Problem Set 2

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Macroeconomics 6475

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Real GDP is many things, but primarily it is an inflation-adjusted measure for a country's productivity and economy. It is also a rough estimator for the standard of living in a country, as it is correlated with life expectancy, literacy rates, and other measures of human development. Real GDP per capita is a measure of the company dispersed equally to its people, giving an average amount of output per a person. As real GDP per capita increases, we'd expect standard of living to also increase in the country for its citizens.

Real GDP can be measured by the summing of consumer expenditures (C), private investment of businesses (I), government spending (G), and net exports (imports minus exports, i.e. Im-Ex or NX). This shows the national aggregate demand (Y):

$$Y = C + I + G + NX$$

Aggregate demand shows the output of a nation, but aggregate demand isn't always just a magic number; nations can surpass their long-run aggregate demand estimates and also produce below it. While these short-term over or under performances can be possibly explained by short term demand shocks like changes in consumer in government spending, long-term growth is affected by a nation's factors of production and change for capital, a measure of number of machines, tools, and land a country uses or has available; labor meaning the number of laborers in a nation or number of labored hours; and human capital, like education, technology, judicial efficiency, clearly defined property rights, etc. A Cobb-Douglas function is a formulaic representation of this, where Y is output, A represents human capital and technology, L is labor, K is capital:

$$Y = AK^{\alpha}L^{1-\alpha}$$

Because long-term growth in real GDP is dependent on the factors of production and how changes in a nation's machinery, population dynamics, and human capital change over time. In the long run growth in human capital, growth in capital, growth in labor (L) growth in GDP (y) can be depicted then as follows, the real potential output:

$$g(\bar{Y}) = g(\bar{A}) + \alpha g(Kbar) + (1-\alpha)g(\overline{\mathbf{L}})$$

If a country sustains growth in these areas, it will see growth in real GDP, and if it increases relative to change in population, then real GDP per capita would also increase. However, there are interesting long-run implications of the above

model, because the complementary relationship between labor and capital. With each being increased on their own, they have diminishing returns, while if increased in proportion, we'd expect constant returns to output. This means in the long-run, we'd expect a balanced growth, where the growth rates of both K and L are identical. While in the medium-run, changes to capital can change to compensate for shocks in markets and the economy (capital deepening) we'd still expect it to efficiently level out so that the growth rates equal each other. This would further simplify our model so that growth in real output is dependent solely on growth in A, our technology, education, worker efficiency, etc.

$$g(\bar{Y}) = g(\bar{A})$$

Changes in labor markets has effects on economic output, as it inherently affects labor, L. There are a few ways we may think about this like labor force participation, hours worked, and unemployment.

Looking at the employment-population ratio, we see some pretty drastic changes in participation over the last 70 years:

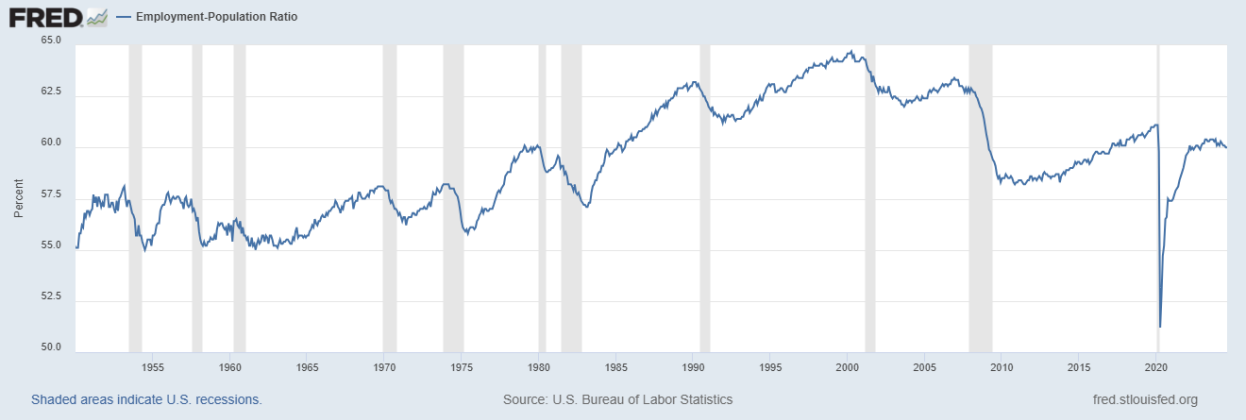

Figure 1 – Employment Population Ration

While generally steady, we see gains in participation from the 70s up until the 2000s. This is in part due to women joining the workforce and advancements in birth control. We see declines after 2000, with sharp declines during the 2008 Financial Crisis and Covid-19 Pandemic. These rates end up recovering but have yet to reach their maximum from the late 90s. This could be due a few things like aging populations or discouraged workers leaving the labor market.

