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Real myths and a monetary fact

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In their paper 'Business cycles: real facts and a monetary myth,' Kydland and Prescott (*Federal Reserve Bank of Minneapolis Quarterly Review*, **14**, 1990) present a series of statistics, generated by using the Hodrick–Prescott filter, which they define as the 'business cycle facts.' Prescott (*Federal Reserve Bank of Minneapolis Quarterly Review*, **10**, 1986) argued that the facts are immune to the method of detrending; however, even if we use the Hodrick–Prescott filter, we can get a set of facts that differ in important ways from those in Kydland and Prescott (1990). In particular, we can generate the conventional wisdom that real wages are acyclical, very different relative volatilities of consumption, investment and output, and M1 leading the cycle. In addition, we note that the other important fact generated by Kydland and Prescott, the countercyclicality of prices, was not actually a new result.

I. INTRODUCTION

In their paper, 'Business cycles: real facts and a monetary myth,' Kydland and Prescott (1990) present a series of statistics they define as the 'business cycle facts.' While couched in terms of being a dispassionate display of the facts of business cycle behaviour (which Kydland and Prescott call 'measurement without theory'), there is little doubt about what theory is being supported by the statistics reported; the content of the paper functions as a brief for real business cycle models. Kydland and Prescott report a series of facts, all of which are the sort of facts one would find if real business cycle models are correct. To wit, they demonstrate that real wages are procyclical, not acyclical or even countercyclical as earlier theorists believed, and that the relative volatility of consumption, investment and output are those predicted by real business cycle theory. Moreover, they dispose of the 'monetary myth' that M1 leads the cycle. Finally, they note that contrary to widely held beliefs, prices are countercyclical, not procyclical.

These seemingly dispassionate 'facts' are all quite fortuitous for real business cycle modelling. Indeed, the paper was perfectly timed to dispose of the growing criticisms of real business cycle methodology. For example, Summers (1986) had criticized real business cycle models for predicting procyclical real wages, when in the data real wages are acyclical; Kydland and Prescott then showed that in the empirical data, real wages actually are procyclical. Mankiw (1989) argued that real business cycle models are flawed because they do not explain the comovement of prices and money with output and that these comovements demonstrate the need for putting money in the model; Kydland and Prescott then showed that in the empirical data, the comovements are not those that are widely believed to be there and thus real business cycle models omit nothing by omitting money.

Kydland and Prescott, however, did not generate the statistics reported in their paper using the standard NBER method of detrending a series or even the widely used method of linear detrending. Instead they used the Hodrick–Prescott (HP) filter. Prescott (1986, p. 10) argued that the facts are immune to the method of detrending: 'If the business cycle facts were sensitive to the detrending procedure used, there would be a problem. But the key facts are not sensitive to the procedure if the trend curve is smooth.'

Subsequent research, however, showed that the Hodrick–Prescott filter was not so benign. By now the evidence is fairly overwhelming that the HP filter can induce spurious correlations, and thus the 'facts' may really be 'artefacts.' (See Hoover, 1995). For example, Harvey and Jaeger (1993) show that detrending using the HP filter can induce spurious cyclical behavior. For example, 'applying the standard HP filter to a random walk produces detrended observations which have the characteristics of a business cycle for quarterly observations' (p. 234). Moreover, they demonstrate that there is a non-negligible chance of finding spurious cross-correlations between two series detrended with the HP filter. Similarly, Cogley and Nason (1995)

demonstrate that the HP filter can create business cycle dynamics even if there are no such dynamics in the data. Kydland and Prescott (1996, pp. 76–77n) are unconvinced, however: 'Given the finding that business cycle fluctuations are quantitatively just what neoclassical growth theory predicts, the resulting deviations from trend are nothing more than well-defined statistics ... talking about the resulting statistics as imposing spurious cycles makes no sense.'[1]

However, the problems associated with the facts presented in Kydland and Prescott (1990) are not limited to problems with the Hodrick–Prescott filter. Even if we use the Hodrick–Prescott filter, we can get a set of facts that differ in important ways from those in Kydland and Prescott (1990). In particular, we can generate the conventional wisdom that real wages are acyclical, very different relative volatilities of consumption, investment and output and M1 leading the cycle. Thus, Prescott's (1986) argument that the facts are immune to the method of detrending does not hold even when we use the detrending procedure he advocates. In addition, we note that the other important fact generated by Kydland and Prescott, the countercyclicality of prices, was not actually a new result.

