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EXECUTIVE SUMMARY

This study provides estimates of output losses of the banking crisis in Cyprus for the period 2012-2020. Unlike most studies, where the effects of banking crises are computed ex post using actual data, the crisis in Cyprus is still evolving and the output losses and the period over which the economy will be below its potential output are not known. So our analysis is conducted on the basis of the output gap approach, where projected replaces actual output in the comparison with potential output. Furthermore, we provide alternative output loss estimates to account for the uncertainty about the magnitude and the duration of the recession.

- In terms of output level the loss, computed as the cumulative deviations of actual from potential GDP, over 2012-2014 ranges from about -8.4 €bn to -5.3 €bn (between -56% to -35% of 2011 GDP). Over the period 2012-2020 losses lie between -35.3 €bn to -16.7 €bn (-233% to -110% of 2011 GDP).

- In terms of output growth, computed as the cumulative deviation of the actual from the potential GDP growth rate, over the period 2012-2014 the loss ranges between -29.3 to -20.4 percentage points. For the longer time period 2012-2020 output growth losses range from -35.0 to -20 percentage points.

As the crisis in Cyprus is still underway, it should be stressed that the results computed here are conditional on assumptions about the evolution of actual and potential GDP. Nevertheless, the output losses obtained are comparable to estimates reported elsewhere in the literature, particularly those for the Nordic countries, e.g. 40.6 percentage points for Finland and -34.8 percentage points for Norway, over a period of 7-8 years. The financial liberalisation in these countries led to credit expansion accompanied by expansionary fiscal policies. Similarly in Cyprus the credit boom led to hiking property prices in the period prior to 2009. The transient government revenues from property taxes were used to finance an expansionary fiscal policy. The international financial crisis and afterwards the Greek sovereign debt crisis revealed the vulnerability of the Cypriot economy to these shocks and the pressing need for correcting the generated imbalances.

Research shows that the magnitude of output losses is positively and significantly related to banking sector size, bailout and recapitalisation costs incurred by the government; and to large amounts of liquidity infused in the banking system by the central bank. Banking crises are very difficult to predict, but given the economic burden that they inflict, indicators that are found to signal an approaching crisis should be closely monitored by policymakers. Such vulnerability indicators include rapid growth in domestic credit, inflated asset prices (property or equity) and non-performing loans.

1. Introduction

In this report we provide estimates of output losses from the current economic crisis in Cyprus. To our knowledge, there are no studies that attempt to quantify output losses from downturns in Cyprus, as the country has never undergone an economic crisis of the current proportions.[1] Nonetheless, the most recent IMF Country Report refers to an estimate of output loss in Cyprus for 2013-2016 noting that the estimate is larger than losses from other banking crises found in the literature (IMF 2013). This is alarming, given that the output losses inflicted by banking crises on the economy reported in the literature are found to be vast (e.g. Boyd et al 2005; Reinhart and Rogoff 2008, 2009; Haugh et al 2009), and often impossible to be regained (e.g. Cerra and Saxena 2008, Oxford Economics 2012).

The analysis of systemic banking crises in developed and emerging markets by Reinhart and Rogoff (2009) is revealing of the depth and duration of the damage to the economy: (i) large and prolonged declines of asset prices (e.g. real house prices decrease by 36% over 6 years); (ii) increase in the unemployment rate by 7 percentage points lasting for about 5 years, and severe fall in output (over 9%) - although with shorter duration compared to unemployment; and (iii) enormous increase in real public debt, not necessarily because of bailout costs but from the collapse in tax revenues due to the contraction of economic activity and, in some cases, countercyclical fiscal policies.

The economic disruptions associated with banking, currency and sovereign debt crises has, in combination or separately, drawn the interest of academia and international organisations (e.g. IMF, OECD) producing a large volume of research on the measurement of output losses from such crises. As explained by Angkinand (2008) there are mainly two approaches to measuring the output losses associated with crises.

- The *dummy variable* approach, where time series data for different countries are used and output losses are computed from the coefficients of 'crisis' dummy variables obtained from a regression of output growth on these variables, while controlling for other economic variables.
- The *output gap* approach, where the output loss associated with a crisis is measured as the sum of the differences between actual and potential output

[1] There are studies, however, evaluating the economic effects of the Turkish invasion (Pashardes and Hajispyrou 2003); or estimate the output gap, i.e. the deviation of GDP from its potential trend, for the Cypriot economy (Haroutunian et al 2003).

over the duration of the crisis; the end of the crisis occurs when actual output returns to its potential level.

The literature suggests that the output gap approach is more appropriate for representing the output loss from crises, although it is argued to yield outcomes that can be sensitive to the estimation techniques employed (e.g. whether the output variable is defined as growth rate or level) and to how potential output is estimated.

Most studies estimating the effects of banking crises are conducted ex post using actual data before, during and after the crisis (e.g. Angkinand 2008; Haugh et al 2009, IMF 2010).[2] In the case of Cyprus, however, the crisis is still on-going and the post-crisis actual output losses are not known. This renders the dummy variable method inapplicable so our analysis is conducted entirely on the basis of the output gap approach, where projected replaces actual output in the comparison with potential output. In the context of this methodology, the output losses are computed from both the level and growth rate of real GDP methods (Angkinand 2008; Bordo et al 2001; Boyd et al 2005; IMF 1998), described as follows.

- When the *growth rate* is used, output loss is measured by the sum of the differences between actual and potential GDP growth over the crisis period, with the end of the crisis being defined as the period when actual growth first returns to its potential trend. Potential growth trend is usually computed from the average of the growth rates of a number of years prior to the crisis. The number of years used to compute the average growth rate varies in the literature from one to ten years. Notably, too short a period could generate high potential growth as financial crises usually follow booms, while a long period may include the impact of other types of crises. Furthermore, output may often remain below its potential level, even if the growth rate recovers to its potential (pre-crisis) rate. Thus, losses continue to incur as long as output is below its potential level, regardless of whether the growth rate itself fully recovers.

- In the case of the *level* of GDP, output loss is measured by the net present value of the sum of the differences of actual from potential GDP over the crisis period, using an assumed discount rate. The end of the crisis is defined as the

[2] There is also a large body of literature on sovereign debt crises, which are more complicated to analyse than banking crises, as the former can be endogenous to serious economic downturn. Moreover, there is a strong connection between sovereign debt and banking crises with the causality between the two being unclear (Furceri and Zdzienicka 2011).

year when actual GDP returns to its potential trend; as the latter may never happen, the end of the crisis is sometimes taken to be when the growth rate returns to its potential. The potential GDP level is computed by applying a statistical filter, such as the Hodrick-Prescott filter (Hodrick and Prescott 1997), which removes short-run fluctuations in output over the period up to the crisis. Potential GDP after the crisis is extrapolated by applying the average growth rate of the potential GDP over, for example, a three-year period prior to the crisis. Deterministic time trends to allow for changes in potential GDP over time can also be used.

As the crisis in Cyprus is still evolving the output losses and the period over which the economy will be below its potential output are not known. In the current report the output losses are forecasted over 2013-2020, a period sufficiently long for the economy to return to its potential production capacity according to the literature (e.g. Boyd et al 2005; Haugh et al 2009). Furthermore, we compute alternative evolution paths over the period 2013-2020 for actual GDP growth, as well as for potential GDP growth and level. Thus we provide alternative output loss estimates to account for the uncertainty about the magnitude and the duration of the recession.

Section 2 describes the methodology used in the estimation of potential output and projections for actual GDP growth. Section 3 presents the results of the output loss estimations. Section 4 offers a discussion and some conclusions.

2. Potential output and projections

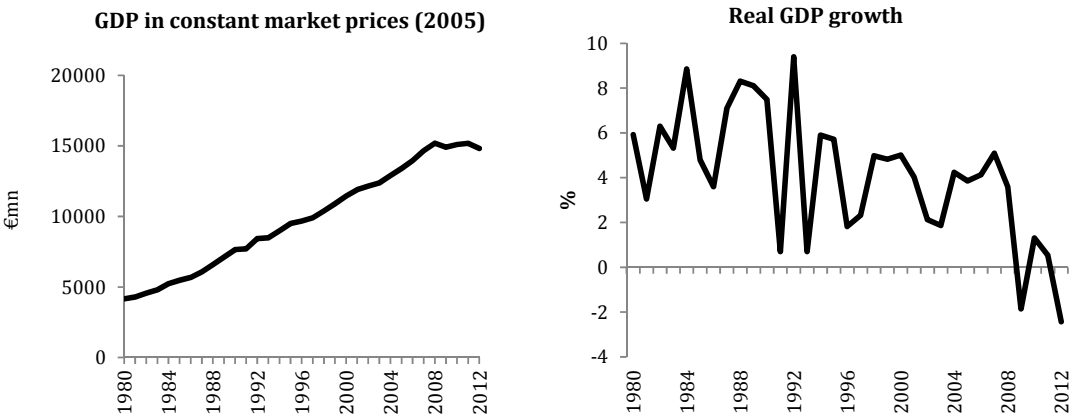
Annual data on GDP in constant market prices (real GDP) covering the period 1980-2012 from the Statistical Service of Cyprus are used in the empirical analysis.[3] Figure 1 shows GDP in constant market prices of 2005 and real GDP growth for the period 1980-2012; the lowest growth rate in the 33-year period was recorded in 2012.

