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It's Complicated: the Relationship Between GDP and Subjective Well-being

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Abstract

This paper estimates and compares different models of the relationship between output and subjective well-being. New results on how GDP and SWB are interlinked in the short-run and in the long-run are provided. Interpretations of both earlier results and the results obtained in this study are emphasised. Although we only study static models, it appears that the relationships are more complex than acknowledged in earlier studies. In particular, how output is associated with well-being differs between the short-term and the long-term. The variation in subjective well-being coincides with the short-run cyclical fluctuations of output. Moreover, in Europe, economic growth has an independent temporary effect above and beyond its effect on the level of economic output. Our results are consistent with the majority of earlier studies but shed more light on the relationship between GDP and subjective well-being within countries over time.

Keywords: Subjective well-being, Life satisfaction, Happiness, Output, Income, Economic growth, Macroeconomics, Easterlin paradox, GDP, Potential output, Output gap
JEL codes: O11, I31

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1 Introduction

The relationship between subjective well-being (SWB) and (real per capita) output has been frequently modeled in the literature. The results from panel regressions presented by Di Tella, MacCulloch and Oswald (2003) and Stevenson and Wolfers (2008) suggest that there exists a positive relationship between real GDP per capita and SWB. However, Easterlin et al. (2010) and Easterlin (2013) argue that these results cannot distinguish the short-term effects of output from the long-term effects. This is due to the fact that output levels are results of both trend growth and cyclical fluctuations. To date, the only attempts to distinguish between the short-term and long-term associations between GDP and SWB are those by Easterlin (2013) and Easterlin et al. (2010).

In this paper, we estimate and compare different models of the relationship between output and subjective well-being. New results on how GDP and SWB are interlinked in the short-run and in the long-run are provided. We emphasise the interpretations of both earlier results and the results we obtain. The estimated relationships from different models are illustrated by simple simulations to attain intuitive understanding of the link between GDP and subjective well-being. Although we only consider static models, it appears that the relationships are more complex than previously thought. In particular, how output is associated with well-being differs between the short-term and the long-term. Moreover, analysis with European data reveals that economic growth has an independent effect above and beyond its effect on the level of economic output. Our results are consistent with the majority of earlier studies but shed more light on the complex relationship between GDP and subjective well-being within countries over time.

2 Data sets

As the dependent variable in our analysis we use the weighted average of individuals' answers on questions concerning their life satisfaction and happiness.[1] These averages are calculated at the country-year level so that we have one observation of the dependent variable for country i in year t.

[1]Weights are calculated based on respondent's attributes compared to the whole population of the country.

We will conduct analyzes using Eurobarometer and World Values Survey (WVS) data. These are the two most commonly used datasets that include SWB questions and cover a long time span. In the Eurobarometer dataset, we have observations from 31 European nations while in the WVS sample we have observations from 39 different nations around the world. In Eurobarometer the longest time series start from the year 1973 and all series end in 2013[2]. In WVS the time span is from 1981 to 2013. In the Eurobarometer sample we have continuous time series for each country but in the WVS sample the series have gaps within a country. This is because the WVS survey is conducted in waves rather than annually. In both datasets, the length of the time series differ between countries. With Eurobarometer the dependent variable is the average of peoples life satisfaction on a scale 1 to 4 and with WVS the dependent variables are the average of life satisfaction on a scale from 1 to 10 and the average of happiness on a scale from 1 to 4. The real GDP per capita data is gathered from the Penn World Tables.[3]

3 Empirical analysis

3.1 Bivariate models

We start by noting that GDP as well as its logarithmic transformation is trending upwards over a reasonably long time period in virtually all countries. It is well known that such a strong trend is absent from time series of subjective well-being in almost all countries. Together with a positive income-SWB gradient at the individual level, these findings give rise to the so-called 'Easterlin paradox', originally presented by Richard Easterlin (1974). Examining the properties of the SWB time-series in our data reveals that unit roots in the series can be rejected. We tested the presence of unit roots in the series by Pesaran's (2007) panel unit root test for cross-sectionally dependent

[2]In Eurobarometer dataset there is a gap in year 1974. In our panel unit root tests (see below), we include interpolated observations for the year 1974 for each country. In all of our static panel regressions we include the observations for 1973 but not for 1974

[3]We use IMF World Economic Outlook data for years 2012 and 2013 to augment the real GDP per capita series attained from the Penn World Tables.

panels.[4],[5]

Given the properties of the well-being and output series, regressing SWB on output gives an estimate of the long-run association between the two variables, missing the potentially important short-run relationship. In turn, running the model in differences estimates the short-run relationship and ignores the long-run. Both types of models are estimated by Stevenson and Wolfers (2008). Di Tella et al. (2003) estimate the model using GDP levels and also a model with level of satisfaction on LHS and economic growth on the RHS. Easterlin et al. (2010) and Easterlin (2013) estimate long-run associations by regressing average SWB change over time in countries on average economic growth rate. Easterlin et al. (2010) estimate short-run associations by regressing deviations from (linear) trend in SWB on deviations from (linear) trend in log of GDP per capita. Given the typical absence of a clear trend and stationarity of the SWB series, models in which SWB is regressed on a non-trending output variable could provide interesting insights. Thus, we start by comparing different bivariate models of SWB that are of type

$$s_{it} = \alpha_i + \beta x_{it} + \epsilon_{it}, \tag{1}$$

where s_{it} is the average life satisfaction or happiness in country i in year t, α_i is the country fixed-effect for country i, and x_{it} is the explanatory variable constructed from GDP. More specifically, a model including the usual variable, logarithm of the real GDP per capita, is compared to models including different measures of the output gap and a model including the growth rate of GDP. We use different methods to extract the output gap from the real output series for each country separately. We estimate linear trend, quadratic trend and apply Hodrick-Prescott filters with three alternative, commonly used smoothing parameters of 6.25, 100 and 400 to attain five different measures for the output gap. To address the endpoint problem in filtering we have used IMF World Economic Outlook growth projections for years 2014 and 2015 to calculate the real GDP per capita also for the years after the end of our sample. In addition to these five variables, output gap measures published by OECD and IMF are used. We present examples of estimated

[4] We can only test the stationarity of the satisfaction variable in the Eurobarometer sample since WVS series have gaps.

