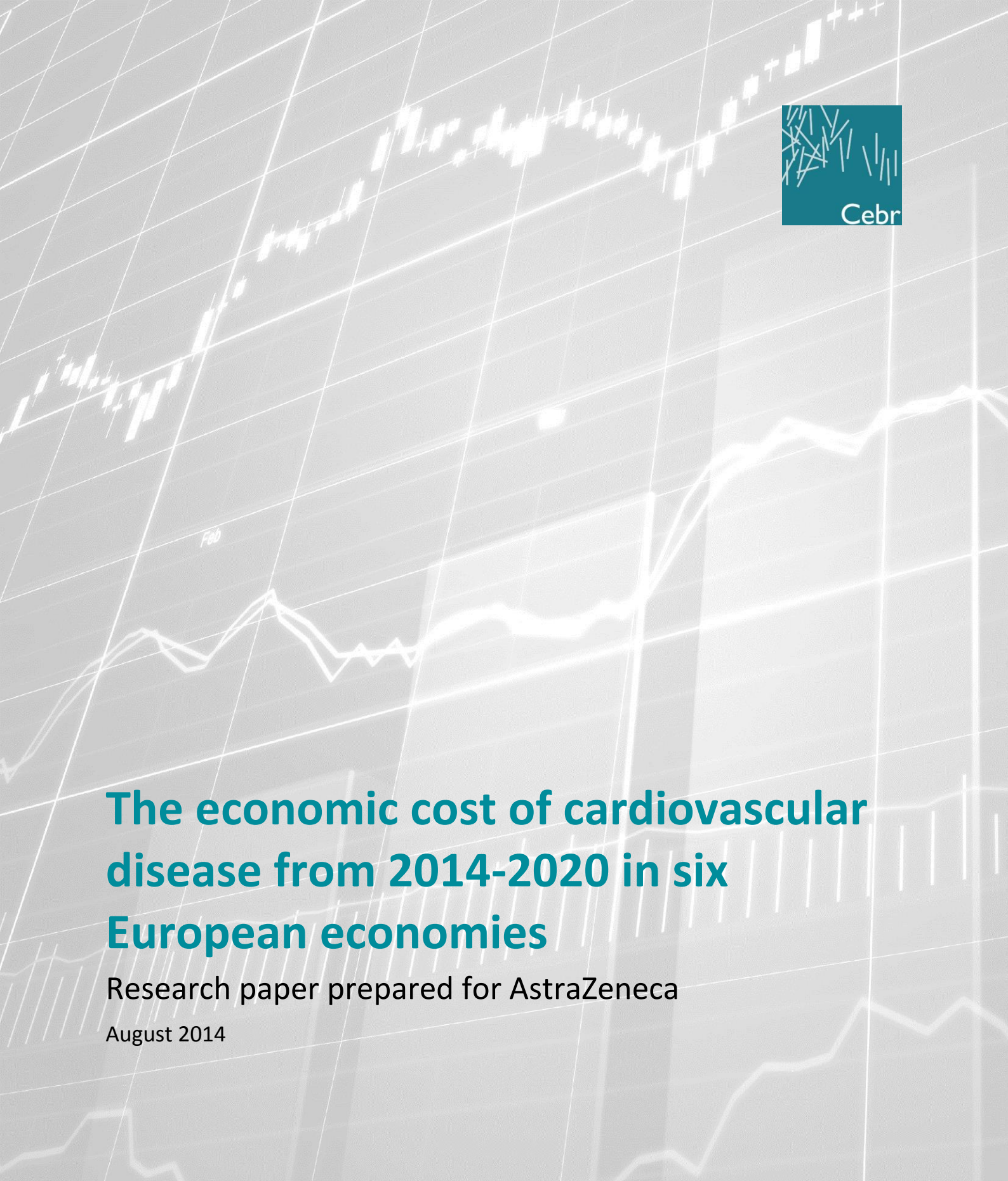

The economic cost of cardiovascular disease from 2014-2020 in six European economies

Research paper prepared for AstraZeneca

August 2014

Cebr

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London, August 2014

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1. Key facts

Across six European economies (France, Germany, Italy, Spain, Sweden and the UK):

- **Total costs to the economies from cardiovascular disease (CVD) are estimated at €102.1 billion** in 2014 - this is roughly equal to the size of the gross domestic product (GDP) of a mid-sized European economy such as Hungary.
- **Direct healthcare costs** attributable to CVD **total €81.1 billion in 2014, they present the largest cost at 70-80% across all six economies**.
- **Indirect costs** from premature mortality **are estimated to be €19.6 billion and** indirect costs from morbidity are responsible for the smallest cost, **accounting for €1.4 billion**.
- Mortality from CVD **will rise from 1,118,457 today to 1,215,088** in 2020.
- Costs from CVD in the six study countries are projected to **increase to €122.6 billion** by the end of the decade, this is an increase of **€20.5 billion over six years**.

