The general examination in formal or quantitative analysis

A. Students taking the written exam in formal or quantitative analysis

A student planning to take the written exam in formal or quantitative analysis should be prepared to demonstrate mastery of the material covered in three of the following courses.

(a) Politics 572 (= Level 1)
(b) Politics 573 (= Level 2)
(c) Politics 578 (= Level 3) or a directed reading course* in quantitative methods, dealing with the subject at a level beyond Politics 573
(d) A course (possibly from a department other than Politics) in econometrics or empirical methods at a level beyond Politics 572.**
(e) Politics 575 (= Level 1)
(f) Politics 576 (= Level 2)
(g) Politics 579 (usually = Level 3) or a directed reading course* in formal theory, dealing with the subject at a level beyond Politics 576
(h) A course (possibly from a department other than Politics) in formal theory or game theory at a level beyond Politics 576.**

*Directed reading courses of appropriate breadth and depth to satisfy the general exam requirement may be designed by interested students in consultation with faculty in the field.

**A student choosing option (d) or (h) should consult with the faculty member who is the field coordinator for formal/quantitative analysis to make sure the course is appropriate.

Students intending to pursue research and teaching in quantitative empirical methods should complete course work at the level of (c) or (d); students intending to pursue research and teaching in formal theory should complete course work at the level of (g) or (h). It is also possible to take a mix of formal and quantitative analysis based on (a), (b), and (e), or on (a), (e), and (f). Comprehensive exams are tailored to the mix of preparation the student has chosen.

The following pages provide more information about preparing for the F&Q examination or “coursing out” of the exam.

B. Students taking formal or quantitative analysis as a third field but not taking the written general exam (coursing out) should take three of the courses listed above for credit and receive a satisfactory grade in each of them. A student choosing option (d) or (h) should consult with the faculty member who is the field coordinator for formal/quantitative analysis to make sure the course is appropriate.
Preparation Guidelines for the General Examination
in Formal or Quantitative Analysis

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For the purposes of the general exam, we identify three levels of competence in quantitative analysis and in formal theory. A student intending to specialize in quantitative empirical methods must demonstrate competence at level 3 in that area. Similarly, a student intending to specialize in formal theory must demonstrate competence in formal theory at level 3. Others taking the exam must demonstrate competence in level 2 in either formal or quantitative analysis, while passing the exam at least at level 1 in the other area.

NB: Even the first-level courses (POL 572 and POL 575) presume some comfort with the use of mathematics and statistics. Generally, this involves familiarity with the topics covered in POL 502, Mathematics for Political Science and POL 571 Quantitative Analysis I. For more details, see the descriptions below. Students with the requisite math background do not need to take POL 502 or POL 571 before taking POL 572 or POL 575. It is always a good idea to check with the instructors of these courses first, to make sure that POL 502 and POL 571 are not needed.

I. Preparing for the Quantitative Analysis Questions

Competence in quantitative methods is measured at three levels, corresponding roughly to the three courses occasionally offered in quantitative analysis.

A. Level 1

The first level of competence pertains to material in the purview of the introductory course, Politics 572. A working knowledge of calculus and matrix algebra, at the level of POL 502 (Mathematics for Political Science) and statistics and probability at the level of POL 571 (Quantitative Analysis I) is presumed. Topics to cover in preparing for a question at this level include the interpretation of coefficients and interaction terms for regression, logit and probit models. You should be able to test hypotheses about a single coefficient and also hypotheses that impose multiple restrictions on groups of coefficients from regression, logit, and probit models. In addition, you should understand the consequences of multicollinearity, measurement error, omitted variables, heteroscedasticity, and serial correlation. You should have a basic understanding of what instrumental variables estimators do, especially two-stage least squares.

Potentially Useful Reading

Achen, Interpreting and Using Regression (Sage)
Gujarati, Basic Econometrics (McGraw-Hill: New York)
Hanushek and Jackson, Statistical Methods for Social Scientists (Academic Press), early chapters
Wooldridge Introductory Econometrics (Thomson Southwestern)
B. Level 2

To show competence at the second level you should be familiar with the material normally presented in Politics 573. Knowledge of calculus and matrix algebra is presumed. A student who is prepared for this exam should be able to derive the mean and variance of the OLS coefficient estimator, and show it is consistent. Students should also be able to prove the Gauss-Markov Theorem, and derive the bias that will result when variables are omitted from a regression. Students should also be able to show analytically how selection bias works, and to derive the variance-covariance matrix for two-stage least squares estimators. The exam presumes a familiarity with maximum likelihood estimation and an ability to formulate the likelihood functions for the OLS, logit, and probit models. Other topics useful to cover in studying for the exam include resampling and bootstrap methods, hazard models, and “measurement models” (e.g., scaling methods, factor analysis, and covariance structures).

