The Digital Economist

Lecture 2 -- Measures of Economic Activity

In order to perform macroeconomic analysis in support of economic policy, it is necessary to collect data over time on key economic variables related to income, employment of resources, price levels, and other indicators of the direction of the business cycle. This collection and analysis of data is called National Income Accounting and represents the tools and methods by which economists and policy-makers measure economic activity and economic growth over time.

NATIONAL INCOME ACCOUNTING -- GDP

There are two types of economic variables used in our analysis: **flow variables**--economic activity measured per unit of time and **stock variables**--measures of economic activity at a point in time. For example:

Flow Variables

- Income (Household, Per-Capita, National)
- Budget Deficits
- Investment Expenditure
- Consumption Expenditure
- Any Income Statement measures (Sales Revenue, Gross Profit, Expenses)

Stock Variables

- Wealth (an accumulation of Savings over time)
- Debt (an accumulation of borrowing over time)
- Capital Stock (Factories, Machinery, Inventory, Infrastructure)
- The Money Supply
- Any Balance Sheet measures (Assets, Liabilities, Owner's Equity)

Typically most of the common, although not all, measures of economic activity are flow variables. It is important to note that in order to interpret the magnitude of any flow variable, a corresponding time period must be attached (i.e., consumption spending per month, quarter, or year).

The evaluation of economic activity is really about measures of output or changes in output in a given period of time. The expectation is that any past additions to the wealth of a nation, whether it be physical capital or human capital, will lead to growth in current output. These output measures, when stated on a per-capita basis (output per person) can be interpreted as a measure of regional or national **Standard of Living**. (SoL) If the

growth rate in output exceeds the growth rate in population then living standards are assumed to be rising

SoL = Output per Capita = Output / Population

such that if:

%ΔOutput > %ΔPopulation,

then,

SoL ↑.

There are difficulties in the attempt to measure output in the aggregate. It is impossible to add different quantities of goods and services, with different units of measure, together as a single aggregate measure. The quantity of autos produced added to the quantity of apples and quantity of houses gives a meaningless measure:

$$Q_{autos} + Q_{apples} + ... + Q_{houses} + ... + Q_n = \Sigma Q_i = ???$$

To overcome this problem of aggregation, economists transform the above sum to a common unit of measure in currency terms. This is accomplished by pre-multiplying each item by its current market price 'Pi '. Thus, instead of adding individual quantities together, economists sum the **expenditure** for each i^{th} good together:

$$P_{autos}Q_{autos} + ... + P_{houses}Q_{houses} + ... + P_nQ_n = \Sigma P_iQ_i$$

$$= \textbf{Aggregate Expenditure}$$

As will be seen below, the use of market prices and expenditure measures to evaluate economic activity causes other problems in attempts to accurately measure growth in a nation's output over time.

The topic of National Income Accounting begins with the use of two methods to determine this measure of aggregate expenditure:

- directly via the expenditure approach (through spending on final goods and services) or
- indirectly via the compensation approach (through payments made to the factors of production in producing goods and services).

The **Expenditure Approach** involves collecting data on the major components of spending in a given time period. This spending is in the form of consumption expenditure 'C', investment expenditure 'I', government expenditure 'G', and net-export expenditure 'NX'.

When added together these four forms of spending make up what is known as the Gross Domestic Product or GDP for a given economy:

$$C + I + G + NX = \Sigma P_i Q_i = \mathbf{GDP}$$

Formally defined, **GDP** represents a measure of *the market value of all final goods and services produced and purchased in a given year*. In the table below, data are provided for the time period 1960-2000 (in billions of $):

Table 1, Expenditure Categories

Year	Consumption Expenditure	Investment Expenditure	Government Expenditure	Net Export Expenditure	Nominal GDP
1960	332.3	78.9	113.8	2.4	527.4
1965	444.3	118.2	153.7	3.9	720.1
1970	648.9	152.4	237.1	1.2	1039.6
1975	1030.3	230.2	361.1	13.6	1635.2
1980	1762.9	477.9	569.7	-14.9	2795.6
1985	2712.6	736.3	878.3	-114.2	4213.0
1990	3831.5	861.7	1181.4	-71.4	5803.2
1995	4969.0	1143.8	1372.0	-84.3	7400.5
2000	6728.4	1767.5	1741.0	-364	9872.9

Source: Economic Report of the President 2002

The **Compensation Approach** involves measuring the amount of compensation paid to the various factors of production (land, labor, capital, entrepreneurship) used as inputs in the production process. For example in 2000 (est.):

Table 2, Income Categories

Category		**Amount**	**(%)**
Compensation of Employees (labor)		$5715.2	(71.6%)
Proprietor's Income (entrepreneurship)		715.0	(9.0%)
Corporate Profits (capital)		876.4	(11.0%)
Net Interest (capital)		532.7	(6.7)
Gross Rental Income	202.5		
less depreciation expense	-61.0		
Net Rental Income (land)		141.6	(1.8%)
National Income		**$7980.9**	**(100%)**

Source: Economic Report of the President 2002

Note that about three-quarters of **National Income** represents the return to labor and the remaining one-quarter is known as the return to capital. Historically, the percentage of

national income allocated between labor and the other factors of production has remained relatively constant over the past century.

The difference between gross domestic product and national income ($1,892.00) is due to **depreciation expense**, **indirect business taxes** (sales and excise taxes), and business transfers to individuals (through donations to the United Way and the like). For example, some of the payments (expenditure) to capital and land are made to cover the consumption of capital and equipment (to allow for wear and tear on the equipment). However, these payments are not received directly by the owners of capital and land in that they must allow for eventual replacement of these items. In the case of indirect business taxes, expenditure on some items like gasoline, liquor, and telephone calls, include the provision for a per-unit tax in the price of these items. These per-unit or excise taxes are transferred to some government agency and do not represent direct compensation to the owners of factor inputs.