About cardiovascular disease (CVD)

CVD covers a range of diseases related to the circulatory system, including ischemic heart disease (known as IHD or heart attack) and cerebrovascular disease (stroke). The diseases can appear suddenly and unexpectedly or take the form of a long-term condition. Cardiovascular disease conditions affect people of all ages. However, the likelihood of cardiovascular disease increases significantly with age meaning that men above the age of 45 and women above 55 are those mainly affected.

2. Introduction

This research paper analyses the economic burden from CVD[1] in six countries: France, Germany, Italy, Spain, Sweden and the UK. These six countries account for 74% of the European Union's GDP and 64% of its population.[2] The study estimates the size of the economic burden resulting from CVD in these countries from 2014 until the end of the decade.

Today CVD is the leading cause of death in Europe; presently 47% of all deaths in Europe and 40% of all deaths in the European Union (EU) are attributable to CVD[3]. This means that across Europe as a whole 4 million deaths per year currently occur due to CVD[4], of which 1.9 million are in the European Union. Among the six European countries analysed in this study, it is estimated that a total of 1.1 million deaths from CVD will occur in 2014. This is expected to rise to 1.2 million in 2020. While these figures make clear

[1] This report follows the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICF X) definition of cardiovascular disease throughout. The full list of diseases included under this definition is included in Appendix II.
[2] Calculation based on Eurostat's most recent data (2013).
[3] These figures are drawn from the European Society for Cardiology's '2012 European Cardiovascular Disease', accessible here: http://www.escardio.org/about/what/advocacy/EuroHeart/Pages/2012-CVD-statistics.aspx
[4] Ibid.

the profound human impact of CVD, which should not be underestimated, the focus of this report is on the associated economic impact.

The way the burden of CVD affects the economy can be thought of through three main channels:

- **Direct costs imposed on the healthcare system as a result of CVD:** Healthcare costs include any expenditure related to CVD, including on primary, hospital outpatient, accident and emergency (A&E) and hospital in-patient care, as well as on pharmaceuticals.
- **Indirect costs from premature mortality relating to CVD:** Mortality measures the number of deaths in a given population. The costs from premature mortality therefore measure the productivity loss due to CVD causing premature deaths.
- **Indirect costs from premature morbidity caused by CVD:** Morbidity refers to the prevalence of a disease, in this case CVD, in a given population. Morbidity can result in losses of productivity where the prevalence of the disease results in work days lost from absences from work and disability.

3. Direct and indirect costs of CVD 2014 to 2020 across the six countries

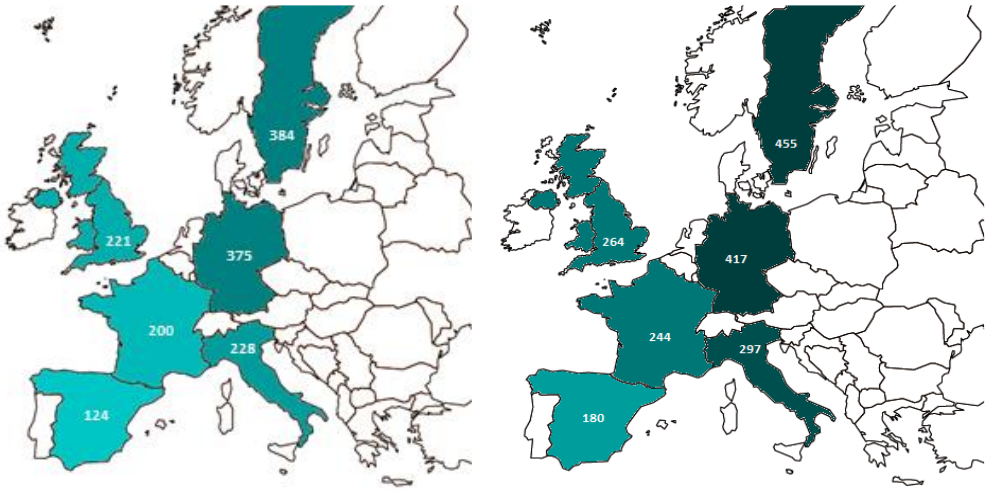
The burden of disease from CVD translates into an estimated total economic cost of €102.1 billion among the six study countries in 2014 and is forecast to continuously rise to reach €122.6 billion by 2020. The total cost of CVD in 2014 consists of €81.1 billion in healthcare costs, productivity losses from premature mortality of €19.6 billion and €1.4 billion from morbidity. By 2020 healthcare costs attributable to CVD will have risen to €98.7 billion and the indirect costs from premature mortality and morbidity to €22.3 billion and €1.6 billion, respectively.

