Relative house price dynamics across euro area and US cities: Convergence or divergence?*

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Abstract

This paper examines the time varying dispersion in city house price levels across the four biggest euro area countries compared with those in the United States. Using available city-level data over the period 1980-2008, it tests for price convergence and analyses key factors explaining price differentials in a panel regression framework including per capita income, population and relative distances. Results indicate limited evidence of convergence in city-level house prices despite synchronised cycles in the national aggregates for most countries since the 1990s. There is an important role for income differentials in explaining city-level house price dispersion in Germany, France, and the US (but not in Italy or Spain once unobserved city factors are taken into account). At the same time, population differences across cities play a role, though this appears to be associated with amenities specific to a particular location. In general, there has been a lower dispersion of city-level house prices in the four largest euro area economies compared with the US in conjunction with a lower estimated income elasticity for house price differentials. The results, particularly for income, appear to be robust to restricting the analysis to large urban centres.

Key words: House price convergence, house price dispersion, house price drivers, panel data analysis.

JEL classification: R21, R31, E31.

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Non-technical summary

House prices are driven by many factors related both to housing's role as a consumption good and asset. These factors influence the extent to which house price convergence across locations would be expected at the city level through time. On the one hand, housing as a consumption good has a very strong non-traded component in the form of land and labour, with only a small traded component in the form of, for instance, construction materials. This would limit the prospect of price convergence across geographic regions, except possibly in the long run to the extent that income –or productivity levels– converge across geographic areas, or in areas where housing has a strong tradable component. In such an environment, city-level house prices would be expected to mainly reflect local factors such as regional per capita income, amenities or population dynamics.

On the other hand, price convergence in house prices might rise over shorter time periods given, inter alia, common movements across various regions in housing fundamentals (such as income) at a business cycle frequency, concurrent changes or convergence in borrowing conditions associated with housing acquisition and, on the asset pricing side, the correlation of housing risk premia in its role as an asset class across regions. Indeed, housing risk premia –or the higher expected return accrued for bearing risk on specific to owning a house– should consist of both a market risk component generally associated with housing assets (which could co-move across regions as the desirability of this asset class varies) and an idiosyncratic risk component (associated with any particular house). Moreover, as with other asset classes, house prices should contain some information on expected future returns on the basis of foreseen developments in fundamentals, potentially implying a higher volatility in house prices than current local income. Any comovement in house prices across regions may be particularly relevant in currency unions, given expected convergence linked to policies, as well as linkages in trade, financial markets and some correlation in general economic conditions.

This paper examines the behaviour of city house price levels across the four biggest euro area countries using available data over the period 1980-2008, and compares their evolution with those in the United States. It first assesses the extent to which house price levels have been evolving across cities in the largest countries of the euro area, and the countries themselves, relative to the US. Secondly, it examines the key local factors explaining differentials in city house price levels in a panel regression framework, using available data on the dynamics of per capita income, population and distances between cities.

The analysis indicates limited evidence of long-run convergence in city-level

house prices for the euro area or the US. Indeed, there appears to have been a varied pattern dispersion of city-level house prices in contrast to fairly similar cycles in the national indices for many (though not all) large euro area countries and the US since the 1990s. In general, however, there has been a lower dispersion of city level house prices in the four largest euro area economies compared with the US. A rise in the dispersion of house price differences across city pairs has been observed in recent years for Germany, Italy and the US, in contrast to a decline in Spain and France. The results of the panel regression indicate an important role for income in explaining city-level house price dispersion in Germany, France, and the US (but not Italy or Spain when unobserved city factors are taken into account). At the same time, population differences across cities play a role in explaining house price differentials, though this appears to be associated with city-level amenities. The results, particularly for income, appear to be robust to changing the sample composition to encompass only large urban centres.

There are several caveats to the analysis, notably relating to the representativeness and comparability of house price data at the city level along with an incomplete list of explanatory factors – economic and financial factors, as well as the role of policies and preferences – hampered by data unavailability. These caveats notwithstanding, this analysis provides some new evidence on the dynamics of city-level house prices in the euro area compared with the US which, given that national housing markets are inherently a function of local markets, may help contribute to a better understanding of more generalised house price dynamics.

1 Introduction

The spatial distributions of house prices at the city level, and their dynamic evolution, are driven by many factors related both to housing's role as a consumption good and asset. On the one hand, housing as a consumption good has a very strong non-traded component in the form of land and labour, with only a small traded component in the form of, for instance, construction materials. This would limit the prospect of price convergence across geographic regions, except possibly in the long run to the extent that income –or productivity levels– converge across geographic areas, or in areas where housing has a strong tradable component. In such an environment, city-level house prices would be expected to mainly reflect local factors such as regional per capita income, amenities or population dynamics. On the other hand, price convergence in house prices might, however, nonetheless arise over shorter time periods given, inter alia, common movements across various regions in housing fundamentals (such as income) at a business cycle frequency, concurrent changes or convergence in borrowing conditions associated with housing acquisition and, on the asset pricing side, the correlation of housing risk premia in its role as an asset class across regions. Indeed, housing risk premia –or the higher expected return accrued for bearing risk on specific to owning a house– should consist of both a market risk component generally associated with housing assets (which could co-move across regions as the desirability of this asset class varies) and an idiosyncratic risk component (associated with any particular house). Moreover, as with other asset classes, house prices should contain some information on expected future returns on the basis of foreseen developments in fundamentals, potentially implying a higher volatility in house prices than current local income. Any comovement in house prices across regions may be particularly relevant in currency unions, given expected convergence linked to policies, as well as linkages in trade, financial markets and some correlation in general economic conditions.

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The analysis indicates limited evidence of long-run convergence in city-level house prices for the euro area or the US. Indeed, there appears to have been a varied pattern dispersion of city-level house prices in contrast to fairly

similar cycles in the national indices for many (though not all) large euro area countries and the US since the 1990s. In general, however, there has been a lower dispersion of city level house prices in the four largest euro area economies compared with the US. The results of the panel regression indicate an important role for income in explaining city-level house price dispersion in Germany, France, and the US (but not Italy or Spain when unobserved city factors are taken into account). At the same time, population differences across cities play a role in explaining house price differentials, though this appears to be associated with city-level amenities. The results, particularly for income, appear to be robust to changing the sample composition to encompass only large urban centres.

In the remainder of the paper, a review of frameworks for regional house price analysis, along with a review of results, is presented in Section 2. Some stylised facts for the five countries analysed are then presented in Section 3. A presentation of the empirical strategy and results follows in Sections 4 and Section 5, respectively. Finally, some concluding remarks are contained in Section 6.

2 Frameworks for regional house price analysis and existing results

One classic approach to modelling the evolution of regional house prices is the framework of Rosen (1979) and Roback (1982). In this approach, wages (or productivity), amenities (physical or other attributes specific to a location such as weather, green space, proximity to the sea/lake/river, crime, etc.), and the user cost of housing play a key difference in generating conditions whereby consumers are indifferent across space at all points in time. Glaeser and Gyourko (2006) build on this framework in developing a more up-to-date dynamic model of house prices.

