



(R)

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Notes:

1. Unicode is supported; see [help unicode advice](#).

```

1 . doedit "C:\
2 . do "C:
3 . *Import dataset.*
4 .
5 . import delimited "C:\
   (21 vars, 1,326 obs)
6 .
7 . *Assign labels to each variable in the dataset.*
8 .
9 . label variable alpha3 "Alpha-3 Code"
10 . label variable q5coverage "MCV1 Coverage in the Wealthiest Quintile"
11 . label variable q1coverage "MCV1 Coverage in the Poorest Quintile"
12 . label variable geoequity "Geographic Equity"
13 . label variable dtp3 "DTP3 Coverage"
14 . label variable mcv1 "MCV1 Coverage"
15 . label variable anc1 "Antenatal Care Coverage (1+ Visits)"
16 . label variable pab "Protection at Birth Against Neonatal Tetanus"
17 . label variable femeduc "Female Primary Education Completed"
18 . label variable polstability "Political Stability"
19 . label variable goveffect "Government Effectiveness"

```

```

20 . label variable corrupt "Corruption"
21 . label variable gii "Gender Inequality Index"
22 . label variable oopexp "Out-of-Pocket Health Expenditures"
23 . label variable govexp "Domestic Government Health Expenditures"
24 . label variable exthlth "External Health Spending"
25 . label variable land "Land Area"
26 . label variable lingfrac "Linguistic Fractionalization"
27 . label variable distance "Distance to Nearest Health Facility (Walking, 60+ Minutes)"
28 .
29 . *****
30 . ***Perform multiple imputation to handle missing data***
31 . *****
32 .
33 . *First, identify missing values in the dataset. Install the "mdesc" package if needed.*
34 .
35 . mdesc q5coverage qlcoverage geoequity dtp3 mcv1 anc1 pab femeduc polstability goveffect corrupt
> rac distance

```

Variable	Missing	Total	Percent Missing
q5coverage	1,110	1,326	83.71
qlcoverage	1,113	1,326	83.94
geoequity	173	1,326	13.05
dtp3	10	1,326	0.75
mcv1	8	1,326	0.60
anc1	1,008	1,326	76.02
pab	233	1,326	17.57
femeduc	537	1,326	40.50
polstability	8	1,326	0.60
goveffect	8	1,326	0.60
corrupt	7	1,326	0.53
gii	649	1,326	48.94
oopexp	140	1,326	10.56
govexp	140	1,326	10.56
exthlth	140	1,326	10.56
land	8	1,326	0.60
lingfrac	51	1,326	3.85
distance	24	1,326	1.81

```

36 .
37 . *Create a pairwise correlation matrix to identify potential auxiliary variables.*
38 .
39 . pwcrr q5coverage qlcoverage geoequity dtp3 mcv1 anc1 pab femeduc polstability goveffect corrup
> frac distance

```

	q5cove~e	qlcove~e	geoequ~y	ntp3	mcv1	anc1	pab
q5coverage	1.0000						
qlcoverage	0.6281	1.0000					
geoequity	0.2300	0.3073	1.0000				
ntp3	0.5752	0.8465	0.4849	1.0000			
mcv1	0.5457	0.8753	0.5076	0.9327	1.0000		
anc1	0.4729	0.5951	0.3168	0.6588	0.6774	1.0000	
pab	0.4227	0.5877	0.4671	0.5965	0.5821	0.4524	1.0000
femeduc	0.3703	0.5205	0.3353	0.5543	0.6116	0.4605	0.3549
polstability	0.2494	0.4526	0.2423	0.5301	0.4956	0.5417	0.3489
goveffect	0.3012	0.3078	0.2922	0.4600	0.4626	0.3677	0.3302
corrupt	0.2340	0.2832	0.1959	0.4221	0.4001	0.3809	0.3100
gii	0.0286	0.1052	0.0784	0.1231	0.1048	0.0473	-0.0129
oopexp	-0.2164	-0.3076	-0.0370	-0.1919	-0.1982	-0.3969	-0.0332
govexp	0.0955	0.3204	0.1907	0.2190	0.2678	0.2461	0.1847
exthlth	0.1314	0.2588	0.0542	0.1583	0.1176	0.1924	0.1691
land	-0.0590	-0.3470	0.0120	-0.0627	-0.0418	0.0529	-0.2108
lingfrac	-0.0580	-0.2804	-0.1435	-0.2875	-0.3367	-0.1515	-0.0855
distance	-0.0729	0.0351	0.0133	0.0245	0.0984	-0.1866	-0.0842
	femeduc	polsta~y	goveff~t	corrupt	gii	oopexp	govexp
femeduc	1.0000						
polstability	0.3344	1.0000					
goveffect	0.4249	0.4793	1.0000				
corrupt	0.2481	0.5881	0.7399	1.0000			
gii	-0.0221	-0.0051	0.0268	0.0044	1.0000		
oopexp	-0.0728	-0.4911	-0.2437	-0.4723	-0.0045	1.0000	
govexp	0.2737	0.2610	0.2712	0.3047	-0.1186	-0.2392	1.0000
exthlth	0.0355	0.2336	-0.0415	0.1797	-0.0721	-0.4768	-0.1415
land	-0.1103	-0.1418	0.1638	-0.0273	0.1948	0.0910	0.0105
lingfrac	-0.4576	-0.1729	-0.0583	-0.0730	0.0277	0.0683	-0.3200
distance	0.2705	0.0602	-0.0898	-0.0958	-0.0326	0.0677	0.2000
	exthlth	land	lingfrac	distance			
exthlth	1.0000						
land	-0.2399	1.0000					
lingfrac	0.0890	0.0268	1.0000				
distance	-0.2347	0.0031	-0.3394	1.0000			

40 .

