530577	.0764309	4.62	0.000	.2032559	.5028594
ys						
--.	.7690742	.0826427	9.31	0.000	.6070976	.9310508
L1.	-.5870667	.0918981	-6.39	0.000	-.7671837	-.4069497
k	.2695409	.0308423	8.74	0.000	.2090912	.3299907
_cons	.5734973	.4345343	1.32	0.187	-.2781743	1.425169

```
Instruments for differenced equation
        GMM-type: L(2/.).n
        Standard: D.w LD.w D.ys LD.ys D.k
Instruments for level equation
        GMM-type: LD.n
        Standard: _cons
```

Arellano-Bond estimator with two lags of dependent variable included as regressors, endogenous covariates and a robust VCE

xtdpd L(0/1).(n w k) year yr1979-yr1984, dgmmiv(n w k) div(year yr1979-yr1984) nocons hascons vce(robust)

```
. xtdpd L(0/1).(n w k) year yr1979-yr1984, dgmmiv(n w k) div(year yr1979-yr1984) nocons hascons vce(robust)

Dynamic panel-data estimation                 Number of obs      =       751
Group variable: id                            Number of groups   =       140
Time variable: year
                                              Obs per group:
                                                           min =         5
                                                           avg =   5.364286
                                                           max =         7

Number of instruments =     91                Wald chi2(12)      =   1163.33
                                              Prob > chi2        =    0.0000
One-step results
                                        (Std. Err. adjusted for clustering on id)
------------------------------------------------------------------------------
             |               Robust
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |    .7074701   .0841788     8.40   0.000     .5424827    .8724576
             |
           w |
         --. |   -.7087965    .117102    -6.05   0.000    -.9383122   -.4792809
         L1. |    .5000149   .1113282     4.49   0.000     .2818157    .7182141
             |
           k |
         --. |    .4659776    .101044     4.61   0.000      .267935    .6640203
         L1. |   -.2151309   .0858525    -2.51   0.012    -.3833987   -.0468631
             |
        year |    .0057636   .0166077     0.35   0.729    -.0267868     .038314
      yr1979 |    .0021095   .0177521     0.12   0.905    -.0326839    .0369028
      yr1980 |   -.0244464   .0337862    -0.72   0.469    -.0906661    .0417733
      yr1981 |   -.0571235   .0520635    -1.10   0.273    -.1591661     .044919
      yr1982 |   -.0347353   .0728319    -0.48   0.633    -.1774833    .1080126
      yr1983 |   -.0158601   .0905961    -0.18   0.861    -.1934253     .161705
      yr1984 |   -.0051171   .1119353    -0.05   0.964    -.2245063    .2142721
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).n L(2/.).w L(2/.).k
        Standard: D.year D.yr1979 D.yr1980 D.yr1981 D.yr1982 D.yr1983
                  D.yr1984
```

Arellano-Bover/Blundell-Bond system estimator with two lags of dependent variable included as regressors, endogenous covariates and a robust VCE

xtdpd L(0/1).(n w k) year yr1979-yr1984, dgmmiv(n w k) lgmmiv(n w k) div(year yr1979-yr1984) nocons hascons vce(robust)

```
. xtdpd L(0/1).(n w k) year yr1979-yr1984, dgmmiv(n w k) lgmmiv(n w k) div(year yr1979-yr1984) nocons hascons vce(robust)

Dynamic panel-data estimation                 Number of obs      =       891
Group variable: id                            Number of groups   =       140
Time variable: year
                                              Obs per group:
                                                           min =         6
                                                           avg =  6.364286
                                                           max =         8

Number of instruments =    112                Wald chi2(12)      =   8455.33
                                              Prob > chi2        =    0.0000
One-step results
                                        (Std. Err. adjusted for clustering on id)
------------------------------------------------------------------------------
             |               Robust
           n |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           n |
         L1. |   .8116309   .0601982    13.48   0.000     .6936446    .9296172
             |
           w |
         --. |  -.7899997   .1162562    -6.80   0.000    -1.017858   -.5621418
         L1. |   .5017474   .1282602     3.91   0.000      .250362    .7531327
             |
           k |
         --. |   .4998722   .0766364     6.52   0.000     .3496676    .6500769
         L1. |  -.3527817   .0693249    -5.09   0.000    -.488656   -.2169074
             |
        year |    .000575   .0001953     2.94   0.003     .0001921    .0009578
      yr1979 |   .0084748   .0106391     0.80   0.426    -.0123774     .029327
      yr1980 |  -.0025071   .0127398    -0.20   0.844    -.0274767    .0224624
      yr1981 |  -.0316978   .0188929    -1.68   0.093    -.0687271    .0053316
      yr1982 |   .0072489   .0187698     0.39   0.699    -.0295393    .0440371
      yr1983 |   .0277412   .0234645     1.18   0.237    -.0182483    .0737306
      yr1984 |   .0504974   .0294984     1.71   0.087    -.0073185    .1083132
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).n L(2/.).w L(2/.).k
        Standard: D.year D.yr1979 D.yr1980 D.yr1981 D.yr1982 D.yr1983
                  D.yr1984
Instruments for level equation
        GMM-type: LD.n LD.w LD.k
```

Income and democracy
[Acemoglu et al.(2008)Acemoglu, Johnson, Robinson and Yared]

Reading

Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations
[Arellano and Bond(1991)]
Efficient estimation of models for dynamic panel data
[Ahn and Schmidt(1995)]
Initial conditions and moment restrictions in dynamic panel data models
[Blundell and Bond(1998)]
Estimating dynamic panel data models: a guide for macroeconomists
[Judson and Owen(1999)]

Reading

Dynamic panel data models: a guide to micro data methods and practice
[Bond(2002)]
A finite sample correction for the variance of linear efficient two-step GMM estimators
[Windmeijer(2005)]
Causal relationship between energy consumption and GDP growth revisited: a dynamic panel data approach
[Huang et al.(2008)Huang, Hwang and Yang]
Does tourism influence economic growth? A dynamic panel data approach
[Sequeira and Maçãs Nunes(2008)]

Thank You!

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