3. PART 1: THE IMPACTS OF THE ALTERNATIVE SCENARIOS OF SECESSION

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P art 1 focuses on the quantification of the economic implications for Catalonia in the event of becoming an independent state. This is a challenging task since such a decision would trigger a long chain of events, marked by a transition period and hence high uncertainty. Therefore, caution has been taken in formulating certain plausible scenarios that allow the capturing of some of the most important mechanisms in the adjustment process of Catalonia towards an independent state. Towards this end three scenarios have been quantified: a) a business as usual reference scenario in which Catalonia remains an integrated autonomous community of Spain and the fiscal imbalances with the Spanish Administration remain as they are, b) a mutual agreement scenario, in which negotiations are successful and Catalonia secedes from Spain, while agreeing to undertake 20% of Spanish debt and c) a unilateral secession scenario in which negotiations fail and Catalonia secedes from Spain, undertaking to service **12% of Spanish debt**. Different interest rates and transition periods are assumed to prevail in each secession scenario, reflecting the different degree of underlying uncertainty. The case where negotiations would lead to extra fiscal autonomy within Spain has not been examined.

The scenarios have been quantified with the use of an applied Computable General Equilibrium model, further developed and calibrated so as to include Catalonia as a separate region. The model is recursive dynamic with projections up to 2030. Modeling work in the context of this study has focused on the reproduction of key elements of macroeconomic interdependence between Catalonia and the rest of Spain. The model computes endogenously the transactions of Catalonia with its trading partners.

The results indicate that the Catalan economy benefits from secession, in both scenarios examined. The improvement can be mainly attributed to two factors: first to the correction of fiscal imbalances with the Spanish administration and second due to the productivity effects induced from investment in infrastructure. The benefit is stronger if secession is the product of mutual agreement with Spain. In this scenario, the lower uncertainty associated with Catalonia's future economic prospects boosts economic

growth, despite the higher debt burden that Catalonia is committed to service. In the secession scenario under unilateral action, Catalonia grows at a pace which is slower than the mutual agreement scenario, but still above the reference scenario. Higher uncertainty surrounding the macro-economic environment, and currency arrangements, weak market confidence and by implication the longer transition period that characterizes the unilateral scenario slow down activity particularly in the short term. In the long term uncertainty lowers and developments in Catalonia resemble those recorded in the mutual agreement secession scenario. Relative to the reference, in the mutual agreement scenario, Catalonia sees its GDP increase by €110 billion over the 2015-2030 period, whereas in the unilateral secession scenario its economy adds €67 billion over the same period. In 2030, unemployment is lower than reference by 3.1 percentage points in the mutual agreement scenario, and by 3.2 per cent in the unilateral action scenario.

Finally, part 1 provides useful insights on the optimal use of the additional revenue that remains with the Catalan government, once secession takes place and its fiscal deficit vis-a-vis the Spanish administration is corrected. The three scenarios are premised upon the assumption that the Catalan government would have a balanced budget and would use the additional funds so as to increase public consumption and to reduce labour costs (the split of the budget between the two options has been assumed to be equal). Three alternative uses of such funds have been examined with the aim to identify the allocation that would be more efficient in stimulating economic activity: i) reduction of indirect taxes ii) reduction of employer's social security contributions and iii) increase in public expenditure. Among the three options considered, the reduction of indirect taxes is found to be most beneficial in terms of GDP, employment and competitiveness.

3.1. Introduction

Catalonia is a well-defined territory within Spain, with distinctive language, cultural, economic, legal and political identity. These characteristics, together with the historical existence of a Catalan sovereign state since the middle ages to early modern times, have long triggered calls for self-determination in Catalonia. These calls have gained strength progressively over time and complemented by a fundamental discontent for the chronic fiscal imbalances with the Administration of Spain. According to the Generalitat of Catalonia (2013), Catalonia contributes more than 19% to total revenues collected by the State's Administration but receives only about 14% of total expenditures undertaken by the latter. The economic implications of the possible secession of Catalonia from Spain are not straightforward and the lack of prior experience or similar cases in the context of the European Union, renders the *a priori* discussion of the impacts difficult. This study aims to assess the economic implications of a hypothetical secession of Catalonia from Spain. For this purpose alternative hypothetical secession scenarios have been developed and quantified with the use of a new dedicated version of the GEM-E3 computable general equilibrium model (the GEM-E3-CAT) that allows the detailed examination of the Catalan economy, and its interconnections with the rest of Spain and the rest of the world. The alternative scenarios have been designed taking into consideration the associated uncertainty and possible modeling limitations of secession, as well as the need to have

sufficiently contrasted scenarios and to include the appropriate theoretical considerations.

Extensive model development has been undertaken to include Catalonia as an individual region in the GEM-E3 model (the regional and sectoral disaggregation of GEM-E3-CAT and a brief description of the model are provided in Appendix A).

As a first step, an effort to split data on Catalonia from those available for Spain has been made. For the individual inclusion of Catalonia in the model appropriate assumptions have been employed with regards to the exogenous parameters of the model so as to reflect the alternative scenarios' assumptions. These include: fiscal parameters, such as public budget, government expenditure, debt, interest rates, infrastructure development and sectoral productivity.

The GEM-E3-CAT model projects macroeconomic and sectoral developments up to 2030, delivering trajectories for a broad range of variables including GDP, investment, employment, activity by sector, trade, public budget and current account balance. Catalonia is identified in the results as a separate region, but the model delivers results also for the rest of Spain, the rest of the EU, the rest of the world and for the world as a whole. The model builds on a reference scenario that projects developments in a "business as usual" approach, where policies and trends observed in the recent past are assumed to continue to prevail up to 2030. In the reference scenario Catalonia continues to be an integrated autonomous region of Spain and it continues to bear the consequences of the fiscal imbalances with the Administration. Subsequently, alternative scenarios are developed the results of which are juxtaposed to those of the reference scenario, enabling to evaluate their relative performance.

The secession scenarios are formulated on the basis of different conditions that would underline the negotiated separation process. These are associated with the degree of agreement or consent of Spain and of the rest of the EU to the independence of Catalonia. This will essentially determine the share of the Spanish debt that Catalonia will undertake under independence, the fiscal policy that independent Catalonia will implement, market perceptions on the long term economic viability of Catalonia's independence, etc. Central to the secession scenarios is the termination of the current fiscal deficit of Catalonia with the Spanish Administration: revenues collected in Catalonia and transferred to the State's Administration in the reference scenario ceases to be transferred in the secession scenarios. These funds thus remain with Catalonia and are directed to the financing of government spending, infrastructure investment, interest payments, bond redemptions etc.

The alternative secession scenarios simulated with the GEM-E3-CAT model are as follows:

I.   **Catalonia's secession following mutual agreement with Spain**: In this secession scenario Catalonia secedes from Spain following bilateral agreement with the latter and the EU. Constructive negotiations and final consent from Spain on secession determine the share of Spanish debt that independent Catalonia agrees to undertake. Catalonia is assumed here to undertake a share of Spanish debt that is proportional

to its contribution to the Spanish GDP, accounting roughly for 20% of the Spanish debt. The transition period to an independent Catalan state which enjoys adequate market confidence is assumed to be rather short-lived in this scenario. Due to the mutual agreement on secession the uncertainties regarding future developments associated among others to currency arrangements, European Union membership, its debt profile, fiscal sustainability, the credibility of policy announcements, etc. are perceived to be lower and the risk and thus the interest rates that Catalonia will be faced with are not expected to be too elevated or highly volatile.

II. Secession following unilateral decisions of Catalonia: In this scenario Catalonia secedes from Spain without the consent of the latter, or of the EU. There is no agreement on the amount of debt that Catalonia will undertake. Catalonia undertakes the repayment of the part of Spanish debt which is held by Catalan economic agents (households, firms etc.). This is estimated to account for approximately 12% of the Spanish debt. However, the failure of the negotiating process would give rise to stronger confidence disruptions. Accordingly, the transition period is assumed to be longer and subject to higher volatility. Perceived risk increases. A larger degree of uncertainty prevails until a number of issues are settled: currency issues, deficit and debt policy, creditworthiness of the new sovereign state, financial market response, the state of affairs between Catalonia, Spain and the EU. The risk and thus interest rate Catalonia faces in this scenario is higher compared to the scenario of Catalonia's secession following mutual agreement.

The results indicate that sovereignty, in either case, allows the Catalan economy to reap the benefits of higher public spending and investment in infrastructure as the fiscal deficit with Spain ceases to exist and the additional funds are directed towards the financing of its own needs. Investment in infrastructure particularly improves the long-term productivity of Catalonia adding further to the positive effects of secession. The economic effects of secession are stronger for Catalonia in the case where independence follows mutual agreement with Spain. On the other hand, independence bears some significant negative repercussions. First, given that Spain is by far the largest trading partner of Catalonia, secession is shown to have an adverse impact on export activity of Catalonia towards Spain, largely attributed to lower import demand from the latter. Catalonia would also suffer from a loss of competitiveness triggered by higher labor costs under independence. With regards to risk and investment, Catalonia would find itself in a better position under secession following mutual agreement as the impact on interest rates, investment and savings is lower and rather short-lived in this case.

The remainder of the study develops as follows: Section 3 reviews the economic literature on secession and its implications for the seceding state, before it turns to an overview of the literature specific to the case of Catalonia. Section 4 reviews recent economic developments in Catalonia and historic trends of the deficit of Catalonia with the State's Administration which is the main economic reasoning underlying Catalonia's calls for secession. Section 5 presents the methodological approaches to modeling the hypothetical secession of Catalonia from Spain. Section 6 summarizes the simulation results on the alternative secession scenarios. Last section concludes.

3.2. Theoretical approaches to secession

3.2.1. Review of the literature

Several studies to date have looked at the factors triggering secession and its economic ramifications. The economic literature identifies several motivating factors which among others include:

i)   Differences in policy preferences (Yarborough and Yarborough, 1998) and, more generally, heterogeneity
ii) Variation in the efficiency of redistribution and mutual insurance, and prospects for economies of scale in public-goods provision (Buchanan and Faith, 1987; Casella and Feinstein, 1992)
iii) Inter-regional differences in taxation effort (Brosio et al, 2002)
iv) Public-finance benefits of large jurisdictions versus the costs of political heterogeneity (Bolton et al, 1996; Bolton and Roland, 1997; Alesina and Spolaore, 1997)

In modeling secession more common are the assumptions about the international economy and trade. In the globalizing economy the importance of intra-country (or inter-regional) trade is generally declining relative to international trade, so the home market can be portrayed as less essential than it was (Young, 2004). The argument becomes more relevant since the access to foreign markets is secured by international trade regimes (i.e. as in the EU, the WTO, NAFTA, etc.) thus small seceding states are less vulnerable than in the past because larger economies cannot close off market access to them. Alesina et al (2000) show that under free trade and global markets even relatively small cultural, linguistic or ethnic groups can benefit from forming small, homogeneous political jurisdictions. Becker, (2009) concludes that due to the growth of the global economy and globalized trading, small nations can benefit economically more than larger ones.

To date economic theory offers no conclusive results on the impact of secession and the long-term economic viability of the emerging states (see Table 1 for a summary of the indicative literature). No clear evidence can be drawn on whether smaller states do worse and grow more slowly than the bigger ones. The literature offers some discussion on both the *pros* and the *cons* of secession and how it can affect the resulting states. However the empirical validation of the secession effects remains rather limited given the relatively few case studies that can be examined. Indicative examples of secession in modern times include the breakup of the Soviet Union, the Yugoslav Republic and Czechoslovakia. However little inference and analogies can be derived from the study of these cases given the particularities and the underlying political and economic conditions in each case.

In 1991 the Soviet Union disintegrated into fifteen separate countries. This was the joint result of failure to create a unified, centralized socialist state which underestimated the degree to which the non-Russian ethnic groups resisted assimilation into a Russianized State and of the failed economic planning to meet the needs of the State, leading thus to economic decline and disintegration. The emerging states declared independence in a peaceful manner and most of them had to undergo a lengthy transition period

with significant impacts on their economies and governance structures. In all the newly independent states the transition regarded their transformation from centrally planned economies to free market economies but also the establishment and the modernization of the existing institutions so as to support a market economy and democratic governance.

Czechoslovakia experienced a two-fold break-up in 1993. The country first disintegrated as a political union, while preserving an economic and monetary union. The Czech-Slovak monetary union collapsed shortly after. This was the result of a failure of the regions to integrate, along with low labor mobility and higher concentration of heavy and military industries in Slovakia, which made the Czechoslovak economy vulnerable to asymmetric economic shocks such as those induced by the economic transition (Fidrmuk and Horvath, 1999). In the longer run, appropriate policy, structural and market reforms can lead to improved outcomes.

The break-up of the Yugoslav Republic which led to the independent states of Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro, Kosovo and the Former Yugoslav Republic of Macedonia was the result of the cultural and religious divisions between the ethnic groups making up the nation and of the centrifugal nationalist forces. The break-up also gained inertia from a series of political events which exacerbated the inherent tensions in the Yugoslav Republic. Following the death of Tito in 1980, the 1974 constitution provided for the effective devolution of all real power away from the federal government to the republics and autonomous provinces in Serbia by establishing a collective presidency of the provincial representatives and a federal government with little control over economic, cultural, and political policy[4]. The split was also affected from external factors. The collapse of the Soviet Union and communism in Eastern Europe, the reunification of Germany and especially the reemergence of a sectarian state-led nationalism in Serbia served to erode Yugoslavia's political stability. As Eastern European states moved toward free elections and market economies, the West's attention focused away from Yugoslavia. This undermined the extensive economic and financial support necessary to preserve a Yugoslav economy already close to collapse, which in the absence of a Soviet threat to the integrity and unity of Yugoslavia and its constituent parts meant that a powerful incentive for unity and cooperation was removed.

Several of the resulting independent states became members of the EU after undergoing a prolonged negotiation period and candidate country status. For instance for the Central and Eastern European Countries, accession negotiations started in 1998 and for most countries negotiations were completed in 2003. These countries had developed already from 1991 onwards institutionalized ties to the EU in the form of the "Europe agreements", which considered cooperation in political, economic, cultural and other areas, a large degree of trade liberalization and the adoption of important parts of EU rules and policies (Goetz, 2004). The stance of the EU towards the new member states included an extended period of gradual approximation and adaptation, great emphasis on the adoption and full implementation of the *acquis* prior to accession and the detailed attention paid to domestic institutional capacity to implement it, the existence of a functioning market economy, as well as the capacity to cope with competitive pressure and market forces within the Union, among other considerations.

4. See: https://history.state.gov/milestones/1989-1992/breakup-yugoslavia

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Accession to the EU exerted "adaptive pressures" to the candidate countries with EU's influence being both direct and indirect (see Guillen and Pallier, 2004). Direct effects have been associated with legislation effects such as of the *Directives* and the *acquis*, the construction of the single market and the EMU. Indirect effects include soft legislation (like recommendations, National Action Plans and cohesion funds among other). Among the most important effects regarded the access of the new member countries to the single EU market and elimination of trade barriers.

