The Endogeneity of the Natural Rate of Growth in the United States

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Abstract

Applying Okun's Equation and Thirlwall's Reversal Method to quarterly data on unemployment and gross domestic product in the United States from 1948 to 2019, I test the assumption that the natural rate of growth is exogenous to actual growth. I find evidence that this assumption does not hold and that the natural rate is between 2.96 and 4.12 percentage points higher in quarters characterized by relatively high growth compared to ones in which growth is relatively low. This provides a plausible explanation for the coexistence of low growth and steady and even falling unemployment in the post-financial crisis period. It also raises the concerning possibility that policymakers may unintentionally "lock in" a recession-induced lower natural rate of growth, which would in turn reduce the long-term growth rate.

Keywords: Natural rate of growth, actual rate of growth, endogeneity, United States

JEL Classification: O40, E10, E23

1 Introduction

In the wake of the global financial crisis, several economists have raised serious questions about our understanding of growth, particularly on the topics of hysteresis and secular stagnation (Yagan 2019; Blanchard, 2015; Ball, 2014). One piece of the puzzle that has received less attention is the natural rate of growth. The natural rate, which can be traced back to R.F. Harrod (1939), is the rate of growth that exactly accommodates increases in the labor supply and labor productivity, keeping the rate of unemployment constant (León-Ledesma & Thirlwall, 2002).

Despite the lack of focus, the natural rate has great theoretical importance. In the Harrod-Domar model, fluctuations in the warranted rate around the natural rate lead to self-reinforcing periods of prolonged inflation or increasing unemployment (Harrod, 1939; Sato, 1964, p. 380). For Solow and the Neoclassical theorists, the natural rate is the long-run steady-state growth rate to which actual growth will converge (1956, p. 70). On the practical side, the natural rate is the desired rate of growth during periods of full employment.

In the models discussed above, this rate is assumed to be exogenous; independent from the actual rate of growth. Even so-called "endogenous" growth theories often fail challenge this assumption in a robust way. Instead, these theories simply adjust the Solow model by introducing the idea that investment matters for long term growth and is affected by current conditions (Palley, 1996; León-Ledesma & Thirlwall, 2002, p. 445-6).

However, there is reason to question this assumption. Researchers like M. A. León-Ledesma & A.P. Thirlwall (2002), have found that the natural rate shifts based on the rate of actual growth.

My research is motivated by this relatively unexamined question: is the natural rate of growth exogenously given, as assumed in the Harrod-Domar and Solow models? Or, as some recent evidence suggests, is the natural rate sensitive to the actual growth rate in the economy? Applying an estimation technique pioneered by León-Ledesma & Thirlwall (2002) to quarterly unemployment and gross domestic product (GDP) data from the United States from 1948 to 2019, I find evidence that the natural rate is endogenous to actual growth. Specifically, I find that the natural rate is between 2.98 and 4.12 percentage points higher in quarters of relatively high growth compared to quarters of relatively low growth.

My paper contributes to the literature in three ways. First, it provides evidence from a unique sample that the natural rate is endogenous to actual growth, and thus that the exogeneity assumption is stronger than often acknowledged. Second, insofar as we would expect the natural rate to be less sensitive to actual growth in industrially mature countries (Libânio, 2009, p. 981), finding endogeneity in the United States provides relatively strong evidence that actual growth does influence the natural rate. Third, the finding has serious policy implications. It suggests that macroeconomic policy makers may unintentionally "lock in" lower natural rates following downturns. This would occur in the following way. If policy makers were to treat a lower post-downturn natural rate as exogenously given and fixed in the short run, they would prevent growth from rising above that rate once inflation has reached the target, out of concern that it would cause unemployment to fall and thus wages and prices to rise above the target. This would lock in the new lower natural rate until the next shock. Given that the natural rate determines the steady state growth rate to which the economy converges, such a move would lower long-term growth in the economy, leading to potentially billions of dollars in unnecessarily forgone wealth.

The rest of the paper is structured as follows. In Section II I briefly survey the existing literature on this topic. In Section III I explain the model and data that I use and estimate the natural rate. In Section IV I present the results from my model and consider their implications. In Section V I briefly conclude.

2 Empirical work on the natural rate of growth

2.1 Empirical work

In 2002, León-Ledesma and Thirlwall jump-started research into the potential endogeneity of the natural rate of growth. Using data from 15 OECD countries between 1961 and 1995, they estimated that the natural rate is between 1.39 and 5.86 percentage points higher in periods of relatively high growth compared to periods of relatively low growth. Since this finding, their method has been applied to regions of Italy (Lanzafame, 2006), to countries in Latin America (Vogel, 2009; Libânio, 2009), to the Turkish economy (Acikgoz & Mert, 2010), and to a selection of countries in Asia (Dray & Thirlwall, 2011). A summary of these papers can be found in Table 1. Overall, each finds evidence that the natural rate is sensitive to the actual rate of growth, shifting up in periods of relatively high growth and shifting down in periods of relatively slow growth.

