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The Flattening of Japan's Phillips Curve: An Unemployment Rate Analysis

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The Flattening of Japan's Phillips Curve: An Unemployment Rate Analysis

By

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This thesis is submitted in partial fulfillment of the requirements for the course Senior Seminar (EC 375), during the Spring Semester of 2020

While writing this thesis, I have not witnessed any wrongdoing, nor have I personally violated any conditions of the Skidmore College Honor Code.

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Abstract

This paper examines the causes behind the flattening of the Japanese Phillips curve by analyzing the unemployment rate measure, and its role in the flattening of the curve. This paper will utilize the actual Japanese unemployment rates from 2002 through 2019, as well as estimate an alternative unemployment rates that takes into consideration discouraged workers. In my study, I recreate the Phillips curve using these two measures of unemployment, as well as implement a simple OLS regression to understand the slopes of each Phillips curves. I will also utilize the Weintraub equation in order to theorize factors that may be leading to the flattening of the curve. I hypothesize that the Phillips curve still maintains the correct relationship, but there is an issue behind how we measure unemployment. However, my results conclude that Japan's Phillips curve flattened more when utilizing the alternative unemployment rate rather than the actual unemployment rate. Furthermore, when applying a quadratic fit to the Phillips curve, it is evident that the recent Japanese Phillips curve has a concave relationship rather than displaying the traditional convex curve. I theorize that changes in the female labor force population within Japan is responsible for a decrease in the discouraged worker effect, thus causing a greater flattening of the curve.

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1 Introduction

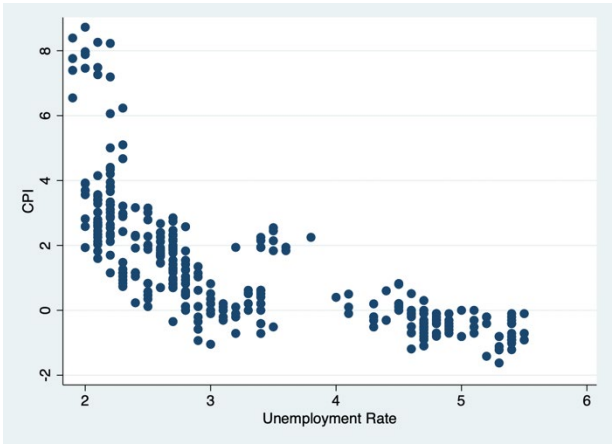
Economists have long debated the validity of the Phillips curve, a structural model of the inverse relationship between unemployment and inflation. In recent years, it seems that the Phillips curve, especially those in industrial nations, are either flattening out, or are declared dead. Japan is no stranger to this phenomenon. Recently, the country's economy has been experiencing high levels of output, coupled with productivity growth and low levels of unemployment. Despite this, wage growth is stagnant, and inflation remains close to zero even in the face of several inflation-stimulating policies from the Bank of Japan. I will examine the flattening of the Phillips curve in Japan by analyzing one of the inputs—unemployment rate. If one of the input variables is not properly measured, the relationship between unemployment and inflation can be impacted. This topic is extremely pertinent to monetary and fiscal policy makers, because they heavily base their policy decisions on the relationship between inflation and unemployment that is highlighted by the Phillips curve.

In Section 2 I give a brief overview on the history of the Phillips curve and some of the theories surrounding the flattening of the curve. I first examine the theories behind the creation of the Phillips curve by examining Phillips (1958). As there are several theories surrounding the flattening of the Phillips curve, I cover some of the popular theories that have been mentioned in the past. Some economists such as Iakova (2007) argue that the effects of globalization on price and wage flexibility has caused the slope coefficient on the Phillips curve to decrease. However, it is evident that globalization is not the only reason for the flattening. Previous studies such as Belz, Wessel, & Yellen (2020) discussed the increased stabilization in inflation prediction, and therefore the stabilization of rational expectations to have contributed to the phenomenon. Structural changes within the economy and labor market could be yet another factor.

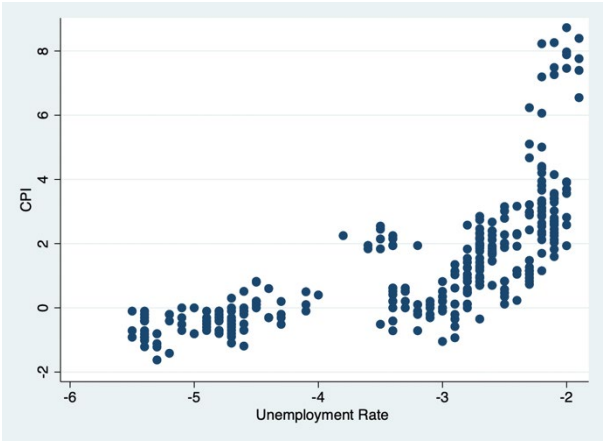
Additionally, some economists such as Ball and Moffitt (2001) believe that the Phillips curve equation does not capture such changes in the economy, and thus has some missing variables, leading to the reshaping of the Phillips curve. Most of these studies focus on the Phillips curve within the United States or the United Kingdom, but similar theories could apply to Japan because it is also an industrialized nation. In this section I also review the studies that focus solely on Japan's Phillips curve. When looking specifically at Japan, Smith (2006) delineates Japan's Phillips curve using data from January 1980 to August 2005 in his paper "Japan's Phillips Curve Looks Like Japan.[1]" Figure 1 below shows Japan's Phillips curve during this time period, and the same data with negative unemployment. When Japan's Phillips curve is rotated on its vertical axis, it resembles the islands of Japan[2].

Figure 1: Japan's Phillips Curve Presented in Smith (2006)

Inflation and Unemployment Rates (January 1980 to August 2005)



Inflation Rate and (Minus) Unemployment Rate (January 1980 to August 2005)



[1] Smith utilizes the datasets "Japan Consumer Price Index" and "Japanese Harmonized Unemployment Rate" found on the Federal Reserve or St. Louis website.

[2] Instruction on how to replicate Smith (2006) was published by the Federal Reserve Bank of St. Louis on the FRED Blog in 2016. https://fredblog.stlouisfed.org/2016/04/replicating-the-japanese-beveridge-curve/

However, when looking at more recent data, it is evident that Japan's Phillips curve is indeed flattening out. Specifically, many Japanese economists have looked at the 1990s bubble burst as a catalyst for the flattening. Yamamoto (2008) summarizes that the bubble burst in the early 1990s resulted in downward nominal wage rigidity coupled with negative inflation rates as well as an increase in the discouraged worker effect that resulted in a flatter Phillips curve.

Policy implications surrounding the Phillips curve impact various monetary and fiscal policies because central bankers and policy makers rely on the delicate relationship between unemployment and inflation. Specifically, in the case of Japan, understanding the country's Phillips curve becomes important given that the Bank of Japan has tried several inflation-stimulating strategies to escape the chronic deflation that has lasted decades. Since the Phillips curve is considered to be one of the foundational models used for forecasting as well as policy advising within central banks, further understanding a country's Phillips curve could directly impact the economy.