As said in the introduction, the empirical analysis in this report is conducted using the output gap approach and the results are computed in terms of both the growth rate and the level of GDP. First, we obtain estimates for the potential growth and potential trend of the output level. Then we calculate projections for GDP growth

[3] In the case of banking crises the literature (e.g. Angkinand 2008) suggests, among other things, that the occurrence of large-scale government interventions in banks can signal the beginning of a crisis, thus the first year of the crisis in our case is defined as 2012.

for the period 2013-2020, under alternative potential growth scenarios. For comparison purposes we also use the projections of the European Commission and IMF in the Cyprus economic adjustment programme (European Commission 2013; IMF 2013).

Figure1: GDP in constant market prices of 2005 and real GDP growth



2.1 Estimations of potential growth rate and level

In the context of the output gap approach the potential GDP level needs to be estimated and compared with the level of actual GDP for the calculation of the output losses attributed to the banking crisis. The same holds true when the output losses are calculated from growth rates: the potential GDP growth rate has to be estimated and set against the actual one. In this section we describe how the estimations of the potential GDP growth rate and level are estimated.

2.1.1 Potential GDP growth rate

Instead of computing the potential GDP growth rate as a simple mean of the actual growth rate over an arbitrary period, we use a method which is more appropriate in the sense that it allows the potential GDP growth rate to be decided by, rather than an a priori restriction imposed on, the data. In the context of this method there can be various ways to compute the potential GDP growth rate, one of which is taking the simple mean over some period. More precisely, we model the actual growth rate as a function of the previous year's growth and dummy variables that capture the effects of outliers on the mean. The resulting potential growth rate, therefore, has the advantage over the simple mean calculation that, if shown to be statistically significant, the time dependency of the GDP growth rate and the excess

impact of certain years on this rate can be taken into account in the calculation of mean.

In mathematics, our model is written as

$$y_t = a_0 + a_1 y_{t-1} + \sum_{k=1}^{K} \delta_k \, d_{kt} + e_{t,} \qquad 1, \dots, T \tag{1}$$

where: y_t is real GDP growth at time t; d_{kt} is a dummy variable that takes the value 1 in a year of unusually high/low growth; and e_t is a random error.[4] The long-run or potential growth rate is computed by solving the estimated equation for y^P after setting $y^P = y_{t-1} = y_t$ and $d_{kt} = \overline{d_k}$, where $\overline{d_k}$ is the average value of the dummy variable k over the sample period.

Equation (1) is estimated for three alternative time periods: 1980-2012, 1995-2012 and 2000-2012. This is done in order to investigate the sensitivity of the value of the potential growth rate to the time period used in estimation. The parameter estimates, together with some diagnostic tests, and the computed potential growth rates, are reported in Table A1 in the Appendix. The results point to a decreasing potential growth rate in Cyprus in recent years. Thinking that the period over which the potential growth rate has to be estimated is likely to be turbulent, we have chosen to perform the calculations of the output losses caused by the banking crisis using two estimates of the potential growth rate, 2.44% and 1.84%. These rates are the lowest obtained from the estimation periods 1995-2012 and 2000-2012, respectively.

The potential GDP growth rates estimated as described above are below the growth rates computed as simple averages over the corresponding time periods because the data suggest that the potential growth rate of the Cyprus GDP has been declining over time. However, it is worth noting that the upper bound of output losses obtained from the parameter estimates of (1) coincide with those calculated using the mean of the actual GDP growth rate over six years before the onset of banking crisis, (i.e. the period 2005-2011), which according to the literature is a plausible estimate of the potential GDP growth rate.

2.1.2 Potential GDP level

Following standard statistical practice we estimate the potential level of GDP using the Hodrick-Prescott filter (Hodrick and Prescott 1997) to decompose the GDP series into a trend and a cyclical component. The trend component from this

[4] Years of unusually high/low growth are shown as outliers in the graph of GDP growth (Figure 1). The statistical significance of the dummy variables in the models is tested.

decomposition, which is free of short-term fluctuations and represents only the long-term movements in output, is then taken to be the potential level of GDP.

Unlike similar studies reported in the literature, where data before, during and in some cases after the banking crisis are used, in the context of our analysis the trend component of GDP level can only be estimated for the period before the banking crisis. Here we perform this estimation using two alternative periods: 1995-2012 and 2000-2012.[5] For the years after 2012 the trend component of GDP is based on projections estimated as follows.

We first estimate two alternative models:

$$\ln Y_t^P = b_0 + b_1 t + u_{t,} \quad t = 1, \dots T \tag{2}$$

$$\ln Y_t^P = c_0 + c_1 t + c_2 t^2 + w_{t,} \quad t = 1, \dots T \tag{3}$$

where: Y_t^P is the potential level of GDP at time t obtained via the application of the Hodrick-Prescott filter; t and t^2 represent a linear and a quadratic trend, respectively; and u_t and w_t are the random errors in the two models.[6] The parameter estimates obtained from (2) and (3) for the sample periods 1995-2012 and 2000-2012 (reported in Table A2 in the Appendix) are then used to estimate the potential level of GDP over the expected banking crisis period 2013-2020.[7]

As shown in Table A2 the coefficient of the quadratic trend is statistically significant and has a negative sign indicating that the level of potential output increases over time, but with a small declining rate. This is consistent with the decreasing potential growth rate of the Cyprus GDP estimated in the previous sub-section and can be interpreted as evidence that after 1995 Cyprus has been acquiring features of a developed (as opposed to developing) economy that tend to slow down the growth rate of its economy.

The last row of Table A2 shows the average potential growth rate obtained from the estimations and projections of the potential output level. The results from the two time periods are very similar and we have chosen to focus on those from the most recent period 2000-2012. The implied potential growth rates corresponding to this period - on average between 1.8% (quadratic model) and 2.5% (linear

[5] As found in the case of potential GDP growth rate, the period 1980-2012 leads to much higher potential growth, thus we focus only on the recent periods that are more likely to be representative of future potential output levels.

[6] For estimation purposes the potential level of GDP, Y_t^P, is expressed in logarithms.

[7] Note that the prediction based on (2) and (3) cannot be contaminated by non-deterministic regressors because the values of t and t^2 for $T > 2012$ are known.

model) - are close to those obtained using the potential GDP growth rate method described in the previous sub-section.

As in the case of the future GDP growth rates, the future values of the potential GDP level are typically calculated in the literature by extrapolation using the average growth rate of the potential GDP in the period prior to the crisis. The simple averages of the growth rate of the filtered GDP over the period 2005-2011 and 2009-2011 obtained from our data are 2.30% and 1.80%, respectively. These growth rates yield potential GDP values below those obtained from the linear model (2) and above those obtained from the quadratic model (3). This suggests that the output losses obtained from extrapolating the average growth rate of the potential GDP in the period prior to the crisis would be within the range of those obtained from the more informed approach based on estimation of the parameters of equations (2) and (3).

2.2 GDP growth projections for 2013-2020

In order to evaluate the output loss from the on-going crisis we need to assume a path for the evolution of the actual growth rate in Cyprus for the period 2013-2020. The recent developments in the banking sector make the task of computing projections for actual GDP growth for this period very difficult, as historical relationships between macroeconomic variables and data offer little information about future changes in output. There is, also, a high degree of uncertainty about the direct effects of the banking sector downsizing and of capital controls on the real economy; and the indirect effects from falling business and consumer confidence.

In view of this uncertainty we employ two alternative scenarios about the development of GDP growth over the period 2013-2020:

A. GDP contraction over the period 2013-2015 amounting to about 17%; subsequently output expands at a rather slow rate and reaches the lower bound of potential GDP growth (about 1.8%) by the end of the period;

B. GDP contraction over the period 2013-2015 amounting to about 21%; afterwards output expands somewhat faster than in scenario A and reaches the upper bound of potential growth (about 2.5%) by 2020.

The projections are obtained using the methodology described in section A.2 in the Appendix, where the estimates obtained from applying econometric analysis to annual real GDP growth rates for the period 1980-2012 are also shown (Table A3 and A4). Describing this methodology in non-technical terms, one would say that the growth projection for each year is computed as a function of: (a) the growth rate in the previous year; and (b) the value of a pre-determined parameter

denoting how much larger/smaller the shock in the projection year is assumed to be, compared to the one occurred in the previous year (or period). The magnitude of the shock in the previous year is estimated by the model through the use of a dummy variable. This addition to the projection amounts to a correction in the intercept of the year forecasted, since it is expected that during the period 2013-2020 many structural changes will take place, due to the economic adjustment programme (banking sector downsizing and restructuring, fiscal consolidation, structural reforms etc.). These structural changes cannot be captured by historical data, i.e. lagged values of GDP growth.

After we obtain the projection for the first year i.e. 2013 the model is augmented by including a new dummy variable for 2013 and is re-estimated using the sample 1980-2013. The same procedure is followed for each additional year up to 2019 (i.e. the model is extended by adding a dummy variable for the extra year and the model is re-estimated using a sample that includes one new projection).

