Handout #1: Characteristics of macroeconomic and financial data

In this handout, we present time series plots for various macroeconomic and financial data series. These plots highlight some of the key properties of such series and motivate the topics covered in the course. The plots are contained in a separate appendix.

(i) Seasonality in macroeconomic data:
Figures 1 and 2 present quarterly US GDP and US consumption; these are the jagged lines on these figures. One striking feature is that the series exhibit a regular pattern reflecting the quarter: Q1 is low, Q2 higher, Q3 is lower and Q4 is the highest. This feature is known as seasonality.

In many cases, the presence of seasonality is nuisance because it complicates comparisons from quarter to quarter. For this reason, it is customary for statistical agencies to seasonally adjust data. In practice, seasonal adjustment involves passing the series through a filter that is designed to remove the seasonal part. This yields what is referred to as seasonally adjusted data. The seasonally adjusted series for GDP and consumption are also presented in Figures 1 and 2. As you can see, they are much smoother. Given the prevalence of seasonal adjustment, the raw data series is commonly referred to as (seasonally) unadjusted.

(ii) Trends in macroeconomic data:
Notice that both the adjusted and unadjusted data for GDP and consumption trend upwards over time over this ten year or so span in the 1990’s. In fact, these series have trended upwards over a far longer period. For example, Figure 3 shows plots of annual, quarterly and monthly consumption over a far longer period; note only the annual series goes back to 1930; the monthly and quarterly series begin in 1959 and 1947 respectively. The upward trend is clear. Various time series models can be used to capture the evolution of trending data. Two such models have received considerable attention in econometrics: deterministic trend models and stochastic trend models. The latter involves so called unit root processes. These two models have some similarities and some very important differences that has prompted considerable debate about which is the most appropriate for macroeconomic data.

(iii) Temporal aggregation:
Monthly, quarterly and annual consumption represent information on the same variable at different frequency and so are related. The monthly and quarterly figures are annualized to put them on a comparable scale to the annual figures; i.e. the plotted figure for quarterly GDP is 4 times the actual figure.

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comparable scale to the annual figures; i.e. the plotted figure for quarterly GDP is 4 times the actual figure. Specifically, quarterly consumption is the aggregate of the consumption in the months corresponding to that quarter. Likewise, annual consumption is the aggregate of consumption from the four quarters of that year. This temporal aggregation has effects on the time series properties of the data. While all three series seem to follow the same trend (as would be expected), a closer inspection shows there are some interesting differences. In Figure 4, these series are plotted over a shorter span. It can be seen that the monthly series exhibits the most variation and the annual series is the most smooth. In other words, the time series properties are sensitive to the level of temporal aggregation.

(iv) Financial time series and volatility modelling:
Figure 5 plots the daily exchange rate between the US$ and UK£ over a period that spans the mid-'70's to mid-'80's. This series exhibits the "classic" behaviour of a random walk, that is a series whose expectation today of its value tomorrow is just its value today. Under the random walk model, the first difference has a zero expectation. Figure 6 plots the first differences of this series and it is clear that these first differences fluctuate about zero. However, this plot also reveals that there is a temporal clustering in the absolute size of the deviations from zero: large deviations tend to be followed by large deviations. In other words the conditional variance - or volatility - of the series is time varying. These patterns of behaviour for both the level and first differences are common to many financial time series. This has led to considerable interest in developing models for time varying volatility, the leading example of which is the autoregressive conditional heteroscedasticity (ARCH) model.

(v) Nonstationary series that move together over time:
Both the macro and financial series exhibit the time paths of non-stationary time series in the sense they do not fluctuate about a particular value. Economic theory suggests that many variables should nevertheless move together. As an example, consider the forward and spot exchange rate. The forward exchange rate between the US$ and UK£ is plotted in Figure 7 and its first difference is plotted in Figure 8. Both the forward and spot rate exhibit random walk behaviour; however, as Figure 9 demonstrates the two series move very closely together. Figure 10 reiterates this point by plotting the two series against each other, and as can be see all point are very close to the 45° line. Two random walk (or more generally unit root) processes that move together are said to be cointegrated.
Figure 1: GDP: Unadjusted VS. Seasonally Adjusted

Source: Bureau of Economic Analysis
Figure 2: Consumption (Non-Durables): Unadjusted VS. Seasonally Adjusted

Source: Bureau of Economic Analysis
Figure 3: Annual, Quarterly and Monthly Data on Consumption
Figure 4: Annual, Quarterly and Monthly Data on Consumption
Figure 5: Spot Exchange Rate: USD vs. UK Pound
Figure 6: First Differences of Spot Exchange Rate: USD vs. UK Pound
Figure 7: Forward Exchange Rate: USD vs. UK Pound
Figure 8: First Differences of Forward Exchange Rate: USD vs. UK Pound
Figure 9: Forward and Spot Exchange Rate: USD vs. UK Pound

Source: Data Resources Incorporated
Figure 10: Forward VS Spot Exchange Rate: USD vs. UK Pound

Source: Data Resources Incorporated