# The Close Tie Between Energy Consumption, Employment, and Recession

The number of jobs available to job-seekers has been a problem for quite a long tine now—since 2000 in the United States, and longer than that in Europe. If we look at the percentage of the US population who are employed, it is now back to 1984 or 1985 levels.

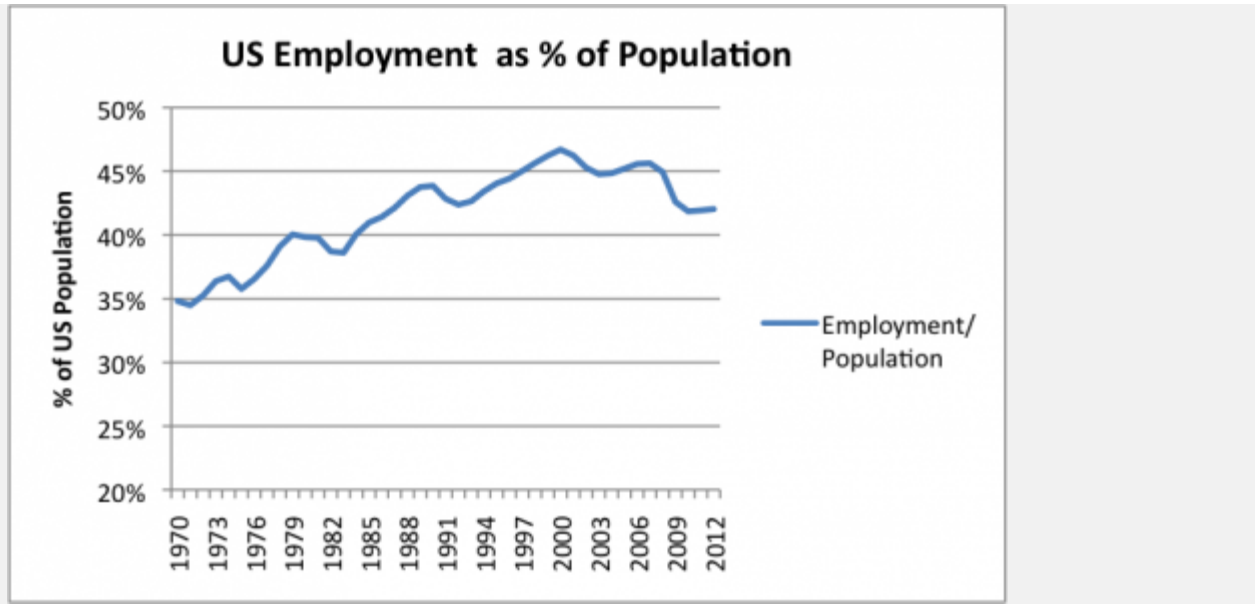


Figure 1. Total number of individuals employed in non-farm labor, and reported by the US Bureau of Labor Statistics, divided by US resident population, as reported by the US Census Bureau.

I have run into a number of clues about what is happening. In this post, I'd like to discuss what I am seeing. Part of the problem is that high oil costs squeeze the economy, reducing employment. Part of the problem is growing trade with Asia. It is even possible that the Kyoto protocol (which the US did not sign) has something to do with what we are seeing. Let me start by explaining a fairly strange relationship.

## A Strange Relationship – A Close Tie Between the Amount of Energy Consumed and the Number of People Employed

Since 1982, the number of people employed in the United States has tended to move in a similar pattern to the amount of energy consumed. When one increases (or decreases), the other tends to increase (or decrease). In numerical terms, $R^2 = .98$.

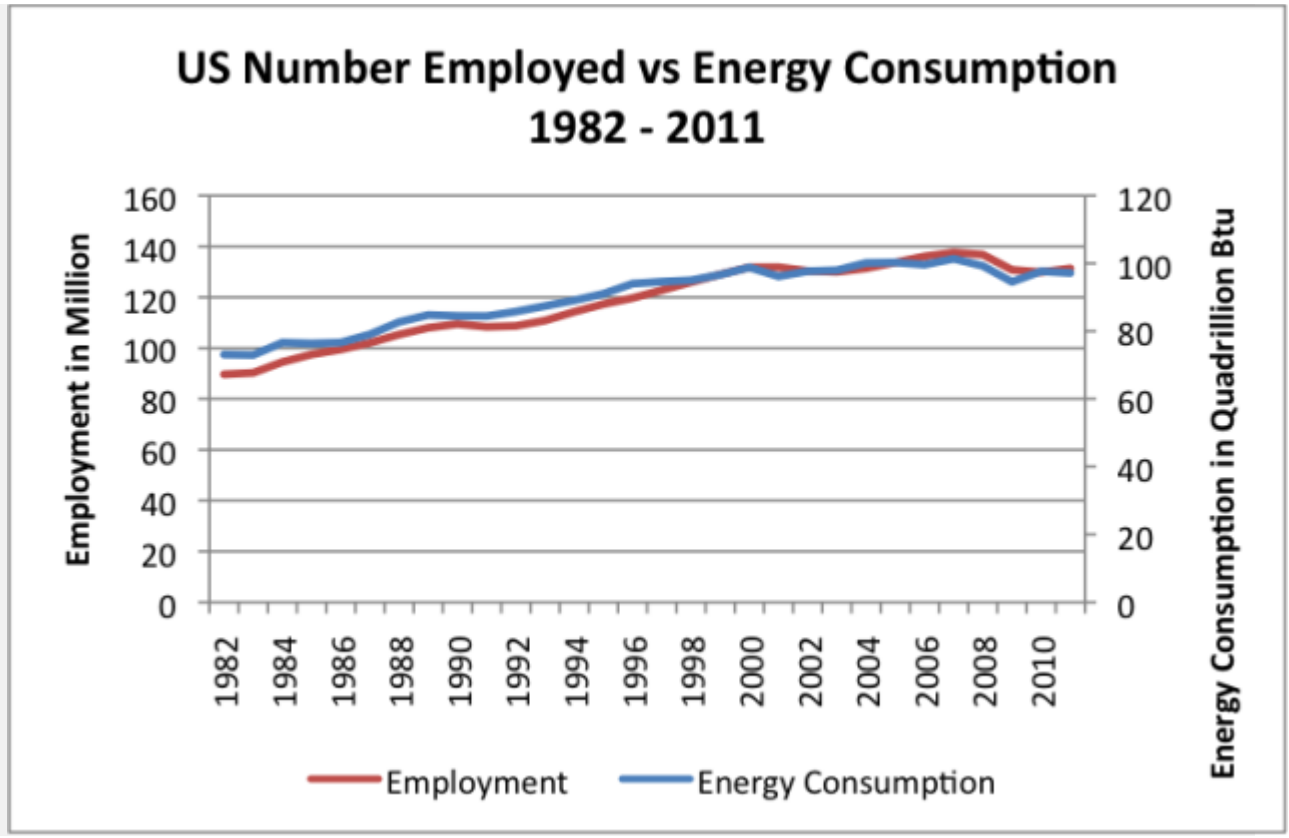


Figure 2. Employment is the total number employed at non-farm labor as reported by the US Census Bureau. Energy consumption is the total amount of energy of all types consumed (oil, coal, natural gas, nuclear, wind, etc.), in British Thermal Units (Btus), as reported by the US Energy Information Administration.