The values assumed for the pre-determined parameters capturing the impact of the shock in the projection year are such that the depth of the slump is less severe under scenario A followed by a slow/moderate recovery; in scenario B recession is assumed to be deeper, followed by a rather stronger recovery pattern than in scenario A. Details can be found in the Appendix (A2).

3. Output loss

In this section we present the results for output loss due to the crisis for the period 2012-2020. Output losses are computed using both GDP growth rates and GDP levels. The projections for the period 2013-2020 are calculated as described above. For comparison purposes we also employ the projections prepared by the European Commission and IMF (EC/IMF) in relation to the economic adjustment programme of Cyprus. The latter projections are more optimistic than those obtained under our scenarios.[8]

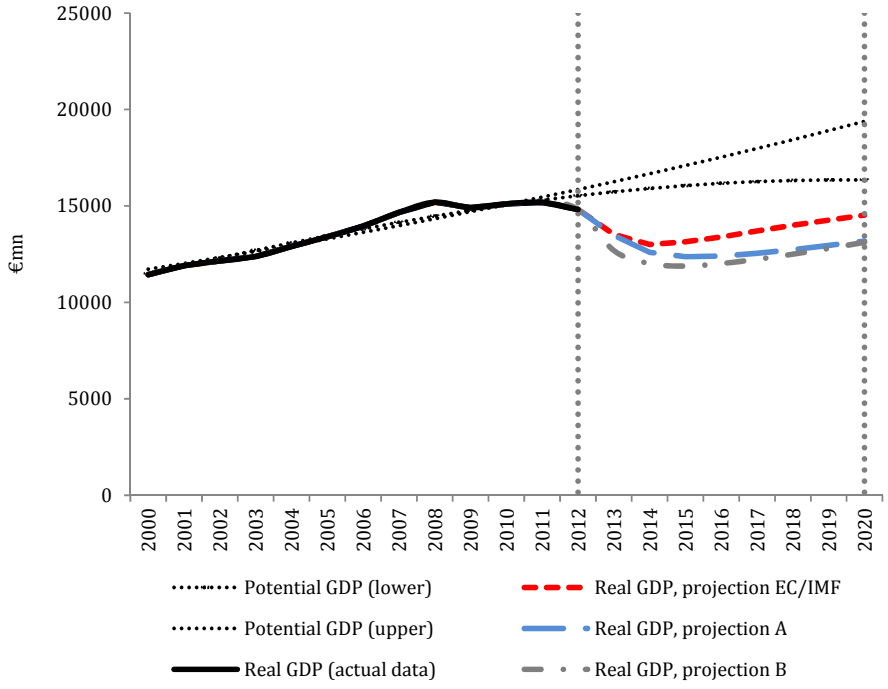
3.1 Level

Figure 2 depicts the level of real GDP up to 2012 and the projected level for the period 2013-2020; it also shows the potential GDP trend derived by fitting a linear

[8] European Commission (2013) provides projections for GDP growth for the period 2013-2016 which are the same as those given in IMF (2013). Furthermore, IMF (2013) presents projections for 2017-2020.

and a quadratic model after having removed all short-term fluctuations. The potential GDP trend obtained from the linear model is steeper than that generated by the quadratic model; therefore, the two trends can be viewed as representations of an upper and a lower bound for the evolution of output in the absence of the banking crisis.

Figure 2: Actual and projected real GDP (level) and estimated potential GDP level



Output loss is computed as the deviation of actual from potential GDP trend level for each year. Subsequently the difference is expressed in present value terms with 2011 being the start year (period 0); 2011 is assumed to be the year prior to the crisis period. The sum of the discounted deviations over a particular period gives the cumulative output loss (in 2005 prices) for that period.

Table 1 presents the output loss for 2012-2020 under the alternative scenarios about the projected GDP level and for the upper and lower bound of potential trend explained above. Output losses are apparently larger when the steeper linear trend is used. Over 2012-2014, output loss ranges from about -7.0 €bn (scenario B) to -5.3 €bn (EC/IMF projections) when the flatter (quadratic) trend is used; whereas losses vary from -8.4 €bn (scenario B) to -6.8 €bn (EC/IMF projections) in

the case of the steeper (linear) trend.[9] Losses expressed as percentages of 2011 GDP are estimated between -56% to -35% for the period 2012-2014. Using the lower bound of the potential level, losses are limited to -46% (scenario B) to -35% (EC/IMF); while employing the upper bound for the potential level, they increase to -56% (scenario B) to -45% (EC/IMF).

Table 1: Output losses, level*

	Potential: lower (quadratic trend)			Potential: higher (linear trend)		
Scenario	A	B	EC/IMF	A	B	EC/IMF
	€mn (2005 prices)			€mn (2005 prices)		
2012	-685	-685	-685	-996	-996	-996
2013	-2086	-2813	-2038	-2571	-3298	-2523
2014	-2948	-3459	-2585	-3626	-4138	-3263
2015	-3151	-3569	-2489	-4040	-4459	-3378
2016	-3099	-3419	-2286	-4214	-4535	-3401
2017	-2936	-3183	-2025	-4292	-4539	-3380
2018	-2722	-2905	-1762	-4329	-4511	-3369
2019	-2481	-2596	-1521	-4348	-4464	-3388
2020	-2223	-2272	-1280	-4359	-4407	-3416
2012-2014	-5719	-6958	-5308	-7193	-8432	-6782
As % of 2011 GDP	-38%	-46%	-35%	-47%	-56%	-45%
As % of 2011 potential GDP	-37%	-46%	-35%	-47%	-55%	-44%
2012-2020	-22331	-24902	-16670	-32775	-35346	-27115
As % of 2011 GDP	-147%	-164%	-110%	-216%	-233%	-179%
As % of 2011 potential GDP	-146%	-163%	-109%	-212%	-229%	-175%

* Losses are expressed in present values of 2011 (i.e. the year before the beginning of the crisis period) by assuming a discount rate of 4%.

Over the period 2012-2020 losses lie between -24.9 €bn (scenario B) to -16.7 €bn (EC/IMF) when the more conservative estimates for the evolution of potential trend are applied. For the same period the estimated output losses range between -35.3 €bn (scenario B) to -27.1 €bn (EC/IMF) in the case of the steeper potential trend. During the same period losses as percentages of 2011 GDP increase by three

[9] The analysis is conducted using GDP in constant 2005 prices, thus when losses are expressed in current prices will be larger due to inflation effects.

to four times, with the estimates ranging from -233% to -110%. Lower potential output level results in smaller losses (-110% to -147%); whereas higher potential GDP generates larger losses (-179% to -233%).

Furthermore, the output losses in Table 1 are also reported as a percentage of potential GDP, as this method of presenting losses is often encountered in the literature. It should be noted here that, since the potential level of GDP is slightly higher than the actual for 2011, losses computed as a percentage of potential output are somewhat lower than those expressed as a percentage of actual 2011 GDP.

Table 2 shows the output loss in each year expressed as a percentage of the actual (projected) GDP in that year. When the computations are carried out using the steeper potential trend level output losses peak in 2020 ranging between -47.8% (scenario B) to -33.5% (EC/IMF). The picture is somewhat different when the potential trend used in the computations is flatter: output loss as a percentage of each year's GDP peaks between 2014 (EC/IMF) and 2016 (scenario A) and decline afterwards. During the period 2012-2014 the loss as a percentage of GDP is found to vary from -14.5% (EC/IMF) to -24.6% (scenario B) per year. Over the period 2012-2020 annual output loss as a percentage of GDP is, on average, estimated between -39.3% (scenario B) and –16.5% (EC/IMF).

Table 2: Output losses as a percentage of GDP (level)

	Potential: lower (quadratic trend)			Potential: higher (linear trend)		
Scenario	A	B	EC/IMF	A	B	EC/IMF
2012	-4.8	-4.8	-4.8	-7.0	-7.0	-7.0
2013	-16.7	-24.0	-16.3	-20.6	-28.1	-20.2
2014	-26.3	-32.4	-22.4	-32.4	-38.7	-28.2
2015	-29.8	-35.1	-22.2	-38.2	-43.9	-30.1
2016	-30.4	-34.6	-20.8	-41.3	-45.9	-30.9
2017	-29.6	-32.9	-18.7	-43.3	-46.9	-31.2
2018	-28.1	-30.6	-16.6	-44.7	-47.5	-31.7
2019	-26.2	-27.8	-14.6	-45.9	-47.7	-32.5
2020	-24.0	-24.7	-12.5	-47.1	-47.8	-33.5
Average 2012-2014	-16.0	-20.4	-14.5	-20.0	-24.6	-18.5
Average 2012-2020	-24.0	-27.4	-16.5	-35.6	-39.3	-27.2

Table 3 reports the output losses expressed as a percentage of potential GDP in each year resulting in the same pattern as in Table 2. As the potential GDP level is higher than that of actual one, output losses in this case are lower, from -12.3% to -18.8% and from -14% to 27.5% for the periods 2012-2014 and 2012-2020, respectively. The persistence of large negative percentages up until 2020 in both Table 2 and 3 shows that the level of GDP is not expected to recover to its potential, i.e. the level that could have been achieved if the banking crisis had not occurred. The finding that output does not rebound to its pre-crisis level is common in the analysis of banking crises (e.g. IMF 2009).