Authors	**Countries/Regions**	**Timeframe**	**Period**	**Estimated Natural Rate(s)**	**Range of Effect Sizes (Percentage Points)**
M.A. León-Ledesma & A.P. Thirlwall (2001)	Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Spain, the United Kingdom, the United States.	1961-1995	Yearly	2.99-7.25%	1.39-5.86
Lena Vogel (2009)	Bolivia, Brazil, Chile, Costa Rica, Colombia, Mexico, Nicaragua, Paraguay, Peru, Venezuela	1979-2004	Yearly	1.78-6.12%	3.19-6.66
Gilberto A. Libânio (2009)	Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Uruguay, Venezuela	1980-2004	Yearly	1.81-4.42%	2.45-8.24
Senay Acikgoz & Merter Mert (2010)	Turkey	1980-2008	Yearly	4.97%	1.77
Matteo Lanzafame (2010)	Regions of Italy	1977-2003	Yearly	1.40-2.65%	2.11-4.88
Mark Dray & A.P. Thirlwall (2011)	China, Hong Kong, Indonesia, Japan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand	1982-2005	Yearly	2.85-10.36%	1.74-5.86

Table 1: Survey of empirical research on the endogeneity of the natural rate of growth.

2.2 Potential mechanisms

Recall that the natural rate, in theory, is determined by growth in the labor supply and growth in labor productivity (Harrod, 1939). There is evidence to suggest that both of these determinants are sensitive to actual growth rates. The positive relationship between labor productivity and economic growth is well understood and captured in the wide literature surrounding "Verdoorn's Law" (Verdoorn, 1949). The mechanisms include static and dynamic returns to scale (Young, 1928), the technological progress embodied in capital accumulation (Hulten, 1992; Greenwood, Hercowitz, & Krusell, 1997), learning by doing (Arrow, 1971), and a reallocation of labor from less to more productive industries (Cornwall, 1977; León-Ledesma & Thirlwall, 2002). The relationship between growth in the labor supply and economic growth is somewhat less discussed in the literature (though recent work on hysteresis does touch upon it). Nonetheless, it is rather straightforward. Faster growth may cause an increase in participation rates, in the overall number of hours worked, and in the flow of inward migration/immigration (León-Ledesma & Thirlwall, 2002; Morley, 2006). These mechanisms provide a plausible theoretical justification for why we may empirically observe an endogenous natural rate of growth. As the growth rate increases, productivity and the labor force grow more quickly, and thus we should expect the natural rate to rise.

3 Building a model and estimating the natural rate

3.1 Using Okun's Law and Thirlwall's Reversal to estimate the natural rate

The first step in testing for endogeneity is to estimate the natural rate itself. Since the natural rate of growth is the sum of the growth of the labor force and the growth of labor productivity, unemployment will rise when actual growth is below the natural rate and will fall when actual growth is above the natural rate. Thus, the natural rate can be interpreted as the rate which keeps unemployment constant. With this understanding, A.P. Thirlwall (1969) recognized that Okun's equation (1) could be used to estimate the natural rate directly.

$$\Delta U = \alpha + \beta_1 G + \epsilon \tag{1}$$

Where G represents the growth rate in a given period and ΔU represents the change in the unemployment rate from one period to the next.

Specifically, Thirlwall recognized that by simply reversing G and ΔU in equation (1), the intercept becomes the rate of growth when unemployment is unchanging. In other words, α in equation (2) is the rate of growth that keeps unemployment constant. That is, by definition, the natural rate.

$$G = \alpha + \beta_1 \Delta U + \epsilon \tag{2}$$

This is a powerful insight that allows me to estimate the natural rate of growth directly. Applying this model to quarterly GDP data from the Bureau of Economic Analysis and quarterly unemployment data from the Bureau of Labor Statistics yields an estimate of 3.22% for the natural rate of growth in the US economy from Q1 1948 to Q2 2019 (Table 2).

	Estimate	**Standard Error**	**2.50%**	**97.50%**
Intercept (Natural Rate)	3.22***	0.17	2.89	3.55
Change in Unemployment	-1.69***	0.11	-1.91	-1.48

Table 2: ***p<0.01, **p<0.05, *p<0.10. Entries are linear regression coefficients. Outcome variable is annualized quarterly change in Gross Domestic Product (GDP). Change in unemployment measured in terms of annualized quarterly change in unemployment. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics. Upper and lower bound of 95% confidence interval shown.

A visualization of the data demonstrates that this is a fair estimate (Figure 1). The growth rate is plotted on the vertical axis, the percentage point change in the unemployment rate is plotted on the x axis, and the diagonal dashed line represents the estimated relationship between unemployment and growth. If we divide the data into 4 quadrants, given the definition of the natural rate, we would expect all points to fall in the second and fourth quadrants, with growth above the natural rate causing unemployment to fall and growth below the natural rate causing unemployment to rise. In practice, this is generally the case, with 63 percent of points falling into quadrants 2 and 4 (Table 3).

Quadrant	Percent
1	8.39
2	35.3
3	22.4
4	27.6
NA	6.29

Table 3: Distribution of observations across quadrants. NA indicates that unemployment was unchanging, and thus the observations did not fall in a single quadrant.

