Monetary Policies and European Office Markets Dynamics

Alain Coën[a,*], Benoit Lefebvre[b] and Arnaud Simon[c]

[a] University of Quebec in Montreal, Department of Finance, Ivanhoé Cambridge Real Estate Chair, Canada

[b] BNP Paribas Real Estate and Ivanhoé Cambridge Real Estate Chair, University of Quebec in Montreal, Canada

[c] Université Paris-Dauphine, PSL Research University, CNRS, DRM [Finance], 75016 Paris, France

Abstract

The purpose of this paper is to study the consequences of unconventional monetary policies on Europe's commercial real estate market. To investigate the role of money supply on the real estate markets dynamics, we use panel modelling. Our main objective is to analyze the relationships between office price indexes and monetary variables. Our panel analysis focuses on price dynamics across 16 main office markets in Europe between 2009 and 2019. We have constructed for each market a monetary index suitable for commercial real estate. Our robust results, corrected for the presence of errors-in-variables, report that a positive relationship exists between the global money supply and office prices. Moreover, the largest markets seem more affected by the massive injections of liquidity from the central banks, especially those from the European Central Bank (ECB). We highlight significant differences among office markets in Europe.

JEL Classification: R10, R30, E50

Keywords: Real Estate, Office prices dynamics, Monetary supply, European markets, Panel Estimation

* Corresponding author:

email: coen.alain@uqam.ca (A. Coen) ;benoit.l.lefebvre@bnpparibas.com (B. Lefebvre) arnaud.simon@dauphine.psl.eu (A. Simon)

1 Introduction

During and since the Global Financial Crisis (2008-2009), the central banks have shifted their policies and introduced unconventional monetary measures, which have affected asset prices and investment allocation. Following the approach of Coën, Lefebvre and Simon (2018), if a simple Mundell-Fleming framework is applied to a small open economy that has flexible exchange rates, then when the money supply increases, the interest rate goes down and net exports rise with an increase in overseas investment. As a result, offices (like all asset classes) become more attractive with the lower interest rates, and investment volumes are expected to grow. As real estate supply is quite inelastic in the short term, these massive money injections may have, in theory, inflated prices by increasing the demand.

In this study we look at the historical dynamics of office prices across the main European markets, from 2009 to 2019, and their relationship to the money supply. Collectively, the 16 markets of our analysis represented a total value stock of EUR 1 593 billion in 2019 and were the destination for almost 70% of office investment across Europe.[1] We explain office price indexes using both the time and location dimensions through parsimonious panel modelling. Sectorial and economic variables have been chosen with reference to the relevant commercial real estate literature. An important volume of literature has focused on the impact of economic variables (such as employment, GDP, interest rates or vacancy) on rental values or returns (Hekman, 1985; Hendershott et al., 2010; D'Arcy et al., 1997 and Mouzakis and Richard, 2007, among others). Notably, the lending market for commercial real estate is particularly dynamic and access to consolidated data is relatively easy. Moreover, as rents are the major source of income for investors, the valuation of their properties will depend on rental dynamics and on expected yields (following the Discounted Cash Flow method). However, despite its growing importance after the 2008 economic crisis, the changes in money supply have not been widely used in previous studies to explain the dynamics of the commercial real estate markets.

In this paper we estimate the impact of both the Eurozone money supply and the global money supply on European office markets. Between 2008 and 2019, London, Paris and the big four German markets saw the total value of their stock doubled, while Southern European markets only recovered their pre-crisis value in 2018. To determine the degree of homogeneity of the monetary influence in

[1] Estimation based on market data from BNP Paribas Real Estate.

the reshaping of wealth, we have introduced several segmentations in our study. We establish that, across Europe, the variations of the European monetary aggregate (M2) have had an impact on office prices with an average elasticity of 0.48. In comparison, the global money supply evolutions have not been significant. However, the dynamics and the forces at play are not straightforward as the segmentations show some heterogeneity across Europe.

This article is organized as follows: Section 2 consists of a literature review on the office prices determinants, on the link between the money supply and the real estate markets, and on the European monetary governance. Section 3 details the data, gives a brief overview of the heterogeneous markets under study, and presents the panel model. Section 4 is devoted to the results and their interpretations, and Section 5 offers concluding remarks.

2 Literature review and conceptual framework

2.1 Price determinants for the office markets

An important volume of literature in real estate economics has been devoted to the study of office cycles. As data on commercial prices are recent and because real estate is seen as a long-term investment, most of the works have been focused on rental value determinants rather than purely on prices. As reported by Sivitanidou and Sivitanides (1999), Hendershott et al. (1999), De Wit and Van Dijk (2003) and Hendershott and MacGregor (2005) (among others), variables related to the level of construction, absorption, vacancies, rents, employment growth and real interest rates are particularly relevant. Hekman (1985) was one of the first to express rent as a function of the vacancy rate, GDP, the employment level and the unemployment rate for 14 markets across the US. McGough and Tsolacos (1994) used VAR modelling to estimate the relationship between rent, company profits, business surveys and construction levels. Some of the studies have concentrated on the European office market. For instance, D'Arcy et al. (1997) estimated the rental dynamics of 22 European cities using a time-series cross-sectional methodology. They found that GDP changes and interest rate movements had a significant impact on European rental values. D'Arcy et al. (1999) also examined the short-run adjustment process of Dublin office rents for the period 1970-1997; changes in GDP and office stock were the main factors that influenced the rental dynamic in the city. Wheaton et al. (1997), Hendershott et al. (1999), Hendershott et al. (2002), Farrelly

and Sanderson (2005) all shed light on the relative importance of employment in the dynamics of office markets. More recently, Hendershott et al. (2010), Lizieri (2009), Lizieri and Pain (2014) and Zhu and Lizieri (2020) analyzed office cycles using employment, interest rates and inflation rates. Brounen and Jennen (2009) also developed rent-adjustment models for 10 European office markets from 1990 to 2006 employing a two-stage error correction model. Mouzakis and Richards (2007), using a panel data technic, explained rental growth across 12 office markets in Europe, with their model providing new insights into the intra-market dependence of markets. They reported that London, Amsterdam, Dublin and Madrid seemed to respond more quickly than others to a change in the explanatory variables.

Due to an evident lack of contemporary studies which incorporate the new economic environment, there is a need to investigate price dynamics at a pan-European level to give greater clarity on the potential changes, especially after the unprecedented Global Financial Crisis (GFC) and the adoption of new monetary policies.

In macroeconomic literature, Mishkin (2007) examined the role played by money supply in the dynamics of the real estate and housing markets in the United States. Taylor (2007) and Feldstein (2011) reported a clear link between accommodative monetary policies between 2002 and 2004 and the housing bubble in the US. More recently, Coën, Lefebvre and Simon (2018) demonstrated that international money supply was a key determinant in the real estate risk premium of the London office market. Following these findings, we now put forward an analysis of the monetary policy led by the European Central Bank (ECB) after the GFC and its potential effect on the European office markets.