Table 3: Output losses as a percentage of potential GDP (level)

	Potential: lower (quadratic trend)			Potential: higher (linear trend)		
Scenario	A	B	EC/IMF	A	B	EC/IMF
2012	-4.6	-4.6	-4.6	-6.5	-6.5	-6.5
2013	-14.3	-19.3	-14.0	-17.1	-21.9	-16.8
2014	-20.8	-24.5	-18.3	-24.5	-27.9	-22.0
2015	-23.0	-26.0	-18.1	-27.6	-30.5	-23.1
2016	-23.3	-25.7	-17.2	-29.2	-31.5	-23.6
2017	-22.8	-24.8	-15.8	-30.2	-31.9	-23.8
2018	-21.9	-23.4	-14.2	-30.9	-32.2	-24.0
2019	-20.8	-21.7	-12.7	-31.5	-32.3	-24.5
2020	-19.4	-19.8	-11.1	-32.0	-32.4	-25.1
Average 2012-2014	-13.3	-16.1	-12.3	-16.0	-18.8	-15.1
Average 2012-2020	-19.0	-21.1	-14.0	-25.5	-27.5	-21.1

Finally, for comparison with results obtained elsewhere in the literature, we should add that when the potential GDP level in 2013-2020 is extrapolated by applying the average growth rate of the real GDP over the period 2005-2011 and 2009-2011 we obtain results that fall within the ranges reported above.[10] In particular, output losses for the period 2012-2014 vary from -7.4 €bn to -5.5 €bn, or, in terms of percentages of 2011 GDP, between -49% to -37%. During the period 2012-2020 the economy is estimated to incur losses between -31.5 €bn to -20.9 €bn, or, -208% to -

[10] As mentioned in section 2.1 according to the literature potential GDP can be also extrapolated by using the average growth rate of the potential GDP over a period prior to the crisis instead of using a model.

138% of 2011 GDP. On average output loss per year as a percentage of actual GDP, is -21.8% to -15.2% and -35.1% to -21.0% over the period 2012-2014 and 2012-2020, respectively. Annual output loss as a percentage of potential GDP, on average, is estimated from -16.9% to -12.8% and from -25.3% to -17.1% for 2012-2014 and 2012-2020, respectively (see Table A5-A7 in the Appendix for details).

3.2 Growth rate

Here we discuss the output loss results in terms of growth rates to be able to compare our estimates of the output losses of the banking crisis in Cyprus with those obtained in other studies, as the growth rates method of computing output losses from crises is the most commonly used in the literature. Based on this method the output loss each year is computed as the deviation of the actual from the potential GDP growth rate for that year (projections for 2013-2020). As discussed in section 2.1, we use two estimates for potential GDP growth rate which act as bounds: 1.8% and 2.4%. Figure 3 plots actual GDP growth rates for 2000-2012, and the projections for the period 2013-2020 under scenarios A, B and those by EC/IMF; as well as the two alternative estimates for the potential growth rate.

Figure 2: Actual and projected real GDP growth and estimated potential GDP growth rates

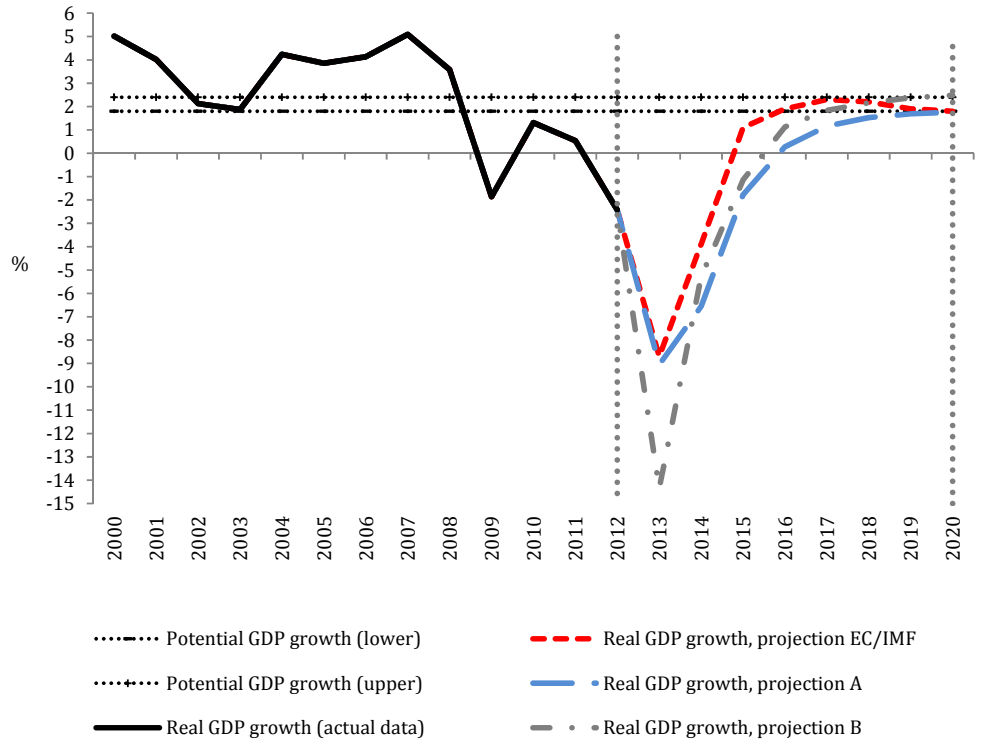


Table A8 in Appendix A presents the output losses in terms of percentage points (ppts) of growth for the period 2012-2020, under the different scenarios regarding the evolution of GDP growth over 2013-2020 and for the two alternative potential growth rates we use in calculations. The numbers reported in Table A8 can be interpreted as the ppts of foregone growth because the banking crisis prevents the economy from expanding at its potential rate.

Output loss is larger when a higher potential growth rate is assumed. Over the period 2012-2014 output loss ranges between -25.2 to -23.4 ppts under scenario A and between -29.3 to -27.5 ppts under scenario B. When the EC/IMF projections are used, the output loss for the same period is smaller, between -22.2 and -20.4 ppts, as these projections are more optimistic. For the longer time period 2012-2020 output losses under scenario A and B vary from -35.0 to -29.6 ppts and from -34.8 ppts to -29.4 ppts respectively, while losses are much lower, between -25.4 to -20.0 ppts in the case of EC/IMF projections.

For comparison of the losses obtained in this section (through the growth rate) with those obtained in the previous section using the level of GDP (Table 1) the results reported for each year in Table A8 in the Appendix are summed recursively to get the cumulative output losses as percentage of the GDP in 2011. Cumulative losses in ppts relative to 2011 are also expressed as present values (€mn) for each year using a discount factor of 4% and the results are reported in Table 4.

- When the slower potential growth rate is assumed, losses vary from -7.2 €bn (scenario B) to -5.4 (EC/IMF) for the period 2012-2014; and from -28.8 €bn (scenario B) to -20.0 €bn (EC/IMF) for the period 2012-2020. Losses expressed as a percentage of 2011 GDP are estimated to range from -47% to -36% and from -189% to -131% during 2012-2014 and 2012-2020, respectively.
- The assumption about higher potential growth rate results in greater losses; the estimates range from -7.7 €bn (scenario B) to -5.9€bn (EC/IMF) and from -32.0 €bn (scenario B) to –23.2€bn (EC/IMF) for the period 2012-2014 and 2012-2020 respectively. These losses as percentages of 2011 vary between -51% to -39% and -211% to -153% for the short and the long period respectively.

In the case of lower potential growth rate (Table 4) the resulting losses are more negative than those estimated using the lower potential level (Table 1). When the higher potential growth rate is used (Table 4) the estimates of output losses are less negative than those obtained using the higher potential level (Table 1). Thus the method that uses the level of GDP presented in section 3.1 gives a wider

interval for output losses that contains the range estimated by the growth rate method presented in this section. Table 5 summarises the ranges estimated for output losses from the two approaches.

Table 4: Cumulative growth rate loss compared to 2011 (percentage points) and loss in €mn (2005 prices)[1, 2]

	Potential growth rate: 1.8%						Potential growth rate: 2.4%					
Scenario	A		B		EC/IMF		A		B		EC/IMF	
	ppts	€mn	ppts	€mn	ppts	€mn	ppts	€mn	ppts	€mn	ppts	€mn
2012	-4.2	-617	-4.2	-617	-4.2	-617	-4.8	-704	-4.8	-704	-4.8	-704
2013	-15.1	-2117	-20.4	-2862	-14.7	-2067	-16.3	-2285	-21.6	-3031	-15.9	-2236
2014	-23.4	-3164	-27.5	-3710	-20.4	-2757	-25.2	-3407	-29.3	-3953	-22.2	-3000
2015	-27.0	-3505	-30.4	-3949	-21.1	-2742	-29.4	-3817	-32.8	-4261	-23.5	-3054
2016	-28.5	-3560	-31.1	-3881	-21.0	-2624	-31.5	-3935	-34.1	-4256	-24.0	-2999
2017	-29.2	-3500	-31.1	-3727	-20.5	-2463	-32.8	-3932	-34.7	-4159	-24.1	-2895
2018	-29.4	-3397	-30.7	-3542	-20.1	-2322	-33.6	-3881	-34.9	-4027	-24.3	-2807
2019	-29.5	-3278	-30.1	-3342	-20.0	-2222	-34.3	-3811	-34.9	-3874	-24.8	-2755
2020	-29.6	-3157	-29.4	-3141	-20.0	-2137	-35.0	-3733	-34.8	-3717	-25.4	-2713
	%	€mn	%	€mn	%	€mn	%	€mn	%	€mn	%	€mn
2012-2014	-39	-5897	-47	-7189	-36	-5442	-42	-6396	-51	-7688	-39	-5941
2012-2020	-173	-26295	-189	-28771	-131	-19952	-194	-29505	-211	-31982	-153	-23163

Notes: [1] Losses are expressed in present values of 2011 (i.e. the year before the beginning of the crisis period) by assuming a discount rate of 4%.