Trade and single market effects have been associated with the benefits of access to a larger market and cost reductions (see Hoffmann, 2000 and Breuss, 2001 among others). Access to a single market resulted in an increasing competitive pressure for the accession countries, an increase of productivity (exploiting economies of scale) and also in a decrease of the price levels (via decrease in mark-ups). The Commission's review (see European Commission, 1996) showed that the single market has fostered the competitiveness and employment effects in the EU. General equilibrium modelling results based on the GEM-E3 model used in this review showed that EU GDP was higher by 1.1% under the single market compared to the GDP that EU would record in the absence of the single market. The results on the competitiveness effects of the single market are also confirmed in Allen et al (1998). In a more recent study Badinger (2007) finds reductions in price mark-ups after the single market came into force. However the author finds that regarding services, results are less encouraging. Mark-ups have been found to increase in the service sectors since the early 1990s, reflecting the weak state of implementation of the single market for services.

Theoretical discussions on possible secessions in EU have evolved around regions where such an option could be the case like Scotland, Flanders or Catalonia and others. Despite the rapid economic integration that has been taking place in Europe over the last decades, secession movements seem to gain speed in these regions over the last years. The secession calls have been associated with some similar features found in all three cases mentioned above (see Connolly, 2012). These regard:

i) A sense of cultural uniqueness. Catalonia, Scotland, and Flanders are well-defined territories with unique historical, cultural, economic and political identities, and they have maintained their unique identities despite being incorporated for long periods of time within larger states.
ii) High level of economic specialization and economic disputes. These regions are relatively richer compared to other regions in the respective countries. Regions have also recorded economic disputes with the respective parent states which have been exacerbated by the Eurozone crises.
iii) Considerable autonomy to administer own regional affairs making it thus easier to imagine a transition to total independence[5]. All three regions have obtained autonomous political institutions, which have tended to reinforce their separate identities and prompt demands for even greater self-rule.

In the latest financial crisis these regions were reluctant to bear the economic costs of recovery of the rest of the poorer regions in their parent countries (see Frayer, 2012; Ortiz, 2012 and Connolly, 2012 among others). On the opposite end national governments have made no efforts to

5. See: https://knowledge.wharton.upenn.edu/article/secession-answer-case-catalonia-flanders-scotland/

provide for a more fair allocation of costs and transfers to the regions claiming independence compared to other regions in their territory. It appears that this asymmetry has further intensified the calls for secession.

The EU legislation and treaties do not provide neither a legal basis for 'automatic' exclusion nor an 'automatic' or 'guaranteed' EU membership to a region going independent from a country that is already an EU member state. However when independence is imminent or has become an established fact, the reaction of the EU and its member states has traditionally been to come to terms with it, and to try to find a constructive solution for problems that may arise. According to official European documentation (see the 3.4.2003 Official Journal of the European Union[6]) and to statements by senior European officials (see among others remarks made in Madrid of the former President of the European Council, Herman Van Rompuy on Catalonia[7] and comments by European Commission Vice-President Joaquin Almunia) "*if a part of the territory of a Member State ceases to be a part of that state, e.g. because that territory becomes an independent state, the treaties will no longer apply to that territory. In other words, a newly independent region would, by the fact of its independence, become a third country with respect to the Union and the treaties would, from the day of its independence, not apply anymore on its territory*". Accordingly, subnational entities declaring independence would most likely be required to re-apply for EU membership. A prospect that may delay or – in the extreme event – hinder the membership process is the following: the constitutional arrangements standing in the EU stipulate that any countries claiming independence have to be recognized from all EU member states prior to being accepted as independent member states. Such recognition may run against the interests not only of the 'parent' Member State, but also of other Members States which have interest in preventing the creation of a precedent, to secure the integrity of their own territory. As argued by Athanassiou (2009:8) in a European Central Bank Legal Working Paper, "*in all likelihood, the assumption that the EU would treat both the rump Member State and the seceding entity as Member States would not hold true, as the rump Member State could veto the accession of the seceding entity under Article 49 TEU (see Happold, pp. 33-34). Moreover, it cannot be in the EU's interest to have an ever increasing number of veto-wielding members, as this would make its business more difficult to manage*".

Although the prevailing view in the literature is that seceding states will have to reapply for union membership, it is also acknowledged that the whole set of lengthy procedures provided in the EU treaties granting membership would not need be strictly adhered to; a swift process to grant EU membership based on negotiation and agreement would rather be followed given that they already meet requirements and criteria to be in the EU and have long applied EU legislation (see among others Ferrando, 2013). Other authors (such as Avery[8], (2014) have argued that the implicit policy of the EU in relation to independentism in Europe consists of initial reluctance followed by pragmatic acceptance, provided that the process can be considered as constitutional and truly democratic.

Schafer (2003) argues that within the EU, given the increasing heterogeneity due to its enlargement and the trend towards centralization and redistribution, secession and opting out may emerge as important consti-

6. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2004:084E:0421:0422:EN:PDF

7. http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/ec/140072.pdf

8. http://www.epc.eu/documents/uploads/pub_4393_independentism_and_the_eu.pdf

tutional arrangements for the EU as they can serve as instruments against stronger centralization and redistribution mechanisms. Secession may facilitate the mechanisms for the endogenous determination of the optimal size of the EU and for the increasing of the efficiency of the EU institutions in the sense of federalism theory.

With regards to secession calls in Belgium, the Flemish separatists have a long history. Several constitutional reforms have taken place since the sixties in order to accommodate secession calls resulting in a complex institutional structure for the country composed of three regions with wide legislative competencies, and three linguistic communities (German, French and Dutch) representing the three linguistic areas of the country (see Gullo, 2012). Regions and linguistic communities share power with the federal government, which holds very few powers apart from foreign and defence policy, social security, taxation and economic policy. This institutional architecture has been called "centrifugal federalism" (see Swenden et al., 2006) because instead of decreasing the demands of the linguistic communities/regions, they have actually encouraged demands for further decentralization.

Flanders' prosperity and calls for independence have much to do with its transformation into a knowledge-based economy with strong high-tech and services sectors, which is well-positioned between the neighboring markets of France, the Netherlands and Germany. The port of Antwerp (which is Europe's second-largest) lies only a few miles south of the border with the Netherlands, much closer to the Dutch sphere of cultural influence than to the French-speaking provinces of Belgium. The region overall is very well integrated with the European economy. As Hunin (2011) suggested Belgium might be headed towards its own "velvet divorce" similar to the case of Czechoslovakia. However in this case, the particularities regarding Brussels, the administrative capital of Europe, would be detrimental to developments. Central question here is whether Brussels will belong to either region or whether it could go as an independent capital state (see for instance Washington, D.C. in the USA) and also if Wallonia will remain independent or will adhere to France or look for other possible options (Germany, Luxembourg etc). So far the population of Flanders, in the event of independence, has not shown interest in joining the Dutch speaking country of The Netherlands.

Shieren (2000) discusses Scotland's independence from a political point of view. The author argues that the results and prospects of such independence will depend much on the EU's reaction to the latter. The question is whether the EU system can have any impact on the Scottish position and it seems that indeed it can have a great deal of impact. The status within the Community of an independent Scotland or of any successor state, even in the case of bilateral agreement between England and Scotland, is likely to be determined by the rules of Community law as interpreted and applied by the Court of Justice. The author concludes that according to European and international law Scotland cannot legally withdraw from the Community unilaterally. According to European and international law Scotland is not entitled to accede to the European Community Treaty as the result of an obtained right. For this it would need the tacit or formal consent of all member states. However there is good reason to doubt that the European member states would be prepared for a tacit or formal consent to Scottish separation[9].

9. Other member countries faced with separatist movements like Spain or Belgium may veto Scottish separation. This can be a case for Catalonia secession as well (see discussion in the following section). In any case it appears very important in determining developments the reaction of the rest of the EU member states.

Murkens (2001) argues that if Scotland went independent and was to apply to become an EU member state the possibility of transition periods should be noted. The process of negotiation of accession into the EU is perceived as unlikely to be easy even for Scotland. Evidence from other candidate countries suggests that the EU uses its pre-accession bargaining strength to extract the maximum concessions from acceding parties. Moreover, any accession treaties have to be ratified by all national parliaments, a lengthy process which can take much longer if major issues are at stake, or the treaty is rejected by a national parliament or in a referendum. In economic terms Holitscher ads Suter (1999) argue that although for Scotland, the EU is regarded as a means to gain more political influence on domestic affairs and local control of economic resources, its importance in economic terms cannot be disregarded. The authors conclude that in the absence of the European single market Scottish independence would be elusive.

In the literature secession effects have been discussed on the grounds of the ethnic homogeneity of the resulting states. Vaubel (2013) argues that if secession is motivated by ethnic differences, which does not apply to the Catalan case, the resulting states will be more homogenous, thus having stronger bonds of solidarity. Empirically, social expenditure as percentage of GDP is found to be higher in more homogenous countries. Thus secession may permit more redistribution. In addition secession strengthens competition among governments, thus by putting politicians under pressure secession may improve their performance. Competition among democratic governments limits the tax and regulation burden as people have more alternatives ("exit" or "yardstick competition"). Weingast (2013) argues that decentralizing authority to regions with more homogeneous populations allows these groups to live in harmony within a larger state (which seems to play a role in "holding together" countries like Belgium, India, Spain, and the Netherlands; see Lijphart (1975) and Stepan (2004)).

A further argument in support of secession and the smaller resulting states is associated with the diseconomies of nation scale that may arise in large and heterogeneous states. Traditionally larger size countries have been associated with larger administrative costs. In large countries, administrative and congestion costs may overcome the scale benefits of size. As countries become larger, diversity of preferences, culture, language and "identity" of their population increases (Alesina, 2003). However it has to be noted here that this stance has been challenged in other studies which argue that the costs of administration and policy coordination are correlated with the different political systems and administrative technology rather than the size of the state (Wittman, 2000).

Bednar (2007) argues that secession and exit alternatives substitute for voice by being an option to use instead of within-system protest; without contradiction, they also increase (complement) voice (Hirschman 1993, Gelbach 2005, Clark et al, 2006) by improving the threat point or bargaining position. In analyses of decentralized systems, exit options lead to subnational gains because the subnational government is able to extract a greater distributional allocation from the State (Treisman 1999; de Figueiredo and Weingast 2005). In general exit options are found to improve utility.

Concerns on the secession effects have focused on the growth prospects of smaller states. However in their study of small states, Easterly and Kraay (2000) find that small states have on average higher GDP per capita and productivity levels compared to large states and grow no more slowly than the latter. The productivity advantage of small states is associated with their human capital differences from the rest of the world. Small states need to rely on imported technology and high quality human capital to compensate for their lack of natural resources.

On the negative effects of secession and exit options authors point to the "home bias" puzzle or border effect (see McCallum, 1995) according to which a simple administrative border imposes a disproportionately large barrier to trade between two countries that are very similar. The administrative border is found to have an even larger effect on trade on countries that are much less alike (Anderson and van Wincoop, 2003). In contrast the merger of states reduces inter-state transaction costs (however it increases intra-state transaction costs, therefore small states can be economically viable, especially if they have access to major trading routes). In fact amongst the 10 richest countries of the world, in terms of GDP per capita, a majority of them can be regarded as small nations.

Alesina et al (2005) show that heterogeneity in large countries may be associated with some benefits. The benefits are associated with trade and stem from a kind of heterogeneity – the production of different intermediate goods by different regions –and this is why a larger country, for given barriers to trade, brings net economic gains through the trade channel.

Table 1. Indicative findings and literature on secession	
Positive effects of secession	**Indicative literature**
-Small countries can be less vulnerable if access to markets and free trade agreements are in place	Young (2004)
-Seceding states are more homogenous, and social expenditure as percent of GDP is higher -Increased competition among national and seceding governments improves performance	Vaubel (2013), Weingast (2013)
-Seceding states are not subject to diseconomies of nation scale which may be present in large and heterogeneous states	Alesina(2003)
-Seceding sub-national governments can extract greater distributional allocation from the center	Treisman (1999); de Figueiredo and Weingast (2005)
-Small states are found to have on average higher GDP per capita and productivity levels compared to large states (skills creation due to lack of natural resources)	Easterly and Kraay (2000)
Negative effects of secession	Indicative literature
-Border effect of secession: Simple administrative borders impose a disproportionately large barrier to trade between countries, even similar ones	McCallum (1995), Anderson and van Wincoop (2003)
-Heterogeneity benefits in large countries (trade, production of different intermediate goods from different regions)	Alesina et al (2005)
-Large countries may be faced with benefits of scale (market size) and can provide "insurance" to their regions. Larger countries are less subject to volatility and business cycles	Alesina (2003), Griffiths et al (2013)
-Management of interregional goods may be better in large united states	Vaubel (2013)
What may determine the impact of secession	Indicative literature
-Debt-sharing across regions and generations	Cattoir and Docquier (2010)
-Transition period, transition costs and bargaining power in secession negotiations	Murkens (2001), Schroeder (1992), Grady (1991)

Source: Authors' notes

A large literature on "endogenous growth" emphasizes the benefits of scale and the fact that large countries can provide "insurance" to their regions. Alesina (2003) points out that the size of the countries affects the size of their markets and that larger economies and larger market increase productivity as larger countries can reap the benefits of economies of scale and scope. In addition larger countries can be less subject to volatility and business cycles. In times of recession, regions which perform worse than the large country average may receive net fiscal transfers from the rest of the country. Obviously, the reverse holds as well. If the smaller regions would be independent they would have a more pronounced business cycle because they would not receive help during especially bad recessions, and would not have to provide for others in case of exceptional booms. The benefits of insurance are even more obvious in the case of natural calamities (for instance an independent region hit by a disaster would probably receive less help as an independent country than as a region of a larger country).

In terms of national security secession may hamper the defense of the resulting states (or generate excessive tax burden for it) in the resulting smaller state. Griffiths et al (2013) argue that large states are generally better at defense because they have more land and a bigger population, and they can reap the benefits of having large internal economies of scale. In contrast, the attraction of small states is that the locus of decision making can be moved closer to one's own preferences.

Vaubel (2013) argues that secession raises questions about interregional goods (i.e. water resources, pollution etc.) which are shared between regions. In a united state the management of interregional goods would be decided centrally and tax burden applied equally among regions. Secession may increase per capita tax burden and average cost in the resulting states (depending on which state gets the highest share or proportion) and particularly in the smaller newly autonomous state. This may have further negative spillovers in the bordering state(s).

Finally Cattoir and Docquier (2010) point to the importance of debt sharing under secession in determining the economic viability of the emerging states. Whether secession is a better or worse option depends on the decisions on debt-sharing across regions and generations. States claiming independence may have limited bargaining power over debt sharing and may end up with a disproportionately large debt burden which may doom their autonomy prospects.