One goal of national income accounting is to measure growth in these income measures over time. Both the gross national product and national income measures are used to determine the rate of overall economic growth. However, the interest is with growth in output, not necessarily growth in expenditure.

Given that aggregate measures include both quantities and prices, changes in expenditure might come about either due to true changes in output, changing prices or both! As stated above, Gross Domestic Product represents the market value of all final goods and services produced. In an inflationary environment (one where the absolute price level in increasing) these market values will also increase and thus lead to an overstatement of the true rate of economic growth.

Any economic dollar variable may be expressed either in measured nominal terms (not adjusted for changes in the price level) or in real terms (calculated using constant prices). **Nominal GDP** (**NGDP**) may be expressed using the aggregate expression from above:

$$\mathbf{NGDP} = \Sigma P_{i,t} Q_{i,t}$$

In contrast **Real GDP** (**RGDP**) is calculated using the same composition of goods and services $Q_{i,t}$ evaluated at base-period (constant) prices $P_{i,o}$:

$$\mathbf{RGDP} = \Sigma P_{i,o} Q_{i,t}$$

Measures of economic growth are measured by calculating the percentage change in real GDP (or in terms of output growth since the price term is held constant).

$$\mathbf{Growth\ Rate} = \%\Delta(RGDP)$$

$$= \frac{(RGDP_t - RGDP_{t-1})}{RGDP_{t-1}}$$

A comparison of nominal and real growth rates for GDP in the U.S. are given in the table below (note: the Implicit GDP Deflator is calculated as the ratio of NGDP and RGDP):

Table 3, Economic Growth

Year	Nominal GDP	Real GDP	Growth Rate (%)	Implicit GDP Deflator
1990	5803.2	6707.9	1.8	0.87
1991*	5986.2	6676.4	-0.5	0.90
1992	6318.9	6880.0	3 0	0.92
1993	6642.3	7062.6	2.7	0.94
1994	7054.3	7347.7	4.0	0.96
1995	7400.5	7543.8	2.7	0.98
1996	7813.2	7813.2	3.6	1.00
1997	8318.4	8159.5	4.4	1.02
1998	8781.5	8508.9	4.3	1.03
1999	9268.6	8856.5	4.1	1.05
2000	9872.9	9224.0	4.1	1.07

**Recession years*

Source: Economic Report of the President 2002

As can be seen in the above numbers, what appears to be robust economic growth (6% per year in NGDP) may be largely due to inflation and corresponding change in market values. Over the past twelve years in real terms GDP in the U.S. has been growing on average by 2.5 to 3.0 percent annually.

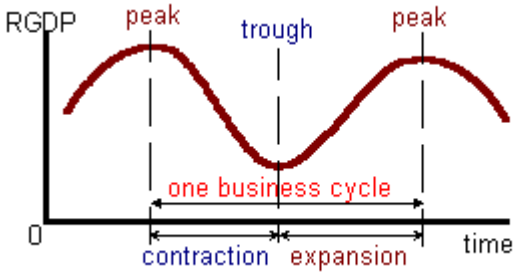
See: The Digital Economist: http://www.digitaleconomist.com/econ_data.html
for annual updates to the data.

REAL GDP AND BUSINESS CYCLES

Business cycles are recurring changes in the level of business and economic activity over time. This business activity is measured via measures of Real Income specifically Real GDP. Quite often these cycles occur because spending in the economy (as measured by RGDP) differs from the ability of the economy to produce goods and services. A prolonged period of growth in spending that exceeds the growth rate in output will lead to tight factor markets. The economy may transition into a period of decline (recession) simply because the current rate of spending cannot continue.

One business cycle is defined as a period of economic decline or a **contraction** followed by a longer **expansion**ary period.

Figure 1, A Business Cycle



These cycles occur at regular intervals in a market economy as the rate of real economic growth exceeds the growth in the potential of the economy to produce goods and services. As resource limits are reached in an expansion credit is restrained, the cost of borrowing increases, and resource prices begin to rise. All of these factors put a squeeze on the profit margins of business firms that often leads to a curtailment of business activity.

Recessions may also occur or be prolonged as consumers and producers become more pessimistic about future economic events. This pessimism may lead to a decline in both consumption and investment spending resulting in an increase in inventory levels. Businesses respond to this unanticipated increase in inventory through cutbacks in production the corresponding layoffs of workers.

Business cycles are characterized by expansions or continued increases in Real GDP followed by contractions or a decline in Real GDP. These contractions or recessions are officially defined as two or more quarters of negative growth in Real GDP. A full business cycle is measured from the peak of one cycle to the peak of the following cycle .

A History of Business Cycles
Since World War II, most business cycles would last 3-5 years peak-to-peak. The average duration of an expansion was 44.8 months and the average duration of a recession has been 11 months. As a comparison, during the Great Depression which saw a decline in economic activity between 1929 and 1933, lasted 43 months peak-to-trough.

Post War (WWII) Recessions
Time Period, (length) -- Reason

1945-1945 (8 months) -- Post W.W.II transitions
1948-1949 (11 months) -- Inter-war adjustments.
1953-1954 (10 months) -- Transition from the Korean War
1957-1958 (8 months) -- Ike's Rolling Readjustment
1973-1975 (16 months) -- Oil price shocks, breakdown of the Bretton-Woods fixed exchange-rate regime, and perhaps the end of the Viet Nam War.
1980-1980 (6 months) -- Second oil price shock and the "Energy Crisis"
1981-1982 (16 months) -- Recession induced in part by the Federal Reserve's reaction to the buildup of inflationary expectations of the 1970's
1990-1991 (9 months) -- End of a long peacetime expansion and perhaps induced by the burden of debt accumulated in the 1980's and triggered by the Gulf War.
March 2001 - Mid 2002 -- End of the 'Irrational Exuberance' in financial markets that emerged in the late 1990's and a built up of excess capacity in the telecommunications sector.