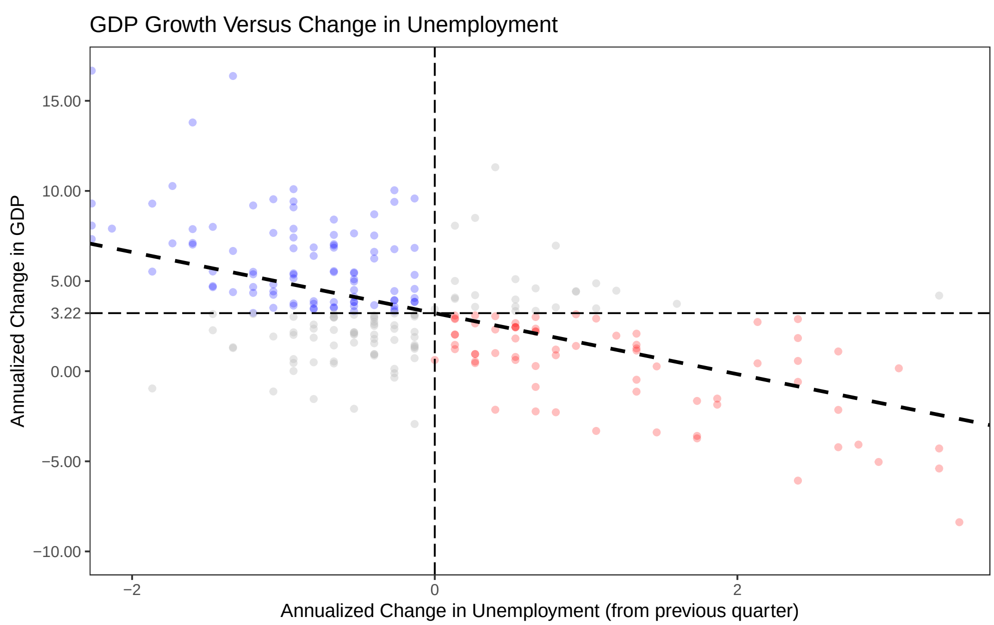

Figure 1: Annualized quarterly change in gross domestic product (GDP) versus annualized quarterly change in unemployment. Dashed diagonal line is fitted linear model using equation (2). Dotted vertical line indicates unchanging unemployment. Dotted horizontal line indicates the estimated natural rate of 3.22%. Blue points indicate high growth quarters. Red points indicate low growth quarters. Grey points indicate "abnormal" quarters in which growth is below the natural rate but unemployment is falling, or vice versa. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

There are several plausible explanations for why the empirical data does not exactly match the theory,

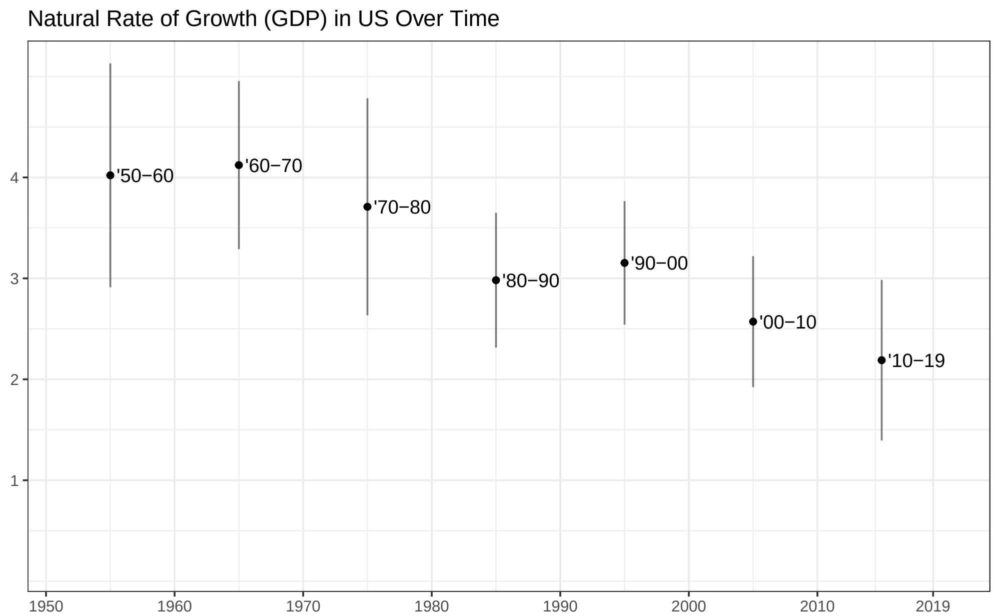

Figure 2: Estimated natural rate by decade in terms of annualized quarterly change in gross domestic product (GDP), using equation (2). The natural rate appears to be on a secular decline. Vertical lines represent 95% confidence intervals. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

with unemployment falling in some quarters in which growth was below the estimated natural rate, and vice versa. First, economic growth and its relationship with unemployment is a complicated and stochastic process. Second, many of the points in quadrant 3 are from the years between 2007 and 2019, a period characterized by relatively slow growth paired with continually falling unemployment. Third, even assuming the natural rate is independent of short-run actual growth, over a long period of time there are certainly exogenous shifts in labor supply and labor productivity in any economy. Thus, an estimate made over such a long period is bound to yield some abnormal points. Reassuringly, an estimate for each decade also gives reasonable results, and appears to reveal a secular downward trend (Figure 2).

Since decades are somewhat arbitrary time periods, I also generate estimates for each peak-to-peak period, as determined by the National Bureau of Economic Research (National Bureau of Economic Research, 2010). These estimates are necessarily nosier, given that some periods have few data points, but the same general trend is apparent, and all estimates appear reasonable (Figure 3).

With these estimates of the natural rate, I can now describe the method I use to test for the sensitivity of the natural rate to actual growth.