The above approach would not suggest a strong likelihood of house price convergence apart from that deriving from the convergence of its main demand determinants. Indeed, housing has a strong consumption good component which is not tradable across geographic areas, given the immovability of the property location (and limited associated arbitrage possibilities). While there is some traded component of housing in the form of raw material costs, construction and other costs might also differ by location.[1]

There are, however, several arguments why house prices may converge across regions. First, housing demand fundamentals such as income or interest rates may converge across regions – both in a shorter term or transitory

[1]Tax and regulatory considerations might also be region specific, thereby contributing to limit price convergence.

manner (possibly associated with the "lift all boats" aspects of an economic cycle) and a longer term or permanent manner (as productivity levels converge). Even in the case that standard housing demand fundamentals do not converge, housing risk premia may nonetheless correlate across regions in the case that a general market risk component of housing as an asset class co-move across regions as the desirability of this asset class varies (independent of either an idiosyncratic risk component associated with any particular house, or of fundamentals at the local level). Moreover, as with other asset classes, house prices should contain some information on expected future returns on the basis of foreseen developments, including convergence, in fundamentals.[2] Indeed, some papers have suggested that convergence in house prices might be expected as shocks to regional house prices "ripple out" across the economy on account of factors such as migration, equity transfer, spatial arbitrage and spatial patterns in the determinants of house prices – see, for instance, the application to house prices in the United Kingdom of Meen (1999).

The evidence on actual house price convergence across regions in Europe at the *country* level is mixed, while any analysis at the *city* level appears to be quite scarce apart from some studies of the United Kingdom. On the one hand, Smullen and MacDonald (2006) argue that convergence of prices has been occurring in Europe over the last ten years, notably in Germany, Italy, France, and Spain. At the same time, they observe that while there have been some developments in relation to market harmonization, the diversity of legal, tax, regulatory, and especially cultural and behavioral aspects of the different marketplaces is so large that this convergence trend is likely to be weak for the foreseeable future. On the other hand, Holmes and Grimes (2008) investigate the long-run convergence of regional house prices in the UK, and find the presence of multiple stochastic trends with, at best, very weak evidence of long-run convergence. Using a principal components methodology, they find that regional house prices in the United Kingdom are driven by a single common stochastic trend and they can be regarded as exhibiting convergence in the long-run, even if the speed of adjustment towards long run equilibrium is low. At the euro area country level, Vansteenkiste and Hiebert (2009) find that house price spillovers are small in the euro area compared with those across states in the US.

While there is limited literature on house price convergence in continental Europe, studies examining convergence in tradable goods are quite numerous. Bergin and Glick (2007) find significant time-variation in the degree of convergence of global prices for goods and services over the last fifteen years. Specifically, there appears to be a general U-shaped pattern with

[2]Hiebert and Sydow (2009) argue on the basis of a dynamic dividend-discount model that stable low-frequency variation in expected returns may have contributed to large and persistent swings in euro area house prices.

price dispersion first falling and then rising in recent years, a pattern difficult to explain in terms of the standard gravity equation variables common in the literature. Rogers (2005) provides evidence of a striking decline in dispersion for traded good prices across European cities, most of which took place prior to the launch of the euro. As a result, dispersion in the euro area is now more similar to that in the US. Bundesbank (2009) report that during the past ten years, there has been, if at all, only a moderate tendency to further convergence in prices of goods and services in the euro area. At the industry level, Goldberg and Verboven (2005) find strong evidence of convergence towards both the absolute and the relative versions of the Law of One Price based on European car market data.

3 Stylised facts on city-level house price dynamics

Since 1990, house prices have exhibited remarkably similar cycles in cities within the 4 largest euro area countries and the US. Following a stagnation in the level of city-level house prices for a decade at their 1990 level across all of the countries analysed, there was a correlated increase thereafter across all countries with the exception of Germany (see Figure 1, Panel f). By 2006-8, national house prices had peaked 135% from their 2000 value in Spain, 100% in France, and 75% in Italy. National house prices in the US increased by a similar amount to France –by around 93%– over the same period. In contrast, house prices at the national level in Germany fell by around 11.5%.

These movements in the national index, however, were associated with considerable heterogeneity in house price levels at the city level *within* each respective country. Whereas a more or less constant wedge in France existed between 2000 and 2008, as measured by the large dispersion between the maximum house price and minimum house price as well as the standard deviation, dispersion across cities appears to have grown over the period in all other countries analysed – that is, Germany, Italy, Spain, and the US.[3]

Indeed, examining house price levels in 2006, there were markedly differing levels amongst cities within the euro area countries – though the dispersion between maximum and minimum paled in comparison with the US (see Figure 2). In Germany, the average house price in Munich in 2006 was $3\frac{1}{4}$ times above its counterpart in Magdeburg. In France, the average house price in Paris in 2006 was $3\frac{3}{4}$ times above its counterpart in Limoges. In

[3]It should be noted that not all cities included in the national aggregate are included in the sample analysed in this paper. As indicated in Muzzicato, Sabbatini, and Zollino (2008), the weight in the general index for Italy of large cities such as Milan and Rome is only of the order of around 5% each, based on the share on total dwellings in 2001 among all municipalities included in the index.

Italy, the average house price in Venice in 2006 was close to 3 times above its counterpart in Palermo. In Spain, the average house price in Madrid in 2006 was $1\frac{3}{4}$ times above its counterpart in Valencia. In the US, however, the average house price dispersion was considerably more marked than in any of the euro area countries, with average house prices in San Francisco in 2006 nearly *10 times* above their counterpart in Detroit. The relatively larger dispersion in US city prices, though per unit and not per square metre, nonetheless hint at a stronger role for heterogeneity in the average city level housing supply elasticity to housing demand shocks compared with the euro area.

Regional per capita income appears to be an important determinant of city-level house prices across all four of the euro area countries analysed. The scatter plot contained in Figure 3 would suggest a positive relationship between regional income and city level house prices in 2006 for both the euro area countries and the US. Within the countries, it would seem that there is a rather strong positive implied trend between city level house prices and regional income in Germany, Spain and the US, a positive relationship with some clustering in Italy (corresponding largely with a geographic North-South distinction), and a fairly limited relationship in France (with Paris being a clear outlier). Comparing an ordinal ranking of house price levels to house price to income ratios, however, it would appear that regional income alone is not sufficient to explain the relative level of city house prices across all four of the euro area countries analysed. Figure 4, which contains an ordinal ranking in 2006 of city-level house price levels (denoted with dots) with their corresponding house price to income ratios (denoted with an "X"), indicates that a clean linear mapping does not exist between house price-income ratios and house price levels for either the euro area (upper panel of the Figure) or the US (lower panel). As indicated in Figure 3, the relationship of city level house prices to regional income, however, appears to have been more robust than the corresponding relationship with population in either the euro area or the US.

More generally, the higher-order moments of the distribution of city level house prices appears to have been only loosely linked to regional income. Examining the evolution of the distribution of standardised city level house prices and regional income between 2000 and 2006 (see top panel of Figure 5), there was a flattening in the distribution of city level house price levels in the euro area countries over the period, in contrast to a tightening of the distribution of income. This corresponded to both an increase in the dispersion of house prices across cities as well as a more positive skew. Comparing these distributions with those of the US, it would appear that house price levels have been relatively even more dispersed in the US. Moreover, income convergence over the period 2000 to 2006 in the US appears to have been more limited than in the euro area countries. This could be taken to

suggest a possible role of heterogeneous supply elasticity as well as higher labour market mobility in regional house price developments in the US when compared with the euro area.