UNEMPLOYMENT

Over time labor markets are impacted in the long run by demographics, changes in productivity and the rate of growth in potential output. In the short run these markets will reflect volatility in the level of economic activity -- imbalances between the ability to spend and the ability to produce. In order to fully understand the employment picture we need to make use of two separate measures. One is the **Unemployment Rate** represents the ratio of those actively seeking work and the total number of people in the labor force. The other is the **Labor Force Participation Rat**e which is a reflection of those entering or leaving the civilian labor force. The following table aids in the understanding of how these values are computed.

Table 4, Measures of Employment and Unemployment.(thousands)

Category	**1990**	**1995**	**2000**
A. U.S. Population:	249,973	263,082	275,372
B.less those not available for work (students, children, institutional population):	60,809	64,498	65,673
C. The Number of People available to the labor force:	189,164	263,082	209,699
D. less those not working (retired persons, home caretakers...):	63,324	66,280	68,836
E. The Labor Force:	125,840	132,304	140,863
F. less those currently seeking work (the unemployed):	7,049	7,404	5,655
G. Anyone working for pay in a given survey week (the employed):	118,793	124,900	135,208

Source: Economic Report of the President 2002

Calculating the above-mentioned common ratios:

	1990	1995	2000
(E)/(C) = the Labor Force Participation Rate:	66.4%	66.6%	67.2%
(F)/(G) = the Unemployment Rate:	5.6%	5.6%	4.0%

we find that over the past decade the Labor Force Participation Rate has been increase. This has been true since the early 1950's when labor force participation rates stood at roughly 50%. As the baby-boom cohort approaches retirement over the next 20 years, this particular rate is expected to decline. Also over the past decade, the Unemployment Rate has bee decreasing largely due to the strong economic growth since the recession of 1990-91. As of this writing the unemployment rate has increased to 6.0% has since been declining to the 5.6-5.7 range as the U.S. economy passes through the recession of 2001-02.

Types of Unemployment

Frictional Unemployment represents those individuals that have left one job but are certain to begin their new job within a relatively short period of time. Often this type of unemployment accounts for those in-between jobs and is the result of individuals responding to market forces in the economy.

Structural Unemployment exists when broad structural changes are taking place in an economy such that certain job categories or skills are eliminated from labor markets. These changes may be the result of technological change, changes in tastes or preferences for particular goods, changes in the regulatory environment with respect to certain products (pharmaceuticals, tobacco, pesticides), or changes in any barriers to trade. Structural unemployment tends to be a long term phenomenon addresses by education and new training of those who are structurally unemployed.

Cyclical Unemployment occurs when individuals suffer job losses due to changes in the economic (business) cycle. Often as growth in economic activity reaches its peak and begins transition to a contraction, employers will begin to curtail production, to avoid additions to accumulating inventories, and thus begin to furlough a fraction of their workforce. In the rebounding period, from contraction to expansion, the opposite occurs as employers add employees to their payrolls and increase the rate of production.

Table 5, Labor Force Data

Year	Unemployment Rate	Labor Force Part. Rate	Earnings (1982 dollars)	Productivity (1992=100.0)
1990	5.6	66.5	259.5	95.2
1991	6.8	66.2	255.4	96.3
1992	7.5	66.4	255.0	100.0
1993	6.9	66.3	254.9	100.5
1994	6.1	66.3	256.7	101.9
1995	5.6	66.6	255.1	102.6
1996	5.4	66.6	255.7	105.4
1997	4.9	66.8	261.3	107.8
1998	4.5	67.1	268.3	110.7
1999	4.2	67.1	271.3	113.4
2000	4.0	67.2	272.2	117.3
2001	4.8	66.9	273.6	119.6

Source: Economic Report of the President 2002

The Natural Rate of Unemployment
The natural rate of unemployment is that rate where there is neither upward pressure nor downward pressure on the price level. If the actual rate of unemployment is below this natural rate, then labor markets are fairly tight making it difficult for firms to hire new workers. The quickest way to meet these hiring needs is to offer higher wages to either bid employees from other firms or to induce new workers to enter the labor force. However, since wages are a significant proportion of production costs, these costs will tend to rise putting upward pressure on output prices as firms attempt to protect profit margins. If the actual rate of unemployment is above the natural rate indicating a slack labor market, this pressure on wages does not exist.

INFLATION AND INFLATIONARY EXPECTATIONS

Inflation (or **Deflation**) is a macroeconomic concept referring to an increase (decrease) in the absolute price level over some defined time period. An increase in the price of all goods has the effect of reducing the purchasing power of money and money incomes and thus must be taken into account when planning future economic activity.
Inflation is difficult to measure because it represents the percentage change over time of a nonexistent economic variable--the price level 'P_t'.

$$\%\Delta P_t = (P_t - P_{t-1})/P_{t-1}$$

Unlike GDP or other national income measures, no single observable measure exists to represent the aggregate price level. Thus economists rely on a price index based on some well-defined market-basket of goods as a proxy to measure the level of prices and changes in prices over time.