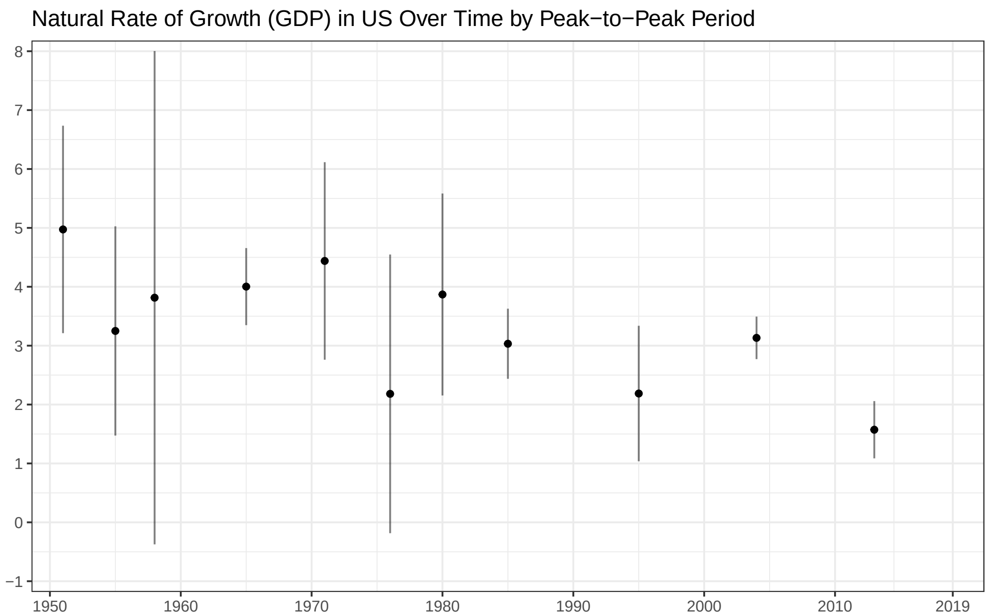

Figure 3: Estimated natural rate by peak-to-peak period in terms of annualized quarterly change in gross domestic product (GDP), using equation (2). Position of points on x-axis based on middle date of peak-to-peak period. The natural rate appears to be on a secular decline. Vertical lines represent 95% confidence intervals. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics. Peak-to-peak periods as determined by National Bureau of Economic Research.

3.2 Model to test for endogeneity

The method to test for the endogeneity of the natural rate, pioneered by León-Ledesma & Thirlwall (2002), is straightforward. Using my estimate of the full-period natural rate, I generate a dummy variable equal to one if actual growth is above the natural rate, and equal to zero if it is below the natural rate. In practice, this splits the data into two periods: one of relatively high growth and one of relatively low growth. Plugging this variable (D) into equation (2) yields equation (3).

$$G = \alpha + \beta_1 \Delta U + \beta_2 D + \epsilon \tag{3}$$

In this equation, β_2 can be interpreted as the shift in the intercept in quarters when actual growth is greater than the natural rate. In other words, it is how much higher the rate of growth must be to keep unemployment constant in quarters of relatively high growth compared to ones of relatively low growth. If this coefficient is positive and significant, it provides evidence that the natural rate is sensitive to actual growth.

I also make one additional adjustment. Equation (3) assumes that there will only be a level shift in the relationship, with the intercept shifting up. However, some authors, such as Matteo Lanzafame (2006), find that the coefficient on ΔU varies between high and low growth periods. Thus, I introduce an interaction to allow the relationship between unemployment and growth to vary between periods. This yields my preferred specification, equation (4).

$$G = \alpha + \beta_1 \Delta U + \beta_2 D + \beta_3 (\Delta U * D) + \epsilon \tag{4}$$

Before discussing the results, it is important to point out that I tested both my main model and all alternative specifications for heteroskedasticity and autocorrelation. I did so using a Breusch-Pagan test and Durbin-Watson test, respectively. For all specifications for which I find evidence of heteroskedasticity, I use a robust linear regression. Ultimately this does not meaningfully affect the magnitude, size, or significance of any estimated effects. For all specifications for which I found evidence of autocorrelation, I use Newey-West estimators for the standard errors. This too does not have a meaningful impact on my estimates. Finally, errors appear to have constant variance, to be independent, and to be approximately Gaussian distributed.

4 Testing the endogeneity of the natural rate

4.1 Main specification

Running equation (4) on the full data, I find evidence of a 3.55 ($p<0.001$) percentage point increase in the natural rate in periods of relatively high growth compared to periods of relatively low growth, with a 95% confidence interval of 2.98 to 4.12 percentage points (Table 4).

	Estimate	**Standard Error**	**2.5%**	**97.5%**
Intercept	1.42***	0.16	1.11	1.73
High Growth Period	3.55***	0.29	2.98	4.12
Change in Unemployment	-0.84***	0.18	-1.21	-0.48
Change in Unemployment* High Growth Period	-0.23	0.24	-0.71	0.25

Table 4: ***p<0.01, **p<0.05, *p<0.10. Entries are linear regression coefficients. Outcome variable is annualized quarterly change in Gross Domestic Product (GDP). Change in unemployment measured in terms of annualized quarterly change in unemployment. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics. Upper and lower bounds of 95% confidence interval shown.

