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Does Size Matter? Evidence from Municipality Break-Ups

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Does Size Matter? Evidence from Municipality Break-Ups

Abstract

Municipal break-ups are an understudied phenomenon despite the fact that such territorial reforms regularly take place across the globe. This paper estimates how seven voluntary splits of Swedish municipalities affected municipal current costs. To predict what would have happened had the break-ups not taken place, we apply the matrix completion method with nuclear norm minimization. Our results do not support the standard view, that smaller municipalities imply higher per capita costs. Instead, we find an intriguing heterogeneity: costs increase in some municipalities, are unaffected in others and decrease elsewhere. The findings point to the complex nature of territorial reforms, the difficulty in drawing general conclusions of such, and hence, the perils of expecting them to have uniform outcomes.

JEL-Codes: H720, R120, R500.

Keywords: territorial reforms, municipalities, matrix completion.

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1 Introduction

Since the mid-1990s, amalgamations of municipalities have been placed high on political agendas across the globe (Bouckaert and Kuhlman, 2016; Fox and Gurley, 2006). The underlying rationale is almost always economic. By merging smaller units into larger, policy-makers hope to reap the benefits of economies of scale and form financially more viable municipalities. However, parallel with this general trend, local forces in, above all, several Central and Eastern European countries – but also in Sweden and Spain – have pushed in the opposite direction, which have resulted in a number of municipality break-ups. In light of current debates on the appropriate size of local governments, this paper asks how municipal costs are affected by municipal splits, and to what extent it is reasonable to expect homogeneous effects of territorial reforms.

By now, there exists an extensive empirical literature studying the economic consequences of municipal amalgamations.¹ While a few studies have found decreasing costs as a consequence of amalgamations – most notably Reingewertz (2012) on Israeli data – the general conclusion is nevertheless that, although administrative costs tend to decrease, total per capita costs remain largely unchanged (see, for instance, Tavares (2018) and Gendzwill et al. (2020) for literature reviews). However, whereas occasional descriptive case studies or purely theoretical papers exist (de Souza et al., 2015; Dollery et al., 2011; Erlingsson, 2005), empirical studies aiming at estimating causal effects of municipal *splits* remain rare, and those that exist reach somewhat different conclusions (Lima et al., 2018; Swianiewicz and Łukomska, 2019).² Since municipal splits are, almost by their very nature, driven from the bottom-up – rather

¹See, e.g., for Germany: Blesse and Baskaran (2016) and Roesel (2017), for the Netherlands: Allers and Geertsema (2016), for France: Breunig and Rocaboy (2008), for Finland: Moisio and Uusitalo (2013) and Harjunen et al. (2019), for UK: Andrews (2015), for Denmark: Blom-Hansen et al. (2014) and Blom-Hansen et al. (2016), for Canada: Cobban (2019), for Australia: McQuestin et al. (2018) and for Japan: Miyazaki (2018).

²Whereas Lima et al. (2018) find that capital spending increases as a result of a major district emancipation in Brazil, Swianiewicz and Łukomska (2019) find that municipal splits in Poland result in increasing administrative costs.

than orchestrated top-down – and since they tend to be democratically rather than economically motivated, results from the amalgamation literature cannot simply be inverted and expected to hold for splits as well.

This paper adds to the limited literature on the effects of municipal splits by focusing on Sweden, a mature democracy in Western Europe.³ The Swedish setting is particularly relevant, given that its local governmental level is organized in the ‘north-ern’ way, which entails giving municipalities many responsibilities and fairly strong self-government (Bouckaert and Kuhlman, 2016). Consequently, Swedish municipalities are responsible for the lion’s share of governmental spending, and therefore the questions of how to provide services more efficiently is of first-order importance. Moreover, Sweden is an appropriate case for our purposes since it has experienced numerous secession-campaigns and municipal break-ups from the late 1970s and onwards. In our analysis, we will focus on the seven cases that took place during the 1980s. The limited number of break-ups that we analyze provides opportunities to gather context-specific information for the individual cases. This, in turn, can help us understand when costs are likely to be affected and when they are not, thereby potentially provide important insights into the overarching question about size and cost-efficiency.

To estimate what would have happened in the divided municipalities, had they not undergone a break-up, we apply the Matrix Completion with Nuclear Norm Minimization (MC-NNM) (Athey et al., 2017). Since the MC-NNM exploits patterns over time as well as across units, it is well-suited in a setting as ours where the observed time period before treatment (in our case the municipal split) is relatively short. To our knowledge, this is the first paper to apply MC-NNM in order to estimate causal effects of territorial reforms.⁴

³The two previous studies focus on relatively new democracies in Eastern Europe (Swianiewicz and Łukomska, 2019) and South America (Lima et al., 2018) respectively.

⁴Earlier work has either relied on difference-in-differences (DiD) or the synthetic control method (SC). Whereas the DiD-approach relies on the parallel trend assumption, the SC only exploits patterns across units, whereas MC-NNM exploits patterns over time. For a detailed discussion of different methods for causal panel data methods and how these relate to each other, see Athey et al. (2017).

We do not find support for the 'dominant view', i.e. that the reduction of municipal size implies higher per capita costs. Instead, we find evidence of an intriguing heterogeneity across the cases, where costs increase in some municipalities, are unaffected in others and decrease elsewhere. More specifically, we observe that costs tend to decrease in densely populated areas close to the metropolitan region near the capital of Sweden, whereas the picture is mixed in non-metropolitan regions. These findings point to the complex nature of territorial reforms and highlights the importance of evaluating effects of municipality break-ups – and, by implication, amalgamations – on a case-by-case basis. Hence our findings underscore the difficulty in drawing general conclusions about the effects of territorial reforms.

The paper proceeds as follows. In the next section, we briefly outline basic theoretical expectations expressed in the previous literature. We then proceed to provide context to our cases by describing the Swedish setting as well as summarizing the main characteristics of the municipal break-ups studied. In the subsequent sections, we present the data used and the empirical strategy employed. Thereafter, we turn to the results and show how municipal splits affect municipal costs. In the last and concluding section, we summarize our findings and discuss their implications in relation to existing research and policy-makers pondering amalgamation reforms.

2 Theory: What to Expect from Splits?

The debate on the optimal size of political units has a long history, dating back to ancient Greece and the writings of Aristotle and Plato. Arguments in favor of either small or large units have co-existed ever since. The question has been extensively debated and studied by scholars from different disciplines, most prominently political science and economics.

In policy debates, the dominant view is that the larger the unit – with respect to population size – the better it will perform economically. There are several theoretical

arguments supporting this view. First, there might be economies of scale, leading to less expensive delivery of public services in larger municipalities (Hirsch, 1959). Second, larger units may have stronger recruitment power, finding it easier to recruit well-educated, high quality staff, thereby enabling a more efficient and cheaper provision of services (Dahl and Tufte, 1973). Third, the larger the unit, the stronger bargaining power the organization might have in negotiations both with private suppliers of goods and services and with the state, thereby reducing purchase prices through more advantageous agreements.

However, there are at least as many plausible arguments in favor of smaller units implying that costs might actually *increase* with size. For example, in a larger municipality, it may be harder for voters to monitor politicians, thereby increasing scope for rent-seeking. Also, the larger the municipality, the more complex the coordination between different parts of the bureaucracy may become, which might contribute to inefficiency and sub-optimal service provision. Moreover, the bigger and stronger the bureaucratic organization is, the more costly and difficult it becomes to supervise and govern, which could lead to organizational slack. As a result, bureaucracies in larger units might increase budgets well above an efficient level. Lastly, a municipality with a larger population is likely to contain more heterogeneous preferences within the municipality, implying a need to provide a broader scope of goods and services. Hence, as argued by Oates (1972), welfare gains might well be associated with smaller units, since public services can be better adapted to citizens' preferences.

The discussion in Oates is intimately related to arguments associated with so called 'polycentric metropolitan regions', i.e. that systems with many decision-making units – rather than few – who are formally independent from one another, are preferable. The municipal competition that arises in polycentric metropolitan regions is expected to contribute to welfare gains through, for example, less rent-seeking. Such mechanisms are similar to those in the theory of yardstick competition, where voters are supposed to use the spending levels in neighboring municipalities as a yardstick against which

to evaluate how efficiently their own elected politicians provide goods and services (Bordignon et al., 2004). However – and importantly for the cases we subsequently analyze – positive outcomes associated with many and small municipalities primarily deals with densely populated metropolitan areas (Ostrom et al., 1961). The conditions assumed to lead to efficiency-enhancing outcomes in the polycentric view are not as obvious in sparsely populated, rural regions. Thus, all else being equal, costs are more likely to decrease as a consequence of break-up in metropolitan regions than in sparsely populated areas.

Whether the pros or cons for larger units dominate is likely to depend on the type of goods and services that the unit provides, since scale economies cannot be expected to be uniform across the variety of services provided. Moreover, the relationship between costs and size might actually be U-shaped, where costs initially decrease when a political unit grows, but increase when it eventually becomes too large.⁵ This implies that we should expect costs to increase when (relatively) small municipalities break up, whereas costs can be expected to decrease when (relatively) large municipalities are divided into smaller units.

Additionally, size not only in terms of population, but with respect to the area of the territory as well as population density, can be expected to have an impact for the conditions to be cost-efficient. For instance, in sparsely populated areas with great distances between towns and settlements, it will probably be more difficult to take advantage of economies of scale in service provision due to transaction costs, such as long traveling times. Hence, it is not obvious that economies of scale will be lost when a densely-populated municipality is split into two. To further complicate the issue: while municipal amalgamations are typically orchestrated top-down, with the intention of saving costs, municipal break-ups are typically initiated from below and democratically motivated. The rationales which underlie the territorial reform are likely to affect outcomes. In cases where the arguments for splits rely heavily

⁵See, e.g., Blesse and Baskaran (2016) for a theoretical discussion along these lines, and the review article Dollery and Byrnes (2002) for empirical illustrations.

on democracy and appeals to local self-government, costs are less likely to decrease. And lastly, municipal splits are often initiated when political preferences of different populations are geographically concentrated in two different parts of a municipality. After the break-up, it is not unreasonable to believe that e.g. the secessionists are centre-right – i.e. favour low taxes and less ambitious welfare services – whereas the opposite is true for the remaining part, or vice versa. Hence, because of potentially varying political ambitions in the smaller units after a split, it is far from self-evident whether total costs, will increase or decrease in the new, smaller municipalities.⁶

In sum, the theoretical prediction of whether costs increase or decrease with size is far from being straightforward and, hence, inconclusive, as is the empirical evidence to date. Therefore, it is not at all obvious what to expect from the break-up of municipalities. The review of theoretical perspectives above tells us that it is hard to generalize about whether splits will become more or less cost-effective. Most likely, we should not expect uniform outcomes when comparing splits that take place in densely populated metropolitan regions and those taking place in sparsely populated rural regions.

3 Institutional Context

When comparative international indices have been constructed aiming to gauge local government capacity and autonomy, Sweden regularly ranks highly ([Ladner et al., 2016](#); [Sellers and Lidström, 2007](#)). Since the late 1970s, Sweden has had numerous experiences of secession-campaigns and municipal break-ups, making it an exception among mature democracies having *more* municipalities today than in the 1970s. Below, we first give a brief historical account of territorial reforms that have taken place in Sweden. Second, we provide context to the Swedish local government level during the studied period.

⁶Lacking a measure of service quality, it is difficult to separate between high costs caused by inefficient service provision and high costs caused by high welfare ambitions.

3.1 Territorial Reforms in Sweden

The current Swedish municipal structure is the outcome of two extensive territorial reforms that took place in 1952 (*Storkommunreformen*) and 1962–1974 (*Kommunblockreformen*). These reforms radically changed the landscape of Swedish local government and reduced the number of municipalities from 2,498 to 278. The philosophy underlying the amalgamations was fairly technocratic and heavily inspired by the Central-place theory (Cristaller, 1966). The primary purpose was to identify a larger town that was to become responsible for providing goods and services for the area surrounding it. In addition, the amalgamated units were required to have above 8,000 inhabitants (SOU 1961:9, 1961).

Directly after these two waves of amalgamations, several ex-municipalities – now post-merger peripheries – voiced criticism within the larger units. In some cases, the discontent was so fierce that parts of the new, larger entities turned to the Government and applied for a formal secession (Nielsen, 2003). Since the last wave of amalgamation ended, and up until now, more than 40 secession campaigns have been denied, but twelve have been successful and resulted in part(s) of municipalities forming new jurisdiction(s). Appendix A provides a timeline of municipal reforms in Sweden from 1965 to 2015.

The legal rules governing how a formal secession procedure takes place are found in the Local Government Act. A request for changing a municipality's borders – in our case, through a break-up – can be put forth by a group of citizens in a municipality, or by the municipality's council. The first step is to apply for secession at the Swedish Legal, Financial and Administrative Services Agency (*Kammarkollegiet*, KK), a politically neutral governmental office. If the request is voiced by a group of 'ordinary citizens' – which historically has been the typical case – the KK turns to the municipal council in the municipality that is affected by the demand, and asks for its dictum.

If the council does not support the proposed split, the law states that the application could be denied. However, if the group that put forward the demand to secede

provides convincing arguments in favor of secession, the KK can choose to move the case forward in spite of the council's opinion. If the council is in favor of secession, the KK needs to perform an in-depth assessment, where two issues are particularly important. First, can the prospective municipality be financially viable on its own, i.e. is the tax base sufficient to carry out the municipal responsibilities regulated by the Local Government Act? Second, are the citizens that are affected by the secession in favor of breaking-up, i.e. is there public support for the split?

If, after the assessment, the KK is convinced that a secession is economically and democratically motivated, the case is forwarded to the Government, which has the final say. If the KK is opposed to secession, it denies the request. However, the Government can choose to overturn this decision if they conclude that the split involves long-term material benefits for the prospective new municipality and if the people affected by the secession are in favor of secession. Hence, for all intents and purposes, long-term financial viability and public support are crucial elements for a secession to be ultimately successful.