I have written recently about the close long-term relationship between energy consumption and economic growth. We know that economic growth is tied to job creation, so it stands to reason that energy consumption would be tied to job growth[1]. But I will have to admit that I was surprised by the closeness of the relationship for the period shown.

This close relationship is concerning, because if it holds in the future, it suggests that it will be very difficult to reduce energy consumption without a lot of unemployment. It also would seem to suggest that a shortage of energy supplies (as reflected by high prices) can lead to unemployment.

## Why Rising Energy Cost (Particularly Oil) Leads to Lower Employment and Less Energy Consumption

Suppose oil prices rise[2]. The critical issue is that **consumers' incomes do not rise at the same time**. Consumers' budgets get squeezed, and they cut back on discretionary

spending. For example, they may go out to restaurants less, make fewer long-distance vacation trips, put off buying a new car, or contribute less to their favorite charities. Workers in discretionary sectors of the economy tend to get laid off, as a result. We have come to know this as part of recession.
(The impact of an oil price rise will be worse if other fuel prices, such as natural gas, rise as well. It will be mitigated, if natural gas prices are low, as they are in 2012 in the United States. Europe has much higher natural gas prices than the United States. This is big part of the reason why recessionary impacts are now worse in Europe than the United States.)

In the case of high oil prices and lay-offs, less energy of all types-not just oil-is used. Laid-off workers may move in with relatives, and thus reduce their living expenses. Each laid-off worker would have used oil to get to their job, and this will no longer be required. The jobs experiencing layoffs themselves may have required fuel use of various types, such as heat for buildings, fuel for airplanes, or electricity used in making new cars, and this is reduced as well.

There is also likely to be a link to housing prices. Moving up to a more expensive home is a discretionary expenditure. If people's incomes are squeezed by high oil prices, and some are being laid off, there will be less demand for homes as well. This lower demand can be expected to reduce housing prices, especially in areas where commuting distances are longest (and thus, oil use for commuting greatest). There are also likely to be layoffs in the construction industry, as there is less demand for new homes and new buildings of all sorts.

As I have mentioned previously, James Hamilton (2011) has shown that 10 out of 11 recessions in the United States since World War II were associated with oil price spikes.

## High Energy Costs in One Area Tend to Lead to Substitution to Places Where Energy Costs Are Lower

If there is a possibility of international trade, manufacturing and some types of services will tend to move to areas where costs are lowest. Part of these costs are energy costs. A manufacturer with cheap electricity costs will have an advantage over one with higher electricity costs. As energy costs rise (as they have in recent years), they get to be more important in determining where manufacturing will be done.

Besides direct energy costs, wages are another part of the difference in costs from one part of the world to another. Wages tend to be lower in the warmer areas of the world. In part, this is because energy from the sun provides much of the needed energy for

heating homes, so there is less need for supplemental energy. This means that wages do not need to be as high for a comparable standard of living.

If we look at recent world energy consumption, we see rapid growth in energy consumption. This pattern is quite different from the US pattern we saw in Figure 2, which was much flatter.

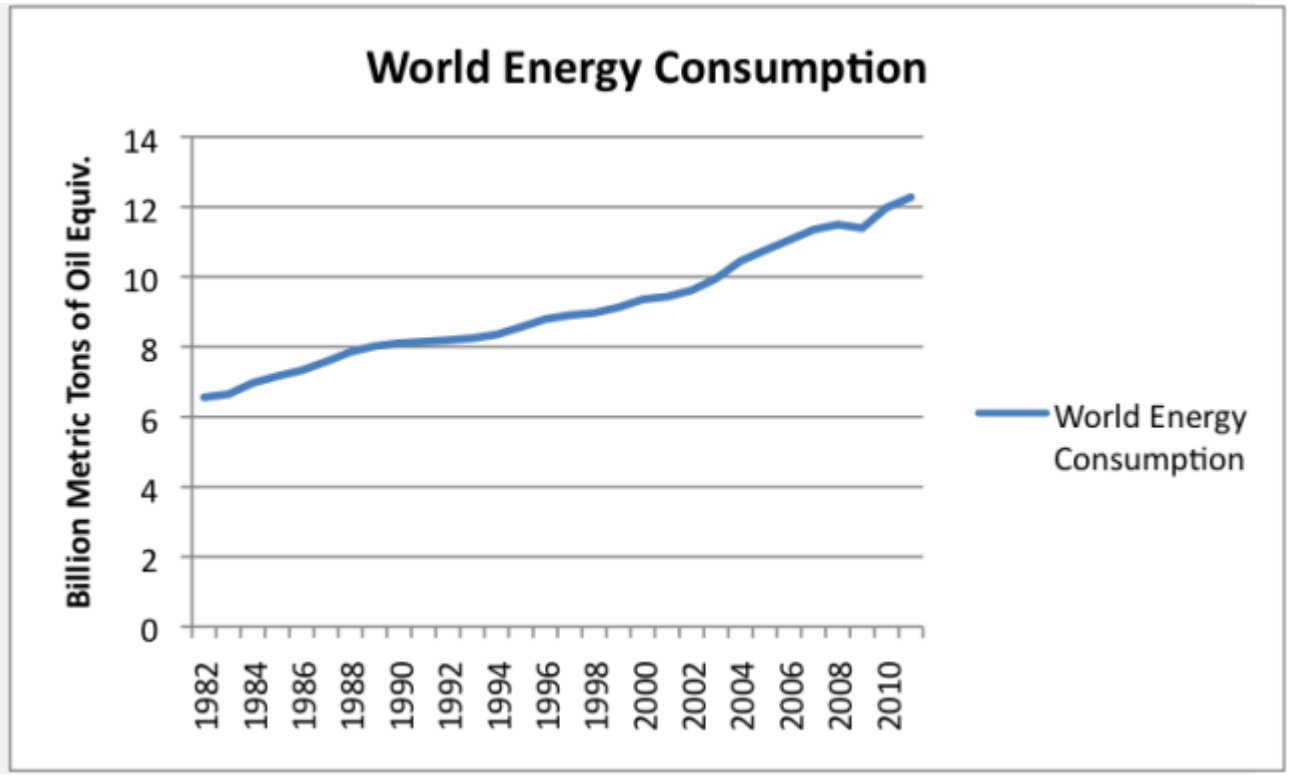


Figure 3. World Energy Consumption based on BP's 2012 Statistical Review of World Energy