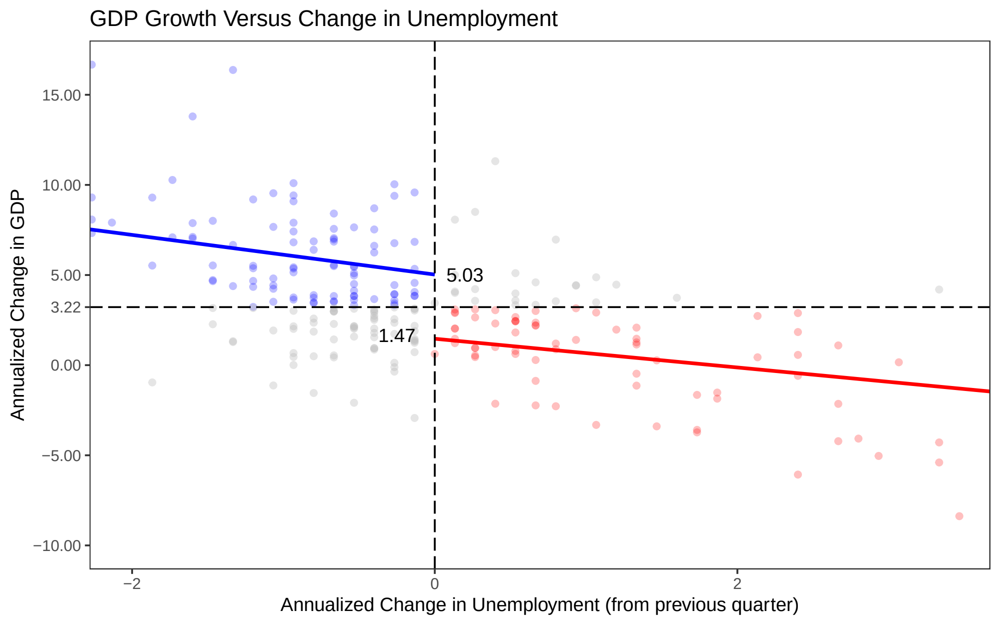

Figure 4: Annualized quarterly change in gross domestic product versus annualized quarterly change in unemployment. Estimated natural rate in high growth periods is 5.03%, versus 1.47% in low growth periods. Blue line represents relationship in high growth periods. Red line represents relationship in low growth periods. Dotted vertical line indicates unchanging unemployment. Dotted horizontal line indicates the estimated full-sample natural rate of 3.22%. Grey points indicate "abnormal" quarters in which growth is below the natural rate but unemployment is falling, and vice versa. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

This can be seen graphically as a positive shift in the intercept in high growth periods, in blue, compared to low growth ones, in red (Figure 4). I estimate that the natural rate is between 1.11 and 1.71% in low growth quarters and between 4.55 and 5.40% in high growth ones. This suggests that actual growth is associated with more than a percentage point shift in the natural rate compared to the full-sample estimate of 3.22% (Figure 5).

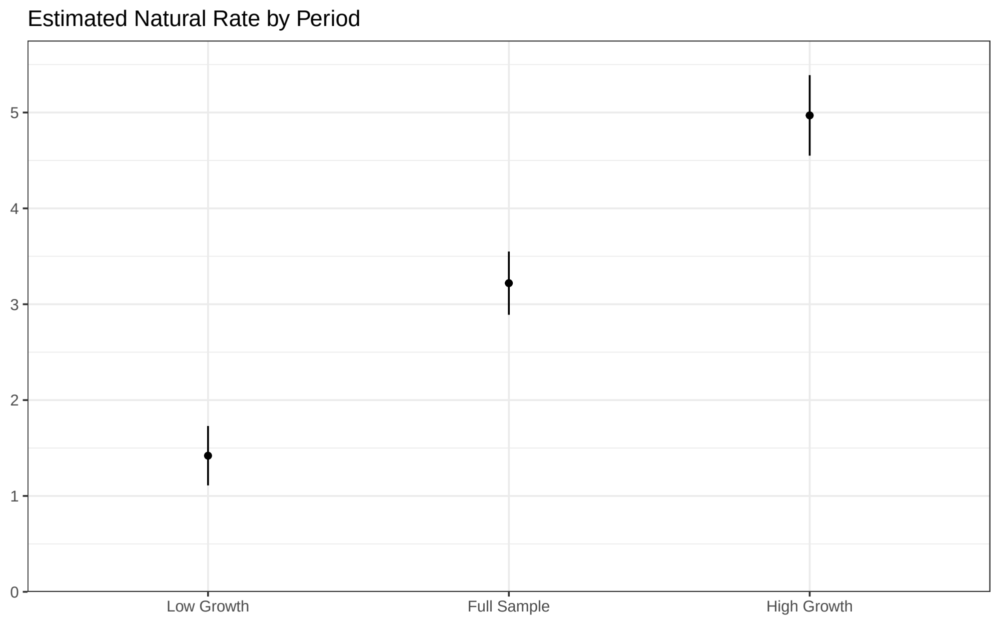

Figure 5: Estimated natural rate in low growth periods, high growth periods, and the full sample. Estimates are in terms of annualized quarterly change in gross domestic product (GDP). Points indicate point estimate. Vertical lines represent 95% confidence intervals. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

4.2 Alternative specifications

I run 11 alternative specifications as a robustness check for this finding. While I will not describe each in detail, I will broadly describe the adjustments I make and graphically present the findings.

