Guidelines and Suggestions for Theses and Extended Essays

My general area of research and supervisory interest is econometrics applied to fields such as production and demand analysis and macroeconomics; also, more narrowly, financial econometrics, in particular asset pricing applications. One way to develop an essay/thesis topic that I might be willing to supervise is to peruse the following books, which offer more of an econometric/empirical orientation than the macroeconomics texts you are likely to have encountered as a student. All but Adda and Cooper can be found in the McPherson Library under the indicated call numbers. In the more theoretically-oriented books such as Hansen & Sargent and Miao, focus on the empirical applications.

Adda, J., and R. Cooper (2003) *Dynamic Economics—Quantitative Methods and Applications* (MIT Press).

Altug, S.G. (2010) *Business Cycles: Fact, Fallacy, and Fantasy* (World Scientific). `HB3711 A424 2010`

Canova, F. (2007) *Methods for Applied Macroeconomic Research* (Princeton University Press). `HB172.5 C26`

Christensen, B.J., and N.M. Kiefer (2009) *Economic Modeling and Inference* (Princeton University Press). `HB141 C525`

DeJong, D., and C. Dave (2007) *Structural Macroeconometrics* (Princeton University Press). `HB172.5 D44`

Diebold, F., and G. Rudebusch (1999) *Business Cycles—Duration, Dynamics, and Forecasting* (Princeton University Press). `HB3711 D54`

Favero, C. (2001) *Applied Macroeconometrics* (Oxford University Press). `HB139 F384`

Ghysels, E., and M. Marcellino (2018) *Applied Economic Forecasting using Time Series Methods* (Oxford University Press). `HB3730 G459 2018`

Hansen, L.P., and T.J. Sargent (2014) *Recursive Models of Dynamic Linear Economies* (Princeton University Press). `HB135 H36 2014`

Juselius, K. (2006) *The Cointegrated VAR Model: Methodology and Applications* (Oxford University Press). `HB141 J87`

Miao, J. (2014; 2nd ed. 2020) *Economic Dynamics in Discrete Time* (MIT Press). `HB141 M53 2014`

Uribe, M., and S. Schmitt-Grobé (2017) *Open Economy Macroeconomics* (Princeton University Press). `HB172.5 U75 2017`

In the Hansen and Sargent (2014) book see Chapter 10 for some examples of applications of their methodology that might be pursued. These include

- the Topel-Rosen housing model is one that could be studied under Topic 50 below;

- the Rosen-Murphy-Scheinkman cattle cycles model that could be studied under Topic 51 below.

If you are interested in developing a topic related to macroeconomics, you may find ideas in the masterly survey by Costas Azariadis (2018) "Riddles and models: A review essay on Michel De Vroey's *A History of Macroeconomics from Keynes to Lucas and Beyond*," *Journal of Economic Literature* 56, 1538–1576.

Another good source of topics is the empirical chapters of the relevant titles in Elsevier's *Handbooks* series, such as the *Handbook of Macroeconomics* (`HB172.5 H36`), the *Handbook of Economic Growth* (`HD75.5 H33`), and the macro-oriented chapters of the *Handbook of Labour Economics* (`HD4802 H36`).

Preliminary Comments

Before turning to my topic suggestions, let me offer some preliminary comments on several issues that often arise in essay/thesis work: the difference between an MA Essay and Thesis; appropriate topics; writing; finding a supervisor; data; and time series analysis.

What is the difference between a Master's Essay versus Thesis? Different supervisors may answer this question differently, depending on the nature of the work they supervise. For me, it is acceptable for an essay to essentially replicate an existing journal article with new or extended data, as long as this is done competently. This obviates any need for an extended literature review to motivate the work or a broader justification of the chosen methodology, as would be necessary in a thesis.

Of course, this not without qualification. The journal article must be one that is worth replicating. That is, you must establish that the topic is still of interest and the methodology still appropriate, and this must be written up appropriately.

A paper that is nothing more than a survey of existing work is not acceptable as either an essay or thesis. This is a term paper. The purpose of the essay/thesis is to go beyond the term papers you have done in your coursework by giving you the experience of taking a research project from inception to completion, including communicating your findings to a professional audience.

In the same spirit, an acceptable topic should be at a level of sophistication that uses your Master's training. After all, if it is something you could have done as an undergraduate, why have you bothered doing a Master's degree?

What should I be looking for in a topic? In looking for an essay/thesis topic, ask yourself the following questions.

- What economic issues am I interested in? What would I like to have the opportunity to learn more about by studying in detail? What questions motivated my original interest in economics?

- What are my career interests? Is there a topic that would complement them?

- What tools would I like to have the opportunity to exercise? (If you hated your econometrics courses, there's not much point choosing a topic in theoretical or applied econometrics.)

- What am I feasibly capable of doing within a reasonable time frame? (Don't bite off more than you can chew. Your topic should be one that is realistically do-able based on your existing skill set. It should not require significant investment in new tools. If you've never taken a course in game theory, don't try to pursue a topic that requires game theory. If you've never studied nonparametrics, don't choose a topic that uses this econometric methodology. If you haven't done much programming, choose a topic that can be done with stock software. On this theme, see the passage below on time series data.)

How do I find a supervisor? In considering topics that satisfy these criteria, you should take advantage of the faculty resources that are available to you in the department. Faculty are generally happy to talk with you about your interests, as long as the topic relates to areas in which they have some expertise. (If you want to talk about your interest in doing an essay related to empirical macroeconomics, you should seek out faculty in that area. There's not much point asking a micro theorist about it, unless you have good reason to believe they might have something to offer. For example—to anticipate one of the suggestions below—a microeconomist knowledgeable about search theory might be able to contribute advice relevant to your estimation of a Diamond-Mortenson-Pissarides model of the aggregate labour market.)

You should discuss your ideas with a number of faculty. Until you have zeroed in on a specific topic, however, there's not much point asking someone to be your supervisor. Unless you have reached the point where you can explain in reasonably precise terms what you want to do, it is

not possible for a faculty member to know whether they are the best person to guide you. Once you have reached that point in your discussions, a prospective supervisor will probably want you to write a *thesis proposal.* This step is formalized for a Ph.D. dissertation; it is more informal (yet still crucial) at the MA level, and different supervisors may have somewhat different expectations.

Many students, especially ones that come to discuss their interests with me, want to do an essay/thesis that applies econometric methods to a topic in some field area of economics, perhaps labour economics, international economics, macroeconomics, or otherwise. In this case it is often a good strategy to have a faculty member in the field area—labour, international, macroeconomics, as the case may be—be your supervisor, and have an econometrician as a second committee member. The reason is that, in any economics department, the econometricians are typically in heavy demand for graduate supervision. A non-econometrician may have more time to devote to you. You should feel free to discuss the pros and cons of this with your prospective committee members, when your discussions with them reach the point where it seems time to establish a committee or at least identify a supervisor.

Writing

> "The ability to express an idea is as important as the idea itself." *Bernard M. Baruch*

Your essay/thesis must be written and formatted to an acceptable standard, and *you* are responsible for doing this—not your supervisor. Furthermore your supervisor has many other demands on his/her time and is limited in how often he/she can read successive drafts of your document, especially toward the end of academic terms as defense deadlines loom. Students often underestimate the amount of time involved in writing their essay/thesis, as distinct from doing the actual research.

In my experience, if an essay/thesis is not in its defense form by the end of November or March it will not be possible to defend that term. "Defense form" means that it incorporates the pre-defense comments of all members of your supervisory committee, not just your principal supervisor. Of course, for them to have had time to read and comment on the document, and for you to incorporate these comments, the document must be substantially complete by the end of October or February at the latest. In turn, "substantially complete" means that it reflects iterations with your principal supervisor in the months prior.

Remember that prospective employers will often ask to see your essay or thesis, and you will want to take it with you to job interviews, even if it is still at the advanced draft stage. In addition to demonstrating your ability to take a research project from inception to completion, an essay/thesis demonstrates your ability to communicate in writing. A properly composed and formatted document is an asset to your employability, especially relative to competing candidates graduating from non-essay/thesis programs. But a sloppy looking, poorly written document will reflect negatively on you, regardless of the quality of the analysis.

Here are some tips to expedite the writing process.

- As you do your research, write up related material as you go along. For example, at the beginning when you are deciding what data to use, write up all the considerations you weighed in resolving measurement issues, the relevant sample, data sources, relationship to data used in related research, and so on. In the long run it will save you time if you write this up while it is fresh in your mind rather than having to remember it months later. Give this preliminary document, properly written, to your supervisor for comment; do not wait to incorporate it into a larger document. He/she may have suggestions, either substantive or presentational, that will save you time later in doing other aspects of the work.

  This is similarly true of other material that you know must ultimately appear in the essay/thesis, such as the literature review. You can write these sections up in a stand-alone fashion without worrying too much about how they will fit into the complete document later on. The modifications that will be needed later to fit them into the larger document will be comparatively modest. For example, you can decide later whether your writeup of the data issues is best modified to be a section within the document or an appendix at the end.

- Your essay/thesis must be motivated in terms of the broader academic literature related to your topic. You can only do this by familiarizing yourself with that literature and explaining it in your own words. This has several implications.

  - Do not cut and paste from the internet or cite internet sources for your text content. (Internet *data sources* are a different matter.) Internet sources for your text content are not reliable because they are generally unmediated. That is, they have not undergone the editorial or peer review that academic articles have. A thesis proposal that includes cutting-and-pasting from the internet suggests that you do not understand how to write a proper essay. By itself this may make a faculty member reluctant to supervise you.

  - If you must cite popular sources, do so sparingly from credible print publications such as *The Economist* magazine or prominent newspapers.

  - Internet data sources must be documented. In addition to other locating information (such as variable codes/acronyms or CANSIM matrix numbers), you should provide the URL. However this should be done as part of your documentation of your data sources in that section of your document, such as a data appendix. Having done this, URL's should not then appear in your bibliography. (If you wish, you may include in your bibliography the DOI numbers of academic articles. This is becoming increasingly common in academic citations.)

- *Tables and Figures* are important tools for presenting information efficiently and you should use them for this purpose. To accomplish this, however, you must put some thought into their design, and construct them artfully. For each table and figure, ask yourself: What am I trying to help the reader understand by presenting this? How can I construct it so that this meaning is best understood?

  Here are some points to keep in mind.

  - When several figures are intended to be interpreted jointly, arrange them on a single page as subfigures within a single figure.

  - If several graphs are intended to be compared, use common units of measure on the axes to facilitate the comparison.

  - Tables and figures should be self-explanatory. In constructing them, provide enough information so that the reader can understand what is being presented. In the case of a table, this will include appropriate choices for the table/figure title, row and column headings, and table footnotes. In the case of a graph, it will include clearly labelled axes that indicate the units of measure. The reader should not have to read the text of your document to understand a table or figure.

  - Having said this, tables and figures must always be referenced and discussed in the text. Although the interpretation of a table/figure should be self-explanatory, it is your accompanying text discussion that explains why this meaning is interesting or important, and what we learn from it in terms of the economic phenomenon that you are studying.