3.2 Swedish Municipalities 1974 – 1987

Since the expansion of the welfare state, Swedish municipalities have been responsible for providing the bulk of Sweden's welfare services and are thus very important economic entities. During the period in focus for our study – 1974–1987 – total municipal costs as a share of Swedish GDP grew from 16 percent to 21 percent. As today, Swedish municipalities varied greatly in population size throughout the studied period. In 1979, the average size was around 30,000, while the median was considerably less (around 16,000). Ten percent of the municipalities had a population size below 8,000 inhabitants, which, in the Swedish context, is viewed as fairly small.

During the period we analyze, municipalities were responsible for providing child care, individual and family care, provision and maintenance of local infrastructure such as roads, parks, water supply and waste management, as well as cultural ser-

vices such as public libraries, sports centers, and recreational areas. Approximately three quarters of the municipalities' expenses were covered by a locally set income tax and user fees on, e.g. child care, electricity provision, and heating, while intergovernmental grants made up the rest.⁷

The municipal councils – the bodies that have the right to inquire for a municipal split and constitute potential veto players if a group of citizens initiates a secession – were elected every third year in local elections that were concurrent with national elections. Typically, the same parties that ran at the national level were also present at the local level. However, as today, it was not uncommon to have genuinely local parties represented. The council appointed a municipal executive board (*kommunstyrelse*), where all parties in the council were represented and from where the municipality's operations were coordinated, steered and led.

4 Brief Case Descriptions ⁸

In the empirical analysis, we focus on the seven municipal splits that took place in 1980 and in 1983. These cases share some basic traits. First, the part that seceded had been a municipality of its own – or a part thereof – before being merged with one (or several) neighboring municipalities. Second, the seceding parts typically perceived the process that led up to the merger as being unjust and/or too swiftly implemented, and thus entered the newly formed larger municipality dissatisfied. Third, either polls, referenda or ambitious petitions, substantiated that there was strong public support for the secession in the parts that wished to secede. However, in many cases, some opposition in the remaining municipality could be observed. Fourth, the Governments that ultimately approved the splits were center-right governments that

⁷In the period we study, roughly 80 percent of total grants were targeted grants, and 20 percent general grants, where the latter consisted mainly of equalizing grants determined by the relative size of the tax base multiplied by a region-specific constant depending on geographic and demographic factors.

⁸This section is based on official statistics and [Kolam and Ekman \(1992\)](#).

Table 1 Descriptive Statistics in 1979

	Botkyrka	Vaxholm	Motala	Vara	Norsjö	Vännäs	Åsele	All other*
Population	75,267	30,051	49,742	22,949	10,048	11,397	8,743	30,614
Land area	251	367	1,175	937	3,390	1,851	7,118	1,505
Share young and old	0.42	0.45	0.45	0.47	0.44	0.44	0.46	0.45
Vote share left-wing	0.53	0.38	0.53	0.22	0.51	0.44	0.59	0.48
Tax base ('000) per cap.	817	810	779	690	766	710	700	779
Grants, per capita	12,316	10,283	8,996	8,258	13,190	13,928	16,506	10,035
Total Costs	38,652	35,994	32,475	29,698	35,971	32,857	37,279	35,161

Notes: Tax base, grants and costs are deflated to 2017-adjusted using CPI (2017). Vote share left-wing is defined as votes for Social Democrats and Left Party out of total votes. Young are defined as below age 19 and old as over 64 * shows the mean for the other 270 municipalities.

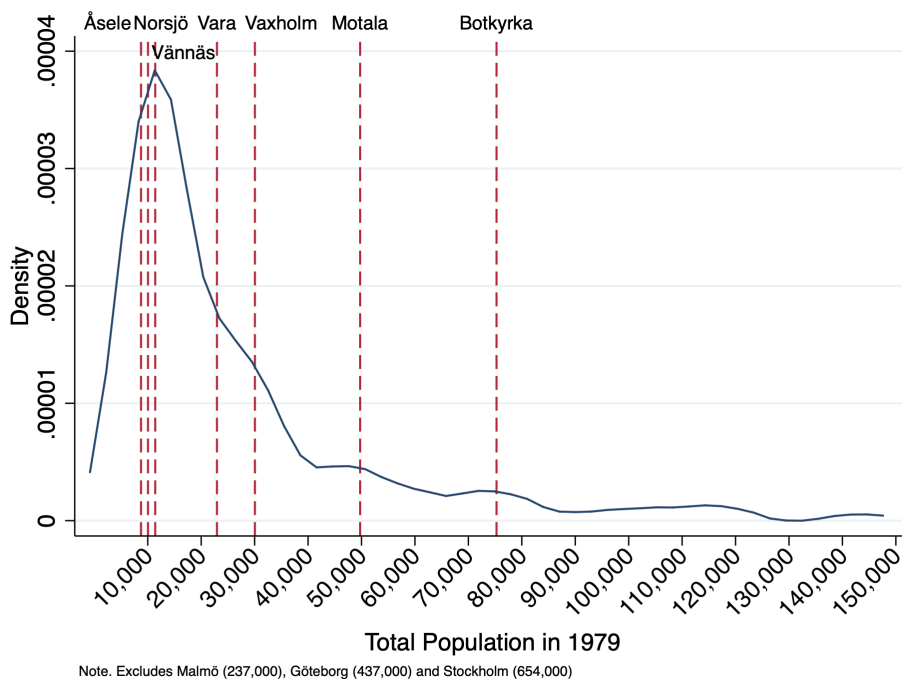
had been opposed to the coerced amalgamations which were forced through by the Social Democratic Governments 1968–1974. Hence, the centre-right parties tended to put strong emphasis on democratic arguments, and paid comparatively less attention to what the evaluations that preceded the splits had said about long-term financial viability of the new, smaller units.

Table 1 shows descriptive statistics for the seven break-up municipalities that we analyze, as well as comparisons to the rest of Sweden’s municipalities, Figure 1 shows their position in the population distribution in 1979, and Figure B.1 in Appendix B shows their geographical location.⁹ From these descriptives, it is clear that there are no unifying characteristics describing the municipalities that underwent municipal splits; they are located all across the country, some are smaller than the average municipality and some are larger, some have higher costs, some lower.

Two of the cases – Botkyrka/Salem and Vaxholm/Österåker – were located in the larger metropolitan Stockholm region. Botkyrka/Salem was the most populous and most densely populated municipality among our cases (circa 75,000 inhabitants), while Vaxholm/Österåker was approximately the Swedish average size (circa 30,000 inhabitants). In the case of Botkyrka and Salem, the Government deemed that both parts

⁹Detailed descriptive statistics for each of the seven cases are provided in Appendix B.

Figure 1 Municipal Population in 1979



were sufficiently financially viable to make it on their own, however, the inquiry preceding the Vaxholm/Österåker split was not as clear cut.

Motala/Vadstena was located in Mideast-Sweden. Although fairly populous, with its circa 50,000 inhabitants – well over the size of the median municipality – it has nevertheless been described as being in the backwater of the two larger, economic hotspots in Mideast-Sweden: the municipalities of Linköping and Norrköping. What distinguishes Motala/Vadstena from most other cases – aside from Vara/Essunga – is its ‘multiple cores’, having 10 villages qualifying as population centers.

Vara/Essunga, located in Midwest-Sweden, is a fourth case that is fairly populous compared to the median municipality, with circa 23,000 inhabitants. Initially when Essunga applied for secession, the KK rejected the request for a break-up. However, after a referendum where inhabitants of Essunga voted heavily in favor of secession, the Government ultimately repealed KKs decision. Important for this decision was that the pre-split Vara municipality had become increasingly difficult to govern because of its abundance of smaller population centers: Vara had 14 of these.

The remaining three cases were all located in the more sparsely populated, rural north of Sweden; i.e. the part of Sweden that has experienced severe de-population over a long period of time. All three municipalities were originally small with respect to population size (Norsjö/Malå 10,000, Vännäs/Bjurholm 11,000, Åsele/Dorotea circa 8,000), in addition to being sparsely populated.

The main reasons underlying the Norsjö/Malå split were that Malå had rapidly lost inhabitants post-merger partly due to loss of municipal job opportunities, and in addition that Malå felt that their needs were not listened or cared to by the administrative center of Norsjö. The split was preceded by an inquiry that found that a separation of the two would most likely have negative economic consequences for both Norsjö and Malå. Despite this, and in light of strong support among the population in Malå, the County Administrative Board of Västerbotten decided to advocate in favour of a separation, and the Government choose to support the split, arguing that it was motivated by democratic concerns.

Considering Vännäs/Bjurholm, it is noteworthy that Bjurholm had experienced population decline for several decades before the two municipalities were merged. An inquiry that preceded the separation stated that a split-up could not be defended economically, and none of the two parts alone was deemed sufficiently large to hold its own financially in the long-term.¹⁰ In the end, the preferences of citizens once again tipped the scale when the Government ruled – this time, though, not after a referendum or poll, but through petitions that revealed a strong public support backing the demand for separation.

In Åsele/Dorotea, the split was preceded by a poll which showed that a majority in both parts were in favor of a split. During the brief period the merged Dorotea municipality existed, politics was largely dominated by territorial belonging rather than party politics: investments in one part of the new, larger municipality was followed by conflict and negotiation about compensating the other part. Observers

¹⁰There was for example a fear that costs for elderly care would rise sharply in Bjurholm if it was to secede.

have viewed it as a disadvantage for both Åsele and Dorotea that the Government's decision came late in the game – less than a year before the municipality was separated into two units – which gave both parts limited time to prepare for the new order.

Since the seven cases we analyze have varying characteristics, and in addition are located in distinctly different parts of Sweden – both metropolitan and rural regions – it seems unreasonable to expect universal, homogeneous economic effects of break-ups. On the contrary, first, as discussed in the theoretical section, we would expect splits in metropolitan regions to be more prone to the positive effects of size-reduction compared to splits in rural Sweden. Second, as noted, the different cases had very different starting points regarding pre-split population size. Third, there are important differences when it comes to how many population centers the municipalities' respective political and administrative centers needed to cater and be responsive to. Fourth, the inquiries that preceded each separation made different evaluations concerning the long-term financial viability of the respective post-merger parts; some getting a clear thumbs up, and others projected a gloomy future.

5 Data

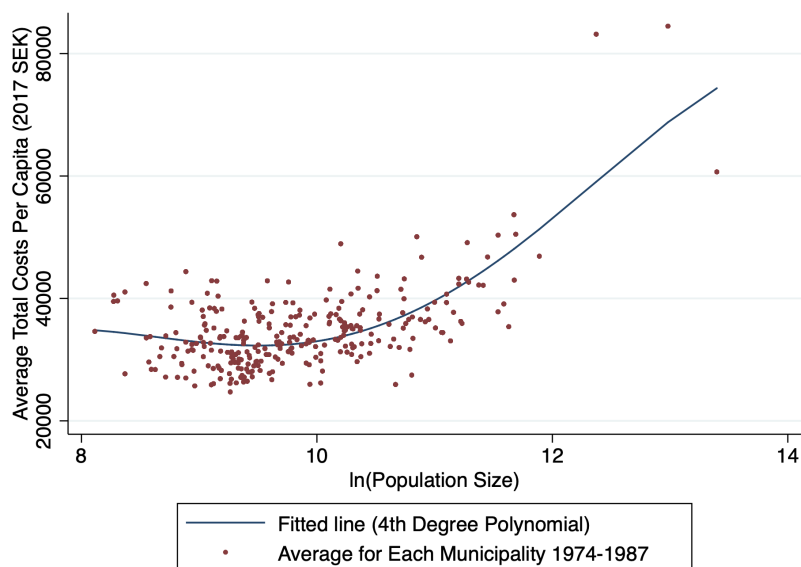
Our data covers all Swedish municipalities over the period 1974–1987, starting the first year with the new municipal structure in place.¹¹ After removing two municipalities¹², we are left with 276 municipalities in 1974, where seven municipalities were involved in splits during the 1980s (two were split 1980, and five in 1983). To examine whether municipalities forfeit economies of scale by splitting up, we study effects on total municipal current costs per capita.¹³ In addition, we have collected information on

¹¹We end in 1987 since Statistics Sweden made changes to the reporting of the survey that collects municipal financial data in 1988, and therefore, complete compatibility with the years before cannot be guaranteed.

¹²We exclude Bara municipality, which only existed between 1974 and 1977, and Gotland, a municipality that also has the regional responsibilities of the Swedish meso-tier *Landsting*.

¹³In an earlier version of this paper, we also analyzed costs for municipal administration. Data on this outcome is only available for a shorter period (from 1978). It turned out that the empirical strategy was not successful in estimating counterfactual outcomes for the period preceding the municipal break-up

Figure 2 Average Costs and Municipality Size



total population, land area, municipal tax rate, share of children and elderly, as well as data on municipal tax base and total intergovernmental grants.¹⁴

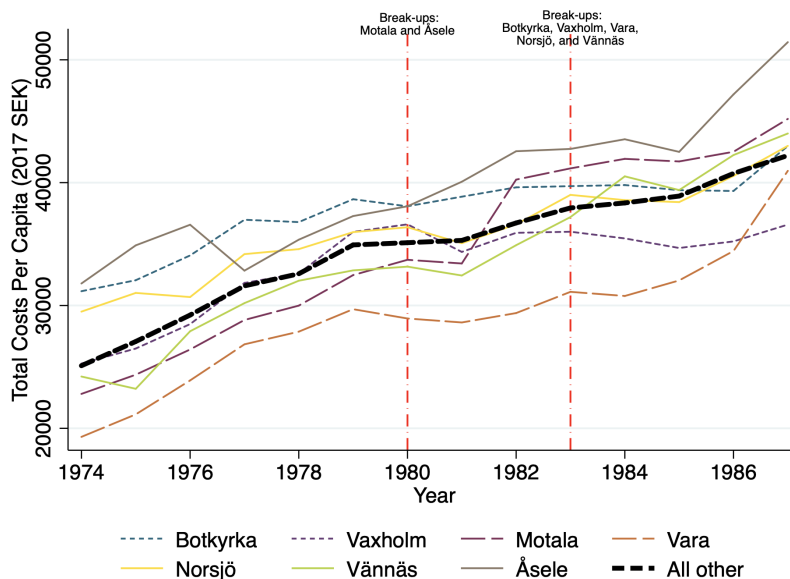
As a first examination of the relationship between municipal size and municipal costs, Figure 2 plots the average (1974–1987) municipal costs per capita for each municipality against the (log) of the average population size in that municipality. The figure indicates that costs per capita are higher in the largest municipalities, suggesting dis-economies of scale. The fitted line suggests that per capita costs increase with population size for municipalities with more than 22,000 inhabitants.