[5] The levels of augmentation in the individual Dickey-Fuller tests that constitute the panel unit root test are chosen according to the Bayesian Information Criterion for each country separately. We take into account cross-sectional dependence since it was detected by Pesaran's (2004) test. The results for the tests are available upon request.

trends in our data in the Appendix to illustrate how they behave. We chose two countries in our Eurobarometer data, Great Britain and Spain. Great Britain is a country of fairly typical trend growth and business cycles. Spain, in turn, is an example of a country with somewhat larger business cycle variation and deep financial crisis in the last years of the data. It can be seen that trends estimated by the HP filter with a low smoothing parameter of 6.25 are very flexible, whereas other trends, especially the linear and quadratic trends, are less flexible. We use multiple trend estimation methods to find a method which produced good fit in our models and to see whether our results are robust to different methods. In addition to the cycle models, we also estimate a models in which the explanatory variable is the rate of economic growth, measured as the difference in the logarithm of GDP per capita. Because output gap measures produced by OECD and IMF are available for different subsets of our data, we present results for the whole sample and for two different subsamples determined by the availability of output gap measures. In what follows, we denote the variables measuring output gap as *cycle* variables. All models are estimated both with and without year fixed-effects. The estimated coefficient β for each model is reported in Table 1.

In the Eurobarometer data, it appears that the coefficient of the logarithm of GDP per capita variable is positive and statistically significant. This is the case for all alternative explanatory variables as well. All cycle variables and the growth rate variable have larger coefficient estimates than the logarithm of GDP. This is natural because their variance is smaller. The R^2 values of the models reveal that those cycle variables which are based on less flexible output trend tend to have more explanatory power than the logarithm of GDP per capita. The trends are less flexible, and, thus, less likely to capture cyclical variation in output, when trend is estimated as linear, quadratic or with a HP filter with a large smoothing parameter. The model with the OECD output gap variable outperforms other models in the data for which this variable is available. The economic growth variable has a statistically significant positive coefficient but tends to do less well as an explanatory variable than the other variables.

The results seem to be more mixed in the World Values Survey data on life satisfaction (Table 2). Results vary between models with and without year dummies and between different data sets (full sample, OECD and IMF). However, as is the case in the Eurobarometer data, the model with the largest explanatory power is never the one with log of GDP as the regressor. In the

Table 1: Bivariate models of life satisfaction. Eurobarometer 1973-2013.

	Full sample		OECD sample		IMF sample	
ln(GDP per capita)	0,11***	0,22***	0,13***	0,36***	0,13***	0,29***
SE	(0,02)	(0,05)	(0,03)	(0,08)	(0,02)	(0,05)
R^2	0,924	0,937	0,915	0,933	0,908	0,929
HP Cycle (6.25)	0,96***	1,05***	1,11***	1,55***	0,94***	1,11**
SE	(0,19)	(0,33)	(0,29)	(0,54)	(0,28)	(0,51)
R^2	0,922	0,936	0,915	0,931	0,905	0,925
HP Cycle (100)	0,69***	0,57***	0,95***	1,05***	0,87***	0,72***
SE	(0,11)	(0,18)	(0,18)	(0,30)	(0,17)	(0,26)
R^2	0,923	0,935	0,919	0,932	0,909	0,925
HP Cycle (400)	0,63***	0,59***	0,79***	0,86***	0,81***	0,73***
SE	(0,09)	(0,14)	(0,13)	(0,22)	(0,13)	(0,20)
R^2	0,925	0,936	0,920	0,933	0,912	0,927
Cycle (quadratic trend)	0,47***	0,48***	0,54***	0,58***	0,56***	0,54***
SE	(0,06)	(0,09)	(0,09)	(0,13)	(0,08)	(0,11)
R^2	0,926	0,937	0,920	0,933	0,914	0,928
Cycle (linear trend)	<u>0,57</u>***	<u>0,69</u>***	0,54***	0,66***	<u>0,57</u>***	<u>0,69</u>***
SE	(0,07)	(0,09)	(0,09)	(0,12)	(0,07)	(0,10)
R^2	0,931	0,943	0,923	0,937	0,918	0,933
OECD output gap	—	—	<u>1,11</u>***	<u>1,45</u>***	—	—
SE			(0,16)	(0,24)		
R^2			0,925	0,939		
IMF output gap	—	—	—	—	0,94***	0,82***
SE					(0,21)	(0,31)
R^2					0,909	0,926
d ln(GDP per capita)	0,58***	0,82***	0,74***	1,41***	0,72***	1,20***
SE	(0,13)	(0,20)	(0,20)	(0,33)	(0,20)	(0,29)
R^2	0,922	0,936	0,916	0,934	0,907	0,928
Year dummies	No	Yes	No	Yes	No	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	644	644	435	435	494	494

Robust standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01.
The coefficient estimate of the model with the largest R^2 in the column is underlined.

models using the full sample or the IMF sample, the cycle variable constructed by removing a linear trend from the log of GDP or by the HP filter with a smoothing parameter of 400 has the largest explanatory power. In the OECD sample, regressing life satisfaction on the HP cycle variable with smoothing parameter of 6.25 results in the largest R squared. Moreover, most cycle variables have better predictive power than the log of GDP variable. Modelling happiness in the WVS data in Table 3 results in models with the log of GDP being a more satisfying explanatory variable. Log-of-GDP models have the largest explanatory power when year dummies are left out. Inclusion of year dummies results in cycle variables being best predictors in the full sample and in the OECD sample and the IMF output gap being the best predictor in the IMF sample. Taken together, results from the well-being models using the WVS data suggest that detrended output variables have more explanatory power than the log of GDP except when the LHS variable is happiness and there are no year dummies in the model.

An interesting observation is that adding year fixed-effects in the Eurobarometer data at least doubles the coefficient of the logarithm of GDP per capita while the coefficients in other models do not change as much. The reason for this is clear. Year fixed-effects account for the development of average output and life satisfaction within the sample countries. This means that differences in the development of log of GDP in countries over time is more closely linked to differences in the development of well-being than the average development in log of GDP is linked to the average development in well-being. Since year fixed-effects capture the common developments in log of GDP, they account for part of the long-run economic growth in countries as well. This is likely to alleviate the problem of regressing the non-trending SWB on trending log of GDP. In other output variables, there is no trend, which explains the fact that their coefficients do not change much. In the World Values Survey data, including year dummies either remarkably lowers the coefficient of log of GDP (full sample, OECD sample) or increases it (IMF sample). The former may be due to large differences between WVS countries' long-term growth rates. In such a case, a large share of the remaining variation in the GDP variable, after accounting for the average development, is variation in the long-term growth rates rather than in the short-term economic fluctuations. We will later show that long-term growth rate differences between countries are usually not very good predictors of long-term SWB growth differences. This may explain why including year dummies make the association between log of GDP and SWB disappear in the WVS data.

