EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 1747 / DECEMBER 2014

DISAGGREGATING OKUN'S LAW

DECOMPOSING THE IMPACT OF THE EXPENDITURE COMPONENTS OF GDP ON EURO AREA UNEMPLOYMENT

Robert Anderton, Ted Aranki,
Boele Bonthuis and Valerie Jarvis

In 2014 all ECB publications feature a motif taken from the €20 banknote.

2012 STRUCTURAL ISSUES REPORT

2012 Structural Issues Report "Euro area labour markets and the crisis"
This paper contains research underlying the 2012 Structural Issues Report "Euro area labour markets and the crisis'', which was prepared by a Task Force of the Monetary Policy Committee of the European System of Central Banks. The Task Force was chaired by Robert Anderton (ECB). Mario Izquierdo (Banco de España) acted as Secretary. The Task Force consisted of experts from the ECB as well as the National Central Banks of the euro area countries. The main objectives of the Report was to shed light on developments in euro area labour markets during the crisis, including the notable heterogeneity across the euro area countries, as well as the mediumterm consequences of these developments, along with the policy implications.

The refereeing process of this paper has been co-ordinated by the Chairman and Secretary of the Task Force.

Acknowledgements
This paper was the result of background research for the Structural Issues Report 2012 entitled "Euro area labour markets and the crisis". The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank. We thank participants of the ESCB Structural Issues Report 2012 Task Force, and an anonymous referee and the Editorial Board of the ECB Working Paper series, for helpful comments which substantially improved the paper. All errors are our responsibility.

Robert Anderton
European Central Bank; and Honorary Professor, School of Economics, University of Nottingham; e-mail: robert.anderton@ecb.int

Ted Aranki
European Central Bank; e-mail: ted.aranki@ecb.int

Boele Bonthuis
Bundesbank; e-mail: boele.bonthuis@bundesbank.de

Valerie Jarvis
European Central Bank; e-mail: valerie.jarvis@ecb.int

Postal address	60640 Frankfurt am Main, Germany
Telephone	+49 69 1344 0
Internet	http://www.ecb.europa.eu

ISSN	1725-2806 (online)
ISBN	978-92-899-1155-9
DOI	10.2866/36377
EU Catalogue No	QB-AR-14-121-EN-N (online)

Abstract

This paper examines the usefulness of the Okun relationship as a "rule of thumb" for predicting changes in unemployment, as a result of changes in output. It argues that a disaggregated version of the Okun relationship – making use of the differential reaction of unemployment to changes in the various expenditure components of GDP - significantly enhances the capacity of the Okun relationship (in comparison to the aggregate "rule of thumb") for predicting movements in unemployment. The paper tests this hypothesis using a dataset for the 17 euro area countries over the period 1996Q1-2013Q4. The results suggest that euro area unemployment is particularly sensitive to movements in the consumption component of GDP, while movements in foreign trade (exports and imports) have a much lower impact on unemployment developments. This reflects the highly labour-intensive nature of the services that represent the bulk of consumers' expenditure, while the higher productivity manufacturing-related content of exports tends to be less labour intensive.

Keywords: Okun relationship, unemployment, expenditure components of GDP, panel econometrics.
JEL Classification: E2, E24, C23.

Non-technical summary

Okun's Law suggests that a decline in output growth of between 2% and 3% is typically associated with a one percentage point increase in the aggregate unemployment rate. According to the literature, although remarkably stable over the long run (and across economies), over shorter periods the Okun relationship can vary considerably. For example, on the basis of rolling regressions, Daly, Fernald, Jorda and Nechio (2012), Meyer and Tasci (2012) and Owyang and Sepkhposyan (2012) find that Okun's law is unstable over time. Some papers point to specific changes in the Okun relationship due to the economic crisis (for example, IMF (2010) and McKinsey (2011), etc). Some of these explanations claim that financial crises and collapses in house prices are associated with higher unemployment for a given level of output, while other explanations suggest that the tendency for unemployment to fall when output rises may be mitigated by shortages of workers with the appropriate skills for the available vacancies. By contrast, Ball, Leigh and Loungani (2013) find that Okun's law is a strong and stable relationship which did not change during the economic crisis.

One aspect that has not been addressed much in the literature is that the various expenditure components of GDP may embody different employment (unemployment) reactions, and may partly explain some of the empirical findings of instability in the aggregate Okun relationship. This is the premise of this paper. Using panel equation techniques, and pooling the data across 17 euro area countries over the period 1996Q1-2013Q4, we find that disaggregation of the expenditure components significantly improves the explanatory power of the Okun relationship over the crisis period. Moreover, the disaggregated approach reveals considerable distinctions in the sensitivity of unemployment to the various expenditure components. From our estimates, it seems that unemployment is most affected by changes in the consumption component of GDP, while movements in foreign trade (export and import) expenditure have a significantly lower impact on movements in unemployment. These estimates of the relative magnitudes of the differential effects also seem intuitively sensible. For example, the high unemployment intensities for consumption capture the labour-intensive nature of the services that represent the bulk of consumers' expenditure. By contrast, goods exports represent about 75% of euro

area exports of goods and services, with manufactures comprising most of the goods exports. Manufactures tend to be higher-productivity, and relatively less labour intensive, than services thereby explaining why exports (and imports) display much lower estimated unemployment intensities than their domestic demand counterparts. Although our estimates are primarily based on a static Okun specification, the relative magnitudes of the parameters for the components of expenditure are also confirmed by a dynamic specification.

These differential impacts are likely, in part, to explain the varying degrees of unemployment movements across the euro area for a given change in aggregate output. Moreover, the relatively small trade (export and import) component elasticity may well explain why the unemployment rate in several euro area countries (most notably, major exporters such as Germany where the initial large downturn in GDP during the early stages of the crisis was driven by falling exports), did not increase as much as the aggregate Okun relationship would have predicted, given the size of the GDP contraction experienced.

However, one should bear in mind that the above estimates are *ceteris paribus* impacts. These ceteris paribus impacts may provide somewhat different relative impacts of the expenditure categories in comparison to full model simulations. For example, an increase in exports in a full model simulation would also capture the second-round impacts resulting from increases in other higher unemployment intensive expenditure categories, such as investment, in response to the initial increase in exports.