To get a first indication of how costs were affected by municipal splits, Figure 3 shows the evolution of costs per capita in the seven municipalities that experienced a split compared to average costs in the municipalities that remained intact. Costs after the split are defined in terms of initial jurisdiction, that is, we take the sum of costs in

and we therefore concluded that it was not possible to estimate post-treatment effects.

¹⁴Data on municipal costs are taken from Statistics Sweden’s annual survey of the municipal finances (*Räkenskapssammandrag för Sveriges Kommuner*), whereas data on total population, land area, municipal tax rate, share of children and elderly are taken from Statistics Sweden. Data on municipal tax base and total intergovernmental grants were collected by digitalizing the statistical journals *Årsbok för Sveriges Kommuner* for the years 1974–1978; 1988–1989, and *Kommunernas Finansier* for the years 1979–1987. Finally, data on number of population centers and percent of inhabitants in population center are collected from the Statistics Sweden publication *Statistiska Meddelanden: Tätorter 1990*.

Figure 3 Municipal Costs 1974–1987



the two new municipalities and divide by the sum of the population.¹⁵ One conclusion from the figure is that for the two municipal break-ups in the Stockholm region, there is a tendency for costs to decrease after the separation. For Motala, instead, there is a slight increase in costs after the divorce between Motala and Vadstena. For the remaining cases, there are no clear patterns in data. However, before we can draw any conclusions about causal effects, we need to form expectations of how costs would have evolved, had the split not taken place. In the next section, we describe how this analysis is conducted.

6 Empirical Strategy

When investigating how municipal splits affect municipal costs, we face the classical ‘missing counterfactual problem’, i.e., we do not observe how costs would have evolved in the original municipalities, had they not experienced the split. To predict the outcome in the absence of treatment, we apply the Matrix Completion with

¹⁵Assume municipality A was split into two municipalities B and C. Then costs after the split are calculated as $(costs_B + costs_C)/(population_B + population_C)$.

Nuclear Norm Minimization (MC-NNM) suggested by [Athey et al. \(2017\)](#).¹⁶

6.1 The estimator

We consider the following model

$$\mathbf{Y} = \mathbf{L}^* + \gamma_i^* + \delta_t^* + \epsilon_{it} \quad (6.1)$$

where \mathbf{Y} is the outcome under no-treatment, \mathbf{L}^* is a low rank matrix to be estimated, γ_i^* are unit fixed effects, δ_t^* are time fixed effects, and $\epsilon_{i,t}$ is random noise. [Athey et al. \(2017\)](#) suggest the following estimator

$$\hat{\mathbf{L}} = \arg \min_{\mathbf{L}} \left\{ \frac{1}{|\mathcal{O}|} \sum_{i,t} (Y_{it} - L_{it} - \gamma_i - \delta_t)^2 + \lambda \|\mathbf{L}\|_* \right\} \quad (6.2)$$

where \mathcal{O} is a set of indices (i, t) corresponding to the non-missing entries in Y_{it} , $|\mathcal{O}|$ is the number of observed entries, $\mathbf{P}_{\mathcal{O}}(\mathbf{A})$ takes any matrix \mathbf{A} and replaces all elements whose indexes are not in \mathcal{O} with 0, $\|\mathbf{A}\|_F^2$ is the squared Fröbenius norm, and λ is the regularization term on the nuclear norm $\|\mathbf{L}\|_*$.¹⁷

The estimator in equation 6.2 puts equal weight on all observed entities, regardless of their similarity with the unobserved entities. [Athey et al. \(2017\)](#) suggest weighting the observed units with their propensity scores in which case the weighed loss function is given by

$$\hat{\mathbf{L}} = \arg \min_{\mathbf{L}} \left\{ \frac{1}{|\mathcal{O}|} \sum_{i,t} \frac{\hat{e}_{it}}{1 - \hat{e}_{it}} (Y_{it} - L_{it} - \gamma_i - \delta_t)^2 + \lambda \|\mathbf{L}\|_* \right\} \quad (6.3)$$

where \hat{e}_{it} are propensity scores, estimated through matrix completion.¹⁸

The estimated treatment effects on the treated ($\hat{\alpha}_{it}$) are obtained by taking the

¹⁶[Athey et al. \(2017\)](#) derive theoretical bounds for their suggested estimator and provide Monte Carlo evidence showing that the estimator performs well in terms of RMSE, especially under staggered adoption of treatment and when the pre-treatment period is short.

¹⁷The nuclear norm $\|\mathbf{L}\|_*$ is given by the sum of the singular values of \mathbf{L} .

¹⁸See section 8.3 in [Athey et al. \(2017\)](#) for details.

difference between the observed outcomes of a treated unit i in $t \geq T_0$, where T_0 denotes the first time period with treatment, and the imputed missing potential outcome:

$$\hat{\alpha}_{it} = Y_{it} - \hat{Y}_{it} \quad (6.4)$$

6.2 Inference

How to conduct inference when applying matrix completion methods is not yet settled. For that reason, we apply two different methods and interpret the overall results holistically. First, we estimate confidence intervals through block bootstrapping, selecting block length by the procedure suggested by [Politis and White \(2004\)](#). Second, we calculate standardized p-values for the two-sided hypothesis test that $\hat{\alpha}_{i,t} = 0$ for each $t \geq T_0$, as suggested by [Abadie et al. \(2010\)](#) and [Kumar and Liang \(2018\)](#).¹⁹

$$\hat{p}_{std} = Pr\left(\frac{|\hat{\alpha}_{j,t \geq T_0}|}{RMSPE_j^{pre}} \geq \frac{|\hat{\alpha}_{i,t \geq T_0}|}{RMSPE_i^{pre}}\right) \forall j \in \mathcal{O} \quad (6.5)$$

where $RMSPE^{pre} = \sqrt{1/T_0 \sum_{t \leq T_0} (\hat{\alpha}^t)^2}$, $j \in \mathcal{O}$ and $i \ni \mathcal{O}$.

Whereas the confidence intervals are calculated through bootstrapping, the standardized p-values instead estimate placebo effects for each of the non-treated municipalities, and then calculate the fraction of such effects greater than or equal to the effect estimated for the treated unit, taking the match quality into account by standardizing with the pre-treatment Root Mean Squared Error. The number of replications is therefore limited by the number of existing municipalities. Which of the two that performs best in terms of size and power remains an open question.

¹⁹The idea is to estimate placebo effects for each non-treated unit in the sample and then calculating the fraction of such effects greater than or equal to the effect estimated for the treated unit. To take the match quality into account, these are standardized by the pre-treatment Root Mean Squared Error.

6.3 Implementation

We estimate equation 6.3 using the algorithm suggested by Mazumder et al. (2010), choosing the regularization parameter, λ , through cross-validation.²⁰

When calculating the standardized p-values, we let each of the non-treated units receive placebo treatment in 1980 and in 1983 one at a time. Thus, we compare the treatment effects for the treated units, estimated jointly, to the placebo treatment effects, estimated one by one. When estimating the placebo treatments, we remove the treated municipalities from our sample.

7 Results

The main conclusion from the discussion in Section 2 is that the expected effect of a municipal split on costs is likely to be case specific. The description of the seven municipal break-ups which we study in this paper illustrates that our cases differ in several theoretically relevant respects. We therefore allow for the effects to vary by each municipal split.

7.1 Main results

Figure 4 shows the evolution over time of municipal costs in i) municipalities experiencing a split (treated), ii) municipalities not experiencing a split (controls), and iii) the predicted counterfactual for the treated municipalities. Figure 5 shows estimated per-period effects (corresponding to equation 6.4) as well as 95-percent confidence intervals.²¹ Municipal costs after the split are calculated as the sum of costs in the new municipalities divided by the sum of the population in these municipalities.

²⁰See Appendix C for a description of the algorithm as well for details in how we implement the cross-validation.

²¹Table D.1 presents the point estimates corresponding to Figure 5 as well as standardized p-values. Figures D.1 and D.2 compares estimated effects for the treated municipalities with estimated placebo-effects for non-treated municipalities.

The top panels of Figures 4 and 5 show the results for Botkyrka and Vaxholm, both located in the larger Stockholm metropolitan region. For the pre-split period, predicted counterfactual costs follow observed costs closely for the treated municipalities, indicating that the empirical strategy is successful. Once the municipalities split, costs per capita begin to decline, being *circa* –5,000 SEK lower four years after the break-up. The confidence intervals in Figure 5 implies that the effect is statistically significant at the five-percent level for years 1985–1987.

The next panels show that the break-ups do not imply lower costs for the more peripheral and multi-cored municipalities of Motala and Vara. In Motala, per capita costs instead increased to around 5,000 SEK. Despite relatively wide confidence intervals, the effect is statistically significant in Motala for most years after the break-up. In Vara, on the other hand, costs are unaffected in the first four years after the split, but increase dramatically in year five. The point estimates for the pre-split period are close to zero for both Vara and Motala, which indicates that the empirical strategy works well.

The last panels show the results for the three smaller municipalities in the north of Sweden. There is no indication that the split affected costs in Norsjö, whereas per capita costs increased by around 3,500 SEK as a consequence of the break-up of Vännäs. For Norsjö, there are indications that the empirical strategy is less successful in predicting the counterfactual outcome for the first two years, but for 1976–1982, predicted costs follow observed costs closely. For Åsele, the empirical strategy is less successful, and the estimates for the pre-split period are relatively large and fluctuate between being (borderline) statistically significant positive and statistically significant negative. Specifically, Figure 4 indicates that something caused actual costs to decrease sharply in 1977.

Figure 4 Municipal Costs – Observed and Counterfactual

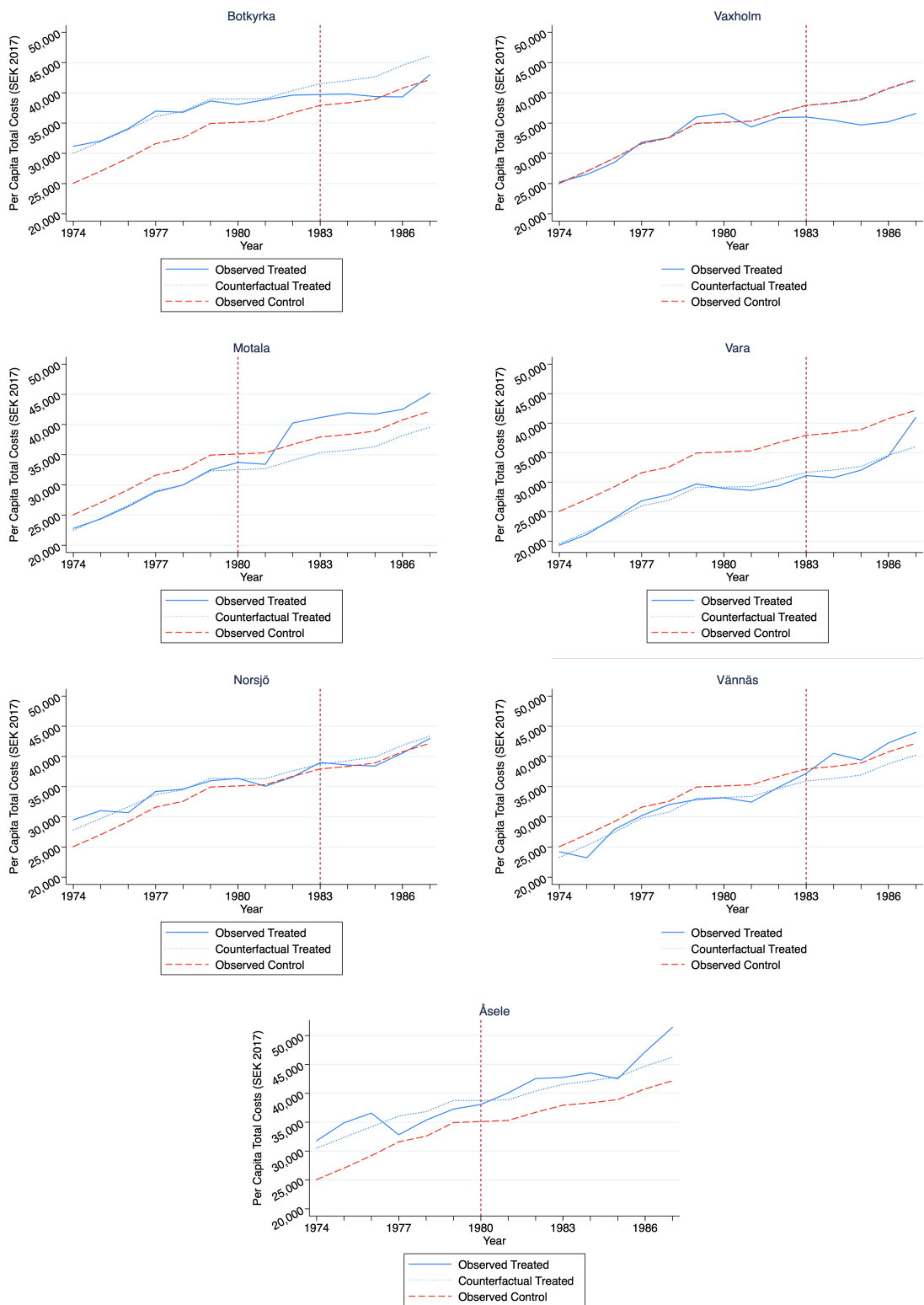
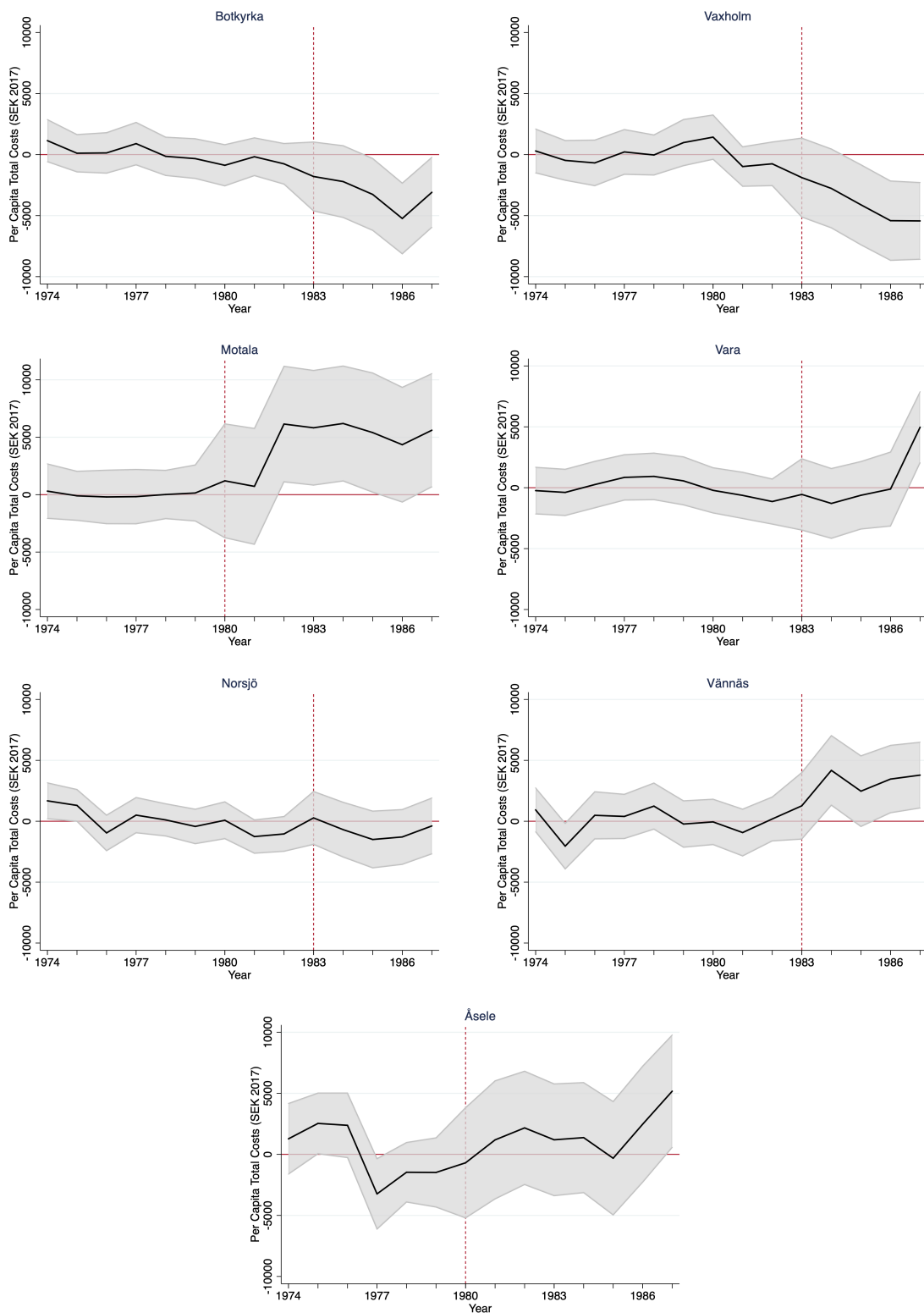


