Income smoothing across cities: time or frequency domain?

Andrea Roberto Lamorgese*

June 1999

Abstract

This paper investigates the channels of risk sharing among the cities of the United States. Contributions for social security and government transfers (government channel) take the bulk of smoothing (17%), and intercity mobility ranks high: about 6% of income shocks are smoothed via the choice of working in another city than the place of residence. The empirical analysis shows another interesting result: cities facing lower income volatility also smooth a smaller share of it, probably reflecting easier access to the credit channel. Finally, the analysis in the frequency domain shows that income smoothing is achieved via different channels and to a different extent over the business cycle.

Preliminary version

JEL classification: E32, J61, R12

Keywords: risk sharing, diversification, labour mobility

*ECARE, Université Libre de Bruxelles, and Ente "L. Einaudi" per gli Studi Monetari Bancari e Finanziari, Via dei Due Macelli 73, 00187 Rome, Italy. Email: andrea.lamorgese@ulb.ac.be. I wish to thank Jorge Rodrigues, Bent Sørensen, Philippe Weil and Oved Yosha for their precious advice.

1 Introduction

Risk-sharing has been a buzz word in both scientific and non scientific economic literature ever since Europe has targeted its monetary union. The argument is that with a common monetary policy and a constraint on national fiscal policies (the pact of stability and growth) asymmetric shocks to the member countries have to be taken care of alternatively than with the usual policy devices.

A natural benchmark to look at are the United States, which have been a monetary union for a consistent amount of time. This union takes care of asymmetric shocks to each state's income through the federal budget and its automatic system of tax and subsidies, and through a substantial amount of cross-ownership of activities across different states (Asdrubali, Sorensen and Yosha, 1996). Both devices are missing for the EU: the federal budget is way undersized with respect to the need of assuring coinsurance across the member states, and apparently there is not much political consensus toward expanding it. On the other hand, financial markets are still underdeveloped to assure a substantial amount of risk sharing through cross-ownership.

Admittedly, risk sharing is then a relevant problem economic theory cannot neglect. Yet, a few issues are left unanswered by the empirical analysis, which can give a crucial apport to designing the right institutions for the EU to achieve a substantial smoothing of income volatility.

One important issue is the dimension of the optimal pool of idiosyncratic risk. Is that the city, the region, the state, the federation of states itself? Answering to this question means to be able to establish the size of the building block of the most efficient risk sharing institutions. If the optimal level of aggregation of risk were i.e. the city, it would be a wrong policy that of designing risk sharing institutions based on a system of taxes and subsidies conditioned on the business cycles at an higher level of aggregation. It would amount to introduce a substantial higher volatility in the pool. This has been exactly on of the problems of the common agricultural policy in Europe, designed for a smaller number of member states (the initial participants to the Community) and then extended beyond the scope of optimal insurance.

The idea here is to try and decompose income volatility at the city level in order to uncover the mechanisms allowing income smoothing along the line set by Asdrubali et al.'s (1996) study on state income. I compare volatility at the level of the state and at the level of the cities within the state, to evaluate whether it is the state or the city the optimal size of risk pooling. Then I compare the contribution to smoothing of the different channels of risk sharing at the level of the city and the state, to assess which are the most efficient devices.

Along this analysis I uncover a different mechanism of risk sharing than those presented in Asdrubali et al. (1996), namely intercity labour mobility, which is specific to the different level of aggregation I take into account. According to the economic theory, people work together for a set of reason ranging from scale effect to 'coffee machine' knowledge spillovers, and live far apart to escape congestion costs (i.e., higher rents, less space available to children). This paper singles out a different rationale for dispersion and commuting: risk sharing. When people work elsewhere than they live, prices, contributions and transfers, secondary revenues have a different dynamics from the main source of income, and this turns out in granting a substantial amount of income smoothing.

The analysis further evaluates the effectiveness of these mechanisms conditioned on the size of the cities and their diversification. Larger cities have less volatile income and smaller shares of income smoothing. The same happens in more diversified cities. This finding seems to point out that income smoothing achieved through taxes and subsidies, labour mobility, and financial markets is less of an issue for cities that achieve a substantial reduction of the volatility of their income through structural mechanisms — that is through the diversification of the productive activities performed in the city. In a sense a larger share of income volatility is left to be smoothed via the credit markets or unsmoothed altogether in more diversified cities, this probably being the counterpart of better access to credit markets.

Finally, this paper deals with the issue of which kind of volatility mainly hits cities, that is whether it is short-run or long-run income volatility what mainly matters. In turn it tries and analyses whether agents are able to smooth the relevant kind of income volatility. This part of the paper bridges the gap between two different ways of analysing the issue of risk sharing: on the one hand Asdrubali et al. (1996) give estimates of the relevance of the different channels through which risk sharing is achieved, but stay agnostic on which is the relevant income volatility agents wish to smooth. On the other hand, Forni and Reichlin (1999) explicitly model the issue and find that long-run volatility is the correct target for income smoothing. They give an assessment of the share of insurable long-run volatility, but stay silent on the device to achieve this result. My contribution is between the two: I provide an analysis in the frequency domain of the contribution of the different channels of risk sharing. Unlike Asdrubali et al. (1996) I focus on cities, like Forni and Reichlin (1999) the bulk of income volatility is shown to be at the low frequencies, where the agent are shown to be worse equipped to smooth it.