Healthcare costs expected to increase significantly

Healthcare spending on CVD is a significant cost within the six economies at a combined €81.1 billion in 2014. The leading cost items are fairly similar across countries with the largest being expenditure on in-patient care, followed by pharmaceuticals. In-patient care accounts for around 50% of CVD-related healthcare expenditure in most economies.

At between 6-11% of their respective total healthcare spending this is also a significant cost to the individual countries. However, a variation in the size of the burden exists with healthcare costs per capita, ranging from €384 in Sweden to €124 in Spain. Healthcare costs from CVD are projected to increase further across all economies until the end of the decade.

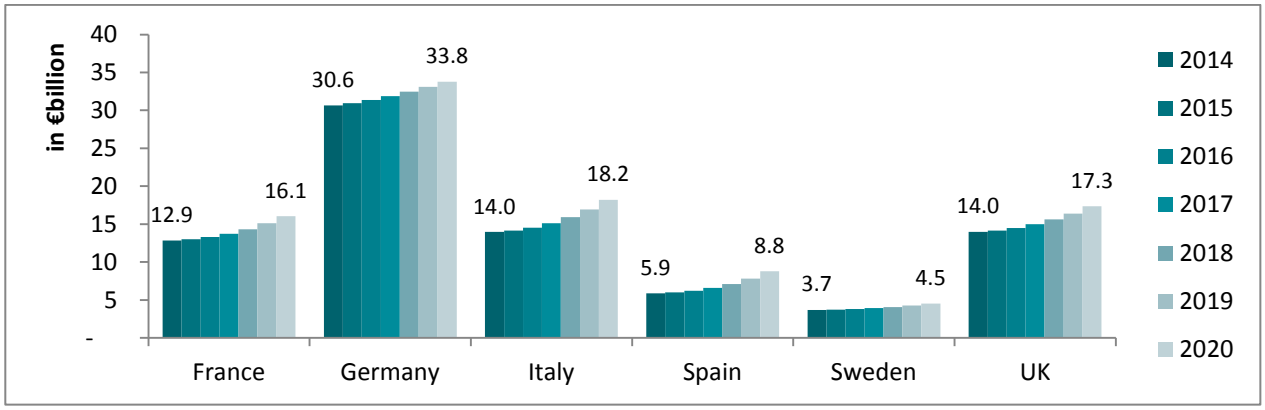
Figure 1: Healthcare cost of CVD per capita (in current prices), 2014 and 2020, in €



Source: Cebr analysis

The projected increase in healthcare costs is illustrated in Figure 2 which displays the total healthcare costs from CVD for the period through to 2020. By the end of the decade, the six countries combined will face CVD-related healthcare costs of €98.7 billion. Hence, there is a rise in per capita costs in each of the individual countries. Sweden and Germany face a per capita cost of €455 and €417, respectively. Costs will also rise in Italy (€297), the UK (€264) and France (€244). Still remaining the lowest, Spain's per capita expenditure is also forecast to increase to €180.

Figure 2: Healthcare cost of CVD, forecasts 2014-2020, in €billion



Source: Cebr analysis

Costs from premature mortality to rise as working age deaths increase to close to 100,000

In the six countries that form the focus of this study CVD results in 1.1 million deaths per year. By 2020 this number will already have risen to 1.2 million. Significantly, deaths among those of working age are also projected to rise, from 93,584 in 2014 to 99,743 in 2020. This has important implications for the costs resulting from CVD; the more deaths that occur during working age, the higher the cost burden from economic output losses – i.e. the *productivity* loss (details of the approach used are outlined in Appendix I – Methodology).

