An important line of macroeconomic research springs from Nelson and Plosser's (1982) discovery that US GNP possesses a sizeable "unit root." The rejection of the null that GNP was a stationary low-order ARMA around a linear trend in favor of the alternative of an integrated process and stochastic trend was not a surprise: No one believed that the factor supply- and technology-determined "potential" which GNP attains in booms and falls below in recessions grows at a constant deterministic rate. In the long run, fluctuations in potential growth dominate the sample and lead to integrated representations.

What did come as a surprise was the "size" claimed for the unit root in GNP, in the sense of the large long run impulse response θ_∞ of output to the canonical univariate shock. A Keynesian, seeing output shocks as a mixture of frequent transitory fluctuations and rare permanent accelerations or interruptions of potential growth, would have expected only a small unit root. Yet Nelson and Plosser found θ_∞ to be near to if not greater than one. The stakes in this line of research are large. Shapiro and Watson (1988) see whether θ_∞ is much less than or near one as telling if "the data [are]...closer to the Keynesian view, in which fluctuations are predominantly transitory, or... closer to the real business cycle view, in which fluctuations are largely the result of permanent shocks." Nelson and Plosser believe that their work shows "stochastic variation due to real factors... essential" for any business cycle model. If θ_∞ is near one there are no transitory fluctuations to model.

Nelson and Plosser (1982) has been followed by a number of related papers some of which try to establish the Keynesian position that many shocks to output are transitory and that θ_∞—properly measured—is much less than one. Harvey (1985) argued that low-order ARMA models do not approximate the long run dynamics of a large class of plausible processes and that Box-Jenkins identification techniques may be inappropriate.[1] Watson (1986) and Clark (1987) estimated unobserved-components models, and Cochrane (1987) constructed non-parametric tests of persistence, that produced estimates of of θ_∞ below one. Blanchard and Quah (1987) and Shapiro and Watson (1988) used unemployment as a cofactor to identify a transitory component in output that did not show up in univariate ARMA models.

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[1]Box-Jenkins procedures add coefficients as long as they significantly improve the accuracy of a one-period forecast. When the object of interest is an n-period forecast, it is not clear that Box-Jenkins procedures are appropriate.

Yet on balance the attempts to upset the conclusions of Nelson and Plosser have been unconvincing. Nelson (1987) argued that unobserved-components models were biased for the reasons that lead to downward bias in the sum of AR coefficients when the true process is integrated (Fuller (1976)), and that Watson (1986) and Clark (1987) would find large “transitory” components even if there were no such in reality. Campbell and Mankiw (1987ab) estimated a range of models and concluded that Nelson and Plosser were if anything conservative: they found a value of θ_∞ of 1.5 or so likely. And they argued that Cochrane’s statistics (i) led to a high estimate of θ_∞ over the postwar period and (ii) were untrustworthy over longer samples because of the excess cyclicality in the data uncovered by Romer (1986ab, 1989).

The present state of play seems to be that economists have no difficulty uncovering persistent, “unit root” components of GNP. By contrast, they have difficulty uncovering transitory business cycle components. These facts seem to upset Keynesian priors—if most shocks are transitory, economists should have difficulty identifying the persistent not the transitory component of output. And if the belief that θ_∞ near one supports a real business cycle view is justified, then such theories appear at least half right.