The rest of the paper is organised as follows: section 2 spells out the technique of decomposition of income volatility, describes the data, and analyses the results in the time domain. Section 3 extends the variance decomposition to the frequency domain. Section 4 wraps up the main issues and results, and concludes.

2 Decomposing income volatility

The aim of this section is to provide a framework to decompose income volatility among its components. The idea is that the income measure one considers is constituted of different components and each component has a different underlying evolution through time. The fact that the different components move out of phase with each other provides the agents with some insurance, in the sense that downturns in the cycle of some components are compensated by upturns in the cycle of some other components. Hence, a measure of the contribution of the different components to the smoothing of income volatility can be provided by estimating a decomposition of income volatility among its components.

Following Asdrubali et al. (1996), I decompose the volatility of income into the parts smoothed through the asynchronous cycle of secondary sources of revenue, through adjustment for labour mobility, through contributions for social security and government transfers, and through dividends, interest payments and rents. A (considerable) part of income volatility is left unsmoothed, and I provide an estimate of this remaining share. Ideally one could also disentangle the part of volatility which is smoothed through the credit market from the part which remain not smoothed, but here I left the two shares pooled together for the absence of a natural measure of consumption at the Metropolitan Statistical Area (henceforth MSA) level.

Let $epow$, oli, pri, $resid$, $contr$, $transf$ and div denote total earnings by place of work, other labor income, proprietors income, residence adjustment, contribution to social security, transfer payments, and dividends, interest and rental payment at a certain time t (time indexes are omitted to save on notation).[1] Let it be

$$\begin{aligned} epow &= w + oli + pri \\ epor &= w + pri + resid \\ nepor &= epor - contr + transf \\ d.inc &= nepor + div \end{aligned}$$

and consider the identity,

$$epow = \frac{epow}{w + pri} \frac{w + pri}{epor} \frac{epor}{nepor} \frac{nepor}{d.inc} d.inc \tag{1}$$

For any stochastic process underlying $epow$, if $w + pri$ does not perfectly comove with $epow$, that is some smoothing is obtained at the level of oli, the ratio $epow/(w + pri)$ features a more dampened volatility than $epow$. The remaining volatility can be smoothed away down in the chain of ratios of identity (1): by inter-city labour mobility provided that earnings by place of residence ($epor$) does not perfectly comove with $w + pri$; by the contribution/transfer system, provided net earning by place of residence ($nepor$) does not perfectly comove with the former ($epor$); by the financial markets, provided that disposable income ($d.inc$) does not perfectly comove with net earnings by place of residence ($nepor$). Any remaining volatility is left unsmoothed by the considered channels of risk sharing.

Should there be full risk sharing at any level, the contribution to income smoothing of any channel down in the chain would be nil. Imagine for instance that $epow$ is hit by a shock, and that oli absorbs all of the shock to $epow$, what equals to say that $w + pri$ is left unchanged by the shock. Than the ratio $epow/(w + pri)$ bears all the shock and the variables down in the identity are left unchanged. The shock is completely smoothed away at the first stage and does not propagate any further.

In order to estimate the contribution of each of these channels in identity (1), let me take logs of both sides and first differences, multiply both sides times $\Delta \log epow$, and take expectations. The result is the following decomposition of cross sectional variance

[1] An accurate description of these variables is provided in section 2.1.

$$
\begin{aligned}
\text{var}\left\{\Delta \log epow\right\} &= \text{cov}\left\{\Delta \log epow - \Delta \log(w + pri), \Delta \log epow\right\} \\
&= \text{cov}\left\{\Delta \log(w + pri) - \Delta \log epor, \Delta \log epow\right\} \\
&= \text{cov}\left\{\Delta \log epor - \Delta \log nepor, \Delta \log epow\right\} \\
&= \text{cov}\left\{\Delta \log nepor - \Delta \log d.inc, \Delta \log epow\right\} \\
&= \text{cov}\left\{\Delta \log d.inc, \Delta \log epow\right\}.
\end{aligned} \tag{2}
$$

Divide both sides by the variance of $\Delta \log epow$ and notice that each term of the RHS becomes a beta coefficient in an OLS regression.

$$
1 = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5. \tag{3}
$$

β_1, β_2, β_3, β_4, β_5 are respectively the OLS estimates of the slope coefficient in the regressions of $\Delta \log epow - \Delta \log(w + pri)$, $\Delta \log(w + pri) - \Delta \log epor$, $\Delta \log epor - \Delta \log nepor$, $\Delta \log nepor - \Delta \log d.inc$, $\Delta \log d.inc$ on $\Delta \log epow$. One can interpret β_1, β_2, β_3, and β_4 as the percentage amount of smoothing achieved by each channel and β_5 as the part left unsmoothed. If the latter is zero, there is full risk sharing and all the other betas sum up to one. If full risk sharing is achieved by the first channel, $\beta_1 = 1$ and all the contribution of the other channels sums up to zero. The betas are not constrained to be positive, and a negative beta indicates that that channel is actually magnifying rather than dampening income volatility (dis-smoothing).