4 Methodology

This section presents details of the methodology followed to generate variables used in the analysis of city-level house prices in the four largest euro area countries and the US. It begins with a brief overview of the variables used in the analysis.[4] It then details the methodology used to generate a database of bilateral city pairs. Lastly, it presents the empirical specification used in generating the panel regression results in Section 5.

4.1 Variable selection

We compare house price level differences across cities among the different countries in order to answer whether geographical mobility, decreasing financial market frictions and increasing market integration have been accompanied by declining price dispersion.

House prices are empirically modelled as a function of several determinants – per capita income, population, distances between cities and amenities that are assumed to be time-invariant in a fixed effects panel regression framework– in a spatial equilibrium framework in the spirit of the models discussed in Section 2. Per capita income has a clear rationale as the main determinant of housing affordability. Population also contains information relevant to housing demand and its effects on prices through changes in density or agglomeration. These two determinants, which can be predominantly classified as housing demand determinants, albeit with some influence on housing supply, are partly chosen on the basis of data availability for city-level analysis for the euro area countries analysed. In addition to per capita income and population, explicit measures of distances between cities are also added to gauge both the geographic propensity for price shock effects "rippling out" across urban centres as well as the possibility of housing substitution between adjoining districts.

While the above list of explanatory factors does not include all relevant variables for regional house price determination, other variables might a priori be expected to have a limited effect. For instance, one component of the user cost of housing with presumably large effects and which fluctuates most over time would tend to be the after-tax mortgage rate, which have been rather similar across regions in the largest euro area countries over the last years

[4]For more on data sources, see Appendix A.

and, at any rate, show little within-country variation.[5] Likewise, though Glaeser, Gyourko, and Saiz (2008) argue that varying degrees of housing supply elasticity is important for explaining the dynamics of city level house price developments in the US, housing supply is not modelled here for lack of data availability but is nonetheless likely to be more uniformly inelastic in euro area metropolitan areas than in cities within the US.

4.2 Generating a database of city-level dispersion

The variables are analysed in spatially differenced form in order to assess factors underlying house price dispersion. This definition of the variables allows for stationary data which can be tested for convergence and clustering. For the tests of convergence, city-level house prices are compared with the corresponding national index. For the panel data econometric analysis, we define price dispersion across cities as the difference (logs of) of relative house prices – following the exposition of Bergin and Glick (2007). Specifically, let $p_{i,t}$ be the price of a unit of housing in city i at time t, where all prices are expressed in local currency. For a given city pair (i, j), the relative price difference at time t in percentage terms (where lower case denotes logs) is:

$$q_{ij,t} = p_{i,t} - p_{j,t} \tag{1}$$

In this way, we define the average price dispersion at time t for the city pair (i, j) as $q_{i,j}$.[6] The same city-level difference transformation is made for income per capita and population. Distances are, naturally, constant across city pairs.

As there is obviously a symmetric matrix of potential city pairs, we only analyse one observation within each set, leading to $N(N-1)/2$ observations. Ultimately, there are potentially $N(N-1)/2$ city pairs in the euro area, for up to 19 annual observations. Thus, the sample consists of $2,485$ static observations of dispersion among city pairs for the euro area countries analysed, compared with 190 static observations of dispersion among city pairs for the cities analysed in the US. The resulting length when taking into account the number of dynamic observations –based on varying time series– is reported in Table 2.

[5] Time series for other relevant variables in the user cost of housing, such as local tax rates, city-specific depreciation, and information on expectations of house price appreciation, are unfortunately difficult to obtain at the city level.

[6] There is also the possibility of obtaining mean *squared* differences across regions as done in Bergin and Glick (2007), which did not greatly influence the results.

4.3 Specification of panel regression

We estimate the equation below for all the possible city pairs within Germany, Italy, France, Spain and the US. We then pool the data for the four largest euro area countries and estimate the same specification for a pooled euro area sample. In this specification, $q_{ij,t}$ is the relative price difference at time t in percentage terms (note that lower case letters denote logs), $dist_{ij}$ is the distance across city pairs, $pop_{ij,t}$ is the relative population difference at time t in percentage terms and $inc_{ij,t}$ is the relative income difference at time t in percentage terms. $e_{ij,t}$ is an error term.

$$q_{ij,t} = \alpha_0 + \alpha_1 dist_{ij} + \alpha_2 pop_{ij,t} + \alpha_3 inc_{ij,t} + e_{ij,t} \quad (2)$$

Standard errors are clustered at the city pair level to address potential problems of heteroskedasticity and autocorrelation in the error terms.[7]

5 Results

This section reports the results of the empirical investigation of city-level house prices in the four biggest euro area countries and the US. It focuses first on the convergence of house prices across cities in the four largest euro area countries (Germany, Spain, France, and Italy) and compares this pace of convergence with that witnessed within cities across the US, in the spirit of the methodology used in Engel and Rogers (2004) and Bergin and Glick (2007). A panel regression is then run on annual city-level house price data spanning the period 1990 to 2007 (the latter subject to data availability), examining time-varying features of data series likely related to price dispersion, such as income, population and geographic distance, and relating price dispersion between cities to these factors.

5.1 Testing for price level convergence to national level

Several panel unit root tests are performed to test price convergence in each of the euro area countries examined and in the US (Levin, Lin & Chu, Im, Pesaran & Shin, Augmented Dickey-Fuller, and Phillips-Perron). For each country, the log of nation-wide house prices is used as a numeraire. For each city, a dynamic relative price difference (in logarithms) between city house prices and nation-wide prices is computed. In all tests reported, the null hypothesis is the presence of non-stationarity (i.e. a unit root). A rejection

[7] All estimation is done using STATA 9.0. Clustering at the country pair level allows the variance to differ across pairs while permitting an unstructured covariance within the clusters to control for correlation across time.

of the null hypothesis of non-stationarity is generally interpreted as price convergence or at least an indication that relative prices return to a fixed value in the long-run.

Results for the formal tests of price convergence are reported in Table 1. In Germany and Spain there is generally no indication of price convergence. Results for France, generally pointing to price convergence, have to be cautiously interpreted given the shorter time span of the sample (8 years) compared to the other countries. In Italy there is an indication of convergence and that relative prices tend to be fairly anchored within the sample period examined. This notwithstanding, a clustering of relative house prices between cities in the North of the country (exhibiting higher relative prices) and cities in the South (with lower relative prices) is evident and does not disappear over time. For the US, results are not conclusive, as the Philipps Perron test does not indicate convergence while the other three tests point in the opposite direction. Moreover, results for the US, contrary to those for the euro area countries, are not robust to changes in the lag specification and therefore do not allow for firm conclusions.

Given issues related to the low power of unit root tests in finite samples, the results can be supplemented with a review of graphical evidence on the time variation in the dispersion of city-level price levels by country. Figure 6, which contains the standard deviation of large euro area and within-country city pairs, suggests a rise in the dispersion of house price differences across city pairs in recent years for Germany, Italy and the US, in contrast to Spain and France. That said, a "U-shaped" pattern in Germany, with falling city-level house price dispersion in the 1990s followed by rising dispersion thereafter, may suggest some role of unification for convergence of house prices in east Germany to west German levels in the earlier period. More generally, the dispersion of the US city pairs appears to be considerably higher on average than the dispersion in euro area countries –consistent with the static representation for 2006 in Figure 2– despite a relatively lower dispersion in regional income.

