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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 Yosha (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. Surprisingly, there seems to be full interregional risk sharing in the short run, with public employment absorbing about 20 % of regional shocks to private output. The combined effect of capital markets & commuting is even more important, however, absorbing up to 70 % of regional shocks. In the longer run, a significant fraction of regional shocks remain unsmoothed. Government smoothing increases and market based smoothing decreases as shocks become more permanent.

1 Introduction

How much risk sharing is there between nations and between regions within a country? What are the most important channels for the risk sharing that takes place? These two questions has been subject to extensive research in the past few years. The interest in issues relating to risk sharing at the aggregate level stems partly from the continuing integration of national capital markets, and partly from the process of monetary integration in Europe. The possibility of pooling nation specific risks is one of the primary arguments in favor of international financial integration, making it important to

establish whether and to what extent risk sharing occurs in international financial markets. This issue is of particular importance for the EMU countries, since the elimination of a national monetary policy and the current restrictions on national budget deficits generate a need for other mechanisms to tackle country specific shocks.

A dominant finding in existing research is that risk sharing between countries (including the EMU nations) is limited. This is apparent both through the home country bias in asset portfolios (e.g. French and Poterba, 1991; Tesar and Werner, 1995), and the low cross national consumption correlations documented by e.g. Obstfeld (1994) and Obstfeld and Rogoff (1996). More direct evidence on the limited risk sharing between nations can be found in B. Sørensen and Yosha (1998).

Existing studies of regional, or intranational, risk sharing indicate that there is more risk sharing taking place at this level. Asdrubali *et al.* (1996), Athanasoulis and van Wincoop (1998), and Mèlitz and Zumer (1999) all report that the amount of interstate risk sharing in the US is substantial, and much larger than what is found in international data. Similar results are reported for Canada by Bayoumi and Klein (1997) and Mèlitz and Zumer (1999)[1], and for Japan by van Wincoop (1995).

An interesting aspect by some of the regional studies, is that they decompose the contribution to the reduction in the cross sectional covariance between output and consumption into different channels. These channels can be divided into two main categories: First, insurance mechanisms inherent in the policy of the federal government, e.g. the tax-transfer system and grants to local governments. Second, market transactions that provide regional insurance via, for instance, cross-ownership of stocks and borrowing/lending in national credit markets.[2] Asdrubali *et al.* (1996) and Athanasoulis and van Wincoop (1998) find that interstate risk sharing in the US takes place dominantly through markets. Using somewhat different techniques for measuring, both papers find that the amount of regional market insurance is about 5 times larger than the cross-state insurance provided by the federal government.

In this paper we study the amount and channels of interregional risk sharing in Norway. We argue that the lessons for Europe from the US studies can be limited because the US has much larger capital markets and smaller central government budgets relative to the size of the economy. To

[1] Mèlitz and Zumer (1999) does also report results for Italy and the UK, but, in their own words, "..the model performs badly in the UK and Italy..." (p. 181).

[2] Financial markets are not the only markets where regional shocks can be absorbed. The labor market does also provide such opportunities through e.g. migration or commuting. More on this later.

learn something about the amount and type of regional insurance one can achieve in an economy with large governments, we believe that Norway is an instructive case. Moreover, regional redistribution has been, and continues to be, an important political aim in Norway. Arguably, even more so than in other European countries. Hence, our analysis can also be viewed as an assessment of how successful this policy has been in terms of providing equal consumption opportunities for the inhabitants in different parts of the nation.

We extend the analysis of Asdrubali *et al.* (1996) to take account of public employment as a possible shock absorber. In Norway and other countries, we believe that regions that experience a bad private sector shock are often compensated by higher employment in the public sector. In addition to the approach of Asdrubali *et al.*, we thus also use an alternative approach where shocks occur in the private sector and where output in the public sector (public employment) is viewed as a shock absorber.

Surprisingly, our analysis indicate full interregional risk sharing in the short run. And, public employment is indeed an important channel of regional risk sharing, with 20 % of a shock absorbed by this channel in our short run analysis. The combined effect of capital market smoothing and commuting is even more important though, with up to 70 % of a shock absorbed by this channel in the short run. We would like to stress, however, that the latter estimate may be upwardly biased due to possible measurement errors in our data for gross regional product.