Potentially Useful Reading

All books included in level 1.

Hanushek and Jackson *Statistical Methods for Social Scientists*, later chapters


C. Level 3

The third level involves mastery of more advanced material, of the sort likely to be covered in Politics 578 or in an independent reading course with the faculty in the area. The emphasis is on demonstrating mastery of a topic at an advanced level. Topics to be covered might include: maximum likelihood analysis; simultaneous equations with qualitative variables; time series models; fixed and random effects models; general method of moments; discrete choice models; scaling and preference estimation; ecological inference; and Bayesian analysis.

Potentially Useful Reading

Material in Levels 1 and 2.

Any articles covered in classes and reading courses.

Bernardo and Smith, *Bayesian Theory* (Wiley).


Gelman, Karlin, Stern, and Rubin, *Bayesian Data Analysis*


Hamilton, *Time Series Analysis*

Maddala, *Limited Dependent and Qualitative Variables in Econometrics*

Wooldridge, *Econometric Analysis of Cross Section and Panel Data*
II. Preparing for the Formal Theory Questions

Competence in formal theory is measured at one of three levels that correspond roughly to the three courses offered in formal theory at the graduate level. The three competence levels reflect increasingly sophisticated understanding and application of the following list of topics:

Topics in Formal Theory

- Notions of preference and individual choice: utility, risk and uncertainty, and rationality.
- Social choice theory: individual vs. collective choice, preference aggregation rules, Arrow’s Theorem, the core and uncovered set, and intransitivities.
- Games in normal form: Nash equilibrium in pure and mixed strategies.
- Spatial models of voting: the median voter theorem and equilibria in multiple dimensions.
- Games in extensive form: equilibrium, backward induction, and subgame perfection.
- Agendas: Condorcet winners, agenda manipulation and sophisticated voting.
- Repeated games: cooperation in infinitely repeated games and the folk theorem.
- Games of incomplete information: beliefs and perfect Bayesian equilibria.
- Signaling games: sequential equilibria and cheap talk.
- Bargaining: Nash bargaining solution; Rubinstein bargaining; bargaining under incomplete information; majority rule bargaining (e.g., Baron-Ferejohn).

Competency Goals

A. In order to satisfy competence level 1, students must have:

- a mastery of the topic list at the level of Politics 575, the introductory course in formal theory. *Political Game Theory: An Introduction* by Nolan McCarty and Adam Meirowitz is the textbook at this level.
- a mastery of the basics of modeling, such as going from a statement of a political phenomenon to its formal characteristics; structuring the technical argument; and solving for equilibria in relatively simple situations.
- mathematical knowledge of, at a minimum, basic algebra and solving equations, basic notions of probability, random variables, expectation and variance, Bayes’ rule, functions and relations, basics of calculus. Students without the requisite math background should take POL 502 (*Mathematics for Political Science*) before taking POL 575.

B. In order to satisfy competence level 2, students must have:

- a mastery of the topic list at a somewhat deeper level, as typically encountered in Politics 576. This implies greater familiarity with concepts of equilibrium, issues of commitment and reputation, problems of individual versus collective choice, and the importance of institutions in political
processes. Students should have a mastery of noncooperative game theory that includes various equilibrium refinements, games of incomplete information, repeated games and folk theorems, and bargaining theory. Students should also have an understanding of the main results in social choice theory (Arrow’s theorem and properties of the core in the spatial model) and mechanism design (the revelation principle and an understanding of incentive compatibility and individual rationality constraints).

• an ability to discuss technical issues in articles using formal models in journals such as *American Political Science Review* or *American Journal of Political Science*. An example of this level of article is:


• mathematical knowledge of, at a minimum, multivariate differential and integral calculus, and constrained optimization.

Textbooks at this level include:

McCarty and Meirowitz, *Political Game Theory: An Introduction*

C. In order to satisfy **competence level 3**, students must:

• demonstrate expertise in at least one of the topics on the topic list. This requires a student to have a thorough understanding of the technical issues and applications of a particular topic. This expertise may come from Politics 579, course work in other departments such as Economics, or directed independent work. For example, a student might develop expertise in applied game theory (e.g., signaling games in politics) or social choice theory.

• mathematical knowledge of, at a minimum: basic concepts of real analysis; basic concepts of the theory of measure and integration and its application to probability.

• an ability to discuss technical issues in articles on applied game theory and social choice theory in journals such as *Econometrica, Games and Economic Behavior*, or *Social Choice and Welfare*. An example of an article at this level is


Textbooks at this level include:

  Fudenberg and Tirole, *Game Theory*
  Osborne and Rubinstein, *A Course in Game Theory*