Figure 5 Municipal Costs – Estimated Effects



Note: 95 percent confidence intervals (blue area) estimated by taking $\bar{\alpha}_{it} \pm 1.96$ the standard error of the distribution of 999 block bootstrap replicates of $\bar{\alpha}_{it}$.

Table 2 Municipal Costs – Estimated Effects and Standardized p -values, 5-year averages

	Botkyrka	Vaxholm	Motala	Vara	Norsjö	Vännäs	Åsele
Average yearly effect – Pre	-457	128	0	-98	-506	45	0
Average yearly effect – Post	-1,788	-1,898	1,827	190	-611	1,539	475
Baseline	39,715	36,006	32,475	31,112	39,006	37,199	37,279
$RMSE^{pre}$	887	1,161	486	732	700	827	2,036
Standardized p-value – Pre	0.52	0.37	0.80	0.66	0.68	0.56	0.07
Standardized p-value – Post	0.17	0.18	0.01	0.24	0.70	0.15	0.93

Notes: Baseline refers to the year before treatment (1979 for Motala and Åsele, and 1982 for the other five municipalities). Standardized p-values calculated by the method described in [Kumar and Liang \(2018\)](#). Averages and p-values calculated using five years before and after the break-up..

In order to set the estimated effects into perspective, we have calculated the averages of the estimated yearly effects for the first five years following the split as well as the corresponding averages for the five years preceding the split. Table 2 displays these averages, baseline costs (measured the year preceding the split), the RMSPE for the pre-period which measures the goodness of fit, as well as standardized p-values for the pre- and post-periods respectively.²² Reassuringly, pre-split effects are all small, especially compared to baseline, implying that we have managed to estimate a valid counterfactual for the period before the split. However, for Åsele we we reject the null of no-pre effects, given the small the standardized p-value.²³

In Botkyrka and Vaxholm, annual per capita costs decreased by on average around 1,800 SEK and 1,900 SEK, corresponding to 4–5 percent of costs in the old municipality. The standardized p-values are just below 0.2. In Motala, annual costs increased by around 1,800 SEK, which corresponds to an increase with 5.5 percent. The standardized p-value is 0.01 implying that we can reject a null of a zero-effect at the 1 percent significance level. In Vara, Norsjö and Åsele, there are no indications that costs changed as a result of the break-up: the estimated effects are very small compared to baseline and the standardized p-values are high, especially for Norsjö and

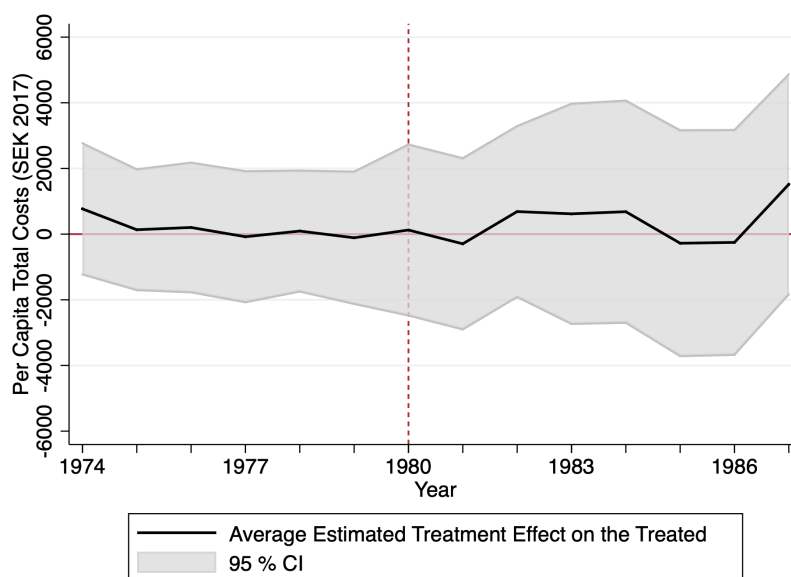
²²The average yearly effect for the post-treatment period is thus: $\bar{\alpha}_{i,post} = \frac{1}{5} \sum_t \hat{\alpha}_{i,t}$ for $t \geq T_0$.

²³The reason for rejecting the null despite an average pre-effect of 0 is because of the RMSPE-correction in the standardized p-values.

Åsele. In Vännäs, on the other hand, yearly per capita costs increased by on average around 1,500 SEK per capita as a result of the break-up, corresponding to an increase of four percent. The standardized p-value is 0.15.

As is clear from the results thus far, the estimated effects of municipal splits vary significantly from case to case. In, e.g. Botkyrka and Vaxholm our results point at decreasing costs per capita as a consequence of the break-ups, whereas in Motala and Vännäs per capita costs seem to have increased. Hence, assuming homogeneous treatment effects of municipal splits (and mergers), as has been done in much of the earlier empirical literature is questionable. This point is further illustrated by the results in Figure 6 that shows the average yearly treatment effects and Table 3 that shows five-years averages, before and after the municipal break-up.²⁴ As is clear from these results, there is no indications that, on average, the seven municipal break-ups affected costs at all.

Figure 6 Municipal Costs – Estimated Average Effects



²⁴The estimator for the ATET for a given time period t is given by $\hat{\alpha}_t = \frac{1}{7} \sum_i \hat{\alpha}_{it}$ where $\hat{\alpha}_{i,t}$. The average treatment effect for the post-treatment period is thus: $\hat{\alpha} = \frac{1}{7} \frac{1}{5} \sum_i \sum_t \hat{\alpha}_{i,t}$ for $t \geq T_0$.

Table 3 Municipal Costs — Estimated Average Effects and Standardized p -values, 5-year averages

	Total Costs
Average yearly effect – Pre-split	169
Average yearly effect – Post-split	351
Baseline	35,262
Standardized p -value – Pre-split	0.96
Standardized p -value – Post-split	0.63

Notes: Baseline refers to the year before treatment (1979 for Motala and Åsele, and 1982 for the other five municipalities). Standardized p -values calculated by the method described in [Kumar and Liang \(2018\)](#). Averages and p -values calculated using five years before and after the break-up.

7.2 Robustness

We conduct two sets of robustness checks. First, we estimate the canonical model where the loss function puts equal weight on all observed elements – i.e. equation 6.1. Second, we remove from the sample all neighbouring municipalities to the treated units, to avoid capturing spill-over effects. Figure D.3 in the appendix shows that the point estimates in these two robustness specifications are very close to our main specification.

As another robustness check, we have estimated our model using the synthetic control method suggested by [Abadie et al. \(2010\)](#). Figure D.4 in Appendix 8 shows how these estimates compare to the MC-NNM, whereas Table D.3 compares the two estimation techniques with respect to $RMSE^{pre}$. As is clear from these results, MC-NNM outperforms SC in terms of lower $RMSE^{pre}$, but the estimated effects point in the same direction.

7.3 Exploring Potential Mechanisms

Why did per capita costs increase in some cases and decreased in others? One potential explanation is that some newly created municipalities came out as winner with respect to the amount of intergovernmental grants received and others as losers. Given that intergovernmental grants make up an important revenue source for many

municipalities, this seems like a natural candidate. However, Table D.2 and Figure D.5 in Appendix D show that the estimated effects on grants are both economically and statistically insignificant. One explanation for the absence of an effect is most likely that 80 percent of total grants were targeted during the studied period, and targeted grants are – as opposed to general grants – unaffected by changes to the demographic composition.

So far we have discussed costs per capita as mainly a result of the cost-efficiency of municipal service production. However, it is likely that citizen’s preferences matter as well, especially since we lack any way of controlling for the quality of service provision. As is clear from the discussion in Section 4, the municipal splits we study were typically motivated by democratic arguments. If the political majority changed in one of the newly formed municipalities following the break-up, we might expect that costs change as a result. Figure 7 shows the vote share for the left-wing parties (panel to the left) and per capita costs (panel to the right) in the pre-split municipality and in the two newly formed municipalities after the split.

Focusing first on the two municipalities for which we find decreasing costs, Botkyrkan and Vaxholm, the figure shows that the political majority changed from a left-wing in the old jurisdiction Botkyrka to a right-wing in the new jurisdiction Salem, which would be in line with lower municipal spending in Salem. Perhaps somewhat surprisingly, costs nevertheless basically followed the same trajectories after the break-up into the two new units.²⁵ The break-up of Vaxholm did not result in changing political majority, although the support for the left wing was somewhat higher in Vaxholm once Österåker broke out of the municipality.

Turning next to Motala, where we find evidence of increasing per capita costs as a result of the split, the left coalition had a majority before the split, and increased its support in the remaining part once Vadstena broke out, whereas it lost its majority in the newly formed municipality Vadstena. After the split, per capita costs are

²⁵However, these results do not inform us what would have happened if Salem had remained in the larger municipality. This was the task of the estimated effects in Figure 5 above.

considerably higher in the jurisdiction where the left coalition kept its majority than in Vadstena, where the right wing majority took over. A similar story can be told for Vännäs, a municipality that also experienced increasing costs: through the split the left-wing parties won the majority in Bjurholm (the part that broke out) and costs are thereafter higher in this part than in the smaller Vännäs.

In Vara, the support for the left-wing parties was very low initially and this pattern remained in the two newly formed municipalities Vara and Essunga. Per capita costs evolve very similarly in these two municipalities after the split. In Norsjö, the left had a borderline majority before the split and kept the majority in both of the newly formed municipalities, although somewhat more secure in Malå, the part that experienced higher costs after the split. In Åsele finally, the political majority did not change in any of the new municipalities after the break-up, but costs are somewhat lower in Dorotea (the part that broke out).

Taken together, the conclusion from this analysis is far from being straight forward. In some municipalities there are indications that the change in political majority could potentially explain our finding, but the picture is not complete.