Practically, one needs to estimate five panel regressions

$$
y_{it}^j = \sum_{t=1}^{T} \alpha_t d_t + \beta_i \Delta \log epow_t^j + u_{it}^j \tag{4}
$$

where

$$
\begin{aligned}
y_{1t}^j &= \Delta \log epow_t^j - \Delta \log(w_t^j + pri_t^j) \\
y_{2t}^j &= \Delta \log(w_t^j + pri_t^j) - \Delta \log epor_t^j \\
y_{3t}^j &= \Delta \log epor_t^j - \Delta \log nepor_t^j \\
y_{4t}^j &= \Delta \log nepor_t^j - \Delta \log d.inc_t^j \\
y_{5t}^j &= \Delta \log d.inc_t^j.
\end{aligned}
$$

j is the city index and range across the 311 MSAs, t is the time index (with $T = 24$), d_t are time fixed effects. Time fixed effects are needed in the estimation to capture year-specific impacts on the growth rate of *epow*. This allows to estimate the regression as if the structure of the shock hitting *epow* were stationary over time.

2.1 The data

The data are taken from the 1994 release of the Regional Economic Information System, by the Bureau of Economic Analysis. It contains data on earnings and employment for 311 Metropolitan Statistical Areas from 1969 to 1993.[2]

The measure of income at the MSA level is earnings by place of work. It consists of wages and salaries, other labor income and proprietors income. Wages and salaries are defined as monetary remuneration of employees, and include compensation of corporate officers. Proprietors income (with inventory valuation and capital consumption adjustments) is the current-production income (including income in kind) of sole proprietorships and partnerships and of tax-exempt cooperatives.[3] Other labour income is the secondary source of revenue I consider in section 2: it includes the payments by employers to privately administered benefit plans for their employees, fees paid to corporate directors, and miscellaneous fees.

Adjustment for labour mobility is accounted for in the database by the item residence adjustment. It corrects earnings by place of work in order to make it possible to compute a measure of income by place of residence.

Personal contribution for social insurance includes the payments by employees, by self employed and by other individuals who participate in the following programs: Old-age, survivors, and disability insurance (OASDI) (social security); hospital insurance (HI) and supplementary medical insurance (SMI) (medicare); State unemployment insurance (UI); temporary disability insurance; government employee retirement; railroad retirement; and

[2]Approximation for confidentiality reasons in the item “adjustment for residence” have been introduced in the latest 1998 release. Since this item is central to the experiment I perform, I decided to trade off length of the series against precision of the data. The cost is 3 years and 14 MSAs.

[3]A sole proprietorship is an unincorporated business owned by a person. A partnership is an unincorporated business association of two or more partners. A tax exempt cooperative is a non profit business organisation that is collectively owned by its members.

veterans life insurance. Transfers payments are income payments to persons for which no current services are performed. They are payments by government and business to individuals and nonprofit institutions.

Personal dividend income, personal interest income, and rental income of persons with capital consumption adjustment are sometimes referred to as "investment income" or "property income". Personal dividend income is the dividends received by individuals, by nonprofit institutions, and by estates and trusts. This income consists of payments in cash and in other assets, excluding the corporation's own stock, made by corporations located in the United States or abroad to stockholders who are U.S. residents. Personal interest income is the interest income received by individuals, by nonprofit institutions, and by estates and trusts. It consists of monetary interest and imputed interest. Monetary interest consists of the interest received by individuals from the municipal bonds issued by State and local governments, the interest received by individuals from money market mutual funds, and the monetary interest from all other sources. Imputed interest consists of the net investment income that is received by life insurance carriers and private noninsured pension plans, which is attributed to persons in the year in which it is earned, and the imputed interest that is received by persons from other financial intermediaries, which represents the value of financial services for which persons are not charged.

2.2 Results

Tables 1 and 2 describe the results. When all cities are pooled together (table 1, 1st column), contributions to social security and transfer payments are the most relevant channel of risk sharing. It smooths away around 17% of total income volatility. Financial markets are used as secondary smoothing device (around 7% of total volatility), and inter-city labour mobility ranks the third with a smoothing capability of around 6%. Other labour incomes act as a dis-smoother, as expected since the procyclical nature of benefit plans and corporate fees. But they count very little (less than 2/10 of a percentage point). The not smoothed share of total volatility amounts to about 70%. All shares are within the significance bound at 5%.

Big cities feature less volatile income than small ones, as well as diversified cities do with respect to specialised ones.[4] But a fact is remarkable:

[4]The index of specialisation is a proxy for technological homogeneity in a metropolitan

cities dealing with higher volatility make a more consistent use of all the channels of risk-sharing I presented here (table 1, columns 2 to 5). Since under full risk-sharing consumption is a fixed proportion of the aggregate output, regardless the nature of the stochastic process governing shocks to income, higher income volatility induces higher consumption volatility. Since consumption volatility is what matters to the agents, one can argue that smoothing through the credit channel is easier in large and diversified cities than in small and specialised. In other words large and diversified city dwellers use less the other smoothing channels and rely more on smoothing through saving/dissaving and borrowing/lending.[5]

Estimates in table 1 could be biased in the sense that big cities are also the most diversified, hence the results conditioned on diversification could be nothing else than a mirror of those conditioned upon size. To try and disentangle these effects, I consider a different subsample. In table 2 the pooled panel regression (4) is run on the set of the top and on the one of the bottom quintile of the distribution of urban population. Within these two subsets I further separate diversified cities from specialised. For both groups of big and small cities the results about specialisation stated above are confirmed: smoothing is higher for each channel in most specialised cities and smaller cities smooth more than bigger cities, regardless their level of specialisation. In my opinion, these results point clearly toward an evidence of easier access to the credit market in larger and more diversified cities.

