Public Employment and Regional Risk Sharing: Norway 1977-90

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Abstract

We provide an empirical analysis of regional risk sharing in Norway over the period 1977-90. The approach of Asdrubali, Sørensen and Yoshia (1996) is extended to take account of public employment as a possible shock absorber. The other channels of risk sharing are capital markets & commuting, taxes & transfers and credit markets. The estimated degree of regional consumption insurance is very high. We cannot reject the hypothesis that there is full interregional risk sharing in the short-term. Public employment absorbs up to 25 percent of private sector output shocks in our analyses. Generally, central government insurance of regional shocks is relatively more important the more permanent the shocks are, and vice versa for market-based risk sharing channels.

1 Introduction

The extent and mechanisms of aggregate risk sharing have been subject to extensive research in the past few years. One particular reason for this interest is the process of monetary integration in Europe. The abolition of a national monetary policy and the current restrictions on national budget

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deficits increase the importance of other channels that can cushion country-specific shocks.¹

A dominant finding in the existing research is that risk sharing between
countries (including the EMU nations) is limited,² while more insurance is
available, it is still far from complete, at the regional, or intranational, level.³
Some of the regional studies decompose the contribution to the reduction in
the cross sectional covariance between output and consumption into different
channels. These channels are either market-based (e.g., interregional equity
investments), or inherent in the policy of the central government (e.g., taxes
& transfers). For the US, both Asdrubali et al. (1996) and Athanasoulis and
van Wincoop (2001) find that the amount of regional market insurance is
about five times larger than the cross-state insurance provided by the federal
government.

This paper contributes to the literature on regional risk sharing in two
ways. First, we extend the approach of Asdrubali et al. (1996) to take ac-
count of public employment as a possible shock absorber. Second, we employ
this framework to analyze the extent and channels of regional risk sharing in
Norway. To our knowledge, ours is the first attempt to empirically analyze
the income buffering role of public employment. However, public finance
theorists have long acknowledged this potential role (see Musgrave, 1982).⁴
In Norway, public employment is used actively in recessions to counteract
the effects of reduced private employment. The national government influences
public employment directly through state employment and indirectly
by grants to the local and county governments. Specific grants with the aim
of stimulating local public employment are typically introduced in recessions.
In our context it is important to notice that both state employment - par-
ticularly the location of state agencies - and grants can be directed quite
effectively towards regions that are hurt by a negative shock to private em-
ployment, and both means are heavily emphasized in official documents on
regional policy. Grants to local and county governments are probably the

¹ Many central articles on the need for insurance mechanisms in the EMU are reprinted in De Grauwe (2001).
² See e.g. Obstfeld (1994) and B. Sørensen and Yosha (1998).
³ Using the same data set, but different methods of measurement, Asdrubali et al. (1996), Athanasoulis and van Wincoop (2001), and Mélitz and Zumer (1999) all report that the amount of interstate risk sharing in the US is substantial. Similar results are reported for the Canadian provinces by Mélitz and Zumer (1999) and for the Japanese préfectures by van Wincoop (1995).
⁴ Musgrave articulates this as follows: "unemployment may vary sharply by industry and location. In such cases, job creation may be targeted more effectively through public employment than through tax reductions and even through public purchases." (1982, p. 15).
easiest to adjust in the short-term, while the location of state agencies requires more planning. We believe that Norway is an instructive case for studying risk sharing in a typical welfare state where regional insurance (and redistribution) is an important policy goal.

Our results show that the extent of regional consumption insurance in Norway was extremely high over the sample period. In our short-term analyses we cannot reject the hypothesis of full interregional risk sharing. Public employment is an important channel for smoothing idiosyncratic shocks, absorbing up to 25 percent of private sector output shocks according to our long-run results. The combined effect of capital markets and commuting is the most important channel in our short-term results. In general, central government insurance increases in importance as shocks become more permanent, while the opposite pattern seems to hold for market-based channels of risk sharing.

In the next section we discuss the different channels for risk sharing. In section 3 we explain our extension of the empirical model of Asdrubali et al. (1996). Section 4 describes our data and reports some important risk sharing statistics. Our results are reported in section 5, and we conclude in section 6.

2 Mechanisms for aggregate risk sharing

Within a regional context, the theory of perfect risk sharing predicts that consumption in each region is a fixed proportion of national output.\(^5\) I.e., consumption in each region would move one-to-one with aggregate output, and hence would be perfectly correlated across regions, with full risk sharing. If risk sharing is less than complete, regional consumption will depend on regional as well as national output.

