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Trading borders: the importance of interregional integration and economy size for the impact of secession

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ABSTRACT
This paper analyses the impact of secession on the 'seceding' and 'successor' regions. A two-regions computable general equilibrium model is initially calibrated to a set of synthetic datasets where the regions only differ in relative size and trade integration. Using the case of two identical regions as a benchmark we show how relative size and trade integration determine the relative impact on both regions. This framework is used to explore three European case studies, the UK, Spain and Italy, demonstrating how, although always detrimental for both regions, trade integration and relative size explain the economic impacts of new trade borders.

KEYWORDS
secession; seceding; borders; international trade; regional trade; trade costs

1. INTRODUCTION

Recent years have seen a growth in the prominence of pro-independence political movements, such that some have argued that we live in the 'Age of Secession' (Griffiths, 2016). Dozens of separatist campaigns are currently active across the world today. In Europe, pro-independence parties have gained traction in Scotland and Wales, Catalonia, Corsica, Flanders, and the Faroe Islands. The rise of separatist debates has not been limited to *within* nation states but extends to membership of international institutions too. Brexit, the decision of the UK to leave the European Union (EU), is perhaps the most high-profile secession campaign in recent years.[1] There is no one catch-all identity that holds such movements together. They often cover broad issues, some of which reflect centuries of political, social and cultural history. Muscatelli et al. (2022) and Madiès et al. (2018) show how, over time, certain 'push' factors (national issues that push a region toward separatism such as disenchantment with ruling political elites, disputes over pooling and sharing of financial and economic resources, and concerns over unequal gains from globalisation) and 'pull' factors (regional issues that pull a region toward separatism such as

demands for improved accountability, policy flexibility and trends in regional/ethnic identity) can have varying degrees of influence over public attitudes to separatism over time.

Trade barriers that may emerge when new borders are created are crucial in determining the economic impact of a nation's break-up. The seminal work of Alesina and Spolaore (1997, 2005) seeks to better understand the factors that lead to the formation and disintegration of political and economic borders over time. In their analysis the number of 'countries increase with the amount of international integration' (p. 1028). Intuitively, newly formed countries could join larger trading blocks and benefit from access to new larger markets. However, in practice, when nations break-up, the newly independent regions of a former country may face higher trade costs with each other in the absence of trade agreements (Brakman et al., 2023; Comerford & Rodríguez Mora, 2019; Huang et al., 2021). Joining bi- or multilateral trade agreements can mitigate some or all of these effects, especially if both the 'seceding' region and the remaining 'successor'[2] are part of it (e.g., see Benz & Gonzales, 2019, for the case of trade in services). However, there are cases in the empirical literature where this is believed not to be

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the case. For instance, for Scotland and the rest of the UK and for the UK and the EU, Brakman et al. (2023), Figus et al. (2022) and Sampson et al. (2021) show that gaining access to new larger markets does not necessarily fully offset the cost of breaking away from former main trade partners. This may reflect the fact that seceding regions are typically small and highly integrated with the successor state and therefore are particularly exposed to such trade costs.

In this paper we develop a framework for the analysis of the economic impacts of secession from a trade perspective.[3] We focus on the impact that secession has on both the seceding and the successor nations for three main reasons. First, not all seceding nations are small, thus can potentially harm the successor's economy. For instance, in the 1990s a secessionist movement in Italy[4] proposed the separation of Northern Italy[5] (a region that in 2019 produced 56% of Italy's gross domestic product (GDP); ISTAT, 2023) from the rest of the country. Second, some productive sectors may be more concentrated on one side of any proposed new border. In this case, whilst the impact of new trade barriers may be less important at an aggregate level for the successor state, it may nevertheless have significant consequences at a sectoral level. Finally, the political economy arguments involved in the break-up of nations – and any subsequent secession negotiations – will be informed by the economic impact on both parties. An ex-ante understanding of the likely priorities of both sides post-secession, including an understanding of any trade-offs, can shed light on the likely positions of each party in secession negotiations.

To analyse these effects, we develop a single analytical framework to capture the economic impact of secession on both the seceding and the successor regions. Using a simulation approach, we assess the role of trade integration and of the size of the seceding nation on the magnitude of the impact that secession has on both the seceding and the successor economies. We begin by looking at a series of hypothetical cases where the relative size and degree of economic integration of two regions is varied systematically through the generation of a set of synthetic datasets. We then calibrate our simulation model to multiregional input–output (IO) tables from Thissen et al. (2018) and consider three real-world secession scenarios each representing differing degrees of relative size and trade integration: Scotland and the rest of the UK, Catalonia and the rest of Spain, and Northern Italy and the rest of Italy. Our empirical case study examples are designed to be illustrative of the applicability of the approach rather than an attempt to provide detailed case study predictions. However, they still serve to identify the relative magnitudes of impacts between two potentially newly formed countries and to link this with the characteristics of these regions prior to secession.

The structure of the paper is as follows. Section 2 discusses the existing literature. Section 3 describes the modelling approach adopted. Section 4 explains the simulation strategy. Results are presented in section 5. Section 6 provides further discussion and a short conclusion.

2. LITERATURE

Alesina and Spolaore (1997) formalised an analysis of the equilibrium number and size of nations and modelled the trade-off between gains from being part of a 'large' country, for example market size and economies of scale, and costs of heterogeneity which can emerge in larger countries. They show that democratisation and global economic integration increase the equilibrium number of countries. Alesina et al. (2000) consider the role that trade openness plays in mediating the effect of country size on growth. They find that the trade regime chosen mediates the benefits of economic size. Specifically, larger countries gain less from increasing openness than small countries, with the equilibrium number of countries increasing in trade openness.

Building on this, Gancia et al. (2022) recently argued that political structures can themselves influence, and respond to, growing international trade opportunities, either by removing borders or by reducing their costliness. In an initial phase, during the 19th century, for example, the trend toward increased country size through consolidation of once separate nations and kingdoms and through empire led to the reduction of trade barriers at a global level. Likewise, the formation of international organisations and the facilitation of international trade by these institutions in the 20th century meant that such large unions were no longer always necessary for trade to take place, and the number of countries increase once again with average country size falling.

On the empirical side, Reynaerts and Vanschoonbeek (2022) assess the economic impact of secession between 1940 and 2016. Their results suggest that secession has lowered GDP per capita in newly formed countries by an average of 24% in the short to medium terms. This has been mitigated by post-secession increased openness to trade and democratisation. However, the authors are cautious about the degree to which these results can be extended to contemporaneous examples (such as the ones analysed in our current paper) as the socio-economic characteristics of current aspirant secessionist regions are quite different from the historical examples.

In practice, factors affecting the trade-off between remaining in a union versus secession will evolve over time (Muscatelli et al., 2022), and even then, dynamics in the ebb and flow of economic gains and within-country heterogeneity may not always lead to changes in the size of nations. 'Unsettled Unions' can exist for decades. But there are also examples of abrupt change, such as the 'Velvet Divorce' between the Czech Republic and Slovakia and the disintegration of Yugoslavia. For this reason, empirical work to test the predictions of this theoretical literature is hampered by identifying causality.

The break-up and formation of nation states are driven by a series of endogenous factors making identifying the causal effect of any individual factor exceptionally difficult.

This is why numerical simulation approaches have become popular as a means of understanding the likely magnitude of the economic impact of secession as well as accession.

Several papers have attempted to understand the costs/benefits of economic secession including studies on the effect of Brexit (Dhingra et al., 2017; Duparc-Portier & Figus, 2022; Ebell & Warren, 2016; Figus et al., 2018; Fusacchia et al., 2022; Sampson, 2017; Thissen et al., 2020) and Scottish, Catalonian and Quebec independences (Armstrong & Ebell, 2014; Brakman et al., 2023; Castells, 2014; Figus et al., 2022; Huang et al., 2021; Lecca et al., 2017; Somers & Vaillancourt, 2014). These studies typically focus on trade linkages and use three main empirical approaches: computable general equilibrium (CGE) models (e.g., Figus et al., 2018; Fusacchia et al., 2022), IO models (Thissen et al., 2020) or econometric models including structural macroeconometric models (Ebell & Warren, 2016) and 'gravity' models (e.g., Brakman et al., 2023; Dhingra et al., 2017; Huang et al., 2021; Sampson, 2017). Two recent papers examine the case of Brexit and a potential future Scottish Independence aimed at rejoining the EU, one using a gravity model (Brakman et al., 2023) and one using a CGE model (Figus et al., 2022).