All in all, these results for large euro area countries and the US are broadly in line with Holmes and Grimes (2008), who document weak evidence of long-run convergence in regional house prices in the UK and a general lack of consensus in the literature on this topic.

5.2 Analysing regional house price dispersion in panel data framework

Table 2a presents estimation results of an OLS specification of equation 2 including time and city dummies. Results of a pooled sample of the four euro area countries analysed are followed by results for individual countries (Ger-

many, Italy, France, Spain and the US). The estimation yields the following findings:

- The distance across city pairs is generally not statistically significant in the country specifications and in the pooled estimation. A priori, being housing a non tradable good, distances across locations, which in gravity models proxy (fixed) transportation costs (see Bergin and Glick (2007)), would not be expected to explain relative house prices across city pairs. Beyond this, results not do not support the idea of housing substitution across adjoining districts.

- The coefficient associated with differences in populations across city pairs is always positive but statistically significant at the 1% level only in Germany, France and in the pooled euro area sample. This would suggest that bigger cities exhibit higher house prices, as graphically shown in Figure 3.

- The coefficient associated with income differentials across city pairs is also positive and statistically significant (generally at the 1% level). As expected, positive income differentials across city pairs, which are related to productivity and wage differentials, should attract flows of workers thus pushing up housing demand and in turn house prices (see Nieuwerburg and Weill (2006)). The magnitude of the income coefficient, i.e. the elasticity of relative house price differentials to relative income differentials, is close to but below 1 in the euro area countries and in the pooled sample, but larger in the US (above 2).[8] This could reflect an extended period of stronger regional house price variation within the US sample period examined, culminated with the subprime crisis, indicating that relative house price changes exceeded corresponding income dynamics. Indeed, Glaeser, Gyourko, and Saiz (2008) suggest that heterogeneous housing supply elasticities across US cities has contributed to price bubbles in certain regions but not others depending on whether quantities are constrained in response to demand shocks.

Table 2b presents the results for the same specification discussed above using a fixed-effects estimation with time and city dummies. As previously discussed, this estimation methodology allows taking into account unobservable time-invariant characteristics which are believed to influence relative house price differentials over time. Among these unobservable components are amenities/disamenities associated with a certain location (infrastructure, supply of green areas, pollution or lack of it, crime rates etc) as well as

[8]For the pooled euro area specification, it is possible that there is a role of differing borrowing conditions across countries in determining the extent of house price convergence.

city specific characteristics (such as weather conditions). The importance of these unobserved factors is confirmed by the fact that some of the country specific results slightly differ from the OLS one. More specifically, for the pooled euro area countries and the US the results of the fixed effects estimation are broadly in line with the OLS. Moreover, the estimated coefficients for the US are similar to the OLS one while for the pooled euro area sample they are larger. The estimation results indicate:

- At the country level, the coefficient associated with differences in populations across city pairs is positive and statistically significant at the 10% level only in Germany. It is however not statistically significant in the other three euro area countries. This would suggest that (in Italy, France, Spain as well as in the US) differences in population do not provide information in explaining relative prices at the city level once the unobserved characteristics discussed above are taken into account.[9] Differences in populations across cities are indeed likely to be correlated to local amenities/disamenities. Moreover, population may embed some information on supply elasticities: Green, Malpezzi, and Mayo (2005) find that population is one of the key supply determinants at the metropolitan level in the US.

- Income differentials continue however to be a driving factor in explaining relative house price differentials in all countries except in Italy and Spain where the coefficients are not statistically significant. For the case of Italy, this would be consistent with the finding of Miles and Pillonca (2008), who find evidence of only a modest real income contribution to house prices changes over the period 1996-2006.

Finally, we have estimated the same specifications discussed above both with OLS and fixed effects for a sample of large cities for the pooled euro area (including cities above 600,000 inhabitants) and for the US (including metropolitan areas with a population above 4 million).[10] Results for the euro area are confirmed (see Table 3). Interestingly, the elasticity of relative prices to relative income for the fixed effect specification is lower for the sample of euro area larger cities (0.76 versus 1.56) pointing to more subdued changes in relative prices for a given income differential within this sample of more homogenous cities in terms of income level. Results for the US panel of larger metropolitan areas indicate that population differentials is positively related to price differential (in the OLS) while it continues to be insignificant in the fixed effect estimation. Surprisingly, the coefficient for

[9] This stands somewhat in contrast to the finding at the national level in Spain by Miles and Pillonca (2008).

[10] In larger cities, arbitrage may be more likely given a larger proportion of foreign population.

the distance across cities is negative and statistically significant. Finally, the coefficient associated with income differential is remarkably stable in terms of size (above 2) and statistical significance across all the specifications and samples examined.

6 Conclusions

This paper examined the behaviour of city house price levels across the four biggest euro area countries using available data over the period 1980-2008, comparing their evolution with those in the US. The analysis indicates limited evidence of long-run convergence in city-level house prices for the euro area or the US. Indeed, there appears to have been a varied pattern dispersion of city-level house prices in contrast to fairly similar cycles in the national indices for many (though not all) large euro area countries and the US since the 1990s. In general, however, there has been a lower dispersion of city level house prices in the four largest euro area economies compared with the US. The results of the panel regression indicate an important role for income differentials in explaining city-level house price dispersion in Germany, France, and the US (but not Italy or Spain when unobserved city factors are taken into account). At the same time, population differences across cities play a role in explaining house price differentials, though this appears to be associated with city-level amenities. The results, particularly for income, appear to be robust to changing the sample composition to encompass only large urban centres.

There are several caveats to the analysis, notably relating to the representativeness and comparability of house price data at the city level along with an incomplete list of explanatory factors – economic and financial factors, as well as the role of policies and preferences – hampered by data unavailability. These caveats notwithstanding, this analysis provides some new evidence on the dynamics of city-level house prices in the euro area compared with the US which, given that national housing markets are inherently a function of local markets, may help contribute to a better understanding of more generalised house price dynamics.

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Appendices

A Data sources

HOUSE PRICES

Definition: Log of house prices from national sources (see below):a series for existing houses is used for Germany and Italy, a combined series (incorporating existing and new houses) for France and Spain. In the US house prices for a median dwelling in 2000 from the Census were chained dynamically using house price indices from S&P / Case-Shiller.

Units: EUR per square metre (Euro area countries), USD per typical dwelling (US).

Source: BulwienGesa AG (Germany), Federation Nationale de l'Immobilier – FNAIM (France), Nomisma (Italy), Ministerio de Vivienda (Spain), Case-Shiller S&P and Census (US).

PER CAPITA INCOME

Definition: Disposable income of private households by Nomenclature d'unités territoriales statistiques (NUTS) 2 regions. Purchasing power standard based on final consumption per inhabitant. For cases in which city-level income was unavailable, income from the relevant region was used as a proxy.

Units: EUR (Euro area countries), USD (US).

Sources: Eurostat and Bureau of Economic Analysis/ Census (US).

POPULATION

Definition: Total resident population.

Units: Thousands.

Sources: Eurostat (Euro area countries) and Census (US).

DISTANCES

Definition: Distance between city pairs, computed using the great circle formula on the basis of geographical coordinates.

Units: Kilometres.

