Japan 1985-2015: A Country Risk Analysis

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Table of Contents

List of Figures

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Japan is commonly viewed as having one of the most advanced and stable economies in the world, and in 2015, it had the world's third-largest economy by Nominal GDP (World Bank, 2021). The purpose of this paper is to examine the state and development of the Japanese economy in the period ranging from 1985 to 2015. In correspondence with the structure with which macroeconomists tend to analyze economic history, the subsequent chapters of this papers will focus on the short, the medium, and the long run, all in the period at hand. First, however, it seems prudent to provide an overview of the broad trends that emerged during this 30-year period. Chapter 1 therefore examines the long-run development and baseline indicators for the Japanese economy.

Chapter 2 expands the analysis into two topics that pertain to the medium run of the Japanese economy: the dynamics of inflation, and unemployment, respectively. The main tool of analysis used is the Phillips Curve and various ways to graphically explore this relation for economic inference. This chapter also examines trends in inflation and unemployment.

Chapter 3 covers the long run, and it examines key drivers of economic growth, such as population dynamics and technological progress. A detailed analysis of the dynamics, ownership structure, and cause of Japan's extraordinary debt is combined with a conclusion about its sustainability.

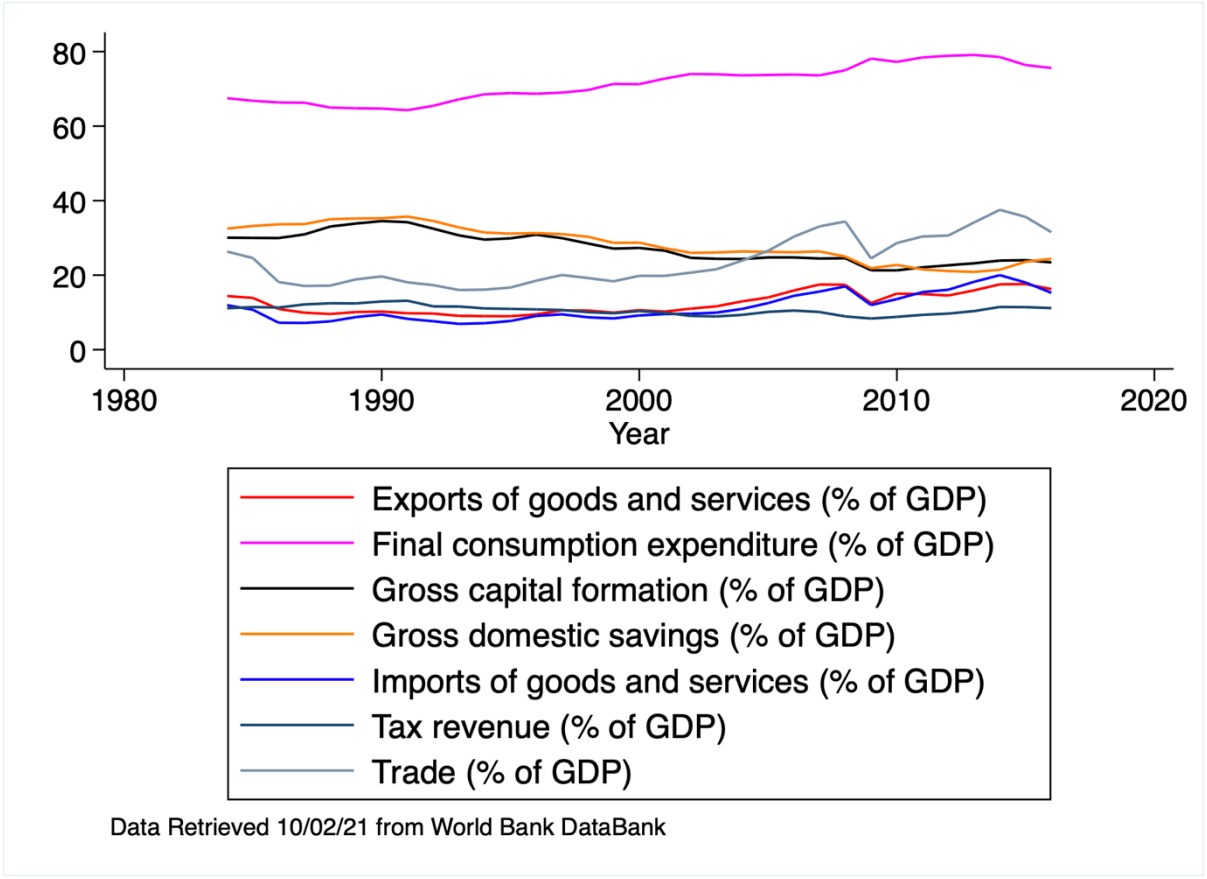
Chapter 4.1 analyzes the monetary policy conduct of Japan's central bank. It divides the period into three sections and explores causes and reactions of monetary policy.

Chapter 4.2 concludes the paper by discussing challenges to Japan's economic resilience.

Chapter 1: Overview

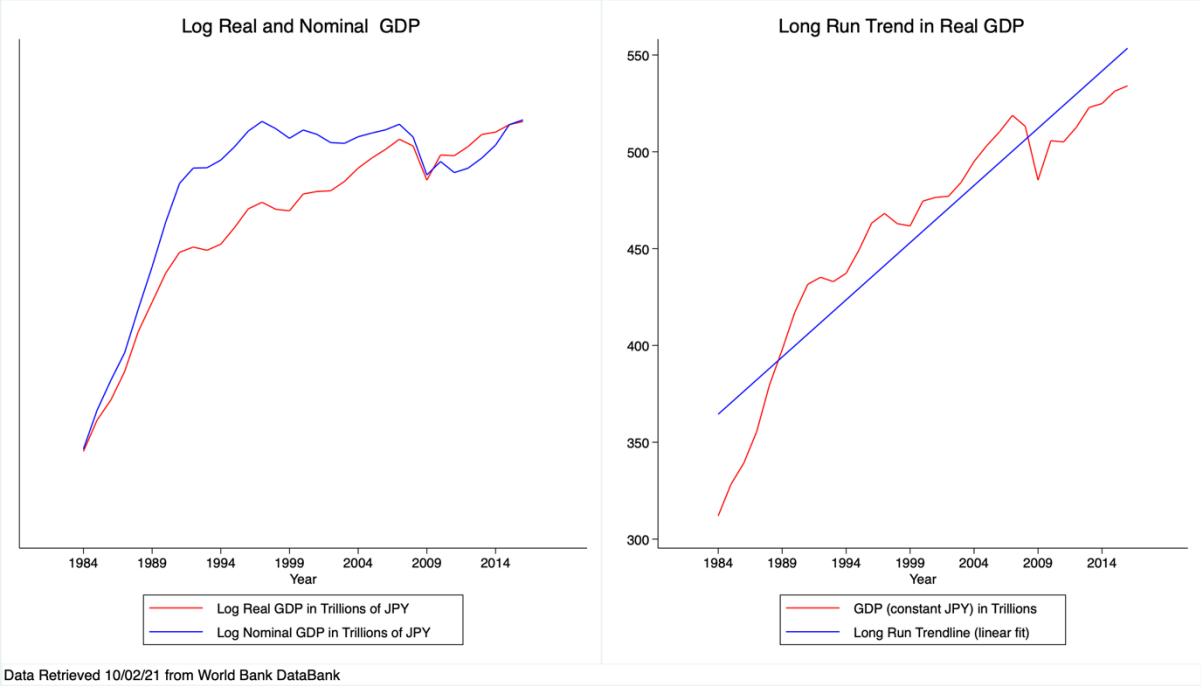
Although Japan currently is a wealthy country with stable economic growth, a mature industrial base, and strong trade ties, the state of its economy has not been rosy for the entirety of the last 40 years. The first indicator that lends itself to a big-picture analysis is Gross Domestic Product (GDP), usually defined by the identity $Y \equiv C + I + G + X - IM$, where output is denoted by *Y*, Consumption by *C*, Investment or capital formation as *I*, Government expenditure as *G*, Exports as *X*, and Imports as *IM* (Blanchard, 2020). In line with the popular tale of economic prosperity as a direct consequence of ever-tighter global integration, the share of net exports has risen considerably since the turn of the century, as shown in Figure 1. Parallel to the increasing importance of trade, there is also an evident decline in the role of investment, as well as a steady, albeit slow, rise in the importance of consumptive spending. Whereas the composition of the Japanese GDP has undergone comparatively slow change, the same cannot be said for the level of GDP itself.

Figure 1: GDP Composition



At the very beginning of the period at hand, the Japanese economy began to grow rapidly after the signing of the Plaza Accord, a multilateral agreement that led to the currency of Japan, the yen (JPY), dramatically increasing in value. Figure 2 shows the drastic increase in both nominal and real GDP, both in logarithmic terms (left panel) as well as absolute terms (right panel). The right panel of figure 2 features an overlaid trendline, calculated as a univariate OLS regression. By the end of the 1980s, Japan's real GDP exceeded 400 Trillion JPY, and it remained above its long-term trend until the Great Financial Crisis (GFC), which in 2008 plunged the global economy into a deep recession.

Figure 2: Nominal and Real GDP



From this first simplistic measure, one might well conclude that the Japanese economy did not exhibit downturns until the advent of the GFC, but upon close examination, this turns out not to be the case. Figure 3 showcases all years in the period during which percentage growth in real GDP was negative, which I will use as an indicator for a recession.[1] As the left panel of figure 3 shows, the Japanese economy exhibited negative growth in the years 1993, 1998 and 1999, 2008 and 2009, as well as 2011. The last three of these are a direct result of the GFC, and the subsequent global debt crisis, and will be more closely examined in the following chapters. The recessionary periods in the 1990s are part of a phenomenon referred to as the

[1] The most commonly used definition of a recession, 2 consecutive quarters of negative GDP growth, is more precise, but for this chapter, which gives an overview of a 30-year period, annual changes are sufficient.

"lost decade" (Obstfeld, 2009), and their causes and effects are the point of focus of the next chapter. The right panel of figure 3 presents the change in the penultimate macroeconomic variable of choice for this general overview: unemployment.