There are several mechanisms for sharing output risk among regions. The main distinction is between market transactions and transactions across regions that are implemented by the central government.

In regard to the policies of the central government, it is important to notice that even policies aimed at redistribution may have an effect on the degree of regional risk sharing (Sala-i-Martin and Sachs, 1992). For instance, a system with progressive income tax and counter-cyclical transfers (e.g., through unemployment benefits) will help buffer the effects of shocks on a region’s consumption (i.e., provide risk sharing), even though the original objective of these policies is to redistribute income. One may expect that the

\(^5\)See, e.g., Cochrane (1991) for a complete markets model of risk sharing, and, e.g., B. Sørensen and Yosha (1998) for an aggregate level interpretation.
tax-transfer channel is particularly important in welfare states like Norway, since they are characterized by a very progressive tax system and generous transfer schemes. In addition to the tax-transfer system, we also consider public employment as a possible shock absorber (to private output growth). As discussed in the Introduction, public employment is an important instrument in the Norwegian central government’s regional policy.

Market-based channels for risk sharing include transactions, financial markets, and labor markets. Risk sharing through labor markets is related to the mobility of labor. Extensive interregional migration, in response to the slightest shock, would, for instance, quickly even-out small differences in per capita gross regional product. Likewise, large scale commuting can contribute to separate regional output growth and consumption growth. We ignore migration as a potential risk sharing device in our analysis, but we do attempt to control for commuting. Risk sharing through financial markets can occur as cross-border ownership of productive assets (typically stocks) and/or through borrowing and lending in national credit markets. As opposed to investments in stocks, credit markets can only provide insurance against transitory shocks (see, e.g., Baxter and Crucini, 1995). We include both potential channels in our analysis.6

3 The empirical model

We now briefly explain our empirical approach. It closely follows Asdrubali et al. (1996), but we focus on shocks occurring in the private sector and include public employment as a possible shock absorber. Our point of departure is the following identity:

\[ grp_{pr} = \frac{grp_{pr}}{grp} \frac{grp}{ri} \frac{ri}{dri} \frac{dri}{c}, \]

where \( grp_{pr} \) is private sector gross regional product, \( grp \) is total gross regional product, \( ri \) is regional income, \( dri \) is disposable regional income and \( c \) is regional consumption. All variables are in per capita terms. Regional income includes wages, dividends and interest, whereas disposable regional income includes (federal) taxes and transfers. By taking logs and differences, multiplying both sides with \( \Delta \log(grp) \) and taking expectations, the following

\[6\text{We do not explicitly consider international risk sharing. To the extent that Norwegian individuals or regions operate in international financial markets, it will occur in our analysis as a part of capital markets smoothing.}\]
decomposition of the variance in gross regional product can be obtained:

\[
\text{var}\{\Delta \log(\text{grp}_\text{pr})\} = \text{cov}\{\Delta \log(\text{grp}_\text{pr}), \Delta \log(\text{grp}_\text{pr}) - \Delta \log(\text{grp})\} + \text{cov}\{\Delta \log(\text{grp}_\text{pr}), \Delta \log(\text{grp}) - \Delta \log(\text{ri})\} + \text{cov}\{\Delta \log(\text{grp}_\text{pr}), \Delta \log(\text{ri}) - \Delta \log(\text{dri})\} + \text{cov}\{\Delta \log(\text{grp}_\text{pr}), \Delta \log(\text{dri}) - \Delta \log(\text{c})\} + \text{cov}\{\Delta \log(\text{grp}_\text{pr}), \Delta \log(\text{c})\}
\]

Finally, the above equation is divided by the variance of \(\Delta \log(\text{grp})\) to get:

\[
1 = \beta_P + \beta_K + \beta_F + \beta_C + \beta_U
\]

where \(\beta_P, \beta_K, \beta_F, \text{ and } \beta_C\) are the fraction of shocks to \(\text{grp}_\text{pr}\) smoothed through public output (employment), via capital markets and commuting, by the federal fiscal system, and via credit markets. \(\beta_U\) is the fraction of shocks that are not smoothed.

Unlike Asdrubali et al., we interpret \(\beta_K\) as the fraction of shocks smoothed by capital markets and commuting. This is because our source of income data (described in detail in section 4) assigns wage income to the region where earners live, which need not be the region where they work. As a consequence, our estimates of \(\beta_K\) will pick up both risk sharing through commuting and cross-regional asset ownership. Below, we attempt to control for commuting by analyzing data at two levels of aggregation, those of county and of region. Commuting between regions is much less widespread than commuting between counties.