The import of these findings is that there is little reason to accord the 'facts' as set down in Kydland and Prescott (1990) some form of canonical status. Even if we are content to use the Hodrick–Prescott filter in the light of the criticisms made about it, we need not conclude, for example, that real wages are procyclical. It still remains to be shown that the facts necessary to validate real business cycle models are not simply artefacts of the particular means of detrending the data used by Kydland and Prescott.

The exercise below has a broader implication: the ideal of measurement without theory is not necessarily a practical ideal. Below we show that even if we agree on the method of detrending data, we can get different sets of facts for our theories to explain. There is little empirical reason to pick one set of facts over another; we need theory to guide us.

II. REAL WAGE

By far, the most important of the real facts reported by Kydland and Prescott is that the real wage is procyclical. The cyclicality of real wages is a ready means of determining what sorts of shocks are affecting the real economy. If the shocks are primarily technology shocks, as real business cycle models argue, then the cycle is caused by changes in labour demand and we should see procyclical real wages. If real wages are not procyclical, then the real business cycle model is not particularly persuasive. Moreover, since earlier theorists in general and monetary theorists in particular accorded no particular role to real shocks to labour demand to explain the cycle, these theories would predict acyclical (or even countercyclical) real wages. Thus, the cyclicality of real wages is an important datum in discriminating between the theories.

To examine the matter, we use real GDP and real hourly compensation.[2] We detrend the logarithm of GDP and real hourly compensation using the Hodrick–Prescott filter.[3] In filtering, we follow Kydland and Prescott by using a value of lambda equal to 1600. The cycle is the difference between the value of the variable and the Hodrick–Prescott filter derived trend.

The first row of Table 1 shows the results. As in Kydland and Prescott (1990), the procedure generates a procyclical real wage. This is exactly the evidence that Kydland and Prescott use to support their 'real fact'.

However, look at Fig. 1, which shows the two cycles. The relationship between the two series does not appear to be constant. The appearance is not deceiving; when we break up the period, the results change. Table 1 also reports the correlations between the two series for the period 1969:4–1980:1 (both business cycle peaks) and the rest of the time. Real wages were highly procyclical during the 1970s, but were acyclical for the rest of the period.

The conventional wisdom of acyclical real wages holds except for the 1970s. This is not particularly surprising. Even conventional theorists agree that in the 1970s the economy was hit by a series of particularly large supply shocks. The question is not what happened in the 1970s, but what happens over longer periods of time. Kydland and Prescott's 'fact' of procyclical real wages is actually a 'fact' only during the 1970s and does not generalize. At all other times, real wages are acyclical.[4]

III. RELATIVE VOLATILITIES

In addition to the 'facts' about the real wage, Kydland and Prescott report 'facts' about the relative volatilities of consumption, investment and output. In reporting these

[1] Hartley *et al.* (1997) discusses this debate in more detail.
[2] Real Hourly Compensation is for the business sector and is provided by the Bureau of Labor Statistics. The dates used are 1959:3–1997:1
[3] The HP filter is described in Hodrick and Prescott (1997). The filter works as follows: A series y is broken into two parts, the trend component, g, and the cyclical component, c; so, $y_t = g_t + c_t$. The trend component is chosen to solve the following problem:

$$\underset{\{g_t\}_{t=-1}^{T}}{\text{Min}} \left\{ \sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \right\}$$

The value of λ affects the smoothness of the trend; the larger the value of λ, the smoother the trend.
[4] Abraham and Haltiwanger (1995) report a similar finding. However, the results they report are not directly comparable to the results in Kydland and Prescott (1990).

Table 1. *Cross correlations between real GDP and other aggregates*

Variable x	Cross correlation of real GDP with								
	$x(t-4)$	$x(t-3)$	$x(t-2)$	$x(t-1)$	$x(t)$	$x(t+1)$	$x(t+2)$	$x(t+3)$	$x(t+4)$
Average hourly real compensation (1959:1–1997:4)	0.47	0.45	0.43	0.40	0.29	0.16	0.04	−0.11	−0.24
Average hourly real compensation (1969:4–1980:1)	0.67	0.75	0.74	0.74	0.59	0.46	0.28	0.04	−0.20
Average hourly real compensation (1959:1–1969:3; 1980:2–1997:4)	0.30	0.18	0.13	0.07	0.00	−0.10	−0.14	−0.19	−0.15
M1	0.18	0.21	0.24	0.23	0.16	0.09	0.03	−0.04	−0.10
M1 (from Kydland and Prescott, 1990)	0.12	0.23	0.33	0.35	0.31	0.22	0.15	0.09	0.07