In this paper, I aim to examine the impact of how unemployment rates are measured on the flattening out of the Phillips curve. First, I use the Weintraub equation to analyze factors in the Japanese economy that may lead to a flatter Phillips curve. I will then gather data on the Japanese unemployment rate from 2002 through 2019, and also generate an alternative unemployment rate that encompasses the discouraged worker rate. I will then create two separate Phillips curves, and run an OLS regression to further analyze the slope coefficient. I hypothesize that the unemployment measure, collected by the Japanese Ministry of Internal Affairs and Communications and presented by the Japan Statistics Bureau, does not capture actual unemployment. Furthermore, I hypothesize that the flaw in the methodology of calculating one of the variables of the Phillips curve could be a potential cause of the flattening. By utilizing a

more comprehensive unemployment measure, I believe it is possible that the slope of the Phillips curve will increase.

My paper contributes to the literature by examining the unemployment measure rather than the inflation measure of the Phillips curve. Much of the analysis examines and discusses how there are changes within the inflation aspect that is causing the Phillips curve to flatten. Furthermore, I explore the possibility of a structural problem with how our economic measures are being collected and calculated. If there proves to be a problem with how countries collect various economic measures, there could be repercussions in other economic models as well. However, my results show that by utilizing the alternative unemployment, the slope flattens even more. In Section 5, I theorize how changes within the female labor market in Japan specifically may lead to such a flattening out when encompassing discouraged workers.

In total, my paper is structured as followed: Section 2 outlines previous research related to my topic through the literature review; Section 3 will give an overview of my data and my methodological approach; Section 4 presents my results; Section 5 discusses my results and some theory to back up my results as well as some limitations, and presents areas for future research; and Section 6 concludes the paper.

2 Literature Review

Several economists and researchers have discussed the flattening out of the Phillips curve. Analyzing the relationship between inflation and unemployment, as well as understanding whether the relationship still holds true today, is important for economists as well as lawmakers. Monetary and fiscal policy are both contingent on this delicate balance of stable prices and high employment. However, central banks around the world continue to use the Phillips curve to

conduct inflation targeting as well as justify the implementation of monetary and fiscal policy decisions. Economists seem puzzled because there seems to be no singular reason why the Phillips curve—representing the trade-off between inflation and unemployment rate—is flattening out in industrial nations in recent years. Japan's economy is no exception to this, as the Phillips curve shows significant flattening out following the economic bubble's burst in the early 1990s.

2.1 Defining the Phillips Curve

The Phillips curve, originally developed by A.W. Phillips, defines the macroeconomic relationship between inflation and unemployment. Phillips (1958) defines the inverse relationship between wage inflation rate and unemployment. He builds his hypothesis on the theory that if the unemployment rate is high and labor markets are loose, it could be expected that there would be downward pressure on wages rising since labor supply is greater than labor demand. Therefore, it would imply that there is no reason for firms, ceteris paribus, to raise prices. The opposite is true if labor markets are tight—labor market demand is greater than supply, meaning there is upward pressure on wages and firms are compelled to raise prices. Phillips finds that empirical evidence in the United Kingdom from 1913 to 1957 supports his hypothesis, and thus the short-run wage Phillips curve was solidified as a principal macroeconomic model. Besides the wage Phillips curve, there is the short-run price Phillips curve and the long-run Phillips curve. Although there are slight discrepancies between the short-run wage Phillips curve and price Phillips curve, both the short run Phillips curves are showing signs of flattening out (Yellen 2006). Friedman (1968) and Phelps (1968) claimed the long-run Phillips curve is simply a vertical line at the point of the natural rate of unemployment. In the long run, the inflation rate will also behave in relation to the natural rate of unemployment, rather

than the current unemployment rate. Friedman further states that a current unemployment rate that falls below the natural rate would see an increase in inflation, and unemployment that falls above the natural rate would see an increase in deflation. New Classical economists such as Lucas (1972) and Sargent (1973) have suggested that monetary policy can be used to stabilize the natural rate of unemployment, and thus also control for long-term unemployment and inflation rates. This close relationship between the natural rate of unemployment and inflation has caused the non-accelerating inflation rate of unemployment (NAIRU) to have a synonymous relationship with the natural rate of unemployment. In recent years, the decrease in NAIRU as well as the natural rate has caused shifts in the long-run Phillips curve as well. For the purpose of this paper, I will be looking at the short-run Phillips curve in order to examine the trade-off between inflation rates and unemployment.

2.2 The Death of the Phillips Curve

Today, several economists are observing the flattening out of the Phillips curve across industrial nations. Some economists go as far as to claim that the Phillips curve is dead, and the inverse relationship between unemployment rate and inflation no longer holds true. There are several theories as to why the Phillips curve is flattening out. These theories can largely be broken down into two categories: globalization and inflation predictions.

Iakova (2007) observes consistently low levels of inflation in the United Kingdom during the 1990s that were not accompanied by high levels of unemployment. This sort of flattening out of the Phillips curve's slope is being observed in other industrial nations around the world. Iakova argues that there are three ways globalization is causing such flattening out. First, an increase in globalization creates an increase in competition. As competition increases, domestic companies lose the power to increase prices, despite the fact that demand is rising. Therefore,

prices remain low. Second, as international trade and investment increase, price sensitivity of goods decreases because of an increase in the supply and competition for products. Specifically, price in industrial nations become less sensitive to domestic demand because of the increased competition from other nations that often have cheaper labor or lower opportunity costs. Lastly, globalization has also affected the human labor market by increasing mobility. Similar to how trade and investment make prices of goods and services less sensitive to domestic demand, labor mobility makes prices less sensitive in the service sector. Domestic workers' ability to demand for higher wages decreases because of the immediate threat that their jobs can be taken by cheaper foreign labor. Therefore, despite the fact that domestic labor markets are tightening, worker wages may remain low. Although Iakova successfully investigates the effect of globalization on inflation rates, specifically in tight markets, she fails to address the other half of the Phillips curve—unemployment. Foundationally, if labor markets are tight, labor market demand is greater than supply, implying that there will be an upward pressure on wages and firms may be compelled to raise prices. Furthermore, with cheaper foreign labor and lower opportunity costs, jobs will be taken by such foreign labor, causing domestic unemployment to rise. Although globalization could be a contributing factor to the flattening out of the Phillips curve, it is difficult to imagine that it would be the only factor. Whether globalization has a large enough effect on domestic inflation to distort the Phillips curve is questionable. Ball (2006) also questions the extent to which globalization actually influences domestic inflation. He suggests that globalization has ultimately not contributed to a great enough change in inflation behavior. Therefore, he concludes that globalization has not had a great enough effect to result in a structural change of the Phillips curve.

Conflicting arguments are made in Yellen (2006). Her argument also supports the globalization argument, because she states, "the first channel is the most obvious one—the direct effect of the reductions in the prices of imported goods and services that may be caused by globalization, and which are included in the indices of consumer prices that central banks commonly target" (Yellen, 2006). This combined with the effect of lower import prices "reduce workers' demand for nominal wage increases" (Yellen, 2006). However, Yellen concludes that ultimately globalization has had the greatest effect on the flattening of the Phillips curve because firms have lost the ability to mark up and set prices due to an increase in globalization and import prices.