2.2 Money supply, unconventional monetary policies and real estate markets

For a period of 10 years, which has seen interest rates fall close to zero, central banks have shifted their policies and introduced unconventional monetary measures. Analysis of the effects on asset prices of these massive monetary injections, rather than the effects of interest rate movements, is nowadays more relevant. If the impact of money supply on stock prices is well-documented in literature (Rozen, 1974; Patelis, 1997; Bernanke and Kuttner, 2005; and Feldstein, 2011, among others), fewer studies have focused on the influence of money supply on real estate prices. The limited number of recent articles dealing with it are mainly fixed on the housing markets (Iacovello,

2015 and Chiang et al., 2015, for the US) and far less frequently on office markets (Coën et al., 2018, for London). The lack of studies in this area must be emphasised.

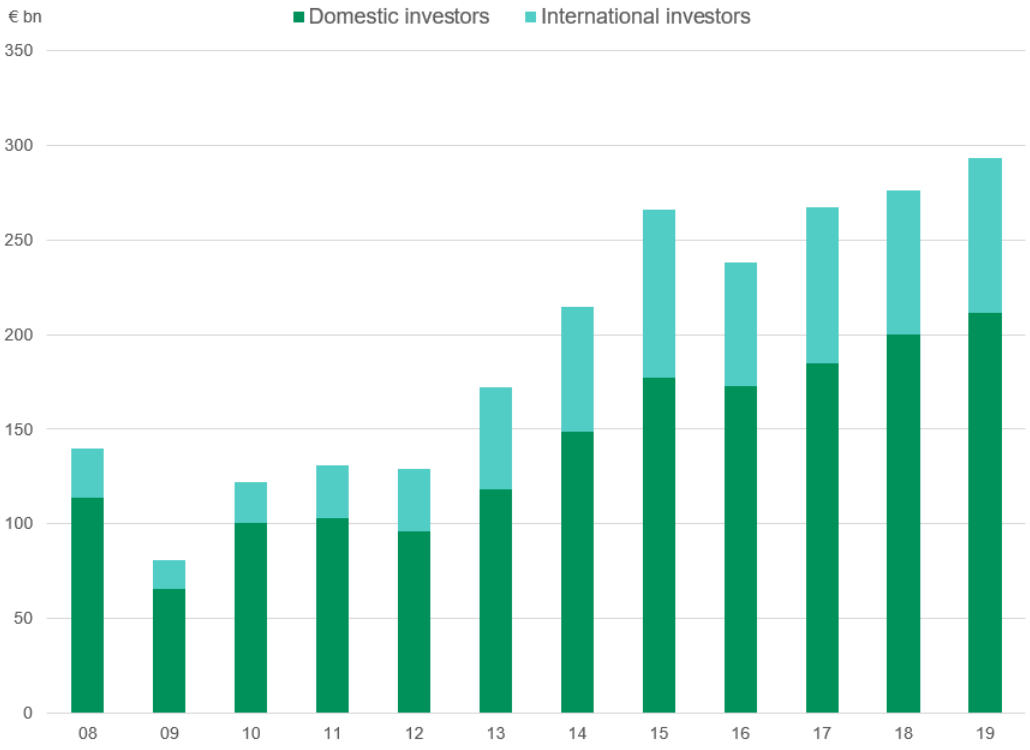
From a theoretical point of view, the effect of money supply in an international context can be modelled using a simplified Mundell-Fleming framework for a small open economy with flexible exchange rates. By considering an increase in the money supply, the LM (Liquidity preference - Money supply) curve shifts to the right, inducing a decline of domestic interest rates relative to foreign interest rates. Capital outflow increases, leading to a rise in the real exchange rate and, ultimately, this shifts the IS (Investment - Savings) curve to the right until domestic interest rates equal foreign rates (assuming horizon balance of payments). However, the relationship between the money supply and the property market is specific given the inelasticity of the real estate supply (Geltner et al., 2001). Indeed, in case of an increase in the demand for space, the supply response is limited for time and space reasons. In the context of inelastic supply, markets are mainly adjusted through prices.

Two additional and relevant elements ought to be mentioned. First, during the last decade, as the short and long interest rates reached very low levels, bonds became less attractive for investors. Second, it is important to recall that a quantitative easing policy generally consists of reselling bonds to the central banks. These elements generated considerable outflows from the bond market and created a high level of capital available for other asset classes (such as stock or real estate). At the same time, the regulatory context for institutional investors (Basel III and Solvency II) contributed to reinforce the competitiveness of real estate investment over other asset classes. A recent survey published by INREV (European Association for Investors in Non-Listed Real Estate Vehicles) corroborates this arbitrage: institutional investors have continued to increase their real estate allocations.

As the direct real estate investment market is an over-the-counter (OTC) market, there is a significant lack of transparency and markets are often subject to a 'home bias' (due to better access to information and experts). Moreover, exchange rate movements can have a significant impact on offshore investment performances. In Europe, despite an increasing share of international investors in the market, domestic players have remained dominant and account for around 75% of investment volumes (figure 1). Interestingly, we saw a withdrawal of foreign investors from European markets in 2008 as risks were higher. This supports the 'home bias' theory of real estate, with investors'

unwillingness to buy an illiquid asset in another country in a period of high economic uncertainty. It took around six years for overseas investors to come back and consider European markets as a reasonable alternative in any diversification of their portfolios.[2]

Figure 1: Domestic and international investment across Europe: 2008-2019 (source: BNP Paribas Real Estate)



As domestic investors mostly drive investment volumes, we can expect that the monetary policy lead taken by the European Central Bank and its massive money injections since the GFC may have had a greater impact on European markets than international monetary policies.

2.3 European monetary governance: stylized facts of historical legacies

The efficiency of ECB policy has been widely studied in literature. Since the early 1990s the rule of Taylor (1993) is often the instrument used to guide and evaluate the central banks' decisions. Defined by a single equation, this rule recommends the rise of the federal funds rate if inflation

[2]The European debt crisis also had a strong influence on the level of international investors during this period.

increases above a target of 2%. Using this guidance, Faust et al. (2001) argue that the ECB put too high a weight on the output gap relative to inflation and seemed to respond much more to changes in the business cycles when compared to what the former Bundesbank would have done. However, Fourçans and Vranceanu (2004) found the ECB to have reacted strongly to variations in the inflation rate during the Duisenberg presidency (1999-2003), but less so to output variations. Sauer and Sturm (2007), assuming rational expectations and using a forward-looking specification (as suggested by Clarida et al., 1998), demonstrated that the ECB had followed a stabilizing rule from 1999 to 2006. They also pointed to a large degree of partial adjustment in the short-term interest rate and, supporting the studies of Rudebusch (2002), they indicated that the ECB responded more slowly to changes in the economic environment, when compared to a central bank in a federal state.

This slow but prudent policy of the ECB was required in order to mitigate the economic risks for a zone of heterogeneous European economies. The article produced by Sturm and Wollmerhäuser (2008) is also important; using the asymmetries in inflation and cyclical output developments, they underline notable differences in the adequacy of a single monetary policy across countries of the Eurozone. They show that before the GFC developments, small member countries had received more than proportional weights in monetary policy decisions made by the ECB. In that sense, combined with the low adjustment speed feature, it underlines the fact that the ECB did have a common policy.

After the GFC, the Stability and Growth Pact (SGP) was improved to enhance fiscal and macroeconomic surveillance (regulation of the 'six-pack', 2011) and budgetary coordination (regulation of the 'two-pack', 2013). As reported by Micossi (2015), the role of the ECB also evolved, especially after the launch of the quantitative easing policies in the UK and the US. The institution now has three mandates: an inflation control mandate; an employment mandate; and a mitigation of systemic risk mandate, but with limited instruments.