I make four main adjustments, which I combine in different ways. First, I remove the interaction term to force the slope to be equal across periods. Second, I use annual rather than quarterly data. Third, I use an alternative method of estimating the natural rate. Rather than using Thirlwall's reversal (equation (2)), I estimate the natural rate empirically with both a 3- and 5-year moving average. In this case, I code the dummy as one when the actual rate is higher than this 3- or 5-year average. This accounts for the fact that, if the natural rate is truly endogenous, there may be many natural rates in the sample rather than just one for high-growth quarters and one for low-growth ones. Finally, I include dummy variables for the "abnormal" observations in quadrants 1 and 3. This controls for quarters during which growth is above the estimated natural rate but unemployment is rising, and for quarters in which growth is below the estimated natural rate but unemployment is falling.

While the results are somewhat sensitive to methodology, they all are positive and statistically significant

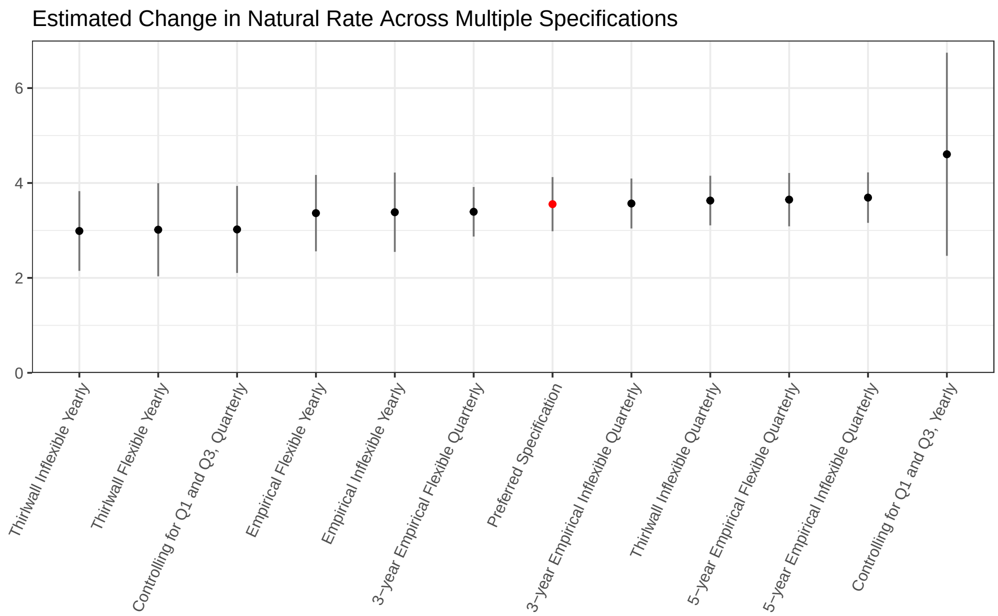

Figure 6: Estimated change in natural rate in high growth periods versus low growth periods, across multiple specifications. Change in terms of annualized quarterly change in gross domestic product (GDP). Points indicate point estimate. Vertical lines represent 95% confidence intervals. Red point indicates preferred specification. For specification labels, "empirical" indicates that the rolling-average was used as a proxy for natural rate. "Thirlwall" indicates that equation (2) was used to estimate the natural rate. "Flexible" indicates an interaction term was included to allow relationship between growth and unemployment to vary by period. "Controlling for Q1 and Q3" indicates that dummies were included for "abnormal" points in quadrants 1 and 3. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

at the 1% level (Figure 6).

4.3 Period-based analysis

Given that the above-described models are applied to a long period that contains many business cycles and plausible secular and exogenous changes to the natural rate, I also run the analysis on the decade and peak-to-peak level, as determined by the National Bureau of Economic Research.

On the decade level, all coefficients are positive and significant at the 1% level, and none of the 95% confidence intervals cross zero (Table 5).