It is mandatory at this stage to compare the results of this exercise with the experiment at the state level in Asdrubali et al. (1996). Overall smoothing is much lower than there. In their experiment 48% of income volatility is left not smoothed via the channels I also consider in my analysis. So there is a substantial 22% of extra not smoothed volatility in my exercise. None the less this does not mean that state represent a better pooling level than city, that is that aggregation at the level of the state is a objective that

area (Lamorgese, 1998b). It is built as the share of total earnings in city j paid by the sectors in the top decile of the distribution of earnings by place of work. City j is highly diversified if the sectors in the top decile paid a share not much larger than 10 % of the earnings paid in total in the region. This means that the distribution of the earnings is rather uniform. Conversely, if the 'richer' decile pays more than 10 % of the earnings paid in the whole area, it means that the area is rather specialised in those productions, that it is rather technologically homogenous.

[5]This conjecture can be verified once one disposes on data on consumption at the MSA's breakdown. Unfortunately these data are available to me only for 38 MSAs, so this analysis is left out for further work.

1970-1993					
	all cities	big cities	small cities	most specialised cities	least specialised cities
Other labour income (β_1)	-0.16	0.49	-0.58	-0.63	0.01
	(0.06)	(0.13)	(0.13)	(0.14)	(0.12)
Mobility (β_2)	5.73	3.80	5.71	6.78	3.99
	(0.22)	(0.48)	(0.45)	(0.57)	(0.43)
Contributions and transfers (β_3)	16.84	13.86	17.67	15.57	15.97
	(0.19)	(0.44)	(0.44)	(0.38)	(0.50)
Financial markets (β_4)	6.69	5.14	7.56	6.60	5.15
	(0.20)	(0.56)	(0.41)	(0.42)	(0.54)
Not smoothed (β_5)	70.90	76.71	69.64	71.68	74.88
	(0.34)	(0.84)	(0.73)	(0.74)	(0.88)
Total variance	0.19	0.13	0.23	0.19	0.18
Total std	4.38	3.60	4.78	4.37	4.24

Standard errors in parenthesis. Big cities are those whose population in 1993 was in the top quintile of the distribution of city population. Small cities are those whose population in 1993 was in the bottom quintile of the distribution of city population. Most specialised cities are those in the top quintile of the distribution of the specialisation index of 1970. Least specialised are those cities in the bottom quintile. The index of specialisation is the share of earnings produced by the sectors within top decile in the distribution of earnings in the city on total earnings in the city.

Table 1: OLS estimates of income smoothing (percent)

should be targeted to create a optimal risk-sharing institutions. It just mean that, conditionally on the differences in the devices considered, risk-sharing is more efficient at the state than at the city level. But this is far from implying that volatility at the state level is lower than at the city level.[6]

Furthermore there are some basic differences in the channels considered that make the two analysis hardly comparable, if not at a qualitative level. The 'government channel', that in my analysis smooths away a share of volatility ranging from about 14% to about 18%, counts in Asdrubali et al. (1996) only for 13%. But in my analysis I could only take into account contributions to social security and transfer payments, that is the only items

[6]**NEED TO CHECK THIS OUT.**

1970-1993				
	Big cities		Small cities	
	most specialised cities	least specialised cities	most specialised cities	least specialised cities
Other labour income (β_1)	0.42	0.51	-0.73	-0.57
	(0.19)	(0.17)	(0.21)	(0.18)
Mobility (β_2)	4.42	3.25	6.79	4.61
	(0.73)	(0.63)	(0.61)	(0.67)
Contributions and transfers (β_3)	14.34	13.44	18.20	17.04
	(0.61)	(0.66)	(0.65)	(0.60)
Financial markets (β_4)	5.04	5.11	7.83	7.05
	(0.53)	(1.00)	(0.57)	(0.62)
Not smoothed (β_5)	75.78	77.69	67.91	71.87
	(1.05)	(1.34)	(1.00)	(1.07)
Total variance	0.12	0.13	0.20	0.26
Total std	3.53	3.66	4.45	5.08

Standard errors in parenthesis. Most specialised cities are those in the top 50% of the distribution of the specialisation index of 1970, least specialised are those cities in the bottom 50%. The index of specialisation is the share of earnings produced by the sectors within top decile in the distribution of earnings in the city on total earnings in the city. Small cities are those in the bottom quintile in the distribution of the population. Big cities are those in the top quintile in the distribution of the population.

Table 2: OLS estimates of income smoothing (percent)

in the government budget that are effectively used for smoothing. They not only consider other taxes inside, but they also have a different time period. If one considers the same time period, 1970-1990, the results are pretty comparable.

Capital markets in the Asdrubali et al.'s (1996) analysis take the bulk of smoothing. This channel capture all the cross-ownerships at the interstate level by comparing gross state products and state income, while in my data financial markets only describe smoothing coming through dividends, rental and interest payments. So I leave outside all the smoothing coming through partnerships and cooperatives ranging across two locations which are not traded in the stock exchange (that is which are not registered as dividends).

In my data these flows enter in the proprietors income, and there is no way to filter them out and consider their contribution to income smoothing. Since it is extremely likely that cross-ownership within partnership and cooperative range across two or more MSAs, a potentially large part of the smoothing via capital markets is hidden in the not smoothed share. No wonder than that the not smoothed volatility is such a larger share here than in their analysis.

The inter city job mobility is not directly estimated in Asdrubali et al. (1996), and it does not need to be a very significant channel at the state level. Commuting is much more relevant at the city level, indeed. It might be important for some states on the East Coast though, but it is probably not very significant in the aggregate.