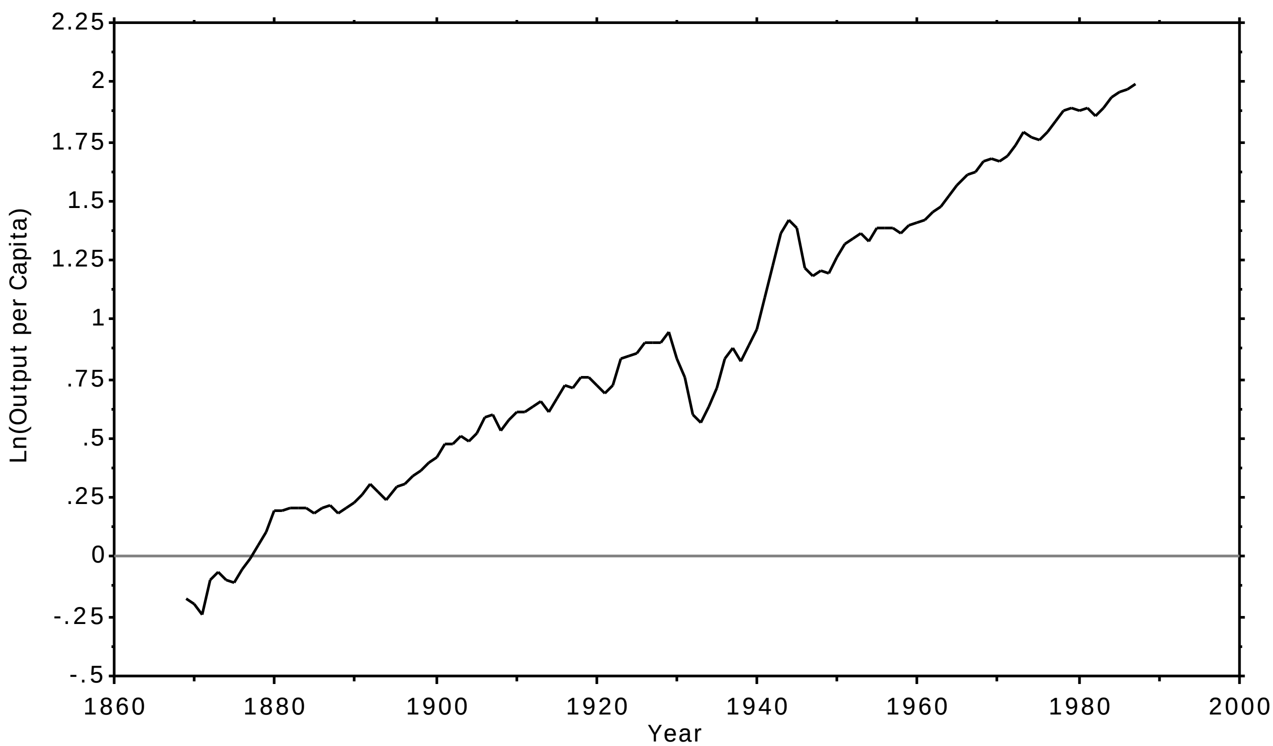
We seek to make two points. First, the ease with which economists detect a “unit root” in GNP is tied to the focus of attention on the post-WWII period. As a reader of Cochrane (1987) would not be surprised to learn, considering a longer run of data makes it easier to identify transitory components even if allowance is made for excess cyclicality in prewar estimates. Second, given the large transitory component of the pre-WWII business cycle, the failure of such components to emerge in post-WWII data supports not a “real business cycle” but an “old-fashioned Keynesian” view of macroeconomics. The economy was afflicted by large transitory cycles in the past; it is not afflicted by such cycles now; a possible inference is that institutions and policies that Keynesians argued would actually did stabilize the economy.

The discussion is organized as follows. The first section establishes that examining long output series makes it harder to uncover persistent and less difficult to uncover transitory components. The second discusses the proper interpretation of the Depression and WWII. And the third argues for a “Keynesian” interpretation of the absence of transitory components in post-WWII data.

1. Searching for a Unit Root in GNP

Anyone assessing the long run behavior of the US economy has a menu of GNP series to choose from: the standard Kuznets-Kendrick-Gallman series (Kuznets (1961), Kendrick (1961), Gallman (1966)),[2] thought by Romer (1989) to overstate cyclical volatility; her suggested alternative;[3] and another alternative from Balke and Gordon (1989) which falls between the Romer and the Kuznets-Kendrick-Gallman series.[4] Here we use the Romer series, for it shows the smallest pre-WWII transitory fluctuations, and is thus more biased against the points we wish to make than the alternative series. The Romer estimates of GNP divided by population are plotted in figure 1 below.

FIGURE 1
ROMER ESTIMATES OF U.S. OUTPUT PER CAPITA



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[2]None of Kuznets, Kendrick, and Gallman thought their series a reliable guide to cyclical movements. Their focus of attention was long-run growth. Milton Friedman started the pattern of using the series for business cycle research by using Kuznets' underlying worksheets for his test of monetary and Keynesian theories of output movements. See Friedman and Mieselman (1963).

[3]Which is likely to be excessively purged of short-run volatility. Romer's series omits any transitory movements in GNP not correlated with contemporaneous commodity production. In the post-WWII period, such movements make up a quarter of the variance of output around linear trends through Romer's benchmark dates.