The most common measure of inflation is that of the **Consumer Price Index** or '**CPI**' as calculated by the Bureau of Labor Statistics (the BLS). This particular index is based on

the prices of a basket of goods which represents the purchasing behavior of some average urban consumer. The CPI, also known as the Laspeyres Index, is calculated using a weighted average of current to past price ratios for this basket of goods:

$$CPI_t = \sum_{[i=1,\ n\text{-goods}]} w_{i,0}[P_{i,t} / P_{i,o}] \qquad (1)$$

These weights '$w_{i,0}$' are based on the expenditure patterns of the consumer in a base period (currently 1982-84) reflecting the importance of each i^{th} good relative to the overall level of consumer expenditure in that base period or:

$$w_i = \frac{P_{i,o}Q_{i,o}}{\sum_{[i=1,\ n\text{-goods}]} [P_{i,o}Q_{i,o}]} \qquad (2)$$

thus

$$\mathbf{CPI}_t = \frac{\sum_{[i=1,\ n\text{-goods}]} [P_{i,t}Q_{i,o}]}{\sum_{[i=1,\ n\text{-goods}]} [P_{i,o}Q_{i,o}]} \qquad (3)$$

where '$Q_{i,o}$' represents the quantity of the i^{th} good consumed in the base time period ($t = 0$), '$P_{i,o}$' represents the price of the ith good in the base time period, and '$P_{i,t}$' represents the price of the same good in the current time period 't'.

A measure of **inflation** is then developed by computing the percentage change in the CPI from one time period to the next:

$$\pi_t = \%\Delta.\mathbf{CPI} = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \qquad (4)$$

It is important to note that the CPI is not a perfect measure of the price level or changes in the price level. Because this index is computed using base-period quantities (reflecting buying behavior and preferences in the base year), it does not allow for substitution among goods as relative prices change. For example, it might be that the overall rate of inflation is 5%. However, within that value some goods might be rising by 3-4% and other goods by 6-7%. Consumers will attempt to soften the effects of increasing prices on household budgets by substituting away from the relatively more expensive goods and towards the relatively cheaper good. This behavior is not captured in the CPI.

A second problem with the CPI is that it does not allow for changes in product quality over time. It may be that prices are rising due to improved quality of the good being purchased such that this good does not have to be replaced as often. Quality changes can also show up in the size of the good in question. Over the past generation, housing prices have been rising. But during this same period of time, the average size of a housing unit

(in terms of square footage, number of bedrooms and baths, size of the garage and lot) has also increased.

Finally, the CPI does not allow for the inclusion of new goods and services as they emerge into the market place. A fixed basket of goods based on 1982/84 preferences ignores DVD players, PDA's, cell phones, audio CD's and many other goods that perhaps lead to improvements in living standards or life style.

Real Interest Rates and the Fisher Equation

A common use of a measure of inflation is to add an inflation premium to interest rates to allow for expectations about future inflation. As stated above inflation erodes the purchasing power of money over time. An individual lending money in an inflationary environment will be repaid in dollars that possess less purchasing power upon maturity of the debt contract. An inflation premium is often built in to nominal interest rates protect against this loss of purchasing power. However, at the time the debt contract is developed the inflation premium is based on expected rates of future inflation. If these expectations differ from actual inflation rates during the life of the debt contract either the lender or borrower can be adversely affected.

The inflation premium represents the difference between nominal interest market rates 'i_{market}' (i.e., those interest rates published in the paper or posted on the wall at a bank) and the desired real rate of interest 'r*' which usually reflects the rate of real economic growth (the amount of reward that should accrue to the lender for lending to a productive economy). Thus the nominal rate of interest (holding risk constant) on a short-term debt contract (one year or less) is developed as follows:

$$i_{market} = r^* + E[\pi_t] \qquad (5)$$

where '$E[\pi_t]$' represents the expected rate of inflation. At the termination of the debt contract an ex-post real rate of interest 'r' can be developed as follows:

$$r = i_{market} - \pi \qquad (6)$$

Thus the **Real Interest Rate** represents the real return to lenders measured in terms of the purchasing power of interest paid. For example suppose we have the following:
A one year loan (**N** = 1) with the following terms:

Principal '**P**' = \$1000, *and*
nominal rate of interest '**i**' = 5%.

At the time the loan is made, the price of a common commodity 'Gasoline' (P_{gas}) is equal to \$1.00/gal. In real terms the lender is providing the borrower with the purchasing power equivalent to 1000 gallons of gasoline.

At the termination of the loan the borrower repays the principal '**P**' of \$1000 plus an interest payment '**I**' of \$50 (\$1000 x 0.05). If when the loan is repaid one year later, the

price of gasoline P_{gas}' has risen to \$1.03/gal. (*a 3% rate of inflation*); the purchasing power of the principal plus interest (\$1050) will be equal to 1019 gallons of gasoline. In real terms, the purchasing power of the lender has increased by roughly 2%.

If the price of gasoline had risen to \$1.07 (*a 7% rate of inflation*) then the purchasing power of the repayment would have been equal to 981 (\$1050/\$1.07) gallons of gasoline. In this case the lender provided the opportunity for the borrower to acquire 1000 gallons of gasoline and at the termination of the loan the borrower repaid to the lender the ability to acquire only 981 gallons. An unexpectedly high rate of inflation had had an adverse impact on the lender -- a negative real rate of return.

If $E[\pi_t]$ is greater than π_t then 'r' will exceed 'r*' to the benefit of lenders (real returns to lending greater than desired and perhaps greater than the rate of real economic growth) as shown by the following operation -- substituting (5) into (6) we have:

$$r = r^* + E[\pi\ ] - \pi$$

If the opposite is true, then benefits will accrue to the borrower.