In the long run, the success of secession is associated with whether a regional economy, organized as a sovereign state, can achieve a higher growth trajectory than that achieved as being a region within a larger state. The literature points to the fact that the outcome will depend on many factors like: how much economic integration continues between the resulting and the predecessor state, how well the newly sovereign country is accommodated within international regimes, how confident foreign investors are, and so on (see Young, 2004 for a detailed analysis).

Apart from these considerations equally important remains the question of the transition to sovereignty costs (Schroeder, 1992). Transition costs

are more proximate in time, and therefore easier to assess, though still highly contestable and may outweigh the long-term benefits of secession. The literature points to several components of transition costs like:

i) Transaction costs which include resources devoted to negotiating new constitutional arrangements and settling substantive matters like the division of the debt and assets;
ii) Trade relations;
iii) Defense arrangements;
iv) Citizenship issues;
v) Costs of transferring programs, revenue sources, and public servants and of re-organizing administrations;
vi) Very substantial but hidden costs to firms and citizens of learning about the new arrangements and accommodating their behavior to them.

Other transition costs may include fiscal costs (when a region is seceding, it may have to increase taxes to pay for public services) and uncertainty costs. Uncertainty costs are the ones that have been discussed as more substantial in transition costs (see Grady, 1991 and Young, 2004 among others). They arise because economic actors have less confidence in their expectations about future conditions. Uncertainty costs occur throughout an economy, involving individuals deciding where to live, firms making choices about investment and purchases, creditors contemplating loans, and so on. Uncertainty costs considerably increase due to (see Young, 2013):

i) Political risk, or uncertainty over the impact of political and institutional change on public policies;
ii) Default risk, because of uncertainty about the creditworthiness of the emerging states;
iii Currency risk due to uncertainty on new currency arrangements and on future exchange rates;

Elevated uncertainty during the transition period can give rise to additional costs as it may be associated with limited access to capital markets, subdued investment, relocation of industries, the potential for capital flight and emigration, trade disruptions, and subsequent negative repercussions on unemployment and government revenues. Such disruptions may cause irreversible changes which may undermine tapping on potential benefits of secession at steady state.

3.2.2. Studies on the implications of Catalonia's secession

To date a number of studies have assessed Catalonia's secession and its implications. Griffiths et al (2013) propose a game theoretical model to assess the capacity of Catalonia to become a recognized, independent country with at least a *de facto* EU membership. Their model predicts an agreement in which Spain and the EU accommodate Catalan independence in exchange for Catalonia taking a share of the Spanish debt. If Spain and the EU do not accommodate, Spain becomes insolvent, which in turn destabilizes the EU. The authors conclude that the current economic woes of Spain and the EU both contribute to the desire for Catalan independence and make it possible.

Padrol (2012) reflects on the prospects of Catalonia's managing all taxes paid in the region in case of Catalonia's secession with the purpose to study the action of the Catalan Tax Agency. To perform the analysis, the different areas where the performance of the Tax Agency is projected are taken into consideration. These areas include the struggle against tax fraud, adequate level of legal certainty taxes for citizens and businesses, and assistance of the taxpayer in the voluntary fulfillment of their tax obligations and, in general, in relation to the different steps that individuals and businesses must meet towards the tax authorities. The author concludes that the management of all taxes paid in Catalonia by the Catalan Tax Agency could improve the efficiency of the public function in any of the latter areas.

Bosch and Espasa (2012) analyze the feasibility of Catalonia as an independent state from the perspective of its public finances. The study concludes that taking the level and structure of earnings and current public spending in Spain and on the assumption that Catalonia inherited them if it became an independent state, it would experience a net gain in terms of public revenues (depending on the year of analysis). The authors find that Catalonia can be completely feasible as an independent state with regard to its treasury, since it would maintain current spending levels and tax burden. Catalonia would be a state with a volume of spending in relation to the GDP comparable to other countries in the EU15, of a 38.9% of GDP. Regarding the tax burden (taxes as % of GDP) it would be placed at the bottom of countries in the EU15, with a 31.4%. Overall the authors conclude that Catalonia could have viable public finances as an independent state and considering the current condition of the Spanish public sector, would have additional net revenues.

White and Brun-Aguerre (2012) argue that an independent Catalonia might be fiscally credible over the long term but in the short run it will have to deal with significant fiscal and political questions. Transition costs of secession are estimated to be relatively high and impact significantly the independent region but also Spain. The authors provide estimations on the costs faced by Catalonia in the case of taking over various shares of the national commitments. Estimations based on 2005 data suggested that if Catalonia would undertake 100% of the total costs of national commitments, this would account to 11.6% of Catalonia's GDP.

Cominetta (2012) is less optimistic of the outcomes of Catalonia's secession. In the case where Catalonia is fully reneging on its part of the Spanish government debt and that net fiscal transfer to Spain are as big as estimated by the Catalan government (best case scenario) it is estimated to have a 20% debt/GDP levels and a 4% fiscal surplus. Even in this case the economic prospects of the region are deemed as disastrous as in all likelihood independent Catalonia would be left outside the EU and the Eurozone (no estimations on the economic prospects in the case where Catalonia is left outside the EU and the Eurozone are provided). This would have rampant effects on the new state as Catalonia would lose access to its predominant export market and it would have to introduce a new currency, with all the attached costs and risks. In addition an independent Catalonia would have to serve a public debt fully denominated in a foreign currency, without access to bond markets and without the European Stability Mechanism (ESM) and the European Central Bank (ECB) protection. Thus a sovereign default, bank runs and a huge drop

in wealth and income are estimated to be the most likely outcomes of Catalonia's secession.

On the political appraisal of the questions associated with secession Gounin (2013) argues that according to the EU legislation any seceding country will be considered a non-member of the EU and will have to undergo the same application process for EU membership as other candidate countries. However the author challenges the practical implementation of such stance as he finds it difficult for nations like Catalonia, Scotland or Flanders (region according to their legal status) to be treated like Serbia, Turkey, Moldova or other countries wanting to join the EU. Since these countries are already regions of the EU and have made explicit their intention to be considered part of the Union, it is hard to imagine developments like the EU sending forces to guard the borders with these regions. The author notes that the decline of the EU to accept as members the seceding states would contradict the founding values of the EU as the right of the regions to self-determination will be disregarded. Gounin (2013) argues that a better and plausible alternative would be the EU to negotiate simultaneously independence and EU membership of the seceding states.

A similar view is developed in a recent report prepared by the Government of Catalonia on *"Paths for Catalonia's integration in the European Union"* (see Generalitat de Catalonia, 2014). The report discusses whether a future Catalan state would be left in or out of the EU and, if the second case would apply, what would be the alternatives to re-enter the Union. The report further develops the practical consequences of the hypothetical Catalan secession and EU-entry scenarios. From the perspective of the Government of Catalonia the following alternatives are discussed:

i) Permanence scenario where the independent Catalan state retains the uninterrupted membership to the EU
ii) *Ad hoc* membership scenario where the EU does not automatically accept Catalan permanence in the Union but, given the special circumstances in this case it decides to begin the process of membership with specific features so as to allow for rapid accession
iii) Ordinary membership scenario where the EU agrees to immediately open the procedure for ordinary membership as a third state
iv) Exclusion as a member state scenario where the EU refuses to open the formal procedure for membership and the new independent Catalan state is left out of the EU *sine die*

In analyzing the alternatives following secession and Catalan EU admission the report concludes that two important factors have to be kept in mind when discussing the future developments: First, neither international law nor EU law make explicit provisions for the future of seceding states. Second, experience shows that the EU has traditionally taken a rather flexible and pragmatic approach to addressing unforeseen problems particularly those associated with the procedures for ratifying the treaties. However these factors do not mean that Catalonia's accession will happen in legal vacuum. A set of legal procedures can be applied in this case, but what might be different is the room for maneuver and freedom in interpreting the law that EU will give to itself in the case of Catalonia's secession (see Generalitat de Catalonia, 2014 for a detailed discussion).

For Catalonia, given its prior EU membership, it is argued that it could easily fulfill the requirements for entering the Union. What might be additionally needed might be the creation of regulating and coordinating bodies and of new organization structures in general which will be imposed by the EU as well as the need to transpose secondary European law to the new Catalan system. Given Catalonia's prior state of relations with the EU and its net fiscal contribution to the Union in case of being accepted as an independent state, the report argues that the most plausible scenario would be that of rapid accession under a transition regime, which nevertheless would have the same practical consequences with the case where Catalonia maintains its uninterrupted membership with the EU.

Overall the literature on secession, and particularly on the possible secession of Catalonia, offers a set of discussions on the causes, the consequences, possible outcomes and the economic ramifications of independence of the seceding states. The latter have been consulted when designing and quantifying the alternative scenarios of a hypothetical secession for Catalonia.

The following sections review the economic reasoning of Catalonia's calls for secession, the alternative scenarios simulated with the GEM-E3-CAT model and the methodological approaches to the latter.

3. 3. The economy of Catalonia: Recent developments and the fiscal deficit with the State's Administration

In economic terms, Catalonia is one of Spain's richest regions. It has a population of more than 7 million, GDP of around €200 bn (as of 2012) and per capita GDP of €27,500 before the crisis (in 2007). Per capita GDP exceeds the EU average: before 2008 GDP per capita in Catalonia was approximately 18% higher compared to the average EU GDP per capita, while Spain recorded GDP per capita values below the EU average by approximately 7%. Even though the financial crisis has depressed per capita wealth, Catalonia has maintained its above EU average position. Total population has been growing at 1.7% on average over the last decade slightly above the growth rate of total population of Spain (1.4%) over the same period. Population (total and active) of Catalonia has accounted for more than 16% on average of Spain's population (total and active respectively).

Catalonia's GDP has accounted for 20% of Spain's GDP on average in the last decade. Since the eruption of the economic and financial crisis, activity in the region has been adversely affected; GDP has dropped by several percentage points (Figure 1). In terms of employment, before 2008 Catalonia recorded lower unemployment rates compared to Spain (6.5% in Catalonia, 9% in Spain). However unemployment in Catalonia has risen considerably during the economic crisis: from levels below but close to 10% prior to 2008, to 16% in 2009 and to over 20% in 2012. Despite this recent increase, unemployment in Catalonia has remained below the Spanish average.

Figure 1. Real GDP growth in Catalonia, Spain and the EU28
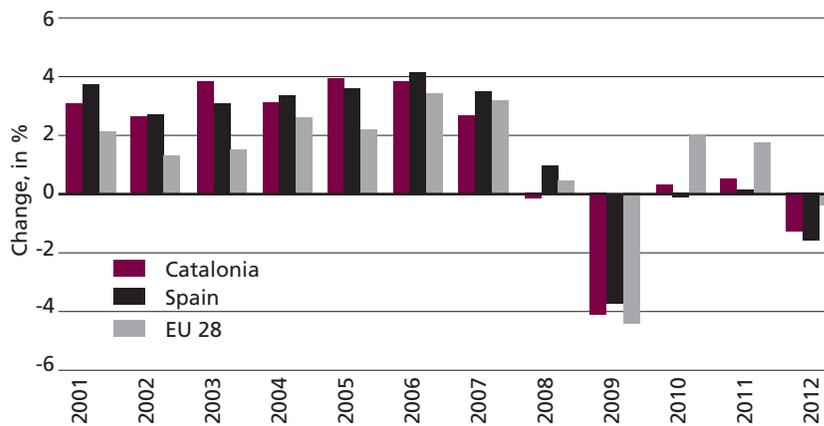
Notes*:* Spain includes Catalonia
Source*:* IDESCAT, Statistical Institute of Catalonia

Sectoral composition of Gross Value Added in Catalonia matches that of developed economies with services recording the largest share. Industry has also accounted for a relatively large share of gross value added, higher compared to Spain but with declining shares over the last decade.

Figure 2. Unemployment rate in Catalonia, Spain and EU28, in % of total labour force
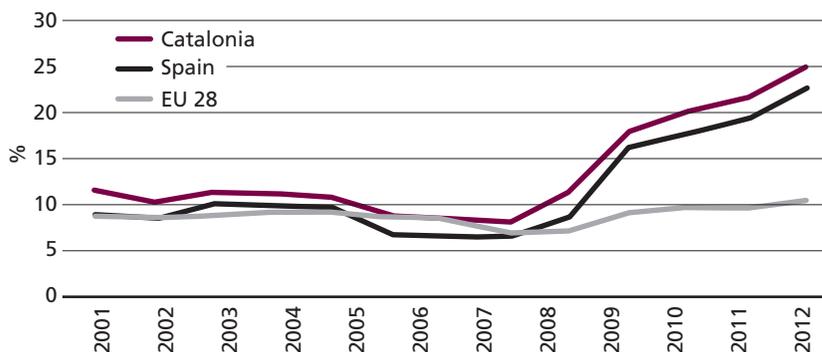
Notes: Spain includes Catalonia, EU regards EU28 excluding Croatia
Source: IDESCAT, Statistical Institute of Catalonia

One of the key economic drivers of Catalonia's calls for secession is the region's chronic budgetary deficit with the State'sAdministration and the perception that local taxpayers contribute disproportionately to Spain's national budget relative to the transfers they receive. Catalonia has been recording fiscal deficits *vis-a-vis* the State'sAdministration, which have been fairly constant over time. Catalonia's fiscal balance with the State's public sector is obtained by the difference between the expenditure which the State's public sector carries out in the territory and the volume of income deducted from it so as to finance the State's public expenditure as a whole. Fiscal balance measures the redistribution effect between territories of the State's Administration's policies (see Generalitat de Catalonia, 2013). When the income deducted from a territory exceeds the expenditure allocated to its citizens, the balance of fiscal flows with the State's

Government in the territory is negative, i.e. there is a net outflow of fiscal resources (fiscal deficit). In contrast, when the expenditure received exceeds the income contributed, there is a fiscal surplus.

The fiscal balance of Catalonia is estimated and made available by the Government of Catalonia using two standard methodologies: the monetary flow and the benefit flow. The monetary flow measures the economic impact caused by the activity of the State's Administration in a territory. The benefit flow measures the impact of an action of the State's Administration on the wellbeing of the residents in a territory. The differences between the two methodologies are minor as regards the allocation of revenues, as the agents finally bearing the tax (flow of benefit) generally reside in the territory where the tax is paid (monetary flow). The difference between the two methods is greater when allocating the expenditure: the benefit flow method takes into account - in addition to direct expenditure in the territory - the wellbeing generated for the individuals of a territory as a result of the expenditure made in another territory which also benefits them (Table 2). For example, Ministries are concentrated in a specific territory, but their activity benefits all the territories as a whole. The monetary flow method allocates all the expenditure of the Ministries where they are concentrated. The flow of benefit method allocates this expenditure among all the territories proportionally to their population. The allocation of expenditure to a territory entails, in certain cases, establishing an allocation hypothesis. For example, the payment of interest on the debt of the State is allocated proportionally to the expenditure of the State in each territory. According to the Government of Catalonia the monetary flow is best in capturing the impact of the stimulus of expenditure by the State's Administration on the recipient economies, thus it becomes the most important in times of economic crisis and high rates of unemployment (see Generalitat de Catalonia, 2013)[10].