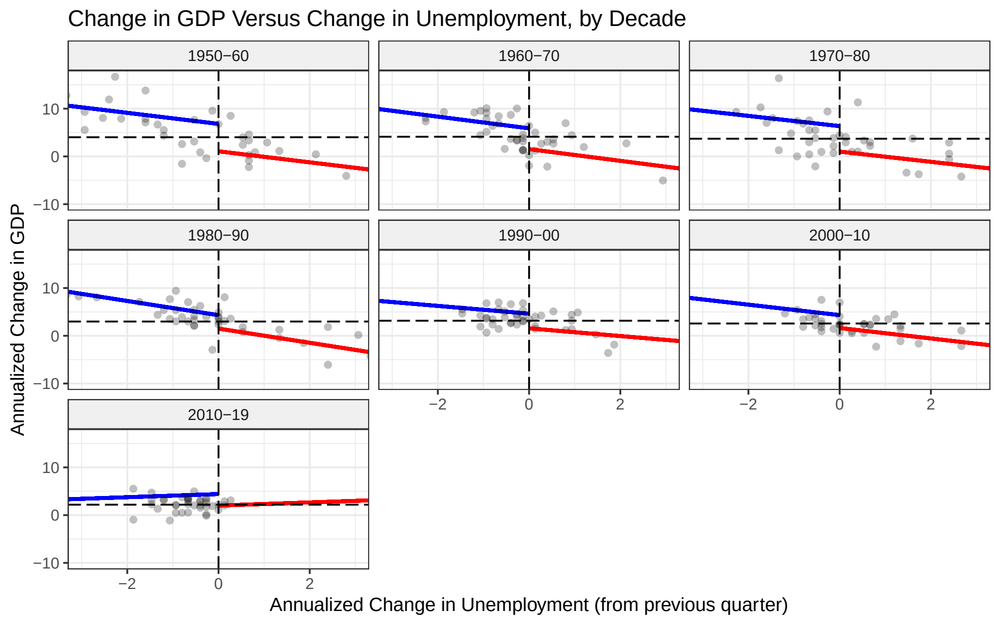

Figure 7: Annualized quarterly change in gross domestic product (GDP) versus annualized quarterly change in unemployment, by decade. An increase in the intercept of the high growth period versus the low growth period, and thus in estimated natural rate, appears in all decades. Relationship between growth and unemployment breaks down in 2010-2019 subset due to nearly continuously falling unemployment. Blue lines represent relationship in high growth periods. Red lines indicate relationship in low growth periods. Dotted vertical line indicates unchanging unemployment. Dotted horizontal lines indicates the estimated natural rate for each decade. Grey points represent "abnormal" quarters in which growth is below the natural rate but unemployment is falling, and vice versa. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

Decade	**Estimate**	**Standard Error**	**2.5%**	**97.5%**
1950-60	5.75***	1.20	3.31	8.18
1960-70	4.36***	0.75	2.84	5.88
1970-80	5.34***	0.91	3.50	7.18
1980-90	2.82***	0.74	1.32	4.32
1990-00	3.08***	0.43	2.22	3.94
2000-10	2.70***	0.57	1.54	3.86
2010-19	2.41***	0.49	1.43	3.40

Table 5: ***p<0.01, **p<0.05, *p<0.10. Estimated percentage point increase in natural rate in quarters of relatively high growth compared to quarters of relatively low growth, by decade. Estimate measured in terms of annualized quarterly change in gross domestic product (GDP). Estimates generated using equation (2). Upper and lower bounds of 95% confidence intervals given.

This tells the same story as my main model: the intercept, and thus the natural rate, is meaningfully higher in periods of relatively high growth compared to periods of relatively low growth (Figure 7).

Unsurprisingly, the data is nosier at the peak-to-peak level. Nonetheless, for all but two periods the coefficient on the dummy variable is positive and significant at at least the 1% level, and the 95% confidence intervals do not cross zero. The data for the period August 1957 to April 1960 is too noisy to get a significant

Period	**Estimate**	**Standard Error**	**2.5%**	**97.5%**
November 1948-July 1953	5.80***	1.98	1.55	10.06
July 1953-August 1957	5.21***	1.40	2.04	8.37
August 1957-April 1960	7.19	8.33	-19.31	33.68
April 1960-December 1969	4.51***	0.75	3.00	6.01
December 1969-November 1973	5.84***	1.57	2.46	9.23
November 1973-January 1980	5.31*	2.03	-0.33	10.95
January 1980-July 1981	5.50***	1.99	1.23	9.77
July 1981-July 1990	1.82***	0.83	0.11	3.52
July 1990-March 2001	3.19***	0.79	1.38	5.01
March 2001-December 2007	2.89***	0.34	2.21	3.57
December 2007-Present	2.38***	0.66	1.06	3.71

Table 6: ***p<0.01, **p<0.05, *p<0.10. Estimated percentage point increase in natural rate in quarters of relatively high growth compared to quarters of relatively low growth, by peak-to-peak period. Peak-to-period taken from National Bureau of Economic Research (NBER). Estimate measured in terms of annualized quarterly change in gross domestic product (GDP). Estimates generated using equation (2). Upper and lower bounds of 95% confidence intervals given.

estimate (though the estimated coefficient is still positive), and the 95% confidence interval for the coefficient for November 1973 to January 1980 just barely crosses zero (Table 6).

This said, we see the same story at this level: the estimated natural rate is higher in periods of high growth compared to periods of low growth. We can see this visually in Figure 8, with the intercept for high-growth quarters (in blue) consistently higher than the intercept for low-growth quarters (in red).