In the longer run, measurement errors is less of a concern. Our long run analysis' show that a significant fraction of regional shocks remain unsmoothed. Moreover, federal insurance mechanisms become more important (with public employment absorbing up to 25 % of a shock), while market based risk sharing appears to decrease. Transactions in capital markets still absorbs close to 25 % of a regional shock in our long run analysis, however. This is lower than the corresponding US estimate in Asdrubali *et al.* (1996), but still high enough to reject our *a-priori* expectation that capital markets would be relatively unimportant in Norway.

The next section lay out and discuss a simple model of regional risk sharing. Section 3 reports some important descriptive statistics from the Norwegian data. In section 4 we discuss and extend the empirical model of Asdrubali *et al.* (1996), while section 5 describes our data. Finally, our results are reported in section 6, and then we conclude in section 7.

2 The principles and channels of aggregate risk sharing

Consider a nation consisting of I regions, $i = 1, ..I$. In each region there is a representative agent with log utility defined over an aggregate consumption good and infinite time horizon. In each period t there is a set of possible states of nature S_t with elements denoted s_t. The transition between outcomes s follows a Markov-process; the probability of outcome s_t (denoted $\pi(s_t)$) depends only on the realized value s_{t-1} and possibly on time. Output of the consumption good in region i in period t is denoted $y_i(s_t)$ and is an exogenous stochastic variable. Let $c_i(s_t)$ be consumption in region i in period t. If there are no sharing of output risk among the regions we would have

$$c_i(s_t) = y_i(s_t), \qquad \forall t, s, i.$$

Thus the "autarky" solution would imply that consumption would move one-to-one with gross *regional* product over time.

The opposite case of autarky is an economy with complete markets. This means that there exists a national Arrow-Debreu market for the delivery of the consumption good for each outcome and period. Let $p(s_t)$ be the price of a claim on the consumption good with outcome s in period t. Each region's intertemporal budget constraint can thus be written as

$$\sum_{t=0}^{\infty}\sum_{s=1}^{S} p(s_t)y_i(s_t) = \sum_{t=0}^{\infty}\sum_{s=1}^{S} p(s_t)c_i(s_t), \qquad i = 1, .., I \tag{1}$$

The representative agent in region i maximize

$$\sum_{t=0}^{\infty}\beta^t\sum_{s=1}^{S}\pi(s_t)\log c_i(s_t)$$

subject to (1), and where β is the (common across regions) discount factor. The first-order conditions are

$$\beta^t\pi(s_t)\frac{1}{c_i(s_t)} - \lambda_i p(s_t) = 0, \qquad \forall t, s, i, \tag{2}$$

where λ_i is a Lagrange multiplier. Market clearing implies that

$$\sum_{i=1}^{I} y_i(s_t) = \sum_{i=1}^{I} c_i(s_t), \qquad \forall t, s. \tag{3}$$

By combining (2) and (3), it can be shown that consumption in region i is given by

$$c_i(s_t) = k_i \sum_i y_i(s_t), \qquad \forall t, s,$$

where k_i is a constant. Thus, in each period every region consumes a constant fraction of GDP, regardless of the realized state of nature. Consumption would move one-to-one with gross *domestic* product over time. When there is partial risk sharing, regional consumption will depend on gross regional product as well as GDP.

There are several mechanisms for sharing output risk among regions. A main distinction is between market transactions and transactions across regions that are implemented by the central government. Market based channels can, in turn, be split into transactions in financial markets and labor markets. Risk sharing through labor markets is related to the mobility of labor. Extensive interregional migration, responding 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 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.[3]

Unless complete insurance can be achieved through markets, the regional tax-transfer policies of the central government will have an effect on the degree of risk sharing. This will be the case even if the policies primarily intends to achieve redistributive goals (Sala-i-Martin and Sachs, 1992). In addition to the tax-transfer system, we also consider public employment as a possible shock absorber (to private output growth). The motivation for this is discussed in more detail in section 4.[4]

[3] We do not explicitly consider international risk sharing. To the extent that Norwegian individuals or regions operate in international financial markets, it will occour as a part of capital markets smoothing in our analysis.