[2] For the period 2012-2014 and 2012-2020 the present value of losses is expressed as a percentage of GDP in 2011 i.e. the year before the crisis.

Table 5: Summary of output losses by estimation approach

	Approach	
	Level of GDP	Cumulative growth rate of GDP
	2012-2014	**2012-2014**
€bn	-8.4 to-5.3	-7.7 to -5.4
% of 2011 GDP	-56% to -35%	-51% to -36%
	2012-2020	**2012-2020**
€bn	-35.3 to -16.7	-32.0 to -20.0
% of 2011 GDP	-233% to-110%	-211% to -131%

4. Discussion and conclusions

This study provides estimates of output losses for the period 2012-2020 associated with the economic crisis in Cyprus. The losses can largely be attributed to the banking crisis, though one has to bear in mind that the accumulated excessive public deficits aggravated the problem, insofar as they undermined the role of government as guarantor of the banking system. Furthermore, the long-standing structural weaknesses of the Cyprus economy have also contributed to the problem through limiting the capacity of the economy to react swiftly so as to dampen the negative impact of the crisis.

The failure of the economy to produce its potential level of GDP or to expand at its potential growth rate during a banking crisis occurs for a number of reasons, including:

- the tightening of credit conditions (limited supply of credit and stricter lending standards) due to the crisis impacting negatively on investment and, consequently, on wages and employment;
- the loss of deposits due to banking sector downsizing triggering loss of wealth for business and households with adverse consequences on consumption, investment and employment;
- the enforcement of restrictive measures on transactions and the freeze on uninsured deposits limiting liquidity in the market and depriving businesses of working capital with adverse effects on firms' viability and, therefore, on economic activity and employment;
- the absence of substantial new inflows in Cyprus effected through international business activities that are supported by the banking industry and have positive spillovers to domestic business (legal, audit, etc) activity;
- the fiscal consolidation leading to lower disposable income, as the government cuts expenditure (salaries, pensions, benefits) and increases taxes, public sector fees and employee/pensioner contributions; and
- increased uncertainty due to the loss of confidence in the banking sector.

As stressed in the literature it is difficult to disentangle output losses due to a banking crisis (financial, currency, etc.) from those resulting from recession, as banking crises often break out during recessions (e.g. Angkinand 2008). In their assessment of the depth of recessions with and without a banking crisis, Bordo et al (2001) find that cumulative output losses are significantly larger when a

recession is accompanied by a banking crisis; interestingly they also find that losses are larger for developed rather than for emerging economies.

To estimate output losses from the crisis we employ an output gap method which is widely used in the literature (Angkinand 2008; Bordo et al 2001; Boyd et al 2005; Haugh et al 2009; IMF 1998). With this method the loss each year is computed as the deviation of actual output from its potential trend. There are two variants of the output gap method: one that uses output growth rates and another applied to the level of output. As shown in the literature (e.g. Angkinand 2008; Boyd et al 2005) the two variants of the output gap method can lead to widely different output costs estimates. This is expected, as the two methods do not measure the same outcome of the crisis: the growth rates method gives the percentage points of lost output (GDP) growth over the period under investigation; while the output level method yields the present value of the deviation of actual from potential GDP level (i.e. foregone output) as a percentage of GDP in the last year before the onset of the crisis (in our case 2011). As shown in this report, the results of the two approaches are similar when the cumulative losses from the growth rate approach are expressed in present values.

The use of GDP growth rates to estimate the output losses from banking crises is more frequently encountered in the literature than the use of the level of GDP (e.g. Angkinand 2008; Bordo et al 2001; Haugh et al 2009; IMF 1998). However, studies that base their estimations on the impact of banking crisis on the level of output argue that while the growth rate can eventually return to its potential rate, the same is not also true for the level of output (e.g. Boyd et al 2005). This argument is supported by our empirical findings: as shown in Tables 3 and 4 the losses obtained from the output level method remain negative until the end of the period under examination[11]. Boyd et al (2005) indicate that an explanation for the grater output losses obtained from the use of output levels method is the fact that this method, unlike the growth rates one, allows the effects of the banking crisis to compound over time.

The output losses attributed to the banking crisis in Cyprus which are estimated in this report can be briefly summarised and compared with findings about banking crisis reported elsewhere in the literature as follows.

- Computing output gap using the *level of real GDP* we find that the cumulative loss of output as a percentage of GDP in 2011 (i.e. the last year before the crisis) ranges from -35% to -56% for 2012-2014; and from -110% to -233%

[11] This can also be seen by comparing the results reported in Figure 2 (level) and Figure 3 (growth).

for the period 2012-2020.[12] Boyd et al (2005) investigate the consequences of banking crises in countries with developed financial markets using the level of GDP (per capita). For 18 countries that experienced output losses during their crises they find that, on average, the economic cost was -76% to -369% of GDP in the year before the onset of crisis.[13] Notably, the range of losses given in Boyd et al (2005) is rather large, as they are obtained using two alternative periods. The smaller losses are calculated from the onset of the crises until the last year in which actual data were available; this computation of losses establishes "an absolute lower bound"; whereas the larger losses, which can be viewed as upper bounds, are computed after the estimation of a break point (at 17 years), when the actual growth rate returns to its potential trend rate.[14] In relation to the recent financial crisis (2007-2009), Laeven and Valencia (2010) estimate median output losses over 22 countries and a four-year period of about -25% of potential GDP; they find output losses of -110% and -116% for Ireland and Latvia respectively, whose banking crises were systemic.

- Using the *growth rate of real GDP* in the computations of output gap, we estimate the cumulative GDP growth loss of Cyprus over the period 2012-2014 to be between -20.4 and -29.3 percentage points (ppts). Losses during the period 2012-2020 range from -20.0 to -35.0 ppts. Studies in the literature that use similar methodology usually pool together a large number of countries and provide the average output loss due to banking crises. For example Bordo et al (2001) use 56 counties over the period 1973-1997 and find average losses of -6.2 ppts, while the IMF (1998) employ 22 industrial and 31 developing countries for the period 1975-1997 and conclude that the cumulative loss of output growth per banking crisis is -15.2 ppts and -14.0 ppts for industrial and

[12] Thus based on the wider interval, output losses are estimated between -8.4 €bn to-5.3 €bn for the period 2012-2014 and from -35.3 €bn to -16.7 €bn for the period 2012-2020. These losses as a percentage of 2011 GDP vary from -56% to -35% and -233% to-110% for the period 2012-2014 and 2012-2020 respectively.

[13] Boyd et al (2005) also estimate output losses for individual countries. For example, defining as "non-systemic" banking crises in Denmark (1987-1992), Greece (1991-1995) and Italy (1990-1995) they find their output losses ranging from -45% to -74%, from -43% to -245% and from -45% to -322%, respectively; while the crises in Finland (1991-1994), Sweden (1991) and Norway (1987-1993), which are considered as "systemic", caused losses from -97% to -474%, from -86% to -314% and from -59% to -257% respectively. A crisis is classified as "systemic" when most or all of the capital of the banking system is exhausted (see e.g. Boyd et al 2005 and the references therein).

[14] If output level reverts to its potential trend by this break point, no further losses are incurred; if it does not, it is assumed that output expands at the potential growth rate after the break point and an infinite sequence of output losses is estimated. As both historical and future output losses are computed, predictions of future actual output and potential growth rate are estimated.

emerging markets, respectively. Haugh et al (2009) provide separate output loss estimates for the banking crises that occurred in Spain (1977-1985), Finland, Norway, Sweden (all in the 1990s), Japan (late 1990s) and in the United States (late 1980s). They find output losses as high as -40.6 ppts and -34.8 ppts for Finland and Norway respectively, -16.7 ppts for Sweden and slightly above -10 ppts for the remaining countries. Thus, our estimates are close to those for the Nordic countries, where the duration of the downturn due to the crisis was estimated around 7 to 8 years (Haugh et al 2009).