41 . *Set the data for multiple imputation. The "mi set mlong" command generates three additional va
 > the imputed datasets and values*

42 .

43 . mi set mlong

44 .

45 . *Summarize missing values in the dataset.*

46 .

47 . mi misstable summarize q5coverage qlcoverage geoequity dtp3 mcv1 anc1 pab femeduc polstability
 > xthlth land lingfrac distance

Obs<.

Variable	Obs=.	Obs>.	Obs<.	Unique values	Min	Max
q5coverage	1,110		216	153	20	100
qlcoverage	1,113		213	182	8.2	100
geoequity	173		1,153	102	0	104
ntp3	10		1,316	75	19	99
mcv1	8		1,318	72	16	99
anc1	1,008		318	204	16.1	100
pab	233		1,093	63	31	99

2	0	0																	
	1 0	1 0	1	1		1	1	1	1		1	1	1	0		1	0	0	0
1	1 0	1 0	1	1		1	1	1	1		0	0	0	1		1	0	0	0
1	1 1	1 1	1	1		1	1	1	1		1	1	1	1		1	0	0	1
1	1 0	1 0	1	1		1	1	1	1		0	0	0	1		1	1	1	0
1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		0	0	1	0
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		0	1	0	1
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		1	0	0	1
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		1	1	0	1
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		1	0	1	1
<1	1 0	1 0	1	1		1	1	1	0		1	1	1	1		1	0	1	0
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	0		0	0	0	0
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		0	0	1	1
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	1		0	1	1	1
<1	1 1	1 1	1	1		1	1	1	1		1	1	1	1		0	1	1	1
<1	1 0	1 0	1	1		1	1	1	1		0	0	0	0		1	0	0	0
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	0		1	1	1	0
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<1	1 0	1 0	1	1		1	1	0	1		1	1	1	1		1	1	1	0
<1	1 0	1 0	1	1		1	1	1	1		1	1	1	0		1	1	0	1
<1	1 0	1 0	1	1		1	1	1	0		1	1	1	1		1	0	0	0
<1	1 1	1 1	1	1		1	1	1	1		0	0	0	1		1	0	1	1

<1	1 0	1 0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1
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<1	1 0	1 0	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0
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<1	1 1	1 1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
<1	1 0	1 0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0
<1	1 0	1 0	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0
<1	1 0	1 0	1	1	1	1	0	1	1	1	1	0	1	1	0	0	0

<1	1 1 1 1	1 1 1 1	0 0 0 1	0 0 1 0
	0 0			
<1	1 1 1 1	1 1 1 1	1 1 1 0	0 0 0 1
	0 0			
<1	1 1 1 1	1 1 1 1	1 1 1 0	1 0 1 0
	1 0			
<1	1 1 1 1	1 1 1 1	1 1 1 0	1 1 1 1
	1 1			
<1	1 1 1 1	1 1 1 1	1 1 1 1	0 0 0 1
	1 1			
<1	1 1 1 1	1 1 1 1	1 1 1 1	0 0 1 1
	1 1			
<1	1 0 0 0	0 0 1 0	0 0 0 0	0 0 1 1
	1 1			
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	0 0			
<1	1 1 1 1	1 0 1 1	1 1 1 1	1 0 0 0
	1 1			
<1	1 1 1 1	1 1 0 1	0 0 0 1	1 0 1 0
	0 0			
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	0 0			
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	0 0			
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	0 0			
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	0 0			
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	0 0			
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	0 0			
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	0 0			
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	1 1			
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	1 1			
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	0 0			
<1	1 1 1 1	1 1 1 0	1 1 1 1	1 1 0 0
	0 0			
<1	1 1 1 1	1 1 1 0	1 1 1 1	1 1 0 1

	1	1																	
<1	1	1	1	1		1	1	1	0		1	1	1	1		1	1	1	1
	0	0																	
<1	1	1	1	1		1	1	1	0		1	1	1	1		1	1	1	1
	1	1																	
<1	1	1	1	1		1	1	1	1		0	0	0	0		0	0	0	0
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	0		0	0	1	0
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	0		1	0	1	0
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	0		1	1	0	0
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	1		0	0	0	0
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	1		0	0	0	1
	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	1		0	1	0	0
	0	0																	
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	0	0																	
<1	1	1	1	1		1	1	1	1		0	0	0	1		1	0	0	0
	1	1																	
<1	1	1	1	1		1	1	1	1		0	0	0	1		0	1	0	0
	0	0																	
<1	1	1	1	1		1	1	1	1		1	1	1	0		0	0	0	1
	1	1																	
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	0	0																	
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	1	1																	
<1	1	1	1	1		1	1	1	1		1	1	1	0		1	0	1	1
	0	0																	
<1	1	1	1	1		1	1	1	1		1	1	1	0		1	1	1	0
	1	0																	
<1	1	1	1	1		1	1	1	1		1	1	1	1		1	0	1	0
	1	1																	

100%

Variables are

Row 1: (1) **corrupt** (2) **goveffect** (3) **land** (4) **mcv1** (5) **polstability** (6) **ntp3** (7) **di**
 (10) **govexp** (11) **oopexp** (12) **geoequity** (13) **pab** (14) **femeduc** (15) **gii** (16) **a**
 Row 2: (1) **q5coverage** (2) **qlcoverage**

```
52 .
53 . *Register the variables to be imputed.*
54 .
55 . mi register imputed q5coverage qlcoverage geoequity anc1 pab
    (1157 m=0 obs. now marked as incomplete)

56 .
57 . *Specify the imputed model.*
58 .
59 . mi impute mvn geoequity anc1 pab = mcv1, add(10) rseed(54321) force
```

Performing EM optimization:

note: 37 observations omitted from EM estimation because of all imputation variables missing
 observed log likelihood = **-8367.4122** at iteration 40

Performing MCMC data augmentation ...