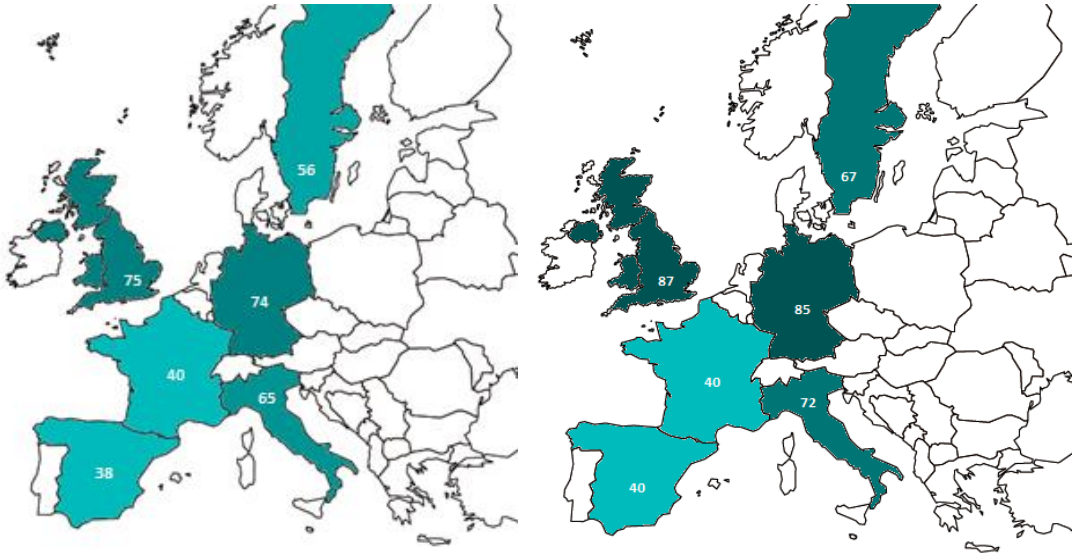
Table 1: Projected absolute number of deaths and workforce deaths from CVD over 2014-2020 period

	Total number of deaths from CVD			Total number of working-age deaths from CVD		
Country	2014	2020	2014-20	2014	2020	2014-2020
France	156,551	176,911	1,169,214	14,030	14,122	98,392
Germany	363,417	389,979	2,631,313	30,703	32,754	222,869
Italy	236,719	252,065	1,712,977	14,518	15,677	105,316
Spain	128,169	141,584	942,943	11,359	12,911	84,769
Sweden	39,362	43,034	289,192	2,385	2,436	16,760
United Kingdom	194,239	211,515	1,422,968	20,589	21,843	147,930

Source: WHO Office for Europe mortality data, UN-DESA for population data; Cebr analysis

The costs from productivity losses as a result of premature mortality are estimated to stand at €19.6 billion in the six economies in 2014. Per capita cost estimates for costs from premature mortality at current levels are presented in Figure 3 below to allow comparison between the individual countries; they range from between €75 per head in the UK to €38 per person in Spain.

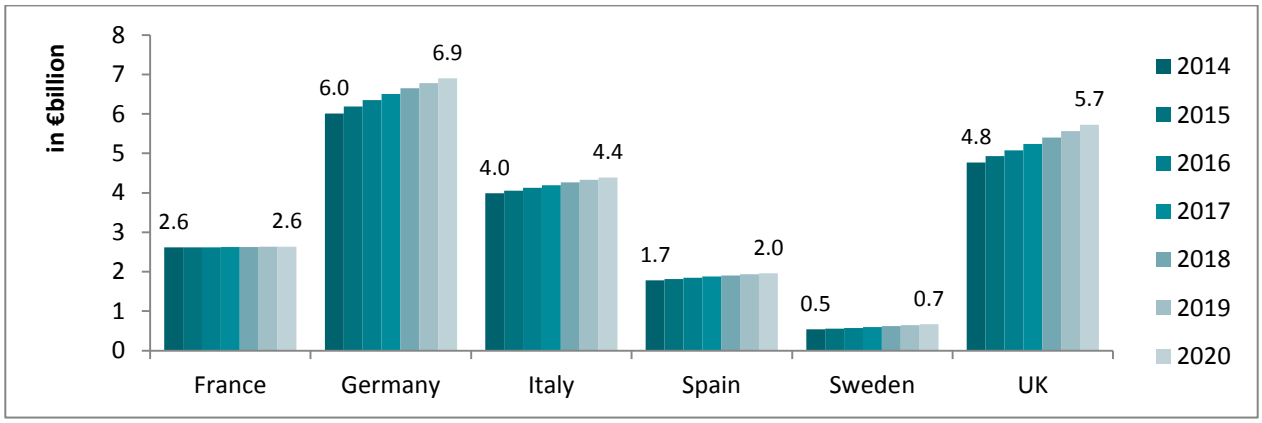
Figure 3: Cost from premature mortality per capita in 2014 and 2020, in €



Source: Cebr analysis

By 2020 mortality costs in the six economies are forecast to rise to €22.3 billion in 2020, an increase of €2.7 billion over a relatively short time period; details by country are shown in Figure 4 below. This increase is caused by the significant increase in mortality expected among the working age population.