While the previous figure gives the employment-population ratio, unemployment rate (U3) is the percentage of people in the labor market who do

not have a job. This doesn't include discouraged workers, retirees, those too young to legally work, etc. As we see in Figure 2, unemployment fluctuates around 4%-6%, but as denoted by the gray, unemployment rate often spikes during in recessionary periods.

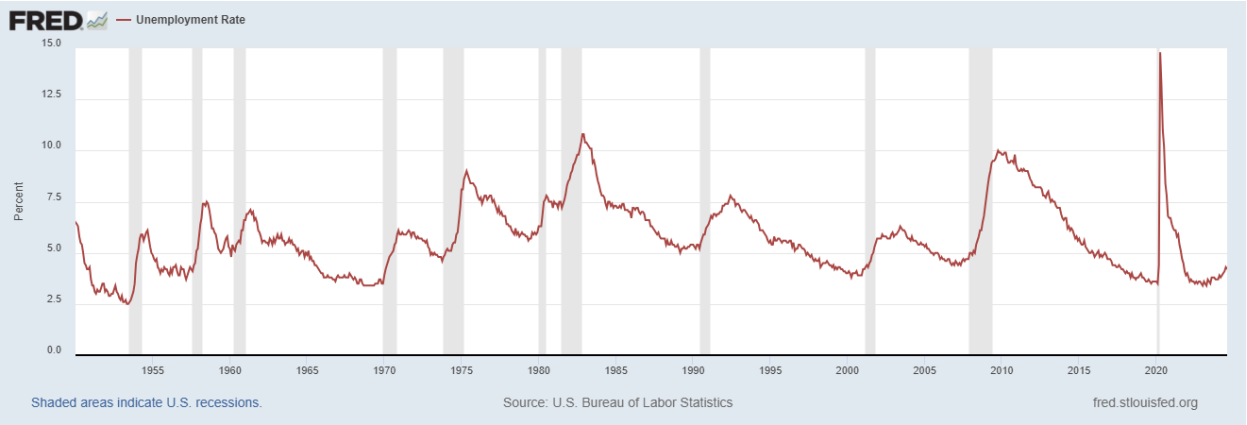

Figure 2 - Unemployment Rate U-3

Unemployment is cyclical and overall steady in the long run as a trend, with ebbs and flows, but largely returns to around normal levels due to business cycles recovery and expansionary periods.

Yet looking at just unemployment rate can be partially misleading; because the unemployment rate is a ratio of those unemployed versus the total labor force, if people leave the labor force, but no one gets a new job, the unemployment rate goes down, despite no one working a new job. People leave the labor market for several reasons, some of which are aforementioned retirement or discouraged workers.