1. Introduction

The relationship between contemporaneous changes in economic growth and unemployment is widely reported in the economic literature and is often referred to as "Okun's Law". More of an empirical "rule of thumb" than a relationship grounded in theory, Okun's Law suggests that a decline in output growth of between 2% and 3% is typically associated with a one percentage point increase in the aggregate unemployment rate.[1]

According to the literature, although remarkably stable over the long run (and across economies), over shorter periods the Okun relationship can vary considerably. For example, on the basis of rolling regressions, Daly, Fernald, Jorda and Nechio (2012), Meyer and Tasci (2012) and Owyang and Sepkhposyan (2012) find that Okun's law is unstable over time. Some papers point to specific changes in the Okun relationship due to the economic crisis (for example, IMF (2010) and McKinsey (2011), etc). Some of these explanations claim that financial crises and collapses in house prices are associated with higher unemployment for a give level of output, while other explanations suggest that the tendency for unemployment to fall when output rises may be mitigated by shortages of workers with the appropriate skills for the available vacancies. By contrast, Ball, Leigh and Loungani (2013) find that Okun's law is a strong and stable relationship which did not change during the economic crisis.

One aspect that has not been addressed much in the literature is that the various expenditure components of GDP may embody different employment (unemployment) reactions, and may partly explain some of the empirical findings of instability in the aggregate Okun relationship. This is the premise of this paper. Earlier studies in this vein are few and far between, but add some corroboration to our hypothesis. For instance, Walterskirchen (1999) finds that a fall in (labour-intensive) domestic demand implies a much larger response of employment to shocks than a decrease in the (capital-intensive) export sector. From our perspective, since a large part of the strong downturn in global economic activity at the start of the crisis was linked to an abrupt and significant decline in world trade, the different responses of employment to

[1] Okun's seminal paper relates to empirical observations of the relationship between US output growth and movements in the unemployment rate over the early post-World War II period. Despite the interval since its original publication, over the longer term, the relationship has proved to be remarkably stable – both over time and across countries (see e.g., Okun, 1962; Kydland and Prescott, 1982; and Millard et al., 1997).

domestic and foreign demand components may help in explaining why many countries (particularly major exporters, such as Germany) did not experience increases in unemployment as much as the (long-term) Okun relationship would have implied. Similarly, Anderton and Tewolde (2008) find that import functions which differentiate import intensities by the components of total final expenditure offer significantly better predictors of the sharp decline in global imports of goods and services over the global financial crisis than specifications based purely on movements in aggregate expenditure.

In this paper, we estimate the differential impacts of the expenditure components of GDP (consumption, investment, government expenditure, exports and imports) on changes in unemployment rates for the euro area over the period 1996Q1 through 2013Q4. The period is chosen so as to maximise the availability of harmonised quarterly national accounts data, as published by Eurostat.[2] For most countries, the time horizon thus covers the run-up to economic and monetary union (EMU) and its launch (for most countries in 1999), the "strong growth" years of the mid-2000s, as well as the onset (and aftermath) of the global financial and economic crisis. We also evaluate the extent to which this disaggregated approach enhances forecasting performance over the aggregate Okun "rule of thumb". We find that disaggregation of the expenditure components significantly improves the explanatory power of the Okun relationship over the crisis period. Moreover, the disaggregated approach reveals considerable distinctions in the sensitivity of unemployment to the various output components.

The next section of this paper briefly reviews some empirical developments from the perspective of "Okun's Law" and shows that relationship deviated strongly over the course of the global financial and economic crisis of 2008-09. Section 3 presents an alternative econometric model for a "disaggregated Okun", whereby movements in the euro area unemployment rate are estimated on the basis of differential changes in GDP expenditure components. The empirical results from this disaggregated model are presented in Section 4. Section 5 assesses the usefulness of the disaggregated approach (including a forecasting evaluation exercise in sub-section 5.1). The final section concludes.

[2] Since all estimates are reported in terms of year-on-year changes, our dataset includes observations for 1995 as base years.

2. Okun's Law for the euro area: the aggregate approach

Fifty years after its original publication, Okun's Law still has considerable *cachet* among economists – likely due to its elegance and simplicity in delineating the contemporaneous relationship between two important macroeconomic variables: the unemployment rate and GDP. The relationship is typically estimated using the following equation:

$$\Delta U_t = \alpha + \beta \Delta Y_t + \varepsilon_t \qquad (1)$$

relating the contemporaneous change at time *t* in the unemployment rate (*U*) to the change in output (*Y*).[3] For the purposes of estimation, we use the year-on-year percentage point change in the unemployment rate, ΔU, and the annual change in the gross domestic product to measure changes in output (ΔY). As regards the coefficients, α is simply an intercept coefficient, giving the long-run "trend" growth in the unemployment rate (as a result of the underlying structural and institutional features of European labour markets); β, known as the so called "Okun coefficient", measures the responsiveness of the unemployment rate with respect to changes in output. In the absence of ill-functioning ("sclerotic") labour markets, the Okun coefficient is almost always expected to be negative, as it denotes that a higher rate of output growth is (generally) associated with a reduction in the unemployment rate, and vice versa; ε is an error term.

Table 1 summarises these "benchmark" estimates of equation (1) for the euro area - estimated on the basis of aggregate euro area data using OLS – covering the full sample period, 1996Q1-2013Q4, as well as the pre-crisis period 1996Q1-2008Q1. Table 1 suggests that since the onset of the crisis in 2008Q2, the aggregate euro area unemployment rate appears to have become rather *less* responsive to changes in GDP than in the pre-crisis period. The Okun coefficient, β, falls significantly from 0.40 to 0.34 with the extension of the sample beyond the onset of the global crisis. Moreover, these comparisons suggest that the rate at which the euro area economy needs to grow to leave the unemployment rate unchanged – given by the ratio of the parameters ($-\alpha/\beta$) - has also risen since the onset of the crisis.

[3] Okun (1962) presented two empirical relationships, a "difference" version and a "gap" version. The difference version of Okun's law captures the contemporaneous relationship between the change in unemployment and GDP growth, while the gap version shows the relationship in the form of deviations from the potential levels. In this paper we estimate only the difference version.