Brakman et al. (2023) estimate the role that distance, common borders, intra-national trading partnerships and free trade agreements have on bilateral trade flows. Results from the model are then used to simulate changes in trade agreements between territorial pairs. This is done by assuming that the impact of secession on trade with the successor state is equal to the average of bilateral trade volumes between existing sub-national entities in the dataset (holding constant other factors in the model). Similarly, the impact on bilateral trade volumes of joining a free trade agreement is taken to be given by the average bilateral trade flows between countries currently part of a free trade agreement (again holding all else constant). Whether these estimated relationships reflect the actual impact on a new seceding state, or a new accession state, depends on how similar it is to those states already having such trading relationships.

Looking at the case of the UK, Brakman et al. (2023) find that while exiting the UK is uniformly bad for the seceding country (they consider the secession of each of the UK nations) and the remaining UK, rejoining the EU can offset the loss of trade implied by secession. Importantly, however, while this model considers the general equilibrium effects on trade, it does not model any economy-wide impacts of rising trade costs, nor does it capture any sectoral detail in each economy or the transition path between equilibria.

Figus et al. (2022) in contrast calibrate a multi-sectoral CGE model of the Scottish and rest of the UK (RUK) economies using pre-Brexit data. They simulate the economic impact of scenarios including the UK leaving the EU, the effect of Scotland leaving the UK, and the effect of Scotland becoming independent and also rejoining the EU. In all cases, implied trade barriers are given by estimates from HM Government (2018) of the scale of non-tariff barriers implied by its trade agreement with the EU. These are used as follows: in their Brexit scenario these non-tariff barriers are applied to both Scottish and UK trade with the EU, in the second case these are also applied to Scotland–RUK trade, and in the third these are removed from Scotland–EU trade. This research shows that rising border costs imply significant economic costs, which results in: Brexit lowering economic activity, Scottish independence further lowering economic activity in Scotland, and rejoining the EU offsetting some of the costs implied by independence, but not all. The paper does not discuss the impact of Scottish independence on the RUK.

Despite several papers similar in approach to the two discussed above, motivated by informing the electorate of some of the economic consequences of the decision involved, there has been less detailed consideration of the impact of one territory seceding on the successor economy.[6]

This lack of focus on the successor economy is, in many ways, surprising.[7] Not all seceding regions are small, either in totality or in key sectors. Given that the ultimate nature of any border costs between the seceding and successor state will be the product of negotiations between the seceding region and its former country, understanding the economic impact of secession on the successor economy can shed light on its likely ex post negotiating position.

In what follows, we address this by analysing the effect on both the seceding and the successor regions. In doing so, we explore the role of both trade integration and relative size, reflecting two elements which the theoretical literature considers key in determining whether a region secedes.

3. MODEL DESCRIPTION

The main issue in our paper is the role of the size of the seceding entity relative to the successor state and the extent to which the trade between these is integrated. We argue that these two factors are crucial in determining the potential impact of secession on both the seceding and the successor states and that these are relatively unexplored in the literature as discussed in the section above. Given the complexity of the issue at hand, and the endogenous nature of the key variables of interest, regression analysis can offer some insights but has limitations. Structural modelling may provide further insight into the mechanisms in play and their respective magnitudes in a controlled setting. For this reason, we develop a stylised two-region CGE model and use it to analyse the role of trade integration and relative size in propagating trade shocks followed by secession. The model is based on Figus et al. (2018, 2022).[8] It uses conventional production functions to model the behaviour of cost-minimising firms that employ capital, labour and intermediate inputs to produce gross output in two regions that are part of the same country (see equations B.14–B.19 in Appendix B in the supplemental data online). Intermediate inputs used in

Figure 1. Schematic representation of the model's structure and dataset.

production by firms in each region can be either produced domestically or imported from the other region or from the rest of the world (ROW) (see equations B.20–B.26 online). Intermediate inputs are considered imperfect substitutes following the conventional Armington assumption. Crucially, whilst the ROW is considered to be exogenous, relative prices and economic activity in the seceding and successor states are endogenous and changes in the cost structure of either has impacts on both regions through induced price changes. This is because the output price of one is equal to the price at which the second imports from them, and vice versa (see equation B.2 online).

In each region households receive income from labour and capital and consume a combination of domestically produced and imported goods which are again imperfect substitutes (see equations B.38–B.42 online). For simplicity we assume that no migration happens between the two newly formed countries following secession so that essentially the only link is the trade of goods and services.

The model is dynamic, and agents have forward looking expectation. However, for the purpose of this paper, we only focus on long-run results; that is a situation where capital stocks are fully adjusted to the desired level of capital and investment is just sufficient to cover depreciation.

Figure 1 presents the model schematically. It can be thought of as a simplified representation of a two-region IO table on which the model is calibrated. The two non-shaded rectangles in the diagonal represent the productive activities of the two domestic regions. In each region, output is either sold within the region or exported. The off-diagonal elements, represented by the two shaded rectangles, consider interregional trade. Reading Figure 1 clockwise, using the centre as the origin of a Cartesian system, the first quadrant is region 1's exports to region 2 or

region 2's imports from region 1. Similarly, the third quadrant is region 2's exports to region 1 or region 1's imports from region 2. The two outer narrow rectangles represent imports/exports from/to the ROW.

In the model, the elasticity of substitution between capital and labour is set to 0.3 following Gechert et al. (2022) and the trade (Armington) elasticity between domestic and imported inputs is set to 2 (Zofío et al., 2020).

4. SIMULATION STRATEGY

We present the results from two empirical exercises. In the first, we simulate two synthetic regions and vary the extent of trade integration between them as well as their relative size. In the second empirical exercise, we explore three real-world secession cases. In both scenarios, we assume that in the baseline the two regions are part of the same country. We then simulate a counterfactual 1% increase in interregional trade cost by shocking the price at which each of the two regions export to the other region to represent the hypothetical cost of secession. This is simulated by setting the trade frictions parameter $\tau_{r,i,t}$ in equation B.2 online, which is initially calibrated from 0.00 to 0.01. This is an illustrative cost, and it is applied symmetrically to both regions; it may arise from the ending of, or reduction in, market access on a privileged basis which results in the imposition of tariffs or the rise of non-tariff barriers, as well as from retaliation (Anderson & Van Wincoop, 2004). Whilst the shock is 1% across the board, it will be proportionate to the degree to which the two regions trade. Crucially, in the second scenario, the shocks are proportionate to the level of relative trade integration at the industry level based on the dataset.

In the first scenario, we calibrate our model to a set of two-region IO tables generated using the 2017 symmetric IO table of the UK (Office for National Statistics

(ONS), 2022). We use the 2017 IO table as the basis to produce a set of synthetic two-region IO tables that have different degrees of trade integration, $\gamma \in (0,1)$[9] and relative sizes, $\delta \in (0,1)$.[10] A special case is when $\gamma = \delta = 0.5$. In this case, the UK is split into two identical and symmetric regions. To explain with reference to Figure 1, the rectangles in the first and third quadrants and the rectangles in the second and fourth quadrants will have the same areas, respectively. However, for all the other parameter values the relative areas of the four rectangles will vary whilst the total area given by the summation of the areas of the four rectangles remains unchanged. This process allows us to explore the impact that changes in trade integration and relative size of pairs of regions have whilst keeping the overall structure of the economy unchanged.

In the second scenario, we calibrate our model to three different real-world cases, namely Scotland and the RUK; Catalonia and the rest of Spain (RoS); and Northern Italy (NI) and the rest of Italy (RoI), using data from Thissen et al. (2018). This dataset provides multi-regional, trade-linked IO tables for EU NUTS-2 regions in 2010 for 14 productive sectors. To calibrate the model, we aggregate all the regions external to the country into a 'rest of the world' region so that we can maintain our two-region structure. We then simulate the same 1% increase in trade cost between the two regions. Again, the size of the shock is illustrative, and it is used in the absence of estimates for the specific cases. Sensitivity on the size of the shock is presented towards the end of the next section. The use of these data allows us provide examples of real-world situations where γ and δ take different values.

5. RESULTS

We begin by considering the results from the first scenario with the purpose of undertaking a systematic exploration of the effects of bilateral trade restrictions under different degrees of pre-secession trade integration and relative size of the seceding region.

5.1. Simulations with synthetic interregional databases

Increased barriers to interregional trade created by secession are captured through a simultaneous rise in the effective prices of all final and intermediate goods and services that are traded between the seceding and successor states. Table 1 presents the results of an illustrative 1% rise in bilateral regional trade costs for sets of hypothetical two-region economies. The cases identified in columns 1–6 differ solely in terms of the degree of initial (intermediate) trade integration of the seceding region with the successor state.