Multivariate imputation	Imputations =	10
Multivariate normal regression	added =	10
Imputed: m=1 through m=10	updated =	0

Prior: uniform	Iterations =	1000
	burn-in =	100
	between =	100

Variable	Observations per m			
	Complete	Incomplete	Imputed	Total
geoequity	1153	173	165	1326
anc1	318	1008	1001	1326
pab	1093	233	225	1326

(complete + incomplete = total; imputed is the minimum across m
 of the number of filled-in observations.)

Note: Right-hand-side variables (or weights) have missing values;
 model parameters estimated using listwise deletion.

```
60 .
61 . *Specify a linear regression model to estimate the missing values.*
62 .
63 . mi estimate: regress q5coverage qlcoverage geoequity anc1 pab
```

Multiple-imputation estimates	Imputations	=	10
Linear regression	Number of obs	=	212
	Average RVI	=	0.1211
	Largest FMI	=	0.2395
	Complete DF	=	207
DF adjustment: Small sample	DF: min	=	82.41
	avg	=	135.34
	max	=	186.54
Model F test: Equal FMI	F(4 , 181.6)	=	29.27
Within VCE type: OLS	Prob > F	=	0.0000


```

68 .
69 . *****
70 . ***Creating new variables for socioeconomic vaccine equity & integrated vaccine delivery.***
71 . *****
72 .
73 . *Create and label a new variable, "ceqr," representing the ratio of MCV1 coverage in the wealth
74 .
75 . generate ceqr = q5coverage/q1coverage
    (12,243 missing values generated)

76 . label variable ceqr "Socioeconomic Equity"

77 .
78 . *Create and label a new variable, integration, representing integrated vaccine delivery.*
79 .
80 . generate integration = 0

81 . label variable integration "Integrated Vaccine Delivery"

82 .
83 . *Create new variables representing all possible absolute differences between MCV1, DTP3, ANC1,
84 .
85 . generate abs_mcv1dtp3 = abs(mcv1-dtp3)
    (110 missing values generated)

86 . generate abs_mcv1anc1 = abs(mcv1-anc1)
    (1,089 missing values generated)

87 . generate abs_mcv1pab = abs(mcv1-pab)
    (313 missing values generated)

88 . generate abs_dtp3anc1 = abs(dtp3-anc1)
    (1,110 missing values generated)

89 . generate abs_dtp3pab = abs(dtp3-pab)
    (334 missing values generated)

90 . generate abs_anc1pab = abs(anc1-pab)
    (1,152 missing values generated)

91 .
92 . *Set "integration" to 0 if MCV1, DTP3, ANC1, and PAB all fall below 70%.*
93 .
94 . replace integration=0 if mcv1<70 & dtp3<70 & anc1<70 & pab<70
    (0 real changes made)

95 .
96 . *Set "integration" to 1 if coverage of at least one of the four services is greater than or equ
97 .
98 . replace integration=1 if mcv1>=70 | dtp3>=70 | anc1>=70 | pab>=70
    (12,089 real changes made)

99 .

```

```

100 . *Set "integration" to 2 if co-coverage levels of at least two of the four services are greater
    > percentage points of one another.*
101 .
102 . replace integration=2 if mcv1>=70 & dtp3>=70 & abs_mcv1dtp3<=10 | mcv1>=70 & anc1>=70 & abs_mcv1
    > mcv1pab<=10 | dtp3>=70 & anc1>=70 & abs_dtp3anc1<=10 | dtp3>=70 & pab>=70 & abs_dtp3pab<=10 | a
    (10,517 real changes made)

103 .
104 . *Set "integration" to 3 if co-coverage levels of at least three of the four services are greater
    > percentage points of one another.*
105 .
106 . replace integration=3 if mcv1>=70 & dtp3>=70 & anc1>=70 & abs_mcv1dtp3<=10 & abs_mcv1anc1<=10 &
    > 70 & pab>=70 & abs_mcv1dtp3<=10 & abs_mcv1pab<=10 & abs_dtp3pab<=10 | mcv1>=70 & anc1>=70 & pab
    > <=10 & abs_anc1pab<=10 | dtp3>=70 & anc1>=70 & pab>=70 & abs_dtp3anc1<=10 & abs_dtp3pab<=10 & a
    (7,627 real changes made)

107 .
108 . *Set "integration" to 4 if co-coverage levels of all four services are greater than or equal to
    > of one another.*
109 .
110 . replace integration=4 if mcv1>=70 & dtp3>=70 & anc1>=70 & pab>=70 & abs_mcv1dtp3<=10 & abs_mcv1
    > anc1<=10 & abs_dtp3pab<=10 & abs_anc1pab<=10
    (2,503 real changes made)

111 .
112 . *Create a table summarizing all values of "integration."
113 .
114 . tabulate integration

```

Integrated Vaccine Delivery	Freq.	Percent	Cum.
0	807	6.26	6.26
1	1,572	12.19	18.45
2	2,890	22.41	40.86
3	5,124	39.73	80.59
4	2,503	19.41	100.00
Total	12,896	100.00	

```

115 .
116 . *Create a new variable ("year_dup") that duplicates the "Year" column of the dataset.*
117 .
118 . generate year_dup = year

119 .
120 .
    end of do-file

121 . do "C:\Users\sjrav\AppData\Local\Temp\STD2804_000000.tmp"

122 . ****
    > ***

```

```

123 . ***Group-based trajectory analysis using socioeconomic equity ("ceqr") as the outcome of interest
124 . ***
125 .
126 . *Repeat the trajectory analysis using "ceqr" (socioeconomic vaccine equity) as the outcome of interest
127 . > g variable. Re-import the dataset, perform multiple imputation, create the variable "integration"
128 . *Specify a directory for reshaped files.*
129 .
130 . cd "C:\Users\sjrav\Desktop\STATA Folder Temp"
    C:\Users\sjrav\Desktop\STATA Folder Temp
131 .
132 . *Reshape the dataset from long to wide format; wide format is required to run the traj Stata plugin
133 . mi reshape wide country q5coverage qlcoverage geoequity dtp3 mcv1 anc1 pab femeduc polstability
    > exthlth land lingfrac distance ceqr abs_mcvldtp3 abs_mcvlanc1 abs_mcvlpab abs_dtp3anc1 abs_dtp3pab
    > i(alpha3) j(year)

```

reshaping $m=0$ data ...