Table 1 - Benchmark Okun coefficients for the euro area: aggregate Okun relationship

	(1)	(2)
	Full Sample	Pre-crisis
VARIABLES	ΔU	ΔU
ΔGDP	-0.340***	-0.399***
	(0.027)	(0.034)
Constant	0.564***	0.648***
	(0.064)	(0.088)
Observations	72	49
R-squared	0.786	0.672

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Full sample refers to: 1996Q1-2013Q4. Pre-crisis refers to: 1996Q1-2008Q1

Chart A shows the strong divergence in the typical Okun relationship over the course of the 2008-09 global financial crisis (as denoted by data points highlighted by the bold diamonds in Chart A), by plotting the contemporaneous changes in euro area output and unemployment course on the basis of quarterly data from the first quarter of 1996 to the fourth quarter of 2013. This shows the strong decline in the responsiveness of unemployment to changes in output, from an estimated 0.40 in advance of the 2008-09 recession (as illustrated by the slope of the bold blue trend line), down to around 0.34 (see the dashed trend line in Chart A) when the period is extended on the basis of data up to and including the fourth quarter of 2013.[4]

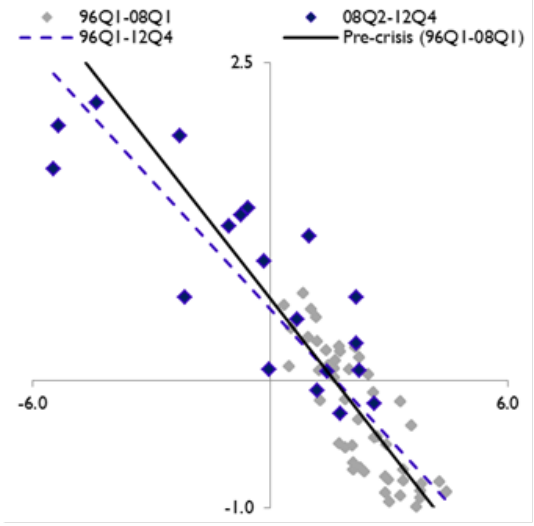
[4] See also the boxes entitled "Back to Okun's Law? Recent developments in euro area output and unemployment", Monthly Bulletin, ECB, June 2011, and "Labour market adjustment in the euro area", Monthly Bulletin, ECB, March 2012.

Chart A - Changes in GDP and the unemployment rate in the euro area

(annual percentage changes; percentage points; quarterly data)

x-axis: annual percentage changes in euro area GDP

y-axis: annual percentage point changes in the euro area unemployment rate

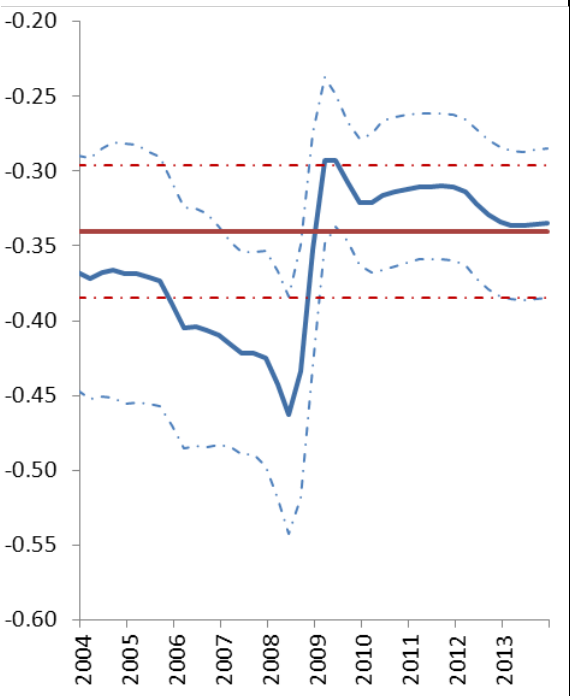


Sources: Eurostat and ECB calculations.

Notes: GDP data are seasonally and working day adjusted; the unemployment rate is seasonally adjusted.

Chart B – Movements in the euro area Okun coefficient: rolling regression results, 1996Q1-2013Q4

Confidence intervals calculated at the 90% level



Source: Eurostat and authors' calculations.

Notes: 32-quarter moving window. This means that the first rolling regression coefficient (for 2003Q4) is estimated on the basis of data from 1996Q1 to 2003Q4, while the final estimate – for 2013Q4 – reflects data covering the period from 2006Q1 to 2013Q4.

To analyse statistically the degree of variation seen in the Okun relationship over the crisis, Chart B re-estimates equation (1) using rolling regression techniques. This means that the Okun coefficients are estimated on the basis of a moving sample, which implies that that older data do not affect later relationships.[5] Allowing time-variance in the Okun coefficient – shows that in advance of the crisis, there seems to have been some increase in the responsiveness of unemployment to GDP dynamics, probably largely as a result of structural reforms carried out in many euro area economies in the mid-2000s.[6] Over the course of the financial crisis, however, this responsiveness fell strongly, reflecting at first some precautionary labour hoarding by

[5] Rolling regressions are typically used to estimate a relationship for several different time periods. Each individual regression produces a number of estimated coefficients. If the relationship is stable over time, the values of the estimated coefficients will not differ very much from each other.

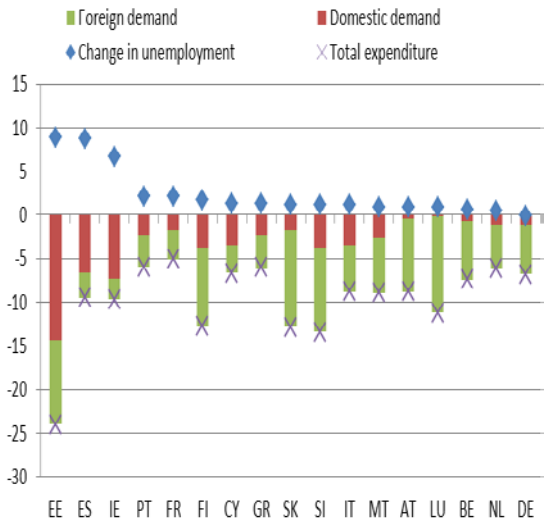
[6] In addition, there may also have been some asymmetry due to strongly overheating labour markets in some economies.

firms (initially unaware of the duration of the crisis) and later supported by widespread "crisis measures" across euro area countries.[7]

The fact that a large part of the strong downturn in economic activity at the start of the crisis was linked to an abrupt and significant decline in world trade may help to explain the lower responsiveness of unemployment to changes in GDP. For example, Walterskirchen (1999) finds that a fall in domestic demand implies a much larger response of employment to shocks than a decrease in the export sector. This is also implied by Chart C, which suggests that unemployment tended to increase most in those countries where a fall in domestic demand contributed most to the overall fall in total domestic expenditure (compare those countries to the left-hand side of Chart C, with those on the right). Overall, it appears that while declines in exports appear to result in a relatively weak employment (or rather, unemployment) response, reductions in domestic demand (i.e. consumption, government expenditure and investment) appear to invoke a rather stronger reaction.