The recent country report on Cyprus by IMF (2013) briefly mentions cumulative output losses relative to the trend for the period 2013-2016 of about 50% of potential output. For the same period, and using EC/IMF projections and our assumptions we find losses of over 60% of potential GDP.[15]

Comparing our findings with those in the literature, it could be inferred that the economic costs of the current crisis in Cyprus are similar in magnitude to those incurred by Finland, Norway and Sweden during their crises in the 1990s. The financial liberalisation in these countries led to a credit expansion accompanied by rather expansionary fiscal and monetary policies; as a response to the boom tighter monetary policy in Finland and Sweden, and a decline in oil revenues in Norway, which led to currency devaluation and high interest rates, resulted in a sharp drop in asset prices; and, subsequently, in bank losses from bad loans (see Haugh et al 2009). Similarly in Cyprus the credit boom (due to the inflow of foreign deposits and lower interest rates) led to hiking property prices in the period prior to 2009. The transient government revenues from property taxes were used to finance an expansionary fiscal policy. The growth rates however, registered during the period 2004-2008 were not sustainable, as they were not fully reflecting improvements in the productive capacity of the Cypriot economy, but rather generated by excessive borrowing by the private and public sector, creating unsustainable current account and government deficits. The international financial crisis and afterwards the Greek sovereign debt crisis revealed the vulnerability of the Cypriot economy to these shocks and the pressing need for correcting the generated imbalances.

Our results show that the crisis can be very costly in terms of lost output/income and growth. Costs of analogous magnitude were experienced by other countries

[15] IMF (2013) does not provide details about the methodology underlying the output loss estimate given, thus our findings might not be directly comparable. The estimate for 2013-2016 of over 60% of potential GDP can be found by adding the percentages in Table 3 (column EC/IMF) for the period 2013-2016.

due to similar banking crises. As the crisis in Cyprus is still underway, it should be stressed that the results computed here are conditional on assumptions about the evolution of actual and potential GDP, hence: (a) worse (better) actual GDP outcomes would lead to higher (lower) losses for a given potential growth rate or level; and (b) higher (lower) assumed potential GDP growth or level, would result in higher (lower) output losses for a given evolution path of actual GDP.

The large economic costs associated with crises cannot be fully explained by exogenous real or financial shocks, but are also found to be connected with banking sector characteristics and crisis management policies. Research shows that the magnitude of output losses is positively and significantly related to banking sector size, bailout and recapitalisation costs incurred by the government; and to large amounts of liquidity infused in the banking system by the central bank (Boyd et al 2005). Crises are very difficult to predict, but given the economic burden that they inflict on countries for a number of years, indicators that are found to signal that the economy could be approaching a crisis should be closely monitored by policymakers. Such vulnerability indicators include widening current account deficits, rapid growth in domestic credit, inflated asset prices (property or equity) and non-performing loans.

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APPENDIX

A1. Estimation of potential GDP growth rate and level

Table A1: Estimation results, potential growth rate of GDP

	1980-2012		1995-2012		2000-2012	
Explanatory variables	Coef. (std. err.)	t-statistic	Coef. (std. err.)	t-statistic	Coef. (std. err.)	t-statistic
GDP growth lagged 1 period (y_{t-1})	0.429 (0.138)	3.11	0.423 (0.170)	2.48	0.489 (0.177)	2.77
Constant	0.026 (0.007)	3.77	0.020 (0.007)	2.96	0.017 (0.006)	2.61
Dummy variable						
1991	-0.050 (0.019)	-2.68				
1992	0.061 (0.019)	3.18				
1993	-0.058 (0.019)	-2.98				
2009	-0.060 (0.018)	-3.27	-0.053 (0.014)	-3.92	-0.053 (0.012)	-4.35
2012	-0.053 (0.019)	-2.78	-0.046 (0.014)	-3.22	-0.044 (0.013)	-3.41
Residual diagnostic LM tests	$Chi^2(1)$	P-value	$Chi^2(1)$	P-value	$Chi^2(1)$	P-value
Autocorrelation (Breusch-Godfrey)	0.713	0.398	0.029	0.865	0.122	0.727
Autoregressive conditional heteroskedasticity (ARCH)	0.518	0.472	1.456	0.228	2.080	0.1492
Potential growth rate (y^P)	3.75%		2.44%		1.84%	
Average growth rate[1]	4.14%		2.84%		2.42%	

Note: [1] The average growth rate for the period 2005-2011 is 2.40%.

Table A2: Estimation results, potential level of GDP

	1995-2012				2000-2012			
Explanatory variables	Coef. (std. err.)	t-statistic	Coef. (std. err.)	t-statistic	Coef. (std. err.)	t-statistic	Coef. (std. err.)	t-statistic
Trend (t)	0.031 (0.001)	28.34	0.076 (0.001)	81.41	0.025 (0.001)	26.77	0.076 (0.001)	61.70
Trend squared (t^2)	-	-	-0.001 (0.000)	-48.96	-	-	-0.001 (0.000)	-41.29
Constant	8.688 (0.027))	322.00	8.15 (0.011)	733.94	8.740 (0.026)	345.15	8.171 (0.016)	499.62
LM tests	$Chi^2(1)$	P-value	$Chi^2(1)$	P-value	$Chi^2(1)$	P-value	$Chi^2(1)$	P-value
Autocorrelation (Breusch-Godfrey)	13.114	0.000	10.527	0.001	7.961	0.005	3.372	0.066
Autoregrressive conditional heteroskedasticity (ARCH)	4.948	0.0261	1.742	0.187	0.733	0.392	0.112	0.737
Estimated average potential growth rate[1]	3.05%		1.84%		2.51%		1.77%	
Average growth rate (filtered GDP)[2]	3.08%				2.54%			

Notes: [1] The projections for the period 2013-2020 are also included in the computation of the average value.
[2] The average growth rate obtained from the filtered GDP (using the Hodrick-Prescott filter) over the period 2005-2011 and 2009-2011 is 2.30% and 1.80% respectively.

A2. GDP growth projections 2013-2020

The projections shown in Table A3 and A4 were computed using an econometric analysis of annual real GDP growth rates for the period 1980-2012. In particular we begin by estimating the following model

$$y_t = a_0 + a_1 y_{t-1} + b_{1991} d_{1991t} + b_{1992} d_{1992t} + b_{1993} d_{1993t} + b_{2009} d_{2009t} + b_{2012} d_{2012t} + e_t, \; t = 1, \dots T \quad \text{(A1)}$$

where: the first observation $t = 1$ in the sample is 1980 and the last T is 2012; y_t is real GDP growth at time t; d_{kt} is a dummy variable that takes the value 1 in the years denoted by the subscript (i.e. years when growth was unusually high/low); and e_t is a random error.

The projection for the subsequent year i.e. $t = T + 1 = 2013$ is computed as

$$\tilde{y}_{2013} = \hat{a}_0 + \hat{a}_1 y_{2012} + \theta_{T+1} \hat{b}_T \,, \quad \text{(A2)}$$

where: $\tilde{y}_{T+1}$ denotes the projection; the symbol ^ denotes the estimated parameters from equation (A1); and θ_{T+1} is a value denoting how much larger/smaller the shock in the projection year is assumed to be compared to the one occurred in the previous year (or period). This addition to the projection amounts to a correction in the intercept for the year forecasted since it is known that during the period 2012-2020 many structural changes will take place, due to the economic adjustment programme (banking sector downsizing and restructuring, fiscal consolidation, structural reforms etc), which cannot be adequately modelled by historical data, i.e. lagged values of GDP growth.

The value of θ_{2013} is set to 2 and 3 under scenario A and B respectively, which approximately reflects the expected impact of the banking sector restructuring (loss of deposits), fiscal consolidation continuing in 2013 together with simultaneous impacts on employment, disposable income and demand, as well as a number of other factors that negatively affect growth (e.g. loss of business and consumer confidence, capital controls) yielding projections for 2013 in the range of -9% and -12% with a number of downside risks that could lead to a more negative outcome (see Economics Research Centre: Economic Outlook, April 2013). Thus the shock to the Cypriot economy in 2013 is assumed to be 2 to 3 times larger than that experienced in 2012.

After we obtain the projection for 2013 the model in equation (A1) is augmented by including a new dummy variable for 2013 and is re-estimated using the sample 1980-2013. The same procedure is followed for each additional year up to 2015 (i.e. the model is extended by adding a dummy variable for the extra year and the model is re-estimated using a sample that includes one new projection - 2014, 2015 - at a time). For estimations after 2016 the procedure is similar but instead of augmenting the model at each round with a dummy variable for the additional year, the dummy variable covers a particular period after 2014.