Irrespective of the degree of integration, all the results exhibit some key features. In each case, regional exports and imports, gross value added (GVA), consumption, investment and employment all fall, pushing up unemployment rates and depressing the real wage. The increase

in trade barriers reduces economic activity in both the seceding and the successor regions, a result that holds across all simulations. These impacts reflect the results of simultaneous rises in regional export and import prices. As the price of a region's exports rises, demand from the other region contracts. This initially creates excess capacity, falling rentals and increased unemployment. The latter puts downward pressure on wages and so moderates the impact on competitiveness and stimulates regional exports to ROW. Overall, however, the demand contraction is associated with a fall in interregional exports (and imports) and economic activity and declining own-region prices.

The increase in the price of a region's imports has several countervailing demand and supply impacts. First, the increase in the prices of imported consumption goods and services ultimately has a positive impact on demand as consumption of domestically produced goods are substituted for imports (a tendency that is evident with a fixed nominal wage that eliminates the transmission mechanism from wages to domestic prices). However, this tends to stimulate employment, reduce unemployment, and push up the real wage. Second, the increase in the price of imports applies to imported intermediates, which represents a negative supply shock, reducing domestic competitiveness, leading to a decrease in exports to the other region and to ROW. The rise in the price of interregional imports unambiguously leads to a fall in interregional trade and in economic activity and, probably (since a predominant adverse supply shock seems more likely) an increase in prices.

Overall, an increase in barriers to interregional trade unambiguously leads to a contraction in economic activity in both regions since both are simultaneously subjected to adverse demand and supply shocks. Interregional trade falls and the contraction in economic activity reinforces the impact of the rise in regionally traded goods' prices. The impact on regional price levels depends on the relative strengths of the demand and supply side shocks. The results in Table 1 confirm that the supply shock predominates; there is upward pressure on regional prices. Impacts on trade with the ROW are, in general, ambiguous: exports to ROW depend on the resultant changes in their domestic prices (given that we treat ROW as entirely exogenous), imports from ROW are driven by the contractions in economic activity in both regions and changes in relative prices. Here the net effect of these forces is to reduce imports from ROW.

While much of the literature, as set out earlier, has emphasised the economic impact on the seceding region, the economy of the successor region is also adversely impacted. Indeed, in the admittedly rather special case in columns 1–6 in Table 1, of a seceding region that accounts for 50% of the national economy (and has a common structure), the impacts on the successor region are identical. The successor region has a clear economic, not only political, interest in threats of secession and this raises issues concerning the incentives of the successor region in responding to pressures before and (where applicable) after

Table 1. Impact of a 1% increase in bilateral regional trade costs in a hypothetical economy with pre-secession relative size and trade integration.

| δ = relative size | 0.5 | | 0.5 | | 0.5 | | 0.3 | | 0.3 | | 0.3 | | 0.1 | | 0.1 | | 0.1 | |
| γ = trade integration | 0.5 | | 0.3 | | 0.1 | | 0.5 | | 0.3 | | 0.1 | | 0.5 | | 0.3 | | 0.1 | |
	Sece-ding 1	Succ-essor 2	Sece-ding 3	Succ-essor 4	Sece-ding 5	Succ-essor 6	Sece-ding 7	Succ-essor 8	Sece-ding 9	Succ-essor 10	Sece-ding 11	Succ-essor 12	Sece-ding 13	Succ-essor 14	Sece-ding 15	Succ-essor 16	Sece-ding 17	Succ-essor 18
GVA	−2.71	−2.71	−1.25	−1.25	−0.33	−0.33	−1.88	−1.05	−1.02	−0.52	−0.31	−0.14	−1.48	−0.26	−0.89	−0.13	−0.30	−0.04
Household consumption	−4.44	−4.44	−2.09	−2.09	−0.57	−0.57	−3.13	−1.76	−1.72	−0.88	−0.53	−0.25	−2.50	−0.43	−1.52	−0.23	−0.51	−0.06
CPI	0.77	0.77	0.33	0.33	0.08	0.08	0.55	0.26	0.28	0.12	0.08	0.03	0.47	0.06	0.27	0.03	0.08	0.01
Investment	−3.29	−3.29	−1.54	−1.54	−0.42	−0.42	−2.30	−1.31	−1.26	−0.65	−0.39	−0.18	−1.81	−0.32	−1.10	−0.17	−0.38	−0.05
UCK	0.97	0.97	0.46	0.46	0.13	0.13	0.68	0.38	0.37	0.19	0.12	0.05	0.54	0.09	0.33	0.05	0.11	0.01
Government consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nominal government revenues	−3.26	−3.26	−1.58	−1.58	−0.44	−0.44	−2.31	−1.35	−1.28	−0.69	−0.41	−0.19	−1.81	−0.34	−1.12	−0.18	−0.39	−0.05
Employment	−2.23	−2.23	−1.01	−1.01	−0.27	−0.27	−1.53	−0.85	−0.82	−0.42	−0.25	−0.11	−1.20	−0.20	−0.72	−0.11	−0.24	−0.03
Unemployment rate	2.10	2.10	0.95	0.95	0.25	0.25	1.44	0.79	0.77	0.39	0.23	0.11	1.13	0.19	0.67	0.10	0.23	0.03
Nominal gross wage	−2.58	−2.58	−1.32	−1.32	−0.38	−0.38	−1.87	−1.14	−1.07	−0.59	−0.35	−0.17	−1.47	−0.30	−0.93	−0.16	−0.33	−0.04
Real gross wage	−3.33	−3.33	−1.64	−1.64	−0.46	−0.46	−2.40	−1.40	−1.35	−0.71	−0.43	−0.20	−1.93	−0.35	−1.20	−0.19	−0.42	−0.05
Trade																		
Total exports	−4.08	−4.08	−2.31	−2.31	−0.90	−0.90	−2.88	−2.21	−1.90	−1.31	−0.85	−0.46	−2.29	−0.79	−1.68	−0.44	−0.82	−0.14
Total imports	−4.17	−4.17	−2.38	−2.38	−0.92	−0.92	−2.96	−2.26	−1.96	−1.34	−0.87	−0.47	−2.36	−0.80	−1.74	−0.45	−0.84	−0.14
ROW imports	−2.20	−2.20	−1.05	−1.05	−0.29	−0.29	−1.54	−0.90	−0.85	−0.46	−0.27	−0.13	−1.20	−0.23	−0.73	−0.12	−0.26	−0.03
Regional imports	−4.92	−4.92	−3.22	−3.22	−2.12	−2.12	−3.49	−3.46	−2.67	−2.63	−2.01	−1.98	−2.81	−2.74	−2.37	−2.31	−1.94	−1.90
Regional export	−4.92	−4.92	−3.22	−3.22	−2.12	−2.12	−3.46	−3.49	−2.63	−2.67	−1.98	−2.01	−2.74	−2.81	−2.31	−2.37	−1.90	−1.94
ROW export	−1.71	−1.71	−0.77	−0.77	−0.21	−0.21	−1.21	−0.63	−0.65	−0.31	−0.20	−0.09	−0.99	−0.15	−0.59	−0.08	−0.19	−0.02
Intermediate																		
Total input	−3.33	−3.33	−1.56	−1.56	−0.42	−0.42	−2.34	−1.31	−1.28	−0.66	−0.40	−0.18	−1.86	−0.32	−1.13	−0.17	−0.38	−0.05
Domestic input	−2.08	−2.08	−0.94	−0.94	−0.25	−0.25	−1.43	−0.79	−0.77	−0.39	−0.24	−0.11	−1.12	−0.19	−0.68	−0.10	−0.23	−0.03
Imports from other region	−5.22	−5.22	−3.49	−3.49	−2.38	−2.38	−3.70	−3.81	−2.89	−2.94	−2.25	−2.26	−2.96	−3.11	−2.57	−2.64	−2.17	−2.19
Imports from ROW	−1.62	−1.62	−0.76	−0.76	−0.21	−0.21	−1.13	−0.65	−0.62	−0.33	−0.19	−0.09	−0.89	−0.16	−0.54	−0.08	−0.19	−0.02

Note: All results are in percentage change from baseline values. CPI = consumer price index, GVA = gross value added, ROW = rest of the world, UCK = User cost of capital.

secession. Furthermore, these incentives may differ ex-ante and ex-post.