3 Data and model

3.1 The heterogeneity of the European office markets

Sixteen European office markets are within our study. Their values jumped from EUR 770bn to EUR 1 593bn between 2009 and 2019 (Table 2). However, whether it is in terms of size, dynamics or international openings, heterogeneity is strong within these markets, which highlights the need for local knowledge.

Central London and Central Paris are the largest occupier and investment markets in Europe. The two markets are also the most attractive for international investment: London as the only Global City in Europe (Sassen, 1991) and Paris as the fifth largest market in the world in 2016.

Table 1: Size, stock value and international investments of the European markets (2009-2019)

	Stock (K. sqm)	Stock Value (EUR billion)		Foreign investments		Stock (K. sqm)	Stock Value (EUR billion)		Foreign investments
	2019	2009	2019	Average		2019	2009	2019	Average
Amsterdam	7 190	23	43	59%	Central London	21 900	111	217	69%
Barcelona	6 030	15.6	21	57%	Lyon	7 000	11	28	30%
Berlin	20 000	43	201	46%	Madrid	15 100	40	62	51%
Brussels	13 290	34	44	53%	Milan	11 975	41	66	45%
DÃ¼sseldorf	9 630	24	53	34%	Munich	21 700	59	159	31%
Francfort	15 470	46	99	44%	Central Paris	36 750	201	413	42%
Hamburg	14 140	39	91	30%	Roma	9 750	45	40	35%
Lisbon	4 250	11	13	62%	Vienna	11 300	26	42	45%
					Total	224 560	770	1 593	46%

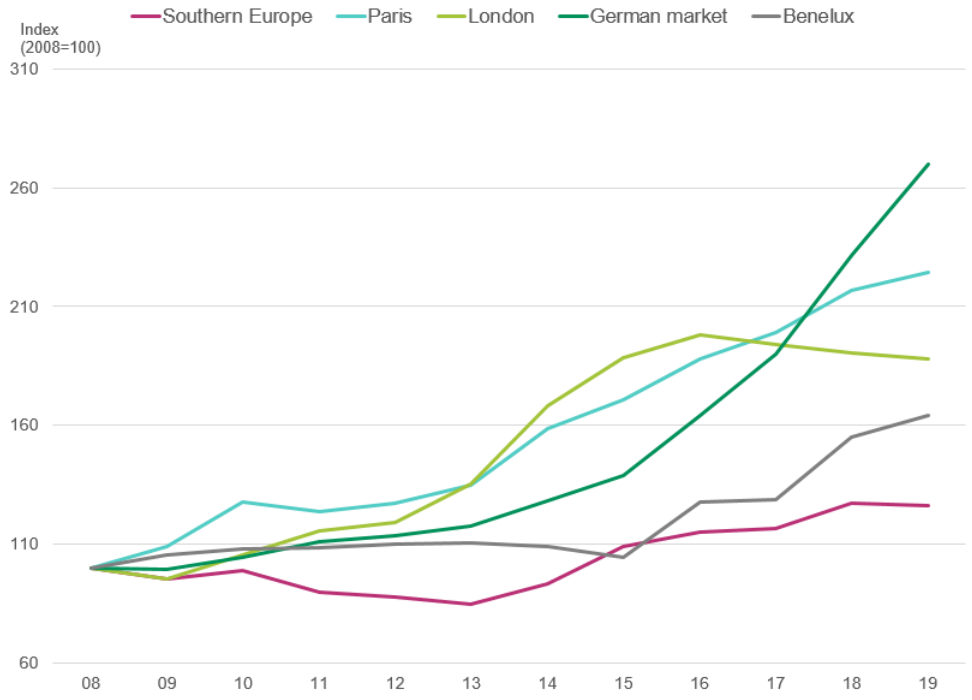
Notes: The percentage of foreign investment represents the cross-border investment on the total. Source: BNP Paribas Real Estate

In comparison, the size of the five German markets is much more homogenous for historical reasons (fragmentation of the Holy Germanic Empire and late unification of the country in the 19th century). At the same time, Germany's degree of internationalization has depended on more recent developments: European construction, reunification and globalization. This has produced a multi-speed Germany: Munich, as the capital of the powerful state of Bavaria but with a low internationalization rate; Frankfurt, the financial capital and a far more internationalized city; and the booming market of Berlin with its stock value having doubled in just a few years. The former imperial capital of Vienna is also comparable to these German real estate markets.

In Southern Europe (Italy, Spain and Portugal), the contrast in markets is marked for economic,

historical and political reasons. As a result, the development of office markets has not been equal and the heterogeneity regarding their size or their attractiveness for investors is still strong. For example, in Italy, while the administrative capital is Rome, the economic capital is Milan; and in Spain, while the GDPs of Madrid and Barcelona are quite similar, the office market in Madrid is three times greater in volume and far more developed.

Figure 2: Variation of the office stock value for various geographies: 2008-2019 (source: BNP Paribas Real Estate)



Notes: Index 100 = 2008. The total value of the stock is computed using the income capitalization approach. The German markets are composed of Berlin, Frankfurt, Munich, Hamburg and Dusseldorf. The Benelux is composed of Brussels and Amsterdam. Southern Europe is composed of Madrid, Barcelona, Lisbon, Milan and Rome. Paris and London refer respectively to Central Paris and Central London.

The valuation of the office stock across Europe has also followed different paths since the GFC (Figure 2). The German, French and UK markets have seen inflationary pressure of their stock value over the last 10 years, Southern markets have started to recover their stock values in 2018. We can also note a stabilization of the stock value in London after the Brexit referendum, implied by a "wait and see" behavior from investors.

3.2 Measuring the impact of the money supply on office markets

In order to test how the price evolution in these 16 markets has been influenced or not by the global and the European money supply, we have retained an annual panel data model on 11 years.[3] The price index (Price) for each market is calculated using MSCI's capital growth indexes. The control variables are chosen according to real estate literature. The vacancy rate (VR) is the ratio between the immediate supply and the existing stock. It is a proxy for market liquidity and for the risk faced by investors (D'Argensio and Laurin, 2009). The Prime rent (PR) is the level of the top headline rent for an office building of standard size, of the highest quality and specification, and in the best location. Real estate studies also clearly establish that the output measure (GDP) is related to office demand (Mouzakis and Richards, 2007); however, it could overestimate the demand when firms increased their productivity instead of their space. Following De Wit and Van Dijk (2003), we prefer using the office-based employment (Emp) as a proxy for demand.[4] Finally, the national stock market index (Stock) is used to approximate the economic health and the investment opportunities in the stock market (Sivitadinou and Sivitadines, 1999). Usually, firms that belong to the national stock index are also among the most important office renters in the country. The variables of interest are the Monetary indexes.

The summary statistics of these variables are reported in Table 3.