Figure 4 below shows that there has been a striking difference in how energy consumption has grown in various parts of the world.

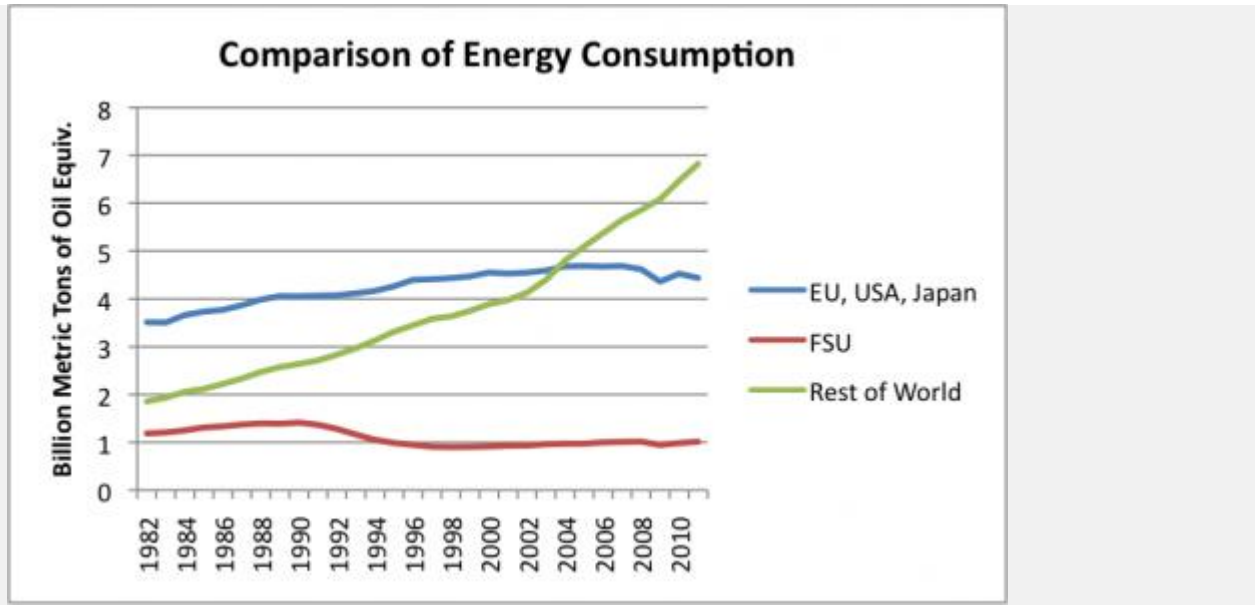


Figure 4. Energy Consumption divided among three parts of the world: (1) The combination of the European Union-27, USA, and Japan, (2) The Former Soviet Union, and (3) The Rest of the World, based on data from BP's 2012 Statistical Review of World Energy.

Energy consumption has been quite flat in the grouping of industrialized countries I show first (European Union-27, USA, and Japan). The Former Soviet Union (FSU) collapsed in 1991, and the consumption for those countries has never recovered. Energy consumption for the "Rest of the World" has been increasing amazingly rapidly since 2002. The rest of the world includes China, India, Bangladesh, and many small countries, plus oil exporters, such as Saudi Arabia and Mexico. Although I don't break it out separately on Figure 4, the increase in energy consumption since 2002 has been especially marked in Asia.

The "bend" in the line for "Rest of the World" energy consumption took place immediately after China joined the World Trade Organization in December 2001. If we look at China's fuel consumption by itself, we see that its huge rise in energy consumption (Figure 5, below) came mostly from increased coal consumption starting at that time. Oil consumption also increased. Nuclear and renewables are too small to be visible on the chart.

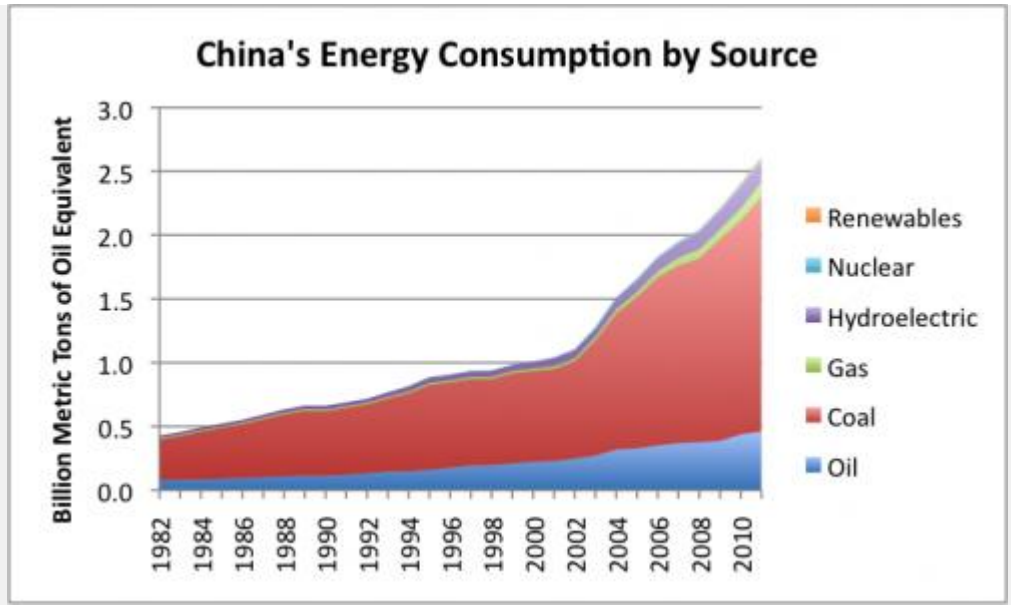


Figure 5. China's energy consumption by source, based on BP's Statistical Review of World Energy data.