[4] Notice that we ignore the potential utility smoothing effect of local public goods provided by the central government. If depressed regions are compensated with more public goods, we are thus underestimating the risk sharing role of the central government.

3 A preliminary look at the data

Based on the model 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), it would suggest limited intraregional risk sharing.

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 1976-90.[5] These numbers are striking: The consumption growth correlations are extremely high and concentrated, with a minimum of 0.92 and a maximum of 0.98. Indeed, this is much higher than found in any similar study we know of, be that inter- or intranational. The corresponding coefficients for gross regional product (grp) is reported in the third column. They vary substantially from county to county, and are lower than the consumption growth correlations for all counties. In section 6 we will also study to what extent shocks to private sector output are smoothed. The last column of table 1 reports correlations between private-sector grp growth in county i and the rest of the nation. These are similar in magnitude to the total grp correlations, with a slightly smaller average.

Taking these numbers 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. But of course, simple correlation coefficients are insufficient to draw firm conclusions. We leave that until the econometric analysis below.

[Table 1 approximately here]

Table 2 reports unweighted average correlation coefficients between region i and the rest of the nation for several economic variables, over the 1977-90 period. The variables are (the growth rates of) the private sector's share of gross regional product (grp_p), regional income (ri), and disposable regional income (dri). For the sake of comparison, coefficients for total gross regional

[5] As consumption data we use annual regional retail sales, complied by Statistics Norway. The same source provided us with data for gross county product for the period 1975-90. We should notice that all output that cannot be sensibly allocated to one of the ordinary counties (mainly from offshore petroleum extraction an international shipping) are allocated to an 'Extra region'. As this region plays no role in our empirical analysis in section 6, output allocated to this region is excluded from national GDP in tables 1 and 2. See section 5 for a detailed description of the data used in this paper.

product and consumption are also included.[6] Notice that we display the numbers for two levels of aggregation, counties and regions.[7]

[Table 2 approximately here]

The general pattern is that all variables are positively correlated across regions. The coefficients are particularly high and concentrated for the income variables and consumption. Hence, there seems to more idiosyncratic variation in regional output growth than in regional income growth. This is also a rough indication that there are indeed risk sharing in some form between the Norwegian regions.

4 The empirical model

The empirical analysis carried out in this paper is an application and an extension of the approach of Asdrubali *et al.* (1996). Their point of departure is the following identity

$$grp = \frac{grp}{ri}\frac{ri}{dri}\frac{dri}{c}c$$

where grp is gross regional product, ri is regional income, dri is disposable regional income and c is regional consumption. Regional income includes wages, dividend and interest, whereas disposable regional income includes (federal) taxes and transfers. All variables are measured per capita. By taking logs and differences, multiplying both sides with $\Delta \log(grp)$ and taking expectations, the following decomposition of the variance in gross regional product can be obtained:

$$\begin{aligned} var\left\{\Delta \log(grp)\right\} &= cov\left\{\Delta \log(grp), \Delta \log(grp) - \Delta \log(ri)\right\} \\ &\quad + cov\left\{\Delta \log(grp), \Delta \log(ri) - \Delta \log(dri)\right\} \\ &\quad + cov\left\{\Delta \log(grp), \Delta \log(dri) - \Delta \log(c)\right\} \\ &\quad + cov\left\{\Delta \log(grp), \Delta \log(c)\right\} \end{aligned}$$

[6] Notice that table 2 is based on growth rates over the period 1977-90, while table 1 was for 1976-90. Our income data is available only from 1976 (giving us growth rates from 1977), and so we report numbers from this period in table 2.

[7] There are five regions, 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 Statisitics Norway in official regional statistics.

Finally, the above equation is divided by the variance of $\Delta \log(grp)$ to get

$$1 = \beta_K + \beta_F + \beta_C + \beta_U$$

where β_K is the fraction of a shock that is smoothed through capital markets, β_F the fraction that is smoothed by (federal) taxes and transfers, β_C the fraction that is smoothed through credit markets, and β_U the fraction that is not smoothed.