We estimate the \(\beta\)s by running the following panel regressions:

\[
\begin{align*}
\Delta \log(\text{grp}_\text{pr}_{i,t}) - \Delta \log(\text{grp}_{i,t}) &= \alpha_P + \beta_P \Delta \log(\text{grp}_\text{pr}_{i,t}) + u_{P_{i,t}} \\
\Delta \log(\text{grp}_{i,t}) - \Delta \log(\text{ri}_{i,t}) &= \alpha_K + \beta_K \Delta \log(\text{grp}_\text{pr}_{i,t}) + u_{K_{i,t}} \\
\Delta \log(\text{ri}_{i,t}) - \Delta \log(\text{dri}_{i,t}) &= \alpha_F + \beta_F \Delta \log(\text{grp}_\text{pr}_{i,t}) + u_{F_{i,t}} \\
\Delta \log(\text{dri}_{i,t}) - \Delta \log(\text{c}_{i,t}) &= \alpha_C + \beta_C \Delta \log(\text{grp}_\text{pr}_{i,t}) + u_{C_{i,t}} \\
\Delta \log(\text{c}_{i,t}) &= \alpha_U + \beta_U \Delta \log(\text{grp}_\text{pr}_{i,t}) + u_{U_{i,t}}
\end{align*}
\]

where the \(\alpha\)s are time specific constant terms and the \(u\)s are error terms. The subscript \(i, t\) denotes region \(i\) in year \(t\). The inclusion of time dummies implies that the \(\beta\)-estimates are unaffected by shocks that are common to all regions. The estimated \(\beta\)s sum to 1, but each \(\beta\) is not constrained to be positive or less than 1.

We can now explain the intuition for why the amount of risk sharing through the different channels increases with the value of \(\beta\). If full smoothing of private sector shocks is achieved through public employment, total gross
regional product will not covary with private sector $grp$, and $\beta_P$ will equal unity. On the other hand, $\beta_P$ equals zero if no risk sharing is achieved through public employment, as private and total $grp$ growth will coincide. Risk sharing through capital markets and commuting is achieved if the co-movement of total $grp$ and $grp_{pr}$ is stronger than the co-movement between regional income and $grp_{pr}$, showing up as a positive $\beta_K$. If full risk sharing is not achieved through public employment and/or capital markets/commuting, there is further scope for risk sharing through taxes and transfers. This is achieved if the co-movement between regional income and regional gross private product is stronger than the co-movement between disposable regional income and $grp_{pr}$, giving a positive $\beta_F$. Finally, risk sharing is achieved through credit markets if the co-movement between disposable regional income and $grp_{pr}$ is stronger than the co-movement between consumption and $grp_{pr}$.

To provide a further comparison with the results of Asdrubali et al., we also estimate their system on our Norwegian data. That is, we look at shocks to total $grp$ and estimate the four lower equations in (1) as a system with $\Delta \log(grp_{i,t})$ as the right-hand-side variable.

4 Data and risk sharing statistics

4.1 Data

To conduct our empirical analyses we collect annual series of the variables in system (1) for each of the 19 Norwegian counties (the counties are listed in table 1 and in footnote 9), covering the period 1976-90. Data on $grp$ and $grp_{pr}$ were provided by Statistics Norway, and their construction is documented in K. Sørensen (1994).8

Regional income is constructed as follows. From Statistics Norway’s Tax Statistics, we collect annual taxable income in each county. This income measure includes wages, capital income, and pensions and other social security benefits. For our purpose, $ri$ should reflect what is available for consumption and saving in each region without intervention by the central government. Accordingly, we deduct pensions, unemployment benefits, disability benefits, and medical benefits from taxable income to arrive at $ri$.

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7 This is the longest span for which we have a continuous series for all six variables.
8 We should notice that all output that cannot be sensibly allocated to one of the ordinary counties (mainly output from offshore petroleum extraction and international shipping) is allocated to an ‘Extra region’ in our data source. As this region plays no role in our empirical analysis in section 5, output allocated to this region is excluded from national GDP in table 1 below.
Disposable regional income is simply regional income net of taxes and transfers. Taxes includes income and wealth taxes to local, county and national governments.

We use retail sales as a proxy for consumption, since regional consumption data are not available. These data are collected from the Wholesale and Retail Trade Statistics. It includes the sale of both durables and non-durables.