Figure 3: GDP and Unemployment in Recession Years

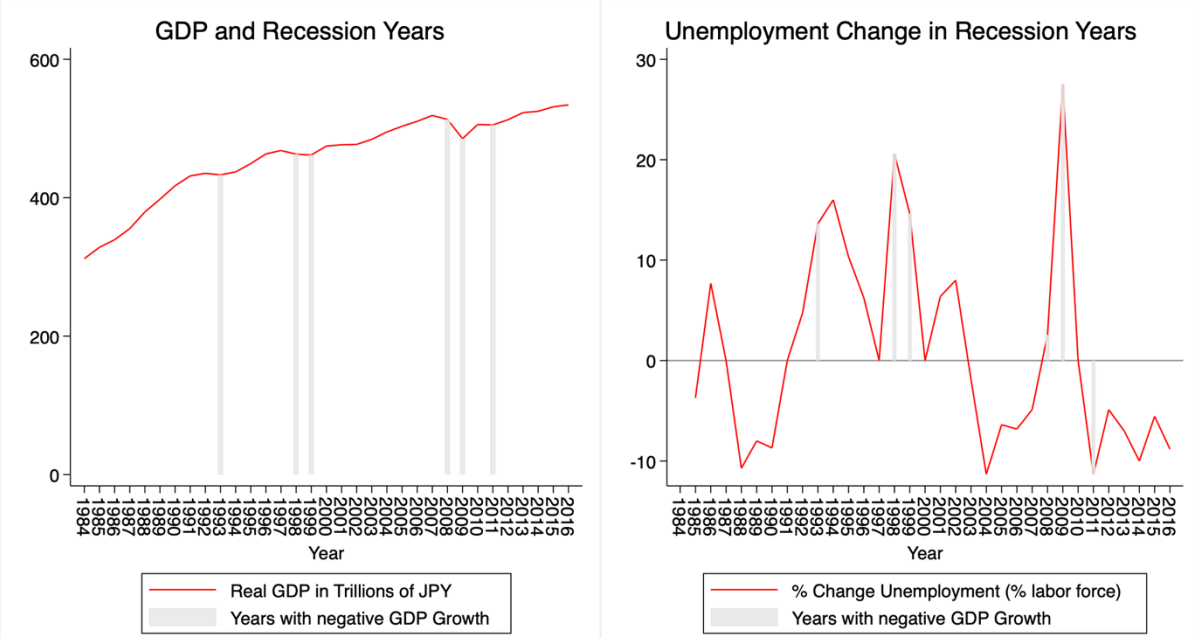


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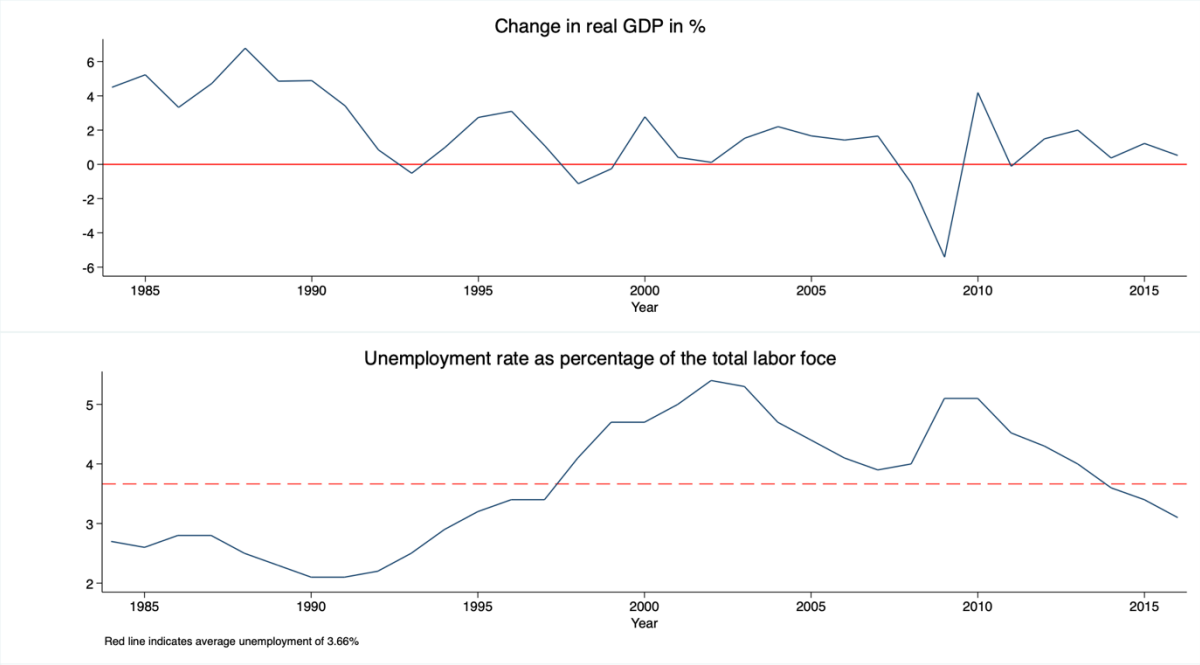
Figure 4: GDP and Unemployment



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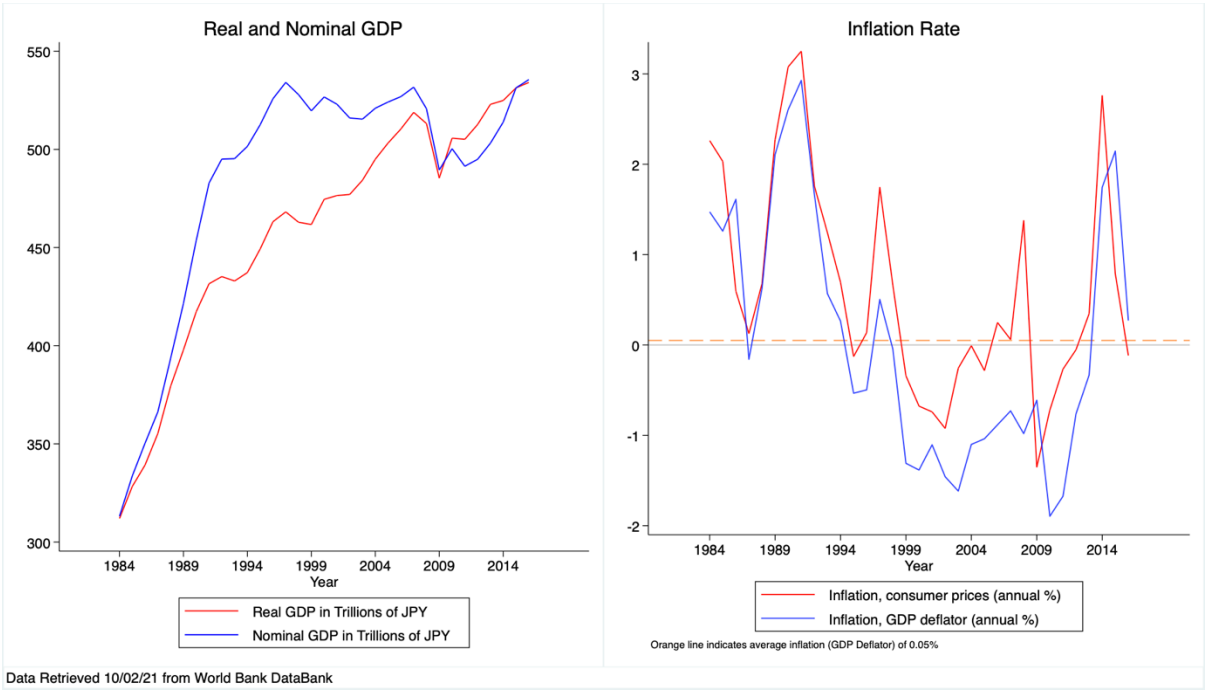
A comparison between the panels of figure 3 presents an intuitive correspondence between years with negative GDP growth and a spike in the percentage increase in unemployment. During an economic downturn, falling demand places cost pressure on businesses, which adapt by laying off workers, especially those in low-skilled or seasonal jobs (Blanchard, 2020). Absolute values of the unemployment rate for these same periods can be gleaned from the lower panel of figure 4. During the aforementioned "lost decade", unemployment rose above its long-term average of about 3.6%, and it took the Japanese economy nearly 20 years to decrease this slack in utilization of human capital to under the average level.

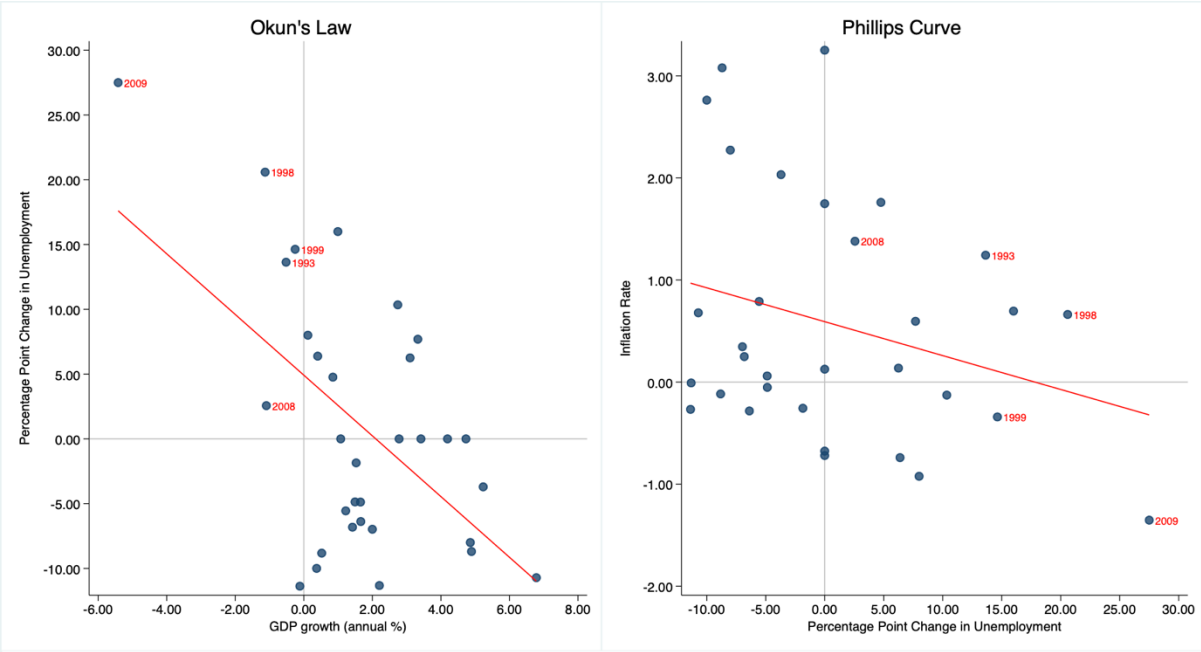
The last individual macroeconomic indicator that provides important context when analyzing long-term economic growth is inflation. A sustained inflation over long periods of time makes it more difficult to correctly attribute an increase in nominal GDP, as part of this increase has to be attributed to an increase in the price level. The large difference between nominal and real GDP that is visible in the left panel of figure 5 between 1989 and 2004 corresponds to a period with substantial inflation between 1989 and 1999 in the right panel of figure 5. The gap between nominal and real GDP in the left panel narrows in unison with a period of sustained deflation from 1999 to 2014, when nominal and real GDP reach parity.

Figure 5: GDP and the Inflation Rate



As a last step in this overview, I will very briefly explore two established descriptive relationships between the four main aggregate economic indicators: GDP growth, unemployment, and inflation. The first, Okun's Law, is an empirical regularity that connects growth in (real) output to the inflation rate. As shown in the left panel of figure 6, the relationship between the percentage change in unemployment and annual growth in real GDP can be fitted as a linear equation with a negative slope, although the fit in this univariate regression is not particularly good. A cursory interpretation of this regression line suggests that over the period considered, the unemployment rate remained constant when GDP growth was at 2%. The second, the Phillips Curve, shown in the right panel of figure 6, describes the interplay between the unemployment rate and the inflation rate and is visualized again using an OLS regression line with a fairly loose fit. A cautious interpretation of this panel yields the conclusion that on average, a rate of unemployment above roughly 4.3% has corresponded with deflation in the Japanese economy during the period considered. It seems prescient to note here that, as Charles Goodhart conjectured, the descriptive relationships visible in this figure should not be interpreted as policy prescriptions, as they "might weaken, and even disappear, should policymakers ever try to exploit them" (Evans, 1985, p. 1).