Other countries, especially Asian countries like India, also ramped up their energy consumption at a similar time. India also uses coal as its primary fuel, with 53% of its energy consumption in 2011 coming from coal (based on BP 2012 data).
While I don't have employment data for Figure 4 groupings, I do have economic growth data (Real GDP is Gross Domestic Product, adjusted to remove effects of inflation), shown in Figure 6, below.

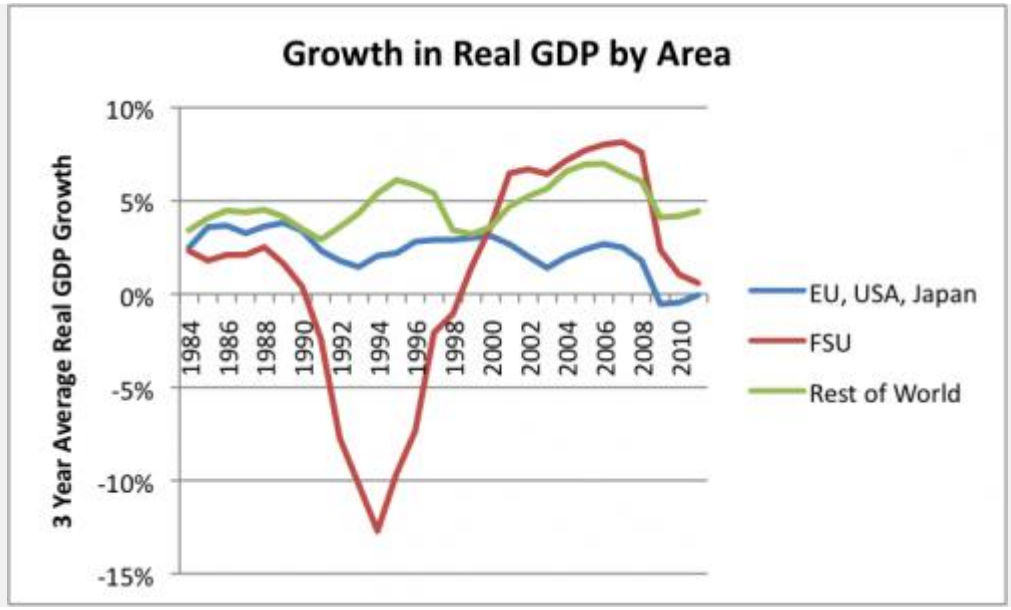

Figure 6. Three-year average real GDP growth for (1) EU-27, USA, and Japan, (2) Former Soviet Union, and (3) Rest of the World, based on data by Angus Maddison through 2008, and USDA since then.

Figure 6 indicates that the economy of the "Rest of World" has been growing much faster than the EU, USA, and Japan grouping since 2001. In fact the Rest of the World's growth has been much faster for nearly the entire period shown on the graph. Based on the steeper rise in energy consumption of the "Rest of World," in Figure 4 compared to the old industrialized countries grouping, this might be the predicted result.

One point that many people miss is that the Great Recession of 2007-2009 was to a significant extent a phenomenon of the older industrialized countries. EU, USA, and Japan all were hit very hard, while the "Rest of the World" almost sailed along. This can be seen in the energy consumption data on Figure 4, and the economic growth data on Figure 6. The Rest of the World slowed down a bit, but even during that period, its growth rate exceeded the best growth rate of the EU, USA, and Japan grouping during the 1984-2011 period (based on Figure 6).

## Is it Possible to Change the Relationship between Energy Consumption and Number Employed?

The answer is pretty clearly, yes, but lower wages may be part of the mix.

Let's look at how the United States changed its energy consumption, per number of people employed, over time. If we go back to the 1949 to 1972 time period, we also see a close relationship ( $R_2$ = 99%) between US energy consumption and employment, but it is a different close relationship than since 1982, (shown in Figure 2, near the top of this post).

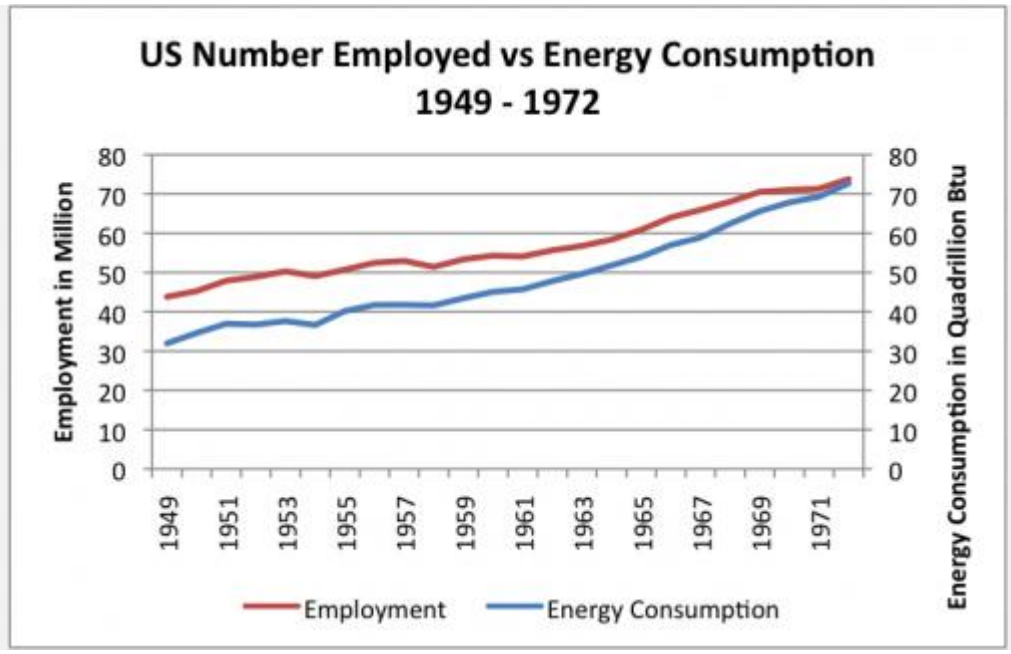


Figure 7. Graph of amounts similar to Figure 2, but for the period 1949 to 1972.