As mentioned earlier, we analyze our data at two levels of aggregation, the county level and the region level. There are 19 counties and five regions. In 1990 the population size of the counties varied from 75,000 to 460,000, whereas the population size of the regions ranged between 375,000 and 2 million. We think it is informative to undertake the analysis at two levels of aggregation, particularly because commuting and cross-border shopping is more widespread at the county level than at the regional level.

The definition and construction of the variables differ from Asdrubali et al. (1996) in one respect (apart from our separation of private and public output). This has to do with the definition of consumption and the treatment of subnational governments. The consumption measure of Asdrubali et al. includes both private consumption and state and local government consumption, whereas we only include private consumption. As a consequence, grants and taxes to subnational governments are not included in disposable regional income. The narrower definition of consumption is motivated by the Norwegian institutional context, in which local and county governments have very limited tax discretion. In principle they can choose tax rates within an interval, but during the period under study they have all used the maximum rate. We think it is less productive to analyze the total of private and subnational government consumption in a situation where subnational governments are unable to transfer resources between the private and the public sectors.

4.2 Risk sharing statistics

Based on the theory of risk sharing, as briefly discussed in section 2, we would expect to find a high degree of cross-regional consumption growth correlation in a nation with extensive regional risk sharing. If, on the other hand, the consumption growth correlations are low, and particularly if they are lower than output correlations (Backus et al., 1992), this would suggest limited interregional risk sharing.

9There are five regions (in italics), aggregated from counties as follows: East: Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark; South: V-Agder, A-Agder, Rogaland; West: Hordaland, Sogn & Fj., Møre & R.; Mid: S-Trøndelag, N-Trøndelag; North: Nordland, Troms, Finnmark. This is the same regional classification as used by Statistics Norway in official regional statistics.
In the second column of table 1, we report the correlation coefficients of changes in annual per capita private consumption \( (c) \) between all Norwegian counties and the nation minus the county in question, over the period 1977-90. These numbers are striking: the consumption growth correlations are extremely high and concentrated, with an average of 0.95. Indeed, this is much higher than can be found in any similar study we know of, international or intranational. For example, Crucini and Hess (2000) report that the corresponding average consumption correlations for Canada, Japan and the US are 0.80, 0.52, and 0.63 respectively. The correlation coefficients for total and private-sector gross regional product \( (grp) \) are reported in the third and fourth columns, respectively. The two measures of output correlation are similar in magnitude, and both vary substantially from county to county. The average output correlation between the different regions and the aggregate is 0.66 for total output and 0.69 for private output. These numbers are of the same order as those reported in Hess and Crucini’s study, where they are 0.63, 0.56, and 0.74 for Canada, Japan, and the US respectively.

[Table 1 approximately here]

Importantly, the output correlations for Norway are lower than the consumption growth correlations for all counties. The '*' in columns three and four indicate the output correlations that are significantly lower than the corresponding consumption correlation, at the 5% level. For private (total) grp the difference is significant in 13 (15) of the 19 counties. Again, this implies that Norway stands out in comparison to the countries in Hess and Crucini’s study, which reports that Japanese and US regions have higher output correlations than consumption correlations. The opposite is true for Canada, but here the difference is statistically insignificant.

Figure 1 presents the full set of bilateral consumption correlations for all 19 counties plotted against the corresponding private grp correlations. According to the theory of perfect risk sharing, the data points should lie above the 45-degree line. This is very much the pattern in figure 1. While the bilateral private grp growth correlations are relatively evenly spread out between 0 and 0.9 (the average is 0.51), the corresponding consumption correlations are concentrated between 0.85 and 0.95 (the average is 0.92).

[Figure 1 approximately here]

Taking table 1 and figure 1 at face value, the risk sharing implications are straightforward: the low output correlations suggest that there is a significant potential for regional insurance in Norway, and the consumption correlations indicate that this has been achieved to a large extent. Compared to other countries, Norway stands out as having very high interregional consumption
correlations, while the output correlations are more in line with findings for other countries. But, of course, simple correlation coefficients are insufficient to allow firm conclusions to be drawn. We leave such conclusions to follow the econometric analysis below.