Table 2: Variables description (2009-2019)

Variable	Description	Source
Vacancy rate (**VR**)	Percentage of vacant space	BNP Paribas Real Estate
Prime rental value (**PR**)	Rent level of the prime building	
National Employment (**Emp**)	National employment in all sectors, expressed in thousands of employees	National Bureau of Statistics
Stock index (**Stock**)	Main national stock index	Euronext
Global Monetary index (**MI-Global**)	Constructed using the M2, the investors' nationalities and the exchange rates	Central Banks, BNP Paribas Real Estate, ECB Change
European Monetary index (**MI-Euro**)	Constructed using the European M2	European Central Bank
Price index (**Price**)	Constructed using office capital growth	MSCI

[3] In this approach, the explanatory variables are supposed to have the same impact on the endogenous variable, while the heterogeneity between the markets is captured by the constants (the pooling test is rejected).

[4] Brounen and Jennen (2009) find a marginal difference between output and employment in their study on the European office market.

Table 3: Summary statistics (2009-2019): annual data

		PR	VR	Emp	Stock	Price Index	MI-Global	MI-Euro
		(local currency)	%	million	index	index	index	index
Amsterdam	Max	460	20.2	9.572	604.6	142.1	233.4	224
No. of obs.	Min	345	6.2	8.725	312.5	84.2	151.4	151.4
(11)	Average	379	14.7	8.968	430.3	101.5	187	180.9
Barcelona	Max	342	17.1	20.266	27790	147.5	208.5	224
	Min	210	6.7	17.803	17157.8	91.9	144.4	151.4
(11)	Average	257	12.6	19.023	22557.8	112.6	170.7	180.9
Berlin	Max	480	7.6	45.27	6122.3	105.6	217.1	224
	Min	242	1.5	40.905	3346.1	70.7	137.4	151.4
(11)	Average	320	4.5	42.889	4830.4	79.3	172.4	180.9
Brussels	Max	315	11.5	4.894	3977.9	98.2	208.7	224
	Min	265	7.1	4.464	2083.4	82	138	151.4
(11)	Average	282	9.8	4.634	3122	87.9	170.5	180.9
Dusseldorf	Max	342	12	45.27	12917.6	100	220.2	224
	Min	282	7.6	40.905	5898.4	84.9	137.7	151.4
(11)	Average	313	10.4	42.889	9144.1	90.5	173.9	180.9
Frankfurt	Max	540	13.8	45.27	6122.3	94.6	233.7	224
	Min	420	6.8	40.905	3346.1	73.7	131.8	151.4
(11)	Average	463	10.9	42.889	4830.4	79.3	180.7	180.9
Hamburg	Max	372	8	45.27	6122.3	115.7	213.1	224
	Min	276	4.1	40.905	3346.1	90.8	137.4	151.4
(11)	Average	308	6.1	42.889	4830.4	96.5	168.7	180.9
Lisbon	Max	300	13.2	4.952	8463.9	99.4	237.9	224
	Min	216	5.2	4.45	4679.2	84.8	151.4	151.4
(11)	Average	237	10.1	4.73	5807.8	90.8	187.5	180.9
Lyon	Max	320	7	28.481	5978.1	175.1	223.4	224
	Min	230	4.7	26.819	3159.8	126.1	147.6	151.4
(11)	Average	290	6	27.442	4421	141.3	179.1	180.9
Madrid	Max	435	12.8	20.266	27790	133.5	212	224
	Min	288	8.4	17.803	17157.8	84.5	137.1	151.4
(11)	Average	350	11	19.023	22557.8	103.8	172.1	180.9
Milan	Max	600	13.2	25.503	23506.4	104.9	238.1	224
	Min	480	9.5	24.339	15089.7	94.4	149.6	151.4
(11)	Average	521	11.2	24.857	19736.5	99.8	188.6	180.9
Munich	Max	474	9	45.27	6122.3	138.8	229.6	224
	Min	360	2.3	40.905	3346.1	88.9	144.6	151.4
(11)	Average	417	5.6	42.889	4830.4	102.5	181.7	180.9
Paris	Max	880	8.5	28.481	5978.1	194.8	243.4	224
	Min	710	4.9	26.819	3159.8	123.2	141.3	151.4
(11)	Average	806	7.1	27.442	4421	151.1	189.7	180.9
Roma	Max	450	8.7	25.503	23506.4	115.4	222	224
	Min	400	5.8	24.339	15089.7	97.7	148.1	151.4
(11)	Average	416	7.2	24.857	19736.5	105.4	179.4	180.9
Vienna	Max	318	6.6	4.539	3420.1	120.3	228.3	224
	Min	264	4.7	4.067	1891.7	99.3	151.3	151.4
(11)	Average	300	5.8	4.28	2615.3	107.6	184	180.9
London	Max	1480	11.2	35.695	7687.8	215.9	372.9	224
	Min	807	4.3	31.529	5412.9	97.8	198.3	151.4
(11)	Average	1213	6.7	33.371	6494.7	165.4	282.3	180.9

As we use annual data for the post Global Financial Crisis period (2009-2019), we have 11 observations for each market and for each variable. No. of obs: number of observations into parentheses.Notes: PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index.

The model is written in first difference of logarithm to ensure the stationarity of the series:

$$\Delta\ln(\text{Price index}_{i,t}) = \alpha_i + \beta_1\Delta\ln(\text{VR}_{i,t}) + \beta_2\Delta\ln(\text{PR}_{i,t}) + \beta_3\Delta\ln(\text{Emp}_{i,t}) + \beta_4\Delta\ln(\text{Stock}_{i,t}) + \beta_5\Delta\ln(\text{MI}_{i,t}) + \epsilon_{i,t}, \quad (1)$$

Or using a standard regression model notation:

$$\text{Y}_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_{i,k}\tilde{\text{X}}_{k,t} + \epsilon_{i,t}, \quad (2)$$

Where $i = 1, ...16$ is the market index, $t = 1, ...10$ is the time index and $\epsilon_{i,t}$ is the error term. α_i allows considering the heterogeneity across the market. Spatial autocorrelation has been tested and rejected.

As per the works of Coën, Lefebvre and Simon (2018), we have also developed for each market a monetary index (MI) and employed it in the previous model to highlight the relative importance of the monetary policy on the real estate market.

The monetary index (MI) has been calculated for each market using an aggregation method.[5] This technique was first developed by Beyer et al. (2001) to reconstruct historical data of money aggregates, GDP and consumption prices for the Eurozone over two decades. Since then, this method has been widely used in literature (Giese and Tuxen, 2008; Belke et al., 2010) to aggregate national data series such as GDP, monetary stocks and interest rates. Following Coën et al. (2018), who adapted the method for international real estate investments, the various monetary growth rates have been aggregated according to investors' nationalities. More precisely, for a given market, the growth rates of M2[6] (expressed in local currency) of each country investing in the market (i) are re-weighted by the investment volume realized by the country (n) in this local market:

$$\text{MI}_{i,t} = 100\prod_{t=1}^{T}\left[1 + \sum_{t=1}^{T}\left(\frac{\text{Inv}_{n,t}}{\sum_{n=1}^{N}\text{Inv}_{n,t}}\right) \times \left(\frac{\text{M2}_{n,t\text{-}k} \times e_{t\text{-}k}}{\text{M2}_{n,t\text{-}k\text{-}4} \times e_{t\text{-}k\text{-}4}} - 1\right)\right], \quad (3)$$

[5] As countries have various definitions of broad money, a simple sum of monetary aggregates would under-represent countries with narrow definitions of M2.