Sources: mapsofworld.com

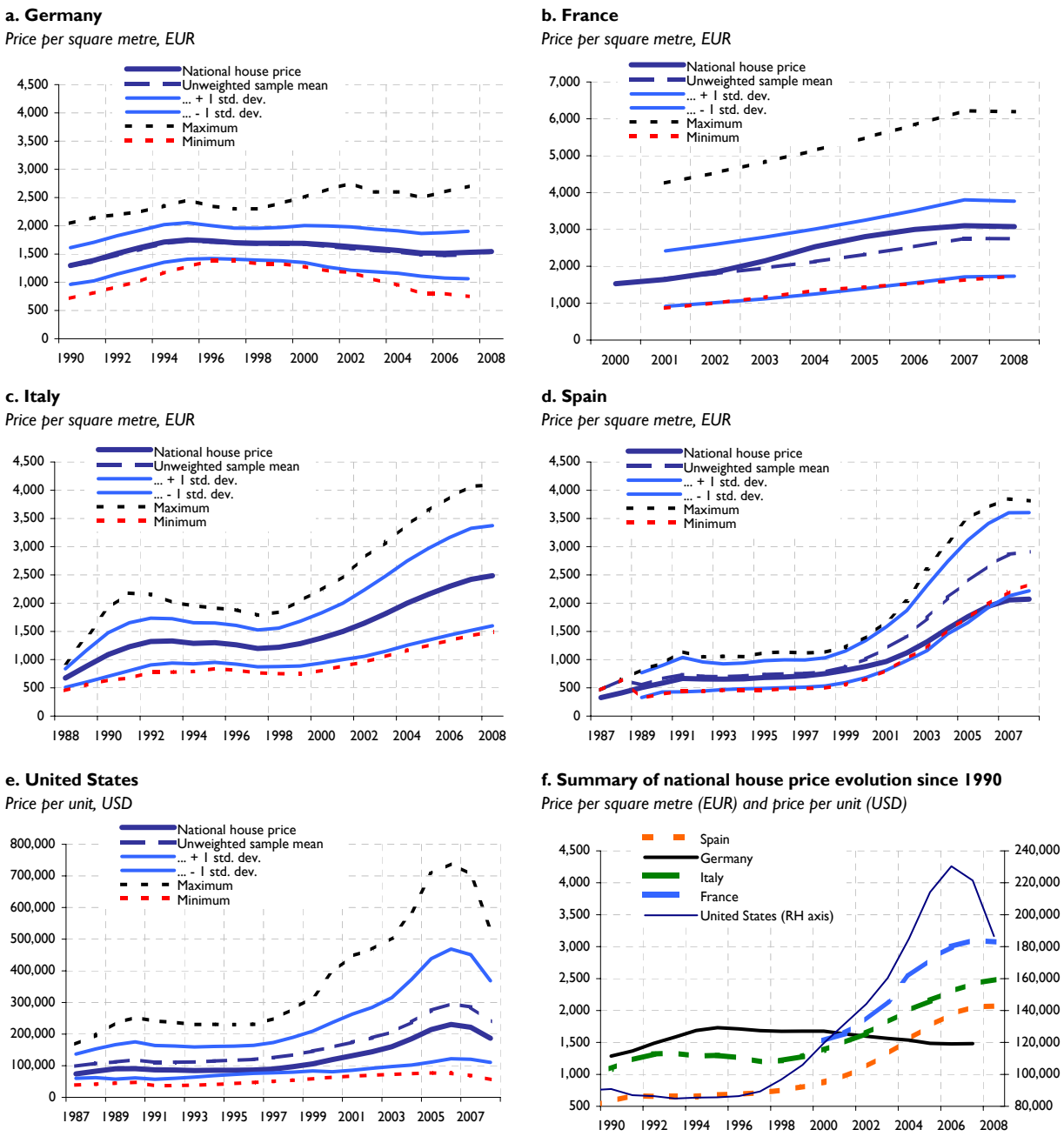


Figure 1: Evolution of house price level

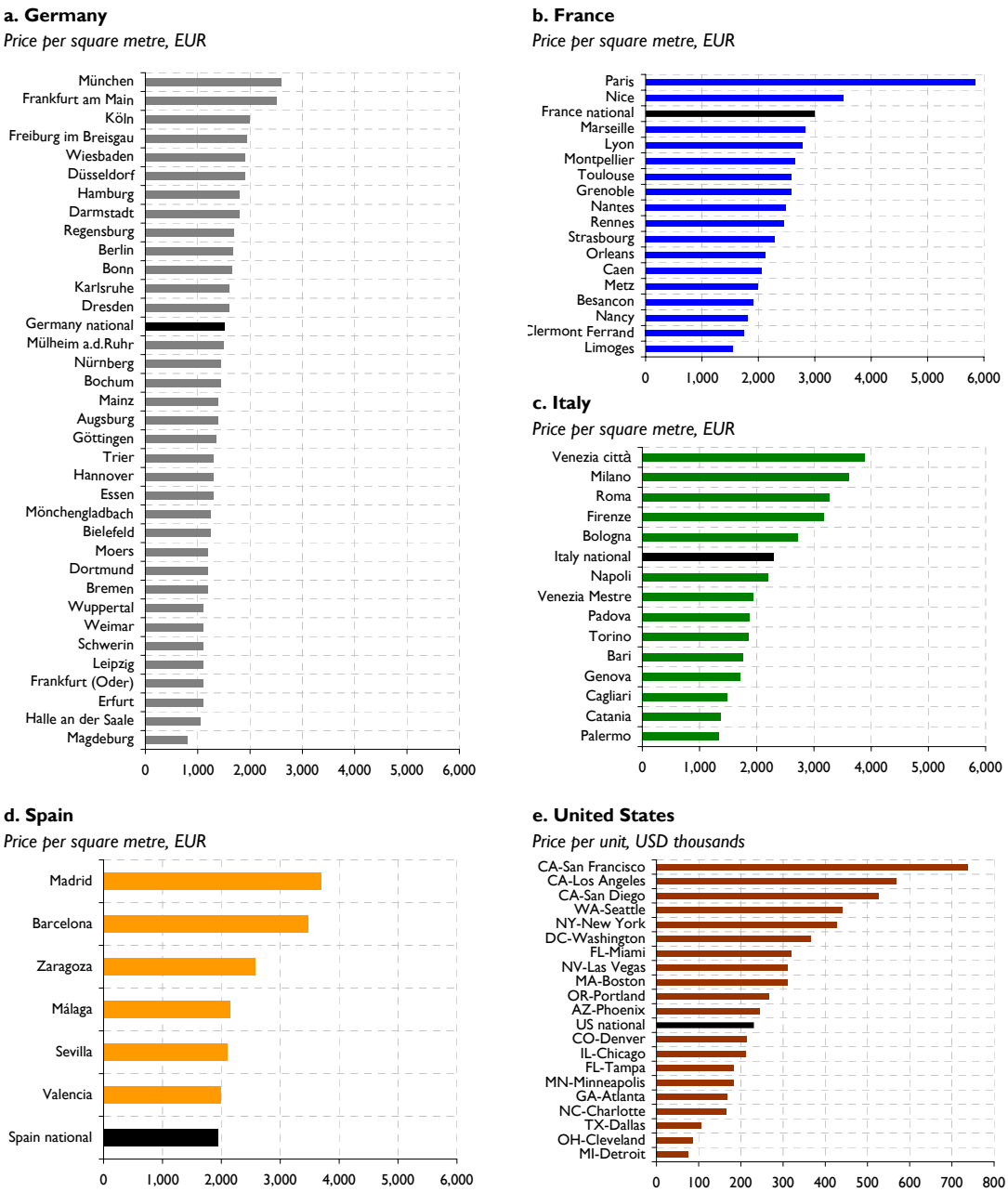


Figure 2: House price level (2006)