Asdrubali *et al.* (1996) estimate the β's by running the following panel regressions

$$\begin{aligned}
\Delta \log(grp_{i,t}) - \Delta \log(ri_{i,t}) &= \alpha_{Kt} + \beta_K \Delta \log(grp_{i,t}) + u_{Ki,t} \\
\Delta \log(ri_{i,t}) - \Delta \log(dri_{i,t}) &= \alpha_{Ft} + \beta_F \Delta \log(grp_{i,t}) + u_{Fi,t} \\
\Delta \log(dri_{i,t}) - \Delta \log(c_{i,t}) &= \alpha_{Ct} + \beta_C \Delta \log(grp_{i,t}) + u_{ci,t} \\
\Delta \log(c_{i,t}) &= \alpha_{Ut} + \beta_U \Delta \log(grp_{i,t}) + u_{Ui,t}
\end{aligned}$$

where the α'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 β-estimates are unaffected by shocks that are common to all regions. The estimated β's sum to 1, but each β is not constrained to be positive or less than 1.

As mentioned above, the amount of smoothing that takes place through the different channels increases with the value of β. The intuition can be explained in the following way: If full risk sharing is achieved through capital markets, regional income will not comove with gross regional product, and β_K will be equal to unity. On the other hand, if no risk sharing is achieved through capital markets, regional income growth coincides with the growth in gross regional product, and β_K equals zero. If full risk sharing is not achieved through capital markets, there is further scope for risk sharing through taxes and transfers. Risk sharing through taxes and transfers is achieved if the comovement between regional income and regional gross product is stronger than the comovement between disposable regional income and regional gross product, which will show up as a positive β_F. Finally, risk sharing is achieved through credit markets if the comovement between disposable regional income and gross regional product is stronger than the comovement between consumption and gross regional product.

Within the approach of Asdrubali *et al.* (1996) shocks are related to gross regional product, and they do not separate between the private and the public sector. In the Norwegian context it may be more productive to use a more narrow definition of shocks since public employment is an important instrument in the national government's regional policy. Regions that are

hit by negative private output shocks are typically compensated by higher employment in the public sector. The expansion of public employment is facilitated by grants to local and county governments, and by locating national government agencies in regions with slow growth in the private sector.

In addition to the approach of Asdrubali *et al.*, we use an alternative approach where shocks are related to gross regional product in the private sector and where gross regional product in the public sector (public employment) is treated as a shock absorber. Within the alternative approach, the point of departure is the following identity

$$grp\_pr = \frac{grp\_pr}{grp}\frac{grp}{ri}\frac{ri}{dri}\frac{dri}{c}c$$

where grp_pr denotes gross regional product in the private sector. The panel regressions to be estimated are as follows

$$\begin{aligned}
\Delta\log(grp_pr_{i,t}) - \Delta\log(grp_{i,t}) &= \alpha_{Pt} + \beta_P\Delta\log(grp_pr_{i,t}) + u_{Pi,t} \\
\Delta\log(grp_{i,t}) - \Delta\log(ri_{i,t}) &= \alpha_{Kt} + \beta_K\Delta\log(grp_pr_{i,t}) + u_{Ki,t} \\
\Delta\log(ri_{i,t}) - \Delta\log(dri_{i,t}) &= \alpha_{Ft} + \beta_F\Delta\log(grp_pr_{i,t}) + u_{Fi,t} \\
\Delta\log(dri_{i,t}) - \Delta\log(c_{i,t}) &= \alpha_{Ct} + \beta_C\Delta\log(grp_pr_{it,}) + u_{ci,t} \\
\Delta\log(c_{i,t}) &= \alpha_{Ut} + \beta_U\Delta\log(grp_pr_{i,t}) + u_{Ui,t}
\end{aligned}$$

where β_P is the fraction of a shock that is smoothed through public employment.

5 Data

Statistics Norway provided us with data on gross county product for the 19 counties, over the period 1973-90.[8] A documentation on how these data are constructed can be found in K. Sørensen (1994).