During the 1949 to 1972 period, energy consumption was **consistently rising** faster than the number of people employed. Oil was cheap, as were other energy sources, so not too much thought was given to how efficiently it was used. Also, as we will see in Figure 9, wages for workers were rising much more quickly (in inflation-adjusted terms) than they have been in more recent times.

About 1972, we discovered we had a big problem:

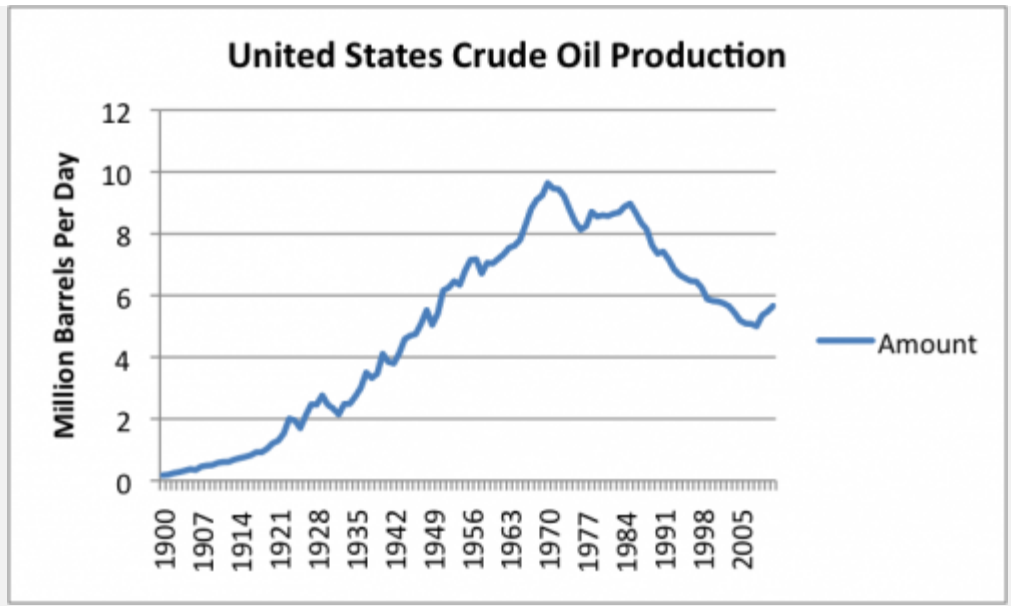

Figure 8. US crude oil production based on data of the US Energy Information Administration.

Oil had been our largest source of energy, and our own domestic production was dropping quite rapidly. By 1973, the Arabs had discovered our vulnerability, and the 1973 Oil Embargo began, leading to a sharp rise in gasoline prices. The US Federal Government regulated oil prices from 1973 to 1981. At the same time, a major effort was made to switch oil use to another fuel whenever possible. Electricity generation was switched to include more coal and nuclear (based on EIA data), and to remove production using oil. There was great demand for more fuel-efficient cars, leading to the import of cars from Japan (a country that had been making smaller cars for years), and the down-sizing of US cars.

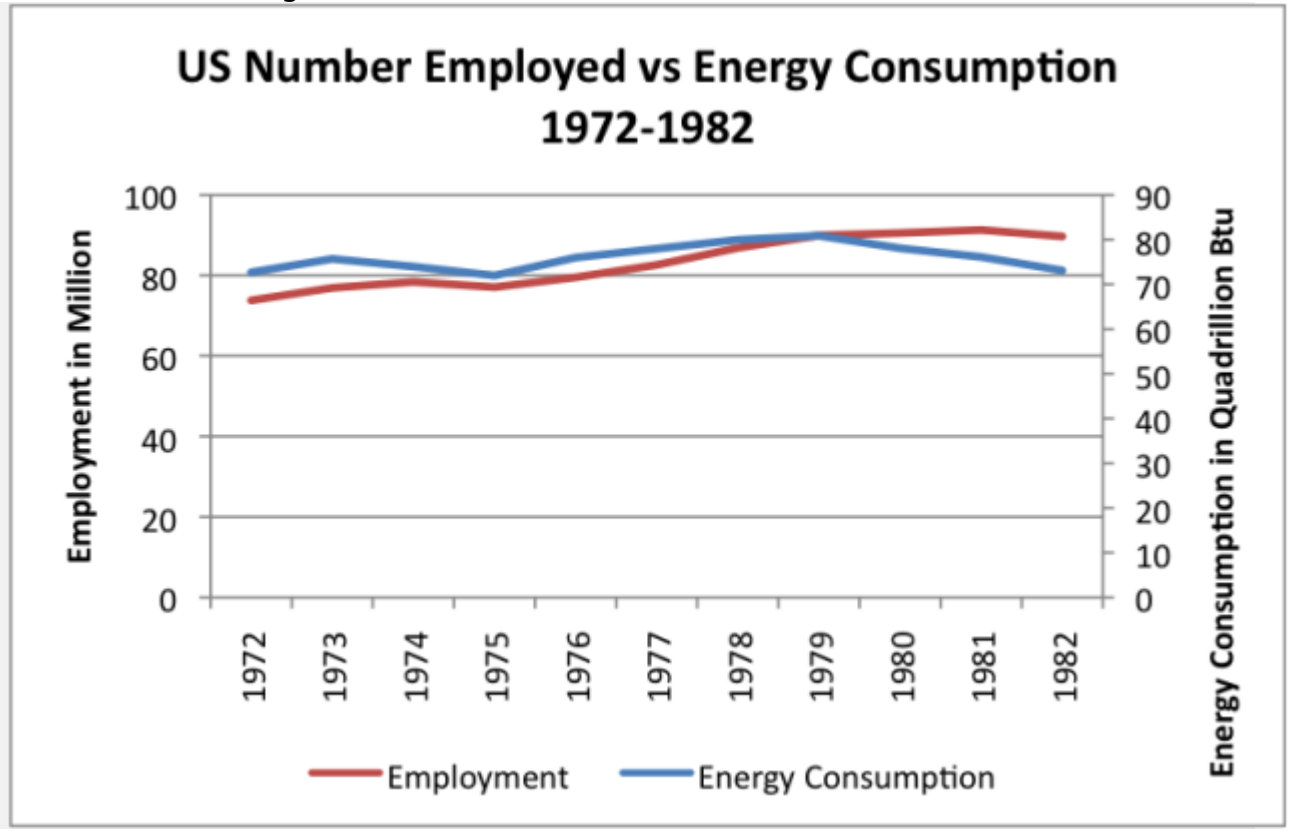


Figure 9. Employment and Energy Consumption using data similar to that used in Figure 2 and 7, but for the 1972-1982 time period.