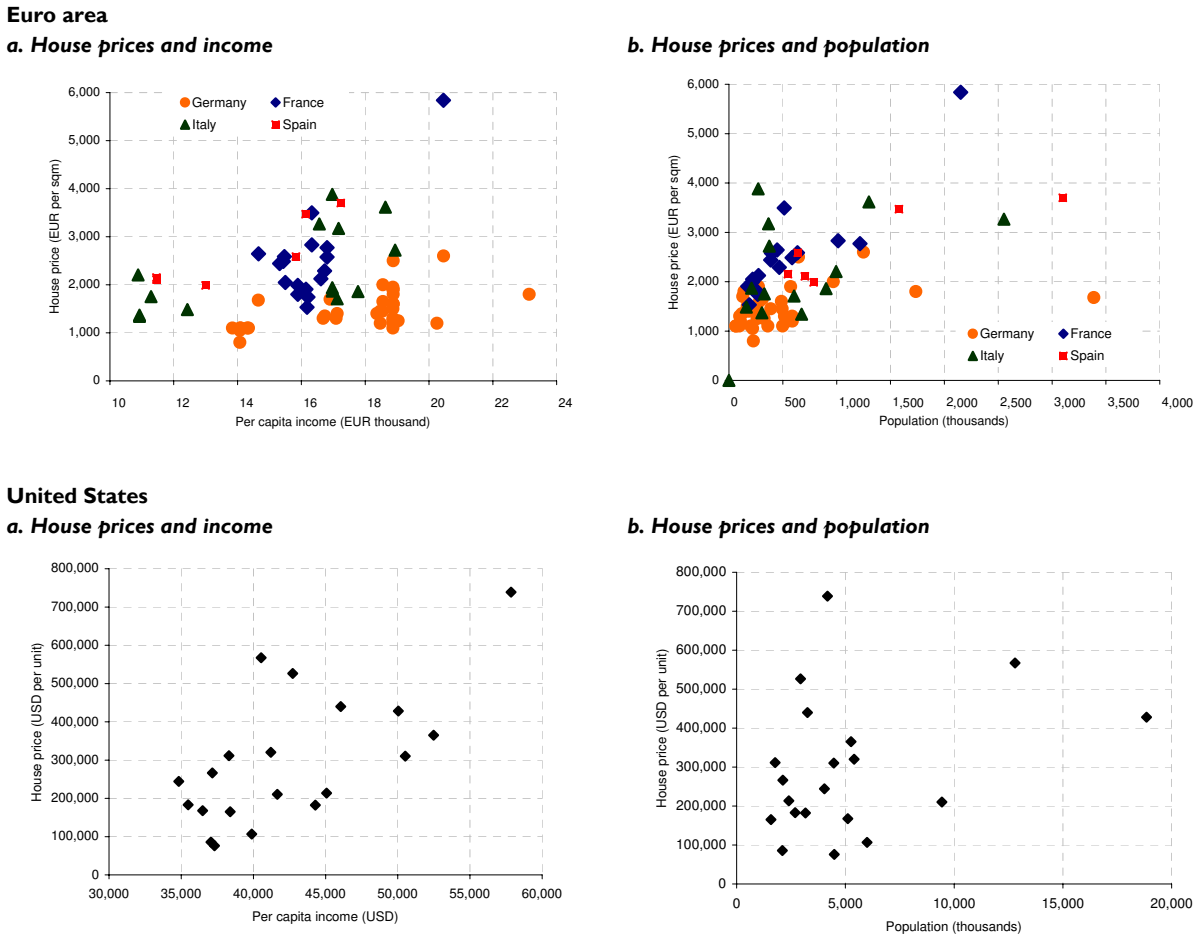
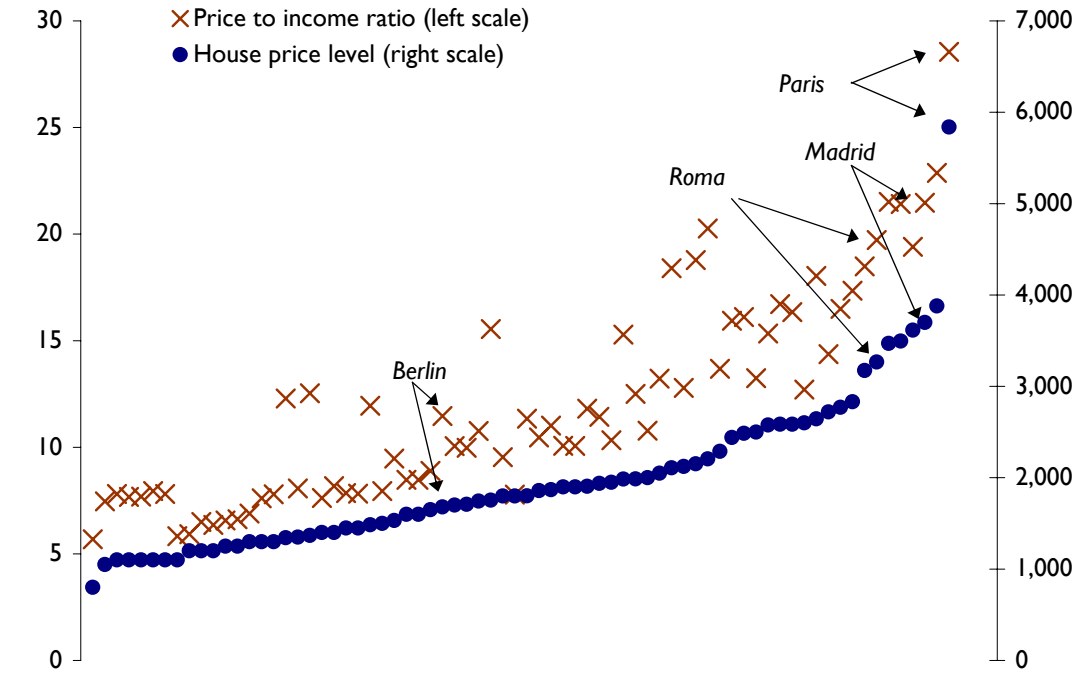