During the 1980's, many economists have felt that the real rate of interest was abnormally high (i.e., in excess of 2.5-3%). This may be explained in part due to the inflationary expectations that built up in the late 1970's and early 1980's. Nominal interest rates have taken these expectations into account. The effects of these inflationary expectations differing from the actual rate of inflation can be seen in the table below where the annualized 6-month T-bill rate is used as a measure of the market interest rate:

Table 6, Real Interest Rates and Inflation Rates

Year	**T-Bill Rate**	**r* (desired)**	**$E[\pi_t]$**	**$\%\Delta$(CPI)**	**r (actual)**
1978	7.57	4.5	3.07	9.0	-1.43
1980	11.37	2.0	9.37	12.5	-1.13
1982	11.08	1.5	9.58	3.8	7.28
1984	9.80	4.0	5.8	3.9	5.90
1986	6.03	3.5	2.53	1.1	4.93
1988	6.92	3.5	3.42	4.4	2.52
1990	7.47	1.2	6.27	6.1	1.37
1992	3.57	2.7	0.87	2.9	0.67
1994	4.66	3.5	1.16	2.7	1.96
1996	5.09	2.8	2.29	3.3	1.79
1998	4.85	4.4	0.45	1.6	3.25
2000	5.92	4.3	1.62	3.4	2.52

Source: Economic Report of the President 2002

Note the anticipated real rate of interest (r*) is based on an average of the actual rate of real economic growth over the previous three years.

Over time, changes in market interest rates may be attributed to changes either in the real desired rate 'r* or due to changes in inflationary expectations. Changes in the desired real rate reflects the behavior in the market for loanable funds. If the supply of these funds (public and private savings) exceeds the demand for these funds (public and private borrowing) then the desired rate should fall in reaction to a surplus of these funds. In periods of economic growth the opposite is true. The growing economy is sustained in part by increased borrowing activity for inventory investment and investment in new capital stock to allow for increased production to meet growth in aggregate demand.

Changes in **inflationary expectations** tends to be a more complicated matter. One may hypothesize that current inflationary expectations are based on the history of past actual rates of inflation. A formal model that may help in understanding the development of these expectations is that of the Adaptive Expectations model. This model is based on the notion that economic agents slowly adapt to a changing inflationary environment. This may have been the case in the late 1960's and early 1970's. During the 1960's, the inflation rate was relatively low in the 2-4% range. Basically, during this period time inflation was not considered to be a major economic problem. Thus in the next decade when actual inflation began to creep up towards the double-digits, many individuals and institutions were surprised. Forecasts of future inflation (based on recent historical experience) consistently lagged behind an accelerating actual rate of inflation.

In the early to mid-1980's the actual rate of inflation was de-accelerating, a phenomenon known as disinflation. During this period, economic agent's expected rates of inflation were greater than what actually occurred. These agents were slow to adapt thus putting upward pressure on ex-post real interest rates.

Note: The GDP Deflator

A different price index, known as the GDP Deflator or the Paasche Index, is constructed using current expenditure shares [to represent the spending habits as reflected in current GDP via $Q_{i,t}$] and is defined by the following equation:

$$P_t = \Sigma [P_{i,t}Q_{i,t}] / \Sigma[P_{i,o}Q_{i,t}]$$

where '$Q_{i,t}$' represents the quantities produced and sold of the i^{th} good in the current time period '$P_{i,t}$' represents the current price of that i^{th} good and '$P_{i,o}$' represents the base (1996) price of that same good. This measure can be interpreted as the ratio of actual spending in the current year (NGDP) and the level of expenditure on that same quantity of goods if prices had not changed (RGDP) -- spending in base-year prices.

The Digital Economist

Worksheet #1: Macroeconomic Data

See: http://www.digitaleconomist.com/macro_data_tutorial.html *for help with these calculations.*

1. Given the following data for a three good economy:

	Base Year		**1998**		**1999**		**2000**	
Good	**P**	**Q**	**P**	**Q**	**P**	**Q**	**P**	**Q**
Apples	1.50	100	1.60	120	1.60	150	1.75	150
Bread	1.00	200	1.25	225	1.25	230	1.40	230
Milk	1.25	150	1.40	140	1.40	180	1.60	180

a. Calculate the following:

	Nominal GDP (**NGDP**)	Real GDP (**RGDP**)
1998	_____	_____
1999	_____	_____
2000	_____	_____

b. Calculate the rate of Economic Growth between:

1998 & 1999: _____ *and* 1999 & 2000: _____

c. Calculate (to three decimal places) the value of the **Consumer Price Index** (CPI) for the following years:

	CPI
Base Year:	_____
1998:	_____
1999:	_____
2000:	_____

d. What are some of the weaknesses of using the CPI to measure changes in the price level over time?

e. Calculate the annual rate of inflation between:

1998 & 1999: _____ *and* 1999 & 2000:_____

Worksheet #1, page 2

2. Values for Real GDP and the Consumer Price Index (CPI) are as follows:

	RGDP	**CPI**
1999	$8,675	166.6
2000	$8,910	175.2

Calculate the rate of inflation between 1999 & 2000, derive the real rate of interest (return) for the year 2000 if nominal interest rates are 7%:

Is this real rate of interest above or below the rate of economic growth for the same period of time ?_____ Is this to the benefit of lenders or borrowers?_____ Explain.