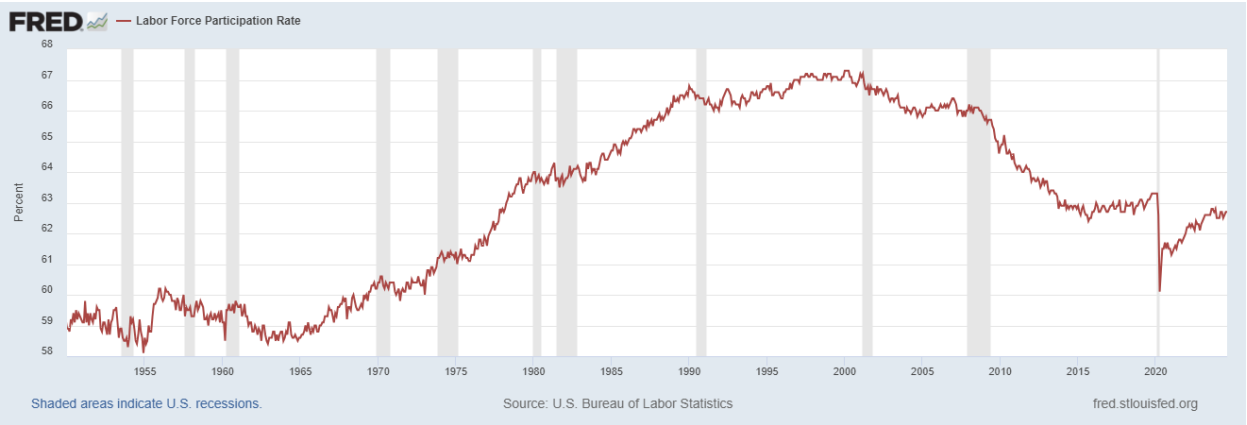

Figure 3 - Labor Force Participation Rate

In the above figure above, we significant growths in labor force participation which is the percentage of adults of legal working age participating in the labor market. After the 1960s, which coincides with the “the pill” being in wide circulation, we can observe unprecedented growth in labor force participation, jolting almost 10% in thirty years which held through the 90s. Since the turn of the millennia, we witness a decreasing trend in labor force participation, expedited at times of recession.

Looking at the unemployment rate versus U-4 which is the total unemployment rate plus discouraged workers as a percent of labor force plus discouraged workers, notice that these measures of unemployment follow each other closely and climb during recessionary periods, but U-4 is only marginally different from U-3, showing discouraged workers don’t make up a large portion of U-4, relative to normal unemployment measure of U-3.

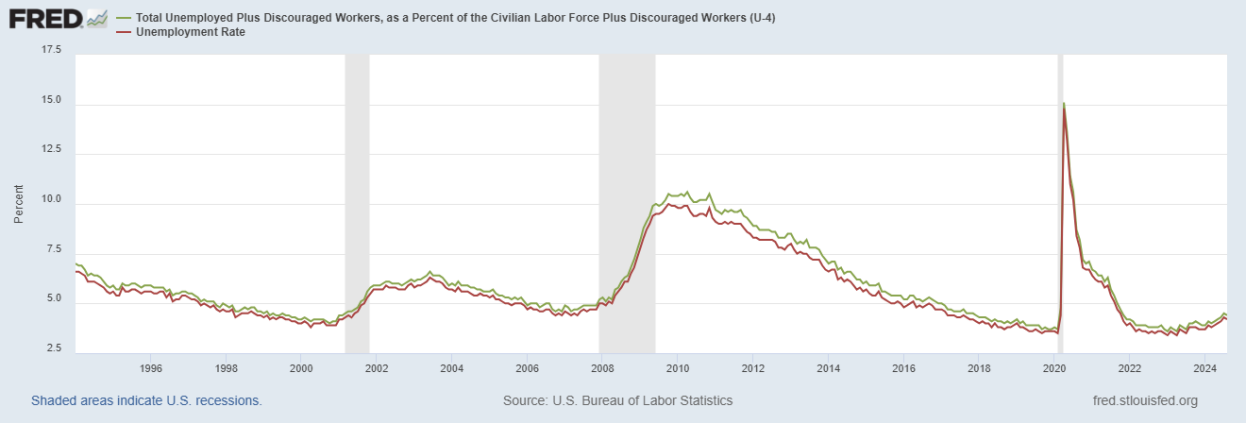

Figure 4 - U-3 and U-4

Aside from the increases in unemployment, we also see shrinking unemployment in recovery periods and expansionary periods. While COVID-19 saw the greatest change in unemployment from around 4% to a whopping 15% almost overnight, the recovery was quick and has sustained at low levels since even before 2022 to present. The shock in employment was due to a supply shock, external from the economy (the Pandemic), but after the 2008 Financial Crisis which was a demand shock that left people holding onto cash, there was a much slower recovery in unemployment rates by comparison. One explanation that I could think of is during demand shocks, private investment in business often plummets, leading to less labor demand, possibly less spending by those without jobs, which causes a bit of vicious cycle. Additionally as it pertains to the COVID-19 Pandemic, some of the supply shock was answerable through technology changes, like increase in work from home policies and work culture, relatively quick production of a vaccine, and

even knew industries growing as an answer to consumer preferences which have sustained to now like gig-economy jobs, technology and manufacturing jobs to answer demand for work-from-home demand, demand of health products like masks, soap, hand sanitizers, businesses retooling work environments to combat pandemic like installing plastic shields between booths and restaurants. Demand was still there, and when supply caught back up, the economy started doing better, recovery was swift, and the unemployment rate with it, dropped from its perilous height.