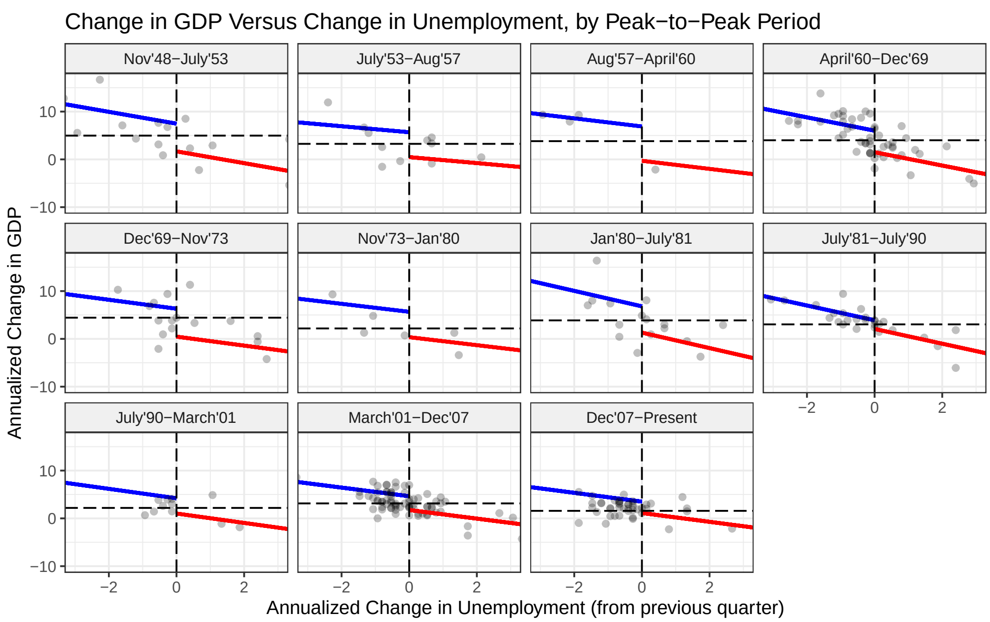

Figure 8: Annualized quarterly change in gross domestic product (GDP) versus annualized quarterly change in unemployment, by peak-to-peak period. An increase in the intercept of the high growth period versus the low growth period, and thus in the estimated natural rate, appears in all periods. Peak-to-peak period determined by National Bureau of Economic Research (NBER). Blue lines represent relationship in high growth periods. Red lines represent relationship in low growth periods. Dotted vertical lines indicate unchanging unemployment. Dotted horizontal lines indicate estimated natural rate for each period. Grey points represent "abnormal" quarters in which growth is below the natural rate but unemployment is falling, and vice versa. GDP data from Bureau of Economic Analysis. Unemployment data from Bureau of Labor Statistics.

Taken together, this analysis of data on the decade and peak-to-peak level provides further evidence that the natural rate differs in high growth quarters as compared to low growth quarters in the United States. Regardless of time period, it appears to be between 2 and 5 percentage points higher in the former as compared to the latter. This evidence, especially from an industrially mature country such as the United States, calls into serious question the exogeneity assumption when it comes to the natural rate. As discussed in the next section, this has serious implications.

4.4 Implications

This finding has both theoretical and practical importance. On the theoretical side, finding a robust and economically significant effect in an industrially mature country using a unique data set provides meaningful evidence that the natural rate is endogenous. This means that the exogeneity assumption found in most existing economic theory regarding the natural rate is, at the very least, a stronger assumption than previously acknowledged.

On the practical side, there are myriad implications. First, this finding suggests that unemployment may persist even in high growth periods due to a buoyed natural rate. Or, viewed the other way, unemployment may stay deceivingly low in periods of low growth due to a fall in the natural rate. This could help to explain the post-global financial crisis period, in which low growth has coexisted with a steady and even falling unemployment rate.

Second, it should also raise concerns about a "lock in" effect like the one discussed in Section I. Policy makers may take the low natural rate following a downturn as exogenously given, and thus prevent actual growth from rising above it so as to prevent unemployment from falling and inflation from rising. This would lock in the new lower rate and consequently reduce growth in the long run.

Relatedly, an endogenous natural rate suggests that policymakers can influence long-run growth through demand-management. Whereas the exogenous natural rate assumed in conventional economic theory implies that policymakers can only work to ensure that aggregate demand facilitates output growth equal to a supply-constrained long-run maximum, an endogenous natural rate implies demand itself serves as a determinant of long-run economic growth. Thus, by facilitating a high-growth economy, policymakers can shift the natural rate upwards and set the economy on a path of higher long-run growth. On the flip side, and perhaps more concerning considering current macroeconomic trends, policymakers could also lock in lower long-term growth by taking as given a natural rate that has been forced lower due to an economic downturn. This could provide a demand-side explanation for some of the "secular stagnation" debated in economic circles today (Summers & Rachel, 2019; Summers, 2015; Baldwin & Teulings, 2014; Summers, 2014).

On a global scale, as Dray and Thirlwall (2011) discuss in an Asian context, this finding suggests that differences in long-run growth across countries should be understood at least in part as a demand-side story. As Dray and Thirlwall point out, demand constraints tend to bite long before supply constraints do, especially in developing countries. This is critical if the natural rate is depressed by slow growth.

In all, given the evidence that the natural rate shifts with regard to actual growth and given the implications discussed above, it is worth reevaluating how we think about and incorporate the natural rate into economic models and policy decisions.

5 Conclusion

Using quarterly data from the United States between 1948 and 2019 and a model first proposed by León-Ledesma and Thirlwall (2002), I find significant evidence, robust across a number of specifications, that the natural rate meaningfully shifts based on actual growth. I find that the natural rate, the rate that keeps unemployment constant, shifts up by between 2.98 and 4.12 percentage points in high growth quarters compared to low growth ones. This is an economically significant shift that both challenges the exogeneity assumption found in traditional economic theory and suggests that demand-constraints are a serious factor in determining long-run growth. This implies that demand-management policies should be considered even more important than they already are. For example, by accepting slow growth due to a steady unemployment rate, policymakers could "lock-in" a lower natural rate and thus lower long-run growth. While I have not made any specific estimates in this paper on this topic, a lower long-run growth trend would, cumulatively, imply billions of dollars in forgone growth and thus wealth. This is an especially poignant concern for developing countries, where demand constraints typically arise before capacity constraints do.

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