As a result, the period 1972-1982 was a time when energy consumption was relatively flat, but employment rose. A big part of this rise reflected the addition of women who had not previously worked outside of the home to the work force. With the higher price of oil, salaries did not go as far, so having another family member working was helpful. According to Toosi, the percentage of women who were part of the workforce rose

from 43.3% in 1970 to 51.1% 1980. Wages of women were lower than those of men (Figure 10, below), helping to hold down the average wage.

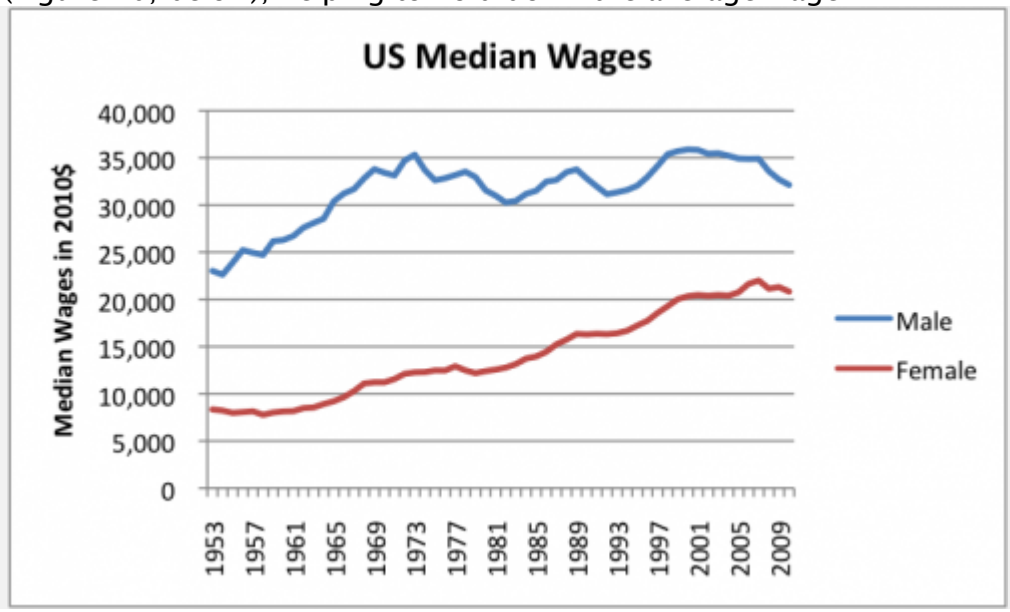


Figure 10. US Median Wages, separately for males and females, in 2010$. Based onCensus Historical Income Tables: People, Table P5 – Regions by Median Income and Sex.

Also, the wages of lower-paid men stopped rising in real (inflation-adjusted) terms. (The wages shown are Figure 5 are median wages–50% of wage-earners earn more than that amount and 50% year earn less.) Wages of high-paid workers, such as business executives and physicians (not shown on the chart), were still rising.

It is hard to tell what the relative impacts were of the many changes that took place in the 1972 to 1982 time period. Clearly, lower average wages (with more women in the work force) and flatter wages were a big part of the change. But there were other changes as well, including more imported manufactured goods, changes to fuels other than oil, and more efficient use of oil, all contributing to the differences we see between Figure 2 and Figure 7. The US became a net importer during this period as well, and thus began running up external debt (based on US Bureau of Economic Analysis data).

Comparing energy-employment patterns in Figure 2 and Figure 7 may be confusing for some. I show the change in the relationship in another way in Figure 11. Here I show (energy consumption/number of people employed). It shows that energy consumption per employed person was rising prior to 1972, came down for a variety of reasons in the 1972-1982 period, and is now pretty close to flat (decreasing slightly).

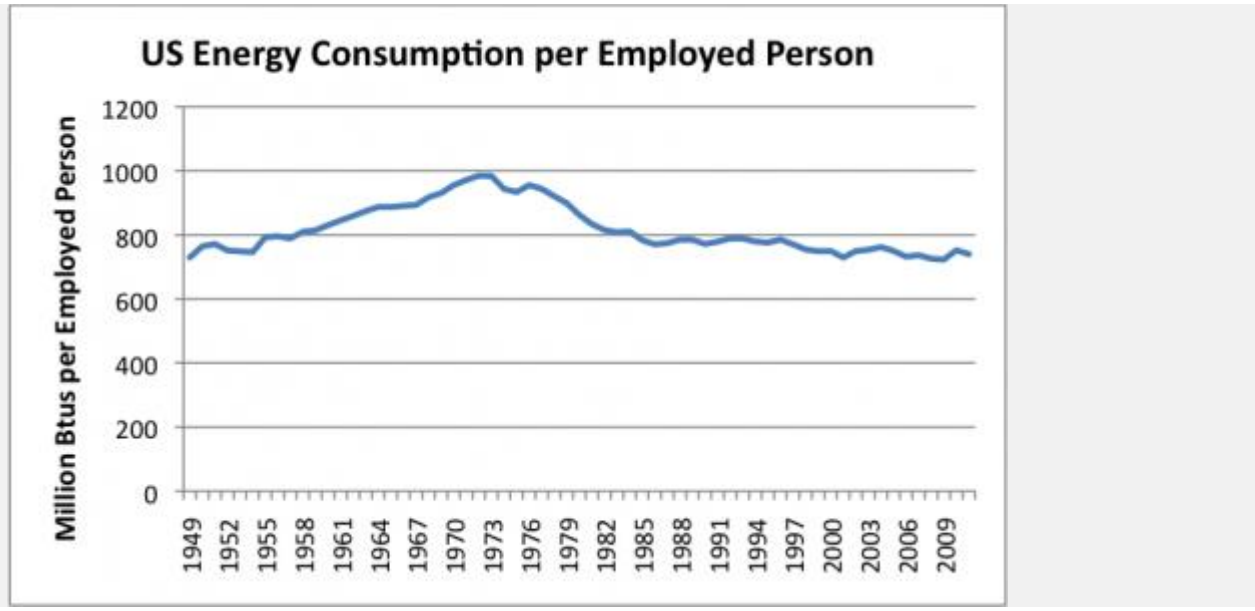


Figure 11. Total US energy consumption divided by number employed. Energy consumption from US EIA, number of non-farm workers from US Bureau of Labor Statistics.