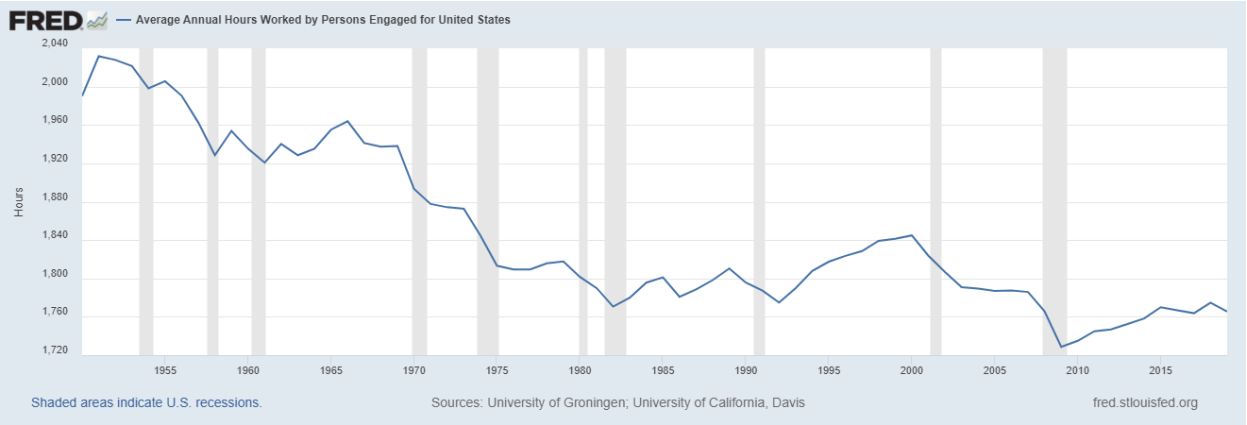

Figure 5 - Average Annual Hours Worked

Another trend we see in labor is number of hours worked per an engaged person in labor force has dropped considerably. This downward trend would suggest that despite growing output, as seen by change in real GDP, and by extension quality of life, Americans are not working longer hours. The growth of the economy has sustained despite decrease in worked hours and even labor force participation (measures of L), likely due to more efficient workers and capital.

One of the important reasons for tracking the growth of the economy is the money supply. If the US economy grows but the money supply doesn't, then there is less dollars chasing more goods and services (from greater output), which could cause unwanted disinflation or even deflation. To avoid these, the Federal Reserve adjusts the money supply so that inflation goals are kept in mind, while also adjusting the amount of money to the US's growth in output.

The money supply is controlled by the central bank and is a function of the price level in the economy (P), real potential output (Y), over velocity of money (v) which is the average amount of times a given dollar exchanges hands in the economy.

$$M_S = \frac{PY}{v}$$

To keep inflation at an acceptable level, we need to adjust the money supply, but we also need to know then what causes inflation, the change in price level in an economy (in this case π, you could also think of this as ṗ); change in price level is a sum of change in change of money supply (ṁ) and change in velocity (v), minus the change in aggregate demand (ẏ).

$$\pi = \dot{m} + v - \dot{y}$$

This makes intuitive sense; the change in price level is not only dependent by how much money is in the system, but how frequently people are spending, and the change in real potential output, the number of things getting produced.

Monetarist theory assumes that change in velocity is constant which would simplify the theory to:

$$\pi = \dot{m} - \dot{y}$$

But is that a sound assumption? By comparing the natural log of nominal GDP, which measures change in output, to M2 a measure of the money supply which is tied to consumer spending like currency, saving deposits, demand deposits by public, and checkable deposits $100,000.