3. In any debt contract, both borrower and lender come to an agreement with respect to the nominal rate of interest based in part on inflationary expectations. Lenders include this inflation premium to protect the purchasing power of the funds being lent. Borrowers agree to this rate on interest because they expect that future inflation will enhance their ability of repay the debt. The ability to pay the debt is known as the (interest) burden of the debt and may be calculated as follows:

$$\text{Burden} = \frac{\text{Interest Expense}}{\text{Income}}$$

Assume that an individual borrows $100,000 to purchase a house at 7% interest. Embedded in this interest rate is an inflation premium (π^e) of 5%. Both borrower and lender agree to this inflation premium.

a. Given this information, what is the real rate of return of the loan to lenders?_____

b. If the borrower has an annual income of $28,000, what is the debt burden of this loan?_____

c. If the actual rate of inflation (p) is 5% over the first three years of the loan, calculate the level of income (growing at this same rate) and the (interest) burden of the debt:

	Income (at 5% growth)	Burden	Income' (at 3% growth)	Burden'
Year 1:	_____	_____	_____	_____
Year 2:	_____	_____	_____	_____
Year 3:	_____	_____	_____	_____

What is happening to the burden of the debt over time?_____

d. Now perform the same calculations for an annual rate of inflation of 3%. Do borrowers benefit or are they hurt by this lower rate of inflation? _____

THE TERM AND RISK STRUCTURE OF INTEREST RATES

Upon casual inspection of any business periodical, one will find that at any point in time there are many different nominal interest rates. The last section began to explain why all interest rates may change through time in reaction to changes in the supply or demand for loanable funds and due to changes in inflationary expectations. This section will examine differences in nominal rates at a point in time and how the spread between nominal rates may change in reaction to economic events.

The following table may be useful in organizing the many different nominal interest rates that exist on any given day:

Table 7, Nominal Interest Rates at a point in time

Term	**No Risk U.S. Treasury**	**Low Risk (AAA-AA)**	**Medium Risk (A-BB)**	**High Risk (B-CC)**
Short-term (1-year or less)	1.80%	3.36%	3.95%	5.00%
Medium-term (1 - 10 years)	4.24%	4.46%	5.12%	8.00%
Long-term (10+ years)	5.54%	6.21%	6.89%	10.00%

By taking credit risk and the length of the lending period into account, differences in nominal interest rates, at a point in time, can be explained with the following equation:

$$i_{market} = \{r^* + E[\pi_t)]\} + \rho + \lambda$$

The first two components in brackets are the familiar desired rate of return and expected inflation that make up the core of any interest rate at a point in time. The third component 'ρ' is known as the risk premium established by credit markets for different categories of risk. This value may be large or small depending on how risk averse lenders might be at any point in time.

The last component 'λ' is known as the liquidity premium which represents the amount of compensation required by a lender for lending to the long end of the market. For example in the above table the T-Note rate is 6.25% and the T-Bond rate is 7.40%. The 1.15% difference implies that lenders require an additional $11.5 per $1000 lent for 30 year loans relative to 5-10 year loans to the Federal government. Greater uncertainty about future rates of inflation or future political events will often widen the spread between the medium and long term. The differences that exist in nominal rates due to this liquidity premium are summarized in the frequently published yield curve constructed by using the different treasury rates (risk-premium = 0) that exist on a given date.

The (Credit) Risk Premium
Each column represents a different level of risk associated with a certain class of borrowers. This risk is also known as credit risk where different types of borrowers (or related projects) have different probabilities of being able to service their debt (make scheduled interest payments) and being able to repay the principal of the debt. These risk categories are commonly established by various credit agencies; the most popular being Standard & Poor's (listed above) and Moody's.

The No Risk category corresponds to Federal Government debt (T-bills, T-Notes, and T-Bonds). In this category, there is absolute certainty that the borrower (the Federal Government) will be able to properly service the debt and repay the principal at all times. This is possible because the Federal Government can always borrow new funds at what ever rate of interest necessary to pay existing interest obligations or to repay any existing debt. The government is not constrained by an income statement of annual profit and loss as are private companies. In addition, unlike state and local governments the Federal Government has the power to establish or perhaps create the currency necessary to meet its existing obligations.

The Low Risk category corresponds to a S&P classification of AAA-AA or investment grade lending. Borrowers in this category have a strong history of debt repayment and a solid stream or revenues to service any future debt. Lenders in this category are very risk averse seeking to protect their asset base (the principal) by avoiding those borrowers who might default on their debt repayment.

The classification of A-BB represents somewhat speculative grade lending or Medium Risk. Borrowers in this category often have a good credit history, however, there is some uncertainty about future revenues to service additional debt. Lenders involved in this type of debt are willing to speculate that all interest payments and principal repayment will take place in return for a slightly higher return on their investment.

Finally the High Risk category carries a S&P rating of B-CCC also known as "junk" or highly speculative lending. Lenders in this category are willing to put their assets at risk in return for a high return as measured by usually double-digit yields for a limited period of time. There is a strong probability of default on debt in this category.

The Liquidity Premium and Term Structure
In the above table, each row represents different lending/ borrowing periods. Short-term lending corresponds to anytime between one day and one year. The Medium-term corresponds to a lending period between one and ten years. Long-term lending is with respect to debt contracts for a time period greater than ten years.

Differing lengths in the lending period correspond to different degrees of uncertainty about future events. Very little change takes place in the political or economic structure of a nation or the world in any given year--the short-term. However, over a 30 year period of time typical for some types of government borrowing (T-Bonds) and private

borrowing (home mortgages), massive changes may take place in rates of inflation, political conflict, and the global balance of power.

In the long-term tremendous uncertainty exists and yet there are institutional lenders that actively seek the long term. For example, pension funds and life insurance companies that need to plan for exact financial obligations well into the future.

The actual derivation of liquidity and risk premiums take place in financial markets through the process of buying and selling financial instruments--concepts that will be discussed in later sections.