Table 2. Objectives and methodology of monetary and benefit flow measures		
	Monetary flow	Benefit flow
Objective	Measurement of the economic impact of the activity of the State's Administration on a territory	Measurement of the impact of the State's Administration on the wellbeing of the residents in a territory
Allocation of revenue	In the territory where the economic capacity subject to taxation is located	In the territory where the agent bearing the tax burden resides
Allocation of expenditure	In the territory where it occurs, regardless of the geographic location of the final beneficiaries	In the territory where the beneficiary of the public spending resides, regardless of where the public service or investment is made

Source: Generalitat de Catalonia (2013)

The fiscal balance of Catalonia with the State's Administration has been stable over time (Table 3). Catalonia has contributed on average 19.5% to the revenues of the State's Administration and Catalans have received on average 14% of all the resources allocated by the State's Administration to the regions from 1986 to 2010 (Table 4). Even when estimations use the benefit flow approach the results are highly stable (figures are available for 2002 onwards). The data show that Catalonia has suffered a continuous negative shock on its economy as a result of the territorial fiscal deficit amounting on average to 8.1% of GDP in the 1986-2010 period. The stability of this result in this 25-year period is remarkable, ranging between 6.7% and 10.1% of the Catalan GDP.

Table 3. Evolution of fiscal deficit of Catalonia with Spain				
Catalonia's fiscal deficit with the State Administration				
	Monetary flow		Benefit flow	
Year	Millions of Euro	% of Catalan GDP	Millions of Euro	% of Catalan GDP
1986	-2,465	-6.8		
1987	-2,868	-7.0		
1988	-3,466	-7.5		
1989	-4,056	-7.7		
1990	-4,867	-8.3		
1991	-5,174	-8.0		
1992	-5,988	-8.6		
1993	-7,263	-10.1		
1994	-6,732	-8.8		
1995	-6,416	-7.7		
1996	-7,088	-7.9		
1997	-7,018	-7.4		
1998	-6,813	-6.8		
1999	-8,124	-7.5		
2000	-8,532	-7.2		
2001	-8,565	-6.7		
2002	-13,696	-10.1	-10,225	-7.4
2003	-13,036	-8.9	-9,586	-6.5
2004	-13,595	-8.7	-10,123	-6.4
2005	-14,186	-8.4	-10,141	-6.0
2006	-14,493	-7.9	-10,320	-5.6
2007	-15,913	-8.1	-11,136	-5.6
2008	-17,200	-8.6	-11,860	-5.9
2009	-16,409	-8.5	-11,261	-5.8
2010	-16,543	-8.5	-11,258	-5.8
Average		-8.10		-6.1
Standard deviation		0.90		0.6

Source: Generalitat de Catalonia (2013)

Table 4. Catalonia's fiscal balance with Spain				
	Monetary flow		Benefit flow	
Year	% revenue	% expenditure	% revenue	% expenditure
1986	18.9	14.2		
1987	19.0	14.2		
1988	19.0	14.0		
1989	19.1	13.9		
1990	19.2	13.8		
1991	19.3	14.0		
1992	19.4	14.1		
1993	19.3	13.7		
1994	19.3	14.0		
1995	19.8	14.8		
1996	19.9	14.7		
1997	20.0	15.0		
1998	19.6	15.0		
1999	19.7	14.3		
2000	19.7	14.4		
2001	19.7	14.6		
2002	19.8	13.0	19.5	14.4
2003	19.7	13.4	19.4	14.8
2004	19.6	13.3	19.3	14.6
2005	19.7	13.4	19.4	14.9
2006	19.6	13.7	19.3	15.1
2007	19.5	13.5	19.2	15.0
2008	19.3	13.5	19.0	15.0
2009	19.3	14.1	18.8	15.3
2010	19.4	14.2	18.9	15.4
Average	19.5	14.0	19.2	14.9
Standard deviation	0.3	0.5	0.2	0.3

Source: Generalitat de Catalonia (2013)

One of the core assumptions employed for the development of the reference scenario considers that fiscal imbalances of Catalonia with the State's Administration continue to prevail up to 2030. This assumption along with other projections adopted in the reference scenario and other methodological considerations are presented in the following section.

3.4. Modeling approach and methodological considerations

The analysis of the economic impact of the hypothetical secession of Catalonia from the rest of Spain draws on the results of the GEM-E3-CAT model. The GEM-E3-CAT model is based on the GEM-E3 model, a well-established and frequently applied in leading European research detailed recursive dynamic global CGE model[11]. Several modifications and extensions to the standard version of the model were required in order to make the model suitable for quantifying the Catalonia secession scenarios. In a first step, the regional classification of the model was further extended to include Catalonia as a separate region (a complete description is found in Appendix B). Toward this end statistics from different data sources have been collected and reconciled. The main source of data on the Catalan economy has been the Statistical Institute of Catalonia (IDESCAT). For the rest of the model regions data have been extracted from several sources including Eurostat, ILO, etc. The model is calibrated on the GTAP v.8 database. The time step of the projections of the model has also been modified so as to provide results on an annual basis up to 2020 and on a 5-year time step up to 2030. The following sections summarize the design of the reference and the alternative scenarios simulated.

3.4.1. The Catalan economy

The snapshot obtained for Catalonia shows that the Catalan economy is a service oriented one: the services sector accounts for more than 60% of the domestic production. The industrial sector has also been strong in Catalonia accounting for 32% of domestic production (Table 5).

Catalonia remains an open economy with the EU being its primary trading partner (Table 6). The rest of Spain is also an important trading partner of Catalonia with almost half of the exports and imports of Catalonia being directed to and originating from Spain in the base year. This is indicative of the strong interdependences that exist between Spain and Catalonia.

With regards to power generation in Catalonia, conventional sources account for a considerable share of electricity production, with gas accounting for 28%, indicating a dependence of Catalonia on energy imports (Table 7). Turning to security of supply and GHG emissions, Catalonia has a considerable share of nuclear power energy in electricity production in 2010 which accounts for more than 57% of electricity production.

11. The GEM-E3 model was originally developed in the '90s by a consortium involving the National Technical University of Athens, the Catholic University of Leuven (Centre for Economic Studies), the University of Mannheim and the Centre for European Economic Research (ZEW) as the core modelling team. Since the initial model version, E3MLab and other contributors have extended the model into various directions, including the development of model versions suitable for analysing growth, market reforms (e.g. EU internal market) and structural policies.
The model has been extensively used in a series of studies conducted for the European Commission and in several research projects. See: http://www.e3mlab.ntua.gr/index.php?option=com_content&view=category&id=36%3Agem-e3&Itemid=71&layout=default&lang=en, http://ipts.jrc.ec.europa.eu/activities/energy-and-transport/gem-e3/ Model versions have also been used in several scholar articles. Indicative is the work of Nemeth et al. (2011), Saveyn et al. (2011), Saveyn et al. (2012), Tsani et al. (2013) and Paroussos et al. (2014).

Table 5. Domestic production in Catalonia in the base year	
Sector	Share in domestic production in 2004, in %
Agriculture	1.1
Energy Sector[12]	2.4
Food products and beverages; Tobacco	5.5
Textiles	2.6
Pulp, Paper and Non metallic minerals	4.0
Basic metals	1.0
Chemicals	6.4
Fabricated metal products, except machinery and equipment	2.5
Machinery and equipment goods	3.8
Electric goods	0.6
Transport equipment goods	4.7
Other equipment goods	1.3
Construction services	10.9
Trade services	16.5
Transport services	5.5
Financial intermediation services	2.5
Other business services	14.5
Rest of market services	2.9
Recreational services	2.9
Non market services	8.3

Source: GEM-E3-CAT based on IDESCAT

Table 6. Main trading partners of Catalonia in the base year (2004)		
Partner	Exports, in % of total Catalan Exports	Imports, in % of total Catalan imports
EU28 of which	83.6	74.5
Spain	53.9	41.1
Germany	4.8	9.4
France	7.6	5.5
Italy	3.8	5.5
Portugal	3.0	1.3
Rest of EU	10.6	11.6

Source: GEM-E3-CAT based on IDESCAT

Table 7. Power generation in Catalonia in 2010	
Energy source	Shares in electricity production, in % of total
Gas	27.8
Nuclear	57.2
Renewable Energy Sources (RES)	15.0

Source: GEM-E3-CAT based on IDESCAT

In order to better understand the interdependencies among the different sectors of production in Catalonia and the forward and backward linkages existing in the economy, a static sensitivity analysis based on the Input-Output (IO) table available for Catalonia for 2004 has been performed so as to estimate the respective multipliers. This has been done so as to obtain a static estimation of the effects of changes in demand for one sector to the rest of the Catalan economy. Such change in demand can be associated for instance with the increase in demand for inputs

12. Energy sector in this table and in the following ones includes the GEM-E3-CAT sectors of: Coal, Crude oil, Oil, Gas, Gas extraction and Electricity supply. For the detailed sectoral aggregation of the model see Appendix A.

from the construction services sector triggered by increased investments in infrastructure that Catalonia is assumed to undertake in the alternative scenarios. In this example investments in infrastructure have three main effects in the static analysis: *i)* the direct effect which is associated with the initial requirements for the goods/services of the sectors necessary for the investment to be undertaken, *ii)* the indirect effect which is associated with the increase for intermediate demand of goods/services in the economy and *iii)* the induced effect which is associated with the increased household demand for goods/services as a result of the additional income earned (wages and salaries).

The static analysis and the identification of the IO multipliers allows for the quantification of the initial impact of a specific policy (i.e. investments in infrastructure) in the Catalan economy, that is the primary effect that changes in final demand of goods and services have on activity without considering the potential structural changes in the economy, the effects from the accumulation of capital stock and from the improvements in total factor productivity (changes and effects which are captured in a general equilibrium modeling framework). The net effect on activity is determined by the share of domestic production in total demand of each country, the Leontief coefficient, which takes into account the back and forth interconnections between sectors, as well as from the share of value to total output of each sector. Table 8 summarizes the estimated coefficients for the Catalan economy. Sectors like the construction, transport and financial intermediation services are found to record relatively larger coefficients.

Table 8. Input Output multipliers for the Catalan economy					
		Leontief multipliers			
		Type I (*)		Type II (**)	
No	Products	Output	Employment	Output	Employment
1	Agriculture	1.35	3.16	1.58	4.52
2	Coal	1.01	0.14	1.02	0.20
3	Crude Oil	1.01	0.17	1.02	0.24
4	Oil	1.30	0.54	1.34	0.78
5	Gas extraction	1.01	0.16	1.02	0.24
6	Gas	1.61	3.03	1.83	4.34
7	Electricity Supply	1.91	3.03	2.13	4.34
8	Food products and beverages; Tobacco	1.75	5.67	2.16	8.12
9	Textiles	1.65	6.93	2.14	9.92
10	Pulp, Paper and Non-metallic minerals	1.70	7.62	2.25	10.90
11	Basic metals	1.40	2.39	1.57	3.42
12	Chemicals	1.65	5.88	2.08	8.42
13	Fabricated metal products, except machinery and equipment	1.70	8.85	2.33	12.66
14	Machinery and equipment goods	1.51	5.82	1.93	8.33
15	Electric goods	1.31	2.32	1.48	3.32
16	Transport equipment goods	1.71	4.97	2.07	7.11
17	Other equipment goods	1.76	7.63	2.30	10.92
18	Construction services	1.97	11.89	2.82	17.02
19	Trade services	1.69	11.36	2.50	16.26
20	Transport services	1.80	8.63	2.42	12.34
21	Financial intermediation services	1.38	13.25	2.33	18.96
22	Other business services	1.48	8.84	2.12	12.64
23	Rest of Market services	1.64	8.10	2.22	11.59
24	Recreational services	1.51	12.96	2.44	18.55
25	Non market services***	1.52	20.26	2.98	28.99

* Direct and indirect effects
** Direct, indirect and induced effects
*** Non market services include public administration and defense services, education, health and social work services, sewage and refuse disposal services, sanitation and similar services, and membership organization services.
Source: Authors' estimations based on Catalan Input-Output table available for 2004

3.4.2. The reference scenario

The reference scenario develops on a path where policies and trends observed in the recent past in Catalonia, Spain and the EU continue to prevail to 2030. Catalonia remains an autonomous community within Spain. Fiscal imbalances continue to be recorded up to 2030, thus Catalonia continues to record fiscal deficits similar to those recorded over the last years (8% of GDP). Debt as a share of GDP continues the upward trend observed in the recent past while Catalonia sees little improvement in infrastructure and human capital investment. These developments hamper Catalonia's long run productivity and competitiveness. Thus Catalonia grows at rates slightly lower than those recorded for Spain (Figure 3).

Figure 3. GDP of Catalonia and Spain in the reference scenario
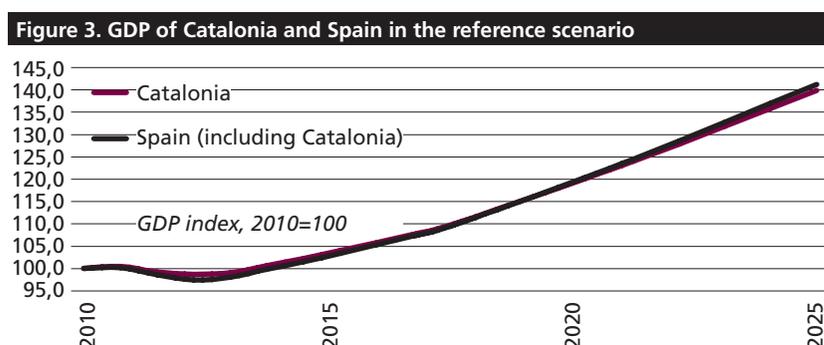
Source: E3-Modelling estimations

Spain (with and without the inclusion of Catalonia) grows more than Catalonia up to 2030 (Table 9). The financial and sovereign debt crisis restrains growth in Catalonia and Spain relative to the rest of the EU up to 2020; in the 2020-2030 period however growth accelerates in Spain and Catalonia and outpaces the rest of the EU.

In terms of GDP per capita Catalonia continues to register levels higher than those observed in Spain and the average for the rest of the EU (Table 10). Following an initial contraction owing to the financial crisis, per capita GDP resumes growth in the period up to 2030 in Catalonia and Spain.

13. Developments in the rest of the model regions in the reference scenario reflect the assumption that policies observed in the recent past prevail to 2030. Current developments such as the tensions in the EU-Russia relationships are not considered in the reference scenario projections.