Figure 7 Vote share for left-wing parties and municipal costs

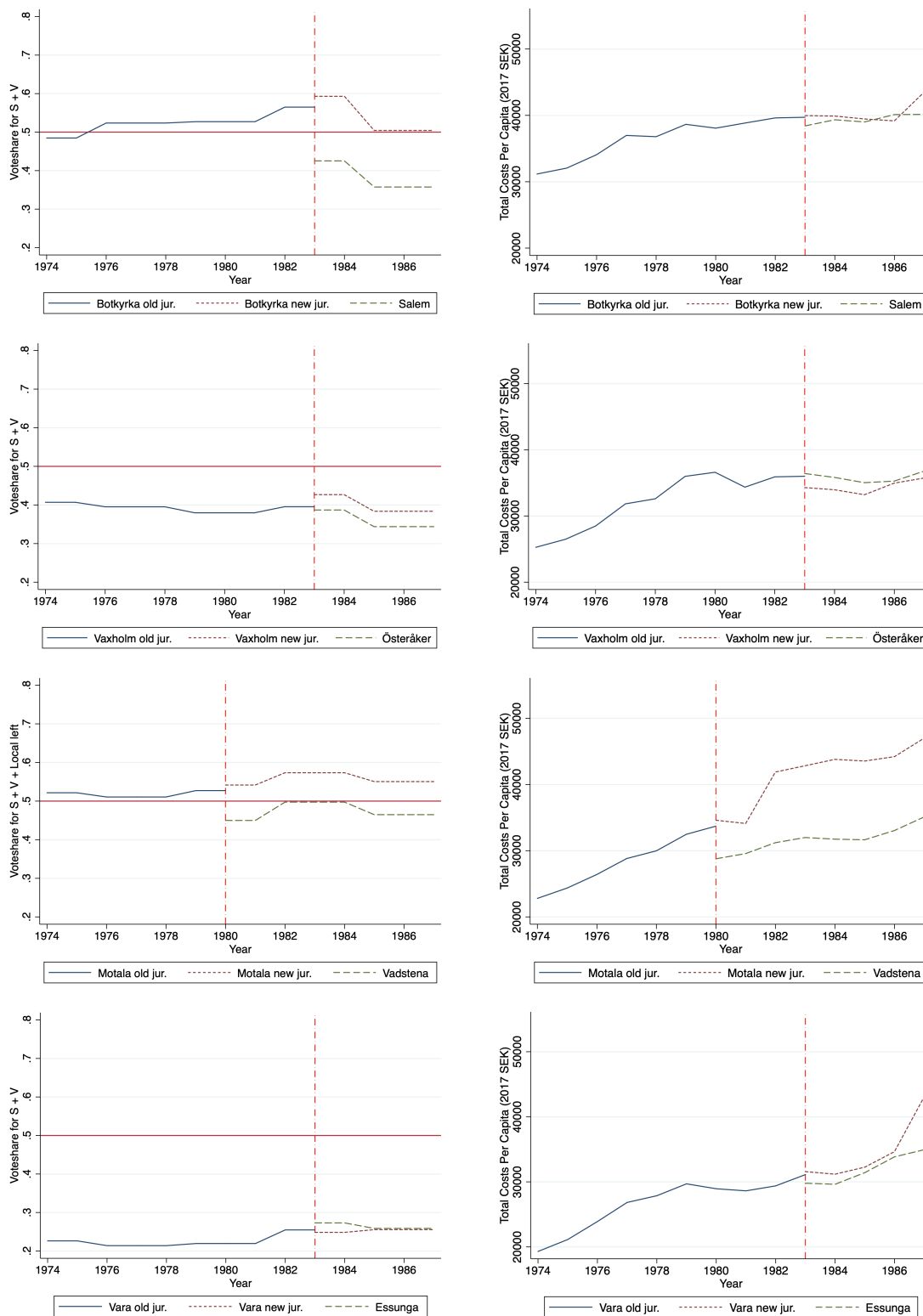
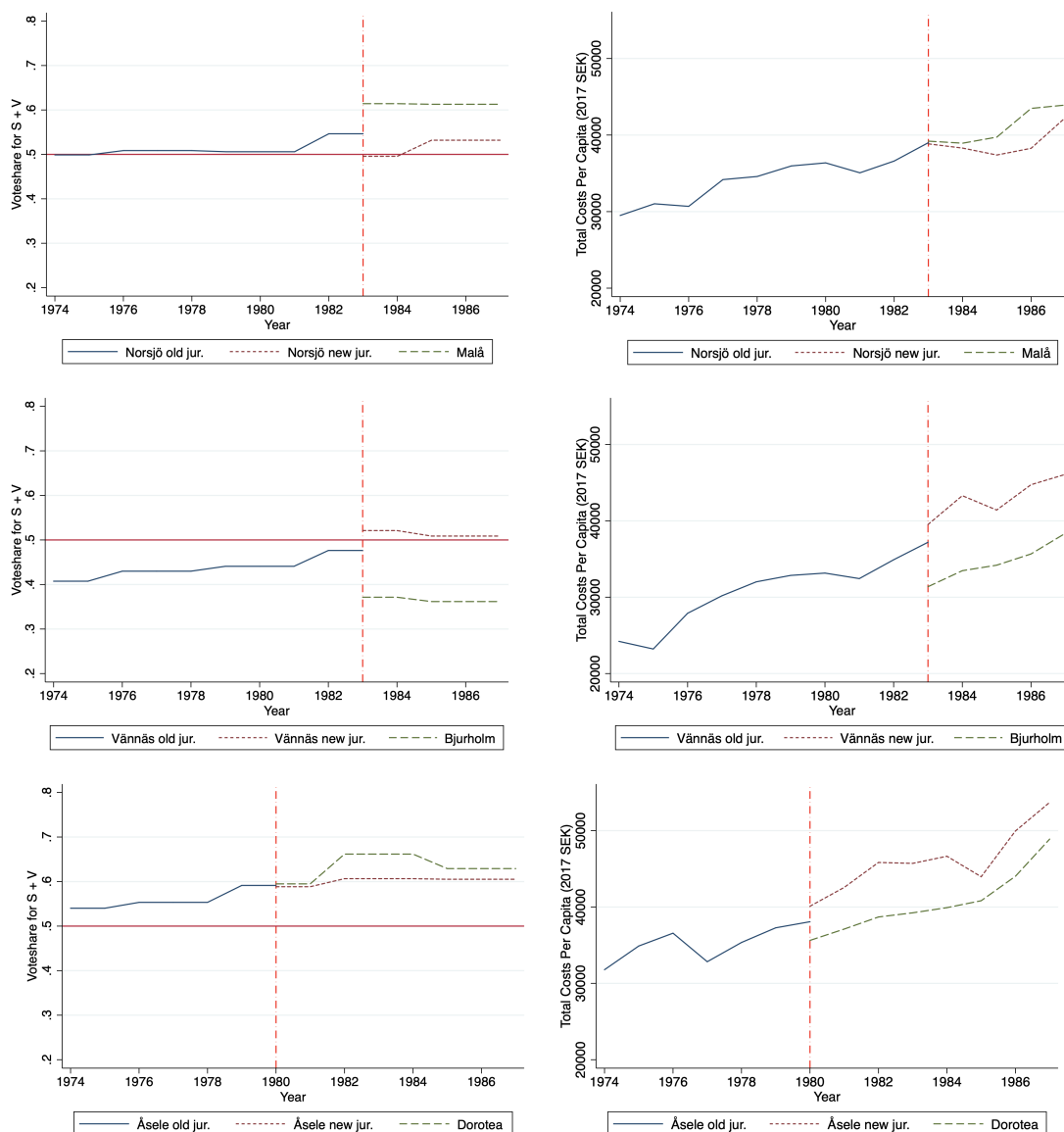


Figure 7 Vote share for left-wing parties and municipal costs (*continued*)



8 Concluding discussion

This paper has analyzed how municipal break-ups affect municipal costs. Focusing on the seven municipalities that experienced a divorce in the early 1980s – resulting in 14 smaller municipalities – we do not find any uniform support for the ‘dominant view’ that a movement to smaller municipalities, which logically follows from break-ups, imply higher per capita costs. Instead, we find evidence of an interesting and

intriguing heterogeneity in outcomes: costs increase in some cases, are unaffected in others, but decrease elsewhere. More specifically, costs have a tendency to decrease in densely populated areas close to the metropolitan Greater Stockholm region, whereas splits tend to lead to unaffected or higher costs in the more sparsely populated regions of Sweden.

The decreasing costs in the metropolitan Stockholm cases can be understood both in light of the polycentric view, stating that splits in metropolitan regions could lead to cost-efficiency as a result of increased competition between municipalities for taxpayers, as well as the idea of a U-shaped cost function, where their relatively large initial size might have been associated with dis-economies of scale. The increasing costs in Motala and Vännäs could potentially also be understood in light of the polycentric view. For Vännäs, however, another possibility is that the break-up allowed for a better matching between political preferences and policy, when the left-wing parties – who are more prone to spending – won the majority in one of the two splitting parts.

These heterogeneous empirical findings point to the importance of evaluating potential effects of territorial reforms – municipal break-ups as well as amalgamations – on a case-by-case basis. If we had treated our cases in the aggregate and ignored the potential heterogeneity in effects, we would have reached the erroneous conclusion that the territorial reforms that took place in Sweden in the early 1980s did not affect municipal costs. Our findings, therefore, underscore the perils of policy makers' propagating territorial reforms as 'universal' or 'one size fits all' solutions to complex societal challenges. By implication, the findings also highlight the difficulty in drawing general conclusions about their effects. In fact, it could make sense to advocate splits in certain cases and parts of a country, and amalgamations in others. Consequently, although this paper has had its focus on break-ups, our findings rejoin the overall results from the empirical literature on amalgamations, which underline the naivety of policy makers placing their bets on that sweeping and all-encompassing amalgamation reforms will save costs.

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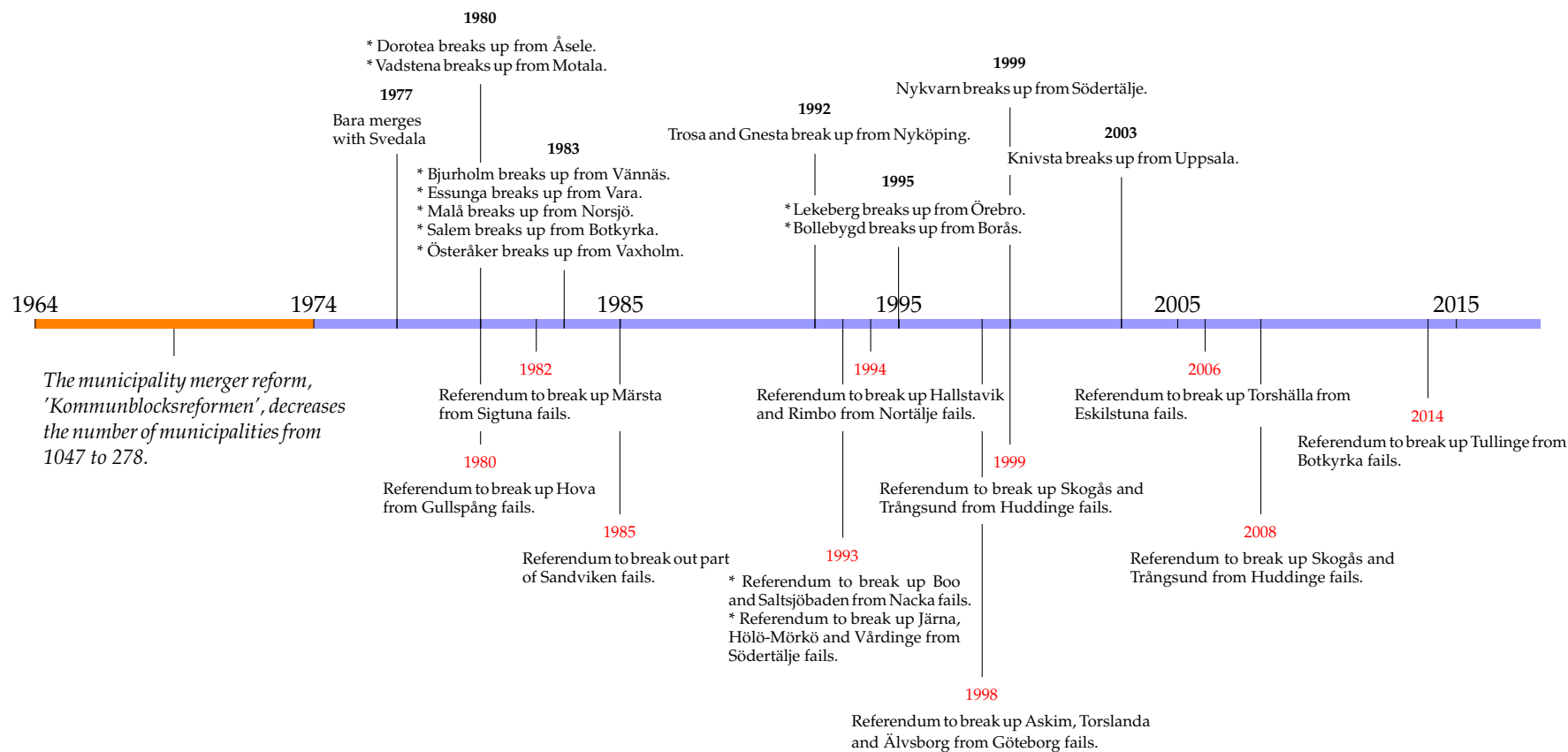
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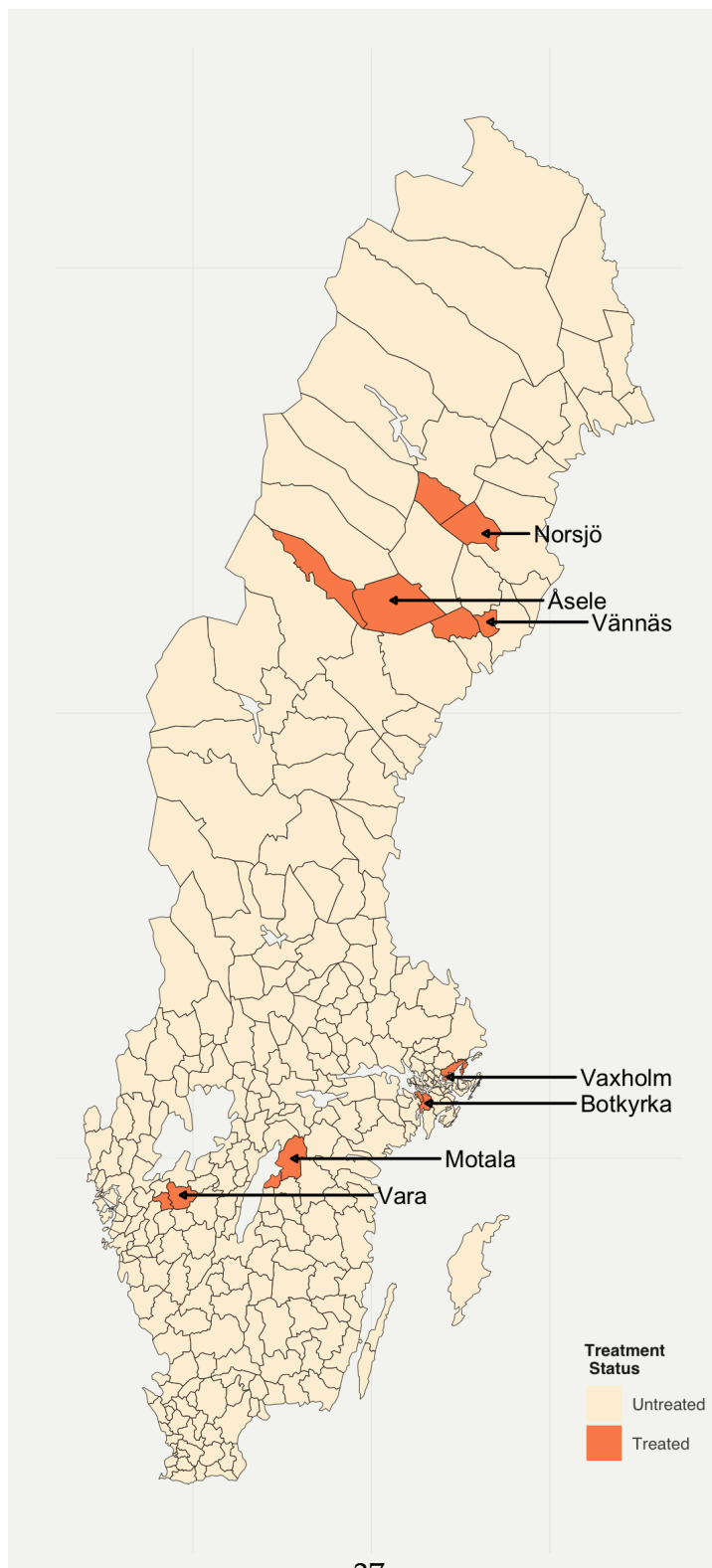
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Appendix A: The History of Territorial Reforms in Sweden