(note: j = 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019)

Data	long	->	wide
Number of obs.	1326	->	78
Number of variables	30	->	477
j variable (17 values)	year	->	(dropped)
xij variables:			
country	->		country2003 country2004 ... country2019
q5coverage	->		q5coverage2003 q5coverage2004 ... q5coverage2019
qlcoverage	->		qlcoverage2003 qlcoverage2004 ... qlcoverage2019
geoequity	->		geoequity2003 geoequity2004 ... geoequity2019
dtp3	->		dtp32003 dtp32004 ... dtp32019
mcv1	->		mcv12003 mcv12004 ... mcv12019
anc1	->		anc12003 anc12004 ... anc12019
pab	->		pab2003 pab2004 ... pab2019
femeduc	->		femeduc2003 femeduc2004 ... femeduc2019
polstability	->		polstability2003 polstability2004 ... polstability2019
goveffect	->		goveffect2003 goveffect2004 ... goveffect2019
corrupt	->		corrupt2003 corrupt2004 ... corrupt2019
gii	->		gii2003 gii2004 ... gii2019
oopexp	->		oopexp2003 oopexp2004 ... oopexp2019
govexp	->		govexp2003 govexp2004 ... govexp2019
exthlth	->		exthlth2003 exthlth2004 ... exthlth2019
land	->		land2003 land2004 ... land2019
lingfrac	->		lingfrac2003 lingfrac2004 ... lingfrac2019
distance	->		distance2003 distance2004 ... distance2019
ceqr	->		ceqr2003 ceqr2004 ... ceqr2019
abs_mcvldtp3	->		abs_mcvldtp32003 abs_mcvldtp32004 ... abs_mcvldtp32019
abs_mcvlanc1	->		abs_mcvlanc12003 abs_mcvlanc12004 ... abs_mcvlanc12019
abs_mcvlpab	->		abs_mcvlpab2003 abs_mcvlpab2004 ... abs_mcvlpab2019
abs_dtp3anc1	->		abs_dtp3anc12003 abs_dtp3anc12004 ... abs_dtp3anc12019
abs_dtp3pab	->		abs_dtp3pab2003 abs_dtp3pab2004 ... abs_dtp3pab2019
abs_anc1pab	->		abs_anc1pab2003 abs_anc1pab2004 ... abs_anc1pab2019
integration	->		integration2003 integration2004 ... integration2019
year_dup	->		year_dup2003 year_dup2004 ... year_dup2019

reshaping $m=1$ data ...

reshaping $m=2$ data ...

reshaping $m=3$ data ...

reshaping m=4 data ...
 reshaping m=5 data ...
 reshaping m=6 data ...
 reshaping m=7 data ...
 reshaping m=8 data ...
 reshaping m=9 data ...
 reshaping m=10 data ...
 assembling results ...

134 .
 135 . *Run the plugin several times, changing only the number of groups specified ("order") and holdi
 > ect the group number that produces the highest BIC value.*
 136 .
 137 . traj, model(cnorm) var(ceqr*) indep(year_dup*) min(-1000) max(1000) order (0 0)

==== traj stata plugin ==== Jones BL Nagin DS, build: Mar 17 2021

858 observations read.
 99 had no trajectory data.
 759 observations used in the trajectory model.

Maximum Likelihood Estimates
 Model: Censored Normal (cnorm)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > T
1	Intercept	1.30917	0.00969	135.106	0.0000
2	Intercept	3.83211	0.04706	81.436	0.0000
	Sigma	0.45353	0.00666	68.082	0.0000
Group membership					
1	(%)	96.70227	0.69614	138.912	0.0000
2	(%)	3.29773	0.69614	4.737	0.0000

BIC= -1588.45 (N=2343) BIC= -1586.20 (N=759) AIC= -1576.94 ll= -1572.94

Entropy = 0.956

138 . traj, model(cnorm) var(ceqr*) indep(year_dup*) min(-1000) max(1000) order (0 0 0)

==== traj stata plugin ==== Jones BL Nagin DS, build: Mar 17 2021

858 observations read.
 99 had no trajectory data.
 759 observations used in the trajectory model.

Maximum Likelihood Estimates
 Model: Censored Normal (cnorm)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > T
1	Intercept	2.12900	0.03410	62.435	0.0000
2	Intercept	1.23249	0.00908	135.703	0.0000
3	Intercept	4.30515	0.04263	100.988	0.0000
	Sigma	0.37365	0.00568	65.812	0.0000
Group membership					
1	(%)	13.59573	1.42739	9.525	0.0000
2	(%)	84.95490	1.47444	57.618	0.0000
3	(%)	1.44937	0.43429	3.337	0.0009

BIC= -1352.84 (N=2343) BIC= -1349.46 (N=759) AIC= -1335.57 ll= -1329.57

Entropy = 0.838

139 . traj, model(cnorm) var(ceqr*) indep(year_dup*) min(-1000) max(1000) order (0 0 0 0)

==== traj stata plugin ==== Jones BL Nagin DS, build: Mar 17 2021

858 observations read.

99 had no trajectory data.

759 observations used in the trajectory model.