- *Style and Format* From the outset compose your essay/thesis drafts in conformity with UVic Grad Studies templates and guidelines. I recommend 11 point font (12 point is a bit large) with space-and-a-half line spacing (double spacing is a bit much), without extra spacing between paragraphs or sections/subsections. Avoid needlessly excessive spacing around displayed mathematics or between sections/subsections. To appear professional your document should look "solid," not like a lot of empty space.

  Adopt a consistent citation and bibliographic style. Which one you adopt is less important than that you use it consistently. My own preference is the style used by the North-Holland journals such as the *Journal of Monetary Economics* or the *Journal of Econometrics*. That of the *Canadian Journal of Economics* is also fine. These journals have style guides that are available on their websites.

Use Canadian spelling, the authority for which is the *Canadian Oxford Dictionary,* available online through the McPherson Library website.

- Unless your supervisor specifically requests otherwise (in connection with, say, a particular chapter or appendix), each draft of your essay/thesis should be complete, incorporating all suggested revisions discussed up to that point. Do not send your supervisor partial or provisional versions, promising that "the rest will come later." Do the rest, then send it. Otherwise you will exhaust your supervisor's patience and they will limit the frequency with which they are willing to receive revisions from you. Your goal should be to minimize the number of successive drafts standing between you and completion, not maximize them.

- Anything that you ask your supervisor to read must be properly written and formatted. Never give your supervisor something to read without proofreading it thoroughly multiple times. Even if you have difficulty with English grammar or idiom, there is no excuse for spelling errors, absence of a logical development of ideas, sloppy formatting, and poorly composed tables and figures that do not float to the top (or sometimes bottom) of pages—even at the draft stage. It is wrong to think that these things need only be "tidied up" at the final stage of producing the version of the document that will form the basis for your defense.

  If you fail to make each draft the best that it can be, not only in terms of the substance of the work but also its presentation, you will increase both the number of iterations and the time between iterations, significantly lengthening your time-to-completion. It is in your interest to make each draft something your supervisors want to read, not something they dread reading. Some students write almost in a kind of code that a reader must make a conscious effort to decipher. If your supervisor has to decode what you have written, you will find that it does not happen quickly.

- A good practice, especially if you have difficulty with English, is to write in short sentences. This will force you to order your thinking logically and coherently, and make it easier for your supervisor to suggest clarifying edits. Students often make the mistake of using excessively long sentences that confuse several ideas. This makes their writing difficult to understand and time-consuming to correct, both for their supervisor and for them.

- *Audience.* To whom is your essay/thesis addressed? That is, who are you writing for? Students are often unsure of the appropriate level and tone to strike, and how much should be assumed on the part of their readership—or even who that readership is.

  Most immediately and obviously, you are writing for your supervisory committee. More generally, in a PhD dissertation you are writing for an academic audience. Each of your three essays—assuming that is the format—should be written with the intention that it be readily convertible into a journal submission. Hence published journal articles are your model for the chapters of a PhD dissertation. For specific suggestions on how to write papers suitable for journal submission, google *How to Publish in Scholarly Journals* to locate a helpful pamphlet put out by Elsevier Publishing.

  In the case of an MA essay or thesis it may be helpful to think of your intended audience a bit differently. Let's return to that hypothetical job interview I mentioned, perhaps with the provincial or federal public service. Your interviewer is someone who earned their MA in Economics a decade ago, and so has a general understanding of economics as a field and the tools it uses, but no knowledge of your particular topic. You have given them a copy of your essay/thesis, even if just in draft form. (You took a copy with you to the interview, right?) When you first handed it to them, out of politeness they flipped through it superficially but did not, of course, have time to read it. On this initial cursory inspection they were impressed with the professional appearance of the document: the logical structure and clear sectioning, the neat and consistent formatting, the proper use of mathematical notation, the composition of the displayed mathematics, the use of correct citation style, the artful construction of tables and figures, and so on. (You paid careful attention to all this, even at the draft stage, right? If you didn't the interview will be a short one, your paper will go straight into the recycling the

moment you leave the room, and you will not get the job. If you wondered why it took your supervisor a month to give you comments, it is for the same reason.) Because of their positive first impression, after you have left the interviewer picks up your paper a second time. They read the abstract. Finding this engaging, they then read the introduction and conclusion. (They will merely flip through the meat in the middle, noticing mainly whether your figures, tables, and displayed mathematics are composed professionally.) This is your opportunity to distinguish yourself from other applicants for the job.

My point: In addition to writing for your supervisory committee, think of this hypothetical interviewer as your intended audience and adopt the appropriate style. You are writing for someone familiar with economics generally, but not with your particular topic or even the broader area to which you are contributing. Nevertheless, your written presentation allows them to understand in general terms what you have done, why your analysis is useful, your key findings and conclusions, and why these are significant. They have confidence that you have applied appropriate methodological tools competently so as to shine light on something of practical importance, even if they don't have time to understand the details. Most importantly, they can see that you have the ability to make technical material accessible to others.

Now you're on the short list for the job!

Please read Chapter 2 on "Writing Papers" in Thomson (2011) *A Guide for the Young Economist.* This book is available in the McPherson Library under call number `H62 T465 2011` and contains much valuable advice. For example, his Section 1.6 (pp. 50-51), "In the Literature Review, Tell a Story; Don't Enumerate," is spot-on in identifying a classic student error. John Cochrane's *Writing Tips for Ph.D. Students* (which he describes as "My all time most-read paper"!) also contains useful advice; it is on the Teaching page of his Chicago Booth personal website.

Data You are likely familiar with many of the traditional online data sources, or can quickly become so by tracing the sources cited in articles that interest you. Here are some prominent examples.

- Statistics Canada and the Bank of Canada.

- Federal Reserve Economic Data (FRED) website, hosted by the Federal Reserve Bank of St. Louis. This is convenient one-stop source for many U.S. macroeconomic and financial series, and even some Canadian ones.

- International data sources such as the World Bank, International Monetary Fund, OECD, and the Penn World Tables. For discussion of the current state of development of the Penn World Tables see Feenstra, Inklaar, and Timmer (2015) "The next generation of the Penn World Table," *American Economic Review* 105, 3150–3182.

- The Pacific Exchange Rate Service of UBC's Sauder School of Business. (Google Pacific Exchange Rate Service to locate this convenient source for exchange rate data.)

- The Canadian Financial Markets Research Center database for the Toronto Stock Exchange may be available through the McPherson Library. (Google Canadian Financial Markets Research Center for information about this database.)

- The Journal Data and Program Archives page of the American Economics Association's Resources for Economists website.

- The Data page of the Quantitative Macroeconomics and Real Business Cycles website.

- Data sets available via www.quandl.com.

- Historical data. For example:

  - Via the McPherson library website you can access UVic's subscription to the online International Historical Statistics.

- Data of the kind cited in Jeffrey Williamson (2016) "Review essay on *British Economic Growth, 1270–1870* by ..." *Journal of Economic Literature* 54, 514–521.
- The European historical data reviewed by Fouquet and Broadberry in the Fall 2015 issue of the *Journal of Economic Perspectives.*

- The website www.measuringworth.com is remarkable in providing well-documented historical macroeconomic and financial series that continue to be updated.

In addition to conventional data sources like these, be aware that another exciting trend is the original collection of data from online sources. See Edelman (2012), who lists (Table 1) examples of diverse papers grounded in online data and provides (Figure 1) a sample worksheet and script for basic online data collection.

Edelman, B. (2012) "Using internet data for economic research," *Journal of Economic Perspectives* 26, 189–206.

Time Series Data: A Warning Students often want to use time series data to investigate some topic that interests them. You should be aware of two pitfalls that commonly arise.

First, the methods of time series econometrics—even at their most basic—cannot be picked up quickly or casually. You must take at least one course in time series econometrics, such as Econ 468 or 547. In the absence of this there is no point pursuing a topic that involves the analysis of time series data (or, at least, asking me to supervise it). Instead find a topic that can be studied with cross-section data. Any hope that your supervisor can somehow provide you with a quickie crash course in these methods, or that you can learn them on your own, reveals a lack of awareness of their complexity.

Second, to study any question using time series data presupposes that reasonably long time series are available. The qualification "reasonably long" cannot be defined precisely because it depends on the model you want to estimate and the data frequency. Heavily-parameterized models (involving, say, a system of equations or the treatment of structural shifts) will require longer time series to estimate usefully than will simpler models. Monthly or quarterly series must be longer than annual series because seasonality must be treated, and because the economic issues at stake may be more related to the span of the data than merely the number of observations. In any case, there is no point hoping to base an essay/thesis topic on, say, 25 time series observations. Chinese data are particularly notorious in this respect: much as we might like to study macroeconomic or trade issues related to China, reliable time series data have not yet been observed over a long enough time span for formal time series analysis to be practical (at least in my opinion). This is not to say that nothing can be learned from the modest amount of data that is available, but any useful analysis is more likely to be descriptive rather than inferential. Descriptive data analysis alone is not a basis for an essay/thesis, at least one that I could offer to supervise.

In the case of macroeconomic data, a reasonable minimal guideline is the typical spans of data for the OECD countries. For example, US macro models are often estimated with post-Korean war quarterly series beginning around 1953. Thus, currently, around $60 \times 4 = 240$ quarterly observations are available. Most Canadian macro time series begin around 1961.

Suggested Topics

In terms of specific topic suggestions, the ideas below are listed in no particular order. How deeply a student might get into a topic would depend on whether it is used for an MA essay or thesis or a PhD dissertation. Some topics may even be suitable for Honours theses.

Macroeconomics

1. **Factor shares under increasing returns**

Traditionally macroeconomic models have assumed constant returns to scale which, under competitive markets in which factors are paid their marginal products, has the implication that factor payments exactly exhaust production. In terms of the national income accounts, gross national income equals gross national product and factor shares sum to one.

But what if, as is true in endogenous growth models, there are increasing returns and imperfect competition. How should this be implemented empirically so as to achieve a logically consistent treatment of factor shares? Epifani and Gancia (2006) is one interesting attempt, and might be applied to Canadian data. See also Basu and Fernald (1997,2003) who model the economy as an aggregation of heterogeneous firms that are not necessarily perfectly competitive and may not have constant returns.

This topic is probably too difficult for a Master's thesis, but might be suitable for a Ph.D.

Basu, S., and J.G. Fernald (1997) "Returns to Scale in U.S. Production: Estimates and Implications," *Journal of Political Economy* 105, 249–283.

Basu, S., and J.G. Fernald (2002) "Aggregate Productivity and Aggregate Technology," *European Economic Review* 46, 963–991.

Epifani, P., and G. Gancia (2006) "Increasing returns, imperfect competition, and factor prices," *Review of Economics and Statistics* 88, 583–598.

A related analysis that approaches things from an accounting perspective is:

Karabarbounis, L., and B. Neiman (2018) "Accounting for factorless income," *Federal Reserve Bank of Minneapolis Research Division Working Paper 749.*

2. **Business cycle turning points**

In a series of papers over the past decade Don Harding and Adrian Pagan, with collaborators, have implemented a turning-points approach to studying various aspects of business cycles. This work has culminated in their 2016 book. Google their names to bring up their websites with listings of their work. Section 2.5 of Altug's (2010) book contains some discussion of this work in relation to contemporary business cycle research.