For the projection regarding 2014 we obtain a substantial negative carryover from 2013; however the adoption of fiscal consolidation measures of slightly below 2% of GDP in 2014 is likely to have further contractionary effects on activity. Moreover, fiscal consolidation measures in 2015 and 2016, estimated according to the economic adjustment programme to 1.5% and 1% of GDP, respectively, together with continuing adjustments in other sectors of the economy (e.g. financial, real estate) will impact negatively on growth, although in a declining manner over the years.[16] We assume, therefore, that the projection in 2014, 2015 and 2016 will be determined by the carryover from the previous year (first two terms of equations A3-A5), as well as by an additional exogenous effect capturing the impacts of the economic adjustment programme and related structural changes (assumptions about the last term in equations A3-A5):

[16] Fiscal consolidation measures as percentages of GDP were obtained from the "Memorandum of Understanding on Specific Economic Policy Conditionality" (April 2013). Details about planned fiscal consolidation measures and reforms can be found in European Commission (2013) and IMF (2013).

$$\tilde{y}_{2014} = \hat{a}_{0,13} + \hat{a}_{1,13}\tilde{y}_{2013} + \theta_{2014}\hat{b}_{2012,13} \quad \text{(A3)}$$

$$\tilde{y}_{2015} = \hat{a}_{0,14} + \hat{a}_{1,14}\tilde{y}_{2014} + \theta_{2015}\hat{b}_{2014,14} \quad \text{(A4)}$$

$$\tilde{y}_{2016} = \hat{a}_{0,15} + \hat{a}_{1,15}\tilde{y}_{2015} + \theta_{2016}\hat{b}_{2015,15} \quad \text{(A5)}$$

where the number at the subscript of the parameter estimates denotes the last year of the estimation period at each round. [17,18]

After 2016 no fiscal measures are planned according to the economic adjustment programme. Nevertheless, the Cypriot economy will continue to undergo structural changes/reforms and will, in general, be in a state quite different from that prior to 2012. This change in the state of the economy is modelled as a dummy variable covering the period 2015-2019 under scenario A and the projections are given by:

$$\tilde{y}_{2017} = \hat{a}_{0,16} + \hat{a}_{1,16}\tilde{y}_{2016} + \theta_{2017}\hat{b}_{2015-2016,16} \quad \text{(A6)}$$

$$\tilde{y}_{2018} = \hat{a}_{0,17} + \hat{a}_{1,17}\tilde{y}_{2017} + \theta_{2018}\hat{b}_{2015-2017,17} \quad \text{(A7)}$$

$$\tilde{y}_{2019} = \hat{a}_{0,18} + \hat{a}_{1,18}\tilde{y}_{2018} + \theta_{2019}\hat{b}_{2015-2018,18} \quad \text{(A8)}$$

$$\tilde{y}_{2020} = \hat{a}_{0,19} + \hat{a}_{1,19}\tilde{y}_{2017} + \theta_{2020}\hat{b}_{2015-2019,19} \quad \text{(A9)}$$

where all θ parameters are set equal to 1.

Under scenario B the dummy variable covers the period 2014-2017 for the estimation period up to 2017; for the estimation period after 2017 two dummy variables are used covering the periods 2014-2015 and 2016 onwards. The projections are given by:

$$\tilde{y}_{2017} = \hat{a}_{0,16} + \hat{a}_{1,16}\tilde{y}_{2016} + \theta_{2017}\hat{b}_{2014-2016,16} \quad \text{(A10)}$$

$$\tilde{y}_{2018} = \hat{a}_{0,17} + \hat{a}_{1,17}\tilde{y}_{2017} + \theta_{2018}\hat{b}_{2014-2017,17} \quad \text{(A11)}$$

$$\tilde{y}_{2019} = \hat{a}_{0,18} + \hat{a}_{1,18}\tilde{y}_{2018} + \theta_{2019}\hat{b}_{2016-2018,18} \quad \text{(A12)}$$

$$\tilde{y}_{2020} = \hat{a}_{0,19} + \hat{a}_{1,19}\tilde{y}_{2017} + \theta_{2020}\hat{b}_{2016-2019,19} \quad \text{(A13)}$$

where all θ parameters are set equal to 1.[19] Therefore, this differentiation between the two scenarios allows us to obtain a rather stronger recovery pattern under scenario B.[20]

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[17] Under scenario A associated with a less negative carryover from 2013, we assume that the exogenous impact on the projection for 2014 will be the same as that estimated in 2012 ($\theta_{2014} = 1$), for the 2015 projection the effect is assumed to be 0.3 times that estimated in 2014 ($\theta_{2015} = 0.3$) and for the 2016 projection the impact is assumed to be equal to that estimated in 2015 ($\theta_{2016} = 1$). Under scenario B associated with a more negative carryover from 2013, we assume that the exogenous impact on the projection for 2014 will be 0.33 times that estimated in 2012 ($\theta_{2014} = 1/3$), for the projection for 2015 the effect is assumed to be 0.85 times that estimated in 2014 ($\theta_{2015} = 0.85$) and for the 2016 projection the effect is assumed to be to be 0.66 times that estimated 2015 ($\theta_{2016} = 2/3$). Details of the estimations/calculations and assumptions are shown in Table A3 and A4.

[18] Under scenario B the additional exogenous impacts affecting the projections lower growth rates by about the same (percentage points) as the extent of fiscal consolidation; Under scenario A the projections are affected negatively by more (percentage points) than the magnitude of the planned fiscal consolidation.

[19] Parameter estimates in equations (A3)-(A13) differ between scenario A and B but we use the same notation to avoid complicating the exposition.

[20] Details regarding the estimated coefficients of the dummy variables and their treatment in the calculation of the projections can be found in Table A3 and A4.

Table A3: Estimation results and projections, scenario A

Estimation results								
Period	1980-2012	1980-2013	1980-2014	1980-2015	1980-2016	1980-2017	1980-2018	1980-2019
Explanatory variable								
y_{t-1}	0.429 (0.138)	0.429 (0.138)	0.429 (0.138)	0.429 (0.138)	0.429 (0.131)	0.429 (0.131)	0.429 (0.119)	0.429 (0.114)
Constant	0.026 (0.007)	0.026 (0.007)	0.026 (0.007)	0.026 (0.007)	0.026 (0.007)	0.026 (0.006)	0.026 (0.006)	0.026 (0.006)
Dummy variable								
1991	-0.050 (0.019)	-0.050 (0.019)	-0.050 (0.019)	-0.050 (0.019)	-0.050 (0.018)	-0.050 (0.018)	-0.050 (0.018)	-0.050 (0.017)
1992	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.018)	0.061 (0.018)
1993	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.018)	-0.058 (0.018)
2009	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.017)	-0.060 (0.017)
2012	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.018)	-0.053 (0.018)	-0.053 (0.018)
2013	-	-0.106 (0.021)	-0.106 (0.021)	-0.106 (0.021)	-0.106 (0.021)	-0.106 (0.020)	-0.106 (0.020)	-0.106 (0.019)
2014	-	-	-0.053 (0.026)	-0.053 (0.026)	-0.053 (0.025)	-0.053 (0.024)	-0.053 (0.024)	-0.053 (0.023)
2015	-	-	-	-0.016 (0.024)	-	-	-	-
2015-2016	-	-	-	-	-0.016 (0.017)	-	-	-
2015-2017	-	-	-	-	-	-0.016 (0.014)	-	-
2015-2018	-	-	-	-	-	-	-0.016 (0.012)	-
2015-2019	-	-	-	-	-	-		-0.016 (0.010)
LM tests[1]								
Autocorrelation (Breusch-Godfrey)	0.713 [0.398]	0.735 [0.391]	0.757 [0.384]	0.778 [0.378]	0.770 [0.380]	0.762 [0.383]	0.762 [0.383]	0.767 [0.381]
Autoregr. cond. Heterosk. (ARCH)	0.518 [0.472]	0.376 [0.540]	0.264 [0.608]	0.177 [0.674]	0.111 [0.739]	0.063 [0.802]	0.030 [0.863]	0.010 [0.923]

Projections								
	2013	2014	2015	2016	2017	2018	2019	2020
Intercept correction								
$\theta_{2013}\hat{b}_{2012}$	-2*0.053	-	-	-	-	-	-	-
$\theta_{2014}\hat{b}_{2012}$	-	-1*0.053	-	-	-	-	-	-
$\theta_{2015}\hat{b}_{2014}$	-	-	-0.3*0.053	-	-	-	-	-
$\theta_{2016}\hat{b}_{2015}$	-	-	-	-1*0.016	-	-	-	-
$\theta_{2017}\hat{b}_{2015-2016}$	-	-	-	-	-1*0.016	-	-	-
$\theta_{2018}\hat{b}_{2015-2017}$	-	-	-	-	-	-1*0.016	-	-
$\theta_{2019}\hat{b}_{2015-2018}$	-	-	-	-	-	-	-1*0.016	-
$\theta_{2020}\hat{b}_{2015-2019}$	-	-	-	-	-	-	-	-1*0.016
	-9.05	-6.56	-1.77	0.28	1.16	1.53	1.69	1.76

Note: [1] The Chi squared test statistic is reported and the corresponding p-value is shown in square brackets.