However, one concern should be raised at this point. It may be that the highly unusual results reflect measurement errors. If the output data are measured with errors, the reported correlations for output are much lower than the correct correlations. Hence, the apparently high degree of risk sharing in Norway may be due to better consumption data and worse output data than elsewhere. In order to investigate this we use formulas from Hess and Shin (1998) and Crucini and Hess (2000) to see how large the measurement errors in output data must be to reverse the inequalities between consumption and output correlations. Based on the same premises as those of Hess and Shin (1998, p.298), and assuming no measurement errors in consumption data, we can show that the following inequality must hold:

$$\frac{\sigma_\eta}{\sigma_y} \geq 1 - \frac{\text{corr}(\text{grp}_i, \text{grp}_j)}{\text{corr}(c_i, c_j)}$$

if consumption correlations are higher than measured output correlations, while being lower than the true output correlations. In this equation, $\sigma_\eta$ and $\sigma_y$ are the standard deviations of the measurement error and measured output growth (both assumed to be equal across regions), while the correlations are for two arbitrary regions $i$ and $j$. If we let $\text{corr}(\text{grp}_i, \text{grp}_j)$ and $\text{corr}(c_i, c_j)$ take the average values of the private output correlations and the consumption correlations reported in table 1, we find that $\frac{\sigma_\eta}{\sigma_y} \geq 0.72$. Therefore, in order for the output data measurement errors just to equate the average correlations of consumption and private output, more than 70 percent of all the variance in measured private output growth must be due to measurement error. This fraction would only increase if we also allow for (likely) measurement errors in consumption. Although we cannot rule out such severe measurement errors, they seem quite unlikely with annual data. Furthermore, we will also present some results for 'long-term' risk sharing below, and any measurement errors should be less serious in those analyses.

5 Econometric results

5.1 Baseline regressions

We start out by estimating (1) and (2) for our two levels of aggregation, using OLS. The results from these regressions are displayed in table 2. Several aspects of these results are worth commenting upon.
First, the analyses indicate that there is close to full regional risk sharing, regardless of the model specification or the aggregation level. Second, public employment is an important channel of risk sharing. The fraction of private sector shocks smoothed through public employment is estimated to be 17% at the county level and 20% at the region level. Third, the combined smoothing effects of capital markets and commuting are even more important, absorbing 70% or more of shocks to private grp according to these results. Within the Asdrubali et al. approach (where we analyze shocks to total grp), this channel absorbs over 90% of a shock, but then it also picks up the public employment channel. Fourth, taxes and transfers seem to be relatively unimportant, absorbing less than 8% in any of the baseline regressions.

The results in table 2 are based on simple OLS regressions. Asdrubali et al. (1996) use a slightly different estimation technique, whereby they correct for heteroskedasticity and estimate the equations as a system in the second step. When we apply the same method, the estimates are very similar to those reported in table 2. At the county level the difference between the two methods is always less than 1 percentage point. The differences are somewhat larger at the regional level (2-3 percentage points). Mélitz and Zumer (1999) propose other extensions of the Asdrubali et al. model. They remove the time dummies from the model and include a set of controls capturing the regional business cycle, regional size, the real interest rate and an index of persistence. In addition they use a predetermined value of $\beta_U$ calculated as the ratio between the variance of consumption and the variance of output. When we use this approach, it appears that the amount of a shock that remains unsmoothed is not much affected. It is first and foremost the composition of market-based smoothing that changes. The amount of smoothing through capital markets & commuting is even higher than in table 2, whereas smoothing through credit markets becomes negative and in the order of 10-35%. We find these estimates rather implausible, and given that the OLS estimates are very similar to those obtained using the method of Asdrubali et al., we rely on OLS in the following.10

5.2 Long-term risk sharing and measurement errors

The impression from the analysis above is that, compared to other countries, Norway has an extremely high degree of regional risk sharing, with capital markets & commuting as the dominating channel(s). The results basically

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10 The results discussed in this paragraph are available from the authors upon request.
reflect that the annual correlation between \(\text{grp}\) growth and the growth of regional income is fairly low. The average of the annual correlations is 0.20 between regional income growth and private \(\text{grp}\) growth, and 0.14 between regional income growth and total \(\text{grp}\) growth. Moreover, consumption growth is practically uncorrelated with the growth of private and total \(\text{grp}\) (correlation coefficients of 0.04 and 0.01), and only weakly correlated with regional income and disposable regional income (correlation coefficients of 0.22 and 0.18).

As mentioned earlier, a possible concern is that these low correlations reflect measurement errors in the data for gross regional product. We expect that such measurement error is more serious in the short-term than in the longer term. Hence, it is useful to repeat the analysis above using a longer differencing interval. This also provides an indication of which risk sharing mechanisms are better suited for smoothing permanent shocks.