An essay/thesis could apply their methodology to Canadian data, or perhaps to the synchronization of the Canadian and US cycles. A Harding-Pagan turning points algorithm has apparently now been programmed into Stata.

Harding, D., and A.R. Pagan (2016) *Econometric Analysis of Recurrent Events in Macroeconomics and Finance* (Princeton). `HB141 H368 2016`

[One version of this topic was done by Ron Gibson for his MA Essay, completed August 2012. He explored the sensitivity of the Harding-Pagan algorithm to deseasonalization.]

3. **Technology capital**

Kapička (2012) provides an intriguing empirical implementation of important work by McGrattan and Prescott (2009,2010). In one version, the world is dichotomized into the US and the rest of the world. Conduct a similar analysis in which the dichotomy is between Canada (or another country of your choice) and the rest of the world, studying for that country the question posed in of the title of Kapička's article.

Kapička, M (2012) "How important is technology capital for the United States," *American Economic Journal: Macroeconomics* 4, 218–248.

4. **Do banking crises lead sovereign debt crises?**

In their discussion of a 2011 article by Reinhart and Rogoff, Gorton and Metrick (2012, p. 134) state:

They find several interesting results. First, external debt increases sharply in advance of banking crises. Second, banking crises tend to lead sovereign-debt crises. In fact, not only does external debt rise sharply, but so does domestic government debt—a new data series built by the authors for their analysis. The second finding—that banking crises lead sovereign debt crises—is also supported by a VAR analysis. Although the direction of causality cannot be conclusively determined from such analyses, the consistent findings across many different countries and time periods suggests that banking crises play an important accelerator role in broader debt crises.

A graduate essay or thesis could usefully survey and contribute to this literature. See the Diebold-Rudebusch book listed on page 1 for a collection of work using methods that may be relevant.

Gorton, G., and A. Metrick (2012) "Getting up to speed on the financial crisis: A one-weekend-reader's guide," *Journal of Economic Literature* 50, 128–150.

5. **Estimating intertemporal conditions**

One of the most important dimensions across which decisions are made is time. Intertemporal optimality conditions govern diverse areas such as consumption, asset allocation, investment, resource extraction, and speculative bubbles. Mathematically, these conditions are derived using dynamic programming, the mathematics of optimization over time. Nevertheless the marginal conditions that arise are highly intuitive. The origins of the mathematics of optimization over time date back to the mathematician Euler; the marginal conditions that result are therefore called Euler equations.

Despite their theoretical importance, economists have not had great success implementing Euler conditions empirically. There have been many efforts to estimate these conditions, in various areas of application, but without very encouraging results. See the Adda and Cooper book for a sampling of this work, and also the article by Attanasio and Low (2004). Chap. 18 of the Diebold-Rudebusch book, "New and old models of business investment," nicely documents the poor performance of Euler investment equations. A thesis could investigate and contribute to this literature.

Here is one example of an idea that could be pursued. Euler equations are typically multiplicative relations that are estimated in logarithmic form. In an influential contribution, Santos Silva and Tenreyro (2006) have argued that OLS estimation is inconsistent when applied to regressions obtained by nonlinear transformation. Although their contribution is cast in terms of the gravity equations of international trade, they note that the same result applies in other contexts, and they mention Euler equations as one example. They advocate an alternative estimation procedure, Poisson pseudo-maximum likelihood (PPML), that has been programmed in both Stata and R. An interesting essay/thesis project could apply PPML to a stock Euler equation problem and compare the results. One such stock problem, for which the data are available, is the classic Hansen-Singleton estimation of the Euler equations of the consumption-based capital asset pricing model.

Attanasio, O., and H. Low (2004) "Estimating Euler equations," *Review of Economic Dynamics* 7, 406–435.

Cutanda, A., Labeaga, J.M., and J.A. Sanchis-Llopis (2020) "Aggregation biases in empirical Euler consumption equations: evidence from Spanish data," *Empirical Economics* 58, 957–977.

Santos Silva, J.M.C., and S. Tenreyro (2006) "The log of gravity," *Review of Economics and Statistics* 88, 641–658.

Smith, G., and J. Yetman (2013) "Estimating dynamic Euler equations with multivariate professional forecasts," *Economic Inquiry* 51, 445–458.

6. **The Canadian productivity program**

A major initiative of Statistics Canada's economic accounts division is the Canadian Productivity Program, which has constructed high-quality data particularly suited to studying issues of productivity growth. Yet so far this impressive data set seems to have been little-exploited in academic research. These annual data go back to 1961, and so now cover a long enough span to be amenable to a credible time series analysis. For example, they might provide the basis for pursuing Topic 1 (Alternative approaches to estimating the CES production function) for the Canadian business sector.

The Canadian Productivity Program has, in its treatment of capital, some ties to the work of Erwin Diewert. For a comparison of the Statcan and Diewert approaches, see Gu (Fall 2012) "Estimating capital input for measuring business sector multifactor productivity: response to Diewert and Yu," *International Productivity Monitor.*

7. **The World KLEMS Initiative**

A data set related to the preceding topic is the Statistics Canada KLEMS (capital, labour, energy, materials, and services) data. It could be used to investigate for Canada many of the issues that Jorgenson and coauthors have constructed similar US data to study. For an introduction see Jorgenson's article in the Fall 2012 issue of the *International Productivity Monitor.*

Statistics Canada's KLEMS initiative is part of larger international efforts: Google world klems to visit the coordinating website. Each year the *International Productivity Monitor* publishes a special issue of papers from an annual World KLEMS Conference, which include examples of how KLEMS datasets are being used internationally.

For more ideas about what can be done with KLEMS data, see:

Caselli, F. (2017) *Technology Differences Over Space and Time* (Princeton University Press). HC79 I52C37 2017

Peyrache, A., and A. Rambaldi (2017) "Incorporating temporal and country heterogeneity in growth accounting—an application to EU-KLEMS," *Journal of Productivity Analysis* 47, 143–166.

8. **Measuring the effect of the zero lower bound on interest rates**

Apply the methodology of the following article to Canadian data.

Swanson, E., and J. Williams (2014) "Measuring the effect of the zero lower bound on medium- and longer-term interest rates," *American Economic Review* 104, 3154–3185.

[This topic was used by Armon Alamolhoda for his 2017 Honours thesis. However variations on the analysis are always possible.]

9. **Speed of adjustment and aggregation over time**

In many areas of empirical macroeconomics, econometricians estimate dynamic models that yield estimates of the speed of adjustment to disequilibrium. Often these indicate surprisingly slow adjustment: the estimates suggest that adjustment takes much longer than would seem plausible. Classic examples are inventory models, estimates of which suggest slow adjustment to disequilibrium, and models of the real exchange rate. For example, Rogoff (1996, p. 647) asks "How can one reconcile the enormous short-term volatility of real exchange rates with the extremely slow rate at which shocks appear to damp out?"

One possibility is that there is an aggregation-over-time problem at work. The data we use to estimate our models is available at relatively low frequency (say, quarterly) in comparison with the speed at which economic decision makers and markets are operating (say, daily). Thus the available data are an aggregation over time of the data what are really needed to estimated our models. It is not possible to correctly estimate the parameters of high-frequency decision and market activity with low-frequency data.

This idea could be investigated as a Master's or PhD thesis.

Rogoff, K. (1996) "The purchasing power parity puzzle," *Journal of Economic Literature* 34, 647–668.

10. **The credit cycle**

The 2008–9 financial crisis has sparked a renewed interest in the role of credit in the business cycle. An important example is Schularick and Taylor (2012), who compile an extensive annual panel data set on 14 countries over the years 1870–2008 and find (p. 1032) that "lagged credit growth turns out to be highly significant as a predictor of financial crises, but the addition of other variables adds very little explanatory power." Their data set is posted to the AER archive, and has been used by Summers (2017) to replicate their results.

You might investigate this literature with a view to contributing to it. For an introduction see the entry on Credit cycle in Wikipedia and the references it cites. A good survey is Gertler and Gilchrist (2018); Gennaioli and Shleifer (2018) offer an interesting perspective—see in particular the references they cite on pp. 167–8. The articles reprinted in Bernanke (2000) may also be useful. Mian and Sufi (2018) describe one interesting strain of the empirical literature. For example, an interesting essay/thesis could study whether Canadian data exhibit patterns similar to those found by Mian and Sufi in the US data.

The credit cycle is sometimes called the *financial cycle*. The belief among some economists that it often plays an important role in business cycles, although renewed by the 2008–9 crisis, goes back many years. It was emphasized in the writings of the British economist Ralph Hawtrey in the first half of the 20th century and, later, by the American economist Hyman Minsky.

Bernanke, B.S. (2000) *Essays on the Great Depression* (Princeton University Press). `HB3717 1929 B3718`

Gennaioli, N., and A. Shleifer (2018) *A Crisis of Beliefs—Investor Psychology and Financial Fragility* (Princeton). `HB74 P8G45 2018`

Gertler, M., and S. Gilchrist (2018) "What happened: Financial factors in the great recession," *Journal of Economic Perspectives* 32(3) 3–30.

Kiyotaki, N., and J. Moore (1997) "Credit cycles," *Journal of Political Economy* 105, 211–248.

Mian, A., and A. Sufi (2018) "Finance and business cycles: The credit-driven household demand channel," *Journal of Economic Perspectives* 32(3) 31–58.

Schularick, M., and A. Taylor (2012) "Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008," *American Economic Review* 102, 1029–1061.

Summers, P. (2017) "Credit booms gone bust: Replication of Schularick and Taylor (AER 2012)," *Journal of Applied Econometrics* 32, 1033–1038.

11. **The econometrics of stocks and flows**

The distinction between stock and flow variables has long been ubiquitous to economics, especially macroeconomics. As one example, see the index entries relating to *Stock-flow equation* in Petrosky-Nadeau and Wasmer (2017). An interesting essay/thesis could study the following.

- As a general class, what methods of econometric inference apply in this context? For this purpose, is the distinction between discrete versus continuous time important?
- What are the classic empirical applications?
- What is the relevance/importance of aggregation-over-time issues?

Petrosky-Nadeau, N., and E. Wasmer (2017) *Labor, Credit, and Goods Markets: The Macroeconomics of Search and Unemployment* (MIT Press). `HF5470 P49 2017`

12. **The agricultural origins of time preference**

Consider extending the analysis of

Galor, O, and Ö. Özak (2016) "The Agricultural Origins of Time Preference," *American Economic Review* 106, 3064–3103.

13. **Estimation of a rich model of adjustment costs**

Adda and Cooper (2003) describe the work of Cooper and Haltiwanger (2000,2006) using U.S. data, and remark that "Comparable data sets are available in other countries. Similar estimation exercises using these data sets would be of considerable interest." Consider redoing the work with Canadian (or other) data.

Adda, J., and R. Cooper (2003) *Dynamic Economics—Quantitative Methods and Applications* (MIT Press).

Cooper, R., and J. Haltiwanger (2000) "On the nature of the capital adjustment process," NBER Working Paper 7925.

Cooper, R., and J. Haltiwanger (2006) "On the nature of capital adjustment costs," *Review of Economic Studies* 73, 611–633.