Maximum Likelihood Estimates
Model: Censored Normal (cnorm)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > T
1	Intercept	1.19663	0.02342	51.094	0.0000
2	Intercept	1.28746	0.03072	41.908	0.0000
3	Intercept	2.13300	0.03263	65.360	0.0000
4	Intercept	4.30517	0.04214	102.163	0.0000
	Sigma	0.36920	0.00546	67.584	0.0000
Group membership					
1	(%)	50.68896	10.46004	4.846	0.0000
2	(%)	34.31097	10.79958	3.177	0.0015
3	(%)	13.55073	1.40141	9.669	0.0000
4	(%)	1.44935	0.43447	3.336	0.0009

BIC= -1359.85 (N=2343) BIC= -1355.34 (N=759) AIC= -1336.81 ll= -1328.81

Warning: variance matrix is nonsymmetric or highly singular

Entropy = 0.509

```
140 . traj, model(cnorm) var(ceqr*) indep(year_dup*) min(-1000) max(1000) order (0 0 0 0 0)
```

```
==== traj stata plugin ==== Jones BL Nagin DS, build: Mar 17 2021
```

```
858 observations read.
```

```
99 had no trajectory data.
```

```
759 observations used in the trajectory model.
```

Maximum Likelihood Estimates
Model: Censored Normal (cnorm)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > T
1	Intercept	1.18527	0.04879	24.294	0.0000
2	Intercept	1.18527	0.01199	98.838	0.0000
3	Intercept	1.77021	0.02483	71.297	0.0000
4	Intercept	2.76229	0.04984	55.428	0.0000
5	Intercept	4.30517	0.03929	109.579	0.0000
	Sigma	0.34409	0.00562	61.179	0.0000

Group membership

1	(%)	8.28242	4717.85935	0.002	0.9986
2	(%)	66.68085	4717.85973	0.014	0.9887
3	(%)	19.35626	2.05674	9.411	0.0000
4	(%)	4.23117	0.78550	5.387	0.0000
5	(%)	1.44929	0.43428	3.337	0.0009

```
BIC= -1288.54 (N=2343) BIC= -1282.90 (N=759) AIC= -1259.74 ll= -1249.74
```

```
Entropy = 0.603
```

```
141 .
```

```
142 . *Next, toggle the polynomial order for each of the groups to achieve the largest possible BIC.  
> option with a high BIC value, high entropy, and at least 1% membership in the smallest group.*
```

```
143 .
```

```
144 . traj, model (cnorm) var(ceqr*) indep(year_dup*) min(0) max(6) order (1 0 1) tcov(integration*)
```

```
==== traj stata plugin ==== Jones BL Nagin DS, build: Mar 17 2021
```

```
858 observations read.
```

```
99 had no trajectory data.
```

```
759 observations used in the trajectory model.
```

```
Start
```

```
Parameter estimates
```

```
0.72526, 0.00000, 0.00000, 1.43083, 0.00000, 2.13641,  
0.00000, 0.00000, 0.70558, 33.33333, 33.33333, 33.33333
```

	Neg. Log Likelihood	Percent Decrease
0	2496.3545797	
1	2326.7198866	6.79529641
2	2217.0682264	4.71271428
3	2180.8425208	1.63394636
4	2156.1376261	1.13281424
5	2142.5081573	0.63212425

6	2141.0240155	0.06927123
7	2138.9637912	0.09622612
8	2138.2020550	0.03561240
9	2137.6973897	0.02360232
10	2132.6779167	0.23480746
11	1916.8239385	10.12126475
12	1911.8711275	0.25838633
13	1909.2038708	0.13951027
14	1907.5034921	0.08906219
15	1905.9545348	0.08120338
16	1904.7892248	0.06114049
17	1903.4093853	0.07244053
18	1602.7668067	15.79495094
19	1445.9178209	9.78613889
20	1440.0777043	0.40390377
21	1439.9438773	0.00929304
22	1439.8448057	0.00688024
23	1407.2219214	2.26572226
24	1383.3844043	1.69394157
25	1288.3820494	6.86738658
26	1251.6872784	2.84812808
27	1247.2072585	0.35791847
28	1203.9208267	3.47066868
29	1203.9208267	-0.00000000
29	1203.9208267	-0.00000000
30	1203.9075265	0.00110474
31	1203.9016229	0.00049038
32	1203.8950577	0.00054532
33	1203.8797104	0.00127480
34	1203.8626946	0.00141341
35	1199.4920190	0.36305433
36	1193.1525833	0.52851004
37	1187.9113055	0.43927976
38	1159.0516710	2.42944354
39	1158.1252306	0.07993090
40	1158.1042271	0.00181358
41	1158.0253041	0.00681484
42	1157.9830338	0.00365020
43	1157.9756290	0.00063946
44	1157.9657096	0.00085662
45	1154.0990677	0.33391680
46	1154.0822178	0.00146000
47	1154.0497720	0.00281139
48	1154.0313867	0.00159311
49	1137.3896551	1.44205191
50	1137.3776819	0.00105269
51	1102.3514628	3.07955920
52	1064.3735198	3.44517554
53	1054.2186096	0.95407392
54	1050.4454945	0.35790633
55	1049.5757024	0.08280221
56	1049.5700406	0.00053943
57	1049.5686947	0.00012823
58	1049.5659423	0.00026224
59	1048.1135982	0.13837569
60	1047.6430916	0.04489080
61	1045.6215326	0.19296258
62	1040.8934572	0.45217847
63	1039.6614493	0.11836061
64	1038.6121811	0.10092403
65	1038.3449950	0.02572531
66	1038.1436207	0.01939378
67	1037.9627639	0.01742117
68	1037.3974298	0.05446574
69	1036.0670989	0.12823734