Table 9. GDP in the reference scenario[13]

	GDP					
	in bn Euro, (2004)		Annual growth rate, in %			
	2010	2030	10-15	15-20	20-25	25-30
Catalonia	177	248	0.11%	1.75%	2.49%	2.43%
Spain (excluding Catalonia)	733	1037	-0.09%	1.90%	2.64%	2.58%
Spain (including Catalonia)	910	1285	-0.05%	1.87%	2.61%	2.55%
Germany	2369	2850	1.42%	0.94%	0.80%	0.56%
France	1776	2401	0.84%	1.63%	1.93%	1.68%
Italy	1384	1640	-0.64%	1.05%	1.53%	1.49%
Portugal	153	182	-1.42%	1.19%	1.78%	1.99%
Rest of EU28 countries	4678	6331	0.88%	1.83%	1.72%	1.67%
China	3120	11269	8.05%	6.78%	6.32%	5.40%
Russian Federation	600	2627	3.78%	3.37%	2.38%	2.11%
Emerging Economies	2672	5181	3.86%	3.47%	3.07%	3.07%
Rest of World	21824	39511	2.87%	3.25%	2.93%	2.99%

Source: Authors' estimations

Table 10. GDP per capita in the reference scenario						
	GDP per capita					
	in thousand Euro, (2004)		Annual growth rate, in %			
	2010	2030	10-15	15-20	20-25	25-30
Catalonia	23.8	29.8	-0.43%	1.11%	1.96%	1.92%
Spain (excluding Catalonia)	18.8	24.9	-0.20%	1.49%	2.20%	2.22%
Spain (including Catalonia)	19.6	25.7	-0.23%	1.42%	2.16%	2.17%
Germany	29.0	36.6	1.63%	1.16%	1.05%	0.87%
France	28.3	35.2	0.34%	1.19%	1.54%	1.33%
Italy	22.9	25.4	-1.11%	0.70%	1.25%	1.25%
Portugal	14.4	16.9	-1.52%	1.12%	1.72%	1.95%
Rest of EU28 countries	19.3	25.0	0.54%	1.55%	1.52%	1.55%
China	2.3	8.0	7.59%	6.50%	6.21%	5.43%
Russian Federation	4.2	7.8	3.89%	3.54%	2.67%	2.49%
Emerging Economies	3.6	6.2	3.00%	2.76%	2.51%	2.67%
Rest of World	5.3	7.3	1.33%	1.81%	1.60%	1.78%

Source: Authors' estimations

Trade patterns recorded over the last years for Catalonia continue to prevail up to 2030. Spain remains the main exporting partner of Catalonia along with the EU. The trends observed in the recent past with regards to labour market developments continue up to 2030 (the trends have been derived from IDESCAT (2013). Similar to the 2000-2010 period, Catalonia is assumed to continue to record a lower (by two percentage points) unemployment rate, relevant to Spain (Table 11). Labour force growth remains low in both Catalonia and Spain (Table 12). The labour force of Catalonia accounts for about 16% of Spain's labour force up to 2030. Sectoral production continues to grow at rates similar to those observed in the last decade (see Table 13).

Table 11. Unemployment rate in the reference scenario, in % of labour force			
	2010	2020	2030
Catalonia	17.8	17.2	7.3
Spain (excluding Catalonia)	20.5	21.2	9.9
Spain (including Catalonia)	20.1	20.6	9.5

Source: Authors' estimations

Table 12. Labour force in the reference scenario			
	2010	2020	2030
	In thousand people		
Catalonia	3,815	3,873	3,996
Spain (excluding Catalonia)	19,274	19,465	19,935
Spain (including Catalonia)	23,089	23,339	23,931
	Annual growth rate, in %		
Catalonia	1.7	0.2	0.3
Spain (excluding Catalonia)	2.4	0.1	0.2
Spain (including Catalonia)	2.3	0.1	0.3

Source: Authors' estimations

In the majority of sectors (with the exception of the energy sector), developments in Catalonia are characterized by relatively lower growth rates compared to the rest of Spain (see Table 13), but at a higher rate compared to the rest of Europe.

Table 13. Sectoral production in Catalonia in the reference scenario, annual growth rates, in %				
	2010 - 2015	**2015 - 2020**	**2020 - 2025**	**2025 - 2030**
	Catalonia			
Agriculture	-0.04	1.33	1.52	1.43
Energy Sector	-0.31	1.32	2.00	1.63
Food products and beverages; Tobacco	1.42	1.65	2.00	1.77
Textiles	-1.82	-1.55	-1.05	-1.10
Pulp, Paper and Non metallic minerals	-1.46	1.68	1.95	1.49
Basic metals	-0.70	0.72	0.88	0.81
Chemicals	0.74	2.06	1.73	0.93
Fabricated metal products, except machinery and equipment	0.26	2.76	3.65	2.48
Machinery and equipment goods	0.29	2.76	3.65	2.47
Electric goods	0.35	2.79	3.68	2.48
Transport equipment goods	0.33	2.77	3.66	2.48
Other equipment goods	-0.27	1.96	1.56	0.65
Construction services	-3.52	2.37	2.51	2.48
Trade services	1.05	2.13	2.38	2.37
Transport services	2.31	1.79	1.97	1.88
Financial intermediation services	0.46	1.88	2.84	3.16
Other business services	0.47	1.88	2.85	3.17
Rest of Market services	0.47	1.88	2.85	3.17
Recreational services	-0.52	1.36	2.57	2.28
Non market services	-1.08	1.41	2.34	2.25
Total	**0.07**	**1.90**	**2.45**	**2.30**

Source: Authors' estimations

On the expenditures side, Catalonia receives on average 14% of expenditures of the Spain's Administration (Table 14) while its revenues amount to 19.4% of total revenues of the Administration up to 2030 (numbers are based on the monetary flow approach).

Table 14. Catalan share to Spanish State's Government revenues and expenditures in the reference scenario		
	2015	**2030**
Revenue collected in Catalonia, in % of total revenues of the **State's** Administration	19.4	19.4
Expenditure allocated to Catalonia, in % of total expenditures of the State's Administration	14.0	13.7

Source: Authors' estimations based on Generalitat of Catalonia (2013)

3.4.3. Alternative scenarios on Catalonia's secession from Spain

Alternative scenarios on Catalonia's secession from Spain have been simulated with the GEM-E3-CAT model. The alternative scenarios simulated regard plausible secession alternatives which are not necessarily the most likely secession options and conditions attached to the latter. For the secession alternatives modeled appropriate assumptions on plausible developments following secession are employed (discussed below in detail). Two alternative scenarios have been developed that build upon different conditions attached to Catalonia's secession from Spain regarding the consensus of Spain and of the rest of the EU on Catalonia's independence. These regard:

- **Mutual Agreement Scenario (S01)** in which Catalonia secedes following mutual agreement with Spain and,
- **Unilateral Exit Scenario (S02)** in which Catalonia secedes from Spain without the consent of the latter (or of the EU).

The degree of consent will in turn affect other important contingencies, including the European Union membership, the share of Spanish debt that Catalonia will assume under independence, and the length and costs of the transition period.

Different options and outcomes of self-governance of the new Catalonian state have been embedded to the two scenarios. These regard:

• Public budget implications and fiscal consolidation
• Infrastructure
• Uncertainty

The mechanisms through which the above are modeled are discussed below.

3.4.3.1. Debt sharing

Domestic residents in Spain have held on average 60% of Spanish gross national debt over the 2000-2012 period (Figure 4). In 2012, the share stood at 62%. Disaggregated data on the amount of Spanish debt held by Catalans is not available. In the event that Catalonia becomes an independent state it will need to undertake and service a portion of the outstanding Spanish debt. Debt sharing alternatives vary by secession scenario. In the mutual agreement scenario, the consent on the part of Spain is premised upon the willingness by Catalonia to undertake a significant share of Spain's national debt. In determining this share, the present study follows Barceló-Soler (2013): a possible and rational share of the debt burden that Catalonia might undertake under secession would be approximately 20% of Spain's national debt, proportional to the -relatively stable overtime - weight of the Catalonian economy to the Spanish GDP. This would take Catalonia's debt/GDP at somewhat above 100%.

Figure 4. Debt held by residents, in % of total (2000-2012
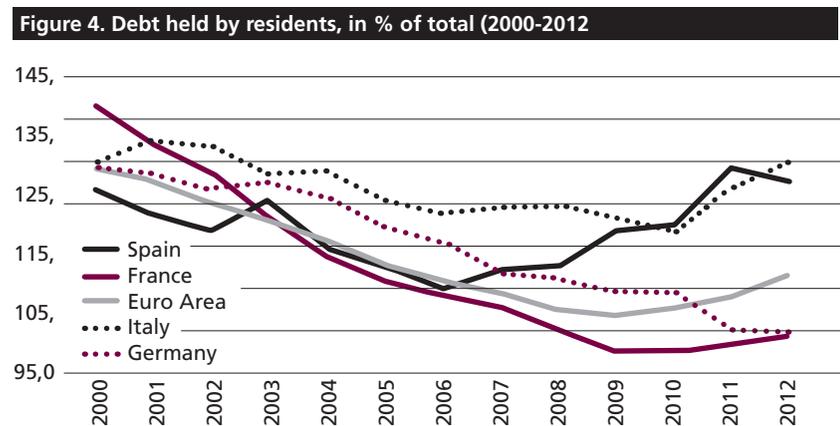
Source: Gordo et al (2013), Bank of Spain Economic Bulletin, July-August 201

Debt sharing under unilateral action will result in Catalonia assuming a lower share of Spanish debt that is more or less restricted to the portion held by Catalan citizens. Since no data is available on the share of Spanish debt held by Catalan agents, it is assumed here that (i) given that 60% of

Spanish debt is held by Spanish residents (according to Gordo et al (2013)) and (ii) Catalonia accounts for about 20% of Spanish GDP, Catalonia will be willing to undertake 20% of the debt held by residents in Spain, *i.e.*, 12% of total Spanish debt. This would bring the debt/GDP ratio of the new independent state to 60%.

The two alternatives with respect to debt sharing are presented below:

Table 15. Assumptions on Spanish debt sharing in the alternative scenarios		
	Mutual agreement (Scenario S01)	**Unilateral action (Scenario S02)**
Share of Spanish debt undertaken by Catalonia	20% of total Spanish debt (proportional to Catalonia's contribution to Spanish GDP)	12% of total Spanish debt
Debt as % of Catalan GDP	100%	60%

Source: Authors' notes

Debt sharing will affect the interest rates Catalonia will be faced with and its ease of access to capital markets (discussed below).

3.4.3.2. Transition period

The length of the transition period per scenario is defined using evidence from countries defaulting on their debt and their emergence following default provided by Standard and Poor's (see Standard and Poor's, 2011). Historically, countries defaulting on their debt have been able to emerge from default and return back to their pre-default ratings in a relatively short time period varying from a few months to few years (evidence suggests that the emergence from default does not extend over many years). The present study makes use of the evidence on the time when countries return to their pre-default ratings following default so as to set the time legth of the transition period following secession. In the case of mutual agreement, the transition period is envisaged to be relatively short-lived and similar to that recorded for defaulting countries; this is set to be 3 years following secession. In contrast, in the unilateral action scenario the transition period is assumed to be double, (*i.e.*, 6 years). *Recall that these assumptions on debt ratings are fixed in a scenario where there's no credible political agreement in relation to debt. Nevertheless, the effects of a expected balanced budget's policy or the following negotiation agreements may lower debt risk during the transition period.*

3.4.3.3. Public budget and fiscal consolidation

Catalonia receives revenue from several sources: income taxes, (VAT), the Social Security income, the income of Public companies such as State Harbors, autonomous institutions, state agencies and other public bodies (see Bosch and Espasa, 2012 and Generalitat of Catalonia, 2013). The largest part of this revenue is currently transferred to the Administration of Spain. Revenue returns to Catalonia in the form of public expenses made directly by the Spanish government or in the form of transfers of resources to the regional government (Generalitat), local governments and the private sector.

The projections on the fiscal budget employed in the reference scenario are based on the results of Catalonia's fiscal balance with the Spanish StateAdministration in 2010 published by the Generalitat of Catalonia (2013) [14]. In this study the balanced budget hypothesis is used to compute the total revenue contribution by Catalonia to the Spanish government and the expenditures which should be transferred to Catalonia by the Spanish StateAdministration.

In both secession scenarios it is considered that Catalonia will cease to transfer tax revenue to the Spanish administration from 2015 onwards; this translates to an additional revenue of 8% of GDP. Accordingly, Catalonia will be left with some fiscal space, which will allow some leeway to either increase public consumption/expenditure or to reduce taxation. In the context of the present study, the Catalan government is assumed to run balanced budgets following secession.

In an independent Catalonia the public costs and the administration costs are assumed to be higher. The new independent –small in size – Catalan state will cease to benefit from the existence of scale economies resulting from its integration with Spain. This would imply higher unit costs of public services and also higher needs of spending on services and national public goods (defense, justice, government IT systems, de-merging of databases, functions and processes, transferring of public servants and pensions systems) which today are provided centrally in Spain. White and Brun-Aguerre (2012) assess that the present difference between tax payments and public spending would be eroded under Catalan independence due to increased public costs and spending. Even in the case where Catalonia would service only half of such costs the amounts required would reach 5.8% of GDP. These estimations imply minimal benefits on fiscal balance from the independence of Catalonia. Bosch and Espasa (2012) anticipate better prospects under Catalan independence, as the new state would achieve higher effectiveness in the fiscal system, better distribution among categories of payers and more efficient spending, all of which can be drivers of growth. Their study claims that such reforms are difficult to implement under present circumstances but they would be facilitated in the context of Catalan sovereignty.

In designing the alternative scenarios explicit assumptions have been employed with regard to the fiscal stance of Catalonia in each case. For the quantification of the hypotheses the approach employed by Bosch and Espasa (2012) has been adopted making the following assumptions:

i) Catalonia under secession keeps the same tax system that is in place today;
ii) In an independent Catalonia the level of the tax burden follows its recent trend;

14. http://www20.gencat.cat/
docs/economia/70_Economia_
SP_Financament/documents/
Financament_autonomic/balanca_
fiscal_Catalunya_Administracio_
Central/05%2021%20Fiscal%20
Balance%20(summary)%20(2).pdf.

Regarding expenditures of the independent Catalonia it has been assumed that the Catalan government undertakes the same commitments as the Spanish StateAdministration. All commitments and decisions regarding pensions, public sector wages etc. made by the State Administration are honored by the independent Catalonia (similar assumptions are adopted by Bosch and Espasa (2012) in their analysis). Expenditure is assumed to increase in the secession scenarios due to

the additional to the reference investment in state structures (services which today are provided centrally in Spain) and in infrastructure (see below). The independent Catalan government is expected to invest (additional to reference) 3% of its GDP in state structures and 1.3% of its GDP in infrastructure.

Table 16 summarizes the assumptions employed on how the additional public revenues (8.1% of Catalan GDP) will be used by the Catalan government in the secession scenarios. These revenues are additional to the reference in the sense that they include revenues collected in Catalonia and not transferred to the Spanish Administration, which was the case in the reference scenario.