14. **To what extent are business cycles still inventory cycles?**

Historically, fluctuations in GDP over the business cycle were disproportionately due to fluctuations in inventory stocks. Economic recovery was associated with a buildup of inventories, which would reach a maximum around the peak of the cycle. When growth slowed firms reacted by ceasing to add to their inventory stocks, instead beginning to run them down. Business cycle decline therefore saw inventory decumulation, with stocks reaching a minimum during the trough. This cyclical pattern of inventory accumulation and decumulation was recognized at least as long ago as the 1920s.

At least two things have changed in recent decades, both of which suggest that inventory fluctuations may be less important for the business cycle. The first is the decreasing importance of manufacturing relative to the service sector, where inventory stocks are small or nonexistent. The second is improved systems of inventory management, or alternatives to inventory holding such as just-in-time manufacturing.

To what extent are business cycles still inventory cycles, in Canada or elsewhere?

15. **The natural rate of interest**

Observed market rates of interest are called *nominal interest rates.* They are bid up by expectations of inflation, and so incorporate some aggregate of the inflationary expectations of financial market participants. Once the rate of inflation is known, as measured by some chosen price index such as the GDP deflator or CPI, an *ex post real rate of interest* can be obtained arithmetically (as, approximately, the nominal rate minus the inflation rate).

A somewhat different question is the hypothetical one of: What would the market rate of interest be in the absence of inflationary expectations? This hypothetical rate might be called the *ex ante real rate of interest.* How is this related to other ex ante notions of real rates, in particular:

- the *natural rate of interest,* a concept that Laubach and Williams (2003) attribute to Wicksell (1936) and define as "the real short-term interest rate consistent with output equaling its natural rate and constant inflation."

- an inferred *expected real rate of interest,* obtained as the nominal rate less expected inflation. (A measure of expected inflation can be obtained in several ways. One is to use data on indexed bonds.)

How do these various ex ante concepts of real interest rates relate to one another, or do they all amount to the same thing? Given that none is directly observable, but must be inferred, why are they important or interesting? (The goal of scientific inquiry, in economics just as in other sciences, is to explain observable phenomena, not theoretical unobservables.) An essay/thesis could investigate this literature with a view to applying available methodologies to Canadian or other data.

A seminal contribution is Laubach and Williams (2003); a more recent one is Anari and Kolari (2016).

Anari, A., and J. Kolari (2016) "Dynamics of interest and inflation rates," *Journal of Empirical Finance* 39, 129–144.

Laubach, T., and J. Williams (2003) "Measuring the natural rate of interest," *Review of Economics and Statistics* 85, 1063–1070.

16. **The elasticity of substitution**

The elasticity of substitution between capital and labour is a key parameter in many economic models. Yet, as discussed in the appendix of Nordhaus (2021), despite intensive study there remains much uncertainty about its value. Nordhaus describes a data set from the U.S. Bureau of Economic Analysis (BEA) that can be used to estimate this parameter with a CES-translog production function. It would make a nice Master's essay to use the updated data to estimate the elasticity of substitution, explaining the CES-translog model and how it is applied in this context.

Nordhaus, W.D. (2021) "Are we approaching an economic singularity? Information technology and the future of economic growth," *American Economic Journal: Macroeconomics* 13, 299–332.

Growth Economics

17. **Empirical work related to economic growth**

There are many stylized facts of economic growth, and other aspects of growth empirics, that can be investigated. Here are a couple of examples.

- The book by La Grandville (2009) discusses some empirical topics related to economic growth that could be updated or extended. For example, consider adding Canada to his estimation of the elasticity of substitution using time series data shown in Table 5.4 on p. 146.
- Grossman, Helpman, and Oberfield (2017) document a pattern of falling investment-good prices in U.S. data, which is important because it is inconsistent with balanced growth in standard growth models such as the Solow-Swan model. They then proceed to consider extensions to growth models that can accommodate this pattern in the data. Does the same pattern hold in Canadian data (or other national data, such as the U.K.)?

Grossman,G., Helpman, E., and E. Oberfield (2017) "Balanced growth despite Uzawa," *American Economic Review* 107, 1293–1313.

La Grandville, O. de (2009) *Economic Growth: A Unified Approach* (Cambridge University Press). `HD75 L25`

18. **Extension of Mankiw, Romer, and Weil**

The famous 1992 Mankiw, Romer, and Weil article can be extended in a number of directions. For a summary of the analysis and the related literature, see Chapter 9 of Stewart (2005) *Introduction to Applied Econometrics* (`HB139 S753`). See also the update of the MRW analysis in D. Acemoglu (2008) *Introduction to Modern Economic Growth,* Sec. 3.4.

One extension of MRW that is not mentioned in Stewart is to generalize it to the CES production function:

Masanjala, W.H., and C. Papageorgiou (2004) "The Solow model with CES technology: Nonlinearities and parameter heterogeneity," *Journal of Applied Econometrics* 19, 171–201.

Thesis work could estimate this extension using an updated data set.

19. **Testing endogenous versus exogenous growth**

Lau (2008) uses readily-available time series from the Penn World Tables to estimate bivariate error-correction models for France, Japan, and the UK. The ECM is formulated in order to allow him to test for the stochastic implications of endogenous growth. A Master's essay/thesis could apply or extend Lau's methodology in some way.

Lau, S.-H.P. (2008) "Using an error-correction model to test whether endogenous long-run growth exists," *Journal of Economic Dynamics and Control* 32, 648–676.

[One version of this topic was done by Abu Asihaer for his MA Essay, completed August 2012. He repeated Lau's analysis for a larger number of countries using an updated data set, and found that this extended data set confirmed Lau's conclusion that the time series implications of endogenous growth models are rejected.]

20. **Growth and structural transformation**

As economies have grown and developed over the past two centuries, the relative importance of agriculture, manufacturing, and services has changed. Agriculture begins as far-and-away the dominant sector, sometimes accounting for as much as 70–80% of employment and GDP; the remainder is divided between manufacturing and services. But over time the relative importance of agriculture shrinks, eventually becoming minor. Manufacturing expands initially, typically peaking in its share of employment and GDP during the 1950s, but then begins to shrink in its relative importance. The service sector expands continually, and now has replaced agriculture in accounting for 70–80% of economic activity in many countries. These patterns are nicely documented in the early pages of the survey by Herrendorf, Rogerson, and Valentinyi (2014).

This changing role of economic sectors is called *structural transformation,* and the literature studying the forces driving it is an important part of theoretical and empirical growth economics. Thesis work could seek to contribute to it, perhaps by focusing on the Canadian historical data in the way that Herrendorf, Herrington, and Valentinyi (2015) focus on the US or Bustos, Caprettini, and Ponticelli (2016) focus on Brazil; Alvarez-Cuadrado and Poschke provide a comparative country analysis with some inclusion of information for Canada. Leukhina and Turnovsky (2016) is a related recent contribution. For a survey of some background economic theory, see Greenwood and Seshadri (2005). You might consider constructing a Canadian data set comparable to the data described in Appendix A of Herrendorf, Rogerson, and Valentinyi (2014), although be aware of the qualifications to Maddison's data discussed in Williamson (2016).

A related but more specific topic is the distinction between gross and value added production functions: see Herrendorf, Herrington, and Valentinyi (2015). This alone could be the basis of a more narrowly focused thesis or essay.

Alvarez-Cuadrado, F., and M. Poschke (2011) "Structural change out of agriculture: Labor push versus labor pull," *American Economic Journal: Macroeconomics* 3, 127–158.

Bustos, P., B. Caprettini, and J. Ponticelli (2016) "Agricultural productivity and structural transformation: Evidence from Brazil," *American Economics Review* 106, 1320–1365.

Greenwood, J., and A. Seshadri (2005) "Technological progress and economic transformation," Chap. 19 of *Handbook of Economic Growth,* vol. 1B (Elsevier). `HD75.5 H33`

Herrendorf, B., Herrington, C., and A. Valentinyi (2015) "Sectoral technology and structural transformation," *American Economic Journal: Macroeconomics* 7, 104–133.

Herrendorf, B., R. Rogerson, and A. Valentinyi (2014) "Growth and structural transformation," Chap. 6 of *Handbook of Economic Growth,* vol. 2 (Elsevier). `HD75.5 H33`

Leukhina, O.M., and S.J. Turnovsky (2016) "Population size effects in the structural development of England," *American Economic Journal: Macroeconomics* 8, 195–229.

Williamson, J. (2016) "Review essay on *British Economic Growth, 1270–1870* by Broadberry, Campbell, Klein, Overton, and van Leeuwen," *Journal of Economic Literature* 54, 514–521.

21. **Measuring productivity growth**

The measurement of productivity growth is a topic of longstanding interest. Consider an application that draws on the literature conveniently cited in the following article.

Mizobuchi, H. (2017) "Productivity indexes under Hicks neutral technical change," *Journal of Productivity Analysis* 43, 63–68.

Macro Labour

22. **Multidimensional skill mismatch**

An intriguing article in the January 2020 *AEJ: Macro* uses U.S. data. Is there a Canadian (or perhaps other national data set) to which the same analysis can be applied? This would be a great essay/thesis topic for a student who can arrange a committee that includes a labour economist knowledgeable about Canadian labour data.

Guvenen, F., Kuruscu, B., Tanaka, S., and D. Wiczer (2020) "Multidimensional skill mismatch," *American Economic Journal: Macroeconomics* 12, 210–244.

23. **The elasticity of labour supply**

Consider constructing a Canadian (or other) data set to do work related to the literature studied in:

Peterman, W.B. (2016) "Reconciling micro and macro estimates of the Frisch labor supply elasticity," *Economic Inquiry* 54, 100–120. [This article was the winner of *Economic Inquiry*'s Best Paper Award for 2016.]

24. **The joint labour supply and consumption decisions**

As a topic somewhat related to the preceding one, household incomes are determined by a production sector joint with household labor supply decisions. For an analysis that focuses on joint consumption and labor supply, see Mankiw, Rotemberg, and Summers (1985). They estimate three marginal conditions governing the behavior of a representative individual: the tradeoff between present and future consumption, between present and future leisure, and between present consumption and present leisure. Another important paper in this vein is Browning, Deaton, and Irish (1985). Although these papers provide important benchmarks, their empirical success is at best mixed, consistent with my remarks in Topic 10. Hall (2009) is a more encouraging study along these lines that combines theory and empirical analysis masterfully.

Browning, M., A. Deaton, and M. Irish (1985) "A profitable approach to labor supply and commodity demands over the life-cycle," *Econometrica* 53, 503–543.

Hall, R. (2009) "Reconciling cyclical movements in the marginal value of time and the marginal product of labor," *Journal of Political Economy* 117, 281–323.

Mankiw, N.G., Rotemberg, J.J., and L.H. Summers (1985) "Intertemporal substitution in macroeconomics," *Quarterly Journal of Economics* 100, 225–251.

25. **The Diamond-Mortensen-Pissarides model**

The DMP model is the dominant theoretical framework for understanding the aggregate labour market and unemployment. There are many possibilities for interesting empirical work related to this model. Hall (2017) has useful references and would be one good starting point for exploring this literature. For an accessible introduction to the DMP model, see Bhattacharya et al. and the textbook references it cites. Another good introduction is the chapter entitled *Search and Unemployment* in the intermediate macroeconomics textbook by Stephen Williamson, *Macroeconomics*.