THE BALANCE OF PAYMENTS

The Balance of Payments 'BOP' is an account of all transactions between one country and all other countries--transactions that are measured in terms of receipts and payments. From the U.S. perspective, a receipt represents any dollars flowing into the country or any transaction that require the exchange of foreign currency into dollars. A payment represents dollars flowing out of the country or any transaction that requires the conversion of dollars into some other currency. The three main components of the Balance of Payments are:

- The Current Account including Merchandise (Exports Imports), Investment income (rents, profits, interest)
- The Capital Account measuring Foreign investment in the U.S. and U.S. investment abroad, and
- The Balancing Account allowing for changes in official reserve assets (SDR's, Gold, other payments)

U.S. Exports are any goods or services produced in the U.S. and sold to other countries in the international market. U.S. Imports are goods or services produced by other countries and bought by individuals in the United States An increase in U.S. receipts (i.e., increased U.S. exports, investment income inflows, or more foreign investment in the U.S.) will lead to increased demand for dollars and an increased supply of foreign currency on foreign exchange markets (individuals and businesses are selling foreign currency and buying dollars). This increased demand will lead to a stronger dollar relative to other currencies. An increase in U.S. payments (i.e., U.S. imports, investment income outflows, or more U.S. investment abroad) will lead to an increase in the supply of dollars and thus a weaker dollar relative to foreign currencies.

Table 8, BOP Data -- yr: 2000 ($millions)

Category	Receipts	Payments	Net
I. Current Account			
A. Merchandise Account (Exports/Imports)	848,678	-1,224,417	-375,739
B. Income Account (Rents, Interest, Profits)	352,866	-367,658	-14,792
C. Transfers			-54,136
Current Account Balance			**-444,667**
II. Capital Account			
A. Foreign Investment in the U.S.	1,024,218		
B. U.S. Investment Abroad		-580,952	
C. Statistical Discrepancy			1,401
Capital Account Balance			**444,667**
III. Balancing Account (Official Reserve Transfers)			0

Source: Economic Report of the President 2002

Currently, the U.S. maintains a deficit in merchandise trade-- the trade deficit and, in the absence of strong net investment income inflows, a current account deficit. These deficits are offset by the current account surpluses--the purchase of U.S. assets by foreign individuals and institutions such that net flow of receipts and payments is in balance (allowing for statistical discrepancy) without the need for any type of official transfers.

The History of the U.S. Balance of Payments
The history of the balance of payments in the U.S. can be divided up into five stages

Stage I: The U.S. is a young debtor nation (1770-1870) -We have a current account deficit due to the need to import most goods and inability to produce many goods for export. -We have a capital account surplus due to a great deal of foreign investment in the U.S. in the areas of roads, farming, cattle ranches, railroads, and canals.

Stage II: The U.S. is a mature debtor nation (1870-1920) - There is still a current account deficit due to large investment income being paid back to foreign investors based on the investment of stage I. The merchandise account is in surplus -- exports > imports.

Stage III: The U.S. is a young creditor nation (1920-1945) -There is a huge surplus in the current account due to large volume of post-war (WWI) exports. -The capital account is now in deficit due to a great deal of U.S. investment in Europe for post-war reconstruction.

Stage IV: The U.S. is a mature creditor nation (1945-1980) -The current account has a merchandise deficit -- exports < imports but an investment income surplus with a slight net surplus overall. -The capital account is in deficit largely due to post-war (WW II) reconstruction in Europe and Japan.

Stage V: (1980-) -There is a large (and growing) deficit in the merchandise accounts (The Trade Deficit) and a slight surplus in the investment income accounts. -There is a large surplus in the capital account partially to finance the above merchandise deficit (foreign individuals and banks lending money to individuals in the U.S.) Additionally, since the U.S. has had a low inflation rate since 1982 and consistent economic growth , the U.S. has been a good place to invest relative to the rest of the world. However the current inflow of capital investment could eventually lead to large investment income payments in the near future. The investment income surplus we now enjoy may soon be eroded thus worsening the current account deficit.

EXCHANGE RATES

Exchange rates represent the linkage between one country and its partners in the global economy. They affect the relative price of goods being traded (exports and imports), the valuation of assets, and the yield on those assets. In the period of fixed or constant exchange rates these prices, values, and yields were predictable over time. However, since 1973 we have been living in a world of flexible rates where foreign exchange markets determine these rates based on trade flows, interest rate differentials, differing rates of inflation, and speculation about future events.
Exchange rates can be expressed as the foreign price of a domestic currency (i.e., the Euro price of a U.S. dollar) or its reciprocal -- the domestic price of foreign currency. We will express these values using the following notation:

the Euro price of a Dollar: €P/$

or

the Dollar price of a Euro: $P/€

Currently this particular ratio of currencies is near parity (1:1) and thus numerically not very interesting. The following represents the foreign-exchange value of a U.S. dollar as of October 2002 (from here on out, exchange rates will be expressed as the Foreign Price of a Dollar 'FP/$'):

Table 9, Exchange Rates (10/2002)

Country / Region	Currency	Rate
Britain	Pound '£'	0.6402
Canada	Dollar 'C$'	1.59
China	Yuan 'RMB'	8.278
Europe	Euro '€'	1.013
Indonesia	Rupiah 'Rp'	9007.0
Japan	Yen '¥'	124.1
Mexico	Peso	10.12
Russia	Ruble	31.69
Singapore	Dollar 'S$'	1.79
South Korea	Won	1260.0
Switzerland	Franc '₣'	1.48

All of the above rates represent Nominal Exchange Rates in that they are the actual posted trading rates on foreign exchange markets. These particular rates can be used to find the domestic price of foreign goods. For example, suppose that we are interested in the price of a portable CD player manufactured in Japan:

P_{Japan} = ¥ 8060

if the exchange rate is:

¥124 = $1

then the domestic (U.S.) price of this same good is:

$P_{U.S.}$ = $65 (8060/124)

As exchange rates fluctuate, the domestic prices of foreign goods will often be affected:

New exchange rate: ¥140 = $1 (a weaker Yen)
Price of CD player in Japan: P_{Japan} = ¥ 8060 (unchanged)
Price of CD player in the U.S.: $P_{U.S.}$ = $57.60 (less expensive)

The weaker yen (it now takes more yen to buy a U.S. dollar) or stronger dollar (a dollar now buys more yen), has led to a reduction in the price of Japanese exports and U.S. imports. We would expect that this change will lead to an increase in the flow of goods from Japan to the U.S. However, trade flows are affected not by nominal exchange rates, but instead, Real Exchange Rates

Purchasing Power Parity
In order to understand the determination of real exchange rates, we need to examine the concept of Purchasing Power Parity or PPP.