Chart C - Changes in unemployment and demand by country

Peak-to-trough percentage change in total national expenditure with domestic and external breakdown, 2008Q1-2009Q2, and percentage point change in unemployment over corresponding period



Sources: Eurostat and ECB calculations.
Notes: Domestic demand denotes combined expenditure from consumption, investment and government sources; Foreign demand measures the contribution to total expenditure from exports.

3. Econometric specification

Given the salient facts briefly reviewed in Section 2, there is room to suspect that some decomposition of the Okun relationship, which takes fuller account of the differing reactions of unemployment to movements of the various expenditure

[7] Meyer and Taschi (2012) find a similar pattern for the United States for this period. However, they conclude – wrongly, in our view – that the lack of stability in the coefficients undermine Okun's Law as a suitable "rule of thumb" for forecasting unemployment, given changes in GDP. Our paper argues, by contrast, that Okun's Law remains useful, *if* sufficient care is taken to *disaggregate* the expenditure components during recessionary periods.

components, may significantly enhance the predictive capacity of the Okun relationship in comparison to its aggregate form. To test our hypothesis directly, we thus augment the standard Okun relationship, as given in (1), using the accounting approximation (2) which decomposes changes in aggregate GDP (*Y*) into changes of its constituent expenditure components (GDP_g); private consumption (*con*), government spending (*gov*), investment (*inv*), exports (*exp*) and imports (*imp*):

$$\Delta Y = \Delta \sum GDP_g \approx \sum_g \left(GDP_g \Big/ \sum_g GDP_g \right) \Delta GDP_g \equiv \sum_g \lambda_g \Delta GDP_g \qquad (2)$$

where λ_g gives the weight of each component as a share in total expenditure.[8] Substituting (2) into (1) yields:

$$\Delta U_{it} = \alpha + \sum_g \beta_g \lambda_g \Delta GDP_{g,it} + \varepsilon_{it} \qquad (3)$$

Thus, in contrast to the aggregate Okun specification, we estimate *separate* coefficients, $ß_g$, for each component of GDP. [9] By introducing $\lambda_g \Delta GDP_g$ we are able to isolate the differential unemployment responsiveness ("unemployment *intensity*"), $ß_g$, of each institutional sector in aggregate demand, rather than estimating the composite term, $ß_g \lambda_g$, for all sectors. However, the product of $ß_g \lambda_g$ is also useful, yielding the differential "component *elasticities*" – i.e., the proportional responsiveness of unemployment to movements in each GDP component (which is then partly due to the weight of the expenditure component in GDP).[10] The sum of these elasticities ($\sum_g \beta_g \lambda_g$) should be roughly equivalent to the Okun coefficient estimated from an aggregate specification.

To compare the effectiveness of this approach with the aggregate Okun relationship, we now estimate both specifications (1) and (3) for the panel of seventeen euro area countries covering the time period 1996Q1-2013Q4. In order to address the problem of unobserved cross-country heterogeneity, we include country-specific fixed effects

[8] Anderton and Tewolde (2011) use a similar decomposition to study the role of expenditure components in explaining trade movements during and after the global financial crisis. Following them, we use a 6-quarter moving average share for component movements to increase the accuracy of the approximation.

[9] Descriptive statistics and panel unit root tests are given in the Appendix. All variables used in estimation are of the same order of integration, i.e., unit root tests show that all are stationary in difference form.

[10] As the λ_g are moving averages, the component elasticities also vary over time.

(FE).[11] By way of a robustness check on our preferred FE model, we also present estimates yielded by alternative panel methods, namely using the Mean Group Estimator (MG in Table 2, which is the simple arithmetic average of the individual countries' coefficients, and may be appropriate given the rejection of the common slope restriction) and the 2-Step generalized method of moments estimator (GMM in Table 2, in which we use lagged values of the variables as instruments). [12]

4. Empirical results

Table 2 presents the estimates of the aggregate Okun coefficient (from equation 1), as well as the estimates of the unemployment intensities of the separate components of GDP (see equation 3), on the basis of a panel of 17 euro area countries.

Focusing on the fixed effect (FE) models, the estimated aggregate Okun coefficient (column 1) of -0.31 suggests that a one per cent increase (or, conversely, a one per cent fall) in euro area GDP growth is associated with a contemporaneous 0.31 percentage point decline (or increase) in the euro area unemployment rate. The (absolute) value of the estimated aggregate Okun parameter, at 0.31, shown here is only slightly lower than the (0.34) estimate presented in Table 1. The difference between the two estimates reflects the substitution of panel data (i.e., a bottom-up aggregation of all 17 euro area countries) used here for the aggregate data (for the euro area as a whole) used in Table 1.

[11] Some criticism may be levelled at our choice of a least-squares-based model, since our estimates may suffer from endogeneity problems. Output and unemployment clearly both affect each other, with their values endogenously determined from a complex system. However, Okun's Law has gained popularity as an empirical regularity that exploited the tight correlation between unemployment and output, enabling the prediction of one variable given the other. The basic idea (and implicit) assumption behind Okun's Law is that, in the short term, output supply is primarily driven by demand. Hence, although the assumption of the exogeneity of the regressors may not be strictly satisfied for least-square estimates (i.e., regression parameters may be biased and inconsistent), the estimates remain valid as a best linear estimator to predict changes in unemployment given changes in output.

[12] Using lagged values as instruments has the advantage that it addresses the possible endogeneity problem encountered in the contemporaneous version of Okun's law.