[Table 3 approximately here]

In table 3 we investigate whether the amount of smoothing and its composition are affected by the frequency of the data used in the regressions (county level). When \(k=2\), the differencing interval is two years and the data set includes the growth rates for the periods 1977-79, 1978-80, ..., 1988-90. The total amount of smoothing decreases as the frequency of the data increases. For \(k=5\) the total amount of smoothing is about 80%, compared to 100% for \(k=1\). It should be noted, however, that 80% is still very high compared to other countries (see, e.g., Crucini and Hess, 2000). Government smoothing (public employment and taxes & transfers) increases as the differencing interval increases, whereas the opposite is the case for the market-based channels (capital markets & commuting and credit markets).

[Table 4 approximately here]

Analyses at the regional level with different frequencies of the data are reported in table 4. In most respects, the results are similar to those of table 3: as the differencing interval increases, government smoothing increases and market-based smoothing decreases. Moreover, total smoothing is reduced as the drop in market-based smoothing is larger than the increase in government smoothing. The finding that total smoothing decreases as shocks become more permanent is in line with Asdrubali et al. (1996). In addition, the quantitative impact of the increased differencing interval is similar. Our estimates indicate that the fraction of a shock that remains unsmoothed increases by 20% points as the differencing interval increases from one to five years. Asdrubali et al. (1996) estimate the increase to be 17% points. On the other hand, we find a sharper increase in the importance of govern-
ment smoothing and a sharper decline in the importance of market-based smoothing.

The county and region results in tables 3 and 4 differ in one important respect. As the growth horizon increases, the estimate of $\beta_K$ (the fraction of the shock smoothed by capital markets & commuting) drops much faster at the regional level. With $k = 5$, this estimate at the regional level is less than half the corresponding estimate at the county level. Given that the long-run analysis may be more reliable, this suggests that commuting may indeed be an important part of the high estimates of $\beta_K$ at the county level. Finally, for $k = 4$ and $k = 5$ at the regional level, the combined smoothing effects of public employment and taxes & transfers are larger than the total market-based smoothing effects.

Concentrating on the regional level analysis, it appears that the comparison with the US study of Asdrubali et al. (1996) changes as the differencing interval increases. When the differencing interval is one year, Norway stands out with an extremely high degree of regional risk sharing and with capital markets & commuting as the most important channels. When the differencing interval is five years, Norway still comes out with a higher degree of risk sharing than the US (80% versus 60%), but government smoothing is now twice as important as the market-based channels of smoothing.

5.3 Discussion

Regardless of the aggregation level, the estimation method, or the differencing length of the data, our results indicate extremely high interregional risk sharing in Norway, compared to other countries. Several factors may help explain this result. First, measurement errors in the output data may play a role. However, both the statistics reported in section 4.2 and the results from the long-term regressions suggest that measurement errors alone cannot overturn the main thrust of our results.

Second, (economic) size may matter.\footnote{We owe this explanation to an anonymous referee.} As mentioned in section 4.2, Crucini and Hess (2000) report that the US and (to a lesser extent) Japan have higher regional output correlations than consumption correlations, while Canada has (insignificantly) higher consumption correlations. We have shown that Norway has much higher consumption correlations than output correlations. Hence, it seems that the amount of interregional risk sharing may be negatively related to the size of the country, or the country’s regions, involved in the analysis. (We also recall that international risk sharing is generally reported to be smaller than that within the US.)
A third, and related, explanation is that there may be more commuting (and cross-border shopping) between Norwegian counties than takes place in other countries with larger regions. A comparison of tables 3 and 4 shows that, for the long-run analysis (where measurement errors are smallest), the estimate of $\beta_K$ is much smaller at the regional level, where commuting is less widespread. This suggests that commuting may partly explain the extremely high estimates of $\beta_K$ at the county level.

Last, but not least, our results demonstrate that public employment is an important channel for cross regional insurance in Norway. To the extent that governments in other countries use this vehicle less actively than it is use in Norway, this can contribute to a higher degree of risk sharing in Norway. We believe that this is a plausible explanation, but since we are the first to include this channel we do not have the opportunity to make comparisons.