The main hypothesis is that Catalonia under secession will aim for a balanced budget. Under this condition additional government revenues will cover: (1) expenditure in state structures investment, (2) expenditure in infrastructure investment, (3) additional interest payments due to the higher debt and deficit than in the reference scenario and (4) scenario government consumption. The balanced budget implies that the debt-to-GDP ratio decreases as GDP grows over time. Given that in the period 2015-2030 a 2.2% average annual GDP growth for Catalonia is projected in the reference scenario, debt-to-GDP ratio can be reduced by more than 20 percentage points in both secession scenarios.

Table 16. Additional revenues and expenditures for Catalonia in the secession scenarios						
	Mutual agreement (Scenario S01)			Unilateral action (Scenario S02)		
	2015	2020	2030	2015	2020	2030
Additional revenues						
in bn € 2010	16.6	18.1	23.1	16.6	18.1	23.1
in % of GDP	8.1	8.1	8.1	8.1	8.1	8.1
Allocation of additional revenues, in % of total						
Infrastructure	15.7	15.7	15.7	15.7	15.7	15.7
State capacity*	37.0	37.0	37.0	37.0	37.0	37.0
Government consumption	1.35	9.7	15.8	10.4	13.9	19.8
Tax Reduction	1.35	9.7	15.8	10.4	13.9	19.8
Payment to balance the public budget	9.9	0.0	0.0	9.9	0.0	0.0
Interest payments	34.7	27.9	15.7	16.6	19.5	7.7

*Spending in state structures to cover services which today are provided centrally in Spain
Source: Authors' estimations

An important element to be considered is fiscal sustainability of autonomous Catalonia. As explained above, autonomy will in itself bear a front-loaded fiscal impact, which is however expected to be financed through the elimination of the fiscal deficit *vis-à-vis* the Spanish State Administration. Debt redemptions differ in the two scenarios, being higher in the mutual agreement scenario; by analogy, independent Catalonia will need to resort to increased bond issuance in the mutual agreement scenario to meet its financing needs. By implication, the terms of its access to credit and capital markets differ across the two scenarios, being more restrictive in the unilateral action scenario; thereafter the terms are improved in both scenarios, with interest payments in the unilateral action scenario being lower than the mutual agreement scenario in the longer term due to the lower debt that needs to be serviced.

In order to quantify the effects of fiscal imbalances on the solvency of Catalonia (and Spain), the approach of Alogoskoufis (2013) in defining and estimating debt sustainability has been adopted. Following this approach, based on the comparison of real interest rate on government debt and the growth of GDP, the debt accumulation process is defined as sustainable in the case where the rate of GDP growth is higher than the real interest rate on government debt.

3.4.3.4. Infrastructure

Over the last decades Catalonia has recorded a deficit of investment and stock compared to its relative population and GDP weight to Spain. While population and GDP have accounted for approximately 16% and 20% of the respective total Spanish (including Catalonia) population and GDP, infrastructure stock in the region has on average accounted for less than 14% of the total infrastructure stock of Spain over the same period (Table 17). In the period 1991-2008 investment in infrastructure in Catalonia has accounted for 0.7% of Catalan GDP while the Spanish meant was 1.1%[15].

Table 17. Total stock of infrastructure in Catalonia, in % of total stock of infrastructure in Spain								
Year	1964	1970	1980	1985	1990	1995	2001	2004
Catalan stock of infrastructure, in % of Spanish total	13.1	14.3	14.9	14.4	13.6	13.7	13.3	13.6

Source: Generalitat de Catalonia (2009)

In the reference scenario it is assumed that the trend in infrastructure investment from the State's Administration directed to Catalonia in the 1991-2008 period continues to prevail up to 2030. Thus up to 2030 investment in infrastructure in Catalonia accounts to 0.7% of Catalonia's GDP.

In case Catalonia's secession materializes, the Catalan government will increase the financing of infrastructure projects. These might include the construction of an international airport hub, direct rail connections, active political and financial support for the Mediterranean rail-way corridor, energy infrastructure, etc. These prospective infrastructure investments will bring benefits to productivity and competitiveness will improve business, industry and tourism attraction and might further attract skilled personnel.

The *National Pact for Infrastructure Investments* (see Generalitat of Catalonia, 2009) is assumed to be undertaken by the independent Catalan government. The purpose of the pact has been the agreement on the infrastructure requirements for the sustainable development of the country and the welfare and quality of life of its residents. The pact covers transport, water, waste, energy, telecommunications and land productivity related infrastructure investments. The pact's horizon extends to 2020.

According to the pact Catalonia should aim at investing 2% of its GDP in infrastructure projects. The additional from reference infrastructure investments in the secession scenarios are assumed to amount to 1.3% of the Catalan GDP over the period 2015-2030. Under this assumption the amounts invested in infrastructure in Catalonia up to 2030 are summarized in Table 18. These investments are assumed to take place under both the unilateral and bilateral secession scenarios.

15. See Generalitat de Catalonia (2009), 'Pacte Nacional per a les infraestructures'. Available at: http://www.gencat.cat/especial/pni/pdf/pni.pdf

Table 18. Investments in infrastructure in Catalonia in the reference and in the secession scenarios				
	2015	2020	2025	2030
Reference scenario				
Investments in infrastructure (in % of GDP)	0.7	0.7	0.7	0.7
Investments in infrastructure (in bn € 2010)	1.5	1.6	1.8	2.1
Secession scenarios (Mutual agreement- Scenario S01 & Unilateral action-Scenario S02)				
Investments in infrastructure (in % of GDP)	2.0	2.0	2.0	2.0
Investments in infrastructure (in bn € 2010), in addition to reference	2.6	2.8	3.2	3.6
Investments in infrastructure (in bn € 2010), total	4.1	4.5	5.1	5.7

Source: Authors' estimations

Total infrastructure investment is differentiated by type of infrastructure distinguishing among transport (rail, road, air, sea), information and communication technology-ICT (investments in ICT are mainly private), education and human capital, energy and state and governance structures. To calculate the split among the different types the following sources have been consulted:

- National pact (Generalitat of Catalonia, 2009);
- Disaggregated data on infrastructure investment in the period 1992-2011 in the EU provided in a recent study of Dobbs et al. (2013) prepared for McKinsey&Company;
- Data on infrastructure investment undertaken in various countries as extracted from the World Bank, World Development Indicators database.

Infrastructure stock depreciates over time. In this study depreciation rates from Dobbs et al. (2013) have been employed where the depreciation rate for transport and power has been set at 2.5%. It has been assumed that the depreciation rate is lower for investment in education and state capacity building, while it is higher for the ICT sector (5%) given the rapid technological innovations taking place.

Table 19. Investments in infrastructure by type and depreciation rate of infrastructure in Catalonia		
Infrastructure category	Investment in infrastructure, in % of total	Depreciation rate, annual, in %
Transport (rail, road, air, ports)	35	2.5
Information and communication technology (ICT)*	25	5.0
State capacity and governance structure	5	1.5
Education and human capital	15	1.5
Energy sector	20	2.5

Source: Authors' estimations based on Generalitat de Catalonia (2009), Dobbs et al. (2013) and World Bank, World Development Indicators

Investments in infrastructure are expected to have multiple effects on the Catalan economy. They are expected to stimulate activity in the sectors involved in the construction of infrastructure as they generate additional demand for sectors providing inputs to infrastructure investments (construction, market services, etc.). This is expected to boost demand and consumption in the domestic sectors exerting a positive effect on GDP. This effect will also be associated with multiplier effects in the economy where higher demand for sectors providing inputs to infrastructure investments will generate income and thus demand for other sectors of the economy. Demand and multiplier effects associated with investments in infrastructure take place in the short

term, last only during the construction phase and are partly offset by pressures on capital and labor markets if these markets do not display sufficient flexibility.

Investing in infrastructure will increase the total factor productivity in the Catalan economy which exerts a positive permanent effect on GDP (exports will become more competitive, etc.). Increases in total factor productivity imply lower unit costs for delivering services, such as transportation, communications and tourism. The effect on total factor productivity is a long-term permanent benefit and it depends on the type of infrastructure. In the GEM-E3-CAT model, the productivity effects caused by new infrastructure depend on the already accumulated stock of infrastructure, are differentiated by type of infrastructure and the related sectors which benefit in terms of productivity.

3.4.3.5. Risk and interest rates

An important determinant of the costs of transition to an independent Catalan state is the impact of uncertainty. Uncertainty would affect confidence in the Catalan economy and in turn its ease of access to capital markets. The following major risk factors are considered:

i *Currency risk* associated with the uncertain status of the EU membership of Catalonia under secession; the currency it will use;
ii. *Deficit and debt risk* associated with the policy that the independent Catalan government will implement regarding public deficit;
iii. *Debt risk* related to the long term debt profile/commitment to fiscal policies consistent with a sustainable debt profile.

Currency risk is largely associated with the status of EU membership of the seceding Catalan state. The prevailing consensus which the present study adopts is that the outcome on EU membership of the new Catalan state will only come with a lag. In the unilateral secession scenario the process could prove cumbersome and the lag lengthy[16]. This is premised on Article 49 of the Treaty on the European Union that provides that the accession of a new member state must be ratified by all other member states, which could potentially provide dissenting Spain with veto power. Accordingly, in the **unilateral secession scenario** upside risks prevail due to the fragile commitment to the euro, with implications on trade, Catalan banks' access to funding, deposit flows and business and investment sentiment. Accordingly, currency risk is eminent up to 2020, but eliminated afterwards as markets slowly gain confidence on the independent state. Currency risk however is mitigated in the **mutual agreement scenario**, which assumes that constructive negotiations on EU membership are swift and perceived by markets to be credible, thereby eliminating currency risk.

The **debt risk factor** corresponds to the difference between the government primary surplus or deficit and the primary surplus needed for the debt to be sustainable. For the assessment of the sustainability of Catalan debt in each time period the approach proposed by Alogoskoufis (2012) has been used in order to determine the primary surplus needed for the debt to be solvent. **Deficit risk factor** corresponds to the risk that economic agents perceive associated with the consistency of the government to pursue balanced budget policies. Catalan deficit and debt targets under independence, especially during transition affect the perceptions and anticipations on the long term sustainability

16. Such event may also force both parties to quickly negotiate and come to a lasting and successful agreement for all.

of the Catalan fiscal policy and debt targets. In the first years of secession the perceived risk of future public policies and of the ability of the economic actors to commit to fiscal policy announcements and meet their policy targets might be high; accordingly the uncertainty associated with deficit policies is expected to be higher than the reference during the transition period in both secession scenarios and the highest in the case of unilateral secession.

At this point it is useful to make a distinction regarding the assumptions on the policies implemented by the Catalan government following secession and the risk perceptions of economic agents associated with deficit. In the secession scenarios it is assumed that the Catalan government aims for and implements a balanced budget policy. Nevertheless it is assumed that it takes time for economic agents to realise the time consistency of the Catalan government with regards to the implementation of balanced budget policies. At the early years of transition following secession, economic agents perceive a deficit risk. This risk is assumed to be higher in the case secession follows unilateral action. In the latter transition years economic agents lower their defitic risk perceptions as they realize the consistency of the Catalan government in implementing balanced budget policies. Economic agents perceive no deficit risk in the long run in both secession scenarios. As a sensitivity run, a variant of the unilateral secession scenario has been simulated where the deficit risk is set equal to the scenario in which secession follows mutual agreement (see section 3.5.1).

In the alternative scenarios specific targets of debt-to-GDP ratios have been assumed to be set by the Catalan government (see Table 20). In the mutual agreement scenario (Scenario S01) the debt undertaken by the Catalan government amounts to 100.5% of its GDP (Catalonia undertakes 20% of Spanish debt, proportional to its contribution to Spanish GDP). Each year a 10% of the debt is refinanced with bonds and loans at the prevailing interest rate.

In the unilateral secession scenario Catalonia undertakes a lower share of Spanish debt: that which corresponds to the debt undertaken by Catalan entities (private sector and banks). This is taken to be 12% of Spanish national debt. Accordingly the debt undertaken by Catalonia stands at 60.3% of Catalan GDP once secession takes place. However, unilateral action fuels a sharp increase in uncertainty faced by the public and private sector in Catalonia. The lack of consent is negative for market and business sentiment, which in turn places a drag on investment, affects financial flows and the outlook for growth. The borrowing terms are negatively affected. The debt as a share of GDP follows a slightly increasing path in the first years following secession but gradually declines in the longer term. Similar to S01, a 10% of the debt is financed at the prevailing interest rate.

Table 20. Debt-to-GDP ratio of Catalan government, in %					
	2014	**2015**	**2020**	**2025**	**2030**
Reference scenario	30.7	31.1	29.6	26.2	23.2
Mutual agreement - Scenario S01	100.5	99.8	87.7	77.2	68.2
Unilateral action -Scenario S02	60.3	60.9	53.8	46.2	41.0

Source: Authors' estimations

In the GEM-E3-CAT model these uncertainties are captured and quantified via the interest rates. To reflect uncertainties a higher risk premium would be requested by markets. Interest rates are adjusted accordingly with the use of risk factors which change by scenario based on the assumptions

employed in each case. In the reference scenario risk factors equal to 1 while their value is differentiated by scenario and year reflecting the different underlying assumptions.

Table 21 summarizes the values of the risk factors and the interest rates Catalonia is faced with in secession following mutual agreement. Since secession is the result of bilateral agreement between Catalonia and Spain/EU in this scenario no currency risk is applied to Catalonia; Catalonia is expected to remain within the Euro and continue using the Euro as its official currency. No Euro-exit actions are assumed to be taken by the EU. Deficit and debt risk factors are assumed to subside relatively fast and market confidence in the new independent state is soon restored.

Table 22 summarizes the values of the risk factors and the interest rates Catalonia is faced with in secession following unilateral action. Increased perceived risk in the unilateral action scenario, amid elevated currency risk, political risk and default risk, would imply that the debt of the seceding state would stand at a higher premium for a longer period of time. Accordingly, the risk factors are higher in this scenario and require a longer time to be smoothened out.