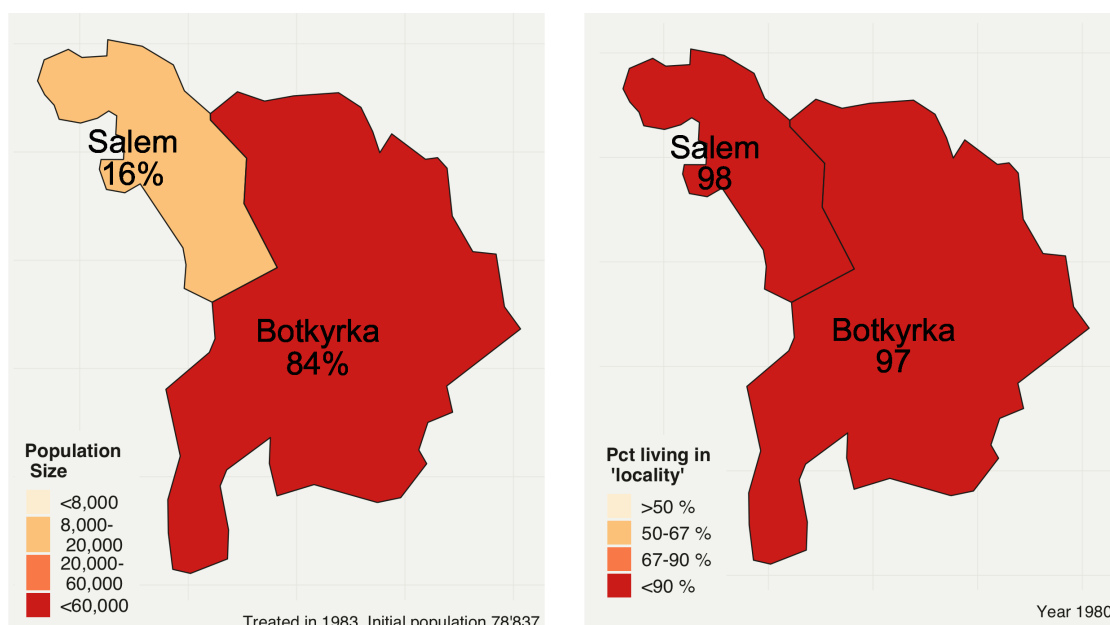
Appendix B: Description of the Seven Municipalities that Experienced a Break-up

Figure B.1 Geographical position



Botkyrka 1983

Figure B.2 Botkyrka - Demography



(a) Population

(b) Degree of urbanity

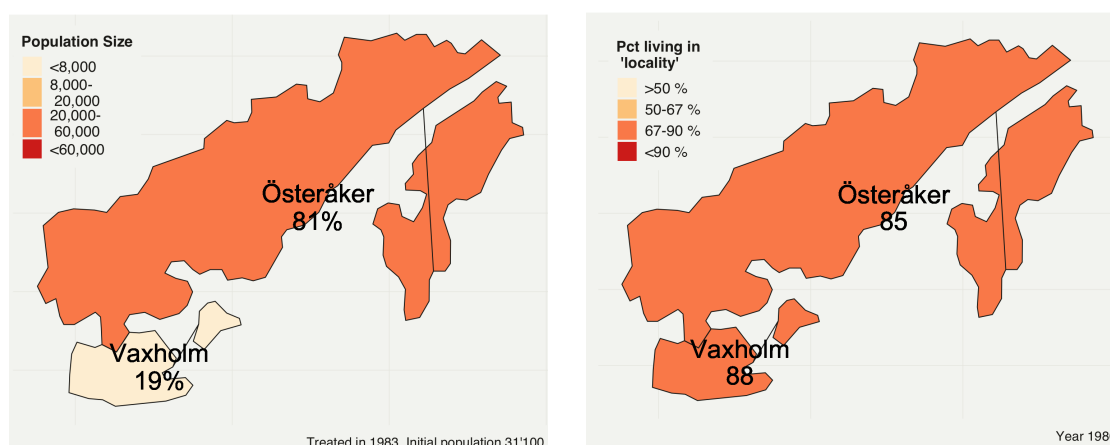
Table B.1 Botkyrka: Descriptive Statistics

	Botkyrka -82	Botkyrka -83	Salem -83
Total Population	78,361	66,062	12,775
Land Area (km ²)	251	197	55
Population Density (Pop./km ²)	312	336	234
Share Children and Elderly (%)	41	40	46
Turnout in Municipal Election	85	83	90
Vote Share Left-Wing Parties, S+V (%)	53	59	43
Vote Share Center Party, C (%)	11	7	16
Tax Base Per Capita (2017 SEK)	871,107	870,390	862,079
Local Income Tax Rate (%)	16	16	16
Unemployment Rate* (%)	2	2	1

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1979 election for Botkyrka 1982, and the 1982 elections for Botkyrka and Salem 1983. * Measured in 1984.

Vaxholm 1983

Figure B.3 Vaxholm - Demography



(a) Population

(b) Degree of urbanity

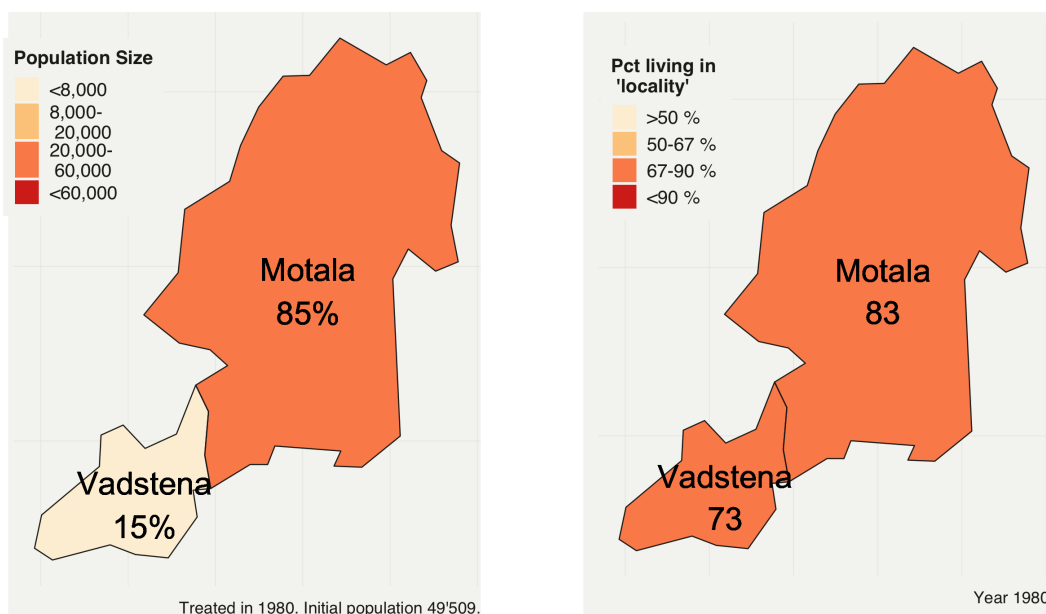
Table B.2 Vaxholm: Descriptive Statistics

	Vaxholm -82	Vaxholm -83	Österåker -83
Total Population	30,743	6,061	25,039
Land Area (km ²)	367	57	310
Population Density (Pop./km ²)	84	106	81
Share Children and Elderly (%)	44	41	44
Turnout in Municipal Election	90	91	91
Vote Share Left-Wing Parties, S+V (%)	38	43	39
Vote Share Center Party, C (%)	12	8	8
Tax Base Per Capita (2017 SEK)	852,677	944,795	821,261
Local Income Tax Rate (%)	16	16	16
Unemployment Rate (%)	5	2	1

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1979 election for Vaxholm 1982, and the 1982 elections for Vaxholm and Österåker 1983. * Measured in 1984.

Motala 1980

Figure B.4 Motala - Demography



(a) Population

(b) Degree of urbanity

Table B.3 Motala: Descriptive Statistics

	Motala -79	Motala -80	Vadstena -80
Total Population	49,742	41,945	7,564
Land Area (km ²)	1,175	992	182
Population Density (Pop./km ²)	42	42	41
Share Children and Elderly (%)	45	45	46
Turnout in Municipal Election	91	90	91
Vote Share Left-Wing Parties, S+V (%)	51	54	45
Vote Share Center Party, C (%)	19	14	20
Tax Base Per Capita (2017 SEK)	778,568	749,116	782,275
Local Income Tax Rate (%)	16	16	16
Unemployment Rate (%)	.	3	1

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1976 election for Motala 1979, and the 1979 elections for Motala and Vadstena 1980. We lack unemployment data before 1980.

Vara 1983

Figure B.5 Vara - Demography

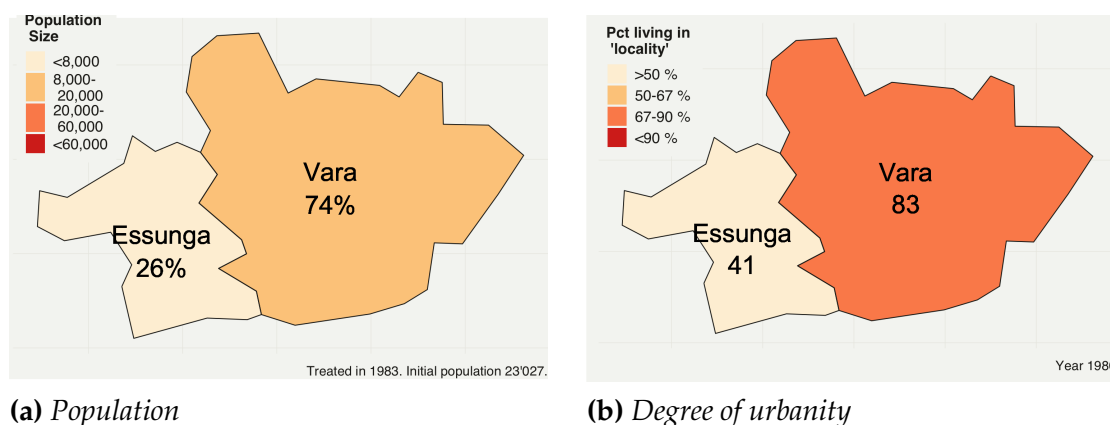


Table B.4 Vara: Descriptive Statistics

	Vara -82	Vara -83	Essunga -83
Total Population	22,963	17,054	5,973
Land Area (km ²)	937	701	237
Population Density (Pop./km ²)	24	24	25
Share Children and Elderly (%)	47	47	48
Turnout in Municipal Election	90	90	91
Vote Share Left-Wing Parties, S+V (%)	22	25	27
Vote Share Center Party, C (%)	32	27	30
Tax Base Per Capita (2017 SEK)	677,634	694,355	659,345
Local Income Tax Rate (%)	15	16	16
Unemployment Rate (%)	3	3	2

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1979 election for Vara 1982, and the 1982 elections for Vara and Essunga 1983. * Measured in 1984.