Figure 4: Mortality costs attributable to CVD, forecasts 2014-2020, in €billion

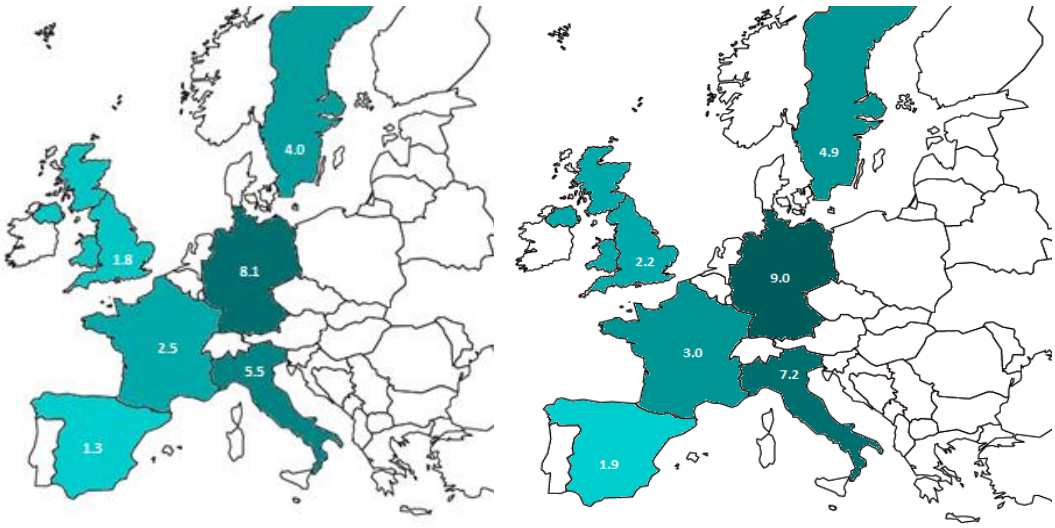


Source: Cebr analysis

Costs from premature morbidity highest in Germany but biggest increase expected in Italy

CVD also increases morbidity within the workforce leading to quantifiable productivity losses from absences from work or disability. In 2014, a combined cost of €1.4 billion from CVD-related morbidity is expected in the six economies. However, the costs vary considerably between the countries, ranging from €8.1 per capita in Germany to €1.3 per capita in Spain.

Figure 5: Per capita morbidity costs in 2014 and 2020, in €

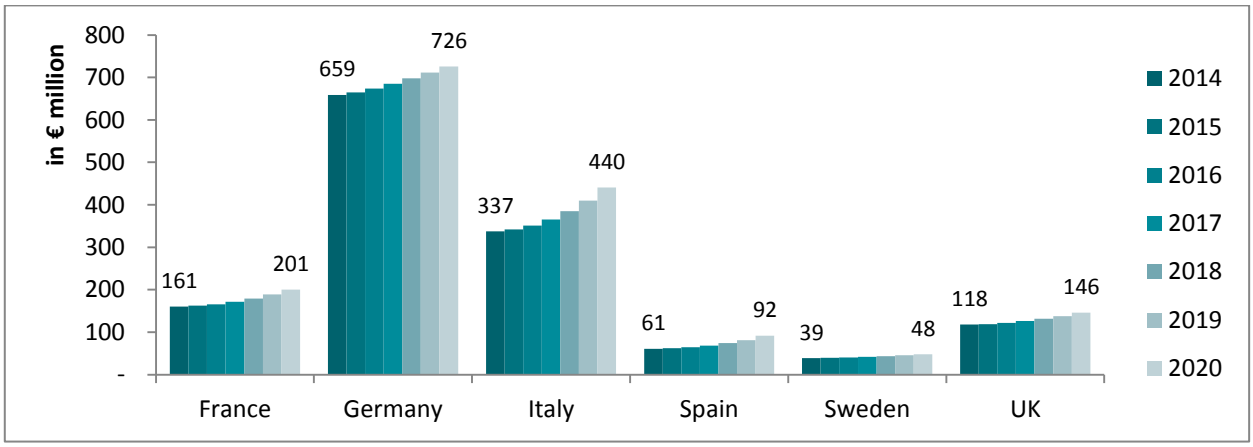


Source: Cebr analysis

Future estimates for the costs resulting from morbidity were also assessed[5]; they show that by 2020 costs of morbidity attributable to CVD increase to €1.6 billion, from €1.4 billion in 2014. The results presented in Figure 6 show that the costs from morbidity increase across all the six study countries. However, they increase more steeply in some places, notably Italy, than in others such as Spain or Sweden.