Table 2: Bivariate models of life satisfaction. World Values Survey 1981-2013.

	Full sample		OECD sample		IMF sample	
ln(GDP per capita)	0,56***	0,01	0,45	0,11	0,12	0,67
SE	(0,20)	(0,26)	(0,39)	(0,58)	(0,29)	(0,97)
R^2	0,875	0,924	0,869	0,932	0,869	0,924
HP Cycle (6.25)	5,28**	2,62	10,06**	10,45**	2,77	-9,01
SE	(2,58)	(2,33)	(3,97)	(4,43)	(6,13)	(9,21)
R^2	0,866	0,925	0,904	0,952	0,869	0,923
HP Cycle (100)	5,08***	3,13***	5,24**	4,15	5,43**	5,52
SE	(1,01)	(1,00)	(2,41)	(3,11)	(2,29)	(4,81)
R^2	0,889	0,932	0,897	0,942	0,891	0,924
HP Cycle (400)	4,05***	2,67***	3,94**	2,65	4,15**	5,99
SE	(0,59)	(0,65)	(1,94)	(2,54)	(1,72)	(3,93)
R^2	0,899	0,935	0,893	0,939	0,898	0,931
Cycle (quadratic trend)	2,82***	1,71***	2,48*	1,63	2,52**	2,91
SE	(0,56)	(0,62)	(1,36)	(1,83)	(1,18)	(2,79)
R^2	0,892	0,932	0,884	0,937	0,890	0,926
Cycle (linear trend)	2,08***	1,06*	1,67*	1,57	1,00	2,23
SE	(0,51)	(0,63)	(0,98)	(1,20)	(0,86)	(1,86)
R^2	0,893	0,929	0,880	0,939	0,875	0,927
OECD output gap	—	—	5,55**	4,82	—	—
SE			(2,26)	(2,87)		
R^2			0,901	0,942		
IMF output gap	—	—	—	—	3,72*	5,48
SE					(2,09)	(5,03)
R^2					0,878	0,925
d ln(GDP per capita)	3,03**	2,53*	4,44	4,78	1,50	2,17
SE	(1,51)	(1,30)	(3,04)	(3,00)	(2,97)	(5,67)
R^2	0,869	0,928	0,880	0,940	0,869	0,919
Year dummies	No	Yes	No	Yes	No	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	179	179	63	63	50	50

Robust standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01.
The coefficient estimate of the model with the largest R^2 in the column is underlined.

Table 3: Bivariate models of happiness. World Values Survey 1981-2013.

	Full sample		OECD sample		IMF sample	
ln(GDP per capita)	0,18***	-0,02	0,23***	0,04	0,20***	0,23
SE	(0,04)	(0,08)	(0,08)	(0,13)	(0,04)	(0,17)
R^2	0,819	0,919	0,817	0,883	0,932	0,957
HP Cycle (6.25)	0,10	-0,03	2,30	4,08*	-0,50	-0,40
SE	(1,01)	(1,01)	(1,54)	(2,07)	(1,25)	(2,02)
R^2	0,793	0,919	0,812	0,921	0,884	0,948
HP Cycle (100)	0,68*	0,49	0,99	1,63	0,68	1,53
SE	(0,36)	(0,37)	(0,78)	(1,01)	(0,63)	(1,08)
R^2	0,801	0,922	0,799	0,903	0,888	0,953
HP Cycle (400)	0,67***	0,50**	0,82	1,11	0,66	1,28
SE	(0,21)	(0,23)	(0,62)	(0,79)	(0,46)	(0,94)
R^2	0,809	0,925	0,801	0,898	0,892	0,955
Cycle (quadratic trend)	0,44***	0,32*	0,68	0,77	0,55*	0,54
SE	(0,15)	(0,17)	(0,45)	(0,58)	(0,32)	(0,67)
R^2	0,805	0,923	0,806	0,898	0,896	0,951
Cycle (linear trend)	0,46***	0,23*	0,25	0,40	0,05	0,30
SE	(0,12)	(0,14)	(0,32)	(0,38)	(0,28)	(0,44)
R^2	0,818	0,923	0,788	0,889	0,884	0,950
OECD output gap	—	—	0,68	1,04	—	—
SE			(0,57)	(0,88)		
R^2			0,790	0,889		
IMF output gap	—	—	—	—	1,19	1,95*
SE					(0,82)	(0,99)
R^2					0,896	0,958
d ln(GDP per capita)	0,52	0,49	0,04	0,61	0,09	-0,36
SE	(0,31)	(0,35)	(0,53)	(0,84)	(0,86)	(1,16)
R^2	0,797	0,922	0,783	0,885	0,883	0,948
Year dummies	No	Yes	No	Yes	No	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	179	179	63	63	50	50

Robust standard errors in parentheses, * $p<0.10$, ** $p<0.05$, *** $p<0.01$.
The coefficient estimate of the model with the largest R^2 in the column is underlined.

It can be seen from our analysis thus far that the bivariate within-country relationship between GDP and SWB is often best modelled by first extracting a non-flexible trend, such as a linear trend, or the potential output measure calculated by the OECD, from the output series and using the residual as the predictor of SWB. Although the interpretations of the different model specifications are simple, it is worth emphasising them by using graphics. Because the interpretation of a log-of-GDP model is straightforward, we only take a look at a model with growth and a model with cyclical component of output. In Figure 1, we use the estimation results in Table 1 to simulate two different models. The figure shows the behaviour of SWB predicted by the models. In the models that are simulated, the explanatory variables are the the deviation of log of GDP per capita from its linear trend, and the GDP growth rate. We take the parameters from the full-sample models with year fixed-effects. The GDP data is from Great Britain, a country with a fairly typical trend growth and business cycles in the Eurobarometer data.