Bhattacharya, A., Jackson, P., and B.C. Jenkins (2018) "Revisiting unemployment in intermediate macroeconomics: A new approach for teaching Diamond-Mortensen-Pissarides," *The Journal of Economic Education* 49, 22–37.

Hall, R. (2017) "High discounts and high unemployment," *American Economic Review* 107, 305–330.

26. **Aggregate labour dynamics**

A large literature studies the dynamics of labour market stocks (of employed, unemployed, and those not in the labour force) and flows (of hires, separations, job creation, and job destruction). See the survey by Rogerson and Shimer in Vol. 4 of the *Handbook of Labor Economics.* For discussion in relation to the Diamond-Mortensen-Pissarides search model see Peter Diamond's Nobel address in the June 2011 AER the books by Miao (2014, Chap. 18) and Petrosky-Nadeau and Wasmer (2017). Another useful introduction to some of the issues is the Davis, Faberman, and Haltiwanger article in the Summer 2006 issue of the *Journal of Economic Perspectives.* This literature provides scope for many interesting thesis topics. A replication of an existing study with new data would be acceptable for a Master's essay or thesis.

One example would be the estimation of an aggregate labour construct such as a Beveridge curve or matching function, a topic that is listed separately below.

Historically most labour market data were on stocks: numbers of employed, unemployed, etc. More recently some statistical agencies have devoted considerable effort to measuring flows, notably the JOLTS data published by the US Bureau of Labor Statistics. For examples of interesting use of the JOLTS data, see the short papers by Lazear and Spletzer and Davis, Faberman, and Haltiwanger in the 2012 AER Papers & Proceedings.

One interesting approach would be to analyze labour stock-flow data in a manner rigorously consistent with the older theoretical literature on stock-flow equilibria. For a textbook treatment of the latter, see Bushaw and Clower (1957) *Introduction to Mathematical Economics* (Irwin). As an example of an analysis that carefully treats stock-flow distinctions and issues of aggregation over time, see Petrongolo and Gregg (2005) "Stock-flow matching and the performance of the labor market," *European Economic Review* 49, 1987–2011.

There may also be some potential for relating search and matching models to issues of composition bias in the real wage over the business cycle: see Carneiro, Guimarães, and Portugal (2012).

Carneiro, A., Guimarães, P., and P. Portugal (2012) "Real wages and the business cycle: accounting for worker, firm, and job title heterogeneity," *American Economic Journal: Macroeconomics* 4, 133–152.

Petrosky-Nadeau, N., and E. Wasmer (2017) *Labor, Credit, and Goods Markets: The Macroeconomics of Search and Unemployment* (MIT Press). `HF5470 P49 2017`

27. **The Beveridge curve and matching function**

Use Canadian data to estimate a Beveridge curve or a matching function. A good starting point for learning about these literatures is Barnichon and Figura (2015).

Barnichon, R., and A. Figura (2015) "Labour market heterogeneity and the aggregate matching function," *American Economic Journal: Macroeconomics* 7, 222–249.

28. **The demand for employment versus hours**

As production activity expands and contracts employers face a choice between hiring and firing workers versus varying the hours of existing workers. In the short term, hours can be varied to adjust to modest changes in production levels; in the longer term, employment must be varied to adjust to larger changes. Although this is related to the labour demand of Topic 3, employment and hours are not distinct factors of production; they do not, for example, each have a distinct factor price.

The dynamics of employment versus hours is discussed in the book by Hamermesh (1993, pp. 268–270) cited above. In addition to the references cited there, see Nakanishi (2001).

29. **Jobless recoveries**

An important feature of the business cycle appears to have changed, at least in the US. Historically, jobs were created quickly during recoveries, so that employment re-attained its pre-recession peak within a few quarters of the trough. Beginning with the recession of 1990–91, however, this seems to have changed. In the recessions of 1990-91, 2001, and 2008–12, it has taken much longer for employment to recover. For a brief popular discussion of this phenomenon by a respected academic that summarizes of some of the competing hypotheses advanced to explain it, see pp. 87–89 of Raghuram Rajan (2010) *Fault Lines* (Princeton University Press).

A thesis or extended essay could review the current status of empirical research on this phenomenon and contribute to it, ideally in a manner that would distinguish between the alternative hypotheses. One direction this could take is to see whether the US pattern is evident in the Canadian data.

Graetz, G., and G. Michaels (2017) "Is modern technology responsible for jobless recoveries," *American Economic Review: Papers and Proceedings* 107, 168–173.

Nakanishi, Y. (2001) "Dynamic labour demand using error correction model," *Applied Economics* 33, 783–790.

Monetary Economics

30. **The time-ordering of the real effects of monetary policy**

Monetary policy is usually exercised via open market operations or, in Canada, deposit shifting. This creates new reserves at the commercial banks, which in turn spawns a sequence of new loan and deposit creation.

The kind of borrowing that is most immediately affected by these new loans has changed over the years. Prior to World War II bank lending was principally for mortgages and business loans, and mortgage lending stimulated home construction. Thus the new money went to finance investment in residential construction and business investment. These were the sectors that got the new money, and bid resources away from the rest of the economy, predominantly consumption. Expansionary monetary policy therefore had "forced saving" as a byproduct.

With the rise of consumer lending in the second half of the 20th century, increasingly it is households that are taking out the new loans created as part of the process of money creation.

Although an expansion of the money supply has its effect through short-term interest rates rather than long-term rates, paradoxically the effect is often on components of spending that are long-term in nature. Lower short-term rates are often the trigger that makes it possible for first time home buyers to afford the monthly payments on a house, especially if the lower rates are thought to be temporary. Even if the mortgage has a 25 year amortization, the purchase decision may hinge on the rate that applies to the initial term of as little as six months or

a year. Similarly for purchases of consumer durables: cars, major appliances, and furniture. Of course, analogous considerations apply to contractionary monetary policy. Bernanke and Gertler (1995, p. 29) list as one of the basic facts of a tightening in monetary policy that "The earliest and sharpest declines in final demand occur in residential investment, with spending on consumer goods (including both durables and nondurables) close behind." The effect on fixed business investment may be a response to this consumer demand rather than to interest rates. Bernanke and Gertler state as another basic fact that "Fixed business investment eventually declines in response to a monetary tightening, but its fall lags behind those of housing and consumer durables and, indeed, behind much of the decline in production and interest rates."

Quite in contrast to residential investment, Bernanke and Gertler find that business investment in structures is little affected by monetary policy; instead it is equipment investment that is most interest-sensitive. Businesses invest in new structures in response to demonstrated increased demand that is seen to be permanent, not to transitory increases in demand arising from stimulative monetary policy.

An interesting essay/thesis could explore these issues for Canada.

Bernanke, B., and M. Gertler (1995) "Inside the black box: The credit channel of monetary policy transmission," *Journal of Economic Perspectives* 9, 27–48.

31. **Long run money demand**

The demand for money is a topic of longstanding interest in monetary economics. Since the development of unit root econometrics, money demand functions have been interpreted as cointegrating relationships, to the point that they have become a standard testing ground for cointegration methods: see, for example, Stock and Watson (1993), Banerjee, Dolado, Galbraith, and Hendry (1993), and Juselius (2006); the latter book has data sets to replicate the empirical exercises. However a comparison of studies shows that empirical results are sensitive to the sample period, a point emphasized by Ball (2001). This is largely because of the anomalous period of the 1970s and 1980s when money growth, inflation, and interest rates escalated, later returning to their historical norms.

Whereas the treatment of nominal transactions and the money stock as I(1) is compelling, the appropriate treatment of the interest rate is less clear. In the 1960s and 1970s interest rates rose steadily, peaking around 1982. For samples dominated by this historical episode, it is natural to treat the interest rate as I(1) as well. But, in the longer historical context, nonstationary interest rates are implausible.

Another long tradition, going back to the 1960s, studies money demand and supply as a simultaneous system. A recent example is Hsing and Jamal (2013). How can this be married with the cointegration approach?

Thesis or essay work could construct an updated data set and revisit these issues. For example, an acceptable Master's thesis could simply repeat the analysis of the empirical examples in Juselius (2006) using an updated Canadian (or other) data set.

Ball, L. (2001) "Another look at long-run money demand," *Journal of Monetary Economics* 47, 31–44.

Banerjee, A., Dolado, J.J., Galbraith, J.W., and D.F. Hendry (1993) *Co-integration, Error-Correction, and the Econometric Analysis of Non-stationary Data* (Oxford: Oxford University Press).

Benati, L., Lucas, R.E. Jr., Nicolini, J.-P., and W. Weber (2017) "International evidence on long-run money demand," Working Paper.

Haug, A. (2006) "Canadian money demand functions: Cointegration-rank stability," *The Manchester School* 74, 214–230.

Haug, A., and R. Lucas (1996) "Long-run money demand in Canada: In search of stability," *Review of Economics and Statistics*.

Haug, A., and J. Tam (2007) "A closer look at long-run U.S. money demand: Linear or nonlinear error correction with M0, M1, or M2?" *Economic Inquiry* 45, 363–376.

Hsing, Y., and A. Jamal (2013) "A simultaneous-equation model for money demand and money supply in Canada," *Modern Economy* 4, 32–36. http://dx.doi.org/10.4236/me.2013.41004

Juselius, K. (2006) *The Cointegrated VAR Model: Methodology and Applications* (Oxford). `HB141 J87`

Stock, J., and M. Watson (1993) "A simple estimator of cointegrating vectors in higher order integrated systems," *Econometrica* 61, 783–820.

32. **Exchange rates and currency substitution**

Exchange rates are volatile to an extent that seems to defy all attempts by economists to explain them. The comprehensive survey by Rossi (2013), for example, shows that although some classes of model may fit well in-sample for certain currencies over certain time periods (and, less often, enjoy some success in forecasting out-of-sample), this rarely transfers to other currencies or time periods. On the whole it is difficult to beat the forecasts of a naive zero-drift random walk. (Which is just a fancy way of saying that the best forecast of next period's exchange rate is this period's.) Hence I am not particularly interested in supervising work that merely estimates the same classes of models that Rossi surveys.

A more appealing possibility is a famous article by Kareken and Wallace (1981) who showed that, when alternative fiat moneys are perfectly substitutable, the exchange rate is indeterminate. Wallace (1979) provides an accessible introduction to the idea. For a textbook treatment see Chapter 4 of Champ, Freeman, and Haslag (2011) (which is the Econ 406 textbook) or, more briefly, Rocheteau and Nosal (2017, p. 333). Later discussion, with references, may be found in Calvo (1996): see the chapters in Part III on *Currency Substitution.* For a more current list of references, see Gomis-Porqueras, Kam, and Waller (2017).

Essay or thesis work could investigate the hypothesis that currency substitution contributes to exchange rate volatility.

Calvo, G. (1996) *Money, Exchange Rates, and Output* (MIT Press).

Champ, B., Freeman, S., and J. Haslag (2011) *Modeling Monetary Economies* (Cambridge University Press).

Gomis-Porqueras, P., Kam, T., and C. Waller (2017) "Nominal exchange rate determinacy under the threat of currency counterfeiting," *American Economic Journal: Macroeconomics* 9, 256–273.

