EC 7087 Econometric Theory, 2011: A Summary of the Course

1. We began by considering the formula for the conditional expectation of a variable y, given the value of an associated variable x, under the assumption that these have a bivariate normal distribution. This is a linear function of x. Within the context of a multivariate normal distribution of a vector $z = [y', x']'$, we found the expression for $E(y|x)$, which we have used at the end of the course in developing linear filters.

2. Next, we considered, in some detail, the classical linear regression model $(y; X\beta, \sigma^2 I)$. In particular, we derived the formulae for the estimators of the sub vectors β_1, β_2 within the partitioned version $(y; X_1\beta_1 + X_2\beta_2, \sigma^2 I)$ of this model. It was straightforward to specialise these formulae to encompass the regression model with an intercept term, and we saw how the slope parameters could be estimated by taking the data in deviation form. We also considered the consequences of omitting some of the variables comprised by the regression relationship in the course of estimating the parameters.

3. We also developed a theory of hypothesis testing within the context of the the normal regression model $N(y; X\beta, \sigma^2 I)$. We took a geometric approach in demonstrating the decomposition of a chi-square variate, which led to a proof of Cochrane's theorem. This enabled us to construct an F test for an hypothesis relating to β.

4. I have also been keen to teach the rudiments of time-series analysis. The document titled *Filtering Macroeconomic Data* contains some of the basic theory. In particular, it contains an analysis of transfer functions. It shows how to perform the power-series expansion of a rational transfer function and it uses the partial-fraction decomposition of the function to reveal its dynamic implications.

5. I have placed considerable emphasis on the frequency composition of time series generated by stationary stochastic processes, which is the spectral analysis of time series. We analysed in detail the frequency composition of a finite sequence, which is revealed by its periodogram. It was essential to understand that the periodogram can be derived, equally, by regressing the data on the trigonometrical functions at the Fourier frequencies or by applying a cosine Fourier transform to the sequence of empirical autocovariances.

6. We have used our understanding of the frequency domain to assist our interpretation of linear filters. In econometrics, we have to adapt the theory of linear filtering to cope with short trended sequences. Econometricians appear to be fixated on the so-called Hodrick–Prescott filter, which is inadequate for most of their purposes. Nevertheless, we took care to derive it from first principles, and we were able to analyse its deficiencies. There are other filters that we can use more effectively.