Figure 3: Correlations between house prices and income-population (2006)

a. Euro area *(EUR)*



b. United States *(USD)*

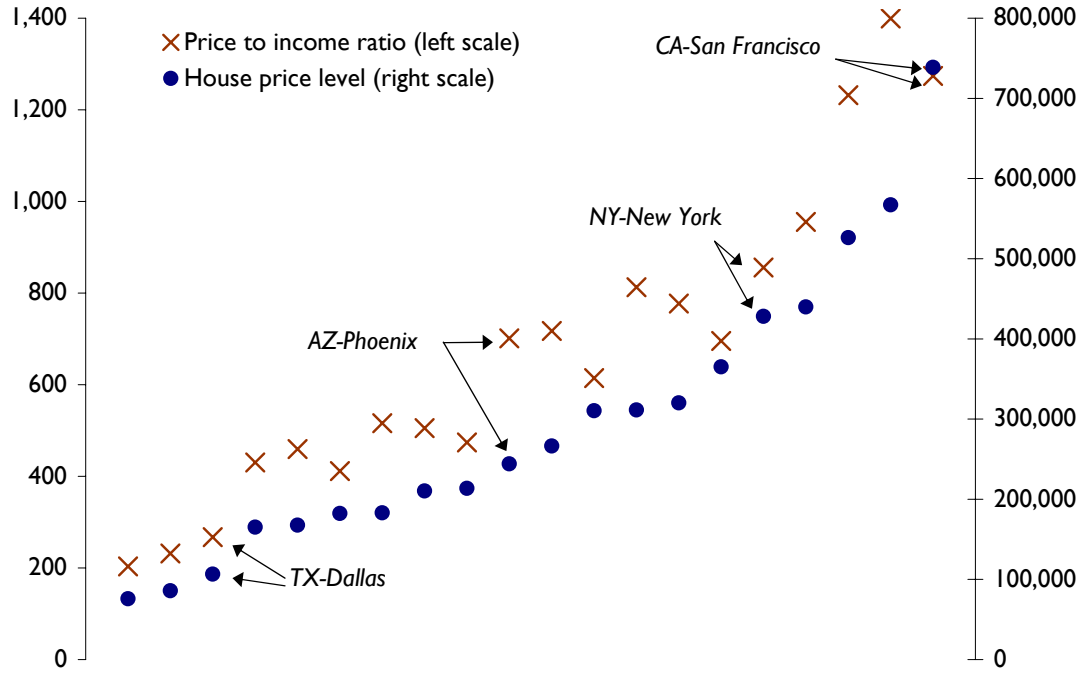


Figure 4: Euro area house prices and their ratios in per capita income (2006 data)