70	1033.7273807	0.22582690
71	1030.7875461	0.28439167
72	1028.4740911	0.22443568
73	1026.7649562	0.16618162
74	1026.3398725	0.04140029
75	1026.2966853	0.00420789
76	1026.2763892	0.00197761
77	1026.2651008	0.00109994
78	1026.2262405	0.00378657
79	1026.1581501	0.00663503
80	1026.0219239	0.01327536
81	1025.8691700	0.01488797
82	1025.7833699	0.00836365
83	1025.7668560	0.00160988
84	1025.7658262	0.00010039
85	1025.7657976	0.00000279
86	1025.7657957	0.00000018
87	1025.7657956	0.00000001
88	1025.7657956	0.00000000

Maximum Likelihood Estimates
Model: Censored Normal (cnorm)

Group	Parameter	Estimate	Standard Error	T for H0: Parameter=0	Prob > T
1	Intercept	11.29572	11.31957	0.998	0.3184
	Linear	-0.00417	0.00563	-0.740	0.4594
	integration2	-0.45322	0.02372	-19.105	0.0000
2	Intercept	1.73245	0.02581	67.127	0.0000
	integration2	-0.16612	0.00822	-20.213	0.0000
3	Intercept	79.75245	15.90533	5.014	0.0000
	Linear	-0.03752	0.00791	-4.744	0.0000
	integration2	-0.79609	0.05551	-14.341	0.0000
	Sigma	0.33967	0.00538	63.084	0.0000
Group membership					
1	(%)	14.50142	2.03064	7.141	0.0000
2	(%)	82.66876	2.04003	40.523	0.0000
3	(%)	2.82982	0.75038	3.771	0.0002

BIC= -1068.44 (N=2343) BIC= -1062.24 (N=759) AIC= -1036.77 ll= -1025.77

Parameter estimates for adding risk factors

11.29572,	-0.00417,	-0.45322,	1.73245,	-0.16612,	79.75245,
-0.03752,	-0.79609,	0.33967,	1.74060,	-1.63403	

Parameter estimates

11.29572,	-0.00417,	-0.45322,	1.73245,	-0.16612,	79.75245,
-0.03752,	-0.79609,	0.33967,	14.50142,	82.66876,	2.82982

Entropy = 0.752

```

145 .
146 . *Plot the trajectories for the three groups, along with accompanying confidence intervals. Asse
> es an additional diagnostic check for the model (i.e., narrower, non-overlapping CIs are prefer
147 .
148 . trajplot, xtitle("Year") ytitle("Socioeconomic Vaccine Equity Ratio") ci
149 .
end of do-file

150 . graph export "C:\Users\sjrav\Desktop\Disseration\Aim 3 - Quantitative Analysis\Data\STATA Outp
> ty.png", as(png) replace
(note: file C:\Users\sjrav\Desktop\Disseration\Aim 3 - Quantitative Analysis\Data\STATA Output\M
> ng not found)
(file C:\Users\sjrav\Desktop\Disseration\Aim 3 - Quantitative Analysis\Data\STATA Output\MI GBTM
> tten in PNG format)

151 . do "C:\Users\sjrav\AppData\Local\Temp\STD2804_000000.tmp"

152 . matrix strt = 11.29572, -0.00417, -0.45322, 1.73245, -0.16612, 79.75245, -0.03752, -0.79609, 0.

153 .
154 . bootstrap _b (100/(1+exp(_b[theta2]))) (100*exp(_b[theta2])/(1+exp(_b[theta2])), reps(1000) do
> ) indep(year_dup*) min(0) max(6) order (1 0 1) tcov(integration*) detail start(strt) novar
(running traj on estimation sample)

```

Bootstrap replications (1000)

```

_____ 1 _____ 2 _____ 3 _____ 4 _____ 5
..... 500
..... 1000

```

```

Bootstrap results                                Number of obs      =           858
                                                Replications            =          1,000

```

```

command: traj, model(cnorm) var(ceqr*) indep(year_dup*) min(0) max(6) order(1 0 1) tcov(in
novar

```

```
[_eq2]_bs_1: 100/(1+exp(_b[theta2]))
```

```
[_eq2]_bs_2: 100*exp(_b[theta2])/(1+exp(_b[theta2]))
```

	Observed Coef.	Bootstrap Std. Err.	z	P> z	Normal-based [95% Conf. Interval]	
_eq1						
interc1	11.29572	323.7757	0.03	0.972	-623.2929	645.8844
linear1	-.0041679	.1611444	-0.03	0.979	-.3200051	.3116694
integration2G1	-.4532207	.326841	-1.39	0.166	-1.093817	.1873759
interc2	1.732449	.0642917	26.95	0.000	1.606439	1.858458
integration2G2	-.1661203	.0154312	-10.77	0.000	-.1963648	-.1358758
interc3	79.75245	4.545301	17.55	0.000	70.84382	88.66108
linear3	-.0375161	.0022589	-16.61	0.000	-.0419435	-.0330887
integration2G3	-.7960891	.1172229	-6.79	0.000	-1.025842	-.5663364
sigma	.3396704	.0150866	22.51	0.000	.3101012	.3692396
theta2	1.740595	.8512299	2.04	0.041	.0722153	3.408975
theta3	-1.634033	1.006986	-1.62	0.105	-3.60769	.3396234
_eq2						
_bs_1	14.92373	6.125558	2.44	0.015	2.917861	26.92961
_bs_2	85.07627	6.125558	13.89	0.000	73.07039	97.08214

```
155 .
156 . estat bootstrap, percentile bc
```

```
Bootstrap results                                Number of obs    =      858
                                                Replications    =     1000
```

```
command:  traj, model(cnorm) var(ceqr*) indep(year_dup*) min(0) max(6) order(1 0 1) tcov(in
          novar
[_eq2]_bs_1: 100/(1+exp(_b[theta2]))
[_eq2]_bs_2: 100*exp(_b[theta2])/(1+exp(_b[theta2]))
```