3 Different risk sharing devices for different frequencies? An analysis in the frequency domain

So far the analysis has been performed for all the data pooled together. But it is a natural question to wonder whether income volatility differs from the short- to the long-run and whether agents are differently able to smooth it away at different frequencies.

A natural way to tackle this issue is to reproduce the volatility decomposition in the frequency domain by computing the real part of the transfer function. In simple words, the betas estimated in the time domain are newly estimated non parametrically in the frequency domain by computing the ratios between real part of the co-spectrum of y_{it} of equation (4) and the growth rate of earnings by place of work and the variance of this latter variable. Formally I compute

$$\beta_i(\omega) = \frac{\left|C^{xy_i}(\omega)\right|}{S^x(\omega)} \tag{5}$$

where $S^x(\omega)$ (with $-\pi < \omega < \pi$) is the spectral density of x, while $C^{xy_i}(\omega)$ is the cospectrum of x and y_i, with x and y_i being respectively the stack vector of all the cross sections of 1 period growth rates of the earnings by place of work and the stack vector of all the cross sections of 1 period growth rates of y_{it}^j, that is

$$x = \begin{bmatrix} \Delta \log epow_1 \\ \Delta \log epow_2 \\ \dots \\ \Delta \log epow_T \end{bmatrix}, \quad \Delta \log epow_t = \begin{bmatrix} \Delta \log epow_t^1 \\ \Delta \log epow_t^2 \\ \dots \\ \Delta \log epow_t^J \end{bmatrix} \quad t = 1, \dots, T,$$

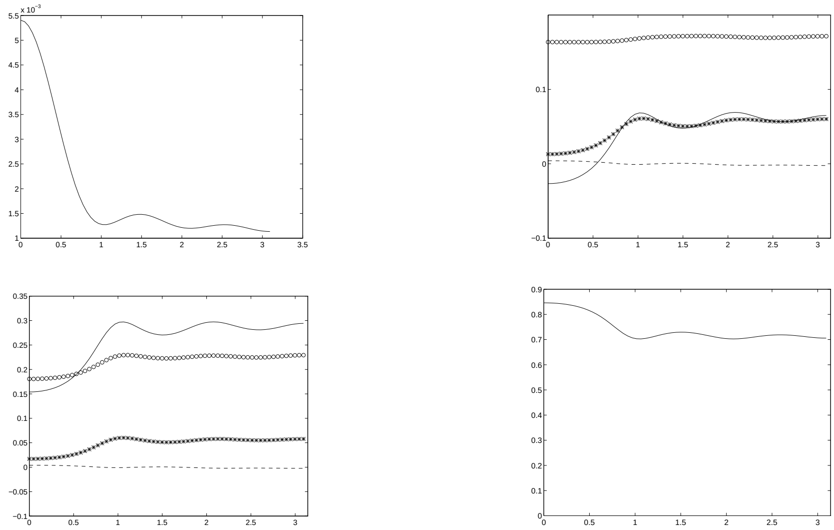
and

$$y_i = \begin{bmatrix} y_{i1} \\ y_{i2} \\ \dots \\ y_{iT} \end{bmatrix}, \quad y_{it} = \begin{bmatrix} y_{it}^1 \\ y_{it}^2 \\ \dots \\ y_{it}^J \end{bmatrix} \quad t = 1, \dots, T.$$

All cities

By the inspection of figure 1 a few facts emerge. Income volatility is mainly concentrated in the long run: 55% of the volatility is imputable to cycles of more than 6 years. Other labour income does not provide agents with a significant smoothing device at any frequency, while contributions to the social security and transfer payments smooth around 17% of the variance regardless the period of the cycle.[7] Intercity labour mobility smooths very little volatility at low frequencies and around 5% for cycles with period shorter than 6 years. Financial markets feature the same drift, but they increase volatility, rather than dampening it in the long-run (for cycles of period longer than 12 periods). This is expected once one thinks to the components of the variable which stands for financial markets: dividends, rental and interest payments. The idea is that the owners of assets which are hit by very persistent shock may find difficult to trade their assets for some other asset that provide them with some insurance. In a sense, no one is willing to buy their assets, or should there be anyone, she would be willing to trade at a low relative price, hence limiting the scope for coinsurance. For interest and rental payments the idea is a bit different: the owner of an assets who

[7] These are the institutional instrument devoted to provide agents with smoothing. It works properly, but none the less it does not provide more smoothing when is more deeply needed. This is probably due to the way contributions are gathered and payments are corresponded. Should they be made somehow more state contingent?