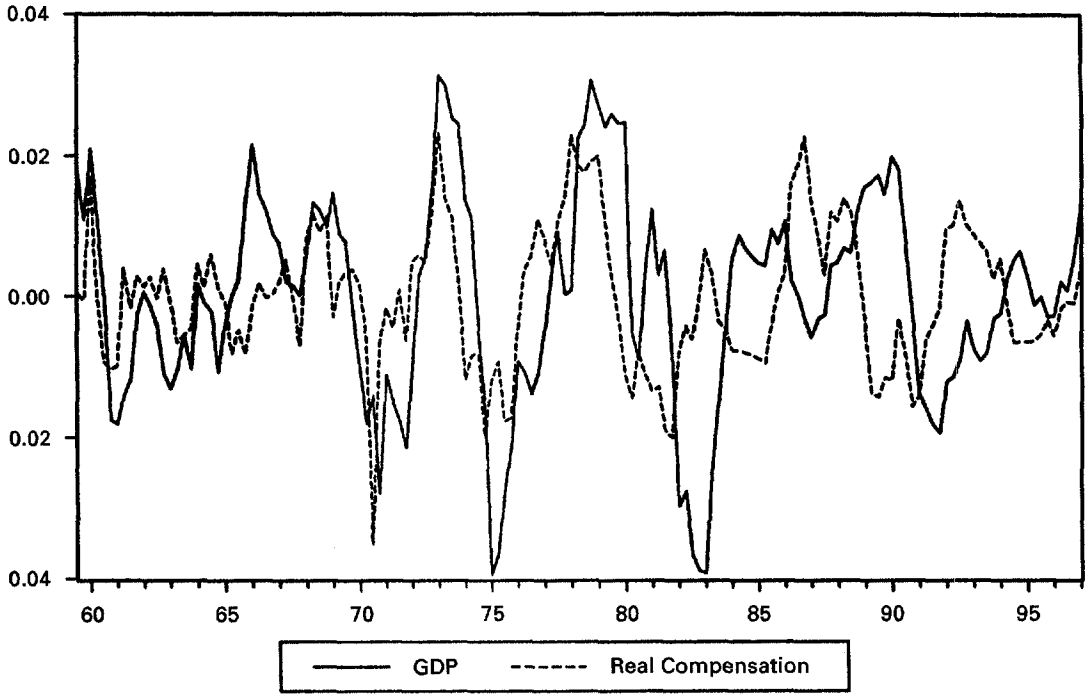

Figure 1. *Detrended Real GDP and Real Hourly Compensation (1959:3–1997:1)*

facts, Kydland and Prescott consistently use a value of 1600 for lambda in the Hodrick–Prescott filter. Why 1600? Kydland and Prescott (1990, p. 9) offer up the rather weak argument that this value implies a trend path for real GNP that 'is close to the one that students of business cycles and growth would draw through a time plot of the series'. Hodrick and Prescott (1997, p. 4) offer up the slightly more elaborate justification that under certain assumptions about the variances of the trend and cycle components of a variable, lambda is related to the ratio of these variances. However, Hodrick and Prescott acknowledge that the necessary assumptions do not in fact hold in reality. Nevertheless, proceeding apace, they make guesses, based on 'our prior view,' about the values of the variances.

This does not make a compelling case for the value of lambda chosen, as Hodrick and Prescott acknowledge. They thus present results demonstrating that varying the value of lambda between 400 and 6400 does change the standard deviation of the output cycle from 1.56% to 2.03%, an increase of 30% in the standard deviation of the business cycle. Moreover, using a value of lambda equal to infinity raises the standard deviation of cyclical GNP to 3.12%. However, they note that the 'comovement results are not particularly sensitive to the value of the smoothing parameter λ used ... the relative magnitudes of the series change little' (p. 7). They do not state how small 'not particularly sensitive' is nor do they report the values themselves.

We investigate the robustness of the volatility measure to different values of lambda.[5] Table 2 contains the results. For all three series the absolute volatility increases dramatically as we increase the value of lambda; for consumption the volatility increases by 65%, while for investment it increases by 31%. If we care at all about absolute volatilities, these are large changes. There is no reason to accord the value of 1600 canonical status.

Kydland and Prescott, however, are unconcerned with absolute volatility, preferring to focus on relative volatility. And here, too we see large changes as we change the value of lambda. The relative variances are reported in Table 3. Restricting ourselves to the values of lambda suggested by Hodrick and Prescott, the relative volatility of consumption to income varies by 152%, while that for investment varies by 99%.

Hodrick and Prescott (p. 7) argue that 'We do think it is important that all series be filtered using the same parameter λ' but they do not provide any argument for why this is important. Moreover, there is no obvious reason why we would expect the trend lines for output, consumption and investment to exhibit the same degree of smoothness. Nevertheless, even when we look only at the relative variances when all series use the same value of lambda, the values still differ by 10% and 15%.