	Observed Coef.	Bias	Bootstrap Std. Err.	[95% Conf. Interval]		
_eq1						
interc1	11.29572	252.0916	323.77566	-31.58296	669.2193	(P)
				-36.80255	666.5546	(BC)
linear1	-.00416786	-.1254908	.16114442	-.3316471	.0171122	(P)
				-.3303199	.0197288	(BC)
integratio~1	-.45322069	.2804412	.326841	-.4880465	.2712846	(P)
				-.5265808	-.3451803	(BC)
interc2	1.7324487	.0408966	.06429173	1.671633	1.891477	(P)
				1.640257	1.857885	(BC)
integratio~2	-.16612027	-.0096441	.01543115	-.204167	-.1496037	(P)
				-.1941656	-.1413382	(BC)
interc3	79.75245	-1.156366	4.5453009	72.40398	82.26769	(P)
				73.6969	82.69172	(BC)
linear3	-.0375161	.0005746	.00225894	-.0387678	-.0338628	(P)
				-.0389796	-.0345066	(BC)
integrati~G3	-.79608909	.0013102	.11722293	-.8335739	-.7639533	(P)
				-.8279467	-.7566609	(BC)
sigma	.33967039	-.0095594	.0150866	.3000907	.3598782	(P)
				.3201697	.373725	(BC)
theta2	1.7405953	.6596783	.85122993	1.465697	3.717476	(P)
				1.371057	3.518992	(BC)
theta3	-1.6340335	.6921629	1.0069863	-2.26368	.7319252	(P)
				-2.560508	.4249983	(BC)
_eq2						
_bs_1	14.923733	-4.458555	6.1255578	2.371894	18.75975	(P)
				2.877665	20.24492	(BC)
_bs_2	85.076267	4.458555	6.1255577	81.24025	97.62811	(P)
				79.75508	97.12234	(BC)

```
(P)    percentile confidence interval
(BC)    bias-corrected confidence interval
```

```
157 .
      end of do-file
```

```
158 . do "C:\Users\sjrav\AppData\Local\Temp\STD2804_000000.tmp"
```

```

159 . *Create a program, "trajstats," to calculate several other diagnostic criteria for group-based
160 .
161 . program trajstats
162 .     1.
163 .     2.
164 .     *This step calculates the average posterior probability.*
165 .     generate Mp=0
166 .     3.
167 .     foreach i of varlist _traj_ProbG* {
168 .         4.         replace Mp = `i' if `i' > Mp
169 .         5.     }
170 .         6.     sort _traj_Group
171 .         7.
172 .     by _traj_Group: generate countG = _N
173 .     8.
174 .     *This step calculates the odds of correct classification.*
175 .
176 .     by _traj_Group: egen groupAPP = mean(Mp)
177 .     9.     by _traj_Group: generate counter = _n
178 .     10.    generate n = groupAPP/(1 - groupAPP)
179 .     11.    generate p = countG/ _N
180 .     12.    generate d = p/(1-p)
181 .     13.    generate occ = n/d
182 .     14.
183 .     *This step calculates the estimated group probabilities vs. the proportion of the sample assigned
184 .
185 .     scalar c = 0
186 .     gen TotProb = 0
187 .     foreach i of varlist _traj_ProbG* {
188 .         15.    scalar c = c + 1
189 .         16.    quietly summarize `i'
190 .         17.    replace TotProb = r(sum)/ _N if _traj_Group == c
191 .         18.    }
192 .         19.    gen d_pp = TotProb/(1 - TotProb)
193 .         20.    gen occ_pp = n/d_pp
194 .         21.
195 .     *This step displays:
196 .     *Group number [_traj_~p],
197 .     *Count per group (based on the max post prob), [countG]
198 .     *Average posterior probability for each group, [groupAPP]
199 .     *Odds of correct classification (based on the maximum posterior group assignment rule), [occ_pp]
200 .     *Odds of correct classification (based on the weighted posterior probabilities), [occ_pp]
201 .     *Observed probability of groups [p] versus the probability based on the posterior probabilities
202 .
203 .     list _traj_Group countG groupAPP occ occ_pp p TotProb if counter == 1
204 .     22.
205 .     restore
206 .     23.
207 .     end
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```

```

186 . *Now, run the trajstats program.*
187 .
188 . trajstats
    (858 real changes made)
    (754 real changes made)
    (22 real changes made)
    (82 real changes made)
    (754 real changes made)
    (22 real changes made)

```

	traj~p	countG	groupAPP	occ	occ_pp	p	TotProb
1.	1	82	.8061659	39.35882	24.52127	.0955711	.1450141
83.	2	754	.9213567	1.615952	2.456145	.8787879	.8266878
837.	3	22	.7986288	150.7062	136.1827	.025641	.0282982

```

189 .
    end of do-file

```

```

190 . do "C:\Users\sjrav\AppData\Local\Temp\STD2804_000000.tmp"

```

```

191 . *Reshape the dataset into long format.*

```

```

192 .
193 . mi reshape long country q5coverage q1coverage geoequity dtp3 mcv1 anc1 pab femeduc polstability
    > exthlth land lingfrac distance ceqr abs_mcvldtp3 abs_mcvlanc1 abs_mcvlpab abs_dtp3anc1 abs_dtp3
    > i(alpha3) j(year)

```

reshaping m=0 data ...

(note: j = 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019)

Data wide -> long