[4]Who use more indicators than Romer to backcast GNP. The advantage of more information is offset by the fact that the coefficients of their backcasting equation fit our prior beliefs less well.

The basic sample is the union of the pre-Depression (1889-1929) and post-WWII (1948-87) periods. Both the 1930-47 Depression/war period, during which output per capita follows a different law of motion, and the pre-1889 period for which Shaw (1947) lacks confidence in the reliability of the underlying commodity production data are omitted.[5]

Consider, for years since 1889, a test of the null that output per capita is a random walk:

$$H_0: \quad y_t = y_{t-1} + \gamma + \varepsilon_t$$

where ε_t is a white-noise innovation and where the value y_t of the economy's normal output is not observed during the Depression/war years 1930-47, against the alternative that output per capita follows an AR(1) about a linear trend:

$$H_1: \quad y_t = \gamma t + \rho y_{t-1} + \varepsilon_t$$

where ε_t is a white-noise innovation, and where the value y_t of the economy's normal output is not observed during the Depression/war years 1930-47. Neither the null nor the alternative can be taken seriously as a description of the underlying process. No one believes that output really follows a random walk with unchanging drift. And no one believes that the underlying growth of potential on top of which the business cycle is imposed is linear and deterministic.

Nevertheless the null and alternative are useful heuristic devices. If the alternative fits the data in the sense that its estimated residuals exhibit little correlation, and if the data possess sufficient power to reject the null, then the "permanent" long run component of output is small and is dominated in the sample by transitory fluctuations that accord with the Keynesian view.

Performing the simplest possible Dickey-Fuller tests (Fuller (1976)) on the Romer series for output per capita does lead to a rejection of the integrated process null:

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[5]Including the 1869-88 period for which annual data exist but are less reliable does not qualitatively alter the conclusions. The simple Dickey-Fuller tests still reject the random walk null at the .01 level. In general, it appears that the longer is the U.S. data series the more strongly do the Dickey-Fuller tests speak against the random walk null.

TABLE 1
DICKEY-FULLER REGRESSIONS USING 1889-1929 & 1948-87 AS THE SAMPLE PERIOD

Coefficients of:				Test Statistics:		
Time	Y_{-1}	ΔY_{-1}	ΔY_{-2}	SEE	$n(\rho-1)$	Significance
0.006 (.001)	0.690 (.081)	--	--	.029	-24.8	.003
0.006 (.002)	0.663 (.088)	0.098 (.115)	--	.030	-29.4	.001
.005 (.002)	0.715 (.096)	0.063 (.117)	-.154	.030	-22.8	.010

Because the sample contains an eighteen-year gap in its middle the test statistic $n(\rho-1)$, where ρ is the regression coefficient of y_{t-1}, does not have the distribution tabulated by Dickey (Fuller (1976)). Monte Carlo simulations generated the significance levels reported in the last column of table 1.

We do not see the proper interpretation of table 1 as that output per capita “is” an AR(1) about a linear trend. We strongly reject such an inference. We agree that the restrictive parametrizations of the null and alternative—requiring θ_∞ to be either one or zero but not in between—mask an integrated, stochastic trend.[6] Nevertheless, when given a choice between a stationary AR(1) about a linear trend and a random walk, the data choose the trend-stationary model. The transitory business cycle component dominates the sample. It is easy to uncover, and it is the persistent integrated component that is hard to find.

2. Interpreting the Great Depression

It would be naive to take the 1930-47 period to be a realization of the same time-series process that generates the surrounding years. The shift in the magnitude of output movements provides sufficient evidence to reject the null of a constant structure. The variance of year-to-year changes in per capita output over 1930-47 is ten times the variance in the surrounding periods. Under the maintained hypothesis that year-to-year changes are independent and normal, the null of unchanging structure can be rejected with an asymptotic $\chi^2(1)$ statistic of 38.

[6]Schwert (1987) analyzes spurious rejection of the null of an integrated process (θ_∞>0) in favor of the stationary alternative (θ_∞=0) when moving-average terms are omitted from the integrated specification and the stringent requirement θ_∞=1 is imposed on the null.