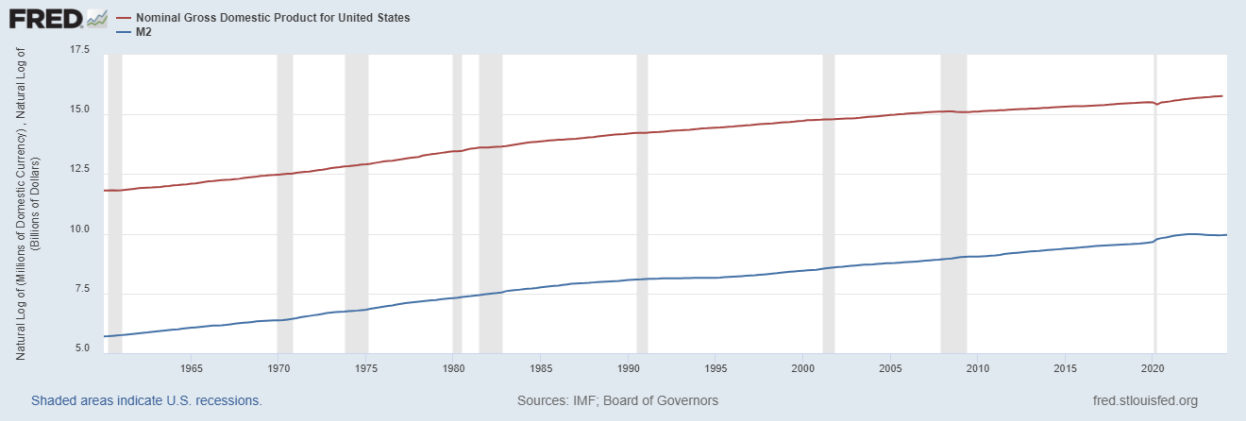

Figure 6 - Change in Money Supply (M2) and Nominal GDP

Taking the difference in nominal GDP and M2 money supply we can see the change in velocity, which is persistent and hovers around a velocity of 6 over the past 60 years.

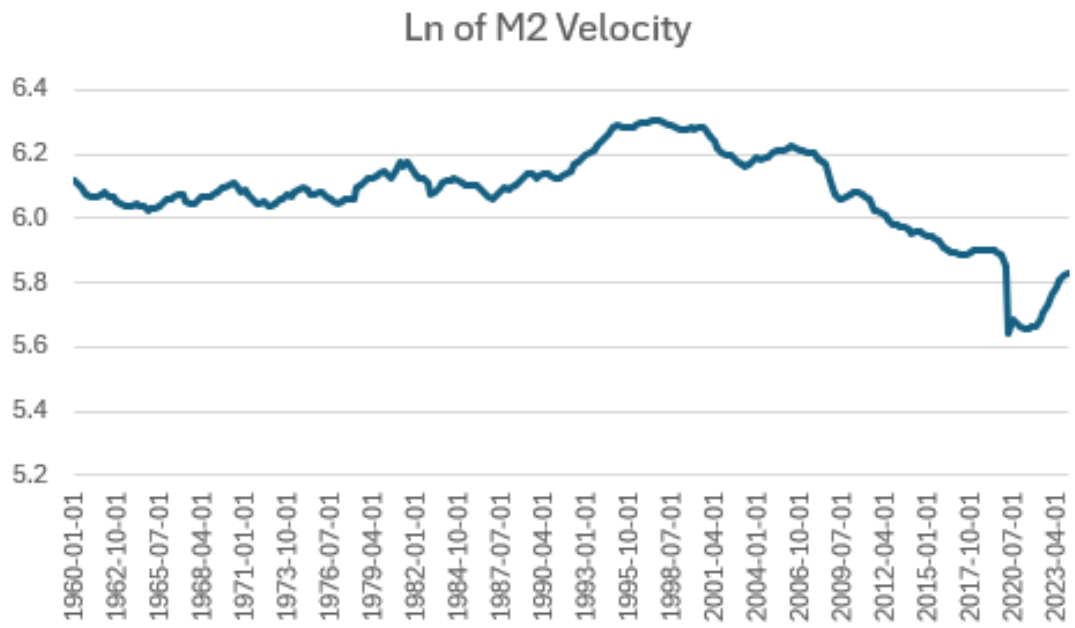

Figure 7 - Change in M2 Velocity

There are fluctuations of course; observing times of recession like late 2007-2008 and early 2020, we can see (sometimes exceptionally) steep decreases in velocity. Again, velocity measures the amount of times on average a given dollar changes bank accounts, meaning people are consuming less and holding on to money, which we saw in the Financial Crisis as market uncertainty, especially credit markets, and COVID-19 Pandemic. We also see increases in the recovery from the pandemic (approaching its pre-pandemic velocity of about 5.9) and during a rather economically prosperous 90s.

Overall, this long run, rather consistent rate of change allows us to simplify our inflation equation.

$$\pi = \dot{m} - \dot{y}$$

This means that a target inflation rate for the central bank can be accomplished by taking the desired inflation rate and adjusting the money supply accordingly to the change in output.