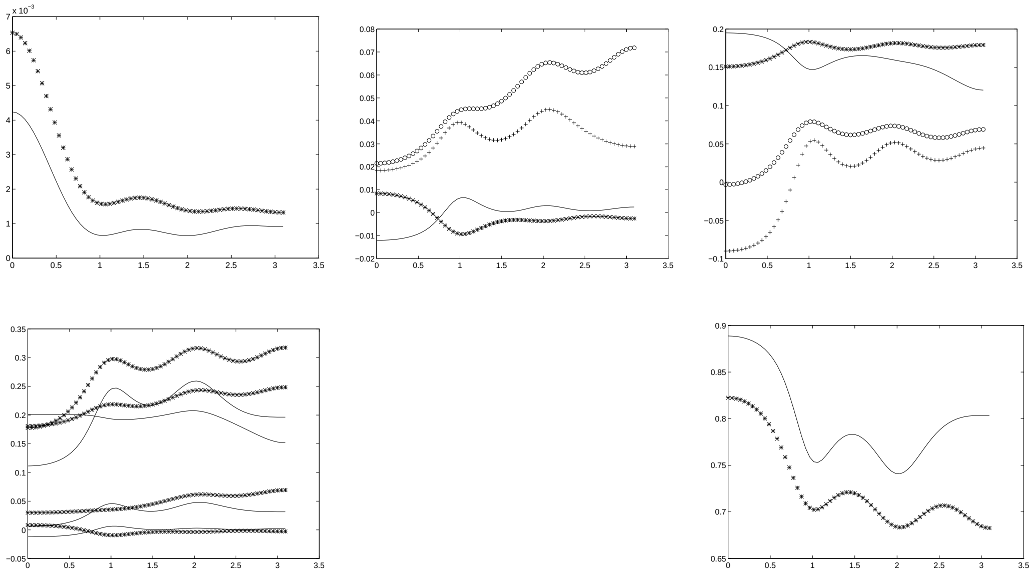
Note: The top left panel shows the spectral density of earnings by work of place. The top right panel shows the betas in the frequency domain (transfer functions): β_1 (dashed line), β_2 (starred line), β_3 (circled line), and β_4 (solid line). The bottom left panel shows the cumulate of the betas at each frequency: β_1 (dashed line), $\beta_1 + \beta_2$ (starred line), $\beta_1 + \beta_2 + \beta_3$ (circled line), and $\beta_1 + \beta_2 + \beta_3 + \beta_4$ (solid line). The bottom right panel shows the not smoothed volatility at each frequency.

Figure 1: All cities

is hit by a persistent shock is expected to eat part of the capital, hence reducing the amount of the flows of payments in the future and the scope of smoothing.

Big vs small cities

Figure 2 shows the differences concerning earnings volatility and ability to smooth it between big and small cities at all frequencies. Big cities are those belonging to the top decile of the distribution of the population, small cities those belonging to the bottom decile. From the top left panel it appears clear that small cities face much higher volatility than big ones at all frequencies, and that the difference is the largest at lowest frequencies. Hence, long-run volatility is more of a concern for small cities than for big ones. Other labour incomes mirror each other at all frequencies: they repre-



Note: The top left panel shows the spectral density of earnings by work of place: small cities (plus-ed line), big cities (solid line). The top central and right panel respectively show β_1 and β_2, and β_3 and β_4 in the frequency domain (transfer functions) for both large and small cities. β_1 and β_3: big cities (solid line), small cities (starred line). β_2 and β_4: big cities (plus-ed line), small cities (circled line). The bottom left panel shows the cumulate of the betas at each frequency: big cities (solid line), small cities (starred line), with the betas cumulated according to the subindex. The bottom right panel shows the not smoothed volatility at each frequency: big cities (solid line), small cities (small line).

Figure 2: Big vs. small cities

sent a smoother for small cities and a dis-smoother for big cities at the low frequencies, but the situation is reverted for cycles with a period of 9 years or shorter. Intercity labour mobility smooths the same amount of volatility in both small and big cities in the long-run, but to a much higher extent in small cities in the medium- and short-run (top central panel). Big cities exploit institutional channels of risk-sharing (contributions to social security and transfer payments) as a more effective smoothing device in the long-run, and once again the situation is mirrored for small cities. The twist occurs for cycles of 8 years or shorter. This is perhaps a reflex of a change of targeting by the fiscal policy: in the short-run small cities are more volatile and hence represent the primal target. In the long-run 'too big to fail' considerations bias the targeting toward big cities. Financial markets provide a huge dis-smoothing (-10%) to big cities for cycles of 8 years or longer, smoothing for cycles of shorter period. For small cities they are a source of smoothing at any frequency, but stably more efficient for cycle of 7 years or shorter, where they smooth around the 7% of income volatility. This is perhaps an index of a substantially different diversification policy according to the size: small cities dwellers know they face higher volatility and diversify their portfolio to a considerably higher extent (top right panel). The bottom left panel shows that at each incremental level of smoothing small cities perform much better in smoothing medium- and short-run volatility, while the institutional channel bias income smoothing toward the big cities in the long-run. This and the fact that a much higher share of income volatility is left not smoothed in large cities (bottom right panel) confirm at all frequencies one result achieved in the time domain: big cities have probably access to better consumption smoothing, that is smoothing through lending/borrowing and saving/dissaving.

Diversified vs. specialised cities

As figure 3 shows, diversified cities have an overall lower income volatility, though higher than specialised cities for cycles of period of 9 years or longer (top left panel). Facing higher long-term volatility, diversified cities seem more able to target and smooth exactly this kind of volatility, by the mean of each of the channel considered. Indeed, overall smoothing is much higher than in specialised cities in the long-run, while it is comparable in the short-run. Specialised cities best perform smoothing at business cycles frequencies (bottom left panel), mainly due to mobility, and contributions and transfers. Despite a similar share of not smoothed volatility over all frequencies (49.72 for specialised cities against 49.59 for diversified one), diversified cities mainly target income volatility at the low frequencies (bottom left panel): for these cities smoothing long-run volatility is apparently what matter the most. Even when jointly controlling for size and diversification (figures 4 and 5, in the appendix), these results go through: big diversified cities face slightly higher long-run volatility, and smooth a much higher share at low frequencies than big specialised cities. Small diversified face much higher long-run income volatility, and smooth a comparable share at the low frequencies than small specialised. It is worth noting that the latter smooth a very great deal of volatility through the intercity labour mobility channel.