[5] However, it has to be noted that the modelling had to rely more on proxies here than for the rest of the report. Whilst this is common in the existing research (due to a lack of suitable data being available), the consequence is that the results are likely to somewhat underestimate the real costs (the approach used is detailed in Appendix I- Methodology).

Figure 6: Morbidity costs attributable to CVD, forecasts 2014-2020, in €million



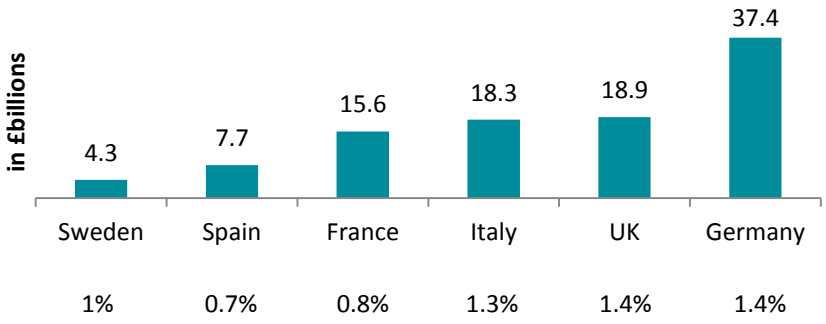
Source: Cebr analysis

Total costs to reach more than €122 billion by end of decade

Overall, total costs are dominated by healthcare costs, accounting for between three quarters and four fifths of the total cost in each of the countries. This mix of costs is common for advanced economies as they are often more able to allocate resources to healthcare.

Combining the three individual cost components, the total costs from CVD come to €102.1 billion in 2014 and are projected to rise to €122.6 billion by 2020, which is a substantial increase of 20%. These are significant costs for each of the six countries (the costs by country are outlined in Figure 7 below), representing between 0.7% and 1.4% of their GDP in 2014.