```

Number of obs.          78 -> 1326
Number of variables      481 -> 34
j variable (17 values)  -> year
xij variables:
country2003 country2004 ... country2019 -> country
q5coverage2003 q5coverage2004 ... q5coverage2019->q5coverage
q1coverage2003 q1coverage2004 ... q1coverage2019->q1coverage
geoequity2003 geoequity2004 ... geoequity2019->geoequity
    dtp32003 dtp32004 ... dtp32019 -> dtp3
    mcv12003 mcv12004 ... mcv12019 -> mcv1
    anc12003 anc12004 ... anc12019 -> anc1
    pab2003 pab2004 ... pab2019 -> pab
femeduc2003 femeduc2004 ... femeduc2019 -> femeduc
polstability2003 polstability2004 ... polstability2019->polstability
goveffect2003 goveffect2004 ... goveffect2019->goveffect
corrupt2003 corrupt2004 ... corrupt2019 -> corrupt
    gii2003 gii2004 ... gii2019 -> gii
    oopexp2003 oopexp2004 ... oopexp2019 -> oopexp
    govexp2003 govexp2004 ... govexp2019 -> govexp
exthlth2003 exthlth2004 ... exthlth2019 -> exthlth
    land2003 land2004 ... land2019 -> land
lingfrac2003 lingfrac2004 ... lingfrac2019->lingfrac
distance2003 distance2004 ... distance2019->distance
    ceqr2003 ceqr2004 ... ceqr2019 -> ceqr
abs_mcvldtp32003 abs_mcvldtp32004 ... abs_mcvldtp32019->abs_mcvldtp3
abs_mcvlanc12003 abs_mcvlanc12004 ... abs_mcvlanc12019->abs_mcvlanc1
abs_mcvlpab2003 abs_mcvlpab2004 ... abs_mcvlpab2019->abs_mcvlpab
abs_dtp3anc12003 abs_dtp3anc12004 ... abs_dtp3anc12019->abs_dtp3anc1
abs_dtp3pab2003 abs_dtp3pab2004 ... abs_dtp3pab2019->abs_dtp3pab
abs_anc1pab2003 abs_anc1pab2004 ... abs_anc1pab2019->abs_anc1pab
integration2003 integration2004 ... integration2019->integration

```

year_dup2003 year_dup2004 ... year_dup2019-> year_dup

```
reshaping m=1 data ...
reshaping m=2 data ...
reshaping m=3 data ...
reshaping m=4 data ...
reshaping m=5 data ...
reshaping m=6 data ...
reshaping m=7 data ...
reshaping m=8 data ...
reshaping m=9 data ...
reshaping m=10 data ...
assembling results ...
```

```
194 .
195 . *Perform multinomial logistic regression to identify covariates with statistically significant
    > etting Group 1 membership as the base outcome.*
196 .
197 . mlogit _traj_Group femeduc polstability goveffect corrupt gii oopexp govexp exthlth land lingfr
    > 1)
```

```
Iteration 0: log likelihood = -1388.6768
Iteration 1: log likelihood = -1168.0126
Iteration 2: log likelihood = -869.64423
Iteration 3: log likelihood = -795.47526
Iteration 4: log likelihood = -751.75884
Iteration 5: log likelihood = -738.19827
Iteration 6: log likelihood = -734.22841
Iteration 7: log likelihood = -733.11051
Iteration 8: log likelihood = -732.82523
Iteration 9: log likelihood = -732.76152
Iteration 10: log likelihood = -732.74799
Iteration 11: log likelihood = -732.74486
Iteration 12: log likelihood = -732.7441
Iteration 13: log likelihood = -732.74395
Iteration 14: log likelihood = -732.74392
```

```
Multinomial logistic regression      Number of obs      =      3,286
                                      LR chi2(24)           =     1311.87
                                      Prob > chi2           =      0.0000
Log likelihood = -732.74392          Pseudo R2           =      0.4723
```

_traj_Group	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
1	(base outcome)					
2						
femeduc	.0335643	.0057491	5.84	0.000	.0222963	.0448324
polstability	.2190126	.1167022	1.88	0.061	-.0097195	.4477448
goveffect	-1.352827	.3111789	-4.35	0.000	-1.962727	-.7429278
corrupt	-.143716	.3211633	-0.45	0.655	-.7731845	.4857525
gii	1.282163	.3894425	3.29	0.001	.5188694	2.045456
oopexp	-.0165694	.0051206	-3.24	0.001	-.0266055	-.0065333

govexp	.014214	.002298	6.19	0.000	.00971	.0187181
exthlth	.0333253	.0082424	4.04	0.000	.0171705	.04948
land	-9.34e-07	1.28e-07	-7.33	0.000	-1.18e-06	-6.84e-07
lingfrac	1.529981	.38087	4.02	0.000	.7834891	2.276472
distance	.0059308	.0049337	1.20	0.229	-.0037391	.0156007
integration	.6124119	.0791537	7.74	0.000	.4572735	.7675504
_cons	-4.40065	.672575	-6.54	0.000	-5.718873	-3.082428
3						
femeduc	-.7187821	158.7327	-0.00	0.996	-311.8291	310.3915
polstability	5.386423	7081.18	0.00	0.999	-13873.47	13884.25
goveffect	-4.53724	9674.134	-0.00	1.000	-18965.49	18956.42
corrupt	-11.25889	6490.384	-0.00	0.999	-12732.18	12709.66
gii	52.10258	9972.683	0.01	0.996	-19494	19598.2
oopexp	-.8452196	185.0853	-0.00	0.996	-363.6058	361.9153
govexp	.0817501	9.445754	0.01	0.993	-18.43159	18.59509
exthlth	-1.743924	581.1434	-0.00	0.998	-1140.764	1137.276
land	.0000257	.0069168	0.00	0.997	-.013531	.0135823
lingfrac	87.24992	31676.4	0.00	0.998	-61997.36	62171.86
distance	-2.383606	131.6725	-0.02	0.986	-260.457	255.6898
integration	-17.87322	3817.841	-0.00	0.996	-7500.704	7464.957
_cons	69.14296	18927.01	0.00	0.997	-37027.11	37165.4

Note: 154 observations completely determined. Standard errors questionable.

198 .
end of do-file

199 .