5.2. Isolating the impacts of the extent of pre-secession integration and of scale

Comparing the first three cases identified in Table 1, the results are sensitive to the degree of pre-secession trade integration between the seceding and successor entities; the greater the degree of integration the greater the impact of secession. For example, when the degree of trade integration γ falls from 0.5 to 0.1, the impact on GVA falls from 2.71% to 0.33%. This is expected: the lower the degree of trade integration between the two regions, the smaller the relative scale of trade flows to which the effective price shock applies within the seceding region. The symmetrical nature of regions in this case means that the same effective shock is applied to the successor region, with identical results.

Holding the degree of pre-secession integration constant ($\gamma = 0.5$) and varying the scale of the seceding economy relative to the successor economy the qualitative results are unaffected, with falls in economic activity across the board, increases in the unemployment rate, falls in the real wage and increases in the consumer price index (CPI). However, as the relative scale of the seceding region declines from 50% to 10% the impacts on both regions fall significantly as the scale of the trade flows to which the price shock is applied declines for both regions.

Note, however, that the impact of the new trade barrier is no longer equal across regions once the seceding region's share of GVA differs from 50%; the contraction in the seceding region's GVA, for example, falls from 2.71% to 1.48% as its relative size declines from 50% to 10%, meanwhile the impact on the successor state falls from 2.71% to 0.26%. The size of the trade flows to which the price shock applies falls with the reduction in the relative importance of the seceding region and, in percentage terms, this represents an even smaller impact for the much bigger successor economy. The results are illustrated in Figure 2, which shows the impacts (in percentage terms) of the hike in trade barriers on employment for various combinations of relative size and the degree of pre-secession integration displayed as the first and second numbers inside the square brackets separated by a comma. For example, the first pair of bars on the left indicate the situation where the two regions are identical sizes and share 50% of their trade with each other, so corresponds to the results reported in columns 1–2 of Table 1. Here the introduction of trade frictions has the greatest negative impact.[11] It is clear from the first three pairs of bars that the impact on equally sized pre-secession regions remains symmetric and increases with trade integration.
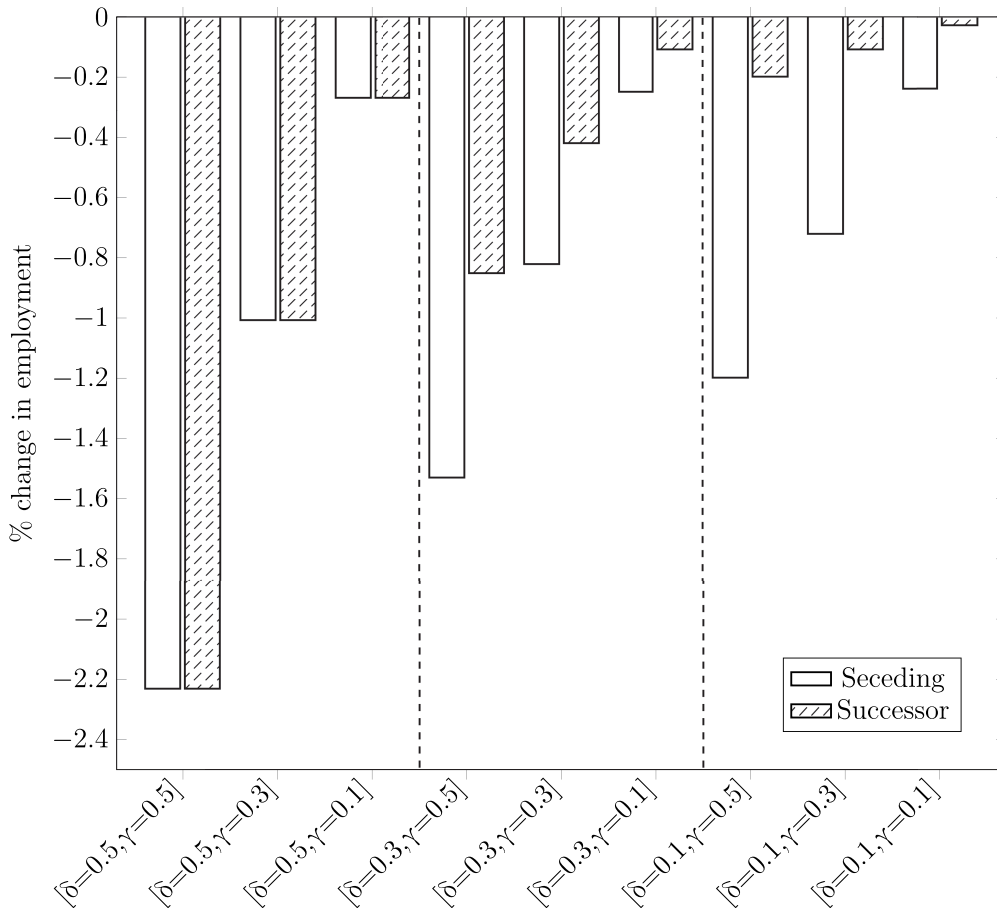

Figure 2. Impact of a 1% increase in bilateral trade cost between the two regions.

The central three bar pairs in Figure 2 reflect the cases where the seceding region is 30% of the pre-secession country. The impacts here become asymmetric and systematically larger for the seceding region. Again, the impacts increase with trade integration. The three pairs on the right show cases where the relative size of the seceding region is 10%. The impact of introducing trade frictions on the seceding country is around six times that on the successor country in percentage terms. The smallest impacts in Figure 2 are associated with the case where the seceding region is 10% of the successor country and they share only 10% of their trade with each other [$\delta = 0.1$, $\gamma = 0.1$]. The combination of the small relative size of the seceding region with little integration with the successor region minimises the size of the contraction for both regions.

5.3. Sectoral results

Up to this point we have not considered sectoral impacts. The reason is simple: our method to generate synthetic IO tables produces sectors that have all the same relative size and trade integration as we apply the same δ and γ to all the sectors. However, one of the main advantages of using a multisectoral framework is the ability to identify sector specific results. Normally, we would assume that the sectoral results would follow the aggregated results at

least qualitatively. This means for example that if the seceding region is more negatively impacted than the successor at the aggregate level, this will be reflected in the sectoral distribution. However, there may be instances where a particular industry is predominantly located on one side of the post secession border, and this may result in sectoral impacts that are significantly different from the aggregate impacts. For example, according to the ONS (2024), Scotland's share of the UK's fishing and aquaculture industry's GVA has been consistently above 60% since 2010, whereas the share of mining and support services activities' GVA is over 75%. Similarly, whilst many industries are particularly concentrated in NI, according to the Italian National Statistics Institute (ISTAT) (2024) fishing and aquaculture is one example of an industry mostly concentrated in the Centre–South of the country.

To illustrate the impact of sectoral concentration, we again split our national dataset, but this time with respect to relative size at the sectoral level.[12] For simplicity we assume that our two economies have three aggregated industries: agriculture, farming and fishing (S1), manufacturing and energy (S2) and services (S3). These are based on the initial 2017 UK Input Output table (ONS, 2022). We focus on two special cases. Case 1 is a departure from our symmetric case ($\delta = \gamma = 0.5$) where the seceding
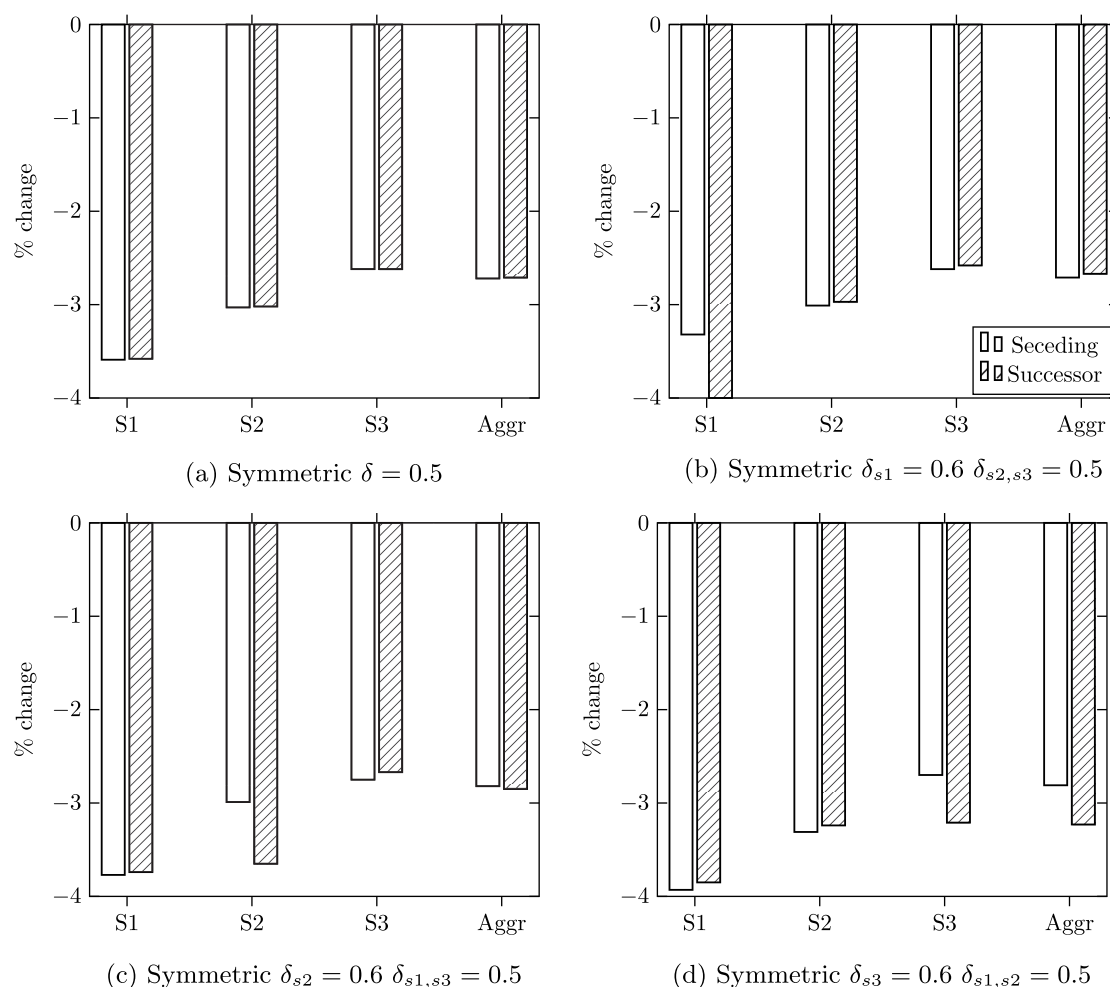