Suppose that we compare the price of a common good in two different countries. The Economist magazine often uses a McDonald's Big Mac™ for this purpose. McDonald's operates in many countries around the world selling products governed by strict specifications and standards. The presentation and taste of a Big Mac™ (based on this author's experience) is identical in Beijing, Denver, Jakarta, Singapore, and Seoul. Using this homogeneous worldwide product, we expect the following to be true:

Exchange rate: ¥124 = $1
Price of a Big Mac™ in the U.S.: $P_{U.S.}$ = $2.25
Price of Big Mac™ in Japan: P_{Japan} = ¥279

If Purchasing Power Parity holds then the nominal exchange rate should be:

¥P(Big Mac™) / $P(Big Mac™) = ¥279 / $2.25 = ¥124 : $1

But what if we had the following:

Exchange rate: ¥124 = $1
Price of a Big Mac™ in the U.S.: $P_{U.S.}$ = $2.25
Price of Big Mac™ in Japan: P_{Japan} = ¥300

In this case,

¥P(Big Mac™) / $P(Big Mac™) > *nominal exchange rate.*

We could therefore take $1000 and buy 444 Big Macs™; export the Big Macs™ to Japan and sell them for ¥300 each. This would generate ¥ 133,200 in revenue. We then sell yen on foreign exchange markets and buy dollars. At the current exchange rate, this would allow us to buy $1074 (¥133,200/¥124) and earn a profit of $74.

However, this process of arbitrage (on a larger scale) should affect Big Mac™ prices and the nominal exchange rate. The buying of Big Macs™ in the U.S. should push the domestic price upwards. The selling of Big Macs™ should drive prices down in Japan. The selling of Yen on foreign exchange markets should weaken the Yen and the buying of Dollars should strengthen the dollar. This activity will continue until the ratio of Big Mac™ prices is just equal to the nominal exchange rate.

The Real Exchange Rate

This information between nominal exchange rates and foreign/domestic prices of a common good can be expressed as a single value -- the Real Exchange Rate 'ε_r'.

$$\varepsilon_r = e.r._{nominal}[P_{domestic} / P_{foreign}]$$

or

$$\varepsilon_r = (¥P/\$)[\$P(\text{Big Mac™}) / ¥P(\text{Big Mac™})]$$

This real exchange rate 'ε_r' is a unit-free measure where, in the case of a single good, its value can be interpreted relative to 1.0 (PPP). In our above example where '¥P/$ = 124:1, the ¥P(Big Mac™) = 300, and the $P(Big Mac™) = 2.25 we would calculate the real rate to be:

$$\varepsilon_r = (124)[2.25 / 300] = 0.93$$

or 1 Big Mac™ in the U.S. is equivalent to 0.93 Big Macs™ in Japan allowing for arbitrage opportunities. Either the Yen must weaken, the price of Big Macs™ in the U.S. must increase, or the price of Big Macs™ in Japan must fall. However, other economic events or conditions (capital flows, trade barriers, price-making power) may prevent this from happening. These real exchange rates do provide a foundation for the direction of trade flows such that:

$$\text{Net Exports 'NX'} = f_{(-)}(\varepsilon_r)$$

The above rate of 0.93 would lead to the export of Big Macs™ from the U.S. and imported into Japan.

The calculation of real exchange rates are more-likely based on a basket of goods rather that a single homogeneous commodity. Thus price indices in different countries are used such that:

$$\varepsilon_r = e.r._{nominal}[CPI_{domestic} / CPI_{foreign}]$$

In constructing the real exchange rate this way we can then think about how differences in rates of inflation among nations either affect this real rate and thus trade flows or perhaps leads to changes in nominal exchange rates:

$$\text{if } \%\Delta P_{U.S.} > \%\Delta P_{Japan} \text{ then either: } \varepsilon r \text{ or } e.r._{nominal}$$

In using these indices, we can no longer interpret the real exchange rate relative to a unit value (1.0). Instead we are forced to look at the direction of change in the real rate to understand the effect on exports and imports.

Be sure that you understand the following concepts and terms:

- Flow Variable
- Stock Variable
- Standard of Living
- Gross Domestic Product 'GDP'
- Expenditure Approach
- Compensation Approach
- Nominal GDP
- Real GDP
- Implicit Price Deflator
- National Income
- Depreciation
- Indirect Business Taxes
- Inflation
- Inflationary Expectations
- Consumer Price Index 'CPI'
- Nominal Interest Rate
- Real Interest Rate
- Desired Real Rate of Return
- Risk Premium
- Liquidity Premium
- Term Structure of Interest Rates
- Balance of Payments
- Current Account
- Capital Account
- Exchange Rate
- Real Exchange Rate
- Purchasing Power Parity

See: The Digital Economist:

http://www.digitaleconomist.com/macro_data.html
http://www.digitaleconomist.com/econ_data.html
http://www.digitaleconomist.com/nia_4020.html
http://www.digitaleconomist.com/inf_4020.html
http://www.digitaleconomist.com/int_4020.html
http://www.digitaleconomist.com/bop_4020.html
http://www.digitaleconomist.com/er_4020.html