The model in which trend is extracted from GDP produces cyclical variation in SWB. That is, SWB follows business cycles. The model with growth has a distinctive feature of predicting immediate recovery of SWB when expansion begins after a trough. This is different from the two previous models, in which SWB increases more slowly as the output approaches the trend. It is clear that two types of models, the cycle model and the growth model are different. In the cycle models, growth only matters to the extent that it takes the economy farther away or closer to the trend or potential output. In the growth model, it does not matter for well-being on which side and how far away the economy is from the trend or potential output. Only the current rate of growth matters. This means that people can be as well-off in the beginning of the economic recovery as they are just before the peak, given that the growth rate is similar in these two phases of the business cycle. Similar logic applies to economic downturns and recessions. Recent results by De Neve et al. (2014) also imply this kind of behaviour of SWB over time. The difference in their model compared to our growth model is that they allow negative growth to have a different effect from positive growth. They find that negative growth has about six-fold effect on SWB compared to positive growth. Using their results, simulation of a growth model would yield similar variation in SWB over time as simulation of our model, the difference being that the predicted SWB series is flatter during the periods of positive growth and the dips during the periods of negative growth are much deeper. Rather than to rely on the predictions of the model with growth

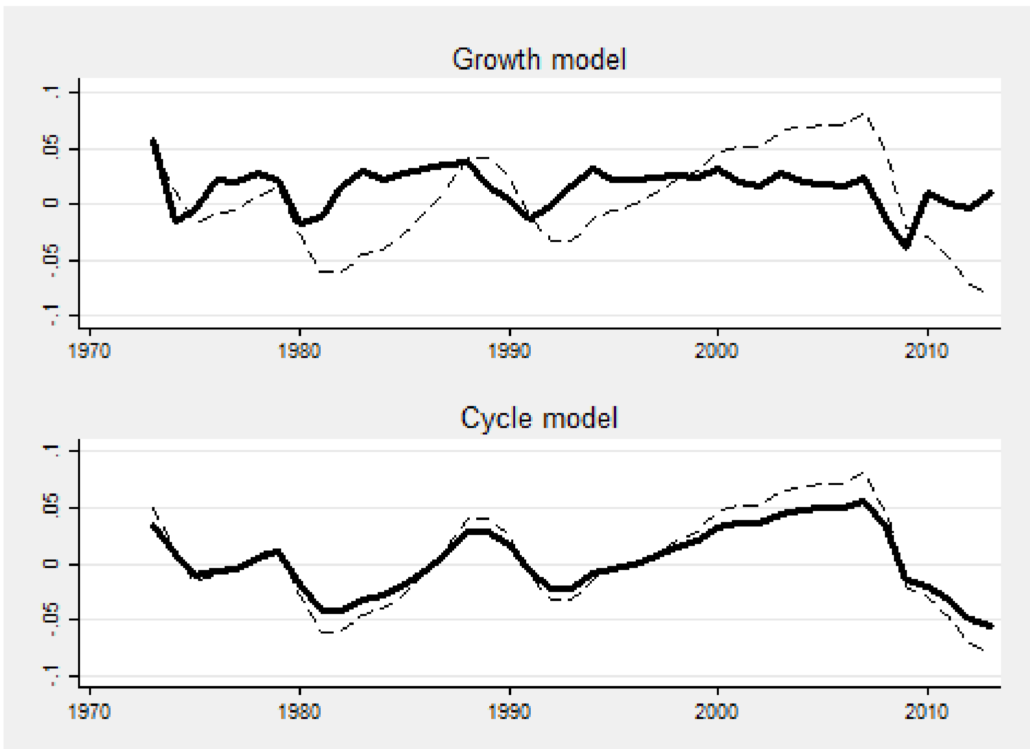

Figure 1: Detrended (linear trend) log of GDP per capita (dashed) and simulated life satisfaction (solid) series for Great Britain. Simulation model parameters: constant = 0, coefficients = 0.82 (Growth model) and 0.69 (Cycle model).

as the regressor, it seems more plausible to think that SWB moves with the business cycle. In addition, our results show that cycle models have more explanatory power than growth models. We still do not think that it can be assumed *a priori* that current economic growth does not influence people's well-being. In what follows, we extend the analysis beyond bivariate models by combining the ideas of a cycle model and a growth model. We also allow SWB to be linked to the long-term trend of output.

3.2 Models with growth, cycle and trend

To allow current economic growth to have an effect on well-being beyond its effect through changes that it causes on the level of output (relative to the trend or altogether), we estimate hybrid models in which we include both a cycle variable and growth as explanatory variables. Although there seems to be no trend in SWB, as discussed earlier, and the unit root test that we conducted point to stationarity of SWB series, we do not want to overlook the possibility of a statistically significant association between trend output and SWB. One reason for this is that in some earlier studies, most notably in Stevenson and Wolfers (2008), a positive association is found between log of GDP and SWB, a result which suggests that there may exist a long-run relationship. Therefore, our models also include trend, or potential output in the cases of OECD and IMF output gaps. The models to be estimated next are of type

$$s_{it} = \alpha_i + \beta_1 growth_{it} + \beta_2 cycle_{it} + \beta_3 trend_{it} + \epsilon_{it}, \tag{2}$$

where $growth_{it}$ is the change in log of GDP per capita from year $t-1$ to year t, $cycle_{it}$ is the cyclical component of log of GDP per capita and $trend_{it}$ is the trend component (or potential output) of log of GDP per capita. As cycle variables we use the same variables as we used in our bivariate models, and the trend components come from the same decompositions as the cyclical components.

The results from the estimated models are presented in tables 4, 5 and 6. According to all Eurobarometer estimations, the growth rate of GDP per capita is statistically significantly and positively associated with life satisfaction. The coefficients of the cyclical component of GDP are always positive and in most models statistically significantly different from zero. As with the bivariate models, the less flexible the trend component is, the more significant predictor the cyclical component is. A notable exception from this is the OECD output gap, which is based on a fairly flexible trend and outperforms all other cycle variables. The models with the largest explanatory power are the ones in which the trend is either a simple linear trend or potential output variable calculated by the OECD. The trend component of GDP is always positively and almost always statistically significantly associated with life satisfaction. Trend components only lose their statistical significance when they are linear or calculated by the OECD and when year dummies are included. However, this also means that trend components are not statistically significant in year-dummy models that provide the best fit. Our results concerning the trend component of GDP from the models including year dummies that fit the data best are essentially the same as the results by Easterlin et al. (2010) and Easterlin (2013). In these studies, it is found that average GDP growth rates in countires are not statistically significantly associated with growth in SWB.

The results obtained using the Eurobarometer data should be contrasted with the discussion on bivariate models in the previous section. First, our bivariate results suggested that the explanatory power of economic growth is limited when compared to the business cycle variables. In turn, the models with many regressors suggest that growth matters even when the economic cycle and trend component of GDP are controlled for. Second, the level of log of GDP has a positive association with life satisfaction but this association is much stronger, and larger in magnitude, for cyclical fluctuations than it is for the trend. In fact, if we test whether the coefficient for the cycle equals that of trend's (that is, if we test $\beta_2 - \beta_3 = 0$) we can reject the hypothesis of equal coefficients in every model except in the one using smoothing parameter 6.25. This is not surprising since, in the models without year dummies that have the largest explanatory power, the coefficient of the cycle variable is about 6, 7 or 9 times as large as the coefficient of the trend component variable. In the best models with year dummies, the estimated coefficients of the trend component variables are not statistically different from zero. Therefore, the association between short-run economic fluctuations and well-being is much more important than the association between the long-run development of economic output and well-being. The analyses using the Eurobarometer reveal that both models with only growth variable and models with only log of GDP are too simple to capture the association between economic output and well-being. A better characterisation of the association is obtained when both output and output growth are present in the model, and a distinction

Table 4: Models of life satisfaction. Eurobarometer 1973-2013.