The starting point for calculating regional income is taxable income from the Tax Statistics. Taxable income includes wages, pensions and other social security benefits, interest and dividend, less of deductions (e.g. interest payments). For our purpose, regional income should be defined as taxable income less of pensions and other social security benefits provided by the federal government. Hence, we have deducted pensions, unemployment benefits, disability benefits and medical benefits from taxable income to arrive

[8] We us only the time span 1976-90 since income data are unavilable prior to 1976. Likewise, we do have data on gross county product for 1992 and 1993, but not for 1991. We have chosen to analyze only the period for which we have a continous series.

at regional income. Disposable regional income is simply taxable income minus taxes, i.e. regional income net of taxes and transfers. Taxes includes income and wealth taxes to local, county and national government.

The Tax Statistics is based on place of residence, i.e. wage income is assigned to the region where the employees live, and not necessarily to the region where they work. As a consequence, what we labeled capital market smoothing in the previous section will also include smoothing through commuting between regions. Below, we attempt to control for commuting by analyzing data at two levels of aggregation, county and regional. Commuting between regions is much less widespread than between counties.

The consumption figures are collected from the Wholesale and Retail Trade Statistics, and retail sales are used as a proxy for consumption. Both durable and nondurable consumption goods are included.

The empirical analysis is based on data for the period 1976-1990 (giving growth rates from 1977), and is carried out at two levels of aggregation. The lowest level is the county level and the highest is the regional level. There are 19 counties and 5 regions. In 1990 the population size of the counties varied from 75 000 to 460 000, whereas the population size of the regions varied from 375 000 to 2 000 000. We think it is informative to do 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 largely follows Asdrubali *et al.* (1996). The main differences are the definition of consumption and the treatment of subnational governments. The consumption measure of Asdrubali *et al.* includes both private and state and local government consumption, whereas we, as Melitz and Zumer (1999) in their analyses of Italy and the UK, only include private consumption. As a consequence, grants and taxes to subnational governments are not included in disposable regional income. The more narrow definition of consumption is motivated by the Norwegian institutional context where 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.

6 Results

We start out by presenting the results for the two levels of aggregation and with the approach of Asdrubali *et al.* and our extended approach. These results are displayed in Table 3, where the equations are estimated with OLS. Analyses at the county level with the Asdrubali *et al.* approach indicate that there is full risk sharing and that most of the smoothing (94%) takes place through capital markets / commuting. Credit markets accounts for nearly 5% and taxes & transfers for a mere 1.5%. Our estimates are quite different from those of Asdrubali *et al.* (1996) for the US states. They find 39% smoothing through capital markets, 13% through (federal) taxes and transfers, 23% through credit markets, and that 25% of a shock remains unsmoothed. One might suspect that commuting and cross border shopping explains our high estimate of smoothing through capital markets / commuting and the low estimate of non-smoothing. Similar analysis at the regional level, where commuting and cross border shopping are less widespread, does not support this hypothesis as the results based on regional level data is very similar to those based on county level data. At both levels of aggregation there is no evidence of non-smoothing and nearly 90% smoothing is achieved through capital markets / commuting. However, compared to the analysis at the county level, the regional level analysis indicates that taxes & transfers and credit markets are more important channels of risk sharing.

[Table 3 approximately here]

The extended approach documents that public employment is an important channel of risk sharing. The amount of smoothing through public employment is 17% when the model is estimated at the county level and nearly 20% when the model is estimated at the regional level. Still, a substantial part of smoothing (70% or more) takes place through capital markets / commuting and the total amount of smoothing is roughly 100%.

The results discussed so far are based on simple OLS regressions. Asdrubali *et al.* (1996) use a slightly different estimation technique where they correct for heteroskedasticity and estimate the equations as a system in the second step. The results from using their estimation method are reported in Table A1 of the Appendix. The 'consumption equation' is left of the estimation and β_U is calculated based on the estimates of the other $\beta's$ and the identity that the sum of the $\beta's$ equals unity. It appears that the estimates using the method of Asdrubali *et al.* is very similar to the estimates reported in Table 3. At the county level the difference between the two methods is always less than 1 %-points. The difference are somewhat larger at the regional level (2-3 %-points).