Figure 6: Okun's Law and the Phillips curve

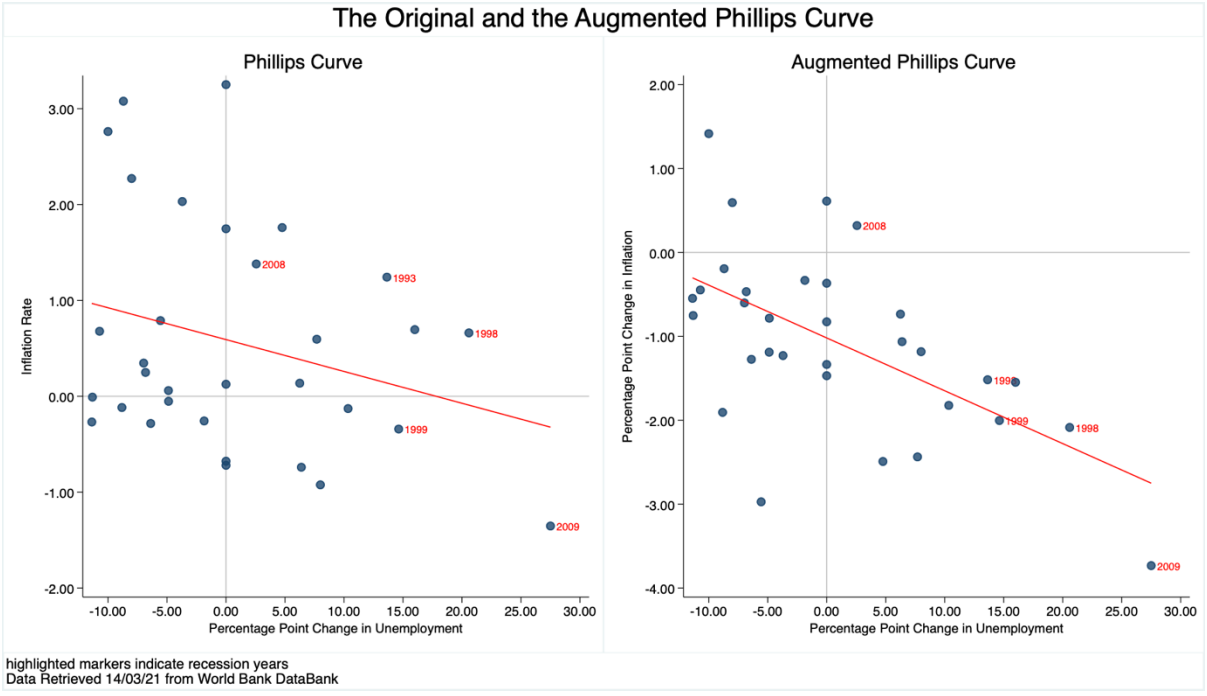


Chapter 2: The Medium Run

As we are currently reminded, it takes time to build up production capacity of goods such as vaccines, no matter how high demand for that given good may be. A direct result of scarcity, human decisions, and regulation, this applies to almost every good and service produced in the world. Whereas in the short run, output fluctuates with demand and production capacity is mostly fixed, in the medium run, output tends to return to an equilibrium level determined by *structural* or *supply* factors, while allowing for larger changes in production. In this medium run of up to 10 years, the level of technology, the size of a country's labor force, and the availability of capital constrain even the most motivated entrepreneurs (Blanchard, 2020). Japan is technologically very well developed, and its financial markets are sizable, comparatively stable, and at least as liquid as their OECD counterparts (World Bank, 2021).

The Phillips Curve (PC) in the right panel of figure 6 shows a steady relation between the unemployment rate and the inflation rate, and therefore presents a typical example of this famous empirical regularity (Sleeman, 2011). Over time, the PC was developed into an *augmented* form that also takes into account *expected* inflation to better suit changing monetary policy regimes (Blanchard, 2020). The right panel of figure 7 showcases this augmented relation for the Japanese economy. It bears repeating that the fit of the following *descriptive* regression lines is not particularly tight.

Figure 7: The Original and the Augmented Phillips Curve



A one-percentage-point increase in the change in unemployment corresponds to a decrease in the change in inflation of about 3 percentage points. As shown in the right panel of figure 3, during all four recessionary years in the covered period, the change in unemployment exceeded 10 percentage points. Correspondingly, throughout the period, recession years coincided with sharp movements in the change in inflation, shown in more detail in figure 8 below.

Figure 9: Labor Market and Inflation Dynamics

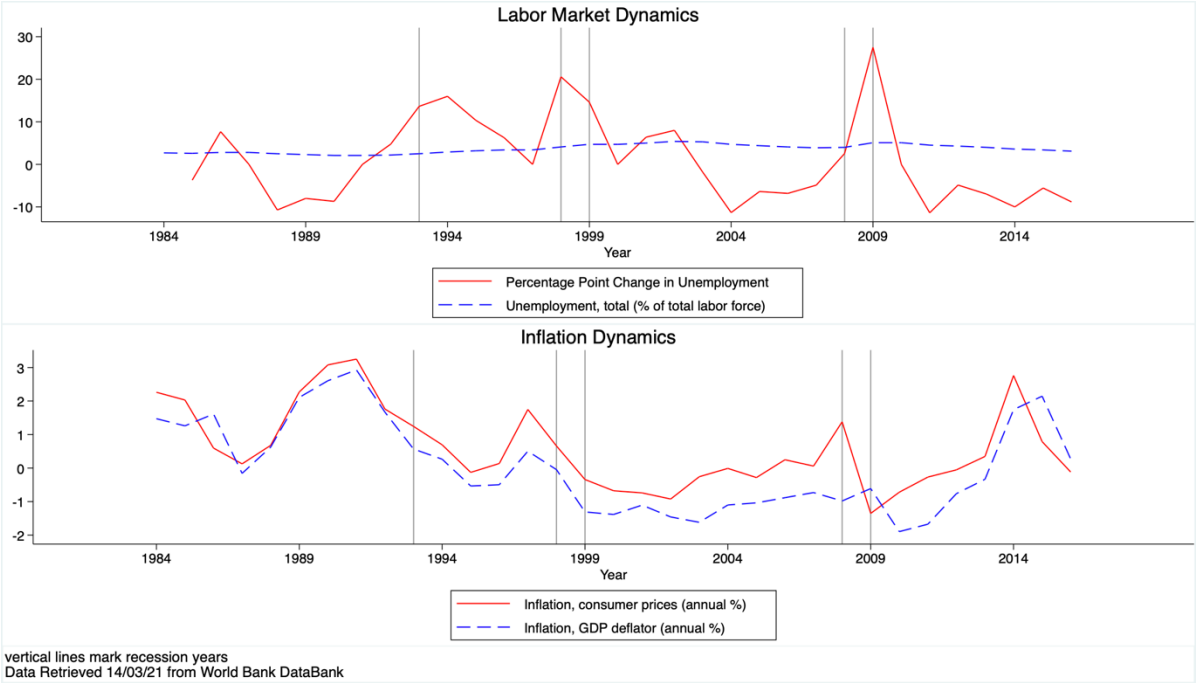
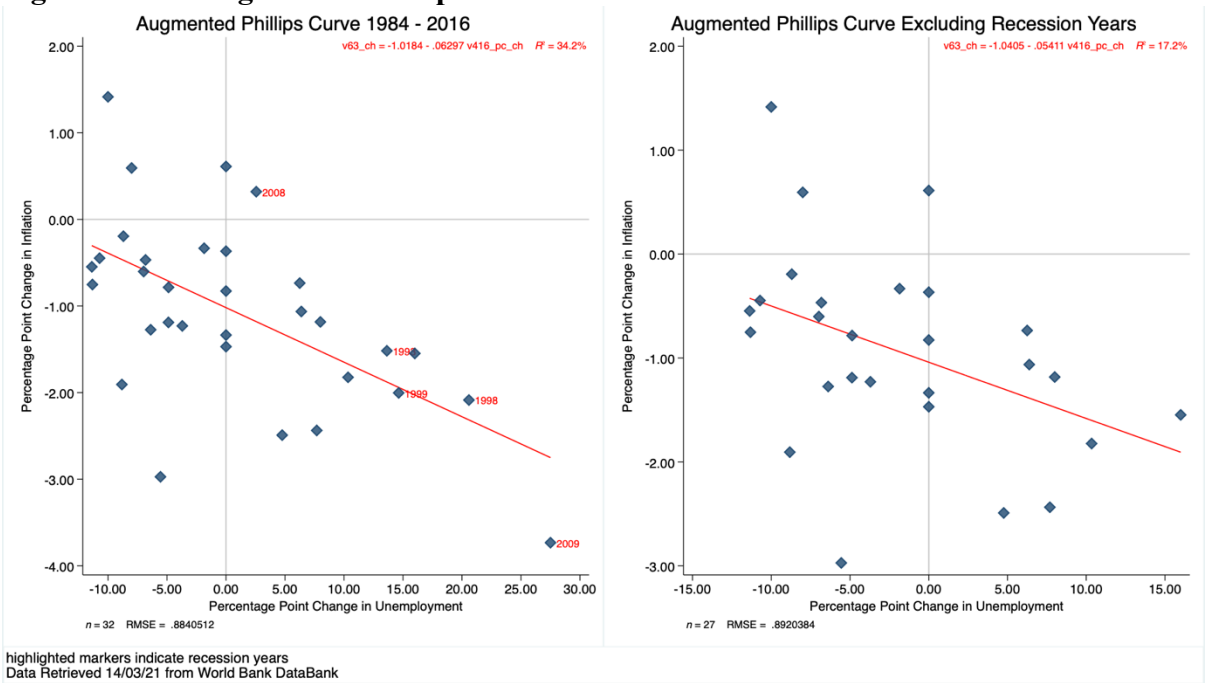
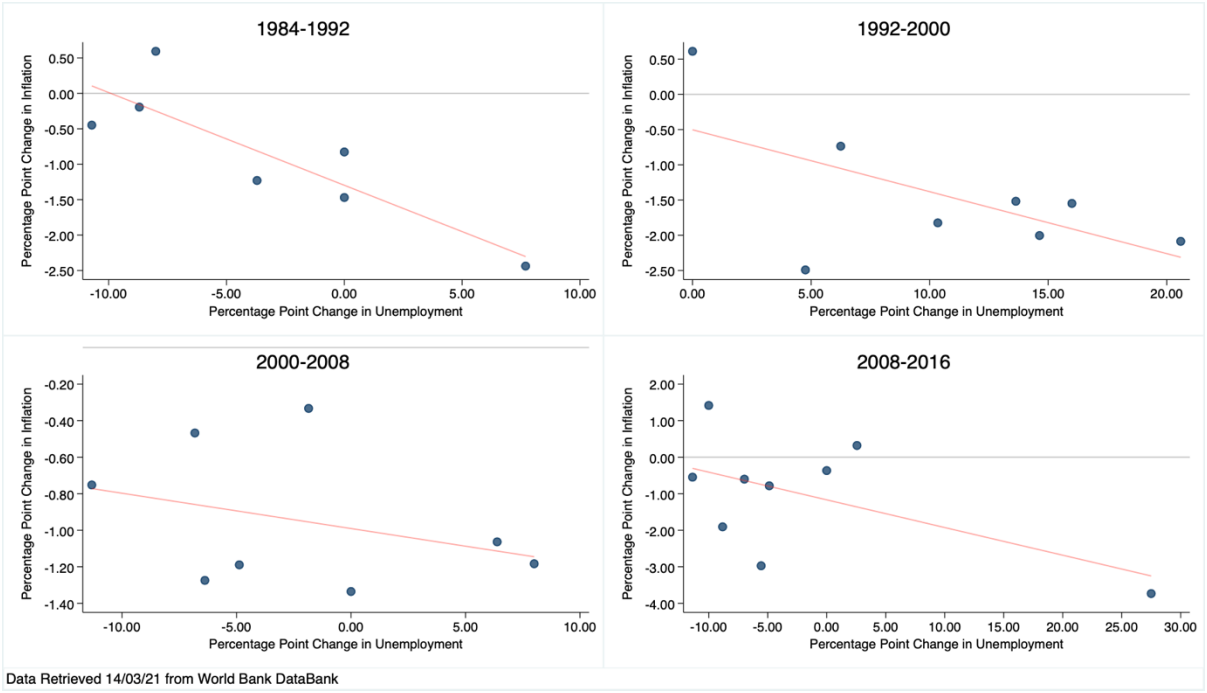