	Coefficient estimates			R^2	Coefficient estimates			R^2
	Growth	Cycle	Trend		Growth	Cycle	Trend	
Full sample								
HP (6.25)	0,59***	0,41**	0,12***	0,928	0,65***	0,44	0,19***	0,939
SE	(0,14)	(0,20)	(0,02)		(0,22)	(0,35)	(0,05)	
HP (100)	0,53***	0,45***	0,11***	0,929	0,70***	0,28	0,20***	0,939
SE	(0,14)	(0,11)	(0,02)		(0,20)	(0,17)	(0,05)	
HP (400)	0,51***	0,45***	0,11***	0,929	0,65***	0,37***	0,17***	0,939
SE	(0,13)	(0,09)	(0,02)		(0,20)	(0,14)	(0,05)	
Quadratic trend	0,52***	0,36***	0,09***	0,930	0,64***	0,38***	0,13**	0,939
SE	(0,13)	(0,07)	(0,02)		(0,20)	(0,09)	(0,06)	
Linear trend	0,34***	0,50***	0,07***	0,933	0,52**	0,65***	-0,06	0,944
SE	(0,12)	(0,07)	(0,02)		(0,20)	(0,09)	(0,07)	
N = 644								
OECD sample								
HP (6.25)	0,97***	0,24	0,19***	0,923	1,48***	0,16	0,37***	0,939
SE	(0,23)	(0,30)	(0,03)		(0,36)	(0,55)	(0,08)	
HP (100)	0,79***	0,56***	0,15***	0,923	1,43***	0,33	0,37***	0,939
SE	(0,23)	(0,17)	(0,03)		(0,36)	(0,28)	(0,09)	
HP (400)	0,76***	0,52***	0,14***	0,924	1,43***	0,34	0,37***	0,939
SE	(0,22)	(0,14)	(0,04)		(0,36)	(0,21)	(0,10)	
Quadratic trend	0,77***	0,39***	0,12***	0,924	1,42***	0,35***	0,37***	0,939
SE	(0,22)	(0,09)	(0,04)		(0,37)	(0,12)	(0,12)	
Linear trend	0,63***	0,48***	0,12***	0,926	1,13***	0,59***	-0,02	0,941
SE	(0,21)	(0,09)	(0,04)		(0,38)	(0,13)	(0,16)	
OECD	0,44**	0,91***	0,10***	0,927	0,93***	1,10***	0,13	0,941
SE	(0,22)	(0,17)	(0,04)		(0,36)	(0,24)	(0,09)	
N = 435								
IMF sample								
HP (6.25)	0,92***	0,10	0,15***	0,915	1,21***	-0,04	0,28***	0,933
SE	(0,21)	(0,29)	(0,02)		(0,28)	(0,50)	(0,05)	
HP (100)	0,76***	0,48***	0,13***	0,916	1,15***	0,20	0,28***	0,933
SE	(0,20)	(0,17)	(0,02)		(0,28)	(0,25)	(0,05)	
HP (400)	0,69***	0,54***	0,12***	0,917	1,08***	0,35*	0,26***	0,933
SE	(0,20)	(0,13)	(0,02)		(0,29)	(0,19)	(0,06)	
Quadratic trend	0,68***	0,40***	0,09***	0,917	1,08***	0,33***	0,25***	0,933
SE	(0,20)	(0,08)	(0,03)		(0,29)	(0,11)	(0,07)	
Linear trend	0,48**	0,49***	0,09***	0,921	0,87***	0,59***	0,05	0,936
SE	(0,19)	(0,08)	(0,02)		(0,32)	(0,11)	(0,09)	
IMF	0,67***	0,67***	0,14***	0,917	1,02***	0,54*	0,26***	0,933
SE	(0,21)	(0,21)	(0,02)		(0,28)	(0,30)	(0,05)	
N = 494								
Year dummies		No					Yes	
Country dummies		Yes					Yes	

Robust standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01. Each row reports two models with the same detrending method and three regressors of interest (growth, cycle component and trend component). The models in the lefthand panel do not include year dummies and the models in the righthand panel do. The coefficient estimates of the model with the largest R^2 in the sample / specification (with or without year dummies) is underlined.

is made between the level of trend output, or potential output, and the deviation of the level of output from its trend or potential.

As was the case with the bivariate models, the results in the World Values Survey data are more mixed. When modelling life satisfaction (Table 5), using HP filters with smoothing parameters of 400 or 6.25 yield the best fit. In most models with the best explanatory power, the cyclical component of GDP is the only statistically significant regressor. In the model using the full sample and including year dummies, the trend component of GDP is statistically significant and *negative*. In the model using the IMF sample and including year dummies, none of the explanatory variables is statistically significant. The results from the happiness models in Table 6 differ from the life satisfaction models in Table 5. The models with largest explanatory power in the full sample use a linear trend or an HP filter with a smoothing parameter of 400. The best models in the OECD sample use HP filter with a smoothing parameter of 6.25. The best models in the IMF sample use the output gap calculated by the IMF. The cyclical component of GDP, similarly to the trend component of GDP, is the only statistically significant regressor in two of the best models. Full sample and year dummies yield a, again, negative and statistically significant coefficient on the trend component, and a positive and significant coefficient on the cyclical component. IMF sample and year dummies yield no significant coefficients, as was the case with the life satisfaction models. An interesting difference between the Eurobarometer and WVS data is that economic growth is not statistically significantly associated with SWB in the WVS data.

If one looks at the WVS models that yield the best fit, some overall conclusion can be drawn from the WVS data. First, current economic growth is not associated with subjective well-being. Second, the cyclical component of GDP is positively associated with SWV, although the coefficient is not always statistically significantly different from zero. Third, the coefficient of the trend component of GDP is positive when year dummies are excluded and negative when year dummies are included. The statistical significance varies. As discussed earlier, year dummies capture the average development in the variables, including the average trend in GDP. Thus, although sample countries' GDP and SWB have both grown on average, the differences between SWB trends in countries are not positively associated with the differences between their log of GDP trends. On the contrary, countries with higher trend growth have experienced less growth in SWB over time. A simple interpretation for the finding is that, in the WVS countries, economic

Table 5: Models of life satisfaction. World Values Survey 1981-2013.