Stabilization in inflation predictions is also considered to be a reason why the Phillips curve is flattening. Belz, Wessel, and Yellen (2020) suggest that expected inflation is becoming steadier and is responding less to changes in actual inflation. As expected inflation becomes more anchored, wage and price settings are less influenced by inflation rates as the rational expectation theory suggests. In the paper, Yellen in fact mentions the possibility that the attenuation of the Phillips curve could be due to the unemployment rate not capturing the full extent of labor market slack. In the United States, the prime age labor force participation level has not recovered to pre-Great Recession levels. In addition, there is an increase in involuntary part time workers and discouraged workers. Such data suggests that the civilian unemployment rate is failing to capture a sector of the unemployed population. Furthermore, Yellen discusses the possibility of downward nominal wage rigidity contributing to the flattening of the Phillips curve. Specifically, during and following recession, wage inflation tends to be modest due to wage cuts being levied on employees.

2.3 Unemployment and Japan's Phillips Curve

Historically, the Phillips curve in Japan displayed a relationship that was in line with A.W. Phillips' theory. In fact, prior to the 1990s, other industrial nations had started to observe the flatter Phillips curve, while Japan's Phillips curve remained steep. However, several researchers have also suggested that the slope coefficient for the Phillips curve in Japan is getting flatter, especially following the bubble burst in the early 1990s. Yamamoto (2008) analyzes changes in labor market structures and operations following the burst of the bubble economy in Japan in 1991. Yamamoto observes that the Phillips curve before the crash of the economy is much steeper. Following the bubble burst, the Phillips curve seems to be much flatter—mimicking other industrialized nations. There are several cultural economic practices within the labor market that can be attributed to the steeper Phillips curve. Yamamoto lists some as: "nominal wage flexibility reflecting flexible bonus payments or annual spring wage negotiations, slow employment adjustment, and the large discouraged effects" (Yamamoto, 2008). On the contrary, he concludes that the flatter Phillips curve is "attributable to the existence of downward nominal wage rigidity under the low and negative inflation rate as well as a decline in discouraged worker effects" (Yamamoto, 2008).

My study mimics parts of Yamamoto's paper, but more recent data. Rather than the 1990s bubble burst, with my data I will be taking into account the 2008 financial crisis. I will also have to take into account the 2011 Tōhoku earthquake as an event that produced a negative economic shock. My discouraged worker effect analysis will also build off of Yamamoto's findings from the 1990s but including modern changes in Japan's female labor market. In his article, Yamamoto fails to mention significant structural changes in the labor market following the bubble burst in Japan, which I plan on observing. I will tie in modern Japanese marital and

fertility rates to build on his theories regarding the impact of Japanese women on the discouraged worker effect.

Furthermore, the discouraged worker effect that was seen following the burst of the bubble can hold true today as well. Naganuma and Uno (2016) write that Japan's long-term unemployment, which remains high despite a decline in unemployment, can be attributed to safety-nets. Specifically, in Japan long-term unemployment is most evident in the young adult male population. Some of this can be attributed to the fact that there is a shift in labor market demand away from manufacturing jobs, where most young adult men originally worked. Furthermore, Japanese families often support their children until the children become employed. It is not uncommon for young men and women to live with their families until they are financially stable, or married, and this safety net that families provide for their children is showing a similar effect on unemployment durations that unemployment insurance has in European nations. Naganuma and Uno calls this the "freeze in hiring period" effect. Such long-term employment can result in discouraged workers, or those people participating in the gig economy[3]. Additionally, Japan's extremely slow recovery from the bubble burst has impacted discouraged worker rates. Japan's economy has not yet shown a full economic recovery from the burst in 1991. Such 30-year recovery from an economic shock suggests that Japan's economy may not return to such high economic growth, and that today's economic state is the new normal. Therefore, it must be debated whether the high numbers of discouraged workers that are being seen today must be considered the new normal. If this is the case, it will be problematic that they are not being taken into account through the unemployment rate measure.

[3] Donovan (2016) and Friedman (2014) discuss the implication of the gig economy as well as how such work can affect the labor markets by examining examples in the United States. Similar gig economies have been emerging in Japan as well, implicating a similar economic effect.

2.4 The New Phillips Curve

Some economists have suggested modifications to the Phillips curve, such as the inclusion of additional variables. Ball and Moffitt (2001) are just two of the many authors that have suggested additions or manipulations in the variables that are currently part of the Phillips curve. They state that the trade-off between inflation and unemployment may no longer hold today because of the significant rise in labor market productivity. The Phillips curve, they argue, is shifting because of the lag in the change in worker wage aspiration relative to productivity growth. Other economists such as Grubb et al. (1982) and Blinder (2000) have also observed the mismatch between wage aspiration and productivity growth causing a shift in the Phillips curve. They state that empirical evidence shows that the U.S. Phillips curve often includes this variable already. Similar to Ball and Moffitt (2001), I will be observing the addition of variables or the manipulation of variables in the Phillips curve.

For the purpose of this paper, I will be building on previous research by examining the unemployment variable in Japan's Phillips curve. Bregger and Haugen (1995) examine the importance of the alternative measures of unemployment, U-1 through U-7, that were introduced in 1994. The unemployment rate measure has been controversial for some time now. Strict guidelines for categorizing those who are unemployed make many economists question whether the unemployment rate encompasses all of those in the labor market who are unemployed and want a job. Alternate unemployment rate measures often try to correct for this error. Specifically, for the purpose of my paper, I will replicate Japan's labor underutilization (LU) measure[4]. When examining the LU measures, they tell a very different story from simply looking at the

[4] Such alternative measures have only been measured starting in January 2018, which is why this study will be replicating the measure in order to be able to examine prior years.

unemployment rate. For example, the LU4 measure includes unemployed workers, underemployed workers, and discouraged workers, making it most similar to the U.S. U-6 measure. Within Japan's alternative unemployment rate measures, the LU4 is the most encompassing. In the first quarter of 2018, Japan's unemployment rate was 2.6%, yet the LU4 measure was 5.9%. Japan's large gap between unemployment rate and LU4 measure suggests that there is a significant group of unemployed people who are not being captured by the unemployment rate. In pointing out this large gap, the National Center of Educational Statistics writes:

> Japan also had very low unemployment rates in 1989. In fact, Japan had the lowest or second lowest unemployment rates for all of the indicators. However, Japan's unemployment rate that takes into account part-time workers and discouraged workers (measure 7) was three times that of its conventional unemployment rate and over four times that of the full-time unemployment rate (NCES).

If there is a structural error in the way unemployment is being measured, then it is highly likely that the Phillips curve will no longer display the same relationship. Therefore, it is possible that the Phillips curve's relationship is in fact still relevant, but a flaw in the variable is causing the relationship to seem unstable.

3. Data Methodology

3.1 Japan's Unemployment Rate and Inflation Measures

Data for Japan's labor market statistics come from the Statistical Bureau of Japan and the Ministry of Internal Affairs and Communications through monthly household surveys. The data I acquired is aggregate unemployment, job searching, and labor force participation rate data. My dataset covers all 47 prefectures of Japan from January 2002 to December 2019. Similar to other industrial nations, Japan utilizes the International Labour Organization (ILO) standards to determine employment and unemployment status. Prior to 2018, those considered in the labor

force were either considered employed or unemployed. Those who were considered employed were then further broken down into those who have a job and worked at least one hour during survey week and those who have a job but for whatever reason did not work during survey week. Those not in the labor market were not further broken down into any categories. However, starting in 2018, Japan changed the labor market breakdown and started to survey for involuntary part time workers and discouraged workers. Within the dataset that I am working with, it is important to note that there are data points from March through August of 2011 that are predictions by the Ministry of Internal Affairs and Communications because the Great East Japan Earthquake prohibited the accurate collection survey results. Although for the purpose of my study, it is more advantageous to collect actual data rather than predictions, this is an aspect that I cannot control for.