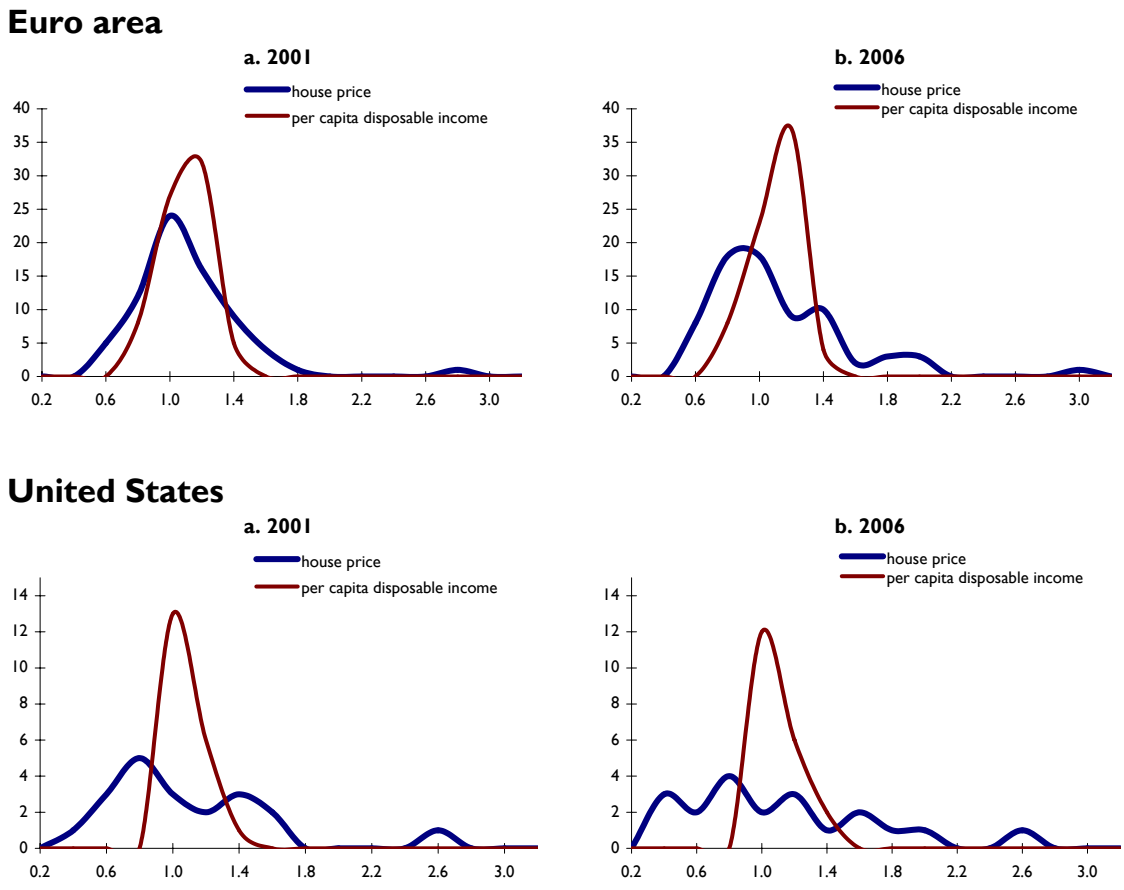


Figure 5: Frequency distributions of standardised house prices and income

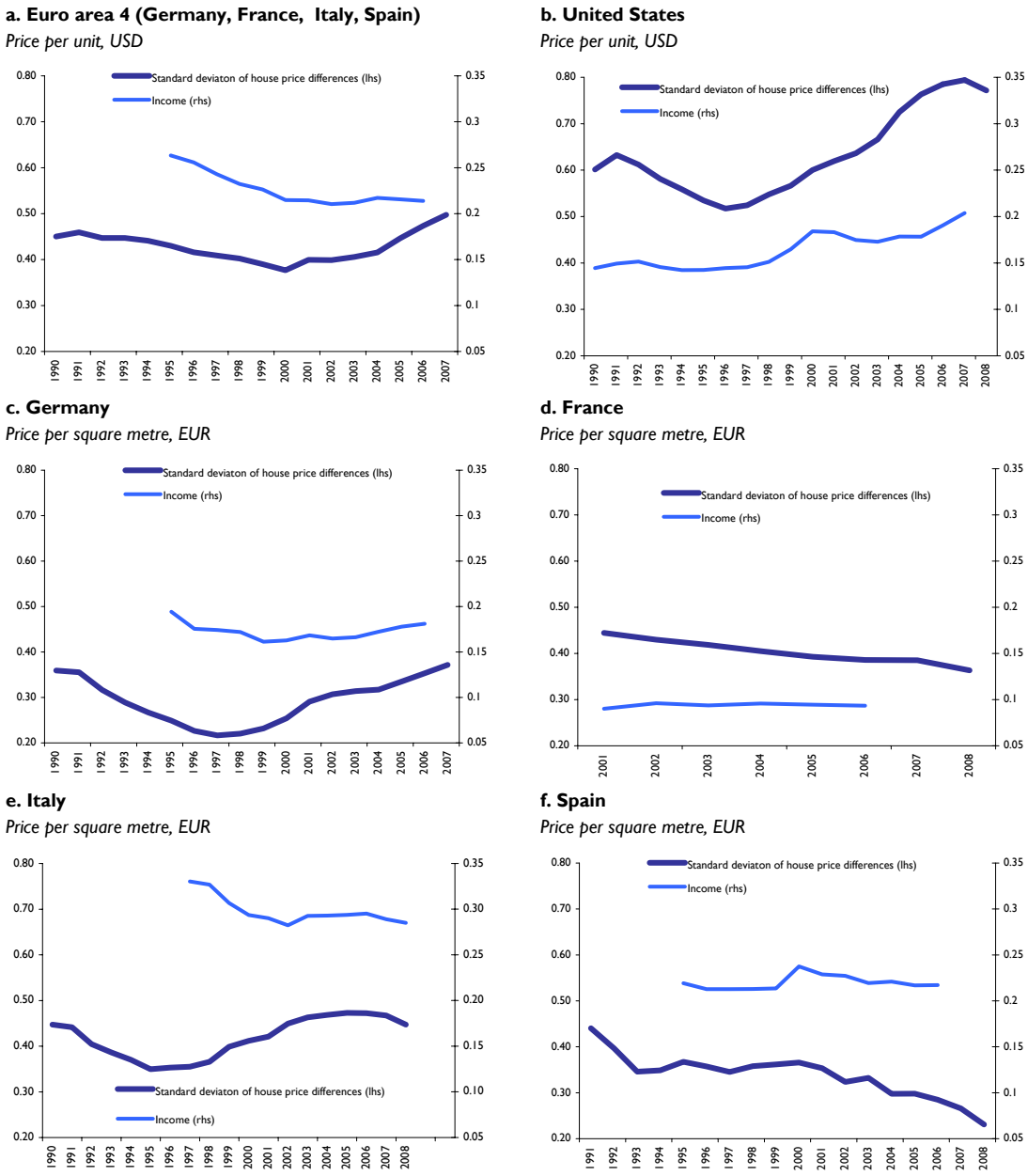


Figure 6: Standard deviation of house price and income dispersion across all city pairs (%)

Table 1. Panel unit root tests for city-level house prices
Test statistics (with p-values in parentheses). The null hypothesis for all tests assumes individual or common unit root process.

	Levin, Lin & Chu	**Im, Pesaran & Shin**	**ADF**	**PP**	**No. obs**
Germany	-2.45	-1.15	84.53	58.69	*595*
	(0.007)	(0.125)	(0.114)	(0.83)	
France	-17.44	-7.08	125.25	43.68	*119*
	(0)	(0)	(0)	(0.124)	
Italy	-5.63	-4.87	83.04	64.70	*280*
	(0)	(0)	(0)	(0)	
Spain	0.37	1.92	3.22	4.39	*110*
	(0.644)	(0.973)	(0.994)	(0.975)	
United States	-10.92	-8.81	152.74	34.80	*372*
	(0)	(0)	(0)	(0.703)	

Test statistics are t-test (Levin, Lin & Chu), W stat (Im, Pesaran & Shin), and Fisher Chi-square (for Augmented Dickey-Fuller, or ADF, and Philipps Perron, or PP)

Table 2. Results of panel estimation

a. OLS with time and city dummies

All variables in logarithms, dependent variable is the house price gaps across city pairs

	Euro area 4	**DE**	**IT**	**FR**	**ES**	**US**
Distance	0.029	0.032	-0.30	-0.005	-0.065***	-0.090
	(0.024)	*(0.019)*	*(0.030)*	*(0.030)*	*(0.011)*	*(0.083)*
Population	0.105***	0.092***	0.044	0.340***	0.201*	0.024
	(0.018)	*(0.016)*	*(0.064)*	*(0.032)*	*(0.087)*	*(0.049)*
Income	0.886***	0.449***	0.911***	0.924**	0.869*	2.22***
	(0.101)	*(0.112)*	*(0.167)*	*(0.413)*	*(0.340)*	*(0.233)*
Constant	-1.032***	-0.032	-1.374	0.158	0.619	0.238
	(0.166)	*(0.153)*	*(2.001)*	*(0.606)*	*(2.646)*	*(0.751)*
Sample span	*1990-2008*	*1991-2008*	*1990-2008*	*2000-2008*	*1990-2008*	*1986-2008*
Avg. sample	*9.4*	*11.9*	*12*	*6*	*12*	*18.4*
No. cities	*71*	*35*	*13*	*17*	*6*	*20*
No. city pairs	*2,485*	*595*	*78*	*136*	*15*	*190*
Total no. obs	*23,426*	*7,106*	*936*	*816*	*180*	*3,497*
R^2	0.484	0.323	0.750	0.493	0.874	0.391

Robust clustered standard errors are reported in brackets.
*** significance at 1% level, ** significance at 5% level, * significance at 10% level

b. Fixed Effects with time and city dummies

All variables in logarithms, dependent variable is the house price gaps across city pairs

	Euro area 4	**DE**	**IT**	**FR**	**ES**	**US**
Population	1.746***	1.065***	0.187	-0.196	-2.275*	0.100
	(0.374)	*(0.214)*	*(0.417)*	*(0.968)*	*(1.045)*	*(0.084)*
Income	1.569***	0.486**	-0.322	2.264**	0.489	2.39***
	(0.379)	*(0.196)*	*(0.299)*	*(1.118)*	*(0.428)*	*(0.149)*
Constant	-1.264***	0.472***	0.211	-0.083	-1.394*	-0.065
	(0.165)	*(0.090)*	*(0.349)*	*(0.174)*	*(0.616)*	*(0.051)*
Sample span	*1990-2008*	*1991-2008*	*1990-2008*	*2000-2008*	*1990-2008*	*1986-2008*
Avg. sample	*9.4*	*11.9*	*12*	*6*	*12*	*18.4*
No. cities	*71*	*35*	*13*	*17*	*6*	*20*
No. city pairs	*2,485*	*595*	*78*	*136*	*15*	*190*
Total no. obs	*23,426*	*7,106*	*936*	*816*	*180*	*3,497*
R^2(overall)	0.173	0.264	0.023	0.024	0.694	0.332

Robust clustered standard errors are reported in brackets.
*** significance at 1% level, ** significance at 5% level, * significance at 10% level

Table 3. Results of panel estimation - large cities sample
All variables in logarithms, dependent variable is house price gaps across city pairs

	Euro area 4 *OLS*	**Euro area 4** *Fixed Effects*	**US** *OLS*	**US** *Fixed effects*
Distance	0.045		-0.252***	
	(0.037)		*(0.038)*	
Population	0.210***	1.885***	0.329***	0.022
	(0.028)	*(0.377)*	*(0.084)*	*(0.128)*
Income	0.873***	0.764***	2.46***	2.34***
	(0.103)	*(0.251)*	*(0.280)*	*(0.260)*
Constant	-0.953***	-0.932**	1.89***	-0.188*
	(0.244)	*(0.144)*	*(0.334)*	*(0.084)*
Sample span	*1990-2008*	*1990-2008*	*1986-2008*	*1986-2008*
Avg. sample	*9.8*	*9.8*	*17.1*	*17.1*
No. cities	*20*	*20*	*11*	*11*
No. city pairs	*190*	*190*	*55*	*55*
Total no. obs	*1,860*	*1,860*	*943*	*943*
R^2(overall)	0.298	0.303	0.656	0.845

Robust clustered standard errors are reported in brackets.
*** significance at 1% level, ** significance at 5% level, * significance at 10% level