Table 2 – Okun's Law estimates under aggregate and disaggregated approaches

	FE		MG		GMM	
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔGDP	-0.313***		-0.265***		-0.558***	
	(0.041)		(0.036)		(0.056)	
$\lambda_{con}\Delta con$		-0.338***		-0.178***		-0.428***
		(0.050)		(0.055)		(0.037)
$\lambda_{gov}\Delta gov$		-0.231***		-0.303**		-0.358**
		(0.071)		(0.140)		(0.144)
$\lambda_{inv}\Delta inv$		-0.234***		-0.322***		-0.387***
		(0.060)		(0.061)		(0.030)
$\lambda_{exp}\Delta exp$		-0.060**		-0.025		-0.207***
		(0.021)		(0.026)		(0.033)
$\lambda_{imp}\Delta imp$		0.050*		0.007		0.239***
		(0.025)		(0.035)		(0.031)
Number of countries	17	17	17	17	17	17
Observations	1150	1132	1150	1132	1061	1093
Adjusted R-squared	0.510	0.581				
RMSE	1.015	0.938	0.862	0.758	1.329	1.022
Hansen J statistic*					3.305	8.965
P-value					0.347	0.176

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors within brackets. Panel estimates for 17 euro area countries. Cols (1) and (2) report the estimated coefficients from an aggregated and disaggregated Okun equation, respectively, using a fixed effects (FE) model; cols (3) and (4) present Mean Group (MG) estimators; cols (5) and (6) use the 2-Step generalized method of moments (GMM) approach, whereby all variables are instrumented by their own lagged values. Sample period 1996Q1-2013Q4. (The Hansen J-test indicates that all instruments are well identified).Wald tests reject the hypothesis that the parameters of the different components of expenditure are equal [ie, Wald test results: FE - F(5, 16) = 30.77, Prob > F = 0.0000; MG - chi2(5) = 26.68, Prob > chi2 = 0.0001; GMM chi2(5) = 584.20 Prob > chi2 = 0.0000].

The parameter estimates for the individual expenditure components in the fixed effects specification (column 2) reveal the differential impact of the components of aggregate demand on unemployment, which varies considerably depending on which expenditure component is driving GDP – the absolute values range from over 0.3 for consumption to less than 0.1 for trade components.[13] All of the expenditure components are statistically significant and have the expected signs (with consumption, government spending, investment and exports all negative, while imports are positively-signed). Moreover, according to the adjusted R-squared, the explanatory power of the model rises significantly – from 0.51 to 0.58 – when the Okun relationship is decomposed by expenditure components. These results are robust to changes in specification (see results from the MG and GMM estimations in column 3 to 6) which generally tend to corroborate our view of the relative magnitudes of the

[13] Wald tests reported at the bottom of Table 2 also confirm that the parameters of the different expenditure components are statistically significantly different from each other (in other words, Wald tests reject the hypothesis that the parameters of the different components of expenditure are equal to each other).

differential impacts of the various GDP components on unemployment developments. l

The relative magnitudes of the estimated differential effects in Table 2 also seem intuitively sensible. For example, the relatively higher unemployment intensities for consumption capture the labour-intensive nature of the services that represent the bulk of consumers' expenditure. By contrast, goods represent about 75% of euro area exports of goods and services, with manufactures comprising most of the goods exports. By their nature, manufactures tend to be higher-productivity and relatively less labour intensive than services, thereby explaining why exports (and imports) display much lower estimated unemployment intensities than their domestic demand counterparts. An additional explanation is that exports of goods have an extremely high import content, due to international chains of production, hence *ceteris paribus* the value added output and labour intensity of a given increase in exports will be relatively lower than the domestic demand components.

However, one should bear in mind that the above estimates are *ceteris paribus* impacts. These ceteris paribus impacts may provide different relative impacts of the expenditure categories in comparison to full model simulations. For example, an increase in exports in a full model simulation would also capture the second-round impacts resulting from increases in other higher unemployment intensive expenditure categories, such as investment, in response to the initial increase in exports.

So far, we have estimated a static Okun specification, which is generally the case in the literature. However, in order to investigate the robustness of the above results, we also estimate a dynamic version of the Okun specification by adding lagged terms of the dependant variable. The results are shown in Appendix 2 and confirm that the relative magnitudes of the parameters for the components of expenditure are similar to those reported above in Table 2.

So far we have only reported the separate coefficients of the individual expenditure components (ie, the unemployment intensities). Now, in Table 3, we show the differential component *elasticities* (which are the unemployment intensities multiplied by the individual weights of the expenditure components). Col. 1 shows the estimated component coefficients, $ß_g$. taken from the estimates in column 2 of Table 2[14]. The

[14] For purposes of brevity we focus on the FE results from Table 2.

weights of each component, λ_g for the whole period are reported in the second column, and the component elasticities are given in the final column of Table 3.

Table 3 - Component elasticities, averages 1996Q1-2013Q

	Unemployment intensities (β_g)	Average weight (λ_g)	Component elasticity ($\beta_g \lambda_g$)
Consumption	-0.34	0.56	-0.19
Government expenditure	-0.23	0.20	-0.05
Investment	-0.23	0.21	-0.05
Export	-0.06	0.57	-0.03
Import	0.05	0.55	0.03

Note: The sum of the component elasticity's is -0.29, which is broadly in line with the aggregated Okun coefficient presented in Table 2.

The key result from these estimated component coefficients and component elasticities is that, for the euro area as a whole, unemployment is most responsive to changes in the consumption component of output, to the extent that a one per cent decrease in consumption expenditure (*cons*) increases unemployment by 0.19 percentage points, on average. The magnitude of the elasticity of the other components ranges from 0.03 to 0.05, confirming that changes in domestic consumption have by far the greatest impact on unemployment developments than other movements in other GDP components. The relatively small trade elasticity (on the export variable) might help to explain why, at the height of the global financial crisis, the unemployment rate in some euro area countries (those to the right hand side of Chart C, and particularly Germany), did not increase as much as the aggregate Okun relationship would have implied. Finally, the sum of the elasticities of all output components is -0.29, which is broadly in line with the estimated aggregate Okun coefficient presented in Table 2 (see e.g., column 1 in Table 2).