Postwar Japan maintained an extremely low unemployment rate of roughly 1 to 2 percent until the bubble burst in the early 1990s. Between the years of 2002 and 2019, Japan has had a mean unemployment rate of 3.744 percent, with peaks in unemployment in August 2002 (5.8 percent)[5] and August 2009 (5.7 percent), as seen in figure 3. However, following the peak in 2009, which was caused by the Great Recession, the unemployment rate has steadily been decreasing and in January 2018, was only 2.6 percent.[6] Compared to other industrial nations such as the United States, Japan proves to have a slow unemployment recovery rate. Japan's struggle with long term unemployment could result in high levels of discouraged workers around times of recession. However, some contrasting information regarding a decrease in discouraged

[5] High levels of unemployment in the early 2000s resulted from a combination of the early 1990s bubble burst, the Asian financial crisis of 1997, and the early 2000s dot-com recession.
[6] Japan's labor force categorization was redefined in 2018 in order to encompass the missing measures of underutilized workers and discouraged workers. Due to this change that allowed for further breakdown, I will be utilizing monthly data from January 2002 to December 2019 but stay consistent with my method in measuring discouraged worker rather than utilizing LU measures for only 2018 and 2019.

worker effect during recessions has also been documented by some economists[7]. Figure 2 graphically outlines the general trend in Japan's Unemployment Rates from 2002 to 2019.

Figure 2: General Trend in Japan's Unemployment (2002-2019)

Since Japan did not provide their alternative labor force measures (Labor Underutilization measures), as well as identify discouraged workers until January of 2018, I will be predicting discouraged workers by examining the flow between 'job searching' and 'not in the labor force,' a method that is also utilized in papers such as Kuroda (2002), Ohta and Teruyama (2003), Sakura (2006), and Yamamoto (2008). To generate the discouraged worker variable, I will create a proxy quotient, the flow between 'job searching' and 'not in the labor force,' as well

[7] Yamamoto (2008) discusses how the persistence of married female workers during recessions in Japan causes a decrease in discouraged worker effects. These women often only search for a job during a recession when the family's liquidity decreases.

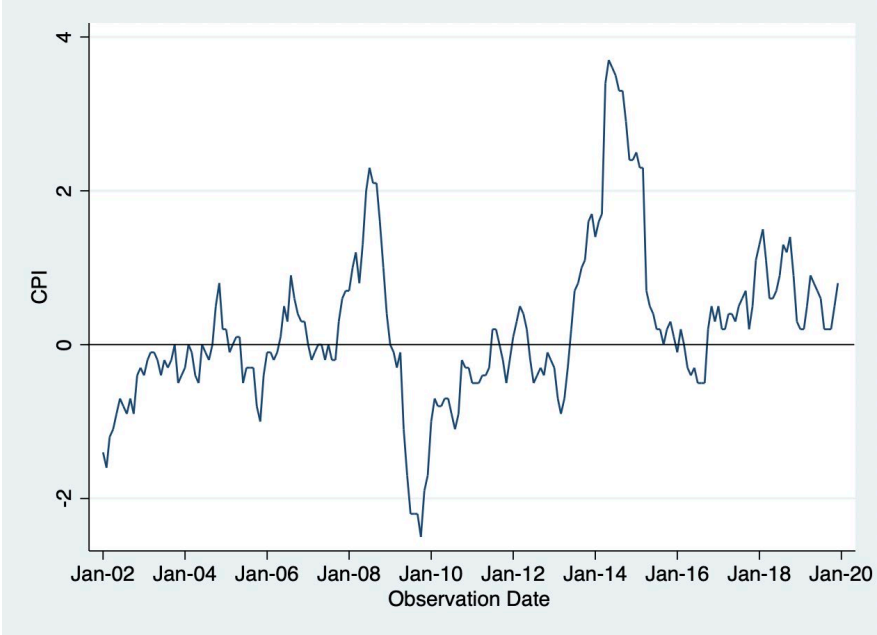
as a lag variable. By creating a lag variable, I am able to account for the information lag present in the labor market. My discouraged worker proxy will therefore be calculated:

$$Discouraged\ Worker = \frac{Job\ Search\ _t - Job\ Search_{t-1}}{Not\ in\ the\ Labor\ Force_t}$$

in which the $Job\ Search_t$ is the number of people searching for jobs at given month *t* and $Job\ Search_{t-1}$ is the number of people looking for jobs at any given time with the time lag taken into consideration.

For the inflation data, I will be utilizing Japan's Consumer Price Index (CPI), also collected by the Ministry of International Affairs and Communications. Between 2002 and 2019, the CPI ranges from -2.5 to 3.7. Specifically, between 2002 and 2012, Japan mostly operated on negative inflation rates as seen in the graph below. It is believed that the lack of monetary easing on the part of the Bank of Japan caused such prolonged periods of deflation. Figure 3 outlines these trends.

Figure 3: Trends in Japan's Consumer Price Index (2002-2019)



Japan's CPI had remained negative early on. Recently, however, there are trends of positive inflation, notably from 2013 onward.

Table 1 presents the summary statistics of Japan's labor statistics as well as their CPI measure from 2002 through 2019. The table shows that I have 216 observations (=12months*18years). It is important to note that my observations are listed per ten thousand persons. The table also includes those statistics for the discouraged worker measures that I calculated.

Table 1: Summary Statistics of the Japanese Labor Market: 2002 through 2019
(per ten thousand persons)

Variable	Obs.	Mean	Std.Dev.	Min	Max
Unemployment Rate	216	4.024	.918	2.2	5.5
Job Searching	216	267.528	59.969	152	368
Not in Labor Force	216	4392.565	102.636	4158	4560
CPI	216	.202	1.032	-2.5	3.7
Discouraged Worker	215	6.1	1.367	3.616	8.667
Alternative Unemployment	215	10.119	2.274	5.88	14.067

Table 1 shows the large range in CPI from 2002 through 2019. However, the labor statistics seem to be pretty constant, as highlighted by the small numbers in the standard deviation. Especially the number of those considered not to be in the labor force only have standard deviation of 102.636 while the range only is 402 (= 4560 – 4158). The variance in CPI with little changes in the labor statistics already suggests a flat Phillips curve, showing that the unemployment rate is remaining relatively steady despite a volatile inflation measure. Here, it is

also important to note that both the discouraged worker effect and the discouraged worker measure only has 215 observations instead of 216 because of the elimination of the first observation that happened due to the creation of the lag variable.

3.2 The Weintraub Equation

In order to theoretically analyze the Phillips curve throughout this paper, I will be utilizing the Weintraub equation to understand the flattening of the Phillips curve in Japan. By analyzing the Weintraub equation, I am able to understand the various factors within the Japanese economy and labor force that are causing such a shift. In this case, the Weintraub equation can indicate where there is a shift within the Japanese economy by examining inflation, wages, and labor force productivity.