(a) Symmetric $\delta = 0.5$

(b) Symmetric $\delta_{s1} = 0.6$ $\delta_{s2,s3} = 0.5$

(c) Symmetric $\delta_{s2} = 0.6$ $\delta_{s1,s3} = 0.5$

(d) Symmetric $\delta_{s3} = 0.6$ $\delta_{s1,s2} = 0.5$

Figure 3. Impact on gross value added (GVA) of a 1% increase in interregional trade cost in case 1.

region has a larger relative size in just one sector so that for instance $\delta_{s1} = 0.6$ and $\delta_{s2,s3} = 0.5$. All three sectors are considered in turn. Case 2 is a departure from an asymmetric case ($\delta = 0.3$, $\gamma = 0.5$) where again the relative size of the three sectors in the seceding region is set to 0.6 in turn.

Results for case 1 are presented in Figure 3. Figure 3a shows the symmetric case corresponding to the first two columns in Table 1. The impacts in the three sectors and on aggregate GVA (Aggr) are symmetric in the two regions as expected. The results differ by sector due to their different input structure that reflects the UK IO table. In Figure 3b, the relative size of S1 is larger for the seceding region. Therefore, the impact on the successor is larger for this sector. Figures 3c, d show the same result for S2 and S3. Again, the successor is more negatively impacted in the two specific sectors.

Figure 4 presents the results for case 2. Figure 4a corresponds to columns 7 and 8 in Table 1. In all four cases the seceding region is more negatively impacted than the successor due to its relative size. This is consistent with the aggregate results presented in the previous section. However, in Figures 4b–d it is interesting to note that, although the seceding region is always more negatively impacted in aggregate, the successor is more negatively impacted in the sectors in which the seceding region has a larger relative size.

There is no ambiguity about the impact of the rising trade restrictions on economic activity: both regions experience contractions. Furthermore, the size of these contractions – in both regions – varies directly and significantly with the relative size of the seceding region and its degree of pre-secession trade integration with the successor entity. The sectoral disaggregation of the results reveals that there may be situations where the seceding region is more negatively impacted in aggregate, but the successor could still experience large sector specific losses.

5.4. Three European case studies

We use our framework to help interpret three case studies: Scotland–RUK; Catalonia–RoS and NI–RoI. The cases are chosen primarily because such secessions have been – and continue to be – the subject of serious political debate (though to different degrees across regions and time periods). They are also instructive as their economic context is different, highlighting the usefulness of our approach for other case studies.

Of course, the countries and their regions vary because of differences in economic structure and behaviour. However, here we abstract from many aspects of these differences by imposing identical model structures and values for key parameters (e.g., substitution elasticities) across each of the cases and we only vary the underlying
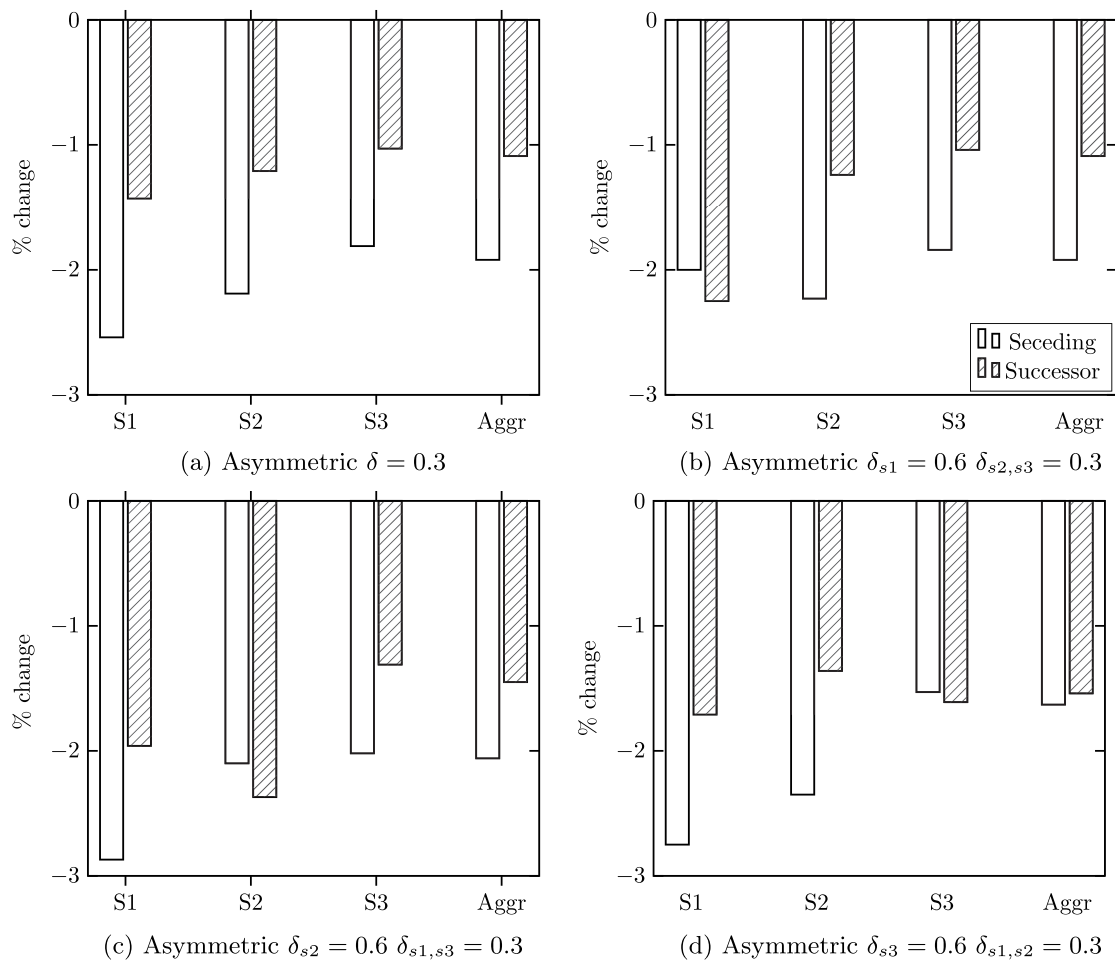

(a) Asymmetric $\delta = 0.3$

(b) Asymmetric $\delta_{s1} = 0.6$ $\delta_{s2,s3} = 0.3$

(c) Asymmetric $\delta_{s2} = 0.6$ $\delta_{s1,s3} = 0.3$

(d) Asymmetric $\delta_{s3} = 0.6$ $\delta_{s1,s2} = 0.3$

Figure 4. Impact on gross value added (GVA) of a 1% increase in interregional trade cost in case 2.

economic data that the model is calibrated to. This allows us to isolate the potential trade impacts that have been so central to secession debates in these countries.