5. Evaluation of the disaggregated approach

To illustrate the usefulness of the disaggregated approach, Table 4 compares the predicted changes in the euro area unemployment rate through a simple calibration of the respective aggregate and disaggregate approaches. As a fuller test of the performance of the disaggregated approach in unusual economic times, aside from the

whole sample period (1996Q1-2013Q4), we also test two shorter sub-periods: (i) the intensification of the global financial crisis (2008Q2–2009Q2 inclusive) and (ii) the subsequent euro area recovery of 2009Q3 to 2011Q3. In the first period, output contracted dramatically - mainly due to a large decline in foreign trade[15]; in the second period euro area activity rebounded from recession, boosted largely by a strong recovery in foreign trade.

Over the depths of the financial crisis (2008Q2-2009Q2), headline GDP declined by a an average 3.3% (over the panel of euro area countries). Applying the aggregate Okun rule of thumb suggests a 1.9 percentage point increase in the euro area unemployment rate, while the latter increased by only 1.2 percentage points. While this lower unemployment reaction in part reflects the lagged nature ("sluggishness") of labour market adjustment, it is also likely to reflect the differential impacts of the downturn on the institutional sectors of the strong decline in global trade.

Table 4 - Estimated changes in unemployment: comparison of aggregate and disaggregated approaches

	Whole sample (1996Q1-2013Q4)			**Financial crisis period (2008Q2 – 2009Q2)**			**Trade recovery (2009Q3 – 2011Q3)**		
	Data	**Aggr.**	**Disaggr.**	**Data**	**Aggr.**	**Disaggr.**	**Data**	**Aggr.**	**Disaggr.**
ΔU	0.2	0.1	0.1	1.2	1.9	1.5	1.0	0.7	0.9
Δcon	2.0			-1.4			-0.1		
Δgov	1.9			3.1			0.2		
Δinv	1.1			-11.9			-5.4		
Δexp	4.7			-10.3			4.7		
Δimp	4.1			-10.7			3.0		
ΔGDP	2.2			-3.3			0.5		

Note: The first block are made for the whole sample; the second block displays the calculation made only for the period of the intensification of the global financial crisis (2008Q2 – 2009Q2); and in the last block the results for the period after the intensification of the global financial crisis and global trade recovery are shown (2009Q3-2011Q3). The first column of each block displays the actual outcome of the variables (the average growth rate during the respective period). The next two columns of each block present the change in unemployment given the estimated elasticities from the two approaches (aggregated and disaggregated approach). Constants (fixed effects) are not shown, but affect the calculations.

Using the disaggregated Okun relationship to take account of the differential movements in expenditure component elasticities – and, in particular, the more muted responsiveness of unemployment to strong variations in the foreign demand components - suggests a rather lower 1.5 percentage point increase in unemployment

[15] This result is robust to changes in the specification and does not simply reflect asymmetries during recessionary periods.

– significantly closer to the 1.2 percentage point increase actually observed in the data. (The difference between the estimated change and the actual change is likely to be due to the strong mitigating effects of the "crisis measures" adopted in a number of euro area countries.) Similarly, for the recovery period, the disaggregated approach seems to provide results which are more in line with the actual outcome, compared to the results provided from the aggregate Okun relationship.

Thus, as Table 4 shows, over the long run (ie, 1996Q1-2013Q4),there appears little reason to prefer the disaggregated approach, as both models appear to predict the overall increase in euro area unemployment rates relatively accurately over the full sample period. However, over the shorter more recent crisis period, the disaggregated model appears notably better at predicting unemployment increases both for the crisis episode of 2008Q2-2009Q2 and for the subsequent rebound in economic activity (2009Q2-2011Q3).

Table 5 - Root mean square errors for the euro area over different samples

Steps ahead	2003Q1 - 2013Q4			2008Q2 - 2013Q4		
	Aggr.	Disaggr.	Relative performance (Disaggr./ Aggr.)	Aggr.	Disaggr.	Relative performance (Disaggr./ Aggr.)
1	0.40	0.34	0.87	0.48	0.38	0.79
2	0.43	0.39	0.92	0.54	0.46	0.87
3	0.45	0.43	0.96	0.56	0.50	0.89
4	0.46	0.45	0.98	0.55	0.48	0.87
Std:	0.81			0.73		

Note: The lower the RMSE, the greater the accuracy of the prediction.

5.1 A forecast evaluation exercise

Using more formal forecast evaluation techniques, Table 5 compares the performance of the two approaches - on the basis of aggregate euro area data covering the period 2003Q1–2013Q4, and the period since the onset of the crisis,ie, 2008Q2-2013Q4 – via comparison of root mean squared errors (RMSE) up to four quarters ahead from an out-of-sample exercise.[16] As a rule, the lower the RMSE, the greater the accuracy of the prediction.

[16] Clearly a dynamic (or complex) version of the Okun relationship would provide better forecasts. However, since our interest is to get an idea of the usefulness of the disaggregated approach as a "rule of thumb" compared to the simplest contemporaneous Okun relationship, we will only evaluate the two approaches as presented throughout this paper.

For each horizon, both models have a smaller RMSE than the simple series standard deviation, indicating that both Okun formulations offer relatively good forecasting performance four quarters ahead. However, the results also show that the disaggregated approach has a significantly lower RMSE compared to the aggregate Okun specification. In particular, for the period since the onset of the financial crisis, the disaggregated approach is around 20 per cent more accurate in predicting changes in unemployment one quarter ahead. As is normal, the RMSE increases as the forecast horizon extends - to the extent that the disaggregated approach becomes marginally (13 per cent) less superior to the aggregated Okun approach over longer horizons.[17]

6. Conclusions

Although the Okun relationship linking changes in unemployment and output growth provides a useful "rule of thumb" over the longer run, the global financial crisis in the late 2000s seems to have led to some distortion in this relationship for many euro area countries. This paper finds that movements in euro area unemployment differ significantly depending on which expenditure component is driving movements in output.

Disregarding the differential impact of movements in the various expenditure components, as is implied by the standard (aggregate) Okun rule of thumb, may be misleading when forecasting changes in unemployment. The paper shows that for the euro area, allowing the output component elasticities to vary adds considerably to the predictive capability of the Okun relationship, particularly over the strong contraction seen at the height of the financial and economic crisis, when forecasting changes in unemployment.