Kareken, J., and N. Wallace (1981) "On the indeterminacy of equilibrium exchange rates," *Quarterly Journal of Economics* 96, 207–222.

Pavlidis, E., Paya, I., and D. Peel (2006) "The econometrics of exchange rates," Chap. 22 in *Palgrave Handbook of Econometrics* ed. by T.C. Mills and K. Patterson (Palgrave Macmillan). `HB139 P345`

Rocheteau, G., and E. Nosal (2017) *Money, Payments, and Liquidity,* 2nd ed. (MIT Press). `HG178 N68 2017`

Rossi, B., (2013) "Exchange rate predictability," *Journal of Economic Literature* 51, 1063–1119.

Wallace, N. (1979) "Why markets in foreign exchange are different from other markets," Federal Reserve Bank of Minneapolis *Quarterly Review,* Fall 1979.

Financial Economics

Students sometimes have an interest in doing an essay/thesis in the general area of finance but are hampered by having little background in the theory of finance. One solution is to focus on a topic that

has strong ties to economic rather than finance theory. Interest rates and exchange rates are prime examples. Although these have been intensively studied many puzzles remain, such as the uncovered interest rate parity puzzle (Ilut, 2012) and the rejection of the unbiased forward rate hypothesis. Another good example of a topic of longstanding interest that is at the intersection of finance, macroeconomics, and monetary economics is speculative bubbles. There are many references, but a topical recent overview is provided by Evanoff, Kaufman, and Malliaris (2012).

Ilut, C. (2012) "Ambiguity aversion: Implications for the uncovered interest rate parity puzzle," *American Economic Journal: Macroeconomics* 4, 33–65.

Evanoff, D., Kaufman, G., and A. Malliaris (2012) *New Perspectives on Asset Price Bubbles: Theory, Evidence and Policy* (`HG4636 N49 2012`).

In terms of specific suggestions, here are a few possibilities.

33. **Macroeconomics and the term structure**

    Gürkaynak and Wright (2012) provide a nice overview of the current state of the theory and empirics of the term structure of interest rates. They survey many empirical studies that could be redone with new data, Canadian or otherwise. You might also consult Zivot and Wang (2006, Chap. 16) and Diebold and Rudebusch (2013); the latter book focuses on the Nelson-Siegel model, which is a benchmark term structure model.

    Diebold, F., and G. Rudebusch (2013) *Yield Curve Modeling and Forecasting—The Dynamic Nelson-Siegel Approach* (Princeton).

    Gürkaynak, R.S., and J.H. Wright (2012) "Macroeconomics and the term structure," *Journal of Economic Literature* 50, 331–367.

    Zivot, E., and J. Wang (2006) *Modeling Financial Time Series with S-Plus, 2nd ed.* (Springer). `HG106 Z585 2006`

34. **ECM representations of present value models**

    In general the price of an asset must be some present discounted value of the future payments it promises. For example, the price of a stock must be determined by, in some sense, the present value of its expected dividend stream. For an introduction to present value models of asset prices, see Chap. 7 of Campbell, Lo, and MacKinlay (1997). Note in particular their discussion (Sec. 7.1.3) of the Campbell-Shiller dynamic Gordon growth model.

    Present value models therefore suggest that in the long run stock prices should be governed by their dividend flows; that is, there should be a cointegrating relationship between stock prices and dividends. However implementing this empirically has been problematic: see Cochrane's (2005) assessment of present value models. Researchers have therefore turned to introducing various elaborations on the framework: a good example is Kasa, Walker, and Whiteman (2014). Nevertheless, although present value models are hardly the last word in describing the relationship between stock prices and dividends, they are an initial benchmark class of models. It is therefore of interest to consider whether they have a benchmark empirical implementation.

    The random walk behaviour of (log) stock prices means that their returns exhibit negligible autocorrelation; this is not true of dividends, which are autocorrelated. The implication is that stock prices and dividends can be modeled by a VAR/ECM with nontrivial dynamics. For such bivariate models, see Lee (1995) and Crowder and Wohar (1998); Cochrane (2005, pp. 404–407) also gives an example. Lee (1996,1998) expands the price-dividend relationship to include earnings in a 3-variable system.

    An essay/thesis could consider the estimation of these VAR/ECM representations of present value models using Canadian data. Can their ability to fit the data be improved by obvious natural extensions, such as allowing for volatility clustering?

    Campbell, J.Y., Lo, A.W., and A.C. MacKinlay (1997) *The Econometrics of Financial Markets* (Princeton University Press). `HG4523 C34`

Cochrane, J. (2005) *Asset Pricing,* 2nd ed. (Princeton University Press). `HG4636 C56 2005`

Crowder, W., and M. Wohar (1998) "Stock price effects of permanent and transitory shocks," *Economic Inquiry* 36, 540–552.

Kasa, K., Walker, T., and C. Whiteman (2014) "Heterogeneous beliefs and tests of present value models," *Review of Economic Studies* 81, 1137–1163.

Lee, B.-S. (1995) "The response of stock prices to permanent and temporary shocks to dividends," *Journal of Financial and Quantitative Analysis* 30, 1–22.

Lee, B.-S. (1996) "Comovements of earnings, dividends, and stock prices," *Journal of Empirical Finance* 3, 327–346.

Lee, B.-S. (1998) "Permanent, temporary, and non-fundamental components of stock prices," *Journal of Financial and Quantitative Analysis* 32, 1–32.

Wang, P. (2009) "Present value models and tests for rationality and market efficiency," *Financial Econometrics,* 2nd ed. (Routledge).

35. **Joint tests of the unbiased forward exchange rate hypothesis, interest rate parity, and purchasing power parity**

All three of these hypotheses have been studied intensively, and large empirical literatures exist. However most empirical work focuses on each taken in isolation. Since all three involve some combination of exchange rates, interest rates, inflation rates, and expectations, are there any new insights to be gained by formulating models in which they are tested jointly rather than individually?

36. **The stock market and the business cycle**

Consider redoing the following analysis with updated or Canadian data.

Beaudry, P., and F. Portier (2006) "Stock prices, news, and economic fluctuations," *American Economic Review* 96, 1293–1307.

37. **Stock price booms and expected capital gains**

Consider redoing the following analysis with Canadian (or other) data.

Adam, K., Marcet, A., and J. Beutel (2017) "Stock price booms and expected capital gains," *American Economic Review* 107, 2352–2408.

38. **Commodity markets**

If you are interested in working on commodities, begin with Ahn (2020). An example of an interesting empirical study is Knittel and Pindyck (2016), which has a useful bibliography.

Ahn, D.P. (2020) *Principles of Commodity Economics and Finance* (MIT Press). `HG6046 A374 2018`

Knittel, C.R., and R.S. Pindyck (2016) "The simple economics of commodity price speculation," *American Economic Journal: Macroeconomics* 8, 85–110.

[In her 2018 MA Essay, Anshul Dhankher applied the KP model to the natural gas market.]

39. **Dual-listed companies**

In the words of De Jong, Rosenthal, and Van Dijk (2009) "A dual-listed company (DLC) structure (also referred to as a "Siamese twin") involves two companies incorporated in different countries contractually agreeing to operate their businesses as if they were a single enterprise, while retaining their separate legal identity and existing stock exchange listings. A well-known example is Royal Dutch/Shell. The shares of the DLC parents represent claims on exactly the same underlying cash flows. In integrated and efficient financial markets, stock prices of the twin pair should move in lockstep." Yet, remarkably, they often do not, exhibiting significant discrepancies for extended periods of time. A thesis/essay could investigate this phenomenon for, say, DLC's cross-listed on the TSX and NYSE.

De Jong, A., Rosenthal, L., and M.A. Van Dijk (2009) "The risk and return of arbitrage in dual-listed companies," *Review of Finance* 13, 495–520.

40. **Is the Canadian public corporation in trouble?**

In a famous article, the financial economist Michael Jensen (1989) argued that the public listing of firms on stock exchanges would become less important as a means of financing corporations, because the public corporation is an inefficient means of solving agency problems between shareholders and managers. Kahle and Stulz (2017) provide an accessible survey showing that Jensen's prediction has been borne out for the US. How do trends compare in Canada?

Jensen, M.C. (1989) "Eclipse of the public corporation," *Harvard Business Review* 67, 61–74.

Kahle, K.M., and R.M. Stulz (2017) "Is the US public corporation in trouble?" *Journal of Economic Perspectives* 31, 67–88.

Population Economics and Demography

41. **VAR/ECM estimation of a demography model**

Macroeconomic time series of the kind used to estimate VAR models often span a fairly modest number of years; many series begin in the 1950s, so there are fewer than 60 annual observations. Furthermore these low-frequency data are often unable to capture the higher-frequency dynamics that are operating. The alternative of using quarterly or monthly data introduces the additional complication of requiring the treatment of seasonality.

One context in which these difficulties are bypassed is demography. Population dynamics are low-frequency and fully represented in annual data, and annual time series go back many decades. Furthermore demography models involve interesting dynamics. In some cases these models may be completely linear, so that the VAR/ECM models that would emerge from them would involve a clear correspondence between the parameters being estimated and those of the difference equations of the underlying demographic model.

One limitation of this framework is that demographic models generally do not involve optimization problems of the kind that typically interest economists. Nevertheless, even without an optimization problem, estimation of demographic VAR model would make an interesting essay or thesis topic.

Analysis could proceed by identifying the cointegrating relationships among demographic variable suggested by the relevant theory. A dynamic model would then embed these cointegrating relationships within an ECM.

For the mathematics of pure demography see Keyfitz and Caswell (2005); for a more applied/empirical/economic orientation see Lee (1997). For treatments of economic growth that give more than the usual amount of coverage to the role of population see Weil (2009) or, at a more advanced level, Galor (2011). Be aware that, because Galor's analysis embeds demographic factors within models of growth, his formulations involve household optimization; however they also lead to nonlinear models. For some discussion of VAR models in demographic research see Lee (1993, pp. 19–28). For relevant empirical studies see Bailey and Chambers (1993,1998), Hagnell (1991), Lee and Anderson (2002), Nicolini (2007), and interesting but as-yet unpublished work by Paul Sharp and coauthors (Google his name to locate his webpage, currently at the University of Southern Denmark).

Bailey, R.E., and M.J. Chambers (1993) "Long-term demographic interactions in precensus England," *Journal of the Royal Statistical Society A* 156, Part 3, 339–362.

Bailey, R.E., and M.J. Chambers (1998) "The impact of real wage and mortality fluctuations on fertility and nuptiality in precensus England," *Journal of Population Economics* 11, 413–434.

Galor, O. (2011) *Unified Growth Theory* (Princeton University Press).

Hagnell, M. (1991) "A multivariate time series analysis of fertility, adult mortality, nuptiality, and real wages in Sweden 1751–1850: A comparison of two approaches," *Journal of Official Statistics* 7, 437–455.

Keyfitz, N., and H. Caswell (2005) *Applied Mathematical Demography,* 3rd ed. (Springer).

Lee, R.D. (1993) "Inverse projection and demographic fluctuations: A critical assessment of new methods," in *Old and New Methods in Historical Demography,* ed. by D.S. Reher and R. Schofield (Oxford University Press).