Mélitz and Zumer (1999) propose another estimation method in a study where they reestimate the model of Asdrubali *et al.* (using their data) and the extends the analysis to Canada, UK, Italy and a panel data set of 23 OECD countries. Their estimation method differs from that of Asdrubali *et al.* in two ways. First, they remove the time dummies from the model and include a set of controls. The main purpose is to increase the degrees of freedom. The controls capture the regional business cycle, regional size, the real interest rate and an index of persistence (Campbell and Mankiw, 1987). Second, they introduce a predetermined value of β_U by calculating the variance of consumption and dividing by the variance of output every year and then taking the average over all years. The argument for this approach goes as follows (p. 161): "If movements in regional consumption stem exclusively from movements in regional output, as the model says, then any lower cross-sectional variance of regional consumption than cross-sectional variation of regional output must reflect smoothing." The results from using the method of Mélitz and Zumer are reported in Table A2 of the Appendix. 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 1, 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 those obtained by using the method of Asdrubali *et al.*, we rely on OLS in the following.

In any case, the impression from the analysis so far is that, compared to other countries, Norway seem to have an extremely high degree of regional risk sharing and with capital markets & commuting as the dominating channel of risk sharing. The results basically reflect that the annual correlation between the growth of gross regional product and the growth of regional income is fairly low. The average of the annual correlations is 0.20 between regional income growth and the growth of private gross regional product, and 0.14 between regional income growth and total gross regional product. Moreover, consumption growth is practically uncorrelated with the growth of private and total gross regional product (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).

We are somewhat concerned, however, that these low correlations may to some extent reflect measurement error in the figures 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 provide an indication of which of the risk sharing mechanisms are better suited for smoothing permanent

shocks.

[Table 4 approximately here]

In Table 4 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 2 years and the data set includes the growth rates for the periods 1976-78, 1977-79, ..., 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. 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 5 approximately here]

Analyses at the regional with different frequencies of the data are reported in Table 5. In some respects, the results are similar to those at the county level: 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). Also the quantitative impact of 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 1 to 5. Asdrubali *et al.* (1996) estimate the increase to be 17 %-points. On the other hand, we find a sharper increase in the importance of government smoothing and a sharper decline in the importance of market based smoothing.

In one important respect does the county and regional results in tables 4 and 5 differ. As the growth horizon increases, the estimate of β_P (the fraction of the shock smoothed by capital markets/ commuting) drops much faster at the regional level. With k = 5, this estimate at regional level is less than half the corresponding estimate at the county level. Given that the long run analysis' may be more reliable, this suggest that commuting may indeed be an important mechanism in response to region-specific shocks.

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 1 year, Norway stands out with an extremely high degree of regional risk sharing and with capital markets/ commuting as the most important channel. When the differencing

interval is 5 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.

7 Conclusions

We have estimated the degree and sources of regional risk sharing in Norway over the period 1977-90. All our results indicate that there is a substantial amount of cross-regional insurance taking place in Norway. Regardless of aggregation level, estimation method or differencing length, less than 20 % of a regional shock to output come out as unsmoothed.

We extend the analysis of Asdrubali *et al.* to take account of public employment as a possible shock absorber. It turns out that this is indeed an important channel for risk sharing, but not as important as capital markets/commuting for the annually differenced data. Due to possible measurement errors, we do however rely more on our long run results. The pattern here is that the market based channels of risk sharing (capital markets & commuting and credit markets) decrease in importance as the differencing interval increase while the 'policy' channels (public employment and taxes & transfers) become more important. At the regional level, the combined smoothing of public employment and taxes & transfers are larger than the total smoothing effects of the market based channels, for 4 and 5 years differencing intervals. This does also suggests that the central government responds to shocks with a lag.

Finally, in our long run analysis (k = 3,4,5), it is a significant difference between the county and the regional level regarding the fraction of a shock absorbed by the capital markets/ commuting channel. At k = 5 for instance, the size of the estimated β_P at the regional level is less than half of the corresponding estimate at the county level. This suggests to us that commuting and cross-regional shopping is partly responsible for the extreme high values of β_P estimated at the county level.

In comparing our results with the US analysis of Asdrubali *et al.* (1996), it is the last two to three columns in table 5 we find most reliable. The picture here is that Norway has a much higher degree of regional risk sharing than the US, and that government smoothing is more important in Norway. It would be interesting to see in future research whether these results are special for Norway or if they are valid for other European countries as well.