Figure 7: Total cost from cardiovascular disease, 2014, in €billion



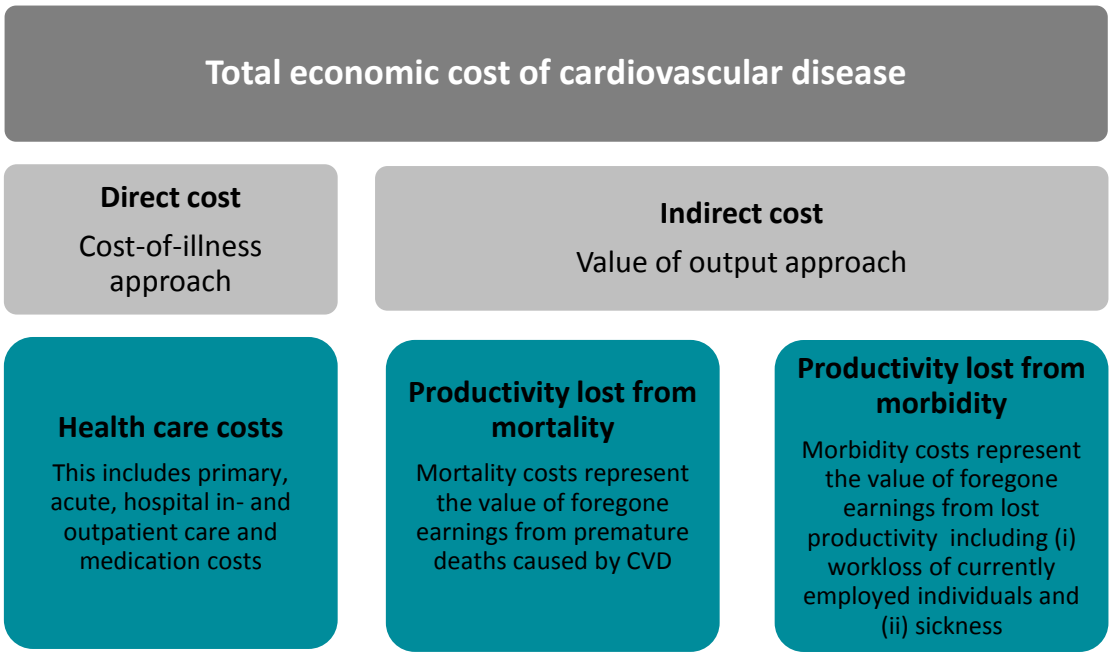
Source: Cebr analysis

Appendix I – Methodology

General approach

The direct cost of CVD is estimated by extracting the relevant country's health care resource use that goes towards the treatment of CVD conditions. The health care costs considered include expenditures on primary, acute, in-hospital and outpatient care, and medication costs. Of particular relevance to the analysis of the six study countries is the potential effect of CVD on the economy, given the importance of CVD within the working age population. These are considered indirect costs, defined as losses that stem from premature death and from disability. Indirect costs are quantified by estimating productivity lost from mortality and morbidity (i.e. by estimating the output lost due to premature mortality from CVD, including productivity lost from mortality), absence from work and premature exit from the workforce stemming from CVD morbidity, including productivity lost from morbidity.

Figure 8: Quantifying the economic cost of CVD



1. Current costs

Direct costs: health care

To quantify the direct health care costs we use a bottom up approach that collects information on several components of the health care cost – primary care, hospital outpatient care, A&E care, hospital inpatient care and pharmaceutical expenditure. The different components of the direct costs from cardiovascular disease are calculated by collecting information from National Statistical Services, the OECD, Eurostat and academic studies.

As the costs are calculated for 2014, the data in most cases came from earlier years. The figures were therefore adjusted by the respective countries' inflation indices using the health care sub-component of the index, which was available from Eurostat.

Indirect cost: productivity foregone due to premature mortality

To calculate the cost from productivity foregone due to premature death mortality statistics from the World Health Organisation Office for Europe were used. These data were available by gender and age bands. For each of the individual gender and age band combinations the average years of life lost and years of working life lost were computed. To this economic activity rates are then applied to narrow down to the actual working population. Average earnings over the remaining working life span, discounted appropriately, are then applied. Box 1 below illustrates procedure by use of an example.

Box 1: Illustrative example of PYLL and PYWLL calculations

1. Calculating years of life lost

Potential years of life lost' (PYLL) is an indicator of premature death. It attempts to measure the number of years of life lost per year due to death as a result of a specific cause, in our case cardiovascular disease. If an individual dies before the life expectancy they have potentially lost years of life.

expected years of life - years of life at death = years of life lost

For example, if one assumes that an average expected age of death for a population is 75 years, then if a person dies at 45 they have lost a potential 30 years (that is, their individual PYLL is 30 years).

i.e.: 75 – 45 = 35

2. Calculating years of working life lost

Potential years of working life lost are calculated in a similar fashion. For example, if one assumes that an average pension age for a population is 65 years, then if a person dies at 45 this equals a potential 20 years of working life lost (that is, their individual PYWLL is 20 years).

expected years of working life – years of life at death= years of working life lost

i.e.: 65- 45 =20

Indirect cost: productivity foregone due to premature morbidity

A second part of examining the productivity lost from cardiovascular disease is to estimate Disability Adjusted Life Years (DALY) lost. This measure includes the impact of disability (e.g. inability to work, prolonged illness). Similar to previous studies on the cost from cardiovascular disease it has not been possible to produce these figures for the six study countries because morbidity data for the group of countries were not available.

Therefore an alternative approach used in existing research is adopted, which uses a proxy for workforce morbidity. Studies of CVD in the workforce of industrial nations have regularly found that disability associated with hypertension and heart disease results in a large number of impaired workdays. To quantify the costs from morbidity induced by cardiovascular disease, absences from work were collected from national statistics where possible and where this was not possible hospital days were used as a

proxy. Expressing these as the total number of days lost, productivity lost was quantified by multiplying by average daily wage. In the absence of better data on morbidity this is a common approach employed in the academic literature.

2. Projections

Future health care costs

Future health care costs are forecasted by creating a disease profile in the population using hospital admission statistics[6]. The historic data on hospital admission statistics are overlaid with the expected future population structure. This allows us to estimate the size of the economic burden between 2014 and 2020 taking into consideration the effect of ageing populations.

Future indirect costs: productivity foregone from premature mortality

The cost from premature mortality in the future is also projected. As a first step in estimating the cost from premature mortality, mortality from CVD is forecast from 2014-2020. For this estimates of population mortality by gender and age band from the WHO Office for Europe mortality database are used. These are combined with population forecast provided by the UN and on this basis forecast for the years 2014-2020.

Using the mortality forecasts, the cost to the economy from premature mortality is estimated. The future costs can be quantified by valuing the labour of those dying prematurely at their annual salary, calculating their life time earnings left and discounting these appropriately. Annual salaries are projected into the future using forecasts of average earnings growth.