Since a different law of motion governed output over 1930-47, estimating a single low-order univariate process for the entire 1889-1987 period suffers from misspecification and produces coefficients with no clear interpretation. An incautious economist might, however, ignore the fact that 1930-47 arises from a different structure and test:

$$H_0: \quad y_t = y_{t-1} + \gamma + \varepsilon_t$$

against:

$$H_1: \quad y_t = \gamma t + \rho y_{t-1} + \varepsilon_t$$

using the entire 1889-1987 period. As the first line of table 2 reveals, such an economist would find a first-order Dickey-Fuller test statistic of -11.7, not significant at even the .2 level, and might conclude that the long-run data are not inconsistent with the null that almost all output shocks are permanent.

Fluctuations in the 1930-47 are not only larger but also more slowly decaying than in the surrounding periods. 1930-47 fluctuations are certainly transitory—by 1941, before the US had entered WWII and begun to run large expansionary budget deficits, output per capita is approximately back to the level one would have forecast in 1929 knowing the 1889-1929 rate of drift. And the wartime expansion of output was no more permanent: the late 1940’s see output per capita once again at the level one would have forecast in 1929 (De Long and Summers (1988)). But although both large movements in output over 1930-47 were reversed, they took longer to reverse themselves than the canonical peacetime business cycle did. The coefficient ρ on lagged output in the first line of table 2 is thus a weighted average of the first-order autoregressive coefficients holding during the ordinary 1889-1929 and 1948-87 periods, and the extraordinary 1930-47 period during which fluctuations decay more slowly. Since fluctuations in 1930-47 are huge, the weight of the anomalous period in the average is high and the joint estimated value of ρ for the whole 1889-1987 period is relatively large.

The eventual return of output approximately to its pre-1929 path suggests that even though the large 1930-47 fluctuations decay slowly they do decay. Sampling the data at less frequent intervals—examining the properties of output sampled only every two, every three, or every four years—provides a natural test of whether the failure in line 1 of table 2 to reject the random walk null comes from the misspecification involved in estimating a single low-order linear model for the entire century. If output per capita really does follow a random walk, sampling data at less frequent intervals is innocuous. The power of statistical tests against alternatives local to the random walk null is unaffected by the frequency of sampling, for:[7]

$$\frac{n\left(\rho^2 - 1\right)}{2} \approx n(\rho - 1)$$

The three lower lines of table 2 reveal that sampling the data at less frequent intervals does lead to rejection of the random walk null. The bottom lines of table 2 are inconsistent with the message carried by the first line—that including the Depression and WWII—makes the persistent component of output more visible. The natural conclusion is that it is not a good idea to impose the same low-order linear structure to hold for annual data over 1930-47 as over 1889-1929 and 1948-87.[8]

TABLE 2
DICKEY-FULLER REGRESSIONS USING 1889-1987 AS THE SAMPLE PERIOD

Sampling Interval	Coefficients of: Time	Y_{-1}	SEE	Test Statistics: $n(\rho\text{-}1)$	Significance
Every year	0.002 (.001)	0.883 (.048)	.049	-11.70	--
Every two years	0.006 (.002)	0.682 (.108)	.078	-15.90	.13
Every three years	0.010 (.003)	0.464 (.161)	.099	-17.69	.08
Every four years	0.014 (.004)	0.229 (.213)	.112	-19.28	.03