Table A4: Estimation results and projections, scenario B

Estimation results								
Period	1980-2012	1980-2013	1980-2014	1980-2015	1980-2016	1980-2017	1980-2018	1980-2019
Explanatory variable								
y_{t-1}	0.429 (0.138)	0.429 (0.138)	0.429 (0.138)	0.429 (0.138)	0.447 (0.107)	0.447 (0.097)	0.432 (0.116)	0.432 (0.114)
Constant	0.026 (0.007)	0.026 (0.007)	0.026 (0.007)	0.026 (0.007)	0.025 (0.006)	0.025 (0.005)	0.026 (0.006)	0.026 (0.006)
Dummy variable								
1991	-0.050 (0.019)	-0.050 (0.019)	-0.050 (0.019)	-0.050 (0.019)	-0.051 (0.018)	-0.051 (0.018)	-0.050 (0.018)	-0.050 (0.017)
1992	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.019)	0.061 (0.018)	0.061 (0.018)	0.061 (0.018)	0.061 (0.018)
1993	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.058 (0.019)	-0.059 (0.018)	-0.059 (0.018)	-0.058 (0.018)	-0.058 (0.018)
2009	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.018)	-0.060 (0.017)	-0.060 (0.017)
2012	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.019)	-0.053 (0.019)	-0.052 (0.018)	-0.052 (0.018)	-0.053 (0.018)	-0.053 (0.018)
2013	-	-0.159 (0.021)	-0.159 (0.021)	-0.159 (0.021)	-0.158 (0.019)	-0.158 (0.019)	-0.159 (0.019)	-0.159 (0.019)
2014	-	-	-0.018 (0.032)	-0.018 (0.032)	-	-	-	-
2015	-	-	-	-0.015 (0.023)	-	-	-	-
2014-2016	-	-	-	-	-0.012 (0.016)	-	-	-
2014-2017	-	-	-	-	-	-0.012 (0.013)	-	-
2014-2015	-	-	-	-	-	-	-0.016 (0.021)	-0.016 (0.020)
2016-2018	-	-	-	-	-	-	-0.012 (0.011)	-
2016-2019	-	-	-	-	-		-	-0.012 (0.010)
LM tests[1]								
Autocorrelation (Breusch-Godfrey)	0.713 [0.398]	0.715 [0.391]	0.757 [0.384]	0.778 [0.378]	0.458 [0.499]	0.456 [0.499]	0.693 [0.405]	0.707 [0.401]
Autoregr. cond. Heterosk. (ARCH)	0.518 [0.472]	0.376 [0.540]	0.264 [0.608]	0.177 [0.674]	0.125 [0.724]	0.075 [0.784]	0.033 [0.857]	0.011 [0.915]

Projections								
	2013	2014	2015	2016	2017	2018	2019	2020
Intercept correction								
$\theta_{2013}\hat{b}_{2012}$	-3*0.053	-	-	-	-	-	-	-
$\theta_{2014}\hat{b}_{2012}$	-	-0.33*0.053	-	-	-	-	-	-
$\theta_{2015}\hat{b}_{2014}$	-	-	-0.85*0.018	-	-	-	-	-
$\theta_{2016}\hat{b}_{2015}$	-	-	-	-0.66*0.015	-	-	-	-
$\theta_{2017}\hat{b}_{2014-2016}$	-	-	-	-	-1*0.012	-	-	-
$\theta_{2018}\hat{b}_{2014-2017}$	-	-	-	-	-	-1*0.012	-	-
$\theta_{2019}\hat{b}_{2016-2018}$	-	-	-	-	-	-	-1*0.012	-
$\theta_{2020}\hat{b}_{2016-2019}$	-	-	-	-	-	-	-	-1*0.012
	-14.36	-5.30	-1.14	1.13	1.84	2.16	2.38	2.48

Note: [1] The Chi squared test statistic is reported and the corresponding p-value is shown in square brackets.

A3. Output loss

Table A5: Output losses, level
(potential growth computed as the average over a pre-crisis period) [1]

	Potential: 1.80% (2009-2011)			Potential: 2.30 (2005-2011)		
Scenario	A	B	EC	A	B	EC
	€mn (2005 prices)			€mn (2005 prices)		
2012	-686	-686	-686	-686	-686	-686
2013	-2158	-2886	-2110	-2230	-2958	-2182
2014	-3114	-3626	-2751	-3255	-3767	-2892
2015	-3433	-3851	-2771	-3640	-4058	-2978
2016	-3515	-3835	-2701	-3786	-4106	-2973
2017	-3503	-3750	-2591	-3836	-4083	-2924
2018	-3455	-3637	-2495	-3847	-4029	-2887
2019	-3392	-3507	-2432	-3840	-3956	-2881
2020	-3324	-3372	-2381	-3827	-3875	-2884
2012-2014	-5959	-7198	-5548	-6172	-7411	-5761
As % of 2011 GDP	-39%	-47%	-37%	-41%	-49%	-38%
As % of 2011 potential GDP	-39%	-47%	-36%	-40%	-48%	-38%
2012-2020	-26580	-29151	-20919	-28948	-31519	-23287
As % of 2011 GDP	-175%	-192%	-138%	-191%	-208%	-153%
As % of 2011 potential GDP	-174%	-191%	-137%	-189%	-206%	-152%

Note: [1] Losses are expressed in present values of 2011 (i.e. the year before the beginning of the crisis period) by assuming a discount rate of 4%.

Table A6: Output losses as percentage of GDP, level
(potential growth computed as the average over a crisis period)

	Potential: 1.80% (2009-2011)			Potential: 2.30 (2005-2011)		
Scenario	A	B	EC	A	B	EC
2012	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8
2013	-17.3	-24.6	-16.9	-17.9	-25.2	-17.4
2014	-27.8	-33.9	-23.8	-29.1	-35.3	-25.0
2015	-32.5	-37.9	-24.7	-34.4	-40.0	-26.5
2016	-34.5	-38.8	-24.5	-37.1	-41.6	-27.0
2017	-35.3	-38.8	-23.9	-38.7	-42.2	-27.0
2018	-35.7	-38.3	-23.4	-39.7	-42.4	-27.1
2019	-35.8	-37.5	-23.3	-40.6	-42.3	-27.6
2020	-35.9	-36.6	-23.3	-41.3	-42.1	-28.3
Average 2012-2014	-16.7	-21.1	-15.2	-17.3	-21.8	-15.8
Average 2012-2020	-28.8	-32.4	-21.0	-31.5	-35.1	-23.4

Table A7: Output losses as percentage of potential GDP, level
(potential growth computed as the average over a crisis pre-period)

	Potential: 1.80% (2009-2011)			Potential: 2.30% (2005-2011)		
Scenario	A	B	EC	A	B	EC
2012	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6
2013	-14.8	-19.7	-14.4	-15.2	-20.1	-14.9
2014	-21.8	-25.3	-19.2	-22.5	-26.1	-20.0
2015	-24.5	-27.5	-19.8	-25.6	-28.6	-21.0
2016	-25.6	-28.0	-19.7	-27.1	-29.4	-21.3
2017	-26.1	-27.9	-19.3	-27.9	-29.7	-21.3
2018	-26.3	-27.7	-19.0	-28.4	-29.8	-21.3
2019	-26.4	-27.3	-18.9	-28.9	-29.7	-21.6
2020	-26.4	-26.8	-18.9	-29.2	-29.6	-22.0
Average 2012-2014	-13.7	-16.6	-12.8	-14.1	-16.9	-13.2
Average 2012-2020	-21.8	-23.9	-17.1	-23.3	-25.3	-18.7

Table A8: Output losses, growth rate (percentage points - ppts)

	Potential: 1.8%			Potential: 2.4%		
Scenario	A	B	EC/IMF	A	B	EC/IMF
2012	-4.2	-4.2	-4.2	-4.8	-4.8	-4.8
2013	-10.9	-16.2	-10.5	-11.5	-16.8	-11.1
2014	-8.4	-7.1	-5.7	-9.0	-7.7	-6.3
2015	-3.6	-2.9	-0.7	-4.2	-3.5	-1.3
2016	-1.5	-0.7	0.1	-2.1	-1.3	-0.5
2017	-0.6	0.0	0.5	-1.2	-0.6	-0.1
2018	-0.3	0.4	0.4	-0.9	-0.2	-0.2
2019	-0.1	0.6	0.1	-0.7	0.0	-0.5
2020	0.0	0.7	0.0	-0.6	0.1	-0.6
2012-2014	-23.4	-27.5	-20.4	-25.2	-29.3	-22.2
Breakdown of loss						
Downturn	-18.0	-22.1	-15.0	-18.0	-22.1	-15.0
Underperformance against potential	-5.4	-5.4	-5.4	-7.2	-7.2	-7.2
2012-2020	-29.6	-29.4	-20.0	-35.0	-34.8	-25.4
Breakdown of loss						
Downturn	-13.4	-13.2	-3.8	-13.4	-13.2	-3.8
Underperformance against potential	-16.2	-16.2	-16.2	-21.6	-21.6	-21.6

Output loss in Table A8 is decomposed into:

(i) loss due to downturn given by the cumulative contraction that occurs over a given period, and

(ii) the loss due to the failure of the economy to expand at its potential rate, which is given by the cumulative potential growth rates over the period, with a negative sign; the potential rate can be viewed as the percentage at which the economy would have grown had the crisis not occurred.

In the short run (2012-2014) output losses due to the recession are larger than losses due to foregone potential growth. The estimated loss due to downturn ranges from -22.1 (scenario B) to -15.0 ppts (EC/IMF); output loss from the foregone potential growth is estimated from -7.2 (upper bound for potential growth rate) to -5.4 ppts (lower bound of potential growth rate). In the long run the opposite occurs as recovery is forecasted after 2015 under scenario A and B, and after 2014 in the case of EC/IMF projections. Thus, output loss due to the downturn is estimated at -13.4 (scenario A) to -3.8 ppts (EC/IMF), while the loss due to the underperformance against the potential rate varies from -21.6 to -16.2 ppts.

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