From our estimates, it seems that unemployment is most affected by changes in the consumption component of GDP, while movements in foreign trade (export and import) expenditure have a significantly lower impact on movements in unemployment. These estimates of the relative magnitudes of the differential effects also seem intuitively sensible. For example, the high unemployment intensities for consumption capture the labour-intensive nature of the services that represent the bulk

[17] On the basis of a broad analysis of the United States and extensions to 20 other advanced economies from 1980 to 2012, Ball *et al.* (2013) find similar results, arguing that "Okun's Law is a strong and stable relationship in most countries. Deviations occur, but they are usually modest in size and short-lived."

of consumers' expenditure. By contrast, goods exports represent about 75% of euro area exports of goods and services, with manufactures comprising most of the goods exports. Manufactures tend to be higher-productivity, and relatively less labour intensive, than services thereby explaining why exports (and imports) display much lower estimated unemployment intensities than their domestic demand counterparts. Although our estimates are primarily based on a static Okun specification, the relative magnitudes of the parameters for the components of expenditure are also confirmed by a dynamic specification.

These differential impacts are likely, in part, to explain the varying degrees of unemployment movements across the euro area for a given change in aggregate output. Moreover, the relatively small trade (export and import) component elasticity may well explain why the unemployment rate in several euro area countries (most notably, major exporters such as Germany where the downturn was driven by falling exports), did not increase as much as the aggregate Okun relationship would have predicted, given the size of the GDP contraction experienced.

However, one should bear in mind that the above estimates are *ceteris paribus* impacts. These ceteris paribus impacts may provide somewhat different relative impacts of the expenditure categories in comparison to full model simulations. For example, an increase in exports in a full model simulation would also capture the second-round impacts resulting from increases in other higher unemployment intensive expenditure categories, such as investment, in response to the initial increase in exports.

REFERENCES

Altig, D., Fitzgerald, T. and Rupert P. (2002), Okun's law revisited: Should we worry about low unemployment?", *Public Administration and Public Policy*, 97, pp. 135–142.

Anderton, R. and Tewolde, T. (2011), "The global financial crisis: Trying to understand the global trade downturn and recovery", *World Economy Journal*, Vol 34 (5), pp. 741-763.

Ball, L.M., D. Leigh and P. Loungani (2013) "Okun's Law: Fit at Fifty?" *National Bureau of Economic Research* WP No. 18668.

Daly, M., Fernald, J., Jorda, O. and Nechio, F (2012), 'Okun's Macroscope: output and employment after the great recession', *Federal Reserve Bank of San Francisco*.

IMF (2010), "Unemployment Dynamics in Recessions and Recoveries," World Economic Outlook, Chapter 3, April 2010.

Knotek II., E. S. (2007), "How useful is Okun's law?", *Economic Review*, Federal Reserve Bank of Kansas City, Issue Q IV, pp. 73-103.

Kydland, F.E. and Prescott, E. (1982), "Time to Build and Aggregate Fluctuations", *Econometrica*, 50(6), pp. 1345–1370.

McKinsey Global Institute (2011), "An Economy That Works: Job Creation and America's Future", June 2011 report.

Meyer, B. and M. Tasci (2012), "An unstable Okun's Law, not the best rule of thumb" *Economic Commentary*, 7 June 2012.

Millard, S. Scott, A. and Sensier, M. (1997), "The Labour Market over the Business Cycle: Can theory fit the facts?", *Oxford Review of Economic Policy*, 13 (3), pp. 70-92.

Moosa, I. A. (1997), "A Cross-Country Comparison of Okun's Coefficient", *Journal of Comparative Economics*, June 1997, *24* (3), pp. 335-356.

Okun, A. M. (1962), "Potential GNP: its measurement and significance", *American Statistical Association, Proceedings of the Business and Economics Statistics Section*, pp. 98–104.

Owyang, M., Sekhposyan, T. (2012), 'Okun's law over the business cycle: was the great recession all that different?', *Federal Reserve Bank of St. Louis Review 94*, no.5, pp. 399-418.

Sögner, L. and Stiassny, A. (2002), "An Analysis of the Structural Stability of Okun's Law: A Cross-Country Study", *Applied Economics*, 14, pp 1775-1787.

Walterskirchen, Ewald (1999). “The Relationship between Growth, Employment and Unemployment in the EU”. European Economist for an Alternative Economic Policy Workshop, Barcelona, Spain.
http://www.memoeurope.uni-bremen.de/tser/Walterskirchen_24months.PDF

Appendix 1

DESCRIPTIVE STATISTICS BEHIND ECONOMETRIC ANALYSIS

Table A1: Descriptive statistics: means and (standard deviations)

	Whole sample (1996Q1-2013Q4)		**Financial crisis period (2008Q2 – 2009Q2)**		**Trade recovery (2009Q3 – 2011Q3)**	
ΔU	0.11	(1.49)	0.90	(2.13)	0.98	(2.05)
ΔGDP	2.29	(3.52)	-2.23	(4.38)	0.47	(3.96)
$\lambda_{con}\,\Delta con$	1.06	(2.03)	-0.30	(2.46)	-0.12	(2.24)
$\lambda_{gov}\,\Delta gov$	0.37	(0.70)	0.61	(0.69)	0.05	(0.83)
$\lambda_{inv}\,\Delta inv$	0.32	(2.45)	-2.36	(3.25)	-1.12	(2.97)
$\lambda_{exp}\,\Delta exp$	2.77	(5.52)	-4.35	(8.07)	3.24	(7.29)
$\lambda_{imp}\,\Delta imp$	2.38	(5.84)	-4.74	(8.79)	2.21	(8.15)

Table A2: Correlation matrix for contemporaneous changes in unemployment, GDP and its components (whole sample, 1996Q1-2013Q4)

	ΔU	$\Delta ln\ GDP$	$\lambda_{con}\,\Delta ln\ con$	$\lambda_{gov}\,\Delta ln\ gov$	$\lambda_{inv}\,\Delta ln\ inv$	$\lambda_{exp}\,\Delta ln\ exp$	$\lambda_{imp}\,\Delta ln\ imp$
ΔU	1.00						
ΔGDP	-0.69	1.00					
$\lambda_{con}\,\Delta con$	-0.68	0.76	1.00				
$\lambda_{gov}\,\Delta gov$	-0.33	0.32	0.38	1.00			
$\lambda_{inv}\,\Delta inv$	-0.65	0.74	0.63	0.24	1.00		
$\lambda_{exp}\,\Delta exp$	-0.33	0.66	0.29	0.06	0.42	1.00	
$\lambda_{imp}\,\Delta imp$	-0.47	0.72	0.49	0.16	0.65	0.89	1.00