[6] M2 is a money aggregate that measures the money supply. It is generally defined as the sum of currency and coins, demand deposits, money markets and savings deposits.

where $Inv_{n,y}$ is the invested volume from a country (n) at time (t); $M2_n$ is the monetary aggregate from a country or a monetary area (n); k is a time lag; and e_t is the exchange rate.

This index reflects the international money supply, but it is limited to the countries who effectively invested in this specific market. It is computed on a quarterly basis but used in the model annually. The M2 are lagged by two quarters due to real estate illiquidity and the length of the investment process.[7]

3.3 Linear economic models and EIV

Our aim here is to report robust and consistent estimates for our panel analysis. Therefore, we advocate the use of the Dagenais and Dagenais (1997) higher moment estimators (DDHME) as instruments in a General Method of Moment (GMM) procedure as defined by Hansen (1982) in a panel framework. As it is well-acknowledged in economic literature, the presence of errors-in-variables (EIV) leads to biased and inconsistent OLS parameter estimates (Durbin, 1956; Hansen, 1982; Pal, 1980; Dagenais and Dagenais, 1997; and Erikson and Whited, 2000 and 2012). The main problem in a multi-variable macroeconomic model (as given by equation (1)) inference is the use of observed variables, $X_{k,t}$ instead of the true factors (generally unobserved). As demonstrated by Cragg (1994), Dagenais and Dagenais (1997) and Lewbel (2007), and later by Carmichael and Coën (2008) for linear asset pricing models, OLS estimates are no longer consistent and may suffer from attenuation and/or contamination effects.[8] To deal with this inference problem, the well-known solution is the use of instrumental variables. This approach has drawbacks as highlighted by Pal (1980): the main problem is the choice of instruments. We follow Coën and Racicot (2007) and Carmichael and Coën (2008), who both suggest the use of Dagenais and Dagenais (1997) higher moment estimators as relevant candidates to deal with the problem of EIV under the assumption that true unobserved variables are non-Gaussian and measurement errors are normally distributed. As put forward by Dagenais and Dagenais (1997) and detailed thereafter by Carmichael and Coën (2008), the relevant instruments are: $z_1 = x*x$, $z_2 = x*x*x - 3x[E(x'x/N)*I_K]]$ and a constant. x_{ij} are the elements of the matrix x and $x = AX$ where $A = I_N^{-ii'/N}$. The matrix x is the $T \times K$ matrix X calculated in mean deviation, standing for the matrix of K factor loadings where T is here the

[7] Between 3.5 and 5 months for the execution (Devaney and Scofield (2014)), plus the period between the change in monetary policy and the investment decision.

[8] For more details, see Cragg (1994) and Carmichael and Coën (2008).

number of observations. The symbol * is the Hadamard element-by-element matrix multiplication operator. As suggested by Davidson and MacKinnon (2004), we run Durbin-Wu-Hausman (DWH thereafter) type test (see Hausman (1978)) to detect the presence of EIV.[9]

4 Empirical analysis

4.1 Monetary policies and the dynamics of European office markets

Table 4 presents the estimation for the whole set of markets with the international monetary index and Eurozone-M2 index.[10]

Firstly, the control variables that we chose (which are in line with the existing literature on the subject) are globally significant and with the expected signs. Indeed, the vacancy rate has a negative relationship with prices. When the occupancy rate becomes lower, the value of the building decreases following both a fall in demand and a higher investment risk. On the other hand, a rise in the employment level has a positive impact on capital values due to stronger demand. Meanwhile, the stock index has a small or non-significant negative effect. This can be understood as an arbitrage behavior: when the stock market decreases, investors tend to look for other asset classes.

The results regarding our two variables of interest need to be discussed. The coefficient of the Eurozone monetary index is positive and significant: an increase in the money supply has a positive impact on office markets. The ECB monetary policy and its massive money injections over the last 10 years or so, seem at first glance to have influenced European building stock value. The level of significance and the coefficient are substantial for the European aggregate, with an elasticity of

[9] To detect the presence of EIV, we can also proceed in two steps using artificial regression as proposed by Davidson and MacKinnon (2004). First, we compute estimates of EIV, $\hat{W}$, as the residuals of k OLS regressions with observed variables, X as dependent variables and the instruments as regressors (higher moments of X such as $X - \hat{X} = \hat{W}$, with $\hat{X}$, estimates of the true variables. Second, we add estimates of EIV as additional regressors (see the appendix of Carmichael and Coën, 2008, for more details).The standard errors are calculated following a standard approach taking into account instruments: the same as the approach described by Carmichael and Coën (2008) (for more details see their appendix) and Davidson and MacKinnon (2004) (artificial regression techniques) and then applying the GMM procedure introduced by Hansen (1982). Thus, we obtain robust statistics with a correction for EIV in a GMM framework.

[10] Because of data availability we use annual data for the post Global Financial Crisis period (2009-2019). As mentioned in the Summary statistics (Table 3), we have 11 observations for each market and each variable. Therefore, we use panel modelling and correct for EIV in a GMM procedure. Nevertheless, the results could be sensitive to data availability.

Table 4: Monetary policies and the dynamics of European office markets (Full sample): 2009-2019

	OLS	GMM
Variables	Estimate	Estimate
PR	0.155***	0.116***
	[3.274]	[3.038]
VR	-0.114	-0.16***
	[-4.123***]	[-10.313]
Emp	1.307***	0.994***
	[5.380]	[7.954]
Stock	0.004	-0.008
	[0.199]	[-0.350]
MI-Global	0.150	0.290***
	[1.532]	[2.993]
Adj-R^2	0.542	0.589
AIC/J-Stat	-3.639	11.657
SC/DWH	-3.747	2.631
Nb of obs	176	176

	OLS	GMM
Variables	Estimate	Estimate
PR	0.162***	0.119***
	[3.459]	[3.882]
VR	-0.109***	-0.143***
	[-4.018]	[-9.843]
Emp	1.210***	1.061***
	[4.964]	[9.641]
Stock	-0.011	-0.009
	[-0.512]	[-0.490]
MI-Euro	0.609***	0.446***
	[2.686]	[2.663]
Adj-R^2	0.542	0.628
AIC/J-Stat	-3.775	168.653
SC/DWH	-3.667	3.329
Nb of obs	176	176

*Notes: Table reports regression results based on the panel equation for all the markets. Variables are in log-difference. *, **, *** indicates significance at 10%, 5% and 1%, for t-stat, respectively. PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index. Robust t-stat are reported into brackets. We use a GMM approach with DDHME instruments and report Hansen(1982) J-Stat and Hausmann (1978) DWH statistic. We also control for fixed city effects.*

0.609. This result is confirmed with the robust GMM approach: the elasticity declines to 0.446 but it is still significant. Interestingly, the international monetary index is significant using the GMM approach, with an estimate of 0.290 (t-stat: 2.993), yet is not with the OLS, with an estimate of 0.150 (t-stat:1.532). This result was expected following the 'home bias' of real estate investment (figure 1): despite a growing international openness, European markets are still driven by domestic investors.

However, a deeper analysis is needed. The heterogeneity of the markets and of their inflationary dynamics since 2008 (figure 2) raises some questions on 'wealth attractiveness'. To examine these results in detail, we have divided our sample. First, we estimate the impact of the monetary policy on the biggest European markets. Then, we will split our sample based on market dynamics (figure 2).