Norsjö 1983

Figure B.6 Norsjö - Demography

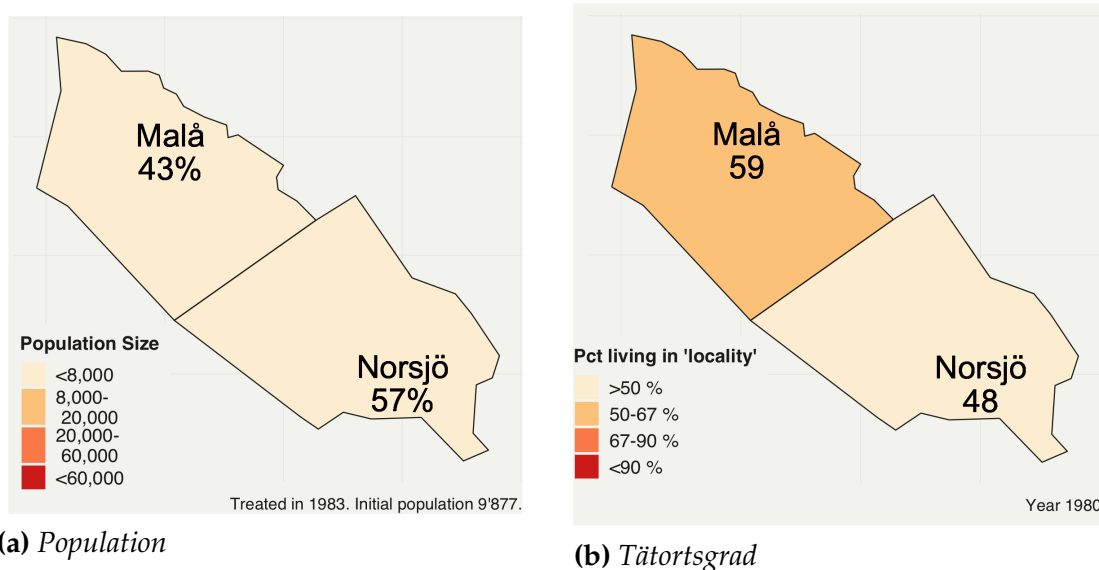


Table B.5 Norsjö: Descriptive Statistics

	Norsjö -82	Norsjö -83	Malå -83
Total Population	9,931	5,610	4,267
Land Area (km ²)	3,390	1,753	1,611
Population Density (Pop./km ²)	3	3	3
Share Children and Elderly (%)	44	44	44
Turnout in Municipal Election	88	88	89
Vote Share Left-Wing Parties, S+V (%)	51	50	61
Vote Share Center Party, C (%)	19	19	13
Tax Base Per Capita (2017 SEK)	784,630	768,269	733,357
Local Income Tax Rate (%)	18	18	18
Unemployment Rate* (%)	10	4	5

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1979 election for Norsjö 1982, and the 1982 elections for Norsjö and Malå 1983. * Measured in 1984.

Vännäs 1983

Figure B.7 Vännäs - Demography

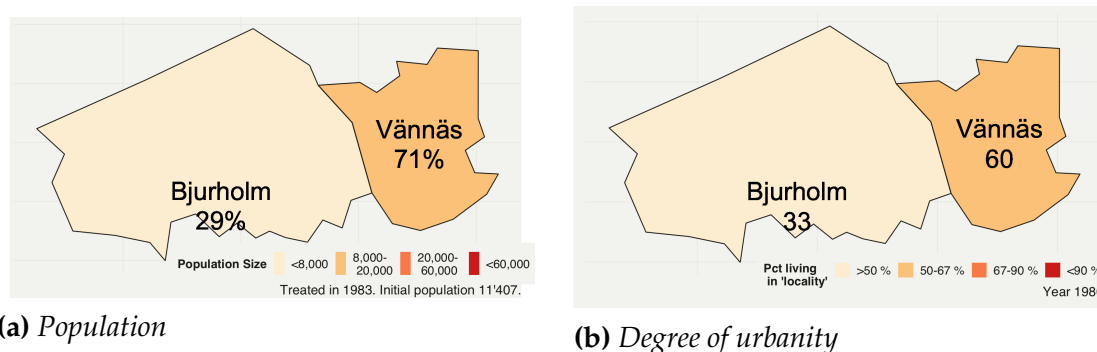


Table B.6 Vännäs: Descriptive Statistics

	Vännäs -82	Vännäs -83	Bjurholm -83
Total Population	11,472	8,152	3,255
Land Area (km ²)	1,851	534	1,317
Population Density (Pop./km ²)	6	15	2
Share Children and Elderly (%)	45	44	48
Turnout in Municipal Election	90	91	90
Vote Share Left-Wing Parties, S+V (%)	44	52	37
Vote Share Center Party, C (%)	27	27	24
Tax Base Per Capita (2017 SEK)	709,457	756,397	668,028
Local Income Tax Rate (%)	16	18	18
Unemployment Rate (%)	5	4	5

Notes: Tax base is price adjusted using the CPI. Children are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1979 election for Vännäs 1982, and the 1982 elections for Vännäs and Bjurholm 1983. *Measured in 1984.

Åsele 1980

Figure B.8 Åsele - Demography

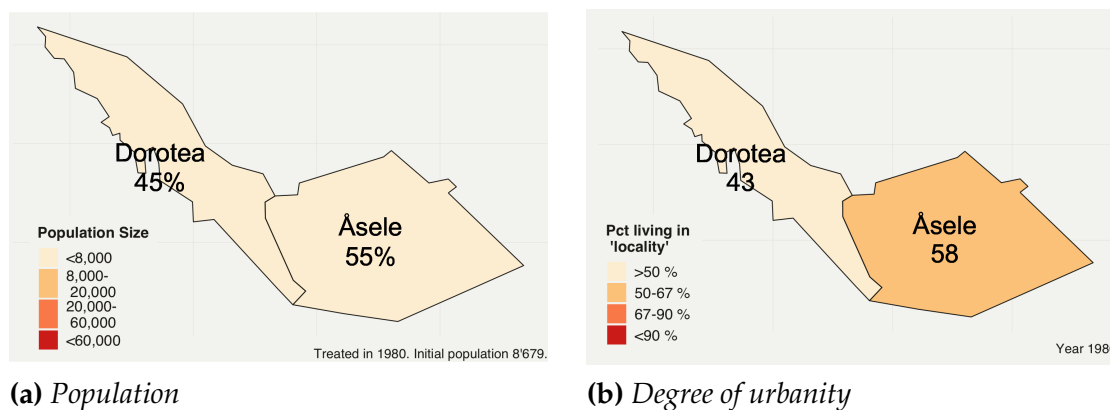


Table B.7 Åsele: Descriptive Statistics

	Åsele -79	Åsele -80	Dorotea -80
Total Population	8,743	4,744	3,935
Land Area (km ²)	7,118	4,315	2,802
Population Density (Pop./km ²)	1	1	1
Share Kids and Elderly (%)	46	46	46
Turnout in Municipal Election	91	88	91
Vote Share Left-Wing Parties, S+V (%)	55	59	59
Vote Share Center Party, C (%)	22	21	19
Tax Base Per Capita (2017 SEK)	700,239	690,523	661,406
Local Income Tax Rate (%)	19	19	19
Unemployment Rate (%)	.	5	4

Notes: Tax base is price adjusted using the CPI. Kids are defined as below age 19 and elderly as over 64. Turnout and vote share for left-wing parties refer to the 1976 election for Åsele 1979, and the 1979 elections for Åsele and Dorotea 1980. We lack unemployment data before 1980.

Appendix C: Estimation and Implementation

The optimization algorithm

Given the SVD for \mathbf{A} , $\mathbf{A} = \mathbf{S}\mathbf{\Sigma}\mathbf{R}^T$, with singular values $\sigma_1(\mathbf{A}), \dots, \sigma_{\min(N,T)}(\mathbf{A})$, define the matrix shrinkage operator

$$\mathit{shrink}_\lambda(\mathbf{A}) = \mathbf{S}\tilde{\mathbf{\Sigma}}\mathbf{R}^T \quad (8.1)$$

where $\tilde{\mathbf{\Sigma}}$ is given by $\mathbf{\Sigma}$ with the i -th singular value $\sigma_i(\mathbf{A})$ replaced by $\max(\sigma_i(\mathbf{A}) - \lambda, 0)$. Start with the initial choice $\mathbf{L}_1(\lambda, \mathcal{O}) = \mathbf{P}_{\mathcal{O}}(\mathbf{Y})$ and then, for each $k = 1, 2, \dots$, define

$$\mathbf{L}_{k+1}(\lambda, \mathcal{O}) = \mathit{shrink}_{\frac{\lambda|\mathcal{O}|}{2}} \left\{ \mathbf{P}_{\mathcal{O}}(\mathbf{Y}) + \mathbf{P}_{\mathcal{O}}^\perp(\mathbf{L}_k(\lambda)) \right\} \quad (8.2)$$

until the sequence $\{\mathbf{L}_{k+1}(\lambda, \mathcal{O})\}_{k \geq 1}$ converges. Our estimator, given the regularization parameter λ , is then given by the limiting matrix $\hat{\mathbf{L}}(\lambda, \mathcal{O}) = \lim_{k \rightarrow \infty} \mathbf{L}_k(\lambda, \mathcal{O})$.

Cross-validation

The regularization parameter λ , is chosen through cross-validation in the following way: First, draw $K = 5$ random subsets $\mathcal{O}_k \in \mathcal{O}$. Second, select a sequence of candidate regularization parameters $\lambda_1 > \dots > \lambda_L > 0$, with large enough λ_1 . Third, for each subset \mathcal{O}_k , estimate $\hat{\mathbf{L}}(\lambda_1, \mathcal{O}_k), \dots, \hat{\mathbf{L}}(\lambda_L, \mathcal{O}_k)$ and evaluate the average squared error on $\mathcal{O} \setminus \mathcal{O}_k$. Finally, choose the largest λ at which the root mean squared error (RMSE) is within one standard error of the minimal RMSE.

Table C.1 Cross-validation

Cross-validation ratio	0.8
Number of folds	5
Fixed unit effects	Yes
Fixed time effects	Yes
Number of λ considered for learning	100
Number of iterations for each fixed value of λ	400
Stopping rule (do not improve beyond)	0.00001
One standard error rule*	Yes

Notes: *One standard error rule: Choose the highest λ producing RMSE within 1 S.E. of the λ producing the smallest RMSE. The estimations are carried out using Jason Poulos' forked version of MCPANEL (used in [Athey et al. \(2017\)](#)), which allows for weighted loss function, available at <https://github.com/jvpoulos/MCPANEL>.

Appendix D: Tables and Figures

Table D.1 Municipal Costs – Estimated Effects and Standardized p -values, by year

	Botkyrka	Vaxholm	Motala	Vara	Norsjö	Vännäs	Åsele
1974	1,140 [0.17]	295 [0.79]	307 [0.57]	-238 [0.76]	1,678 [0.07]	935 [0.34]	1,272 [0.58]
1975	111 [0.86]	-476 [0.50]	-100 [0.78]	-386 [0.43]	1,301 [0.07]	-2,043 [0.02]	2,533 [0.10]
1976	135 [0.85]	-681 [0.40]	-198 [0.64]	258 [0.63]	-958 [0.22]	487 [0.56]	2,378 [0.15]
1977	896 [0.29]	217 [0.82]	-171 [0.72]	847 [0.17]	502 [0.60]	396 [0.68]	-3,239 [0.09]
1978	-144 [0.85]	-33 [0.97]	15 [0.96]	930 [0.10]	111 [0.90]	1,243 [0.14]	-1,466 [0.41]
1979	-331 [0.68]	981 [0.27]	147 [0.84]	562 [0.36]	-426 [0.64]	-229 [0.83]	-1,482 [0.57]
1980	-877 [0.19]	1,428 [0.08]	1,207 [0.03]	-216 [0.72]	83 [0.93]	-53 [0.96]	-692 [0.85]
1981	-176 [0.81]	-980 [0.20]	723 [0.49]	-629 [0.25]	-1,257 [0.08]	-927 [0.26]	1,186 [0.81]
1982	-757 [0.43]	-757 [0.50]	6,149 [0.01]	-1,136 [0.09]	-1,041 [0.32]	187 [0.90]	2,168 [0.70]
1983	-1,794 [0.20]	-1,884 [0.24]	5,825 [0.01]	-551 [0.72]	275 [0.91]	1,267 [0.55]	1,192 [0.87]
1984	-2,211 [0.23]	-2,773 [0.19]	6,198 [0.02]	-1,291 [0.41]	-688 [0.76]	4,177 [0.06]	1,371 [0.87]
1985	-3,264 [0.17]	-4,113 [0.13]	5,406 [0.04]	-621 [0.74]	-1,498 [0.55]	2,470 [0.36]	-318 [0.97]
1986	-5,233 [0.06]	-5,413 [0.07]	4,352 [0.08]	-111 [0.93]	-1,289 [0.62]	3,464 [0.25]	2,471 [0.74]
1987	-3,093 [0.30]	-5,433 [0.15]	5,611 [0.07]	4,962 [0.06]	-385 [0.92]	3,788 [0.28]	5,170 [0.58]

Notes: Standardized p -values reported in square brackets. Post-treatment period: Motala, Åsele: 1980–1987; Botkyrka, Vaxholm, Vara, Norsjö, Vännäs: 1983–1987.

Table D.2 Grants: Estimated Effects and Standardized p-values, 5-year averages

	Botkyrka	Vaxholm	Motala	Vara	Norsjö	Vännäs	Åsele
Avg. yearly effect – Pre	675	200	0	-259	-4	42	0
Avg. yearly effect – Post	-304	-269	1,305	16	286	227	926
Baseline	13,888	11,953	22,963	9,931	9,931	11,472	8,743
Std. p-value – Pre	0.31	0.81	0.25	0.72	0.57	0.45	0.00
Std. p-value – Post	0.89	0.54	0.33	0.98	0.81	0.63	0.99

Notes: Baseline refers to the year before treatment (1979 for Motala and Åsele, and 1982 for the other five municipalities). Standardized p-values calculated by the method described in [Kumar and Liang \(2018\)](#). Averages and p-values calculated using five years before and after the break-up.

Table D.3 Municipal Costs – $RMSE^{pre}$: MC-NNM vs SC-ADH

	Botkyrka	Vaxholm	Motala	Vara	Norsjö	Vännäs	Åsele
MC-NNM	828	943	486	649	928	977	2,046
SC-ADH	1,860	2,495	702	794	1,910	980	3,199

Notes: Synthetic Control Method as suggested by [Abadie et al. \(2010\)](#) implemented with the STATA package *synth*. Matrix Completion estimations carried out using Jason Poulos' forked version of MCPANEL (used in [Athey et al. \(2017\)](#)), which allows for weighted loss function, available at <https://github.com/jvpoulos/MCPANEL>.