Table 21. Interest rates and risk factors for Catalonia in mutual agreement scenario (Scenario S01)				
	Interest rate, in %	Currency risk factor	Deficit risk factor	Debt risk factor
2015	5.06	1.00	1.25	1.04
2016	4.35	1.00	1.15	0.97
2017	3.68	1.00	1.05	0.90
2018	3.29	1.00	1.00	0.84
2019	3.09	1.00	1.00	0.79
2020	2.92	1.00	1.00	0.75
2025	2.76	1.00	1.00	0.71
2030	2.70	1.00	1.00	0.69

Source: Authors' estimations

Table 22. Interest rates and risk factors for Catalonia in unilateral action scenario (Scenario S02)				
	Interest rate, in %	Currency risk factor	Deficit risk factor	Debt risk factor
2015	7.42	1.40	1.30	1.05
2016	7.20	1.40	1.30	1.01
2017	7.02	1.40	1.30	0.99
2019	6.05	1.40	1.20	0.92
2020	4.32	1.20	1.10	0.84
2025	2.82	1.00	1.00	0.72
2030	2.78	1.00	1.00	0.71

Source: Authors' estimations

Table 23. Interest rates for Catalonia and Spain in secession scenarios									
		2015	2016	2017	2018	2019	2020	2025	2030
Mutual agreement - Scenario S01	Catalonia	5.06%	4.35%	3.68%	3.29%	3.09%	2.92%	2.76%	2.70%
	Spain	5.56%	4.78%	4.05%	3.62%	3.40%	3.21%	3.03%	2.97%
Unilateral action - Scenario S02	Catalonia	7.42%	7.20%	7.02%	6.87%	6.05%	4.32%	2.82%	2.78%
	Spain	5.84%	5.02%	4.25%	3.80%	3.57%	3.37%	3.18%	3.12%

Source: Authors' estimations

Table 24. Main scenarios' assumptions on Catalonia's secession from Spain		
	Mutual agreement scenario- Scenario S01	**Unilateral action scenario - Scenario S02**
Secession mode	Mutual agreement between Catalonia and Spain/EU	Unilateral action of Catalonia. No agreement with Spain/EU
Transition period	Short	Long
Debt sharing	Catalonia undertakes 20% of Spanish debt (Proportional to its contribution to Spanish GDP)	Catalonia undertakes 12% of Spanish debt (Equal to Spanish debt held by Catalan agents)
Fiscal stance	Balanced budget.	Same as S01
Investment in infrastructure	2% of GDP in 2015-2030 invested in several infrastructure categories (transport, energy, state capacity, ICT, human capital, etc.) by set shares. Infrastructure stock subject to depreciation	Same as S01
Risk factors and interest rates	Catalonia faced with deficit and debt risk which are higher than reference in the transition period but smooth out relatively fast. Catalonia faced with higher than reference interest rates over a relatively short period.	Catalonia faced with currency, deficit and debt risk which are higher than reference in the transition period. Their smoothing out takes relatively longer thus Catalonia faced with higher than reference interest rates over a longer a period of time.

Source: Authors' notes

3.5. Results of the alternative secession scenarios

3.5.1. Macroeconomic implications

The simulation results show that under secession Catalonia derives a net benefit. The scenario results for GDP for Catalonia are presented in Table 25.

The effects on the macroeconomic aggregates for Catalonia are negative in the first years following secession but they bounce back gradually and return to positive later on in the period of study. This bouncing back takes a longer time to materialize under unilateral secession (scenario S02). The scenario results on the main macroeconomic aggregates for both scenarios are reported in Table 27 and Table 28.

The results indicate that Catalonia benefits in terms of GDP from secession, compared to reference. The benefit is stronger if secession is the product of mutual agreement with Spain. In this scenario, the lower uncertainty associated with Catalonia's future economic prospects and its balanced public budget boost economic growth, despite the higher debt burden that Catalonia is committed to service. **In secession under unilateral action, Catalonia grows at a pace which is slower than the mutual agreement scenario**, **but above the reference scenario**. Higher uncertainty surrounding the macroeconomic environment, currency arrangements and financial market response, and by implication the longer transition period that characterizes the unilateral scenario negatively affect activity and the short term economic prospects of Catalonia. Despite the elevated market and interest rate volatility during the transition period, the beneficial in terms of gross debt initial conditions for the new state in the unilateral secession scenario mitigate the risk of a deficit-debt spiral materializing. In the longer term, the favourable debt and investment profile, coupled with the resolution of outstanding issues, notably currency issues, restore confidence in the economy, which translates to growth outperformance relative to both the reference and the mutual agreement scenarios in the outer years of the projection horizon (2020-

2030). Overall, over the 2015-2030 period, the cumulative gain in terms of GDP in the unilateral secession scenario is 2% above reference, and -1.2% below the mutual agreement case.

Table 25. Impact on GDP in scenario S01 and S02		
	Catalonia	
	NPV* of GDP, 2015-2030	**Cumulative GDP, 2015-2030**
Reference, in bn € 2004	2591.1	3347.4
S01, in bn € 2004	2671.6	3457.0
S01, % change from reference	3.1	3.3
S02, in bn € 2004	2634.6	3414.8
S02, % change from reference	1.7	2.0

* To calculate the Net Present Value (NPV) of the GDP a discount rate of 3% has been applied.
Source: GEM-E3-CAT

The macro-economic effects of secession are marginal for the EU while Spain experiences a negative effect in GDP in both secession alternatives with the effects being more pronounced in the case of unilateral secession of Catalonia. Simulation results for Spain and the EU are summarized in Appendix C.

Simulation results from the sensitivity run (S02_DF) where deficit risk perception in the unilateral action scenario is set equal to the scenario of secession following mutual agreement are summarized in Table 26. In this case economic agents perceive the same risk regarding the implementation of balanced budget polices irrespective of whether secession is the result of unilateral action or mutual agreement. The simulation results show that Catalonia benefits more in this scenario as compared to the standard scenario of unilateral action on secession. Nevertheless benefits remain lower than those resulting from mutual agreement on secession.

Table 26. Impact on GDP in scenario S02_DF		
	Catalonia	
	NPV* of GDP, 2015-2030	Cumulative GDP, 2015-2030
Reference, in bn € 2004	2591.1	3347.4
S02_DF, in bn € 2004	2658.5	3443.2
S02_DF, % change from reference	2.6	2.9

* To calculate the Net Present Value (NPV) of the GDP a discount rate of 3% has been applied. In the S02_DF scenario deficit risk parameter is set equal to S01 scenario. For the rest of the modelling assumptions the standard specifications of the S02 scenario apply.
Source: GEM-E3-CAT

3.5.2. Impact on Consumption, Investment and Trade

In both scenarios, the retention of revenue previously channeled to the State administration implies that Catalan public consumption is significantly above reference, to the tune of 27% to 38%. The increase reflects a low base effect. Public consumption exceeds further the reference in the unilateral secession scenario, as a result of lower debt redemptions. The increase in public consumption is a driver of economic growth in Catalonia, early in the projection period (2016 onwards) for the mutual agreement scenario. However, if the decision is unilateral the growth impact of public expenditure comes with a significant delay (beyond 2020). In both scenarios examined in the short run Catalonia suffers the effects

of higher uncertainties and reduced confidence in its economic viability as an independent state. When these effects are smoothed out and market confidence on Catalonia is established, the independent country enjoys the benefit from higher government spending compared to the reference scenario. The same pattern arises for investment in Catalonia. Elevated uncertainty poses a drag on investment (relative to the reference), which in the mutual agreement case is rather short-lived (lasts during the 2015-2016 period only), but **in the case of unilateral action the drag is severe, and persistent (up to 2020), with corresponding implications on economic growth.**

Household consumption decreases from the reference case in both scenarios examined*given that the reference case is not assuming recession, Table 28 still shows a growing path on GDP terms. However, during the first five years following unilateral secession, growth would be between 2.5 and 0.15 points lower than in the reference scenario".* The decline is sharper in the unilateral action scenario, in line with the longer period of uncertainty and higher interest rates prevailing. The mutual agreement case sees a short lived reduction in household consumption that only lasts during the 2015-2016 period. In 2017 onwards and up to the end of the projection horizon private consumption returns to levels above reference.

Table 27. Macroeconomic effects of scenario S01: Results for Catalonia										
Change from reference		2015	2016	2017	2018	2019	2020	2025	2030	Cumulative 2015-2030
in %	Gross Domestic Product	-0.85	0.45	1.91	2.51	2.98	3.46	4.03	4.32	3.27
	Investment	-3.90	-1.51	0.91	1.46	1.83	2.17	2.46	2.10	1.61
	Public Consumption	27.30	28.22	29.36	30.60	31.88	32.48	34.77	36.39	33.22
	Private Consumption	-3.24	-0.43	2.04	2.56	2.98	3.39	4.40	5.50	3.49
	Exports	-6.65	-6.30	-5.96	-5.77	-5.63	-5.26	-5.71	-6.60	-5.91
	Imports	-2.98	-1.05	0.32	0.49	0.70	0.97	1.18	1.19	0.69
in bn € 2004	Gross Domestic Product	-1.52	0.81	3.52	4.72	5.68	6.73	8.86	10.71	109.56
	Investment	-1.12	-0.44	0.27	0.45	0.58	0.70	0.90	0.87	8.95
	Public Consumption	7.81	8.16	8.58	9.04	9.52	9.83	11.78	13.76	172.55
	Private Consumption	-3.41	-0.46	2.24	2.88	3.43	4.00	5.88	8.30	70.61
	Exports	-7.84	-7.54	-7.23	-7.12	-7.07	-6.71	-8.19	-10.53	-129.21
	Imports	-3.03	-1.09	0.34	0.53	0.78	1.10	1.51	1.68	13.37

Source: GEM-E3-CAT

Table 28. Macroeconomic effects of scenario S02: Results for Catalonia										
Change from reference		2015	2016	2017	2018	2019	2020	2025	2030	Cumulative 2015-2030
in %	Gross Domestic Product	-2.54	-2.67	-2.22	-1.55	-0.15	1.25	4.18	4.25	2.01
	Investment	-7.99	-8.00	-7.46	-6.64	-4.56	-2.60	2.55	2.07	-1.06
	Public Consumption	31.87	32.30	32.83	33.45	34.25	34.67	37.01	38.51	35.76
	Private Consumption	-9.54	-9.39	-8.90	-7.97	-5.06	-2.47	4.68	5.73	0.12
	Exports	-6.09	-5.64	-5.05	-4.60	-4.49	-4.25	-6.09	-7.42	-5.78
	Imports	-5.75	-4.80	-4.19	-3.58	-2.14	-0.98	1.41	1.18	-0.58
in bn € 2004	Gross Domestic Product	-4.53	-4.85	-4.10	-2.91	-0.29	2.43	9.19	10.54	67.42
	Investment	-2.29	-2.35	-2.24	-2.04	-1.44	-0.84	0.93	0.86	-5.85
	Public Consumption	9.12	9.34	9.60	9.88	10.23	10.49	12.54	14.56	185.79
	Private Consumption	-10.02	-10.09	-9.78	-8.96	-5.82	-2.91	6.25	8.65	2.47
	Exports	-7.18	-6.74	-6.13	-5.68	-5.64	-5.42	-8.73	-11.85	-126.41
	Imports	-5.85	-4.99	-4.46	-3.89	-2.38	-1.11	1.80	1.68	-11.13

Source: GEM-E3-CAT

Turning to trade, due to its strategic position, Catalonia acts as an import hub in the reference: it imports goods from the rest of the world and subsequently distributes them to the rest of Spain. Accordingly, Catalonia in the reference has a trade deficit vis-a-vis the rest of the world which is significantly offset by a trade surplus with the rest of Spain. Secession, exerts a substantial negative impact on trade intensity for Catalonia. This holds for both secession scenarios relative to the reference. This is driven by increased short term transaction costs, high risk premium, slackened demand and in the longer term by changes in competitiveness (note that neither scenario accounts for shocks from an active boycott from Spain[17]), (see Table 27 and **Table 28**). The reduction of economic activity in Spain, which is Catalonia's largest export market, accounting for more than one third of Catalan exports has a twofold impact: (i) it poses a significant downward impact on Catalan exports in both secession scenarios. (ii) it also poses a significant downward impact on imports, as the placement of the national border undermines Catalonia's role as a hub. Table 29 and Table 30 presents the exports' results by main export partner of Catalonia for scenario S01 and S02 respectively.

17. Morato et al (2014) estimates that in the extreme case of a total embargo of trade with Spain, the reduction of Catalan GDP would be 16.8%.

Table 29. Changes in Catalan exports by main export partners of Catalonia in scenario S01

	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
EU28	-8.0	-6.1	-7.1	-6.7	-7.3	-5.9	-8.5	-111.5
Spain	-11.8	-8.4	-9.4	-9.1	-6.5	-5.0	-6.7	-91.4
Germany	-2.2	-2.5	-4.0	-3.1	-0.1	-0.2	-0.3	-3.5
France	-2.2	-2.4	-3.3	-2.8	-0.2	-0.2	-0.4	-4.7
Italy	-2.2	-2.4	-3.2	-2.8	-0.1	-0.1	-0.2	-2.0
Portugal	-2.5	-2.2	-2.8	-2.6	-0.1	-0.1	-0.1	-1.4
Total	**-6.7**	**-5.3**	**-6.6**	**-5.9**	**-7.8**	**-6.7**	**-10.5**	**-129.2**

Source: GEM-E3-CAT

Table 30. Changes in Catalan exports by main export partners of Catalonia in scenario S02

	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
EU28	-7.5	-5.1	-8.0	-6.6	-6.9	-5.0	-9.6	-110.5
Spain	-11.9	-7.9	-10.3	-9.4	-6.5	-4.7	-7.4	-93.6
Germany	-1.0	-1.0	-4.8	-2.6	-0.1	-0.1	-0.4	-3.0
France	-1.0	-0.9	-4.1	-2.4	-0.1	-0.1	-0.5	-3.9
Italy	-0.9	-0.8	-4.0	-2.3	-0.03	-0.03	-0.2	-1.6
Portugal	-1.6	-0.9	-3.7	-2.3	-0.04	-0.03	-0.1	-1.2
Total	**-6.1**	**-4.3**	**-7.4**	**-5.8**	**-7.2**	**-5.4**	**-11.9**	**-126.4**

Source: GEM-E3-CAT

Imports of Catalonia are also below the reference scenario due to the contraction of domestic demand (Table 31 and Table 32). The negative impact on imports is more severe and lasts longer if the decision to secede is unilateral. In the mutual agreement, demand for imported goods and services deteriorates in 2015-2016, but it recovers relatively fast and it increases compared to the reference scenario later on and in particular after 2020 as Catalan income grows at high rates. Higher

wages from the reference increase household income but also increase unit labour costs, with negative impact on Catalan competitiveness. Competitiveness of domesticaly produced goods deteriorates mainly at the final years of the simulation period, (2030), with adverse effects on the trade balance (demand for imports increases whereas exports continue to deteriorate).