4.2 Market size and monetary policies

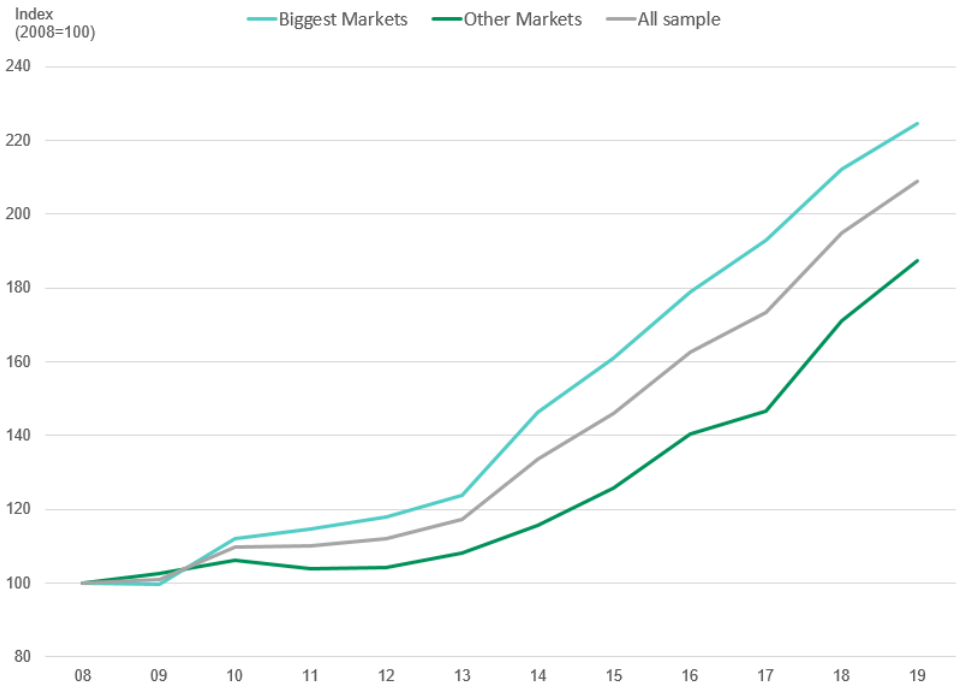
In this section, we consider two different samples, based on the market stock to infer the market depth (table 4).

Table 5: Composition of the subsamples, based on the market depth (source: BNP Paribas Real Estate)

	Office stock > 15 million sq m	Office stock > 10 million sq m
Largest markets	Berlin, Frankfurt, Central London, Central Paris, Madrid	Berlin, Frankfurt, Central London, Central Paris, Madrid, Brussels, Hamburg, Milan, Vienna
Other markets	Amsterdam, Barcelona, Brussels, Dusseldorf, Lisbon, Milan, Vienna, Hamburg, Lyon, Munich, Rome	Amsterdam, Barcelona, Dusseldorf, Lisbon, Lyon, Munich, Rome

325 The dynamics of the stock values of the two samples differ. This divergence tends to grow across time (figure 3). Notably, the value of the stock has more than doubled for the largest markets since the GFC.

Figure 3: Evolution of stock values across time and samples: 2008-2019 (source: BNP Paribas Real Estate)



330

Notes: Index 100 = 2008. The total value of the stock is computed using the income capitalization approach.

This can be explained either by an increase in demand for these markets, by constrained supply, or by both. If overall liquidity increased after the expansionary monetary policies led by the main

central banks (raising investment demand for all asset classes), it seems that real estate markets have not been homogeneously affected.

Table 6: Monetary policies and the dynamics of European office markets: Regressions based on the size of the markets (2009-2019)

	Largest Markets (> 15M sqm)	Other Markets (< 15M sqm)
Variables	Estimate	Estimate
PR	0.120	0.022
	[1.047]	[1.017]
VR	-0.218*	-0.076***
	[-2.592]	[-3.960]
Emp	0.918**	1.586***
	[3.053]	[9.863]
Stock	-0.009	0.033*
	[-0.145]	[1.934]
MI-Global	0.181**	-0.117**
	[3.414]	[-2.165]
Adj-R^2	0.684	0.521
J-Stat	6.762	95.353
DWH	1.452	2.283
Nb of obs	55	121

	Largest Markets (>15M sqm)	Other Markets (< 15M sqm)
Variables	Estimate	Estimate
PR	0.193**	-0.008
	[2.215]	[-0.198]
VR	-0.215***	-0.033
	[-5.225]	[-0.921]
Emp	0.913***	1.497***
	[4.076]	[5.538]
Stock	-0.016***	-0.009
	[-1.264]	[-0.506]
MI-Euro	1.102***	0.343**
	[5.403]	[2.209]
Adj-R^2	0.738	0.524
J-Stat	31.452	6.366
DWH	1.120	4.096
Nb of obs	55	121

*Notes: Table reports regression results based on the panel equation for all the markets. Variables are in log-difference. *, **, *** indicates significance at 10%, 5% and 1%, for t-stat, respectively. PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index.Robust t-stat are reported into brackets. We use a GMM approach with DDHME instruments and report Hansen(1982) J-Stat and Hausmann (1978) DWH statistic.We also control for fixed city effects.*

We have considered two samples for the largest markets: a narrow sample, composed of the markets with an office stock greater than 15 million square meters, and a broader sample, composed of markets with a stock greater than 10 million square meters (table 4). For each sample, we also consider its complement: the smallest markets in a narrow and a broader sense. For these markets, we run the same econometric approach. We use the same methodology as in the previous section: the parsimonious and robust econometric model (with DDHME GMM) replacing alternatively the monetary variables, MI-Euro and MI-Global. We also control for fixed city effects.

As for the entire sample, estimates for Prime rental value, vacancy rate, employment level and the stock market index are consistent with real estate literature.

If we concentrate only on the impact of monetary indexes, the results highlight several points. First, the global monetary index and the MI-Euro variable are significant both for the biggest and more international markets, and for the smallest markets. However, the sign of MI-Global is negative for the smallest market. This result is important to understand the European markets'

dynamics: the more the market is internationally attractive, the greater the impact of the global money supply. This implies that markets such as Paris, London and Berlin will be more dependent on the international environment than other markets in Europe. On the other hand, the negative effect on smallest market implies that when the money supply is increasing, there is an eviction effect and the demand for these markets decreases.

The Eurozone-M2 index is positive and statistically significant for both subsamples. For the largest markets (> 15 million sq m), the elasticity for the euro rises to 1.102 in GMM (with DDHME as instruments) (t-stat: 5.403). We can add that the vacancy rate is negative as predicted, and statistically significant. For the complement of the largest metropolis (in the narrow sample), the variable MI-Euro is statistically still highly significant, but much lower, with an estimate of 0.342 (t-stat: 2.209). The variable related to the stock market is not statistically significant anymore (financial markets are not a relevant substitute for these kind of markets). Interestingly, we also observe that the variable Emp tends to increase and is the most significant variable: 1.497 in GMM (t-stat: 5.538).