Table A3: Panel unit root test (whole sample, 1996Q1-2013Q4)

Variables	Method	Level		Difference	
		t-Statistic	p-Value	t-Statistic	p-Value
GDP	IPS	-0.72	0.24	-1.98	0.02
	ADF-fisher	49.42	0.04	50.13	0.04
	PP-fisher	24.45	0.89	74.69	0.00
Consumption	IPS	-1.08	0.14	-3.01	0.00
	ADF-fisher	37.58	0.31	60.12	0.00
	PP-fisher	43.81	0.12	80.94	0.00
Gov. expenditure	IPS	-1.12	0.13	-1.47	0.07
	ADF-fisher	34.36	0.45	36.56	0.35
	PP-fisher	54.38	0.01	98.01	0.00
Investment	IPS	1.04	0.85	-3.39	0.00
	ADF-fisher	26.24	0.83	77.92	0.00
	PP-fisher	25.49	0.85	188.73	0.00
Export	IPS	-1.88	0.03	-4.26	0.00
	ADF-fisher	45.07	0.10	78.06	0.00
	PP-fisher	32.15	0.56	117.45	0.00
Import	IPS	1.28	0.90	-6.03	0.00
	ADF-fisher	19.78	0.98	98.28	0.00
	PP-fisher	21.19	0.96	137.19	0.00
Unemployment	IPS	0.40	0.65	-5.25	0.00
	ADF-fisher	23.14	0.92	84.73	0.00
	PP-fisher	27.53	0.78	133.85	0.00

Appendix 2:

Regression results from a dynamic version of the Okun specification

In order to investigate the robustness of the results our main specification, we also estimate a dynamic version of the Okun specification by adding lagged terms of the dependant variable. Table 2a shows that the lagged unemployment rate terms are statistically significant in the dynamic Okun specification (ie, $DU_{(t-1)}$.and $DU_{(t-2)}$), and also confirm – as expected - that the unemployment rate is highly persistent.[18] Turning to the parameters of the components of expenditure, although some of the individual parameters are not statistically significant in the dynamic specification, tests show that the expenditure component parameters are statistically significant as a group.[19] Table 2b shows the long-run parameters of the dynamic specification, and along with Table 2a, confirm that the relative magnitudes of the parameters for the components of expenditure are similar to those reported in Table 2 in the main text.

Table 2a – Dynamic Okun's Law estimates under aggregate and disaggregated approaches

	FE		MG		GMM	
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔGDP	-0.074***		-0.087***		-0.076***	
	(0.015)		(0.013)		(0.013)	
$\lambda_{con}\Delta con$		-0.079***		-0.040*		-0.068***
		(0.013)		(0.020)		(0.011)
$\lambda_{gov}\Delta gov$		-0.028		-0.076*		0.058
		(0.025)		(0.040)		(0.082)
$\lambda_{inv}\Delta inv$		-0.040***		-0.081***		-0.059***
		(0.011)		(0.019)		(0.012)
$\lambda_{exp}\Delta exp$		-0.010		-0.010		-0.007
		(0.008)		(0.012)		(0.011)
$\lambda_{imp}\Delta imp$		-0.003		-0.014		-0.007
		(0.008)		(0.017)		(0.010)
$DU_{(t-1)}$	1.184***	1.175***	1.111***	1.054***	1.199***	1.145***
	(0.077)	(0.072)	(0.083)	(0.082)	(0.084)	(0.058)
$DU_{(t-2)}$	-0.394***	-0.404***	-0.377***	-0.335***	-0.415***	-0.370***
	(0.062)	(0.059)	(0.067)	(0.067)	(0.064)	(0.048)
Number of countries	17	17	17	17	17	17
Observations	1123	1111	1123	1111	1113	1085
Adjusted R-squared	0.908	0.908				
RMSE	0.442	0.439	0.398	0.382	0.447	0.448
Hansen J statistic*					1.383	7.198
P-value					0.240	0.303

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors within brackets. Panel estimates for 17 euro area countries. Cols (1) and (2) report the estimated coefficients from an aggregated and disaggregated Okun equation, respectively, using a fixed effects (FE) model; cols (3) and (4) present Mean Group (MG) estimators; cols (5) and (6) use the 2-Step generalized method of moments (GMM) approach, whereby all variables are instrumented by their own lagged values. (The Hansen J-test indicates that all instruments are well identified). Sample period 1996Q1-2013Q4.

[18] The sum of the parameters of the lagged unemployment rate terms tend to be around 0.7-0.8, hence the equation is dynamically stable.

[19] This tests the null hypothesis (H0) that the parameters of the five components of expenditure B1=B2=B3=B4=B5=0 against the alternative hypothesis (H1) that the estimated coefficients (Bi) are not jointly equal to zero (eg, for column 2, the FE specification, F(5,16)=35.11). H0 is rejected, thus we accept the alternative which means that the estimated coefficients of the five components of expenditure are jointly significantly different from zero (eg, for column 2).

Table 2b – Computed long run coefficients (p-values)

	FE		MG		GMM	
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔGDP	-0.352***		-0.326**		-0.354***	-0.354***
	(0.000)		(0.020)		(0.000)	(0.000)
$\lambda_{con}\Delta con$		-0.343***		-0.141		-0.304***
		(0.000)		(0.116)		(0.000)
$\lambda_{gov}\Delta gov$		-0.124		-0.271		0.258
		(0.262)		(0.124)		(0.487)
$\lambda_{inv}\Delta inv$		-0.175***		-0.288**		-0.264***
		(0.002)		(0.025)		(0.000)
$\lambda_{exp}\Delta exp$		-0.043		-0.034		-0.030
		(0.255)		(0.448)		(0.516)
$\lambda_{imp}\Delta imp$		-0.014		-0.049		-0.029
		(0.6900		(0.441)		(0.505)