Figure 8: The Augmented Phillips Curve



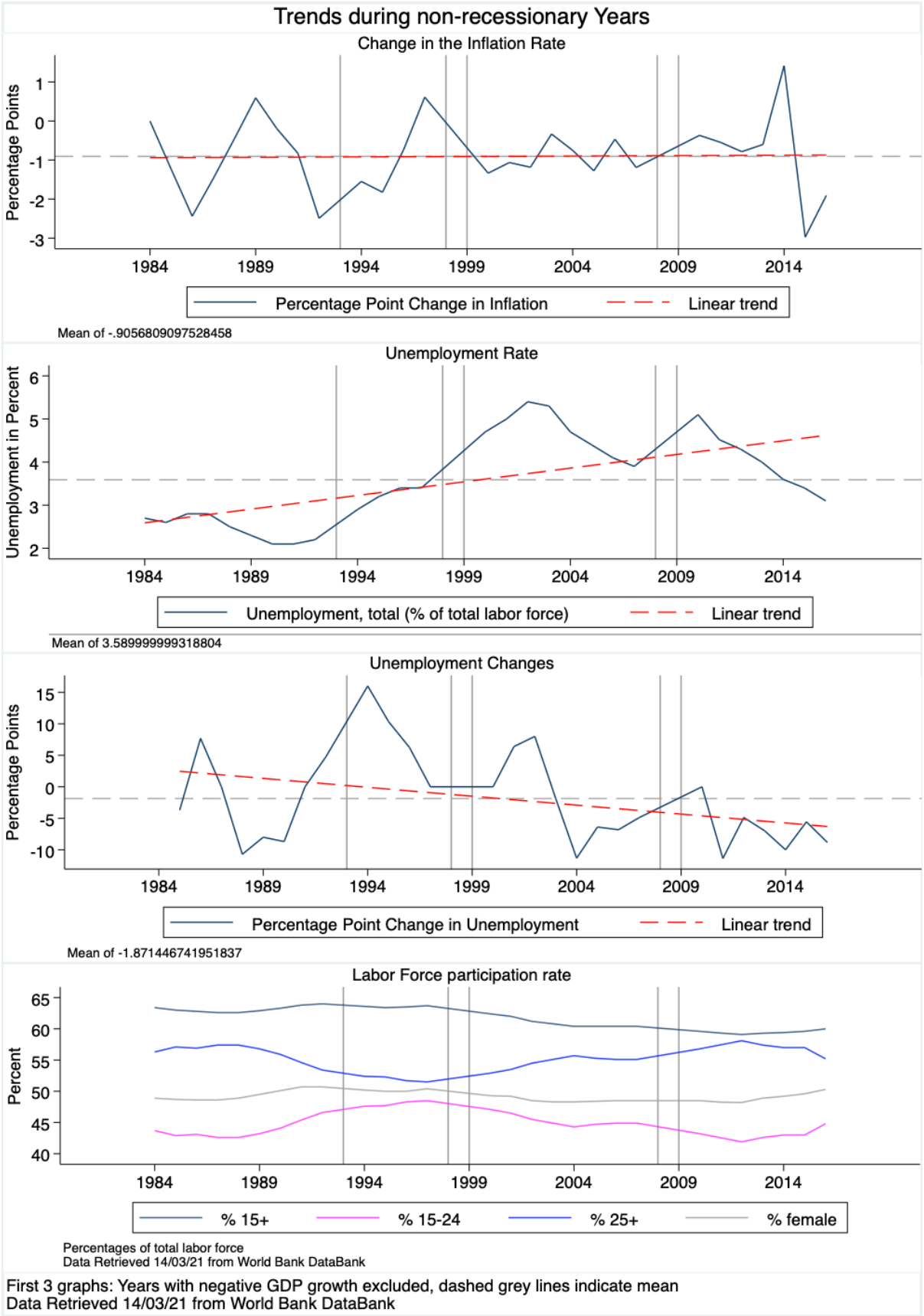
In light of such erratic swings, it therefore appears prudent to examine whether the PC holds if we exclude these 4 years, which are marked in red in the left panel of figure 9. As shown in the right-hand panel, the PC remains remarkably similar. Similarly, the PC is present consistently throughout the period, albeit varying in strength, as shown in figure 9. Smith (2008) even reports a PC for Japan that appears in the geographical shape of the country.

Figure 10: The Augmented Phillips Curve over Time



With this important negative relationship between unemployment and inflation –and, in the modern form, percentage changes in each– presenting itself so consistently, a logical next step lies in the examination of the underlying trends. The second panel of the last figure in this chapter, figure 11 below, shows the long-term trend in the unemployment rate of the Japanese economy. Recession Years are excluded for the same reason as laid out before, that is, to prevent drastic short-term spikes from distorting larger trends. The Unemployment rate rose continually from 1991 to 2001, and again during the Great Financial Crisis. While the phenomena of the "lost decade" and the GFC created a visible upward trend in unemployment, shown by the dashed red line in panel 2, the macroeconomic development during these two periods is commonly attributed to monetary policy (cf. Krugman, Dominquez, & Rogoff, 1998) and a high real exchange rate of the JPY (cf. Obstfeld, 2009). With these periods in mind, two things appear striking in panel 2: the mean unemployment rate over the period is at just 3.59%, a very low value when compared within the OECD, and even though there exists a slight upward trend as a result of the choice of period, unemployment never reaches even just 6%.

Figure 11: : Trends in Inflation, Unemployment, and Labor Force Composition



First 3 graphs: Years with negative GDP growth excluded, dashed grey lines indicate mean
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In panel 3 of figure 11, a congruent trend is visible in the percentage change in unemployment: with a mean of -1.87 percentage points and even a slight downward trend over time, the Japanese labor market evolved progressively to a progressively tight market with a very low equilibrium rate, often also called the *structural* rate of unemployment, of 3.59% and continuously decreasing changes in unemployment. Another way of contextualizing this structural rate of unemployment is linked to the inflation rate, and, by extension, the original Phillips Curve (shown in the right panel of figure 6). In this panel, if one traces the regression line to the 3.59% point on the x-axis, where the corresponding inflation rate is 0.66%, one can find what economists call the NAIRU: the non-accelerating inflation rate of unemployment. At this *rate* of unemployment, the inflation does not *increase*, meaning the inflation *rate* is constant, meaning the *change* in the inflation rate is zero (Blanchard, 2020).

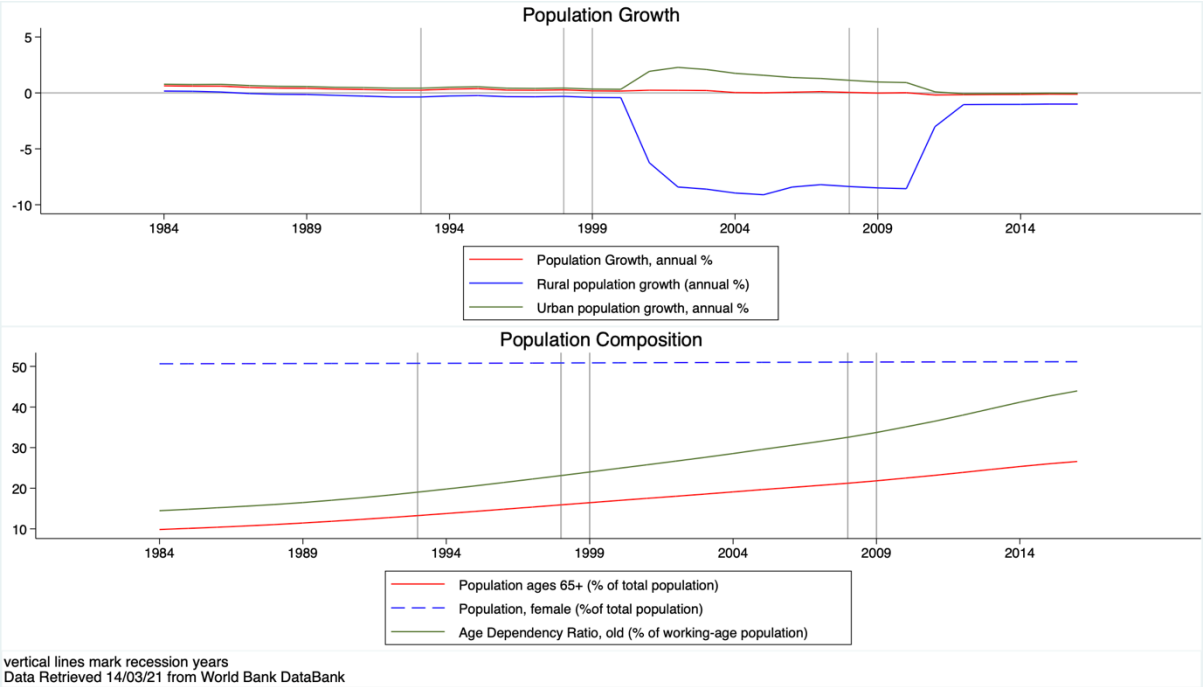
This is far from a coincidence: if we look at the first panel of figure 11, we can see that the mean inflation *rate* over the period is exactly this value of 0.66%. This linkage between figures 6 and 11 allows us to better understand the connection between the first and second panels of figure 11: the slight upward trend in the unemployment rate (panel 2) is exactly mirrored in a corresponding downward trend in the inflation rate. In short, the NAIRU and the mean inflation rate go hand-in-hand and, over the period considered, they converge. As a last step, we can compare the third panel of figure 11 with the left panel of figure 9: the mean inflation rate of -0.9% fits perfectly into the augmented PC, namely at the -0.9% on the y-axis, corresponding with no percentage point change in unemployment.

Even though the preceding analysis may seem a bit circular in nature at this point, that is exactly its purpose. The variations of the PC in combination with the trends underlying them allow us to fully understand the developments in the Japanese labor market and the inflation rate over time, which is precisely what the PC was intended for (Sleeman, 2011).