Table 7: Monetary policies and the dynamics of European office markets: Results for a larger definition of the market size (2009-2019)

	Largest Markets (> 10M sqm)	Other Markets (< 10M sqm)
Variables	Estimate	Estimate
PR	0.242***	0.028
	[3.833]	[0.963]
VR	-0.147***	-0.099***
	[-5.380]	[-4.103]
Emp	0.986***	1.512***
	[3.090]	[6.633]
Stock	-0.039	0.048
	[]-1.472	[1.713]
MI-Global	0.509**	-0.131*
	[2.757]	[-1.995]
Adj-R^2	0.650	0.498
J-Stat	14.653	6.741
DWH	2.917	1.501
Nb of obs	99	77

	Largest Markets (>10M sqm)	Other Markets (< 10M sqm)
Variables	Estimate	Estimate
PR	0.220***	0.017
	[7.370]	[0.880]
VR	-0.143***	-0.083***
	[-8.339]	[-4.395]
Emp	1.035***	1.288***
	[4.575]	[19.125]
Stock	-0.043***	-0.007
	[-5.629]	[-0.239]
MI-Euro	0.807***	0.551*
	[14.865]	[1.839]
Adj-R^2	0.723	0.533
J-Stat	11.914	14.523
DWH	2.169	2.898
Nb of obs	99	77

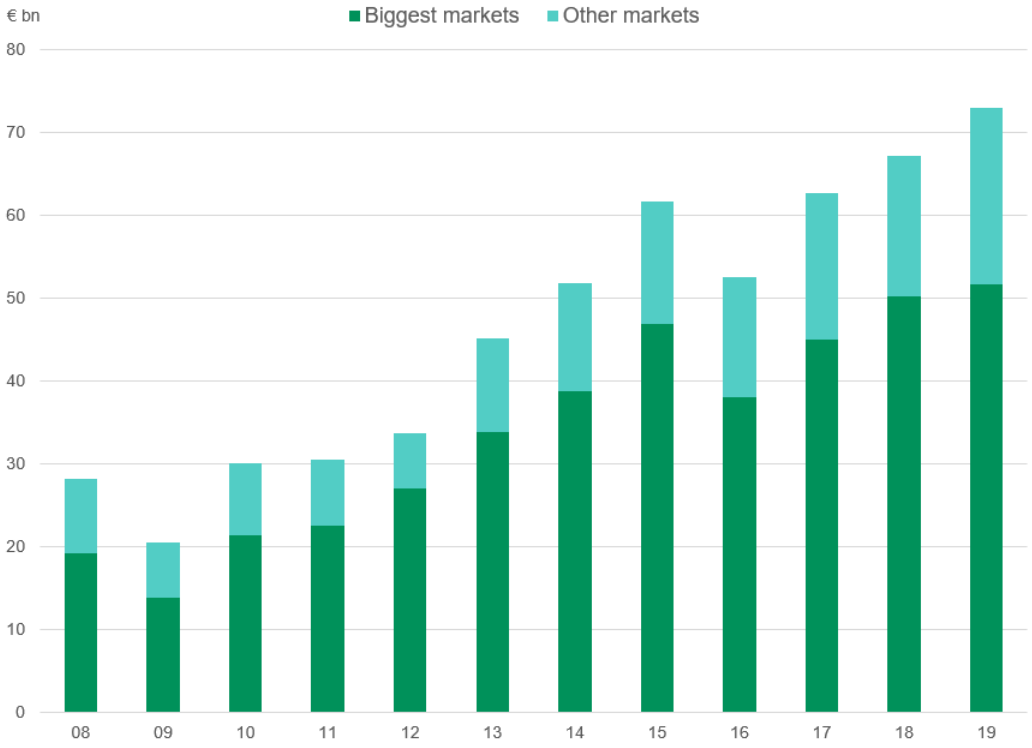
*Notes: Table reports regression results based on the panel equation for all the markets. Variables are in log-difference. *, **, *** indicates significance at 10%, 5% and 1%, for t-stat, respectively. PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index. Robust t-stat are reported into brackets. We use a GMM approach with DDHME instruments and report Hansen(1982) J-Stat and Hausmann (1978) DWH statistic. We control for fixed city effects.*

When we focus on a broader sample (markets with an office stock greater than 10 million sqm),

we see the same trend with, statistically, highly significant results. The estimate for the MI-Euro variable stands at 0.807 (t-stat: 14.865 with GMM) and MI-Global at 0.509 (t-stat: 2.757). For the complement of the broad sample, the variable MI-Euro is still highly statistically significant with a lower value at 0.551 (t-stat: 2.12) while MI-Global is still negative, at -0.131 (t-stat: 1.995).

Interestingly, if we expand the sample, the elasticity of the monetary index decreases. This result is important as it shows that if the Eurozone monetary policy has had a positive influence on real estate markets, its impact significantly decreases as we add the smallest European markets. This may be interpreted as a 'concentration effect', with the biggest and more international markets attracting the available liquidities.

Figure 4: Office investment volumes across our entire sample: 2008-2019 (source: BNP Paribas Real Estate)



Across the overall sample we used, London, Paris, Madrid, Berlin and Frankfurt account for around 73% of the total office investment (Figure 4). These five cities attracted almost three-quarters of invested capital between 2008 and 2019. The continuous increase in available capital therefore mostly benefited markets that were already liquid and internationally developed. This important finding also recalls the 'home bias' of real estate and its asymmetric information explanations. At the same time, overseas investors tend to look for assets in the most transparent and liquid markets. Interestingly, the difference in elasticity of the Eurozone-M2 index between the two samples may imply some 'home bias' even in the same monetary area.

4.3 The ECB monetary policies as a support of the Euro area?

385 In this section, we consider three different samples: 1. Germany; 2. France and the UK[11]; and 3. the Southern European countries. As shown in figure 2, the valuation of their stock has followed different paths since the GFC. While the markets in Germany, France and the UK have seen a large increase in their stock value over the last 10 years or so, Southern Europe only started to recover its stock value in 2018.

Table 8: Monetary policies and the dynamics of European office markets: Distinction between Germany, France and the UK and the Southern markets(2009-2019)

Variables	Germany	Germany Ext.	France and UK	Southern Europe	Variables	Germany	Germany Ext.	France and UK	Southern Europe
PR	0.555***	0.195***	0.063	0.183	PR	0.748***	0.187***	0.066	0.159**
	[4.202]	[8.349]	[1.441]	[1.560]		[6.090]	[8.310]	[1.311]	[3.039]
VR	0.078	-0.005	-0.235***	-0.041	VR	0.115***	-0.005	-0.271***	-0.025
	[1.217]	[-0.337]	[-6.752]	[-0.655]		[2.733]	[-0.316]	[-7.577]	[-0.771]
Emp	2.485*	5.174***	2.157***	1.473**	Emp	0.573	4.612***	0.817*	1.403***
	[1.661]	[12.861]	[4.042]	[3.720]		[0.416]	[12.890]	[2.121]	[15.442]
Stock	-0.003	0.057*	0.007	0.041	Stock	-0.024	0.029	0.046	-0.010
	[-0.056]	[1.907]	[0.388]	[1.053]		[-0.675]	[1.100]	[1.415]	[-0.292]
MI-global	0.234***	0.095**	0.365***	-0.078	MI-Euro	1.237***	0.415**	-0.024	0.418
	[4.293]	[2.298]	[3.954]	[-1.262]		[13.224]	[2.218]	[-0.070]	[1.128]
Adj-R^2	0.306	0.496	0.839	0.761	Adj-R^2	0.405	0.540	0.831	0.797
J-Stat	11.167	8.929	4.643	6.123	J-Stat	3.741	8.019	6.257	7.891
DWH	3.172	1.121	0.620	1.125	DWH	3.834	2.753	0.453	1.588
Nb of obs	44	77	33	44	Nb of obs	44	77	33	44