Further, the results above can leave the impression that capital markets are a more important channel for risk sharing in Norway than in, for example, the US. This would probably strike many as odd. We should notice, however, that the combined effects of size, commuting and possible measurement errors can be responsible for this impression. The last column of table 4 illustrates our point. The results are for the highest level of aggregation (less size effect and commuting), and for the longest differencing interval (smallest measurement errors). The estimated fraction absorbed by capital markets & commuting is 'only' 23% in this case. The corresponding estimate for the US states is 36%, (Asdrubali et al., 1996, table IV). Thus, the high estimates of $\beta_K$ should not necessarily be taken as evidence of much higher capital market integration in Norway.

6 Conclusions

We have estimated the degree and sources of regional risk sharing in Norway over the period 1977-90. The approach of Asdrubali et al. (1996) is extended to take account of public employment as a possible shock absorber. It turns out that this is indeed an important channel for risk sharing. The fraction of a private sector shock smoothed through public employment is in the order of 20-25 percent. Moreover, all our results indicate there is a substantial amount of cross-regional insurance taking place in Norway. Regardless of the aggregation level, the estimation method or the differencing length, less than 20 percent of a regional shock is unsmoothed.
References


Table 1: Basic cross-regional correlation coefficients, 1977-90.

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<thead>
<tr>
<th>County</th>
<th>$c$</th>
<th>$grp$</th>
<th>$grp$ (private)</th>
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<td>0.69*</td>
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<td>0.87</td>
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<tr>
<td>Vest Agder</td>
<td>0.96</td>
<td>0.51*</td>
<td>0.49*</td>
</tr>
<tr>
<td>Rogaland</td>
<td>0.96</td>
<td>0.37*</td>
<td>0.43*</td>
</tr>
<tr>
<td>Hordaland</td>
<td>0.94</td>
<td>0.84</td>
<td>0.86</td>
</tr>
<tr>
<td>Sogn &amp; Fj.</td>
<td>0.93</td>
<td>0.10*</td>
<td>0.22*</td>
</tr>
<tr>
<td>More &amp; R.</td>
<td>0.97</td>
<td>0.72*</td>
<td>0.74*</td>
</tr>
<tr>
<td>Sør Trøndelag</td>
<td>0.95</td>
<td>0.50*</td>
<td>0.58*</td>
</tr>
<tr>
<td>Nord Trøndelag</td>
<td>0.94</td>
<td>0.82</td>
<td>0.91</td>
</tr>
<tr>
<td>Nordland</td>
<td>0.96</td>
<td>0.76*</td>
<td>0.84*</td>
</tr>
<tr>
<td>Troms</td>
<td>0.97</td>
<td>0.64*</td>
<td>0.56*</td>
</tr>
<tr>
<td>Finnmark</td>
<td>0.94</td>
<td>0.43*</td>
<td>0.44*</td>
</tr>
</tbody>
</table>

Unweighted average: 0.95, 0.66, 0.69

Notes: The reported correlation coefficients are averages for the period 1977-1990. A * denotes that the $grp$-correlation is significantly lower than the consumption correlation at the 5% level.
Table 2: Channels and degree of regional risk sharing using the method of Asdrubali et al. and our extended approach

<table>
<thead>
<tr>
<th></th>
<th>Extended approach</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>County</td>
<td>Region</td>
<td>County</td>
</tr>
<tr>
<td>Public employment</td>
<td>0.175</td>
<td>0.198</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(10.58)</td>
<td>(3.90)</td>
<td></td>
</tr>
<tr>
<td>Capital markets/commuting</td>
<td>0.770</td>
<td>0.676</td>
<td>0.944</td>
</tr>
<tr>
<td></td>
<td>(27.21)</td>
<td>(8.05)</td>
<td>(36.20)</td>
</tr>
<tr>
<td>Taxes &amp; transfers</td>
<td>0.025</td>
<td>0.082</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>(2.38)</td>
<td>(3.10)</td>
<td>(1.84)</td>
</tr>
<tr>
<td>Credit markets</td>
<td>0.020</td>
<td>0.061</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(0.63)</td>
<td>(0.98)</td>
<td>(0.85)</td>
</tr>
<tr>
<td>Not smoothed</td>
<td>0.009</td>
<td>-0.017</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(-0.27)</td>
<td>(0.07)</td>
</tr>
</tbody>
</table>

*Note:* The table reports OLS estimates with t-values in parentheses. Time dummies (not reported) are included in all equations. The estimation period is 1977-90, i.e. we have a total of 266 observations at the county level and 70 at the regional level.
Table 3: Channels and degree of regional risk sharing with varying differencing interval, county level