The Weintraub equation, developed in the 1970s by Sidney Weintraub, states that firms determine prices based on wage growth, productivity growth, and the mark-up price, which is held constant. He states that aggregate price level depends on the growth of money wages relative to the growth of labor productivity. The Weintraub equation is described as:

$$P = k(\frac{w}{A}) \tag{1}$$

where P is price, k is the mark-up, w is wage, and A is labor market productivity, also described as $\frac{N}{x}$ where N is total output and x is the total labor hours. In order to more easily understand the relationship between the various variables, I rearrange the equation by taking the natural log on either side of the equation:

$$\ln(P) = \ln(k) + \ln(w) - \ln(A) \tag{2}$$

$$\frac{\Delta P}{P} = k^{\circ} + w^{\circ} - A^{\circ} \tag{3}$$

Equation 7 shows that inflation, or change in price over price, will increase if change in wages are greater than changes in productivity if change in mark-up is constant. In the case of Japan, labor markets have been tightening, which should signal greater change in wage, and subsequent increase in inflation. On the contrary, we are seeing a decrease in unemployment and a decrease in wage change, despite an increase in labor market productivity (Ip, 2018). Furthermore, Japan has enough technological advancement, and as a result, labor market productivity is increasing while prices remain at a minimum (Ip, 2018). This discrepancy suggests that the unemployment rate does not capture structural changes in the labor markets[8]. In fact, this shows the opposite relation between unemployment and wage inflation that Phillips (1958) found. Therefore, when examining the unemployment measure of Japan, we must question who is not being accounted for within the measure. Furthermore, the Weintraub equation suggests another possibility—the Japanese labor market is not as tight as the unemployment rate suggests upon first glance.

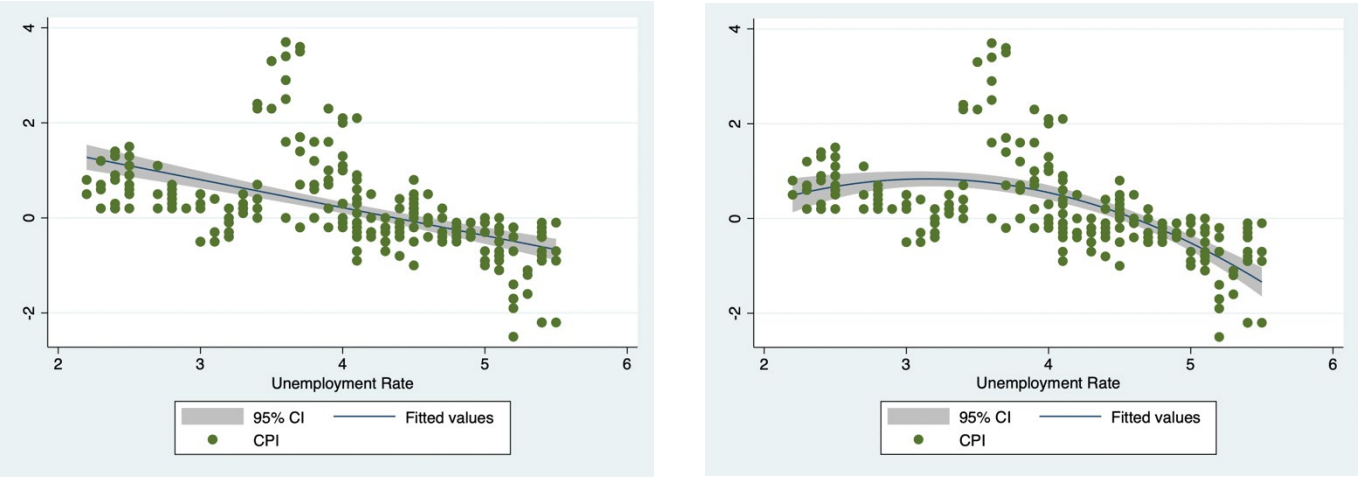
4 Results

4.1 Looking at Alternative Phillips Curves

Figure 4 shows the Phillips curve that was created using the unemployment data from 2002 to 2019 without taking into consideration discouraged workers. This figure is considered to be the current Phillips curve of Japan.

[8] Several structural changes within the Japanese labor force today could be responsible for this such as the deterioration of the lifetime employment system as well as the emergence of gig economy and the guest worker program which was introduced by the Abe administration.

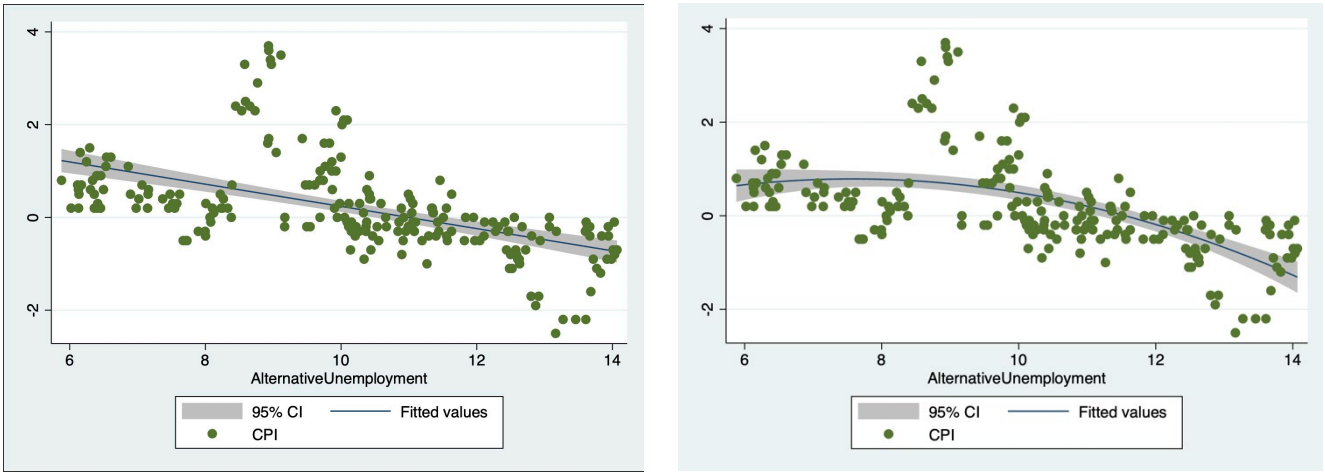
Figure 4: Japan's Phillips Curve (2002-2019)



For the most part it is evident that the inverse relationship is somewhat maintained, although there is a slight shift away from the trend around 4% of unemployment rate. However, the Phillips curve evidently is extremely flat when compared to the Phillips curve that was presented in Smith (2006) that used older data. The line of best fit for the Phillips curve is also shown on the graph. The shaded region represents the region of points within the 95 percent confidence interval. On the left, I present the Phillips curve with a linear fit, and on the right, the same graph with a quadratic fit. With the quadratic fit model, there is an interesting finding of a concaved Phillips curve rather than a convex one.

Figure 5 shows the alternative Phillips curve that was created utilizing the labor underutilization measure, combining unemployment and discouraged workers.