	Coefficient estimates			R^2	Coefficient estimates			R^2
	Growth	Cycle	Trend		Growth	Cycle	Trend	
Full sample								
HP (6.25)	2,25*	3,25	0,52**	0,886	2,37*	0,91	-0,07	0,929
	(1,31)	(2,29)	(0,21)		(1,37)	(2,33)	(0,28)	
HP (100)	1,79	4,01***	0,31	0,896	1,43	3,17***	-0,45*	0,936
	(1,10)	(0,96)	(0,20)		(1,11)	(1,03)	(0,27)	
HP (400)	1,72	3,53***	0,16	0,903	1,23	2,78***	-0,61**	0,940
	(1,10)	(0,60)	(0,20)		(1,03)	(0,64)	(0,24)	
Quadratic trend	2,21*	2,46***	0,21	0,899	1,85	1,54**	-0,44*	0,936
	(1,16)	(0,55)	(0,21)		(1,23)	(0,64)	(0,25)	
Linear trend	2,26**	1,90***	0,08	0,899	1,95*	0,87	-0,42	0,933
	(0,98)	(0,52)	(0,22)		(1,14)	(0,66)	(0,30)	
N = 179								
OECD sample								
HP (6.25)	1,23	8,33*	0,33	0,909	0,34	11,31*	-0,54	0,954
	(2,40)	(4,30)	(0,35)		(3,10)	(6,14)	(0,56)	
HP (100)	2,59	3,85*	0,41	0,907	2,28	3,37	-0,37	0,945
	(2,18)	(2,08)	(0,34)		(3,79)	(4,39)	(0,66)	
HP (400)	3,34	2,82*	0,42	0,906	3,36	1,46	-0,22	0,942
	(2,07)	(1,45)	(0,33)		(3,95)	(3,15)	(0,61)	
Quadratic trend	4,17*	1,98**	0,44	0,905	3,93	0,70	-0,15	0,941
	(2,09)	(0,93)	(0,33)		(3,61)	(1,96)	(0,56)	
Linear trend	4,30**	1,62**	0,49*	0,906	3,34	0,68	-0,20	0,941
	(2,12)	(0,73)	(0,29)		(4,30)	(1,51)	(0,55)	
OECD	2,37	4,17**	0,36	0,908	1,87	4,80	-0,57	0,945
	(2,33)	(1,99)	(0,32)		(3,67)	(3,89)	(0,65)	
N = 63								
IMF sample								
HP (6.25)	1,30	2,34	0,13	0,871	2,25	-10,72	0,79	0,933
	(3,58)	(6,88)	(0,30)		(4,78)	(10,10)	(0,86)	
HP (100)	-1,37	5,83**	-0,01	0,892	0,95	3,62	0,48	0,926
	(3,22)	(2,34)	(0,27)		(5,80)	(5,25)	(1,11)	
HP (400)	-1,66	4,57**	-0,09	0,899	-1,04	5,97	0,13	0,932
	(2,98)	(1,82)	(0,24)		(5,66)	(3,86)	(1,04)	
Quadratic trend	-1,01	2,74**	-0,10	0,891	0,49	2,43	0,38	0,927
	(3,04)	(1,23)	(0,25)		(5,53)	(2,75)	(0,99)	
Linear trend	0,22	1,06	0,11	0,876	-0,89	2,36	0,41	0,930
	(3,45)	(1,02)	(0,28)		(5,46)	(2,06)	(0,95)	
IMF	-0,63	3,89	0,02	0,878	1,37	3,74	0,37	0,926
	(3,72)	(2,43)	(0,31)		(5,55)	(6,16)	(1,27)	
N = 50								
Year dummies		No					Yes	
Country dummies		Yes					Yes	

Robust standard errors in parentheses, * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Each row reports two models with the same detrending method and three regressors of interest (growth, cycle component and trend component). The models in the lefthand panel do not include year dummies and the models in the righthand panel do. The coefficient estimates of the model with the largest R^2 in the sample / specification (with or without year dummies) is underlined.

Table 6: Models of happiness. World Values Survey 1981-2013.

	Coefficient estimates			R^2	Coefficient estimates			R^2
	Growth	Cycle	Trend		Growth	Cycle	Trend	
Full sample								
HP (6.25)	0,55*	-0,41	0,18***	0,824	0,58	-0,44	-0,02	0,922
	(0,28)	(0,95)	(0,04)		(0,36)	(1,09)	(0,09)	
HP (100)	0,42*	0,24	0,18***	0,823	0,32	0,50	-0,10	0,925
	(0,25)	(0,36)	(0,05)		(0,31)	(0,36)	(0,09)	
HP (400)	0,36	0,38*	0,15***	0,824	0,24	0,53**	-0,15*	0,929
	(0,25)	(0,22)	(0,06)		(0,30)	(0,22)	(0,08)	
Quadratic trend	0,41	0,27*	0,16***	0,823	0,36	0,29*	-0,11	0,926
	(0,26)	(0,14)	(0,05)		(0,33)	(0,17)	(0,08)	
Linear trend	0,37	0,36***	0,12*	0,827	0,36	0,20	-0,13	0,926
	(0,24)	(0,14)	(0,07)		(0,30)	(0,14)	(0,09)	
N = 179								
OECD sample								
HP (6.25)	-1,40	3,66	0,13**	0,847	-1,88	6,22**	-0,23	0,936
	(1,34)	(2,76)	(0,06)		(1,16)	(2,71)	(0,17)	
HP (100)	-0,43	1,19	0,19***	0,828	-1,14	2,32	-0,17	0,909
	(0,78)	(1,11)	(0,05)		(1,19)	(1,59)	(0,21)	
HP (400)	-0,18	0,86	0,19***	0,827	-0,80	1,44	-0,11	0,901
	(0,54)	(0,74)	(0,06)		(1,16)	(1,19)	(0,20)	
Quadratic trend	0,00	0,70	0,19***	0,829	-0,40	0,84	-0,05	0,899
	(0,36)	(0,46)	(0,06)		(0,87)	(0,72)	(0,19)	
Linear trend	0,19	0,38	0,22***	0,820	-0,31	0,47	-0,05	0,889
	(0,27)	(0,29)	(0,07)		(1,38)	(0,61)	(0,22)	
OECD	0,05	0,57	0,22***	0,819	-0,28	1,44	-0,12	0,890
	(0,44)	(0,72)	(0,07)		(1,16)	(1,63)	(0,26)	
N = 63								
IMF sample								
HP (6.25)	0,44	-0,32	0,21***	0,933	-0,45	-0,77	0,25	0,958
	(0,56)	(1,23)	(0,04)		(0,98)	(2,05)	(0,18)	
HP (100)	0,33	0,26	0,20***	0,932	-0,76	1,17	0,18	0,959
	(0,58)	(0,61)	(0,04)		(1,09)	(1,13)	(0,20)	
HP (400)	0,27	0,32	0,20***	0,932	-1,02	1,22	0,14	0,960
	(0,56)	(0,40)	(0,04)		(1,10)	(1,02)	(0,20)	
Quadratic trend	0,25	0,31	0,20***	0,933	-0,61	0,40	0,21	0,958
	(0,54)	(0,27)	(0,04)		(1,11)	(0,69)	(0,19)	
Linear trend	0,39	0,18	0,21***	0,932	-0,78	0,42	0,21	0,958
	(0,57)	(0,21)	(0,04)		(1,22)	(0,51)	(0,19)	
IMF	0,01	0,77	0,19***	0,934	-0,68	1,59	0,11	0,960
	(0,61)	(0,80)	(0,04)		(0,98)	(1,09)	(0,23)	
N = 50								
Year dummies		No					Yes	
Country dummies		Yes					Yes	