<table>
<thead>
<tr>
<th></th>
<th>k=1</th>
<th>k=2</th>
<th>k=3</th>
<th>k=4</th>
<th>k=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public employment</td>
<td>0.175</td>
<td>0.182</td>
<td>0.194</td>
<td>0.210</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>(10.58)</td>
<td>(11.90)</td>
<td>(12.42)</td>
<td>(12.08)</td>
<td>(12.78)</td>
</tr>
<tr>
<td>Capital markets/commuting</td>
<td>0.770</td>
<td>0.738</td>
<td>0.645</td>
<td>0.548</td>
<td>0.522</td>
</tr>
<tr>
<td></td>
<td>(27.21)</td>
<td>(23.93)</td>
<td>(19.78)</td>
<td>(15.10)</td>
<td>(14.09)</td>
</tr>
<tr>
<td>Taxes &amp; transfers</td>
<td>0.025</td>
<td>0.052</td>
<td>0.099</td>
<td>0.137</td>
<td>0.148</td>
</tr>
<tr>
<td></td>
<td>(2.38)</td>
<td>(4.03)</td>
<td>(6.75)</td>
<td>(8.51)</td>
<td>(8.71)</td>
</tr>
<tr>
<td>Credit markets</td>
<td>0.020</td>
<td>-0.003</td>
<td>-0.029</td>
<td>-0.049</td>
<td>-0.087</td>
</tr>
<tr>
<td></td>
<td>(0.63)</td>
<td>(-0.08)</td>
<td>(-0.81)</td>
<td>(-1.17)</td>
<td>(-1.96)</td>
</tr>
<tr>
<td>Not smoothed</td>
<td>0.009</td>
<td>0.031</td>
<td>0.091</td>
<td>0.154</td>
<td>0.188</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(0.93)</td>
<td>(2.47)</td>
<td>(3.71)</td>
<td>(4.32)</td>
</tr>
</tbody>
</table>

Note: The table reports OLS estimates with t-values in parentheses. Time dummies (not reported) are included in all equations. The estimation period is 1977-90 and the total number of observations is 266 for k=1, 247 for k=2, etc.
Table 4: Channels and degree of regional risk sharing with varying differencing interval, regional level

<table>
<thead>
<tr>
<th></th>
<th>k=1</th>
<th>k=2</th>
<th>k=3</th>
<th>k=4</th>
<th>k=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public employment</td>
<td>0.198</td>
<td>0.150</td>
<td>0.216</td>
<td>0.217</td>
<td>0.250</td>
</tr>
<tr>
<td></td>
<td>(3.90)</td>
<td>(3.18)</td>
<td>(4.60)</td>
<td>(4.23)</td>
<td>(4.48)</td>
</tr>
<tr>
<td>Capital markets/commuting</td>
<td>0.676</td>
<td>0.686</td>
<td>0.475</td>
<td>0.317</td>
<td>0.233</td>
</tr>
<tr>
<td></td>
<td>(8.05)</td>
<td>(7.82)</td>
<td>(6.45)</td>
<td>(4.20)</td>
<td>(2.95)</td>
</tr>
<tr>
<td>Taxes &amp; transfers</td>
<td>0.082</td>
<td>0.124</td>
<td>0.206</td>
<td>0.261</td>
<td>0.274</td>
</tr>
<tr>
<td></td>
<td>(3.10)</td>
<td>(3.95)</td>
<td>(6.19)</td>
<td>(7.73)</td>
<td>(7.09)</td>
</tr>
<tr>
<td>Credit markets</td>
<td>0.061</td>
<td>0.036</td>
<td>0.019</td>
<td>0.074</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(0.98)</td>
<td>(0.54)</td>
<td>(0.26)</td>
<td>(0.85)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Not smoothed</td>
<td>-0.017</td>
<td>0.004</td>
<td>0.085</td>
<td>0.131</td>
<td>0.195</td>
</tr>
<tr>
<td></td>
<td>(-0.27)</td>
<td>(0.62)</td>
<td>(1.12)</td>
<td>(1.47)</td>
<td>(2.00)</td>
</tr>
</tbody>
</table>

*Note:* The table reports OLS estimates with t-values in parentheses. Time dummies (not reported) are included in all equations. The estimation period is 1977-90 and the total number of observations is 70 for k=1, 65 for k=2, etc.
Figure 1: Cross-county correlations of private output and consumption growth.

Notes: The points in the diagram represent private output growth correlation and consumption correlation for all 171 (19 x 18) pairs of Norwegian counties, over the period 1977-1990.