On a positive note, one factor that has helped keep quality of life up is increased efficiency in using energy. Homes are better insulated now. Home heating and cooling units are more efficient. Businesses have worked hard to keep energy use down, because energy is a major factor in their cost structure. For example, we read about airlines retiring their less fuel-efficient jets. Thus, even though energy consumption divided by number of workers is flat or trending slightly downward, our standard of living has risen considerably since 1970 or 1980.

Another thing that has helped improve living standards is the amount of manufactured goods we are now importing from China and other countries around the world, especially Asian countries. The amount of debt we need to keep amassing to buy all of the goods we buy abroad is a problem, however, because we are not earning enough to pay the full amount of these goods. If we could count on economic growth forever, perhaps we could simply "grow" out of this debt, but this seems increasingly unlikely, for reasons I will discuss in later posts.

## The United States Hit Peak Percentage Employed in 2000

If we look at the percentage of the US population who have jobs outside the home (or self-employed farm workers), the trend is quite alarming (Figure 12):

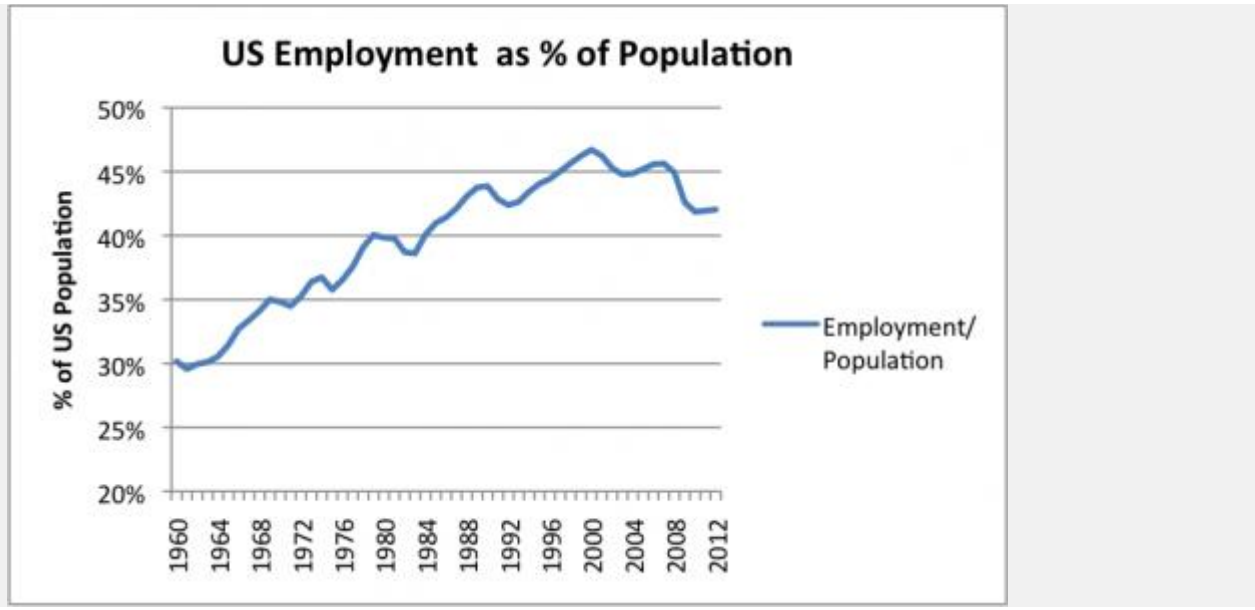


Figure 12. US Number Employed / Population, where US Number Employed is Total Non_Farm Workers from Current Employment Statistics of the Bureau of Labor Statistics and Population is US Resident Population from the US Census. (This includes children and others not usually in the labor force.) 2012 is a partial year estimate.

While the percentage of people with jobs was rising between 1960 and 2000, in recent years it has dropped. The recent drop seems to be at least in part related to the shift in energy consumption growth (and jobs) to the "Rest of the World," which includes China, India, and many other developing countries and oil exporting countries. Jobs that the United States would have had, seem to have been shifted elsewhere.

The percentage of US population employed outside the home or farm has grown for a very long time. The increase started in the 1800s, as the use of coal allowed a reduction to the number of workers needed in farming, because it allowed more use of metals, enabled the use of electricity, and helped make farmers more efficient. See my post The Long-Term Tie Between Energy Supply, Population, and the Economy. See also Smil, (1994) and Lebergott (1966). Later, women increasingly joined the work force, especially after World War II.

The combination of rising energy costs (especially oil) and increased international trade gave China and other Far Eastern countries an opportunity to ramp up their manufacturing and service industries (call centers in India, for example). Jobs migrated to China and to other countries with low energy costs (thanks to lots of coal in the mix) and low costs of living, thanks in part to better solar heating.

There had always been some foreign trade, but the amount of trade increased in the late 1970s, when we started importing smaller cars from Japan, as well as more oil. It increased again later, especially after China entered the World Trade Organization in late 2001. US imports of goods and services increased from $54 billion in 1970, to $291 billion in 1980, to $616 billion in 1990, to $1.4 trillion in 2000, and to $2.7 trillion in 2011 (US Bureau of Economic Analysis).

## Other Observations

**Role of World Trade.** Figure 4 suggests that world trade makes a huge difference in the amount of energy consumed. If we truly wanted to reduce our energy consumption (which I doubt world leaders are really interested in), we could reduce world trade through taxes on imports, or some other mechanism. The number of people employed would likely drop as well, although perhaps part of the difference could be made up by greater efficiency and by lower wages for individual workers.

The important role of world trade also brings up another issue. If world trade were, for some reason, interrupted or seriously scaled back, this would likely significantly reduce energy consumption (and employment) around the world.

**Energy Consumption vs Number of Jobs Patterns by Country will Vary**. I have shown US data. Patterns in other countries are likely to vary, in part because of the different specializations (amount of services compared to manufacturing, for example) of different countries, and different wage levels in different countries.