The cases differ in terms of industrial structure and other characteristics captured by the relevant interregional social accounting matrices (SAMs), including the degree of pre-succession integration, although Scotland and Catalonia are quite similar in this respect, with ($\gamma = 0.35$ and 0.33, respectively) while NI is far less integrated ($\gamma = 0.15$). The relative size of the seceding economy varies substantially across each of the three case studies. In the EUREGIO dataset for 2010, Scotland accounts for just 8% of UK GDP, while Catalonia constitutes 19% of Spanish GDP and NI 55% of Italian GDP.

Table 2 summarises the impact of a 1% rise in interregional trade prices, reflecting the creation of bilateral trade barriers following secession.

The qualitative results are consistent with those of our earlier analysis: regional exports and imports, GVA, consumption, investment and employment all fall in each of the six regions. The impact of secession on interregional trade flows generates a contraction in both the seceding and the successor regions. The extent of the contraction in GVA, in percentage terms, is greatest for the RoI, by far the largest although least integrated seceding economy. The RUK and RoS economies experience the smallest percentage impacts. Note that in Table 2 the CPI rises for all six regions, suggesting that the supply-side pressure generated by the changes in interregional trade prices dominates. ROW imports fall in every case, which reflects the fact that here the contraction in economic activity dominates the generally favourable effects of the change in relative prices. ROW exports are driven solely by relative price changes. The fall in these exports from all regions is consistent with the change in relative prices.

Note that, in the Scottish case, GVA falls by 0.66%, investment (and capital stock) falls by 0.91% and employment by 0.46%, so that production becomes more labour intensive, in part reflecting the fall in the relative price of labour. Exports from Scotland tend to be capital-intensive and the price shocks particularly impact capital. The same qualitative pattern holds for RUK – and indeed all the other regions – though it is typically less marked. In terms of our earlier analysis, Scotland corresponds most

Table 2. Impact of an 1% increase in bilateral regional trade costs in three European countries with potentially seceding regions.

δ = relative size	0.08		0.19		0.55	
γ = trade integration	0.35		0.33		0.15	
	Scotland	RUK	Catalonia	RoS	NI	RoI
GVA	−0.66	−0.06	−0.47	−0.06	−0.61	−0.72
Household consumption	−1.07	−0.10	−0.68	−0.10	−0.72	−0.88
CPI	0.27	0.00	0.12	0.07	0.62	0.76
Investment	−0.91	−0.08	−0.61	−0.08	−0.75	−0.90
UCK	0.21	0.01	0.17	0.06	0.72	0.86
Government consumption	0.00	0.00	0.00	0.00	0.00	0.00
Nominal government revenues	−0.91	−0.13	−0.83	−0.04	−0.47	−0.45
Employment	−0.46	−0.05	−0.36	−0.04	−0.42	−0.46
Unemployment rate	0.43	0.05	0.34	0.04	0.39	0.44
Nominal gross wage	−0.51	−0.09	−0.50	0.00	−0.10	−0.04
Real gross wage	−0.78	−0.09	−0.61	−0.07	−0.72	−0.79
Trade						
Total exports	−1.53	−0.24	−0.88	−0.33	−1.41	−1.67
Total imports	−1.59	−0.22	−1.20	−0.25	−1.28	−1.26
ROW imports	−0.37	−0.07	−0.42	−0.02	−0.21	−0.19
Regional imports	−2.01	−2.31	−1.97	−1.49	−2.53	−2.21
Regional export	−2.31	−2.01	−1.49	−1.97	−2.21	−2.53
ROW export	−0.67	−0.03	−0.17	−0.08	−0.55	−0.81
Intermediate						
Total input	−0.85	−0.07	−0.51	−0.10	−0.77	−0.92
Domestic input	−0.46	−0.03	−0.03	−0.04	−0.55	−0.71
Imports from other region	−1.76	−2.51	−1.69	−1.81	−2.80	−2.50
Imports from ROW	−0.33	−0.06	−0.39	−0.01	−0.22	−0.18

Note: All results are in percentage change from baseline values. CPI = consumer price index, GVA = gross value added, ROW = rest of the world, UCK = user cost of capital, RUK = rest of the UK, RoS = rest of Spain, NI = Northern Italy, RoI = rest of Italy.

closely to the [0.1, 0.3] synthetic case set out above, although the share of the Scottish economy here is only 0.08 and the degree of integration slightly higher (0.35), both of which we would expect to result in smaller overall impacts, ceteris paribus. In fact, this is what we find, with Scottish GVA and employment falling by 0.66% and 0.46% (as compared with 0.89% and 0.72%) and RUK results are even more significantly reduced. The direction and scale of the changes are again consistent with our earlier analysis.

Catalonia has a much higher share of the pre-secession country's GVA than Scotland (19%), leading us to expect greater economic impacts but it is also slightly less integrated with the RoS, which would tend to limit the impacts on economic activity. Combined, we find that the impacts on Catalonia are smaller than in the Scottish case, while those on RoS are very similar to those on RUK.[13]

Of our three case studies, the relative scale of NI is the greatest, which in itself would lead to greater percentage impacts of secession. While the lower degree of integration of NI with RoI mitigates the impact of scale, it does not offset it as is clear from the results reported in Table 2. NI's GVA and employment falls by 0.61% and 0.42% (as compared with 0.47% and 0.36% for Catalonia), while RoI's GVA and employment falls by 0.72% and 0.46% (as compared with 0.06% and 0.04% for RoS). Indeed, in this case, the impacts on the successor region are now greater in percentage terms than the seceding region (NI). We know from our use of the models calibrated on the synthetic database that, with a common structure, percentage impacts become equalised as the seceding region's scale increases to 50% of the successor economy. Once that share is exceeded (with identical structures), the ranking of percentage changes is altered since the seceding region is now also the larger region. Of course, in this case the regions do not have identical structures, but the pressures operate in the same direction.

The impacts of secession on the levels of GVA in each of our three cases are ranked rather differently from the percentage impacts reported in Table 2. The estimated adverse impacts on the levels of GVA are greatest for the Italian case (NI €4709 million and RoI €4484 million), followed by the UK (RUK €894 million and Scotland €812 million) and finally Spain (Catalonia €853 million and RoS €490 million). Notice that while percentage impacts in the smaller regions are always greater (though only marginally in the case of RoI), the impact on the level of GVA in Scotland is actually smaller than that on RUK: in absolute terms RUK is more adversely impacted than Scotland by the latter's secession.

Finally, it is worth reflecting upon migration between regions. In all cases, the unemployment rate rises and the real wage rate falls, so there would be some pressure for outmigration from all regions. If free movement within initial national boundaries was maintained post-secession, these changes would create an incentive for migration from the region with the greatest adverse impacts on real wages and unemployment. Scotland

and Catalonia would therefore lose out to RUK and RoS, respectively, while the bigger regions would experience some mitigation of their losses. Of course, the impact on differential wage and unemployment is much less in the Italian case, given their roughly equal sizes, but again would operate in favour of the larger region, here the seceding region, NI. These real-world case studies are consistent with our earlier numerical analysis, with both regions losing out from the direct trade effects of secession to an extent that is directly related to the degree of pre-secession integration and the scale of the seceding region. Furthermore, the greater the degree of integration of the seceding region with the ROW, the smaller the impact of secession.

5.5. Sectoral impacts

The overall scale of sectoral changes in percentage terms reflects the scale of the corresponding aggregated impacts discussed above. As the gap between the size of seceding region (relative to successor) falls, the gap between regions' results (in percentage terms) declines. For instance, on average, Scottish industries are more impacted than those in the RUK, whereas the gap between the two regions of Italy is typically much smaller. However, there are notable exceptions in all the cases.

In general, we still do find that sectors that are more trade integrated are more affected by the increased trade cost. However, the complexity in interpretation of sectoral results increases significantly, given that sectors trade amongst themselves domestically, there is labour mobility between industries within nations and sectoral output is sold both to other industries and to final demand.

Using our framework, Figure 5 identifies sectors for which percentage impacts on GVA are above or below the own country aggregate change in GVA.[14] The first quadrant reports sectors for which the impact is above the own region average in both the seceding and the successor regions. Italian regions' sectors mostly populate the first quadrant reflecting the fact that the average GVA impact is influenced mostly by the extreme results in a small subset of non-traded sectors such as non-market services (which is co-located in the third quadrant). The proportional impact on Italian sectors is larger on average for industries located in the RoI, consistently with our illustrative results. The second quadrant includes sectors where the impact is below the average for the successor and above for the seceding region. Notable cases here are mining and quarrying[15] and energy supply in Scotland and real estate and renting businesses in Catalonia. The third quadrant is where the impacts are below the average in both regions and here, we find mostly non-traded sectors such as non-market services for all the considered regions. Finally, in the fourth quadrant impacts are above the average for the successor and below for the seceding region. There are some surprising sectors here, such as agriculture, food and beverages, and hotel and restaurants in the RoS showing how Catalonia is an important supplier of food in Spain and that even sectors such

as hotels and restaurants that are relatively protected from trade suffer through their supply chain linkages.