These results are compatible with the evidence put forward in Forni and Reichlin (1999). Figure 3 represents the ideal experiment for their theory: if only long-run volatility matter for the agents, their behaviour has to be driven only by the attempt to smooth income volatility at those frequencies. And indeed, regardless overall volatility those cities facing higher long-run volatility end up smoothing it the most (figure 2 and 3, top left and bottom right panels).

They further endorse the theoretical results about the cost of specialisation proposed Lamorgese (1998a). Specialisation leads to higher long-run volatility and makes smoothing more difficult to achieve at the low frequencies.

4 Concluding remarks

This paper has tried to cope with three set of issues: *i)* Do cities represent a better risk-pooling than states? *ii)* Which are the relevant channels of intercity income smoothing? Do intercity labour mobility provide agents with some additional smoothing? *iii)* Which are the frequencies at which volatility matter the most? And do smoothing devices perform differently at different frequencies?

The analysis in the time domain has shown that states pool the risk more efficiently than cities, in the sense that the former leave a smaller share of income volatility not smoothed. This result is conditional on some differences in the definition of the channels of risk sharing, and does not imply that cities face a higher income volatility than states. It only means that for an equal 1% shock to income, pooling within states smooths one quarter of a percentage point more than pooling within cities.

Contribution for social security and transfer payment are the most important channel of income smoothing at the level of cities (17%), followed by financial markets (7%), and intercity labour mobility (6%). Hence labour mobility matters.

When designing income smoothing institutions it is important to choose correctly which kind of volatility to smooth, that is whether to target long-, medium- or short-run income volatility. The natural instrument to give an assessment about this issue is the analysis in the frequency domain. The last session of the paper estimates transfer functions, that is it decomposes the spectral density of income among its different components. This amounts pretty much to evaluating the contribution at different frequencies of the channels of income smoothing singled out by the experiment in the time domain. The bulk of income volatility is shown to hit cities in the long-run, when agents are worst equipped to smooth it away. Finally, long-run volatility seems to drive agents choices: regardless total variance, the higher the long-run volatility, the larger the share of volatility smoothed at low frequencies (for a given amount of overall smoothing).

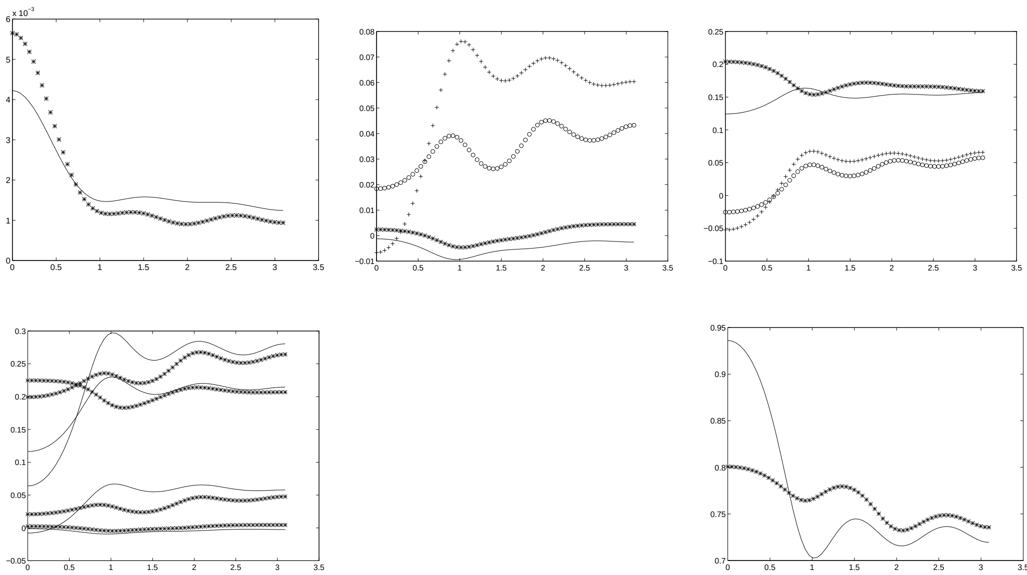
References

Asdrubali, P. E., Sorensen, B. and Yosha, O. (1996). Channels of interstate risk-sharing: United states 1963-90, *Quarterly Journal of Economics* **111**: 1081–1110.

Forni, M. and Reichlin, L. (1999). Risk and potential insurance in europe, *European Economic Review* **forthcoming**.