8 Appendix

[Table A1 here]
[Table A2 here]

References

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Table 1: Basic cross-regional correlation coefficients, 1976-90.

County	*c*	*grp*	*grp (private)*
Østfold	0.93	0.64	0.69
Akershus	0.92	0.90	0.90
Oslo	0.96	0.74	0.90
Hedmark	0.98	0.86	0.93
Oppland	0.97	0.91	0.91
Buskerud	0.97	0.72	0.86
Vestfold	0.97	0.65	0.76
Telemark	0.96	0.31	0.28
Aust Agder	0.94	0.86	0.87
Vest Agder	0.97	0.58	0.49
Rogaland	0.96	0.52	0.43
Hordaland	0.96	0.86	0.86
Sogn & Fj.	0.95	0.57	0.22
Møre & R.	0.98	0.84	0.74
Sør Trøndelag	0.97	0.71	0.58
Nord Trøndelag	0.96	0.87	0.91
Nordland	0.97	0.83	0.84
Troms	0.97	0.80	0.56
Finnmark	0.95	0.65	0.44
Unweighted average	*0.96*	*0.73*	*0.69*

Table 2: Unweighted averages of cross-regional correlation coefficients, 1977-90. Min-max in parenthesis.

	County level	*Regional level*
grp_p	0.70	0.80
	(0.22 – 0.94)	(0.68 – 0.88)
grp	0.67	0.75
	(0.10 – 0.89)	(0.63 – 0.88)
ri	0.94	0.96
	(0.82 – 0.98)	(0.90 – 0.98)
dri	0.96	0.97
	(0.86 – 0.99)	(0.93 – 0.99)
c	0.95	0.97
	(0.89 – 0.98)	(0.96 – 0.98)

Table 3: The ASY approach and the extended approach.
OLS estimates with t-values in parentheses

	ASY		*Extended*	
	County	Region	County	Region
Public employment			0.175	0.198
			(10.58)	(3.90)
Capital markets/commuting	0.944	0.910	0.770	0.676
	(36.20)	(13.53)	(27.21)	(8.05)
Taxes & transfers	0.023	0.058	0.025	0.082
	(1.84)	(1.85)	(2.38)	(3.10)
Credit markets	0.031	0.123	0.020	0.061
	(0.85)	(1.79)	(0.63)	(0.98)
Not smoothed	0.002	-0.091	0.009	-0.017
	(0.07)	(-1.26)	(0.29)	(-0.27)

Table 4: Varying the frequency of the data, county level
OLS estimates with t-values in parentheses

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

Table 5: Varying the frequency of the data, regional level.
OLS estimates with t-values in parentheses

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

Table A1: Reestimating table 3 using the method of Asdrubali et al. (1996)
t-values in parentheses

	ASY		*Extended*	
	County	Region	County	Region
Public employment			0.180	0.181
			(17.13)	(5.05)
Capital markets/commuting	0.956	0.934	0.767	0.697
	(42.30)	(16.78)	(32.49)	(10.40)
Taxes & transfers	0.016	0.035	0.022	0.065
	(1.48)	(1.36)	(2.42)	(2.93)
Credit markets	0.037	0.091	0.026	0.037
	(1.16)	(1.80)	(0.92)	(0.83)
Not smoothed	-0.009	-0.061	0.005	0.020
	(-0.27)	(-1.06)	(0.16)	(0.38)

Table A2: Reestimating table 3 using the method of Mélitz and Zumer (1999)
t-values in parentheses

	ASY		*Extended*	
	County	Region	County	Region
Public employment			0.218	0.262
			(12.61)	(6.95)
Capital markets/commuting	1.041	1.165	1.059	1.185
	(20.90)	(11.20)	(20.45)	(11.40)
Taxes & transfers	0.027	0.008	0.029	0.032
	(0.70)	(0.09)	(0.76)	(0.34)
Credit markets	-0.102	-0.230	-0.349	-0.271
	(-2.68)	(-2.78)	(-7.92)	(-3.28)
Not smoothed	0.034	0.057	0.044	0.053