Robust standard errors in parentheses, * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Each row reports two models with the same detrending method and three regressors of interest (growth, cycle component and trend component). The models in the lefthand panel do not include year dummies and the models in the righthand panel do. The coefficient estimates of the model with the largest R^2 in the sample / specification (with or without year dummies) is underlined.

development may have had negative effects on well-being. Yet, people are better off when the economy is above its long-run trend and less well off when the economy is below it.

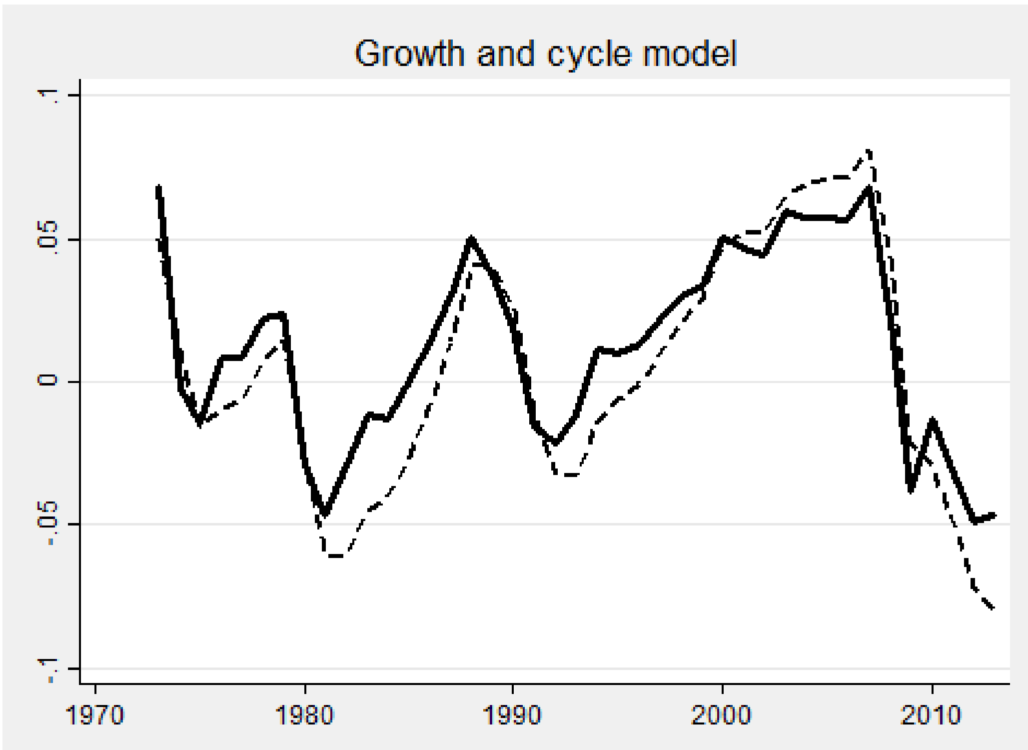

Figure 2: Detrended (linear trend) log of GDP per capita (dashed) and simulated life satisfaction (solid) series for Great Britain. Simulation model parameters: constant = 0, coefficients = 0.52 (GDP growth rate) and 0.65 (cyclical component, linear trend).

We conduct a simulation excercise similar to that related to the bivariate models in Figure 2. We simulate the model with the best fit in the Eurobarometer. Simulation is conducted with Great Britain GDP data using parameters (excluding constant term and the year fixed-effects) from the model including year dummies with linear detrending. The SWB series now follows quite closely to the business cycle, but, on top of that, periods of positive economic growth are associated with a higher SWB and periods of negative growth with a lower SWB. Business cycles are asymmetric in the sense that periods of negative growth are shorter than periods of positive growth. This is reflected in the simulated SWB series. SWB starts to recover from a dip as soon as growth is restored. However, SWB recovers to the pre-recession levels only after economy has recovered from recession.

4 Conclusions

We estimated different models of the relationship between output and subjective well-being and compared their explanatory power. Two commonly used data sets, the Eurobarometer and the World Values Survey, were used because they include observations over long period of time. New results on how GDP and SWB are interlinked in the short-run and in the long-run were provided. Models were given interpretations to shed light on what kinds of links the earlier studies have precisely found between the two variables. Simple simulation excercises further illuminated the the interpretations. Although we only considered static models, it appears that the relationship is more complex than previously estimated. More specifically, we found that cyclical fluctuations of output is able to explain a statistically and economically significant share of the subjective well-being variation over time. Long-run trend differences between countries in output have limited or no explanatory power in a SWB model. However, economic growth has an independent non-permanent effect above and beyond its effect on the level of economic output relative to its long-term trend. Our results are consistent with the majority of earlier studies but shed more light on the complex relationship between GDP and subjective well-being within countries over time.

References

De Neve, J. E., Ward, G., De Keulenaer, F., Van Landeghem, B., Kavetsos, G., Norton, M. 2014. "Individual Experience of Positive and Negative Growth is Asymmetric: Global Evidence Using Subjective Well-being Data." *LSE Centre for Economic Performance Discussion Paper* 1304.

Di Tella, R., MacCulloch, R. J. and Oswald., A. J. 2003. "The Macroeconomics of Happiness." *Review of Economics and Statistics*, 85(4), pp. 809-27.