Figure D.1 Municipal Costs: Treated in 1980 and Placebo

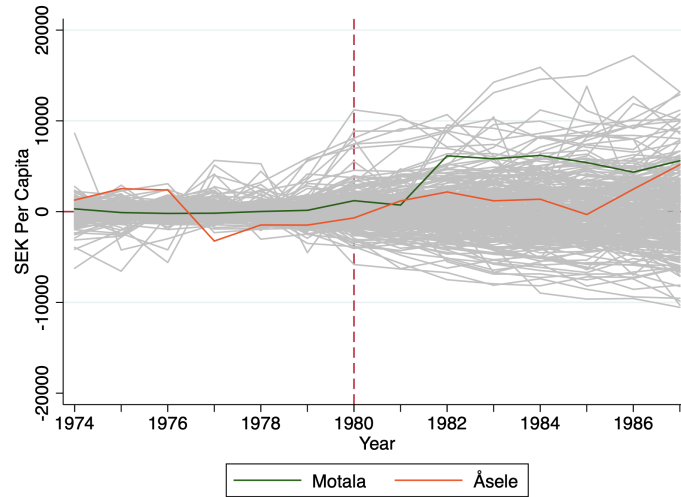


Figure D.2 Municipal Costs: Treated in 1983 and Placebo

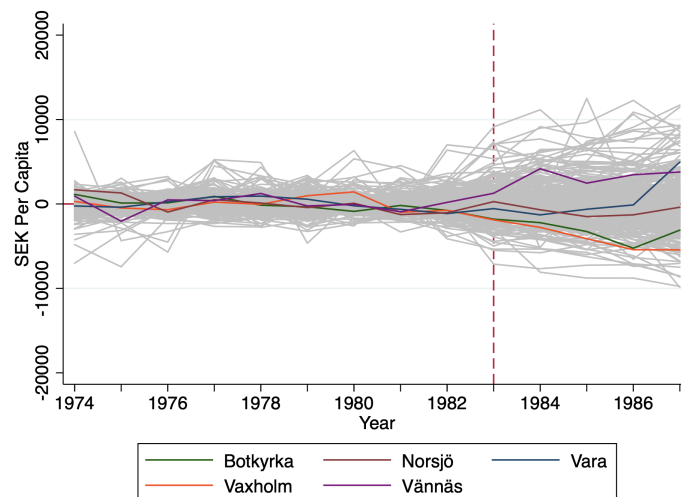
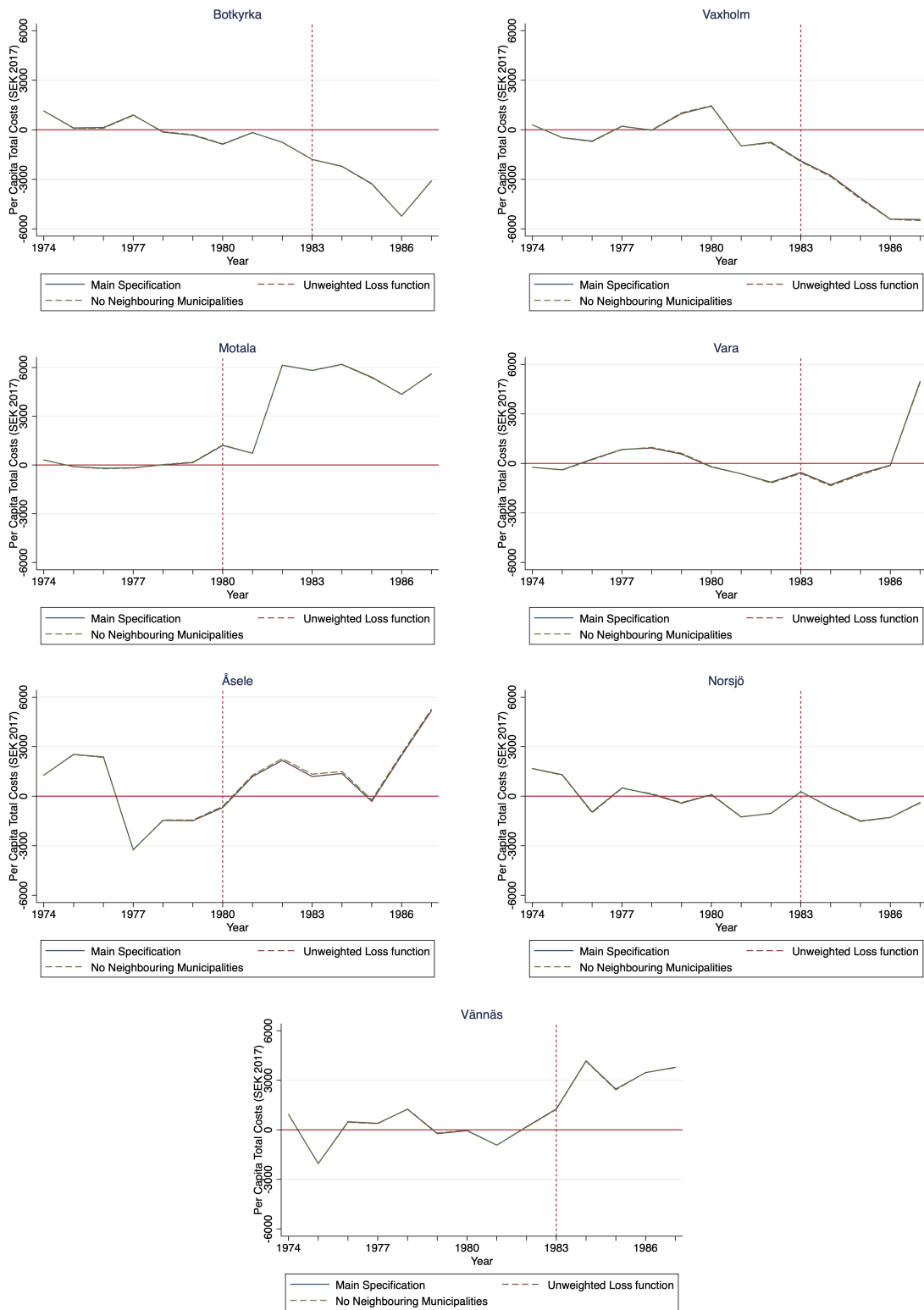
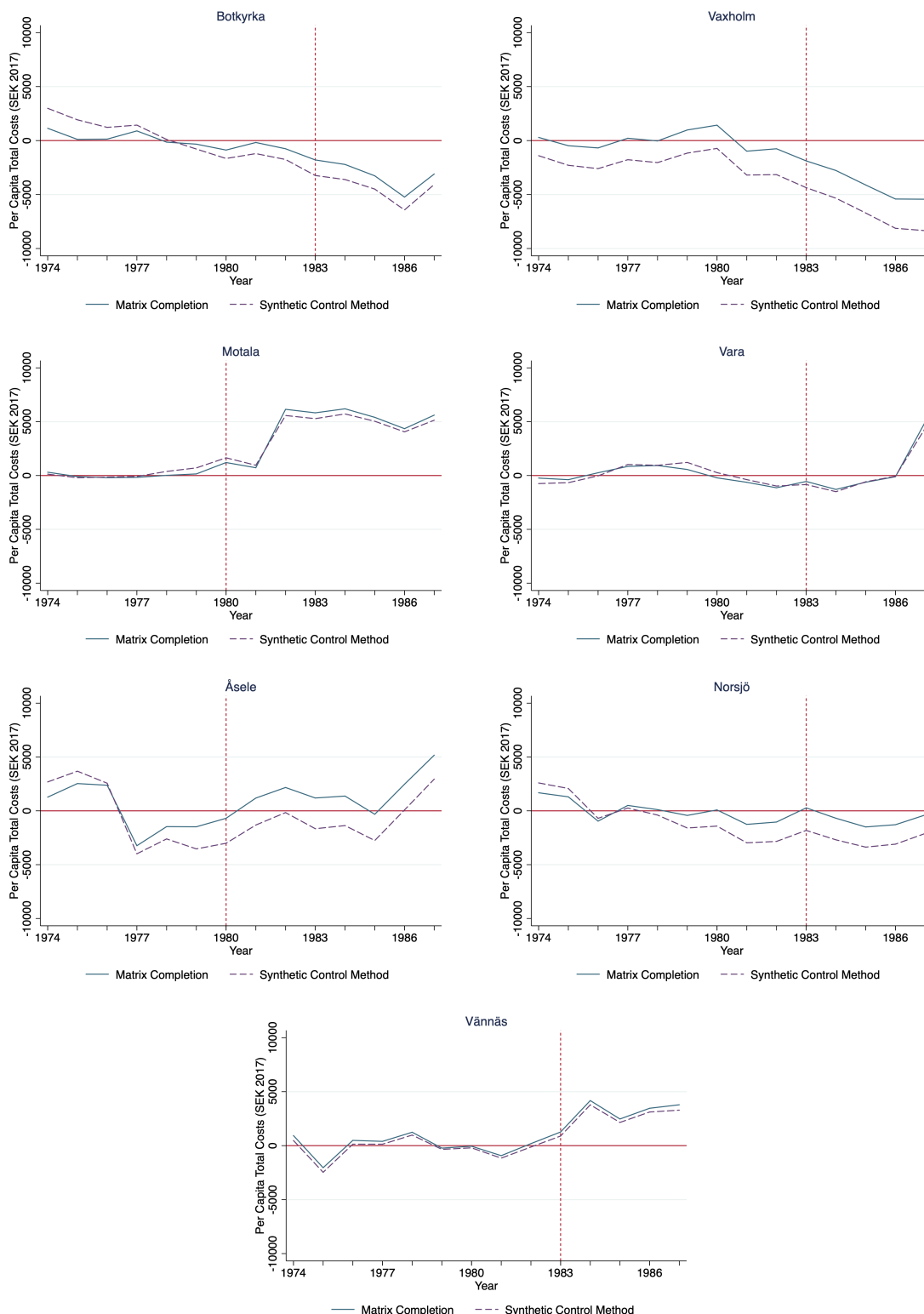


Figure D.3 Municipal Costs – Estimated effects: Main specification, unweighted loss function and neighboring municipalities removed



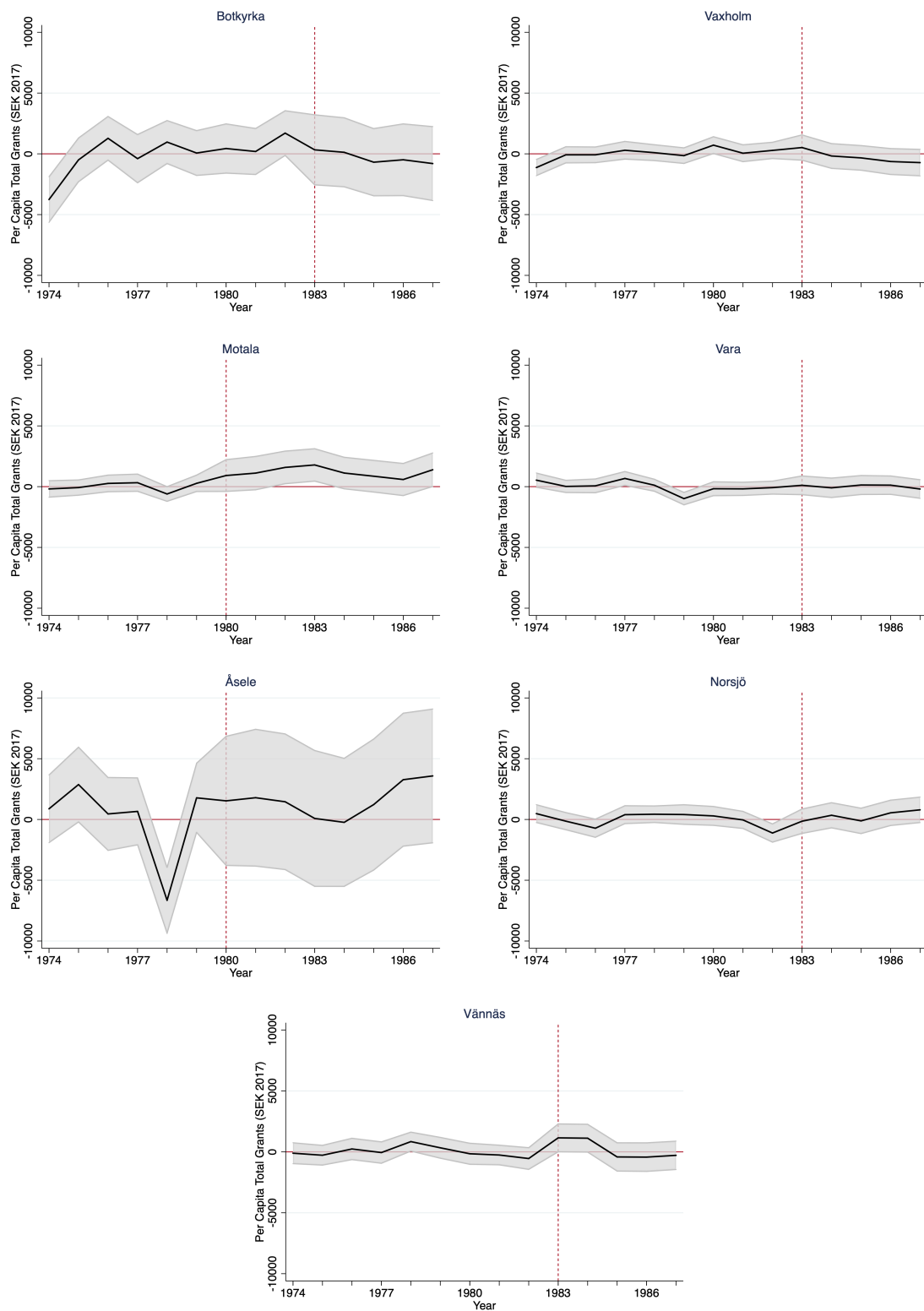
Note: Matrix Completion estimations carried out using Jason Poulos’ forked version of MCPanel (used in Athey et al. (2017)), which allows for weighted loss function, available at <https://github.com/jvpoulos/MCPanel>.

Figure D.4 Municipal Costs – Estimated effects: MC-NNM vs. SC



Note: Synthetic Control Method as suggested by [Abadie et al. \(2010\)](#) implemented with the STATA package *synth*. Matrix Completion estimations carried out using Jason Poulos' forked version of MCPanel (used in [Athey et al. \(2017\)](#)), which allows for weighted loss function, available at <https://github.com/jvpoulos/MCPanel>.

Figure D.5 Grants – Estimated Effects



Note: 95 percent confidence intervals (gray area) estimated by taking $\bar{a}_{it} \pm 1.96$ the standard error of the distribution of 999 block bootstrap replicates of \bar{a}_{it} .