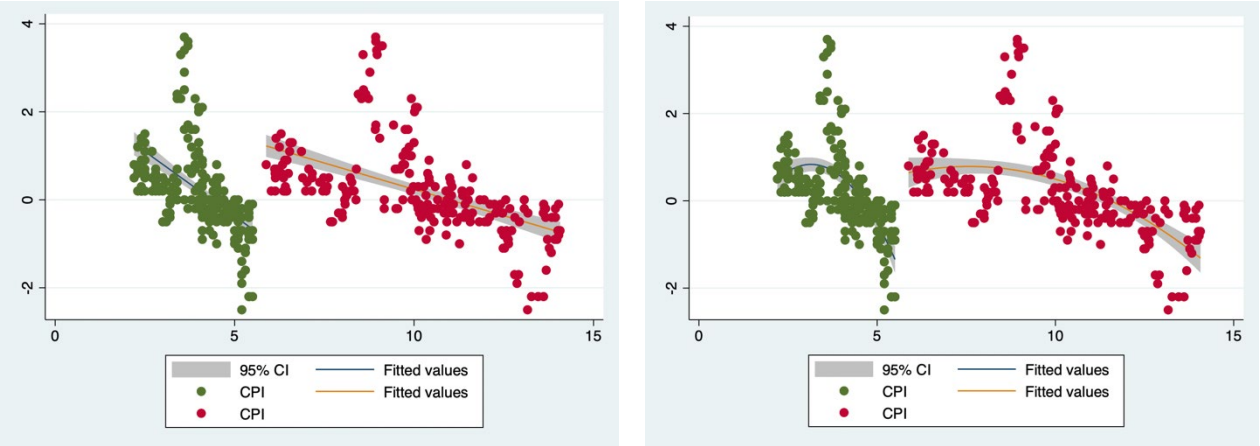
Figure 5: Japan's Alternative Phillips Curve (2002-2019)



These Phillips curves with the alternative unemployment measure still shows a similar trend to those in Figure 4. However, rather than at 4%, there is a slight deviation around 9%. Similar to Figure 4, the line of best fit and the 95% confidence level region is also shown on the graph with a linear fit on the left and a quadratic fit on the right. Compared to Figure 4, the points on the graph are a lot more spread out, which could be explained by the wider range in the discouraged worker measure throughout the years. Again, the quadratic fit shows a concaved Phillips curve rather than a convex one.

In Figure 6, I have laid out the two Phillips curves on one graph. This way, the difference in slopes between the two graphs is more easily evident and the two curves can easily be compared. Those points in green are from the Phillips curve with the original unemployment rate, and those points in red are representative of the Phillips curve utilizing the alternative unemployment rate.

Figure 6: Japan's Phillips Curve and Alternative Phillips Curve (2002-2019)



As evident in the graph, the Phillips curve utilizing the alternative unemployment rate demonstrates a much flatter slope than the original Phillips curve. Again, the left graph has the linear fit and the right has the quadratic fit. When taking into consideration the discouraged workers, the alternative Phillips curve has a flatter slope, and thus has less of a concaved shape. However, with the original Phillips curve, the concaved shape is pronounced.

4.2 OLS Analysis

Once I create the two Phillips curves, I will use and OLS regression model to further analyze the slopes of the two Phillips curves. My models utilize a quadratic fit despite recent trends where the Phillips curve assumes linearity because in his original paper Phillips (1958) concludes that "The relation between unemployment and the rate of change of wage rates is therefore likely to be highly non-linear." Furthermore, this belief is backed up by Phelps (1967) who also concludes that such non-linearity is highly likely. My two models are as follows:

$$CPI_t = \alpha + \beta_1 * Unemp_t + \beta_2 * Unemp^2{}_t + \varepsilon_t \quad (4)$$

where *Unemp* is the unemployment rate at given month *t* and α is the constant. I square the *Unemp* variable because the relationship between inflation and unemployment seems to be a

quadratic fit. Similarly, for the Phillips curve using the alternative unemployment measure, I will use the below model to estimate the coefficient:

$$CPI_t = \alpha + \beta_1 * Alt_t + \beta_2 * Alt^2{}_t + \varepsilon_t \quad (5)$$

where CPI is the inflation at given month *t* and *Alt* is the alternative unemployment at given month *t* and α is the constant. Table 2 below outlines the estimated coefficients from equation 4 that takes into consideration the original unemployment rate. Table 3 presents the estimated coefficients from the equation 5 where the alternative unemployment rate is taken into consideration.

Table 2: OLS Estimates of Original Phillips Curve

CPI	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Unemployment	2.459	0.513	4.79	0.000	1.447	3.471	***
Unemployment2	-0.391	0.065	-5.98	0.000	-0.520	-0.262	***
Constant	-3.027	0.969	-3.12	0.002	-4.938	-1.116	***
Mean dependent var		0.202	SD dependent var			1.032	
R-squared		0.378	Number of obs			216.000	
F-test		64.794	Prob > F			0.000	
Akaike crit. (AIC)		528.783	Bayesian crit. (BIC)			538.909	

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3: OLS Estimates of Alternative Phillips Curve

CPI	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Alternative	0.755	0.217	3.47	0.001	0.327	1.184	***
Alternative2	-0.050	0.011	-4.61	0.000	-0.071	-0.028	***
Constant	-2.074	1.055	-1.97	0.051	-4.153	0.005	*
Mean dependent var		0.209	SD dependent var			1.028	
R-squared		0.346	Number of obs			215.000	
F-test		56.110	Prob > F			0.000	
Akaike crit. (AIC)		535.762	Bayesian crit. (BIC)			545.874	

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The effect of the concaved quadratic fit Phillips curve is evident from the negative coefficient in the squared variables *Unemployment2* and *Alternative2*, an observation that I did not expect at the start of my study. The p-values show that the estimated coefficients are all statistically significant. However, the R-squared value is low, suggesting that the Phillips curve's relationships is becoming weaker as other researchers suggest.

In order to understand the slope of quadratic fit of the Phillips curve, I take the first derivative of equation 4 with respect to *Unemp* and the first derivative of equation 5 with respect to *Alt*. By looking at the first derivative we can observe that for the slope we must calculate the coefficient of $\beta_1 + 2\beta_2$. Therefore, for the original Phillips curve we note a slope of 1.677 (= 2.459 + 2* -0.391) and for the alternative Phillips curve, a slope of 0.655 (0.755 + 2* -0.050). Therefore, the OLS regression model proves the flattening of the curve when taking into consideration the discouraged worker that was evident graphically.

5 Theory and Discussion

5.1 Theory: The Flatter Slope for the Alternative Unemployment Phillips Curve

The increased flattening of the Phillips curve when utilizing the alternative unemployment measure can be explained by a couple of theories. First, when looking at analysis around the 1990s bubble burst, such as Yamamoto (2008), trend in the labor market in Japan showed low female labor market participation. Specifically, women often exit the labor market once they get married and have children in order to focus on housework such as raising their children. However, many of these women would re-enter the labor market during economic booms. Pissarides (2000)[9] states that the equilibrium in job searching is dependent on the business cycle, and therefore fluctuates with the labor market tightness. When their husbands' income fell, and their families faced financial constraints during poor economic conditions, most women felt the need to remain in the labor market or to re-enter if they already had not. Since these women re-enter when considered absolutely necessary for the family, they often continue to search for jobs past the equilibrium in the search model. As Yamamoto (2008) concludes, the discouraged worker effect is dependent on the individual's efficiency during the job searching process throughout the business cycle. Therefore, a decline in the discouraged worker effect in Japan can be explained by married women remaining in the labor market, due to reasons such as their husband's income falling or financial constraints faced by the family, despite there being a decline in the efficiency in job searching. However, marriage rates in Japan have continued to fall, and those who are unmarried by the age of 50 have quadrupled for men and doubled for women[10]. Additionally, fertility rates in Japan have fallen to 1.43 in 2013[11], and the elimination

[9] Pissarides (2000) states that during economic recessions, an individual's job search intensity endogenously decreases, and therefore is able to achieve an efficient level of job searching.
[10] Marriage statistics are gathered by the Ministry of Health Labour and Welfare
[11] Data provided by the Ministry of Internal Affairs and Communication, Statistics Bureau

of the lifetime employment, coupled with the decrease in the husband's income lead to an increase in female labor market participation.