In general, the percentage changes in each sector's GVA are larger in the smaller region, but in five sectors in RUK and ROS and seven in NI the level of GVA falls by more than in the smaller region.

5.6. Sensitivity analysis

The results presented so far are based on an illustrative 1% increase in trade cost between the seceding and the successor region. In reality, as Sampson (2017) argue, there is uncertainty about the precise size of border cost following secession for two main reasons. First, while a wide range of estimates of the so called 'border effect' exist (e.g., Comerford & Rodríguez Mora, 2019, for Scotland; Adam et al., 2023, for Spain; Santamaria et al., 2020, for the EU) the size of estimates varies depending on the research strategy. In addition, some of the estimates are not directly translatable into shocks for our model. Second, there is uncertainty about the future trading relation between the newly formed countries. As Figus et al. (2022) note, the

border cost of two newly formed countries that are part of the same favoured nation trading regime (e.g., the EU single market) is lower than that of two countries that trade under World Trade Organization (WTO) rules.

For this reason, we explore the sensitivity of our result to the size of the shock. Huang et al. (2021) suggest that for the Scottish/British case a low border cost of 15% and a high border cost for 30%. In the absence of similar estimates for the other two cases we simulate an increase in trading cost ranging from 1% (our illustrative shock) to 30% (the high border cost in Huang et al., 2021) for all three case studies.

Unsurprisingly, the results in Figure 6 show that increasing the trade shock produces larger impacts on GVA across the board. Looking at the explored range we see that the seceding regions with a small relative size such as Scotland and Catalonia are still relatively more affected than their corresponding successor regions, whilst the impact on the Italian regions is almost symmetric given their relative size. This is consistent with our central results. Moreover, the gradient of the curves

Table 3. Summary statistics on percentage change in gross value added (GVA).

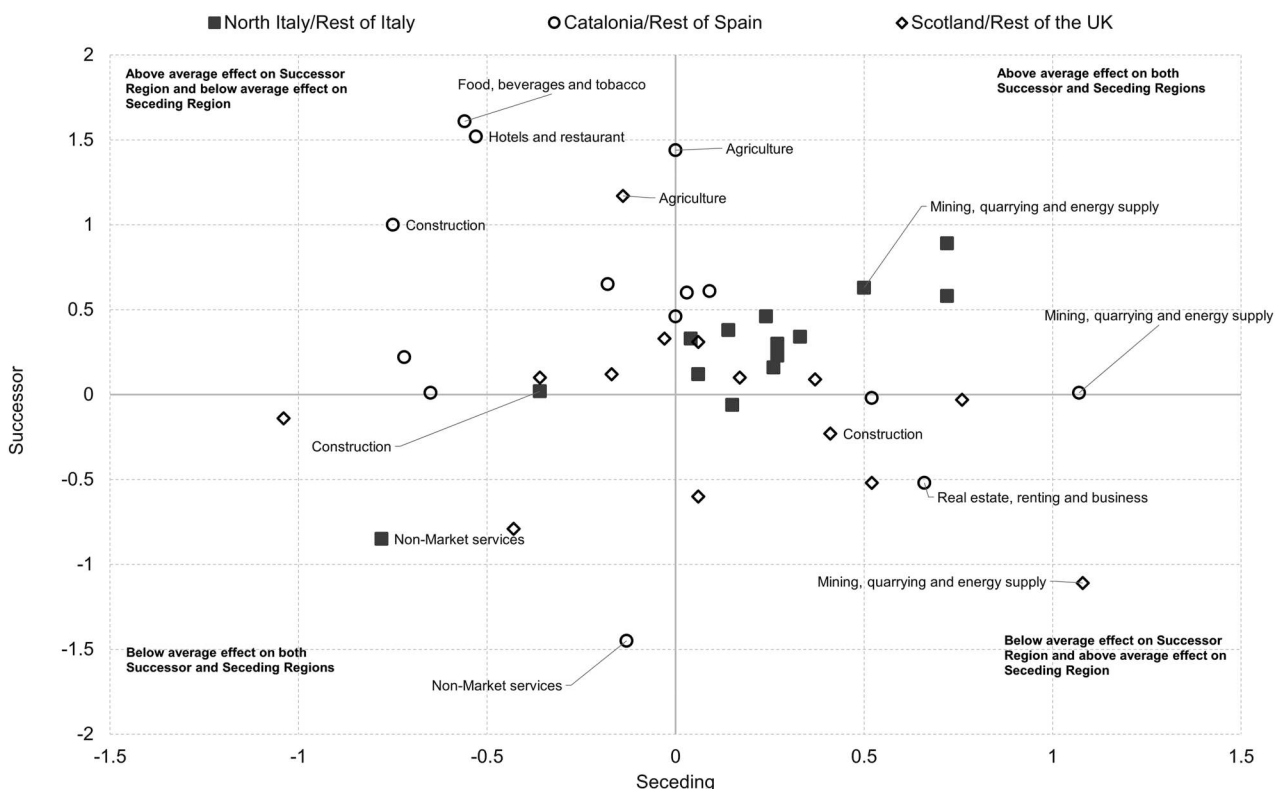|	Scotland	Rest of the UK	Catalonia	Rest of Spain	Northern Italy	Rest of Italy
Average	−8.8	−0.7	−6.5	−0.7	−7.2	−8.3
Minimum	−13.4	−1.0	−10.2	−1.1	−10.4	−12.8
Maximum	−3.9	−0.3	−2.5	−0.3	−2.9	−3.3
SD	1.3	0.1	1.2	0.1	1.0	1.3

Figure 5. Sectoral impacts on gross value added (GVA) from a 1% increase in interregional trade cost on the seceding and successor regions.setter make F5 FPW, margin to margin.
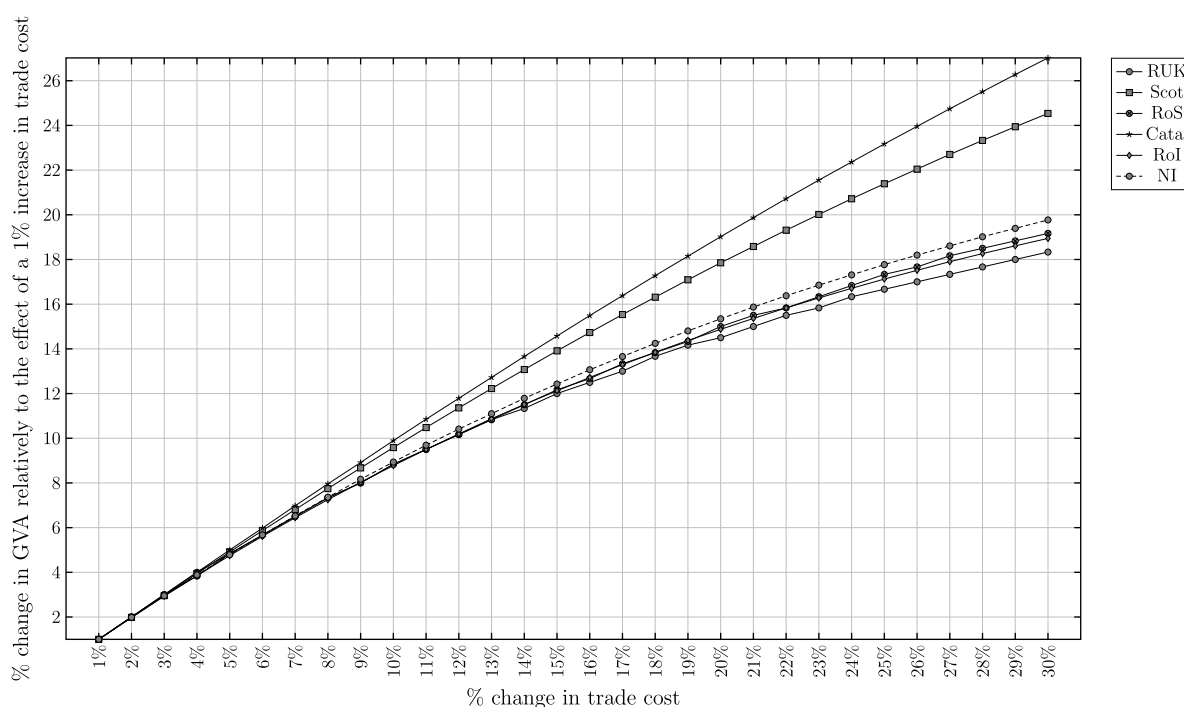
Figure 6. Sensitivity of gross value added (GVA) impacts from increased in trade cost ranging from 1% to 30%.
Note: All results are in percentage change from baseline values relative to a 1% increase in trade cost. Scot = Scotland, RUK = rest of the UK, Catal = Catalonia, RoS = rest of Spain, NI = Northern Italy, RoI = rest of Italy.

associated with the two smaller regions (Scotland and Catalonia) is steeper than that of the larger regions (RUK, RoS and the two Italian regions) indicating larger impacts for larger shocks of the small seceding regions relatively to their corresponding successors.