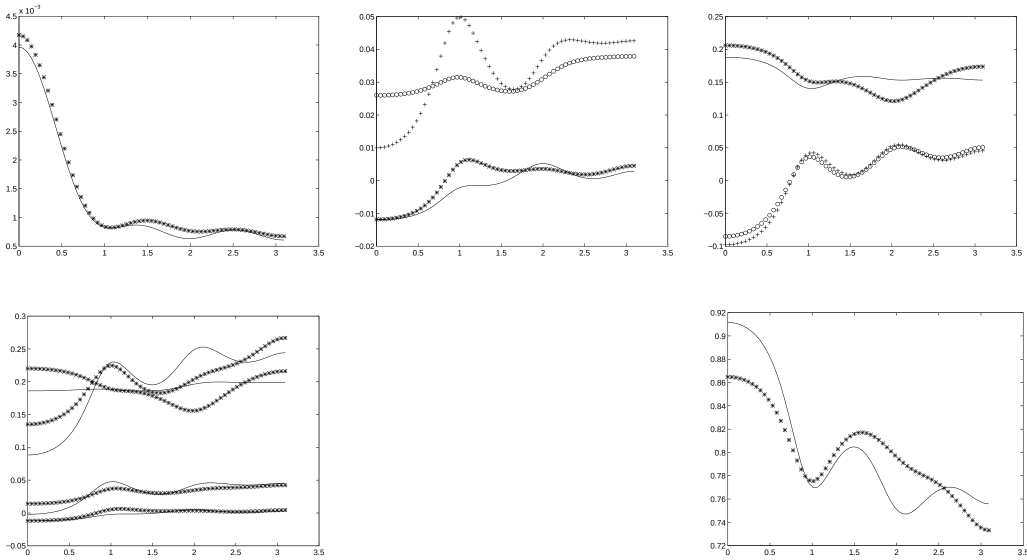
Lamorgese, A. R. (1998a). Death and birth of a city: The myth of the (arabian) phoenix. mimeo.

Lamorgese, A. R. (1998b). Local knowledge spillovers and city growth. ECARE w.p. No.98-02.



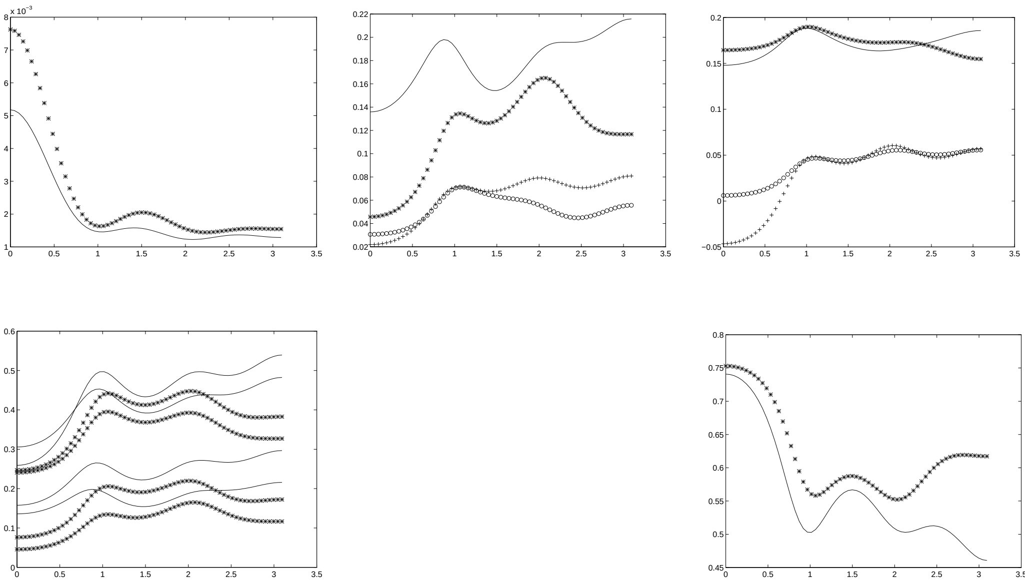
Note: The top left panel shows the spectral density of earnings by work of place: diversified cities (plus-ed line), specialised cities (solid line). The top central and right panel respectively show β_1 and β_2, and β_3 and β_4 in the frequency domain (transfer functions) for both specialised and diversified cities. β_1 and β_3: specialised cities (solid line), diversified cities (starred line). β_2 and β_4: specialised cities (plus-ed line), diversified cities (circled line). The bottom left panel shows the cumulate of the betas at each frequency: specialised cities (solid line), diversified cities (starred line), with the betas cumulated according to the subindex. The bottom right panel shows the not smoothed volatility at each frequency: specialised cities (solid line), diversified cities (small line).

Figure 3: Diversified vs. specialised cities



Note: The top left panel shows the spectral density of earnings by work of place: big diversified cities (plus-ed line), big specialised cities (solid line). The top central and right panel respectively show β_1 and β_2, and β_3 and β_4 in the frequency domain (transfer functions) for both specialised and diversified cities. β_1 and β_3: specialised cities (solid line), diversified cities (starred line). β_2 and β_4: specialised cities (plus-ed line), diversified cities (circled line). The bottom left panel shows the cumulate of the betas at each frequency: specialised cities (solid line), diversified cities (starred line), with the betas cumulated according to the subindex. The bottom right panel shows the not smoothed volatility at each frequency: specialised cities (solid line), diversified cities (small line).

Figure 4: Big cities: Diversified vs. specialised cities



Note: The top left panel shows the spectral density of earnings by work of place: small diversified cities (plus-ed line), small specialised cities (solid line). The top central and right panel respectively show β_1 and β_2, and β_3 and β_4 in the frequency domain (transfer functions) for both specialised and diversified cities. β_1 and β_3: specialised cities (solid line), diversified cities (starred line). β_2 and β_4: specialised cities (plus-ed line), diversified cities (circled line). The bottom left panel shows the cumulate of the betas at each frequency: specialised cities (solid line), diversified cities (starred line), with the betas cumulated according to the subindex. The bottom right panel shows the not smoothed volatility at each frequency: specialised cities (solid line), diversified cities (small line).

Figure 5: Small cities: Diversified vs. specialised cities