Lee, R.D. (1997) "Population dynamics: Equilibrium, disequilibrium, and consequences of fluctuations," in the *Handbook of Population and Family Economics,* Vol. 1B, ed. by M.R. Rosenzweig and O. Stark (Elsevier).

Lee, R.D., and M. Anderson (2002) "Malthus in state space: Macro economic-demographic relations in English history, 1540–1870" *Journal of Population Economics* 15, 195–220.

Nicolini, E.A. (2007) "Was Malthus right? A VAR analysis of economic and demographic interactions in pre-industrial England," *European Review of Economic History* 11, 99–121.

Weil, D.N. (2009) *Economic Growth,* 2nd ed. (Addison-Wesley).

42. **Time series implications of the Beckerian demand for children**

Female fertility (the number of children born per woman) has important implications for many questions in development economics and demography. This includes one of the most remarkable facts of modern economic history, the so-called "fertility transition" from historical high birth rates to the modern low birth rates of most developed countries. Arguably, the survival of the planet depends on the underdeveloped world following this transition to low birth rates.

But what determines female fertility—the child-bearing choices of couples or, to put it in economic terms, the demand for children? According to Guinnane (2011, p. 596),

> Virtually all economic analysis of fertility today starts from Becker's model of the demand for children. Becker's insight was to analyze the demand for children using the tools of consumer choice. The model yields important insights for the fertility transition. Observers have long noted that fertility tends to be negatively correlated with income in the cross-section, and, since the beginning of the fertility transition, over time. Becker's model implies that this is a standard *substitution* effect, that children are not inferior goods: wealthier couples have higher opportunity costs of time, and time is a major cost of child-rearing. The simple version of Becker's model starts with a household utility function $U = U(n, \mathbf{Z})$, where n is the number of children and $\mathbf{Z}$ is a vector of all other commodities. The household maximizes this utility subject to a standard budget constraint. Increases in child costs induce substitution away from children and toward the $\mathbf{Z}$s. A pure increase in income raises the number of children demanded, as we expect. But if that higher income reflects rising wages, then that increased wage may show up as an opportunity cost of having children, and reduce the number of children demanded via the substitution effect.

Becker's hypothesis has potentially profound policy implications. If it is correct, the best way to hasten the fertility transition is to increase the opportunity cost of women's time. The best way to do this is to educate women, increasing their productivity in work outside the home. This hypothesis supports the advocacy of women's education in developing countries by Greg Mortenson in his popular books *Three Cups of Tea* and *Stones into Schools.*

Beckerian models of the demand for children have been estimated extensively with cross-section data. An interesting thesis would study their time-series implications using a dynamic demand system or VAR/ECM framework. What contribution can a time series analysis make to disentangling the income and substitution effects described by Guinnane? Chatterjee and Vogl (2018) is an example of an article that brings macroeconomic data to bear on some of these issues.

Chatterjee, S., and T. Vogl (2018) "Escaping Malthus: Economic growth and fertility change in the developing world," *American Economic Review* 108, 1440–1467.

Guinnane, T.W. (2011) "The historical fertility transition: A guide for economists," *Journal of Economic Literature* 49, 589–614.

43. **The New Demographic Transition**

In light of the above background, can time series methods be used to gain insights into the "new demographic transition" described by Eggleston and Fuchs (2012)?

Eggleston, K.N., and V.R. Fuchs (2012) "The new economic transition," *Journal of Economic Perspectives* 26, 138–156.

Time Series Analysis

44. **Multivariate generalization of the Beveridge-Nelson decomposition: common trends and cycles**

The Beveridge-Nelson decomposition shows that any I(1) series can be decomposed into a random walk plus stationary noise. The random walk is the permanent component, the stationary noise the transitory component.

There is a literature on generalizing this idea to multiple time series, in which case it becomes possible to formalize the notion of cointegrated series sharing common transitory (cyclical) behavior. A good starting point is the survey chapter by Vahid (2006). An essay/thesis could apply this methodology to some empirical problem. The next topic is an example.

Vahid, F. (2006) "Common cycles," in the *Palgrave Handbook of Econometrics,* vol. 1.

45. **Potential output and the natural rate of unemployment: a simple, logically consistent, model-independent framework for their joint estimation**

As one example of such an empirical problem, consider the concepts of potential output and the natural rate of unemployment. Both are important in macroeconomics, yet unobservable. They are related, in that potential output is usually defined to be the level of output that would be produced were unemployment at its natural rate.

A natural empirical definition of potential output is its long run trend. If GDP is modeled as I(1), this trend is given by the Beveridge-Nelson decomposition. To link this to the natural rate of unemployment, consider a trivariate cointegrating system relating GDP with the levels of unemployment and the labour force. A multivariate BN decomposition yields trend series predicted by the pure random walk components. The ratio of this trend unemployment to trend labour force yields a measure of the natural rate of unemployment.

How does such an approach compare with other methodologies for estimating potential output and the natural rate of unemployment? Is the implied relationship between the output gap and the natural rate of unemployment reinterpretable in terms of an Okun's law-type of relationship? How does this relate to New Keynesian Macroeconomic models, in which the output gap plays an important role? Is there a role for a state-space formulation, a framework that makes explicit provision for unobservable variables such as the natural rate of unemployment and potential output?

46. **Persistence**

The word *persistence* is widely-used but ill-defined in time series analysis. Many writers seem to use it loosely as a synonym for autocorrelation: for example Benati (2008), Campbell, Lo, and MacKinlay (1997), and Greene (textbook, various editions). Indeed, Fama (Nobel address published in AER, June 2014) defines *persistent* as "highly autocorrelated." But more extensive reading suggests that this is, at best, an incomplete definition. For example, Diebold and Rudebusch (1999, p. 14) (referenced on page 1 of these Suggestions) say that

"...fluctuations in economic activity exhibit *persistence*; deviations from the average or trend level of activity are maintained for considerable lengths of time ...," suggesting that there is more to the concept than mere autocorrelation.

A more careful definition seems to involve the notion of the permanence of the effect of a shock on a variable. In this terminology a random walk is an extreme case of persistence, because a shock permanently alters the trajectory of the series in the full amount of the shock. Stationary processes, on the other hand, would seem to be the other extreme of a complete absence of persistence, because a shock does not alter their trajectory permanently. This is despite the fact that stationary processes can have infinite memory. (A stationary AR(1) process has infinite memory, but the effect of a shock is transitory because in the long run the variable reverts to its mean.) Campbell and Mankiw (1987) and Cochrane (1988) are seminal analyses consistent with this understanding of the term.

For more recent book discussions, with references, see Section 4.2 of Mills and Markellos, *The Econometric Modelling of Financial Time Series,* 3rd ed., for which the McPherson library provides online electronic access. See also the use of the word in Gourieroux and Jasiak (2001) and Chap. 6 of Wang (2009).

A useful essay or thesis would survey alternative definitions of persistence, implementing these measures in illustrative empirical examples, and consider questions such as the following.

- How do definitions of persistence relate to the Beveridge-Nelson decomposition? Is there an analytical relationship between the Beveridge-Nelson decomposition and certain measures of persistence?

- How do definitions of persistence relate to the memory of a process? (A stochastic process can have no memory (as in an i.i.d. process), short memory (as in a moving average process), infinite memory (as in an autoregressive or unit root process), or long memory (fractionally integrated processes.)

- Consider a measure of temporal dependence in a stationary process, such as the half-life of a shock. Does such a measure, applied to the stationary component yielded by the Beveridge-Nelson decomposition, play a role in measures of persistence for the process as a whole?

Benati, L. (2008) "Investigating inflation persistence across monetary regimes," *Quarterly Journal of Economics.*

Campbell, J.Y., Lo, A.W., and A.C. MacKinlay (1997) *The Econometrics of Financial Markets* (Princeton University Press). `HG4523 C34`

Campbell, J.Y., and N.G. Mankiw (1987) "Are output fluctuations transitory?" *Quarterly Journal of Economics.*

Cochrane, J.H. (1988) "How big is the random walk in GNP," *Journal of Political Economy* 96, 893–920.

Cochrane, J.H. (1994) "Permanent and transitory components of GNP and stock prices," *Quarterly Journal of Economics.*

Gourieroux, C., and J. Jasiak(2001) *Financial Econometrics: Problems, Models, and Methods* (Princeton University Press) `HB139 G68`

Hansen, P.R., and A. Lunde (2010) "Estimating the persistence and the autocorrelation function of a time series that is measured with error," Working paper.

Kapetanios, G. (2007) "Measuring conditional persistence in nonlinear time series," *Oxford Bulletin of Economics and Statistics* 69, 363–385.

Wang, P. (2009) "Shock persistence and impulse response analysis," Chap. 6 in *Financial Econometrics,* 2nd ed. (Routledge).

Demand Analysis

The best introduction to econometric demand analysis is Chapter 9 of E.R. Berndt (1991) *The Practice of Econometrics: Classic and Contemporary.* `HB139 B47` If you are interested in this area you should begin by doing the exericises at the end of that chapter.

47. **Invariant GMM estimation of singular systems**

Demand systems like the translog and AIDS are singular systems; the usual means of resolving this is by dropping one equation. It is important, however, that the estimation results be invariant to which equation is dropped. When a demand system is estimated by iterative GLS, maximum likelihood estimators are obtained and Barten's 1969 invariance theorem applies so we can be confident that the choice of dropped equation is irrelevant. Once one turns to instrumental variables estimators, however, things get trickier, and one must be careful to implement the estimator in such a way (typically, iteratively) as to ensure invariance.

When demand systems are estimated by GMM, what invariance theorems apply? How must GMM be implemented for them to hold?

A natural empirical application to use is Berndt and Christensen (1973, *Journal of Econometrics*). Their data are fully published and citable; their 3SLS estimation results are replicable; their sample size is large enough, and the system small enough, to avoid the singularity problem that afflicts GMM estimation of, for example, the better-known Berndt-Wood translog factor demands.

48. **Dynamic factor or labour demands**

A large literature extends the estimation of static demand systems (both consumer and factor demands) to a dynamic setting. For a seminal contribution to consumer demands see Attfield (1997); for a survey of factor demands, see Nadiri and Prucha (2001). In the most interesting formulations, such as Attfield's, the static system is viewed as the long-run cointegrating relationship between the variables, which is embedded within an ECM that captures the short-run dynamics. Factor demands are especially rich in their theoretical structure because they can be derived explicitly from dynamic optimization problems; quadratic adjustment costs yield linear dynamic demands, so that the VAR/ECM is linked directly to theory rather than merely being posited. The intertemporal Euler conditions are directly interpretable in terms of the parameters of the VAR/ECM. An essay/thesis could construct a suitable demand data set and apply this methodology.

One practical problem with empirical dynamic factor demand systems is that factor market price/quantity data are normally observed only quarterly or annually. (It is in the nature of factors of production like capital, energy, and materials that data are generally not collected as often as monthly.) For at least some factors, dynamic adjustments by firms probably occur more rapidly than quarterly. Dynamic factor demands estimated with quarterly, and especially annual, data are therefore unlikely to correctly capture temporal behaviour accurately.