Chapter 3: The Long Run

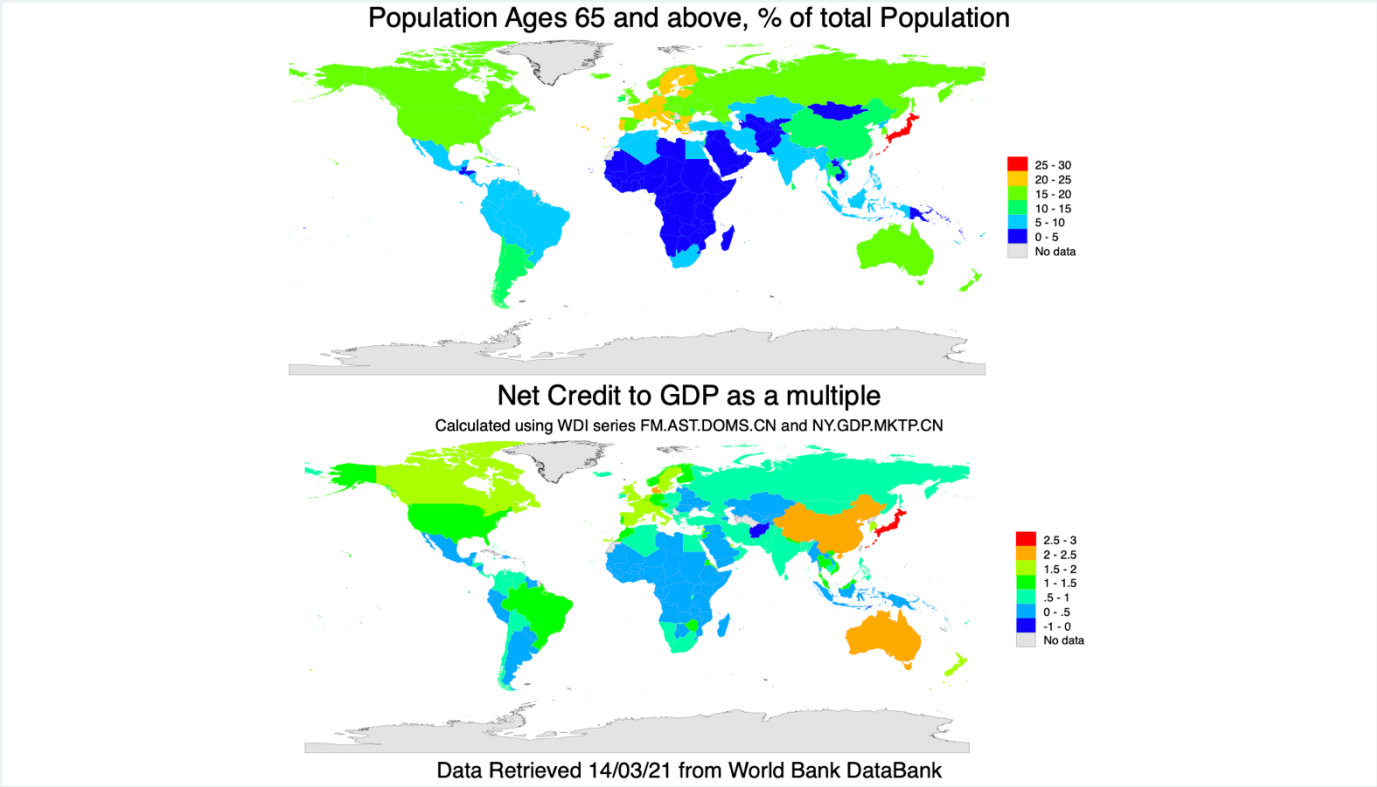
The preceding analysis of the Phillips Curve and its underlying trends for Japan yield insight into supply factors that constrain medium-run output. In the long run, supply factors cannot be assumed to be invariant anymore. The last panel of figure 11 displays a detailed breakdown of the Japanese labor force. Starting in the 1990s, two trends are discernible: the share of 15–24-year-olds in the Japanese labor force declines, while that of over-25-year-olds increases. This trend reflects a broader development in the Japanese population over the long run, shown in figure 12:

Figure 12: Population Growth and Composition



The population became increasingly urbanized and ceased growing around 2004. More importantly, however, the population has aged rapidly, and the percentage of over-65-year-olds who are dependent on younger relatives has skyrocketed, as is visible in the lower panel of figure 12. Long-run economic growth has several key determinants, which I will discuss in this chapter, and Japan exhibits worrying developments in two of them.

Figure 13: Worldwide Age Dependency and Debt

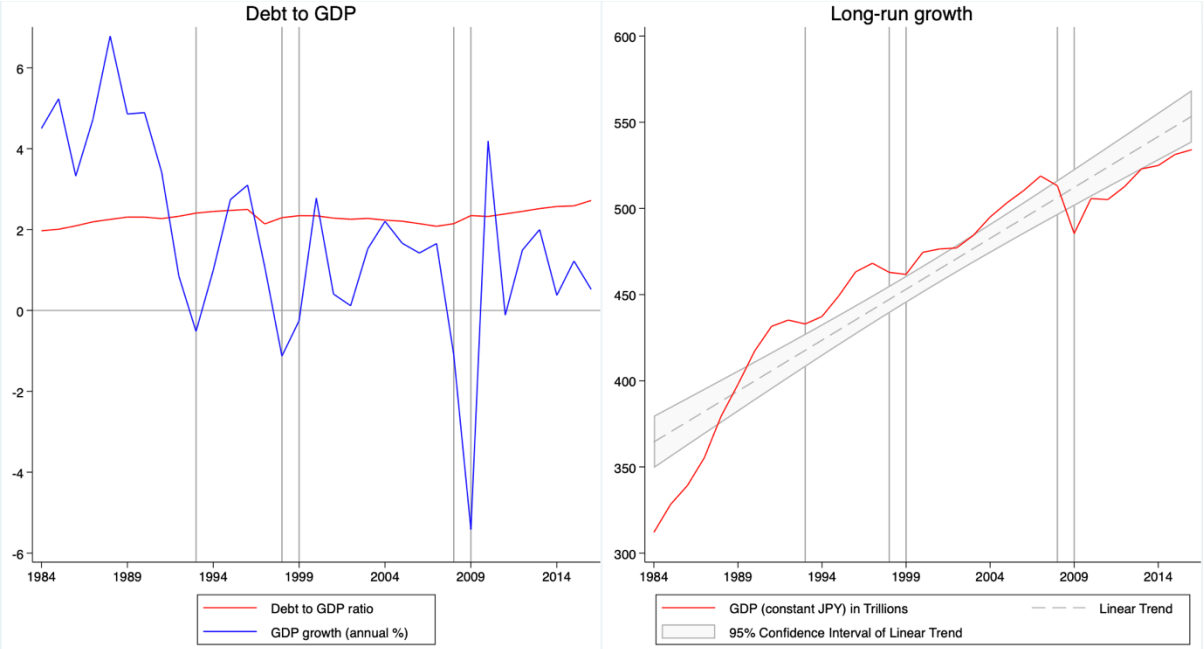


As figure 13 shows, Japan leads the world in two indicators, both marked in red: the proportion of individuals above the age of 65, and the ratio of debt to GDP. Whereas basic neoclassical growth models assume a constant population growth rate, the modern macroeconomic toolkit incorporates population dynamics more discreetly. Increasing social and economic dependency of the old can exert substantial strain on social dynamics, insurance and pensions systems, and the labor capacity of an economy more generally (cf. Cass, 1965; Gali, 2018). Economic growth is not self-sustaining, and the Japanese labor force might well struggle to sustain care for its elderly[2], although Japan is a high-technology nation that spends increasing portions of its GDP on technology; which in turn increases productivity.[3] Ordinarily, this subject might not be front-of-mind when discussing growth, but in the case of Japan,

[2] This situation is also not ameliorated by the facts that birth rates are very low, and that immigration is a very fraught topic in Japan, with the country exhibiting very low rates of immigrants to native-born population.
[3] R&D expenditure as a percentage of GDP rose continually throughout the period, the number of researchers in R&D has increased dramatically, patent applications by both residents and non-residents have also increased substantially. All of these trends combined are sufficient to substantiate the claim that Japan is a high-technology nation that is technologically ahead of its peers (Word Bank, 2020).

population trends have significant implications for the country's saving rate (Blanchard, 2020, p. 249).

Figure 14: Long-Run Growth and Debt to GDP

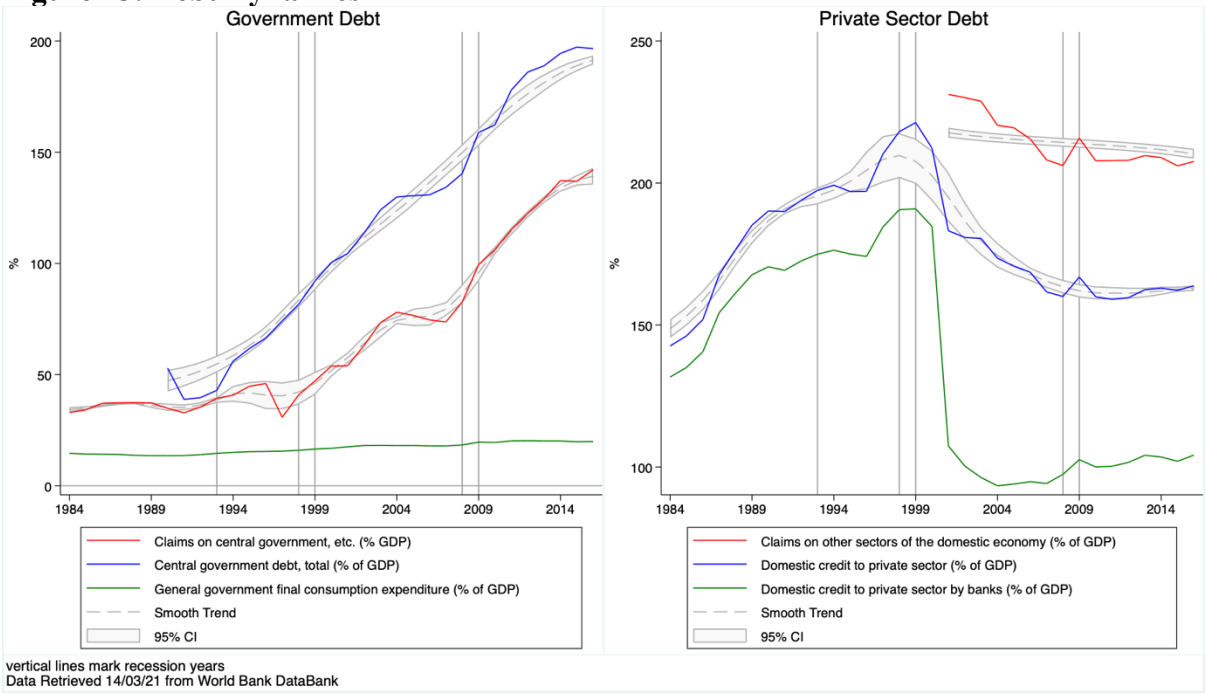


The right panel of figure 14 shows the trend in economic growth, which is stable over the period considered. During the Great Financial Crisis, the Japanese financial sector lost tremendous amounts of money when banks offloaded mountains of financial assets that had become nearly worthless overnight. The left panel of figure 14 shows that GDP growth was volatile, especially during recession years. If demographic trends were –and still are– unfavorable for sustained growth, what is growth attributable to instead?