Easterlin, R. A. 1974. "Does Economic Growth Improve the Human Lot? Some Empirical Evidence." *Nations and households in economic growth*, 89, pp. 89-125.

Easterlin, R. A. 2013. "Happiness and economic growth: The evidence" (No. 7187). *Discussion Paper Series, Forschungsinstitut zur Zukunft der Arbeit.*

Easterlin, R., Mcvey, L., Switek, M., Sawangfa, O., and Zweig., J. 2010. "The Happiness- Income Paradox Revisited." *Proceedings of the National Academy of Sciences*, 107(52), pp. 22463-68.

Pesaran, M.H. 2004. "General diagnostic tests for cross section dependence in panels." *Cambridge Working Papers in Economics* No. 435, University of Cambridge, and *CESifo Working Paper Series* No. 1229.

Pesaran, M. H. 2007 "A simple panel unit root test in the presence of cross section dependence." *Journal of Applied Econometrics* 22.2, pp. 265-312.

Stevenson, B. and Wolfers, J. 2008. "Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox." *Brookings Papers on Economic Activity*, (1), pp. 1-87.

APPENDIX

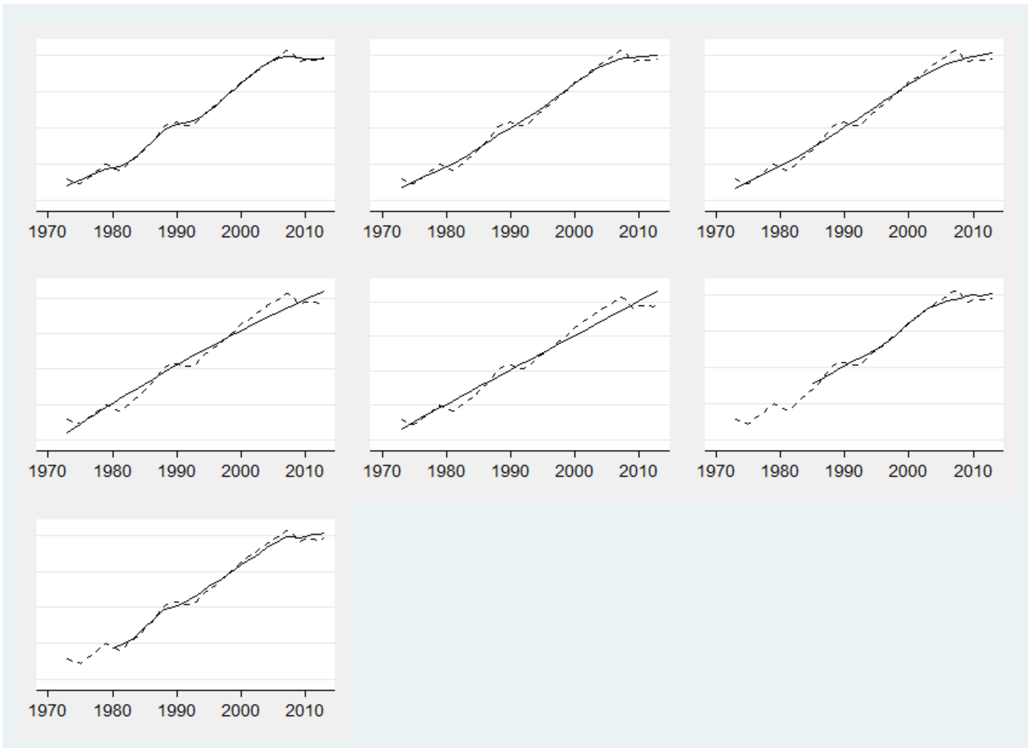

Figure A1. Output trends using different trending methods for Great Britain. Dashed line = log of real GDP per capita, solid line = trend. Sources of the trend series (from top left): HP filter (6.25), HP filter (100), HP filter (400), quadratic trend, linear trend, OECD output gap, IMF output gap.

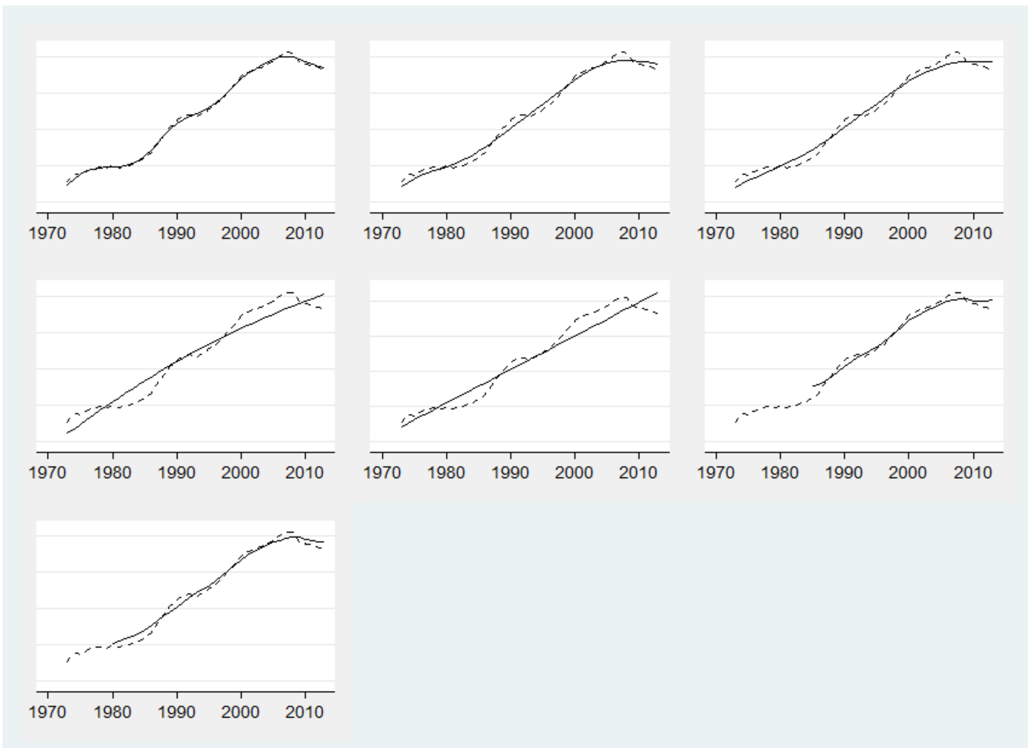

Figure A2. Output trends using different trending methods for Spain. Dashed line = log of real GDP per capita, solid line = trend. Sources of the trend series (from top left): HP filter (6.25), HP filter (100), HP filter (400), quadratic trend, linear trend, OECD output gap, IMF output gap.