Future indirect cost: productivity foregone from morbidity

Forecasts for the second component of the indirect costs from cardiovascular disease have also been undertaken. However, it has to be noted that, as with the current indirect cost: productivity foregone from morbidity, the modelling had to rely more on proxies here than for the rest of the report. Whilst this is common in the existing research, due to a lack of suitable data being available, as consequence the results are likely to somewhat underestimate the real costs.

Using historic data on hospital admission statistics available from Eurostat as a proxy for prevalence rates, these are overlaid with the expected future population structure which allows estimation of the population affected by cardiovascular disease between 2014 and 2020. The morbidity costs are then quantified in the same manner as for the current costs.

[6] In the absence of better data on prevalence and incidence rates hospital admission statistics are often employed as a proxy.

Appendix II - WHO Definition of CVD

WHO Classification of cardiovascular disease		
I00–I99 – Diseases of the circulatory system	**(I00–I02)** Acute rheumatic fever	I00 - Rheumatic fever without mention of heart involvement I01 -Rheumatic fever with heart involvement I02 - Rheumatic chorea
	(I05–I09) Chronic rheumatic heart diseases	I05 - Rheumatic mitral valve diseases I06 - Rheumatic aortic valve diseases I07 - Rheumatic tricuspid valve diseases I08 - Multiple valve diseases I09 - Other rheumatic heart diseases
	(I10–I15) Hypertensive diseases	I10 - Essential (primary) hypertension I 11- Hypertensive heart disease I12 - Hypertensive renal disease I13 - Hypertensive heart disease and Hypertensive renal disease I15 - Renovascular hypertension
	(I20–I25) Ischemic heart diseases	I20 - Angina pectoris I21 - Acute myocardial infarction I22 - Subsequent myocardial infarction I23 - Certain current complications following acute myocardial infarction I24 - Other acute ischaemic heart diseases I25 - Chronic ischaemic heart disease
	(I26–I28) Pulmonary heart disease and diseases of pulmonary circulation	I26 - Pulmonary embolism I27 -Other pulmonary heart diseases I28 -Other diseases of pulmonary vessels
	(I30–I52) Other forms of heart disease	I30 - Acute pericarditis I31 - Other diseases of pericardium I32 - Pericarditis in diseases classified elsewhere I33 - Acute and sub acute endocarditis I34 - Nonrheumatic mitral valve disorders I35 - Nonrheumatic aortic valve disorders I36 -Nonrheumatic tricuspid valve disorders I37 - Pulmonary valve disorders I38 - Endocarditis, valve unspecified I39 - Endocarditis and heart valve disorders in diseases classified elsewhere I40 - Acute myocarditis I41 - Myocarditis in diseases classified elsewhere I42 - Cardiomyopathy I43 - Cardiomyopathy in diseases classified elsewhere

		I50 - Heart failure I51 - Complications and ill-defined descriptions of heart disease I52 - Other heart disorders in diseases classified elsewhere
	(I60–I69) Cerebrovascular diseases	I60 - Subarachnoid haemorrhage I61 - Intracerebral haemorrhage I62 - Other non-traumatic intracranial haemorrhage I63 - Cerebral infarction I64 - Stroke, not specified as haemorrhage or infarction I65 - Occlusion and stenosis of pre-cerebral arteries, not resulting in cerebral infarction I66- Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction I67 - Other cerebrovascular diseases I68 - Cerebrovascular disorders in diseases classified elsewhere I69 - Sequelae of cerebrovascular disease
	(I70–I79) Diseases of arteries, arterioles and capillaries	I70 - Atherosclerosis I71 - Aortic aneurysm and dissection I72 - Other aneurysm I73 - Other peripheral vascular diseases I74 - Arterial embolism and thrombosis I77 - Arterial embolism and thrombosis I78 -Diseases of capillaries I79 - Disorders of arteries, arterioles and capillaries in diseases classified elsewhere
	(I80–I89) Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	I80 - Phlebitis and thrombophlebitis I81 - Portal vein thrombosis I82 - Other venous embolism and venous thrombosis I83 - Varicose veins of lower extremities I84 - Haemorrhoids I85 - Oesophageal varices I86 - Varicose veins of other sites I87 - Other disorders of veins I88 - Nonspecific lymphadenitis I89 - Other non-infective disorders of lymphatic vessels and lymph nodes
	(I95–I99) Other and unspecified disorders of the circulatory system	I95 - Hypotension I97 - Post procedural disorders of circulatory system, not elsewhere classified I98 - Other disorders of circulatory system in diseases classified elsewhere I99 - Other and unspecified disorders of circulatory system