In the case of Japan, the answer to this question features two primary reasons: innovation, and debt. Technological innovation is a substantial factor in increasing productivity per worker and per hour worked, and a consistent investment in R&D has paid off. The economic benefits and risks of technology equally affect developed nations, and as risk in this growth driver is highly idiosyncratic, it will not be covered further. For the remainder of this chapter, I will rather focus on the other key factor that enabled stable economic growth in Japan: debt.

While figure 13 shows that the Japanese economy is highly leveraged in international comparison, figure 14 clarifies that while the ratio of debt to GDP is high, it is very stable over the entire period. The reason for this is simple: debt has risen drastically, as seen in left panel of figure 15, but so has GDP: upon closer examination, the slope of the red and blue lines in this left panel is nearly identical to that of economic growth (right panel of figure 14). As relative government consumption remained constant, most of the new debt was invested into non-consumptive investments. Similarly, the private sector is highly leveraged[4], but both the public and the private sector are indebted to lenders *inside* of Japan. This also explains why the high debt (so far) has not been more problematic: it has stayed inside the country.

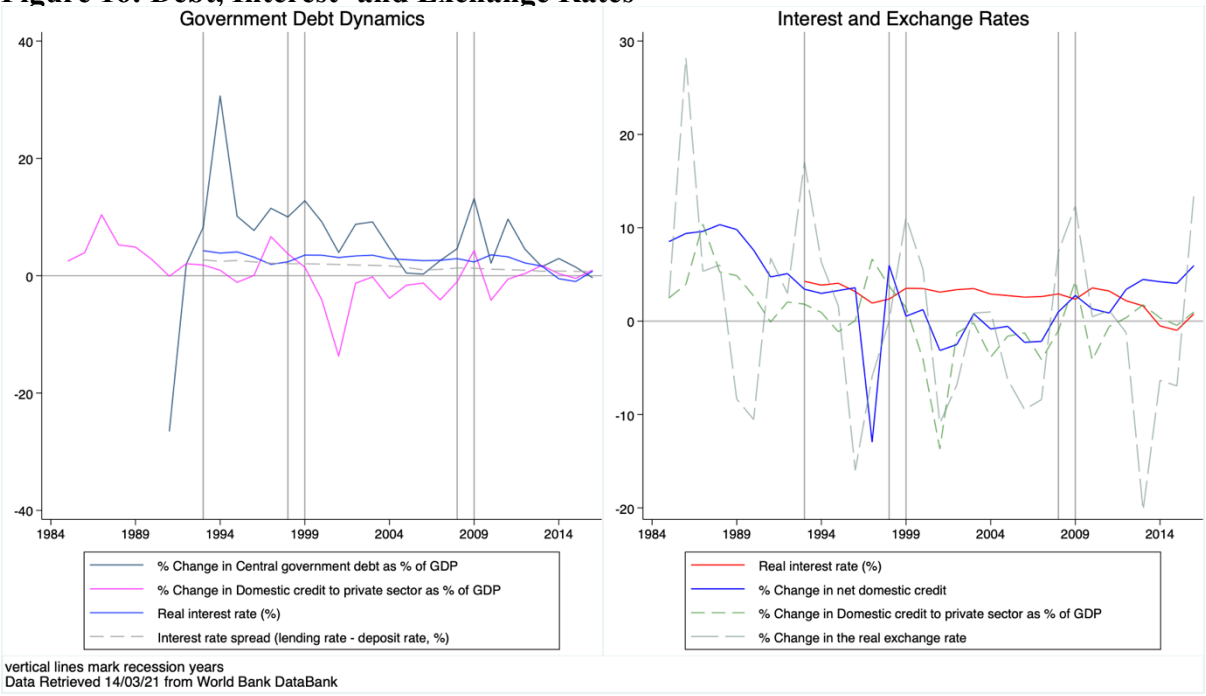
Figure 15: Debt Dynamics



Large external debt is often a problem for countries, as credit pressures depend on monetary policy and exchange rates, which makes debt in foreign currencies substantially harder to manage. Figure 16 shows that in spite of drastic swings in the real exchange rate, changes in outstanding credit were *less than proportional* while risk premia[5] stayed constant. With the exception of the "lost decade" (cf. Obstfeld, 2009), relative debt levels were stable and commensurate with changes in the real interest rate, as shown in figure 16 below.

[4] This latter fact also shows that high government expenditure did not crowd out private and corporate investment as debt in the public and private sectors rose symmetrically for most of the period.
[5] Approximated by the interest rate spread.

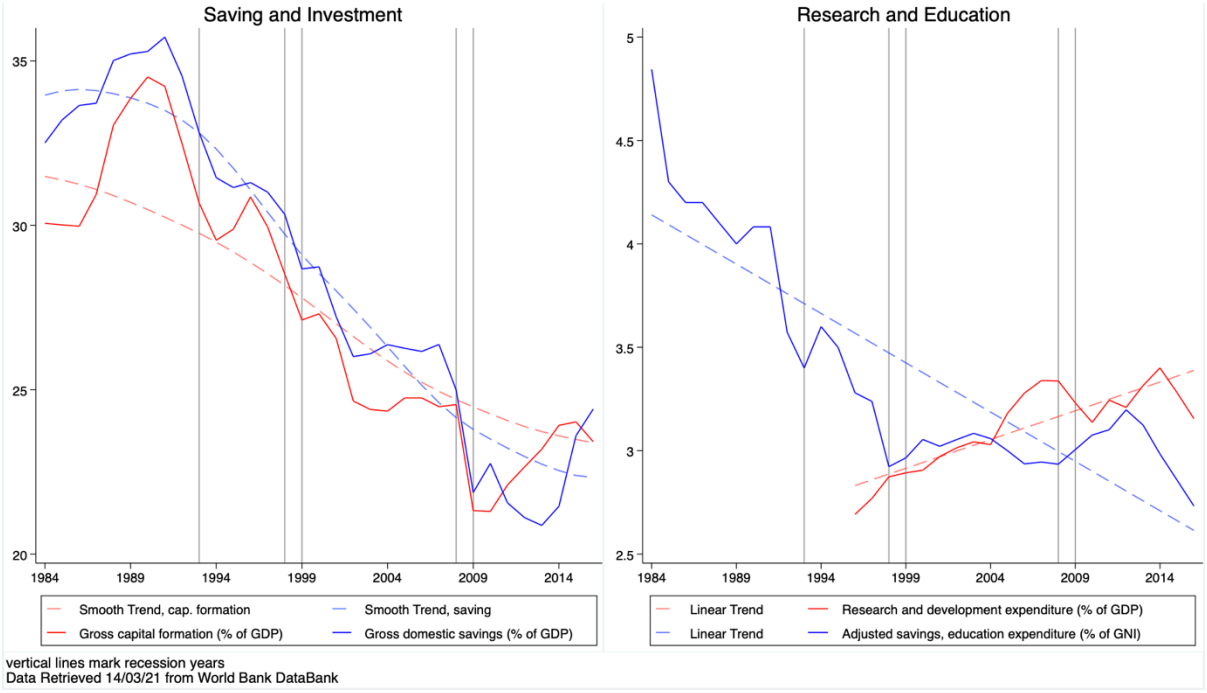
Figure 16: Debt, Interest- and Exchange Rates



In short, Japan's debt is largely domestic in ownership and stable in risk exposure (as shown in figures 15 and 16). However, high levels of debt are correlated with lower growth rates, and GDP growth in Japan was in fact anemic over the period. Empirical work on debt sustainability has shown that countries with very high public debt to GDP have lower average and median growth rates; substantial deleveraging of the private sector dampens growth further (Reinhart & Rogoff, 2010). A pressing question that hence arises is why this mountain of debt was incurred in the first place.

As shown in the right panel of figure 17, the answer is not education, and not really research spending, either. Relative education spending continuously decreased over the period, and only increased after the GFC. Research spending increased consistently, but at its peak reached a mere 3% of GDP. Likewise, as shown in the left panel, saving and investment decreased markedly, bottoming out during the GFC. The main source of debt-financed government spending can, in fact, be traced back to the population dynamics analyzed at the outset of this chapter. Dramatically increasing healthcare and pension costs, as well as stimulus policies designed to counteract recessions, make up most of the current debt pile. The question of how sustainable such a development is, and what it implies for the future capacity of an economy, is subject to ongoing research (Dell'Erba, Hausmann, & Panizza, 2013; Krause et al., 2016).

Figure 17: Saving, Investment, and non-consumptive spending



The main reason why this level of debt has not caused a major debt crisis so far is largely attributable to its ownership structure. As outlined above, most debt is held domestically. Critically, large portions of it are actually held by Japan's central bank, the BoJ. Quantitative and qualitative easing, paired with massive bond-purchasing programs implemented much earlier than in peer OECD economies kept bond prices and yields for government debt in normal ranges, and are likely the sole reason for the apparent stability of Japan's current fiscal state. Japan also holds substantial assets abroad, which mitigates debt pressure. Blanchard (2020, Chapter 22) covers sources of danger relating to high debt. Normal yields[6] tell us that the market does not expect Japan to default on its debt anytime soon. The massive BoJ bond purchases are effectively a form of monetary financing, although there is no apparent danger of a crisis in either interest rates or exchange rates. As long as monetary policy remains accommodative, interest rates and payments will not rise in the foreseeable future, thereby keeping debt serviceable which in turn will keep default expectations at bay and foster stable rates. Still, absent a sudden appearance of evidence for the Ricardian Equivalence, in the long run, Japan's high debt levels may very well lead to lower output as a result of lowered capital accumulation (Blanchard, 2020). We simply don't know yet.

[6] See World Bank (2020) or, alternatively, the BoJ's website.