3. Interpretation

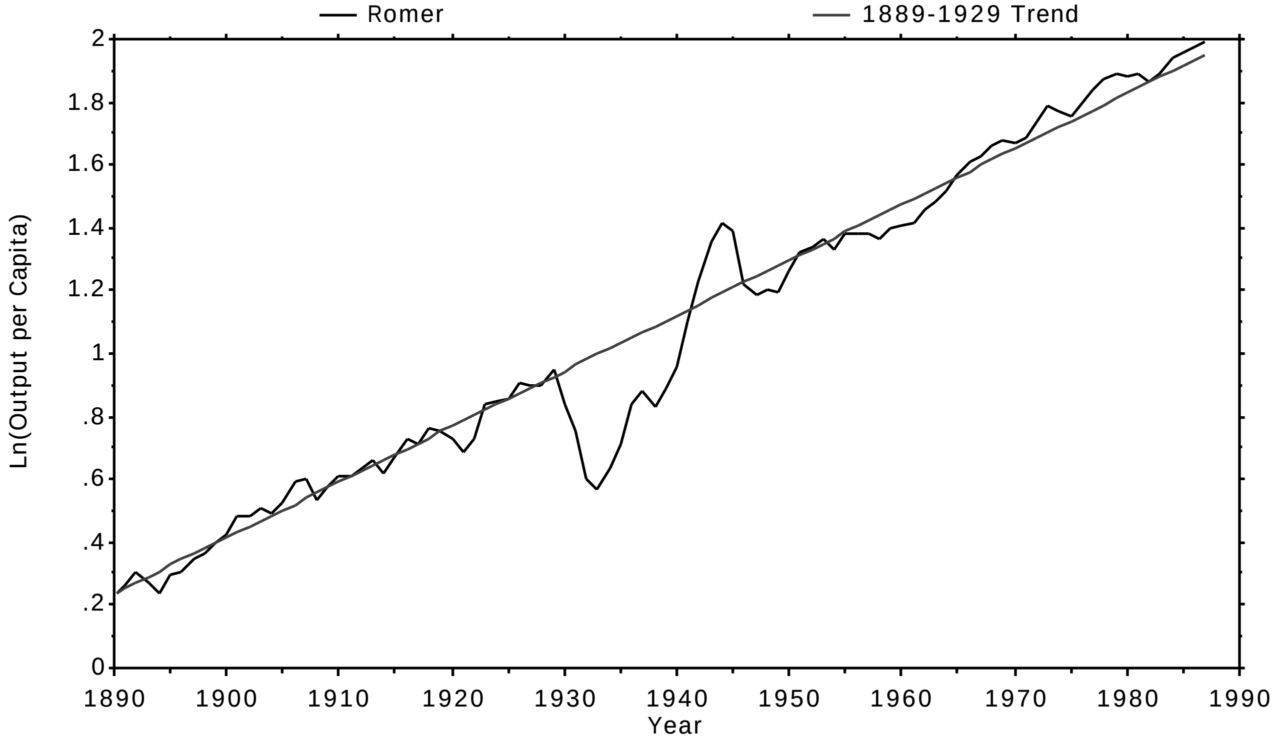
As we have argued above, there is little difficulty in detecting a transitory component in GNP when the time series is examined in historical perspective. Dickey-Fuller tests with a century of data at their disposal reject the null that $\theta_\infty=1$ in favor of a highly-restricted alternative that $\theta_\infty=0$. Specifi-

[7]This point is made by Shiller and Perron (1985) in the context of testing efficient-markets models.
[8]A natural approach to take to analyze the Depression would then be the one advocated by Stock (1987).

cation tests do not appear to suggest that the alternative is misspecified. In light of this, we do not think that the claim that the canonical output shock is permanent and not transitory—that output fits a “real business cycle” rather than a “Keynesian” description—can be sustained. Anyone in 1929 who projected 1987 output on the basis of the 1889-1929 trend would have found herself only 4.5 percent off; either there have been very few permanent shocks to output in the past sixty years, or the shocks that there have been have almost miraculously offset one another.

Given our success at finding a transitory component, the failure of Nelson and Plosser (1982) and of Campbell and Mankiw (1987ab) to find such a component requires explanation. How can the stochastic component to trend be (i) hard to find when the sample is a long period that gives a long baseline against which to look for stochastic trends and ample room for such trends to compound, and yet be (ii) easy to find when the sample is a short period that gives a short baseline and little room for such trends to compound? We suspect that the answer lies in the transformation of the business cycle after WWII. Even according to Romer’s data, the pre-Depression period is full of short sharp recessions like 1892-4, 1907-8, 1913-4, and 1920-2. For the most part, the post-WWII period lacks equivalent sharp transitory contractions. If the magnitude of the transitory component in output has declined, then the persistent component will become more visible.

FIGURE 2
ACTUAL OUTPUT PER CAPITA, AND 1889-1929 TREND



It may be that when Campbell and Mankiw proclaim that absence of transitory dynamics in the post-WWII period they are really proclaiming the presence of successful automatic stabilizers. The post-WWII FRB and FDIC have together kept the US from experiencing financial panics like those that occurred on a semi-regular basis before WWII, and the growth of large, progressively-financed government may have played a part in stabilizing the flow of income to ultimate investors and consumers (De Long and Summers (1986)). The general awareness that the government will act to prevent large business cycles may lead to private actions that stabilize spending without explicit intervention (Baily (1978)). A plausible interpretation of the strong presence of transitory components when long-run series are examined and the absence of transitory components over the post-WWII period is, we think, an old-fashioned Keynesian one.