There seem to be no 'facts' here which one can use with any reliance. Even when we use the Hodrick-Prescott filter and use parameters in the range suggested by Hodrick and Prescott, both the absolute and relative volatilities vary by a great deal. Indeed, if the variability shown in Tables 2 and 3 does not constitute sufficient variability to make one pause before reporting the values as fact, it is hard to imagine what possible values would convince one otherwise.

Table 2. *Absolute volatility of selected aggregates*

	Standard deviation (%)		
Variable	$\lambda = 400$	$\lambda = 1600$	$\lambda = 6400$
GDP	1.16	1.49	1.76
Consumption	0.99	1.31	1.63
Investment	6.42	7.61	8.44

Table 3. *Ratio of standard deviation of consumption and investment to standard deviation of GDP for differing values of lambda*

	GDP		
	$\lambda = 400$	$\lambda = 1600$	$\lambda = 6400$
Consumption: $\lambda = 400$	0.85	0.66	0.56
Consumption: $\lambda = 1600$	1.13	0.88	0.74
Consumption: $\lambda = 6400$	1.41	1.09	0.93
Investment: $\lambda = 400$	5.53	4.31	3.65
Investment: $\lambda = 1600$	6.56	5.12	4.32
Investment: $\lambda = 6400$	7.28	5.66	4.80

IV. MONEY

The 'monetary myth' reported by Kydland and Prescott is that M1 leads the cycle. Kydland and Prescott define a series as leading the cycle if the cross correlation with GNP is positive and highest at time $(t - i)$ where $i > 0$. We adopt this definition and look at the correlation, presented in Table 1. Using Kydland and Prescott's definition, we see that money does lead the cycle. Why does the result here differ from that in Kydland and Prescott (1990)? It does not. The values reported in Kydland and Prescott (1990) are also in Table 1; using their definition of leading the cycle and their own results, Kydland and Prescott show a monetary lead. They do not explain why they conclude that money does not lead the cycle. As noted in Hartley *et al.* (1997), it cannot be the size of the value that induces Kydland and Prescott's conclusion. The cross correlation between real wages and GNP reported by Kydland and Prescott (1990) is exactly the same size as their reported cross correlation between money lagged one period and current GNP. Yet, Kydland and Prescott conclude real wages are procyclical but money does not lead the cycle. The important monetary myth is really a fact.

V. PRICES

The final important piece of evidence submitted by Kydland and Prescott is that prices are countercyclical, not procyclical as was widely believed. Kydland and Prescott note that despite what many economists believe, prices have been countercyclical in the post-War period. Later researchers have found countercyclical prices in other countries and that the result can vary with the method of detrending that is used (see, for example, Kim, 1997). However, the existence of countercyclical prices turns out to not be particularly striking support for real business cycle modelling.

Despite the fanfare which met Kydland and Prescott's discovery of countercyclical prices, they were not the first to observe a change in the cyclicality of prices. Eight years earlier, Friedman and Schwartz (1982, p. 402), hardly real business cycle theorists, reported: 'Most students of cyclical fluctuations doubtless share our own initial expectation that on the whole price and output changes are positively correlated; yet the evidence for the two countries [the US and UK] combined is that the phase rates of change more frequently show a negative than a positive correlation.'

[5] The consumption series is Personal Consumption Expenditures; the investment series is Real Gross Private Domestic Investment. Both are in 1992 dollars and for the time 1959:3–1997:1.

Friedman and Schwartz do not see the negative correlation between prices and output as evidence in favour of real business cycle models; in fact, they argue that the fact is consistent with monetary business cycle models, arguing (p. 403) 'there are strong statistical and economic reasons to expect a negative correlation'.

VI. CONCLUSION

The 'real facts' and 'monetary myth' reported by Kydland and Prescott are easily overturned even if we use the Hodrick–Prescott filter to detrend the variables. There is thus little reason to believe that Kydland and Prescott have uncovered evidence that favours real business cycle models over their rivals.

It is worth repeating that there is nothing in the results presented here that should persuade one to pick the set of 'facts' herein over the set of 'facts' presented by Kydland and Prescott. In fact, that is the point: there is also no reason to prefer the set of facts presented by Kydland and Prescott over the range of possible facts that one can generate with the Hodrick–Prescott filter. Kydland and Prescott's assertion notwithstanding, there really is no such thing as 'measurement without theory.' We must use theory to guide us in selecting which are the set of facts we wish our theories to explain.

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