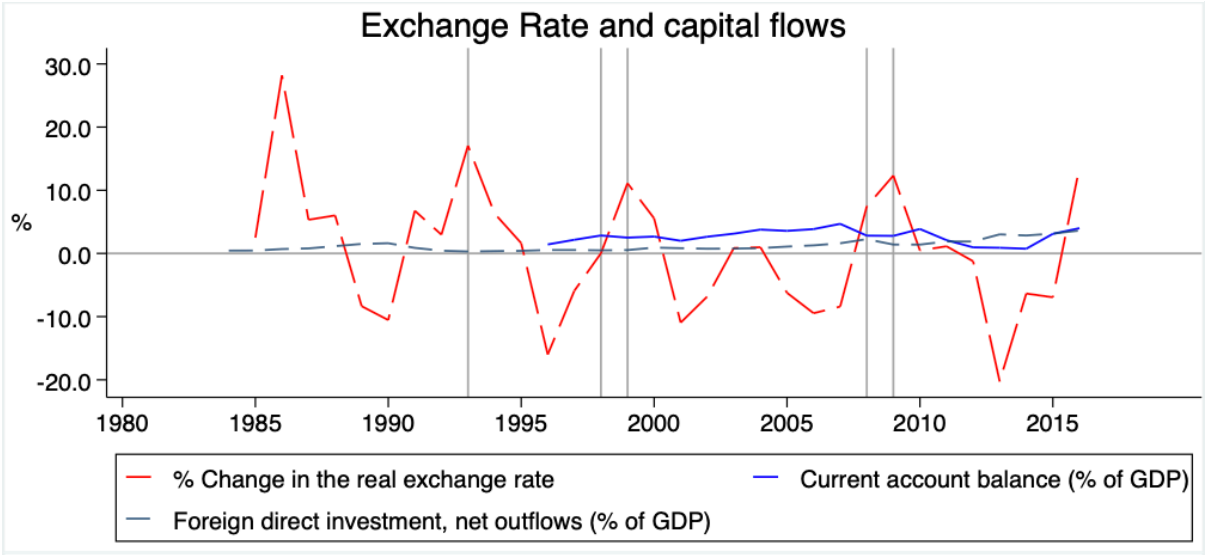
Chapter 4.1: Monetary Policy

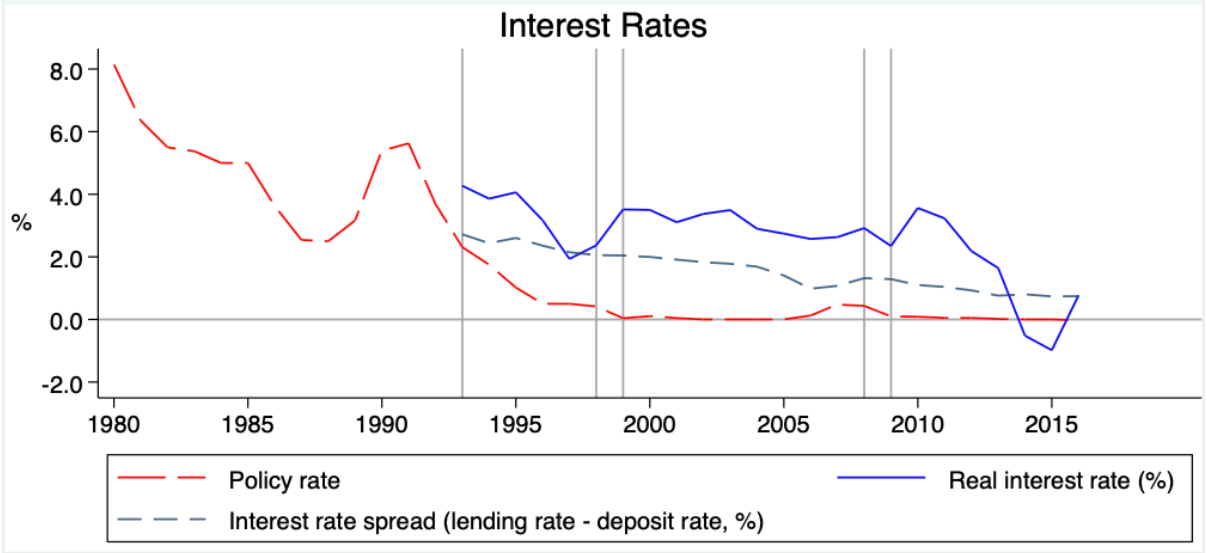
One major lever of macroeconomic policy that substantially affects the economy is that of monetary policy. In the case of Japan, monetary policy plays a big role when looking at the economy as a whole. The main reasons for this importance are, among others, substantial gyrations in the value of the Yen (as mentioned in Chapter 1), as well as its outsized role in enabling the extraordinary level of government debt. As the policy goals and mechanisms implemented by the BoJ over the period consider vary considerably, I will discuss three separate subperiods.

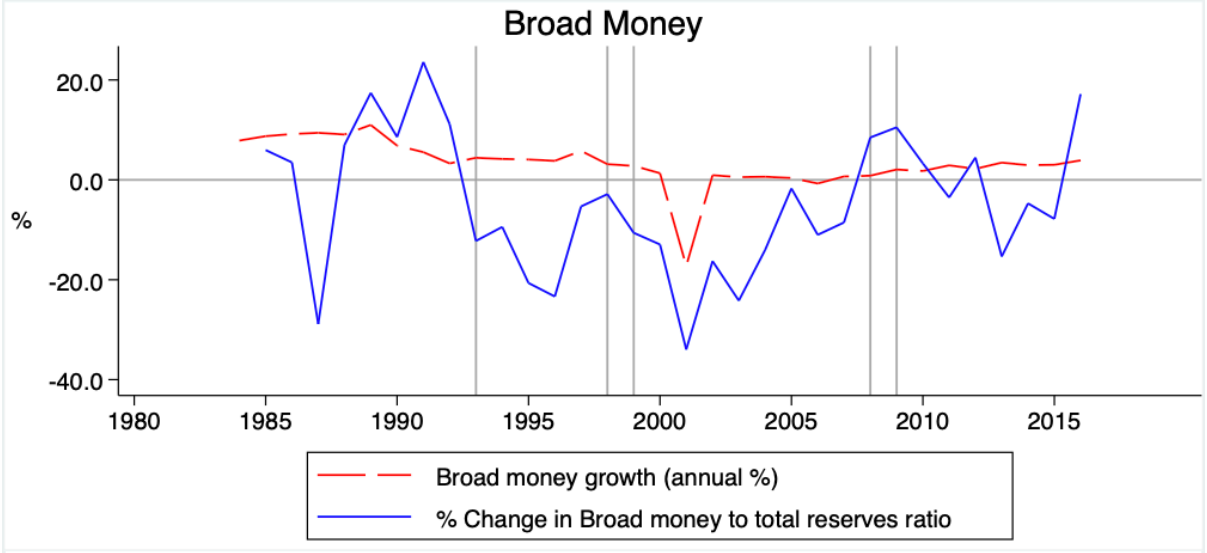
In the late 1980s, Japan underwent drastic asset price inflation with a subsequent economic crash, a phenomenon known as a bubble (Blanchard, 2020). In addition, the Yen began a phase of rapid appreciation in 1985. This latter development is so common in Japanese history that there is an own term for it: "endaka fukyo", which translates to "recession caused by a strong yen" (Obstfeld, 2009). Figure 18 below shows developments in the key instruments and objectives of monetary policy. The first panel shows two periods of *endaka fukyo*, from 1985 to 1989, and 1989 to 1994, respectively, marked by spikes in the percentage change in the exchange rate. Both coincided with variations in the BoJ's policy rate as well as a lowered ratio of broad money (M3) to bank reserves. Such a lower ratio can have two causes: a decrease in the money supply, or a sharp expansion of bank reserves, which are nothing other than central bank currency (Blanchard, 2020). As panel 3 of figure 18 shows, the second one is the correct explanation with the exception of 2002. The reasons for the prolonged stagnation of the Japanese economy between 1985 and 2000 are subject to ongoing debate, but there is one thing that academic and institutional researchers agree upon: the appreciation of the yen rendered the BoJ's policy of gradually lowering the interest rate largely useless (Yoshikama, 2007).

In April of 1998, a new law governing the mandate and instruments of the BoJ came into effect, which enshrined a vague notion of "price stability" as its goal and granted the BoJ true independence in its choice of instruments. This newfound independence was quickly used in 1999 to lower the policy rate to 0 basis points (bps), a policy that turned out to be yet again ineffective and was quickly abandoned (Obstfeld, 2009).

Figure 18: Exchange Rate, Interest Rates, and the Money Supply







vertical lines mark recession years
Data Retrieved 24/03/21 from World Bank Databank and Bank for International Settlements

Between 2000 and 2008, as shown across figure 18, the yen depreciated consistently, central bank reserves continued to expand while M3 ceased growing, the policy rate stabilized around 25 bps[7], the current account balance continually increased, and risk premia gradually decreased. As can be seen in the right panels of figures 4 and 14, output grew well above its trend., which in theory leads to inflationary pressures. However, as shown in the left and lowermost panels of figures 15 , 17, and 11, this period of expansion was primarily debt-financed, saw a marked decrease in saving and investment, and coincided with a steady decrease in the labor force participation rate as well as deflation. These developments forced the BoJ to adopt unprecedented monetary policy tactics, which gained international fame only with the advent of the Great Financial Crisis (GFC), which brings us to the last subperiod.

The response of most of the world's central banks to the GFC, called *quantitative easing* (QE), was unconventional in every way and nearly unprecedented. Nearly, because the BoJ adopted QE around 2001, a full 10 years before its peers. Around the turn of the millennium, BoJ policymakers realized that they were caught in a liquidity trap (Blanchard, 2020; Krugman, Dominquez, & Rogoff, 1998). With their regular instruments rendered largely ineffective by a binding effective lower bound, they instead turned to QE, a concept originally introduced in the context of Japan by Werner (2014, originally 1997). In a nutshell, the radicality of QE lies in the purchase of government and regular private sector bonds by the central bank, a measure meant to inject liquidity into the economy, encourage lending, and with the aim of assisting the central bank in meeting its *inflation target*. As the effectiveness, adequacy, and even legality of QE is subject to heated debate in the academic, institutional, and public realm, discussing it further would lie outside the scope of this course (cf. Wieland, 2009). Rather, the last point of focus in this chapter will be inflation targeting, and more specifically, the most common way of evaluating a central bank's policy rate in this regard: the Taylor rule.

[7] Which equals 0.25 percentage points.

Introduced in 1993 by John Taylor, this rule has the stated goal of determining a central bank's optimal policy rate. Since its introduction, the rule has been used in two main variants, shown in equations 1[8] and 2, respectively, in which the target nominal rate $\bar{\imath} = r_n + \bar{\pi}$ is the neutral rate of interest $r_n$and $\bar{\pi}$ is target inflation

$$i_t = \bar{\imath} + a(y_t - \bar{y}) + b(\pi_t - \bar{\pi}) \qquad \text{(eq. 1)}$$

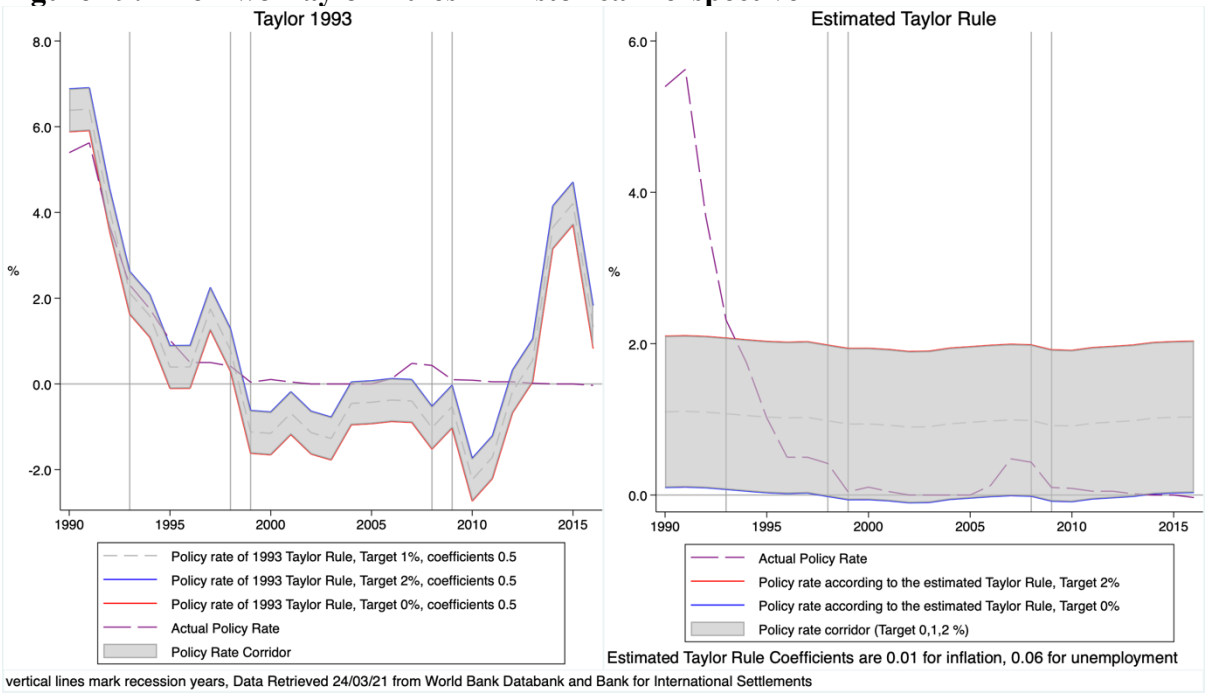
$$i_t = \bar{\imath} - a(u_t - \bar{u}) + b(\pi_t - \bar{\pi}) \qquad \text{(eq. 2)}$$