The shock size may also vary by sector. Again, Figus et al. (2022) implement shocks that differ for goods and services. To account for this uncertainty, we draw random shocks from a uniform distribution (0,30%) that are different by sector and region.[16]

Results in Table 3 show that for the considered range the average percentage change on GVA in Scotland is more than 12 times larger than that on the RUK. The gap reduces for the Catalonian case where the impact on Catalonia is still expected to be about nine times larger when compared with the RoS. In the Italian case the impacts are almost symmetrical.

6. DISCUSSION AND CONCLUSIONS

Debates over secession often centre on the economic impact on the seceding territory. On one level this makes sense, reflecting the fact that the seceding regions are often small (relative to the successor region) and the decision to seek secession often lies with those in that region – perhaps through a referendum – who face the economic consequences of their decision. Yet the successor state is also a participant in any break-up of a union. They also have a crucial role in what arrangements (e.g., over trade) face the seceding region after secession. Just as the economic implications shape decisions by those in the seceding region about whether to secede, and which trading partners to

align with, the successor state must also consider the impact secession has on its economy, including at a sectoral level. It follows that it must also decide on the resources worth devoting to resisting secession, as well as what its economic incentives are in negotiating post secession trade arrangements. These points are often overlooked.

In addition to highlighting the potential economic implications of secession, our findings suggest some interesting political economy perspectives for the manner in which debates over secession are conducted.

For example, our results illustrate that for the successor region, a possible ex-ante strategy to raise the costs of secession may be to strengthen integration between the two regions. In doing so, the successor will increase the cost to the seceding region of leaving. However, as our results show, this also comes at the expense of increasing the resultant economic cost for themselves if the seceding region does ultimately choose to secede. For the successor there is therefore a trade-off between trying to reduce the likelihood of secession by increasing interregional trade integration, and at the same time increasing the economic impact on itself of secession if it occurs. A similar trade-off exists over whether to seek to counter secessionist sentiment by extending regional fiscal and economic powers if it decreases internal economic integration. Exposure to sector disruption and linkages, for example the location of natural resources, are also an important consideration. Indeed, debates over the ownership of natural resources post-secession have been a controversial feature of recent debates, such as control over North Sea oil revenues under Scottish independence.

Our results also speak to the post-secession strategy for both the seceding and the successor regions. Having

decided to secede, a series of decisions must then be made, including over trade alignment. In the case of secession of a European nation, the seceding region may choose to align with the successor, the EU, or to develop distinct trading arrangements and partnerships. The economic consequences of reducing trade costs with the EU at the expense of higher costs with the successor highlight the economic costs that this would imply given the degree of trade integration between seceding and successor regions. Of course, over time trade patterns would change after any realignment, although even the successful experience of countries such as Ireland suggests that this will take some time, perhaps measured in decades rather than years.

Yet what trade arrangements it is possible for the seceding region to agree with the successor will be shaped by its economic incentives. For example, if Scotland (or any other part of the UK) sought to join the EU, the economic impact on RUK of increasing trade costs with the seceding region may mean that the RUK would be willing to offer a generous – or at least slightly more generous trade deal than that which it has with the EU – in the hope of securing a second best outcome for itself. Similarly ex-post attempts by a future Spanish government at blocking Catalonia from joining the EU would put up economic barriers between Spain and a key trading partner and increase the economic cost to the Spanish economy. In this way EU membership helps in minimising the economic costs of Catalonian secession for Spain, even if this is still second best compared with retaining the Spanish union. In both cases, for the successor regions the 'best' outcome is no secession, but if it was to occur, then strategies will change. Modelling frameworks such as ours help highlight those ex-ante trade-offs.

In general, the analytical method discussed in this paper provides a unified framework for the analysis of the trade cost of secession on both the seceding and the successor regions at both aggregate and sectoral levels. This provides a basis from which to think through the complex economic interdependencies that characterise secession for both the seceding and the successor regions and identify how these might shape the incentives and the political economy decisions of each in advance of and following any secession vote.

The results produced using a series of synthetic datasets illustrate clearly how relative size of and the degree of trade integration of the seceding region are directly linked to the magnitude of the impact of potential increased trade costs between two newly formed countries following secession. The applicability of this framework is illustrated using the three case studies of Scotland, Catalonia and Northern Italy. Whilst the results presented for three cases are specific to the regions considered, they can all be interpreted and predicted using our initial framework. The framework could be extended to look at the extent to which access to international markets could contribute to mitigating the cost of secession. Furthermore, it could be extended to consider the role of size and integration in determining post secession public budgets.

DISCLOSURE STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

NOTES

1. We consider secession to be both the break-up of an existing nation or the withdrawal from a larger and economically integrated economic system.
2. For the remainder of the paper, we call a region or nation of a larger country that wants to or has gained independence the 'seceding' entity, and the remainder of the country the 'successor' entity.
3. Our focus is on secession processes that occur as a result of a mutual peaceful agreement. For a discussion of conflict and secession, see, for instance, Rodríguez-Pose and Stermšek (2015) and Reynaerts and Vanschoonbeek (2022). While we recognise the complex combination of other factors influencing secession processes, notably those that are identity linked, we are exclusively concerned here with the economic impacts that have tended to be central in recent secession debates (Rodriguez-Pose & Sandall, 2008).
4. This secessionist movement has significantly lost momentum over the years and the main political party advocating for independence (*Lega Nord*) has shifted its focus away from secession. Nonetheless, this is useful to illustrate a case where the seceding region is almost the same size as the successor, as we explain in the following sections.
5. For simplicity, in this paper we consider North Italy as being a region comprising two NUTS-1 regions ITH (North East) and ITC (North West) according to the nomenclature in Eurostat (2022).

6. Brakman et al. (2023) include modelled estimates of the impact on RUK of different combinations of the break-up of the UK, but do not provide a framework for the systematic analysis of secession.

7. While Brakman et al. (2023), as we have seen, recognise the potential importance of inter-country trade, the approach does not allow for the heterogeneity that characterises the degree of pre-secession trade integration within countries, which we explore further below.

8. For a full model listing, see Appendix B in the supplemental data online.

9. This is similar to β and γ in the framework of Gancia et al. (2022), and we would expect to see that the costs of secession are larger the greater the degree of trade integration, consistent with the theory that country size is increasing in trade integration and in the absence of membership of what Gancia et al. call a 'World Union' where there are no border costs.

10. We would expect that the larger a region, the smaller the costs to it of seceding, given the theoretical prediction that country size is increasing in economies of scale in the presence of border costs. At the same time, the smaller the seceding region, the larger the cost to it of secession.

11. In fact, the negative impact on GVA continues to increase as the size of the seceding region exceeds 50%. However, the percentage changes in the seceding regions then become less than those in the corresponding successor region.

12. For brevity, we do not do the same with trade integration. However, varying the relative size of a region affects the overall volume of trade, thus implicitly we consider variations in exposure to trade as well.

13. This is partly because Catalonia is more integrated with international markets than Scotland. The result is consistent with the literature that suggests that the greater the degree of openness with respect to the ROW reduces the impact of secession.

14. This is calculated as the percentage change between the sectoral percentage change in GVA and the own-country-weighted average percentage change in GVA. For a full set of results, see Table A1 in Appendix A in the supplemental data online.

15. Official Scottish Input Output tables are published for the onshore economy only. That is, the GVA associated with the extraction of oil and gas is excluded from Scottish official accounts and appears in a separate 'region' classified as extra-region. Services of the oil and gas industry – including manufacturing, shipping and finance – are allocated in the onshore accounts (Scottish Government, 2023).

16. A total of 10,000 simulations are performed for each pair of regions.

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