**Good Intentions Aren't Always Helpful.** The Kyoto Protocol with respect to Climate Change was adopted in 1997. Figure 4 and Figure 5 suggest that adding China to the World Trade Organization had far more impact, and in the opposite direction. In fact, additional carbon taxes on goods that require high energy input may have encouraged competition in countries without such controls. Furthermore, reduced oil consumption through, say, higher taxes on gasoline, left more oil on the world market, to be used by developing countries. (This is related to "inelastic supply" of oil. Reducing demand in one area leaves more supply for other areas.)

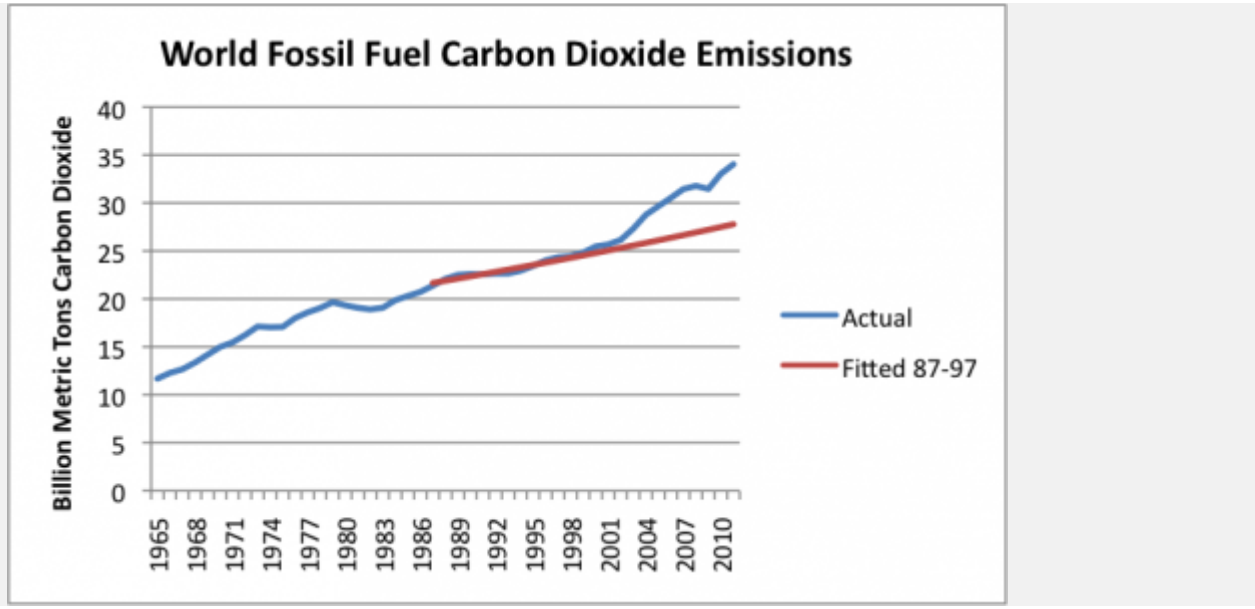


Figure 13. Actual world carbon dioxide emissions from fossil fuels, as shown in BP's 2012 Statistical Review of World Energy. Fitted line is expected trend in emissions, based on actual trend in emissions from 1987-1997, equal to about 1.0% per year.

Figure 13 shows that while Kyoto Protocol may have helped reduce emissions in some countries, world carbon dioxide emissions have grown more than what would have been expected, based on the 1987-1997 trend in emissions. If the Kyoto Protocol influenced China's and the rest of Asia's decision to ramp up exports, this decision would have indirectly affected job availability in the United States, even if the US was not a signer of the Protocol.

**The "Smaller Batch" Issue.** If there is not enough energy to go around at prices people can afford to pay, recession seems to be nature's way of fixing the situation. I compare the situation to a chemical formula, or to a cake recipe. If one necessary ingredient is in short supply, the economy behaves as if it is making a "smaller batch". It contracts in a way that leaves out those who were most marginal to begin with-such as employees of discretionary industries, and borrowers who could only barely make payments on loans (subprime borrowers), and countries with the highest energy costs. Employment is reduced, and unemployed people tend to move in with friends or their family, to cut expenses. This reduces energy consumption.

**Increased Wage Dispersion May Reflect Another of Nature's Coping Mechanisms.** In the animal kingdom, any "K-selected species," such as a dog or cats or primates, (probably including humans), has an inborn instinct toward hierarchical behavior. The manifestation of this instinct tends to be greater as there is greater crowding, and

greater competition for resources (Dilworth, 2009). The intent in the animal kingdom is survival of the fittest, with those at the bottom of the hierarchy being starved out, if there is not enough to go around.

It is striking to me that since the mid-1970s, we have seen what could perhaps be interpreted as increased hierarchical behavior in humans and corporations. Wage dispersion has tended to become greater since the mid-1970s, when we started encountering energy supply problems. We have also seen the growth of international businesses. These large businesses have been increasingly favorably taxed, because they can choose tax havens around the world to incorporate. All of these changes tend to concentrate wealth at the top, in large companies and in the wealth of high paid workers. Perhaps all of this is a coincidence, but the timing is striking.

Increased use of part-time and contract jobs might be considered a trend in this direction as well. Job sharing has been proposed as a way of dealing with having an inadequate number of jobs in the older industrialized countries, but this tends to act in the same way (pushes the wages of lower-paid workers down, while leaving the top wages untouched).

**Economic Models.** Economic models seem not to take into account the very substantial shift in percentage of the population employed. Part of economic growth on the "way up" was growth in the percentage of people employed. If economists miss this change, as well as the fact that the percentage now seems to be headed down, their models will be wrong. Expected economic growth may disappear.

The World War II baby boom generation is now reaching retirement age. This change will tend to push the percentage of population employed down further, all other things being equal.

**Impact on Governments.** If fewer people are employed, this is a problem for governments around the world. Governments in Europe are particularly affected now, partly because of the generous benefits they offer. The US budget deficit is very much related to this issue as well. I will write more about debt and government funding in another post.

**Notes:**

[1] The idea of looking at employment in relationship to the economy after reading Mario Giampietro and Kozo Mayumi's book, *The Biofuel Delusion: The Fallacy of Large-Scale Agro-Biofuel Production*, Earthscan, 2009.

[2] While total energy costs are important, individual energy costs, such as gasoline cost, are important as well, because there is little short-term substitutability across sectors. For example, coal is not an option for running today's gasoline-powered cars, and public transport is not an option in most of the US. If there is a long enough lead-time and citizens can afford the transition, substitutions might be made, but it is not something we can count very much in the short term.

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