The first equation is the one originally introduced by Taylor (1993). It sets the policy rate $i_t$equal to the target nominal interest rate $\bar{\imath}$, a multiple of the *output gap* $a(y_t - \bar{y})$, and a multiple of the difference between realized and target inflation $b(\pi_t - \bar{\pi})$, where $a, b > 0$. In this original form, which was developed as a *descriptive* relation for the US, a *and* b were set to equal 0.5, while $\bar{\pi}$ was set to equal 2.

The second equation represents a modified, modern version of the same rule, in which $a, b > 0$ are chosen by the central bank, and the output gap is replaced with the *deviation of unemployment from its structural rate*. It prescribes that if $\pi_t = \bar{\pi}$ and $u_t = \bar{u}$, the central bank should set its policy rate equal to its target, while if $\pi_t > \bar{\pi}$, the policy rate should be increased to $i_t > \bar{\imath}$. With its history of deflation, this is not a scenario Japan is usually confronted with. However, eq. 2 also prescribes that if $u_t > \bar{u}$, as has been the case after 2004 (figure 11), the policy rate should be decreased in an attempt to cause an increase in output, which ceteris paribus would lead to a decrease in employment. Figure 19 below shows the policy rates that these two rules would have respectively prescribed, beginning in 1990.[9] The BoJ only officially began to target inflation in 2011, so figure 19 instead shows a "what-if" scenario for various target rates, had the BoJ used inflation targeting.

[8] Notation for both adapted from Blanchard (2020).
[9] Reliable data on official policy rates was not available before1990.

Figure 19: The Two Taylor Rules in Historical Perspective



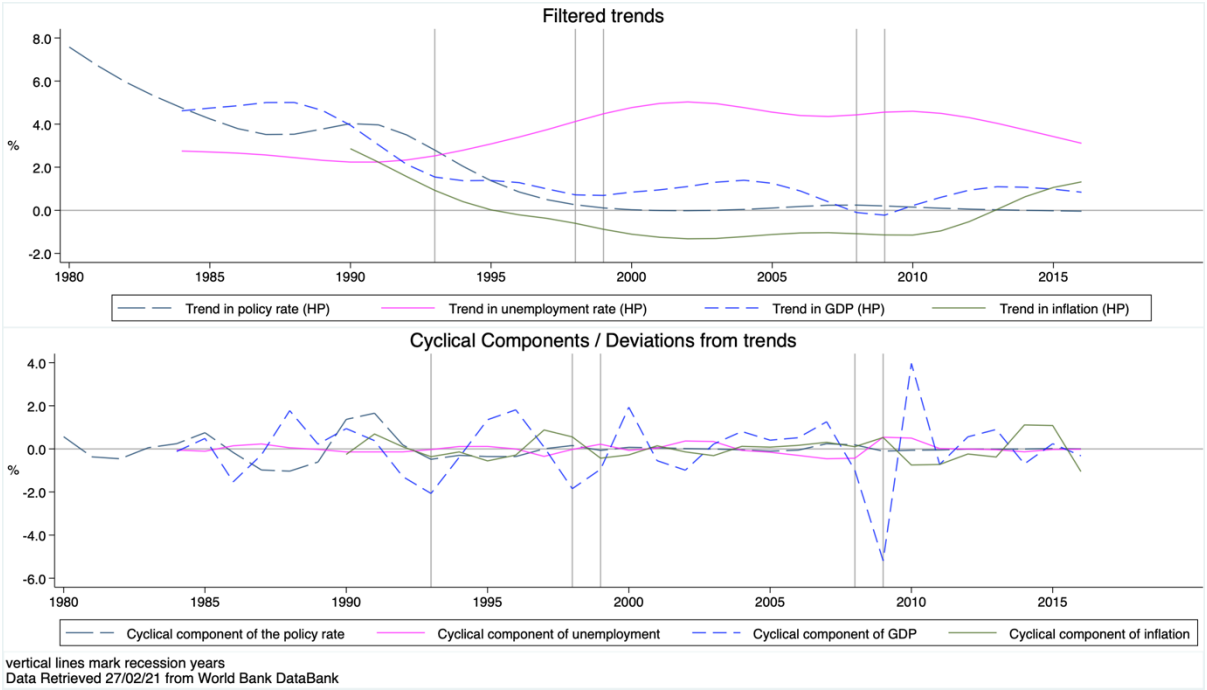
The left panel shows that the actual policy rate was within the hypothetical rate corridor prescribed by eq. 1 from 1991 to 1996 and was as close to the same corridor as possible from 1999 to 2014, as the BoJ only adopted negative policy rates in late 2015. The right panel displays estimates for equation 2 for varying hypothetical target rates of inflation. In this modern form, the BoJ's policy rate has consistently been inside of a –admittedly fuzzy– hypothetical rate corridor as prescribed by the rule. Coefficients for this estimated rule are shown in the panel, they are positive but small, which is attributable in large parts to the absence of real inflation. The appendix to this chapter describes the methods used to obtain figure 19.

In conclusion, the BoJ has faced substantial difficulties over the period considered. It has attempted to use several varying instruments and mechanisms to ensure price stability and keep the Japanese economy on a steady growth path. The unconventional methods used since the turn of the millennium may have had a role in preventing worse economic conditions thus far, but they also bring with them significant risks, which will be discussed in the next and last chapter.

Appendix to Chapter 4.1

As a first step in estimating the Taylor rule, four key variables (the unemployment rate, GDP growth, inflation, and the policy rate) were decomposed into trend and cyclical components using a Hodrick-Prescott filter, one of the standard tools in time-series econometrics (McElroy, 2008; Stock & Watson, 2015; Wooldridge, 2020). Figure 20 displays these trend- and cyclical components, it shows that changes are biggest in recession years. The *output gap* mentioned earlier was constructed as the deviation from the linear trend in GDP in any given years, i.e., $y_t - \bar{y}$, as first constructed by Taylor (1993). The "gaps" in inflation and unemployment were constructed analogously.

Figure 20: Taylor Rule Methodology



With these components, I estimated 4 linear models using OLS with heteroskedasticity-robust standard errors. The estimation results are shown in figure 21 below. The coefficients in model 4 marked in red are the ones used when visualizing figure 19. In fitting the modern taylor rule (models 3 and 4), the estimated coefficient on the difference between current and structural unemployment turned out to be statistically different from zero at the 1% confidence level, both for the full as well as the reduced sample. The *descriptive* explanatory power of model 4 is very high, as shown in the adj. R2, but this should not be regarded as proof of econometric accuracy. The rudimentary estimations carried out in this chapter are a far cry from accurate estimates of taylor rule coefficients in absolutely every aspect and were only carried out to make figure 19 possible. For a good overview of approaches and problems in estimating these coefficients, see among others Davig and Leeper (2007).

Figure 21: Taylor Rule Estimation Results

Estimated Coefficients of the Taylor Rule

	(1) Taylor 93, Naive		(2) Taylor 93, Rolling		(3) Taylor Rule, Naive		(4) Taylor Rule, Rolling	
Deviation from trend in inflation	0.260	(0.42)	0.260	(0.42)	-0.0513	(-0.10)	**0.00598**	(2.13)
Deviation from trend in GDP	0.0163	(0.11)	0.0163	(0.11)				
Deviation from trend in unemployment					-1.248***	(-4.22)	**0.0617***	(27.64)
Constant	0.841*	(2.64)	0.841*	(2.64)	1.132***	(4.50)	0.00479	(1.68)
Adjusted R^2	-0.075		-0.075		0.564		0.980	
Observations	27		27		27		8	

t statistics in parentheses
Naive refers to Regressions over the entire period
Rolling refers to a two-stage estimation process that estimates coefficients over rolling 5-year intervals and keeps only years with positive coefficients. The regression is then re-estimated for the sample starting from the first such year, which explains the small n in model 4.
Heteroskedasticity-robust std. errors used across all models
Standardized beta coefficients reported to facilitate cross-model comparisons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 4.2: Conclusion

At first glance, Japan is a prosperous, high-technology nation in the G3, meaning few people would see an investment in Japan as risky in international comparison. Towards the end of the period considered in this paper, and even in the current global economic crisis, this is mostly true. However, there are three trends that together form reason for concern about just how sustainable or resilient the Japanese economy is long-term.

The first two reasons are shown in figure 13 and described throughout the third chapter. The Japanese population is already very old, and it is aging further at a rapid pace. So far, social systems have remained stable, but if birth rates and immigration remain as low as they currently are, the strain put on a workforce that is already at full employment is only going to increase. The main factor in Japan having economic growth since the turn of the millennium is its astronomical level of debt. As long as this debt continues to be within Japan and held mostly by the BoJ, it can serve as a stable base for continued economic growth. Crucially, this stability in turn depends on 2 factors: the exchange rate, and monetary policy, which brings us two the third and last challenge to Japan's macroeconomic resiliency.

After 2 decades of Quantitative Easing conducted by the BoJ, it is tempting to disregard the pitfalls of unconventional monetary policy. But from a perspective of economic resiliency, it is the single biggest threat currently facing the Japanese economy. In the monetary policy environment shown in figure 18, the mountains of debt that underpin large swaths of Japan's economy rely on steadily increasing central bank currency (total reserves) and effectively– zero interest rates. As long as the economy grows, these are not necessarily problematic. However, it is important to keep in mind that these monetary policies are just about as far as the BoJ can go.

If they are necessary in the first place to prop up an anemic economy, it is worrisome to imagine what measures the BoJ would have to resort to in a severe crisis –such as the one we are currently in– and how those in turn would affect the stability of the crushing load of debt hanging over Japan.

Appendix of Changes

1. Changed in Chapter 1 while writing Chapter 2: Figure 6 was replaced with a near-identical version to ensure visual consistency.

2. Changed in Chapter 2 while writing Chapter 3: Figure 11 was replaced with a near-identical version to ensure visual consistency.

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