Higuchi and Abe (1999) as well as Kuroda and Yamamoto (2007) point out this "added worker effect" where the wife is more likely to enter the labor force due to lack of income revenue from the husband alone. If we consider the discouraged worker effect in Japan to be largely controlled by married females, as Kuroda and Yamamoto (2007) observe, we can insinuate that later marriages or no marriages by Japanese women result in a decrease in the discouraged worker effect in Japan. Since Japan's marriage rates are falling, and the average age at marriage is increasing, we can conclude that the discouraged worker effect driven by women is declining, causing a rise in real friction in the labor market, which leads to a flattening of the Phillips curve (Yamamoto, 2008).

5.1.2 Theory: The Concaved Phillips Curve

Although it is unclear exactly why the Japanese Phillips curve is concaved rather than convex, some theories could be used as an explanation as well as be explored in future research. I hypothesize that there is some sort of threshold effect that is causing the Phillips curve to behave this way. Ho and Iyke (2018) build on previous research that suggests the possibility of a threshold effect on the Phillips curve by examining 11 eurozone countries from January 1999 to February 2017 by examining where the threshold is that the Phillips curve relationship switches from a negative one to a positive one. Their findings show that between 5.00% and 6.54% of unemployment lies a threshold where the relationship between inflation and unemployment switches to a positive one. Furthermore, they find that past this threshold, the relationship between the two variables no longer hold true. While Ho and Iyke (2018) focus on European countries, it is possible that Japan's Phillips curve is contingent upon a certain threshold of

unemployment. Although it is possible that some sort of cultural aspect is impacting Japan's backwards bending Phillips curve, it is also possible that the stubborn low inflation rates that have been observed in both Japan and various European nations somehow are impacting the Phillips curve slope as well. Regardless, in order to have a definitive answer, further research will be necessary.

5.2 Limitation and Future Studies

Although my study was able to contribute to the literature surrounding the flattening of the Phillips curve, it is necessary to mention some limitations within the study. First, my analysis of Japan's Phillips curve is limited in observation points due to the lack of information collected on the part of Japan's Ministry of Internal Affairs and Communications. Data on discouraged worker was not collected until January 2018, which resulted in having to create a proxy to calculate the discouraged worker effect of the previous months. Since this proxy was created by examining the flow from 'job searching' to 'not in the labor force,' it is inevitable that there will be some error in the values I calculated for the number of discouraged workers. When looking at my calculations for 2018 alternative unemployment measure, and the LU3 measure[12], we find a 3.1 percent discrepancy (= 6.3 - 3.2). Furthermore, the job searching data that I was provided with from the Japan Statistics Bureau began in 2002, which limited the number of years that I could examine. However, in future research, there will be more data points available for alternative unemployment measures starting in 2018 that will allow for more accurate analysis. Analysis of this dataset could also have some limitations because of the number of recessions accounted for within the short period of time. In the early 2000s, Japan was still suffering from

[12] The LU3 measure of Japan looks at unemployment rate and discouraged workers. (= (unemployed + discouraged worker) / (labor force + discouraged worker population)*100)

the Asian Financial Crisis as well as the dot com recession, and in 2008 the Great Recession also had a large impact on unemployment data. Furthermore, the Tōhoku earthquake of 2011 also could be counted as an exogenous variable that I did not properly account for in my analysis. However, in order to fully understand how recessions and negative shocks in the economy affect Japan's discouraged worker rates, there should be research conducted on the modern-day labor market regarding this topic.

In the future, it could be beneficial to utilize a wider range of alternative unemployment measures that are covered by Japan's labor underutilization statistics. For example, the LU4 takes into consideration underutilized workers such as those who are involuntary part time workers in addition to discouraged workers. Examining the effects of creating a more encompassing unemployment measure could be more effective when there are more data points that have been collected and published in the future. Furthermore, in the future there will be enough data points to conduct such research with the data points that the Japanese Ministry of Internal Affairs and Communications provided.

Another extension of this paper would be to further examine the concaved Phillips curve of Japan. As mentioned above, although it is possible that there is some threshold effect present that is causing such a shift, but further research will be necessary to fully understand the reasons behind this phenomenon.

5.3 Policy Implication

The Flatter Phillips Curve and Central Banks

The validity of the Phillips curve is important for those who utilize the relationship in order to apply fiscal and monetary policy, specifically those in central banks. The flatter Phillips

curve alone suggests that economic activity and the tightness of the economy may not have as large of an effect on inflation as originally believed. This could largely impact central bank responses to unemployment rates in order to stabilize inflation rates. Economists in the United States such as Ben Bernanke and Janet Yellen have also suggested less harsh responses to changes in interest rates as a response to changes in unemployment in order to stabilize inflation rates. Specifically, for Japan, the Phillips curve has been important in fighting the chronic deflation that has been present for decades. If the relationship no longer holds true, or if there is not a strong enough relation between the two variables for central bankers, it is important that changes are made in order to have more effective policies put in place.

Measuring Economic Statistics: Unemployment and Inflation

My results highlight the large discrepancies between the actual unemployment rate and the alternative unemployment rates in Japan. Large gaps between unemployment rates and alternative unemployment rates suggests that there is an issue in our definition of unemployment. Furthermore, the finding suggests that changes in labor market are requiring this reexamination to happen. Specifically, the emergence of the gig economy questions how we will be categorizing those who are working independently when necessary, but do not work during the survey week.

6. Conclusion

This paper investigated Japan's flattening out of the Phillips curve, and intends to answer the question: Does an unemployment measure that is more encompassing revalidate the Japanese Phillips curve? In order to answer my questions, I gathered labor market data from the Japanese Ministry of Internal Affairs and Communications from 2002 through 2019. My study is the first

to address the validity of methodology of the gathering of such data and its role in the flattening of the Phillips curve. In total, my data set contained 215 observations, which covered the labor market statistics for all 47 prefectures in Japan from 2002 to 2019. My results showed two significant findings. First, the Phillips curve that took into consideration the alternative unemployment rate had a flatter slope than the original Phillips curve. Specifically, the slope for the original Phillips curve is 1.677 and the alternative Phillips curve was 0.655. This phenomenon can most likely be explained by unique changes happening amongst the Japanese female population such as lower marriage rates, later marriage ages, or lower fertility rates. Second, the Japanese Phillips curve shows a concaved curve rather than a convex curve. Although I suggest some possible theories behind this phenomenon, further research is necessary to understand why Japan's Phillips curve is exhibiting such behavior.