Table 31. Changes in imports by main import partners of Catalonia in scenario S01								
	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
EU28	-2.4	1.2	1.3	0.9	-1.7	1.0	1.3	12.5
Spain	-1.1	1.5	1.4	1.2	-0.5	0.7	0.8	9.9
Germany	-4.9	0.7	0.9	0.3	-0.4	0.1	0.1	0.5
France	-4.1	0.4	0.9	0.2	-0.2	0.0	0.1	0.1
Italy	-3.8	0.7	1.0	0.4	-0.2	0.0	0.1	0.3
Portugal	-3.5	1.1	1.6	0.9	0.0	0.0	0.0	0.2
Total	-3.0	1.0	1.2	0.7	-3.0	1.1	1.7	13.4

Source: GEM-E3-CAT

Table 32. Changes in imports by main import partners of Catalonia in scenario S02								
	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
EU28	-5.0	-0.7	1.5	-0.2	-3.7	-0.5	1.5	-3.2
Spain	-3.1	-0.4	2.1	0.4	-1.3	-0.2	1.2	2.8
Germany	-9.4	-0.7	0.6	-1.2	-0.8	-0.1	0.1	-1.9
France	-7.1	-1.4	0.4	-1.3	-0.3	-0.1	0.03	-1.1
Italy	-6.7	-1.2	0.5	-1.2	-0.3	-0.1	0.03	-0.9
Portugal	-6.9	-1.0	1.4	-0.7	-0.1	-0.01	0.02	-0.2
Total	-5.8	-1.0	1.2	-0.6	-5.9	-1.1	1.7	-11.1

Source: GEM-E3-CAT

3.5.3. Labour Market

The additional (to the reference) budget used for government spending and investment in infrastructure, as well as the need to set up structures previously centrally provided by Spain stimulates employment in Catalonia. The unemployment rate in Catalonia falls in both the mutual agreement and the unilateral scenario, compared to the reference scenario (Table 33), initially only marginally but more firmly over time. The increase in labour demand exerts upward pressure on the labour costs in Catalonia (real wages increase under secession compared to the reference scenario) which in their turn harm the competitiveness of the Catalan economy. This is visible mainly in the period 2020-2030 where Catalonia registers low unemployment rates already in the reference case. Hence the potential of labour supply to adjust to higher labour demand is limited and wages increase.

At low unemployment rates the additional demand for labour has a strong effect on wages. However If additional labour force (i.e. through migration) was available the stress on wage rates would be lower and hence the

effects on competitivenes moderate. Sensitivity analysis with the GEM-E3-CAT model showed that in the case where wages remained at the reference levels by increasing labour supply (attracting workers from other EU countries) the net benefit for the Catalan economy would be significant (almost 5% of GDP) while the number of additional labour force required would be 400,000 workers.

Table 33. Employment and labour market effects of scenario S01								
Change from reference, in %	2015	2016	2017	2018	2019	2020	2025	2030
Employment (in m. persons)	0.77	1.91	3.21	3.80	4.23	4.55	4.56	3.37
Unemployment rate*	-0.61	-1.52	-2.58	-3.08	-3.47	-3.77	-4.02	-3.13
Real Wage (Man Hour)	0.38	0.81	1.33	1.66	1.99	2.29	4.12	7.40

Source: GEM-E3-CAT
*change in percentage points

Table 34. Employment and labour market effects of scenario S02								
Change from reference, in %	2015	2016	2017	2018	2019	2020	2025	2030
Employment (in m. persons)	0.04	-0.09	0.32	0.90	2.03	3.07	4.86	3.45
Unemployment rate*	-0.03	0.07	-0.26	-0.73	-1.67	-2.54	-4.28	-3.20
Real Wage (Man Hour)	0.19	0.24	0.39	0.61	1.08	1.60	4.54	8.01

*change in percentage points
Source: GEM-E3-CAT

3.5.4. Sectoral production

Changes in domestic production in Catalonia in the secession scenarios are the joint result of changes in productivity, changes in competitiveness of the products produced, changes in domestic demand due to increased government spending and investment in infrastructure and changes in trade, which are adversely affected from secession.

Domestic production in Catalonia responds to the shock induced by secession in both the mutual agreement and unilateral action scenarios with contractions as compared to the reference scenario (see Table 35 and Table 355 for scenario S01 and S02 respectively). The contraction is stronger in secession under unilateral action in most sectors. Domestic production recovers later on in the period of study with the effects being higher for the sectors providing inputs to investments in infrastructure and government spending, such as construction and non-market services. Changes in the competitiveness of the Catalan products and demand for exports affect mainly the production of relatively labour intensive sectors (like the services sectors) which manage to recover and in some cases exceed their reference scenario production levels.

Table 35. Domestic production in Catalonia in Scenario S01								
	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
Agriculture	-4.5	-2.4	-1.0	-2.3	-0.2	-0.1	0.0	-1.5
Energy sector	-3.0	-0.7	0.4	-0.6	-0.3	-0.1	0.1	-1.0
Food products and beverages; Tobacco	-5.4	-3.3	-1.5	-3.1	-1.1	-0.7	-0.4	-11.6
Textiles	-7.1	-5.5	-8.9	-6.8	-0.4	-0.3	-0.4	-5.3
Pulp, Paper and Non metallic minerals	-6.0	-3.0	-4.9	-3.9	-0.5	-0.3	-0.5	-6.1
Basic metals	-6.1	-4.0	-3.1	-4.1	-0.2	-0.1	-0.1	-1.9
Chemicals	-6.2	-4.9	-5.9	-5.5	-1.3	-1.2	-1.6	-21.2
Fabricated metal products, except machinery and equipment	-5.5	-2.6	-4.2	-3.5	-0.4	-0.2	-0.4	-4.9
Machinery and equipment goods	-6.2	-4.5	-8.1	-5.9	-0.7	-0.5	-1.3	-12.8
Electric goods	-5.1	-3.9	-2.7	-3.8	-0.1	-0.1	-0.1	-1.4
Transport equipment goods	-7.5	-3.7	-2.9	-3.7	-1.0	-0.5	-0.6	-9.8
Other equipment goods	-5.8	-2.4	-3.7	-3.3	-0.2	-0.1	-0.2	-2.3
Construction services	0.5	6.0	5.5	5.3	0.1	1.7	2.0	26.5
Trade services	-3.5	1.1	1.7	0.8	-2.3	0.8	1.5	10.3
Transport services	-3.5	-1.2	-1.7	-1.6	-0.7	-0.3	-0.5	-6.2
Financial intermediation services	-3.3	0.3	-2.7	-1.0	-0.3	0.0	-0.4	-1.9
Other business services	-3.0	1.2	0.6	0.6	-1.6	0.7	0.5	6.5
Rest of Market services	-0.3	3.7	3.5	3.2	0.0	0.4	0.6	6.7
Recreational services	-2.6	2.6	2.3	1.9	-0.3	0.3	0.3	4.0
Non market services	16.8	21.9	25.2	22.5	5.5	7.7	11.1	136.1

Source: GEM-E3-CAT

Table 36. Domestic production in Catalonia in Scenario S02								
	Change from reference, in %				Change from reference, in bn Euro 2004			
	2015	2020	2030	Cumulative 2015-2030	2015	2020	2030	Cumulative 2015-2030
Agriculture	-4.8	-2.8	-1.5	-2.8	-0.2	-0.1	-0.1	-1.9
Energy sector	-3.7	-1.6	0.3	-1.2	-0.3	-0.2	0.0	-2.0
Food products and beverages; Tobacco	-5.6	-3.4	-2.0	-3.4	-1.1	-0.8	-0.5	-12.9
Textiles	-6.6	-4.6	-9.9	-6.8	-0.4	-0.2	-0.4	-5.3
Pulp, Paper and Non metallic minerals	-6.7	-3.6	-5.6	-4.7	-0.6	-0.3	-0.6	-7.2
Basic metals	-5.7	-3.2	-3.6	-4.0	-0.2	-0.1	-0.1	-1.8
Chemicals	-5.8	-4.2	-6.8	-5.5	-1.2	-1.0	-1.8	-21.4
Fabricated metal products, except machinery and equipment	-5.7	-2.4	-5.1	-3.9	-0.4	-0.2	-0.5	-5.4
Machinery and equipment goods	-5.7	-3.4	-9.3	-6.0	-0.6	-0.4	-1.5	-12.9
Electric goods	-3.9	-2.3	-3.6	-3.4	-0.1	0.0	-0.1	-1.2
Transport equipment goods	-8.1	-2.3	-3.5	-3.5	-1.0	-0.3	-0.7	-9.2
Other equipment goods	-6.4	-2.8	-4.6	-4.0	-0.2	-0.1	-0.2	-2.8
Construction services	-3.2	1.6	5.4	2.9	-0.8	0.5	2.0	14.3
Trade services	-6.6	-2.7	1.5	-1.4	-4.3	-2.0	1.4	-17.4
Transport services	-4.5	-2.4	-1.9	-2.4	-0.9	-0.5	-0.5	-9.2
Financial intermediation services	-5.4	-2.3	-3.4	-2.7	-0.5	-0.2	-0.5	-5.0
Other business services	-5.4	-1.4	0.3	-1.0	-2.9	-0.8	0.2	-10.1
Rest of Market services	-2.5	0.8	3.3	1.6	-0.3	0.1	0.5	3.3
Recreational services	-5.8	-1.7	2.3	-0.4	-0.6	-0.2	0.3	-0.9
Non market services	19.6	22.4	27.0	23.9	6.5	7.9	11.9	144.5

Source: GEM-E3-CAT

3.5.5. Alternative uses of public funds

As discussed in the previous sections the Catalan government would have an additional budget to invest. In the base setting of the scenarios its has been assumed that the government would have a balanced budget and use the additional funds so as to increase public consumption and to reduce labour costs (the split of the budget between the two options has been assumed to be equal). In this section we study alternative uses of the public funds in order to identify the most efficient use in stimulating economic activity. Three cases have been considered: i) reduction of indirect taxes , ii) reduction of employers social security contributions and iii) increase in public spending.

The table below presents the results for GDP and its components for each scenario. The results indicate that among the three options considered, the reduction of indirect taxes is found to be most beneficial througout the simulation period (2015-2030). Increasing public expenditure is more effective than reducing labour costs in the short run and up to 2019. This can be explained as follows: the higher unemployment rate up to 2020, implies that labour supply is flexible in meeting additional demand for labour with a minimum effect on labour costs. Thus, competitiveness is not undermined. However when unemployment reaches almost 7% (in 2030) it is preferable to reduce labour costs in order to increase the competitiveness of the economy and not to put any pressure on wages; thus in the long term reducing employers social security contributions becomes more effective in stimulating activity compared to increasing public expenditure.

Table 37. Macroeconomic impacts from alternative uses of public funds									
S01	Government consumption			Social Security			Indirect taxes		
Change from reference	2015-2020	2021-2030	2015-2030	2015-2020	2021-2030	2015-2030	2015-2020	2021-2030	2015-2030
in % Gross Domestic Product	1.84	3.78	3.13	1.73	4.22	3.39	3.16	6.26	5.23
Investment	0.25	2.13	1.51	0.23	2.43	1.70	1.67	4.63	3.65
Public Consumption	32.98	41.97	38.91	27.03	27.76	27.51	27.03	27.76	27.51
Private Consumption	1.55	5.15	3.96	1.06	4.00	3.03	2.98	8.04	6.37
Exports	-6.84	-8.80	-8.14	-4.99	-3.10	-3.74	-3.62	-2.19	-2.67
Imports	-0.29	0.77	0.42	-0.13	1.51	0.96	1.35	3.89	3.04
in bn € 2004 Gross Domestic Product	20.55	84.20	104.75	19.28	94.04	113.32	35.36	139.62	174.97
Investment	0.46	7.93	8.40	0.41	9.02	9.43	3.05	17.21	20.26
Public Consumption	58.21	143.95	202.16	47.71	95.23	142.94	47.71	95.23	142.94
Private Consumption	10.32	69.82	80.14	7.05	54.25	61.31	19.91	108.97	128.88
Exports	-50.35	-127.67	-178.02	-36.73	-45.00	-81.73	-26.60	-31.73	-58.33
Imports	-1.90	9.94	8.04	-0.84	19.46	18.62	8.71	50.11	58.82
S02	Government consumption			Social Security			Indirect taxes		
Change from reference	2015-2020	2021-2030	2015-2030	2015-2020	2021-2030	2015-2030	2015-2020	2021-2030	2015-2030
in % Gross Domestic Product	-1.21	3.33	1.81	-1.36	3.92	2.16	1.84	6.55	4.98
Investment	-6.16	1.23	-1.21	-6.11	1.62	-0.93	-3.04	4.45	1.98
Public Consumption	39.46	46.36	44.01	27.03	27.76	27.51	27.03	27.76	27.51
Private Consumption	-6.72	4.45	0.76	-7.52	2.96	-0.50	-3.90	8.17	4.18
Exports	-6.96	-10.00	-8.98	-3.08	-2.51	-2.70	0.53	-1.33	-0.71
Imports	-3.76	0.40	-0.99	-3.27	1.38	-0.17	-0.09	4.45	2.93
in bn € 2004 Gross Domestic Product	-13.47	74.19	60.73	-15.22	87.49	72.28	20.59	146.14	166.73
Investment	-11.26	4.57	-6.68	-11.17	6.03	-5.14	-5.56	16.55	10.99
Public Consumption	69.63	159.01	228.64	47.71	95.23	142.94	47.71	95.23	142.94
Private Consumption	-44.87	60.31	15.44	-50.24	40.15	-10.08	-26.05	110.67	84.62
Exports	-51.21	-144.98	-196.19	-22.63	-36.34	-58.96	3.87	-19.33	-15.46
Imports	-24.24	5.15	-19.09	-21.11	17.79	-3.32	-0.61	57.36	56.75

Source: GEM-E3-CAT

3.6. Conclusions

Catalan secession from Spain as quantified by the GEM-E3-CAT model is beneficial for Catalonia in all cases examined, reflecting to a large extent the positive impact from terminating Catalonia's net fiscal transfers to the rest of Spain. In the short run uncertainty, high interest rates and a volatile investment environment triggered by the decision to secede is found to slow the Catalan GDP growth rate; the effect is more pronounced if the decision to secede is unilateral. However the structure of the Catalan economy and the pursuit of fiscal policy towards a balanced public budget can deliver higher than the reference GDP and employment growth rates, once the transition period to sovereignty is over.

The overall net effect from secession on the Catalan economy is the result of a multitude of short and long run adjustments with frequently opposing effects. Below we describe the key mechanisms that drive the adjustment process:

Short run

i) The change of the fiscal imbalance between Spain and Catalonia benefits the Catalan economy due to the increased public investment and its economy wide multiplier effects. Stock addition and upgrade of infrastructure stimulates mainly domestic production since the additional demand is addressed to domestic activities (for instance construction).
ii) Higher domestic production lowers unemployment without exerting significant pressure to the wages, as unemployment is still at high levels.
iii) The decision to secede creates uncertainty and increases market interest rates and the risk premium.

Long run

i) The increased infrastructure capacity increases economy wide productivity improving the overall competitiveness of the economy.
ii) Additional public spending reduces unemployment but may deteriorate competitiveness as upward pressure is exerted on wages.
iii) Uncertainty is reduced and **interest rates** become lower than the reference as the fundamentals of the Catalan economy are strengthening (sustainable debt, balanced public budget and low unemployment).

Overall the positive effects induced by additional productivity and better public finances are only moderated by a loss in competitiveness induced by higher wages (depending on how the additional fiscal revenue remaining in the region is allocated). Different assumptions on public spending and fiscal policy were examined as these could lead to different short run and long run adjustments. It has been found that reduction of indirect taxes is the most beneficial option in terms of GDP. Increasing public expenditure is preferred in the short term whereas in the longer term when low unemployment rates prevail it is preferable to reduce labor costs. As expected Catalonia benefits more under mutual agreement on secession as the lower uncertainties and risks associated with secession in this case allow for a faster recovery of the economy from the shock of independence from Spain.