An interesting exception to this is labour market data, which is often collected monthly. In a classic article (using quarterly data) Sargent (1978) showed that quadratic adjustment costs yield linear labour demands that can be estimated as a vector autoregressive system. For a survey that sets Sargent's analysis within the broader literature on employment adjustment see Chapter 9 of Adda and Cooper (2003). For a broader introduction to the general topic of dynamic labor demand see Part Two of Hamermesh (1993) and Stephen Nickell's chapter on "Dynamic models of labour demand" in the *Handbook of Labour Economics* (`HD4802 H36`).

Sargent's contribution pre-dated the Granger representation theorem, which establishes that VAR's always have an error correction representation in which cointegrating restrictions add useful structure. A useful thesis could pursue some aspect of this literature, perhaps estimating an ECM for dynamic labour demands, exploiting the availability of monthly labour data.

The existing literature on dynamic labour demand systems decomposes labour in a number of ways: part-time versus full-time (Friesen, 1997), straight-time versus overtime (Sargent,

1978), white collar versus blue collar (Palm and Pfann, 1990), skilled versus unskilled (Falk and Koebel, 2001), production versus non-production (Pfann and Palm, 1993), etc. An essay/thesis in this area would have to focus on an appropriate decomposition. For an MA essay or thesis even a single-equation study using a single labour aggregate and the methodology surveyed in Nickell's chapter would be acceptable.

Attfield, C.L.F. (1997) "Estimating a cointegrating demand system," *European Economic Review* 41, 61–73.

Engsted, T., and N. Haldrup (1994) "The linear quadratic adjustment cost model and the demand for labour," *Journal of Applied Econometrics,* 9 (Supplement), S145-S159.

Falk, M. and B. Koebel (2001) "A dynamic heterogeneous labour demand model for German manufacturing," *Applied Economics* 33, 339–348.

Friesen, J. (1997) "The dynamic demand for part-time and full-time labour," *Economica* 64, 495–507.

Hamermesh, D. (1993) *Labor Demand* (Princeton University Press). `HD5706 H36`

Kim, H.Y., and J. Lee (2001) "Quasi-fixed inputs and long-run equilibrium in production: A cointegration analysis," *Journal of Applied Econometrics* 16, 41–57.

Manera, M. (2006) "Modeling factor demands with SEM and VAR: An empirical comparison," *Journal of Productivity Analysis* 26, 121–146.

Nadiri, M.I., and I. Prucha (2001) "Dynamic factor demands and productivity analysis," in *New Developments in Productivity Analysis,* ed. by C.R. Hulten, E.R. Dean, and M.J. Harper (University of Chicago Press for the NBER). `www.nber.org/chapters/c10125`

Palm, F.C., and G.A. Pfann (1990) "Interrelated demand rational expectations models for two types of labour," *Oxford Bulletin of Economics and Statistics* 52, 45–507.

Pfann, G.A., and F.C. Palm (1993) "Asymmetric adjustment costs in non-linear labour demand models for the Netherlands and U.K. manufacturing sectors," *Review of Economic Studies* 60, 397–412.

Sargent, T. (1978) "Estimation of dynamic labor demand schedules under rational expectations," *Journal of Political Economy* 86, 1009–1044.

49. **Dynamic demand and supply for beef, chicken, and pork**

Many data sets used in applied demand analysis—both consumer and factor demands—have the deficiency that consistent time series are only available over modest time spans. With just 20 or 25 annual observations—a typical factor demand data set—the prospect for adequate dynamic modeling is limited.

An interesting exception is a U.S. price-quantity data set for beef, chicken, and pork, consistent annual series for which seem to be available from around 1950. These series have been used by a number of authors over the years. Eales and Unnevehr (1988,1993,1994) use them to study the interrelated consumer demand for these products, while Epple and McCallum (2006) use the chicken series for a simultaneous equations analysis of supply and demand. For the versions of these series used in 1964 work by the early demand analyst Frederick Waugh, including additional series for lamb and veal, see Maddala (2001) *Introduction to Econometrics,* 3rd ed., Sec. 8.4. However no authors seem to have exploited the potential these data offer for application of dynamic demand methodology such as that of Attfield (1997), possibly with a simultaneous analysis of supply.

Any study of these series should begin by determining whether they may be available at a higher frequency than annual (say, quarterly or monthly), so that there is some prospect of modeling shorter-run dynamic effects.

Attfield, C.L.F. (1997) "Estimating a cointegrating demand system," *European Economic Review* 41, 61–73.

Brumm, H.J., Epple, D., and B.T. McCallum (2008) "Simultaneous equation econometrics: Some weak-instrument and time-series issues," Working Paper, Carnegie-Mellon University.

Eales, J.S., and L.J. Unnevehr (1988) "Demand for beef and chicken products: Separability and structural change," *American Journal of Agricultural Economics* 70, 521–532.

Eales, J.S., and L.J. Unnevehr (1993) "Simultaneity and structural change in U.S. meat demand," *American Journal of Agricultural Economics* 75, 259–268.

Eales, J.S., and L.J. Unnevehr (1994) "The inverse almost ideal demand system," *European Economic Review* 38, 101–115.

Epple, D., and B.T. McCallum (2006) "Simultaneous equation econometrics: The missing example," *Economic Inquiry* 44, 374–384.

Fox, K.A. (1968) *Intermediate Economic Statistics* (Wiley).

Supply Analysis

50. **Canadian housing supply**

The Centre for Urban Economics and Real Estate in the UBC Sauder School of Business has compiled an impressive set of housing-related data for the major Canadian cities: Google sauder real estate data to find it. The data is quarterly beginning around 1974, and so offers the potential to distinguish between short- and long-run supply elasticities, among other phenomena. Much work of this sort has been done with US data, but the Sauder data seems underexploited in this respect. For one example of a US study that might be repeated with the Canadian data, see Head, Lloyd-Ellis, and Sun (2014). You should also Google the working paper by Wheaton, Chervachidze, and Nechayev (2014) "Error correction models of MSA housing "supply" elasticities: Implications for price recovery." This paper has a useful literature review and bibliography.

As that bibliography indicates, there are several types of empirical supply models that could be estimated, depending on your theoretical and econometric interests and abilities. A strong student (possibly for a PhD thesis) might apply the Hansen-Sargent (2014) methodology to the Topel-Rosen (1988) model, as mentioned in the opening passage of this document.

Another approach would be to study the extent to which particular city price indexes (for example, Vancouver) can be usefully interpreted within the framework of Knoll, Schularick, and Steger (2017).

Head, A., Lloyd-Ellis, H., and H. Sun (2014) "Search, liquidity, and the dynamics of house prices and construction," *American Economic Review* 104, 1172–1210.

Head, A., and H. Lloyd-Ellis (2016) "Has Canadian house price growth been excessive?" *Canadian Journal of Economics* 49, 1367–1400.

Knoll, K., Schularick, M., and T. Steger (2017) "No price like home: Global house prices, 1870–2012," *American Economic Review* 107, 331–353.

51. **Agricultural supply**

The study of agricultural supply has a long history in economics, with particular interest in dynamic phenomena such as cobweb cycles. See the discussion in the Hansen-Sargent book (listed on the opening page of this document) of the literature related to the following article.

Rosen, S., Murphy, K., and J. Scheinkman (1994) "Cattle cycles," *Journal of Political Economy* 102, 468–492.

Sports Economics

In recent years sports economics has emerged as a coherent field within economics, although it remains on the periphery of the discipline. There are at least two journals devoted to the field (the *Journal of Sports Economics* and the online *Journal of Quantitative Analysis in Sport*) and several textbooks; also a number of edited volumes that seek to encompass the contemporary state of research, such as the recent *Oxford Handbook of Sports Economics.* The field is a potentially fruitful one for student research because of the amount of data that is available, and because some students have a personal interest in sports.

However most of the relevant economic analysis is microeconomic, and so I am not particularly interested in supervising research in this area. The following idea is one for which I might be willing to make an exception.

52. **Empirical trade analysis applied to sports data**

    Empirical research on international trade typically involves data with a very particular structure: the data are available on n countries that trade with one another, so that there are $n(n-1)$ bilateral trading relationships among country pairs, with the same number of real and nominal exchange rates, and so on. This cross-sectional data structure is observed over time, so that the data are pooled—in fact, longitudinal, because the same countries are tracked over time, although the panels may be unbalanced in either or both of the time-series and cross-section dimensions. Thus all the usual issues and tools of longitudinal data analysis come into play. See Leamer (2007) for one attempt to survey the relevant econometrics.

    Now consider sports data. Although a number variations exist in the literature, one common data structure is to have observations on n teams that compete with one another in $n(n-1)$ bilateral relationships. This cross-sectional data structure is observed over the seasons, so that once again the data are longitudinal.

    Given the obvious analogy in data structures, can methods in empirical trade be fruitfully applied to gain novel insights into sports data?

    Leamer, E. (2007) "Linking the theory with the data: That is the core problem of international economics," Chap. 67 of the *Handbook of Econometrics,* vol. 6A (Elsevier).

Econometrics

53. **The Log of Gravity**

    One of the most heavily downloaded and cited articles from the *Review of Economics and Statistics* is the 2006 contribution by Santos Silva and Tenreyro (SST). They argue that the estimation of Cobb-Douglas functional forms, such as the so-called gravity equations of empirical trade, as loglinear regressions induces a correlation between the disturbance and the regressors that renders the elasticity estimates inconsistent. To address this inconsistency they propose a Poisson pseudo-maximum likelihood (PPML) estimator, which has been implemented in both R and Stata.

    For a more recent assessment see Sec. 5.1 of the survey chapter by Head and Mayer (2014). SST maintain a website devoted to this literature: Google log of gravity page to find it.

    As SST (p. 641) remark,

    > Despite the focus on the gravity equation, our criticism of the conventional practice and the solution we propose extend to a broad range of economic applications where the equations under study are log-linearized, or, more generally, transformed by a nonlinear function. A short list of examples includes the estimation of Mincerian equations for wages, production functions, and Euler equations, which are typically estimated in logarithms.

An essay/thesis could apply the PPML estimator to one such example and compare the results with conventional findings. Topic 5 above suggests this for Euler equations.

Head, K., and T. Mayer (2014) "Gravity equations: Workhorse, toolkit, and cookbook," in the *Handbook of International Economics,* vol. 4 (Elsevier).

Santos Silva, J.M.C., and S. Tenreyro (2006) "The log of gravity," *Review of Economics and Statistics* 88, 641–658.

Miscellaneous

54. **Gibrat's, Pareto's, and Zipf's laws: comparative empirical implications**

The Pareto distribution and related "laws" arise in many areas of economics, and so potentially provide the basis for a range of essay/thesis topics. For an introduction see Gabaix (2016); Aoki and Nirei (2017) and Balthrop (2021) are examples of recent applications.

Aoki, S., and M. Nirei (2017) "Zipf's law, Pareto's law, and the evolution of top incomes in the United States," *American Economic Journal: Macroeconomics* 9, 36–71.

Balthrop, A.T. (2021) "Gibrat's law in the trucking industry," *Empirical Economics* 61, 339–354.

Gabaix, X. (2016) "Power laws in economics: An introduction," *Journal of Economic Perspectives* 30, 285–206.