Although my finding showed a difference in the Phillips curve slope with and without the alternative unemployment rate for Japan, whether my findings are externally valid is questionable. When examining Japan's labor market as a whole, there are several factors that make it unique from other nations. First, Japan's geographic location allows for less interference, and less possibility of illegal or foreign workers. Since the country is surrounded by water on all sides, it is difficult for foreign labor to enter the Japanese market. Furthermore, the Japanese government had controlled foreign labor to be at a minimum until a recent guest worker program was proposed by the current prime minister's administration. Tighter borders and isolation lead to fewer illegal immigrants, which allows for a clearer case to analyze the Japanese labor market. However, in countries where borders allow foreign workers to enter the country, our findings may not be applicable.

Second, although Japan is an industrial nation similar to other countries that are experiencing a flatter Phillips curve, whether gender trends in the labor market across these countries are the same is questionable. In recent years, Japan has experienced large shifts in the labor market that are not only an effect of an increase in female labor due to a decrease in marriage rates and fertility rates. Japan's labor market also is currently suffering from an extreme aging population. Currently, Japan's population is the oldest in the world, with roughly 28 percent of the country being 65 years old or older. This, coupled with low fertility rates, creates a unique shift in Japan's demographic compared to other developed nations around the world. However, some other industrial nations in the world, such as Germany and Italy have displayed similar trends, which could possibly allow for my results to be externally valid.

Lastly, the security the young men have in Japan may be a cultural factor that is unique to the country. Being able to live with their families until employment or marriage gives these young men the luxury of taking their time to find employment. This may also lead to higher discouraged workers in Japan compared to other countries because young potential workers can be more sensitive to wages within the labor market.

Based on my findings, future researchers can investigate why the Japanese Phillips curve is shaped to be concaved rather than the traditional convex shape. Future studies can also examine various implications for the Japanese economy that result from such a Phillips curve. Future studies should also utilize data that is more accurately collected from the Japanese Ministry of Internal Affairs and Communications rather than utilizing a proxy to measure discouraged workers. However, in order to have ample data points, this will be needed to be conducted several years from now. However, ultimately my research questions whether we can rely so heavily on the Phillips curve for fiscal and monetary policy. My findings show a very flat

slope, and thus little relation between inflation and unemployment, for both Phillips curves that I generated. Yet, many economists and politicians rely on this balance to reason their policy decisions.

References

Akerlof, G. A., Dickens, W. T., Perry, G. L., Bewley, T. F., & Blinder, A. S. (2000). Near-rational wage and price setting and the long-run phillips curve. *Brookings Papers on Economic Activity, 2000*(1), 1-60.

Ball, L. M. (2006). *Has globalization changed inflation?* . Unpublished manuscript. Retrieved from https://www.nber.org/digest/jun07/w12687.html

Ball, L., & Moffitt, R. (2001). No title. *Productivity Growth and the Phillips Curve,*

Belz, S., Wessel, D., & Yellen, J. (2020). *What's (not) up with inflation?* . (). 1775 Massachusetts Ave., NW, Washington, DC 20036: The Brookings Institution. Retrieved from https://www.brookings.edu/wp-content/uploads/2020/01/Inflation-report_1.29.2020.pdf

Blinder, A. S. (2000). No title. *The Internet and the New Economy,*

Bregger, J. E., & Haugen, S. E. (1995). BLA introduces new range of alternative unemployment measures. *Monthly Labor Review, 118*(10), 19-26.

Desai, M. (1975). The phillips curve: A revisionist interpretation. *Economica, 42*(165), 1-19. doi:10.2307/2552982

Donovan, S. A., Bradley, D. H., & Shimabukuru, J. O. (2016). What does the gig economy mean for workers?

Friedman, G. (2014). Workers without employers: Shadow corporations and the rise of the gig economy. *Review of Keynesian Economics, 2*(2), 171-188.

Friedman, M. (1968). The role of monetary policy. *American Economic Review, 58*(1), 1-17.

Grubb, D., Jackman, R., & Layard, R. (1982). Causes of the current stagflation. *The Review of Economic Studies, 49*(5), 707-730.

Ho, S., & Iyke, B. N. (2019). Unemployment and inflation: Evidence of a nonlinear phillips curve in the eurozone. *The Journal of Developing Areas, 53*(4)

Hogen, Y., & Okuma, R. (2018). The anchoring of inflation expectations in japan: A learning-approach perspective. *Bank of japan working paper series 18-E-8* (). Tokyo, Japan:

Iakova, M. D. M. (2007). *Flattening of the phillips curve: Implications for monetary policy*. Washington, DC.: International Monetary Fund.

Ip, G. (2018, May 23,). In booming japan, the phillips curve is dead . *The Wall Street Journal* Retrieved from https://www.wsj.com/articles/injapans-hot-economy-aworrisomelesson-oninflation-1527068471

Kumar, A., & Orrenius, P. M. (2016). A closer look at the phillips curve using state-level data. *Journal of Macroeconomics, 47*, 84-102.

Kuroda, S., & Yamamoto, I. (2008). Estimating frisch labor supply elasticity in japan. *Journal of the Japanese and International Economies, 22*(4), 566-585.

Lucas Jr, R. E. (1972). Expectations and the neutrality of money. *Journal of Economic Theory, 4*(2), 103-124.

Murakami, Y. (2019, May 2,). End of heisei era and lifetime employment . *Japan Times* Retrieved from https://www.japantimes.co.jp/opinion/2019/05/02/commentary/japan-commentary/end-heisei-era-lifetime-employment/#.XlA1BS2ZPs0

Naganuma, S., & Uno, Y. (2016). Long-term unemployment in japan. *Bank of Japan Research LAB,* (16-E), 1.

National Center of Education Statistics.Indicator 19: Unemployment and education. Retrieved from https://nces.ed.gov/pubs/eiip/eiip19s1.asp

Ono, H. (2010). Lifetime employment in japan: Concepts and measurements. *Journal of the Japanese and International Economies, 24*(1), 1-27.

Phelps, E. S. (1968). Money-wage dynamics and labor-market equilibrium. *Journal of Political Economy, 76*(4, Part 2), 678-711.

Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the united kingdom, 1861–1957 1. *Economica, 25*(100), 283-299.

Pissarides, C. A. (2000). *Equilibrium unemployment theory* MIT press.

Sargent, T. J., Fand, D., & Goldfeld, S. (1973). Rational expectations, the real rate of interest, and the natural rate of unemployment. *Brookings Papers on Economic Activity, 1973*(2), 429-480.

Smith, G. W. (2008). Japan's phillips curve looks like japan. *Journal of Money, Credit and Banking, 40*(6), 1325-1326.

Waldfogel, J., Higuchi, Y., & Abe, M. (1999). Family leave policies and women's retention after childbirth: Evidence from the united states, britain, and japan. *Journal of Population Economics, 12*(4), 523-545.

Yamamoto, I. (2008). Changes in wage adjustment, employment adjustment and phillips curve: Japan's experience in the 1990s. *Keio/Kyoto Joint Global COE Discussion Paper Series,* (024)

Yellen, J. L., & Akerlof, G. A. (2006). Stabilization policy: A reconsideration. *Economic Inquiry, 44*(1), 1-22.

Yellen, J. L. (2006). Monetary policy in a global environment, 2006, Federal Reserve Bank of San Francisco.