We do not deny that the correct univariate time-series representation for output will possess a "unit root." We would be incredulous if anyone claimed that long-run potential growth were linear and deterministic. Moreover, one merely has to glance at output per capita for any of a number of European nations over the past century to become convinced that the univariate representation of output may have not one but two unit roots (see Maddison (1982)). The approximate constancy over the past century of the rate of growth of potential output is limited to the United States.

We have presented tests that reject the null that output per capita is a certain very restricted integrated process in favor of an alternative that output per capita follows another tightly-constrained process in order to make two points. First, the present debate over whether the long-run impulse response θ_∞ to a univariate shock is or is not near one could only have arisen in a context that left pre-WWII data by and large unexamined. Anyone who, following Cochrane (1987), examines the US business cycle in historical perspective will find it hard to avoid reaching the conclusion that θ_∞ has been significantly less than one.

Second, examining US fluctuations in historical perspective leads to a shift in the interpretation given to research like that of Campbell and Mankiw. Such studies no longer appear to support theories that attribute macroeconomic fluctuations in general to permanent shocks. Instead, such studies spark inquiry into what has reduced the magnitude of the transitory component of output. Whether it is correct to attribute this reduction to Keynesian institutions and polices is an open question.

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Data

Year	Standard Ln(GNP/Pop)	Romer Ln(GNP/Pop)
1987	1.993	1.993
1986	1.975	1.975
1985	1.959	1.959
1984	1.941	1.941
1983	1.889	1.889
1982	1.862	1.862
1981	1.894	1.894
1980	1.879	1.879
1979	1.894	1.894
1978	1.877	1.877
1977	1.839	1.839
1976	1.795	1.795
1975	1.752	1.752
1974	1.772	1.772
1973	1.785	1.785
1972	1.737	1.737
1971	1.69	1.69
1970	1.667	1.667
1969	1.68	1.68
1968	1.662	1.662
1967	1.627	1.627
1966	1.611	1.611
1965	1.565	1.565
1964	1.518	1.518
1963	1.481	1.481
1962	1.456	1.456
1961	1.416	1.416
1960	1.406	1.406
1959	1.401	1.401
1958	1.364	1.364
1957	1.384	1.384
1956	1.385	1.385
1955	1.381	1.381
1954	1.333	1.333
1953	1.363	1.363
1952	1.342	1.342
1951	1.323	1.323
1950	1.26	1.26
1949	1.194	1.194
1948	1.206	1.206
1947	1.183	1.183
1946	1.219	1.219
1945	1.387	1.387
1944	1.414	1.414
1943	1.358	1.358
1942	1.231	1.231
1941	1.099	1.099
1940	.957	.957
1939	.894	.894
1938	.827	.827
1937	.879	.879
1936	.836	.836
1935	.715	.715
1934	.638	.638
1933	.57	.57

1932	.598	.598
1931	.753	.753
1930	.841	.841
1929	.953	.953
1928	.899	.899
1927	.905	.9
1926	.92	.904
1925	.876	.855
1924	.81	.845
1923	.832	.835
1922	.735	.728
1921	.602	.685
1920	.712	.728
1919	.776	.758
1918	.824	.76
1917	.708	.709
1916	.714	.727
1915	.652	.668
1914	.675	.616
1913	.74	.659
1912	.75	.636
1911	.711	.614
1910	.701	.609
1909	.694	.577
1908	.56	.53
1907	.665	.603
1906	.668	.594
1905	.577	.523
1904	.526	.49
1903	.557	.511
1902	.527	.479
1901	.538	.481
1900	.449	.422
1899	.439	.4
1898	.37	.361
1897	.365	.345
1896	.293	.306
1895	.333	.299
1894	.239	.239
1893	.286	.274
1892	.355	.309
1891	.283	.26
1890	.259	.231
1889	.209	.204
1888	.174	.189
1887	.17	.22
1886	.152	.211
1885	.108	.19
1884	.112	.203
1883	.116	.204
1882	.114	.212
1881	.098	.195
1880	.081	.196
1879	.031	.111
1878	-.004	.052
1877	-.041	-.006
1876	-.082	-.048
1875	-.102	-.103
1874	-.113	-.092
1873	-.084	-.066
1872	-.075	-.093
1871	-.123	-.237

1870	-.159	-.2
1869	•	-.173