*Note: Table reports regression results based on the panel equation using GMM estimator with DDHME as instruments. The German markets are composed of Berlin, Frankfurt, Munich, Hamburg and Dusseldorf. The German markets extended are composed of the German markets, Vienna, Brussels and Amsterdam. Variables are in log-difference. *, **, *** indicates significance at 10%, 5% and 1%, for t-stat, respectively. PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index. Robust t-stat are reported into brackets. We use a GMM approach with DDHME instruments and report Hansen(1982) J-Stat and Hausmann (1978) DWH statistic.We control for fixed city effects.*

390 The results reveal an important heterogeneity across European countries. Firstly, the global monetary index, MI-Global, is highly significant for Germany (0.234) and for the UK and France (0.365). This result is expected, as these are the three main countries in Europe in terms of investment volumes. The transparency of these markets (through the access of long-term series regarding real estate cycles) for overseas investors also seems higher.

395 We see that the variable MI-Euro is highly significant for the German markets, with high estimates

[11]This group is composed of London, Paris and Lyon. London and Paris are the two biggest markets in Europe, both in terms of stock and of investment volume. If we consider only the French markets (Paris and Lyon), we obtain the same conclusions. The estimates of MI-Global is highly significant at 1% (0.479; t-stat:3.708) while MI-Euro is not (0.583; t-stat: 0.922). Detailed results are available upon request.

1.237 (robust t-stat: 13.224). The estimate for MI-Global is lower at 0.234, but also highly significant (t-stat: 4.293). As expected, when we consider an extension of German markets, both variables are still highly significant but tend to decrease: 0.415 for MI-Euro (t-stat: 2.218) and 0.095 for MI-Global (t-stat: 2.298). If we look at the sample of French and UK office markets (London, Paris and Lyon), we note a striking result. The European monetary index is not statistically significant with a value of -0.024 (t-stat: -0.070), while the global monetary index (MI-Global) variable is 0.365 and statistically significant at 1%.[12]

For the Southern European countries (Portugal, Spain and Italy), our results report that neither MI-Euro nor the global indexes are statistically significant. These results suggest that peripheral European office markets have not been significantly influenced by the ECB's monetary policies; it is also clear that they have not benefited from the increasing availability of capital around the world and in Europe. If these markets lack of attractiveness for overseas investors could be justified through a lack of liquidity or of depth, the absence of effect from the Eurozone index may raise some important questions. The new monetary policies led by the ECB, essentially motivated to support peripheral countries (such as Spain, Italy, Portugal and Greece), had no significant impact on their real estate prices.

By contrast, the effect of ECB monetary policy seems to be strong and highly significant for both the German markets and for the extension of German markets (including Amsterdam, Brussels and Vienna) as reported in Table 7. This result prompts another question: could German markets, more than any other European office markets, have gained from the unconventional monetary policies led by the ECB? Historically, the statutes of the European Central Bank, attached as a protocol to the Maastricht Treaty (1992), are derived from the Bundesbank statutes (1957). Two points are of particular importance: firstly, German legislation (defended by the Federal Constitutional Court of Karlsruhe) laid down the Bundesbank's independence from political influence. It was considered to be a critical point that this enshrined political independence be directly transferred to the ECB. Secondly, as for the Bundesbank with the German mark, the initial mission of the ECB was to maintain price stability in the Eurozone and to preserve the purchasing power of the single currency. This stability mandate is supported by the rules of the Stability and Growth Pact (SGP, 1997).

[12] As the Central Bank policies are different for these two countries, the lack of significance from the European index might have been expected. However, the results have also been confirmed when separating the UK and France. These results are available on request.

While fiscal policy, taxation and spending would remain with national governments (despite efforts of harmonization), the SGP was (and is still) a guarantee that no member would evade the ECB's anti-inflation policy by cutting taxes and spending. As suggested by our results, the ECB monetary policies are therefore related to the Bundesbank legacy.

Finally, the inflationary trends of office stock value across Europe can be better understood through these results. Since the GFC, real estate investment has risen as indicated by the increasing level of available capital in the market. However, it is the difference in the markets structure that may have in fact driven demand for offices. Indeed, we can see that prices in Germany were influenced both by the European and the global monetary indexes, while France and the UK were affected only by the global monetary indexes. Southern European markets were not influenced by the monetary policies and were not able to attract this increase in capital. If we consider that the main channel for liquidities moving from the central banks to specific markets is through investors' decisions, the practical plausibility of investing in Germany, France or the UK after the GFC has to be analysed. The reorientation of capital previously invested in bonds toward real estate assets necessitated the comparison of opportunities between the various cities. For obvious reasons, the Southern European markets were not attractive during that period. The small or medium markets, although more stable, were lacking sufficient depth to easily absorb these investments. London and Paris, the more mature and largest markets in Europe, were very expansive compared to the German markets (at least twice as high). Even so, Germany's rapid recovery after the GFC reassured real estate investors, who were generally strongly risk-averse, and helped attract the money supply.

Thus, it is understandable that, through its dominant economic position, Germany drew more capital than other countries. However, Paris and London also benefited from global investments with their international influence.

5 Conclusion

The purpose of this paper was to study the effects of the new European and global monetary policies on 16 important and contrasting office markets in Western Europe. Based on a revised theoretical Mundell-Fleming model and on the estimation of a panel modelling with correction for EIV, we have shed light on a positive relationship between the money supply and office prices. However, by analyzing different samples, we have also revealed that this relationship is not homogenous across

European countries, and that some cities have been more able than others to attract the increasing level of capital in the financial markets. If this heterogeneity among European office markets toward international investment may be expected (as local knowledge and thus the degree of maturity is crucial), the absence of effects from the expansion of the money supply for some European markets could be a surprise.

The optimal federal monetary policy of the ECB tends to produce implicit wealth reallocation movements across states, as forecasted by the Mundell-Fleming analysis and later by Padoa-Schioppa (1982). Studying the link between money supply and office prices was a relevant moment to observe the hidden lines along which the driving forces are acting, favoring or even leveraging some markets (metropolises) while forgetting (or neglecting) others.

Several limitations have to be mentioned. Due to data availability issues, the studied office markets are those in Western Europe. However, the European monetary effects on the Central and Eastern European markets deserve exploration. Finally, the heterogeneous price responses across Europe to the new monetary policies for housing and other real estate assets require analysis.

The ECB's 'conservatism', a supposed Bundesbank legacy for which the European institution is often blamed, is a hardly defendable position today after the strong evolution of the ECB's mandates. However, the paradoxical effects of its unconventional monetary policies, essentially made to support peripheral markets, but mostly favoring the strongest economies, provoke some important economic and political questions. Moreover, following the COVID-19 economic crisis, the monetary policies undertaken by the ECB to support the economy may also prompt some challenging questions in the future. Should Europe consider derogative measures for the SGP to compensate for the unwanted effects of the ECB's monetary policies? Would new European planning investments be necessary to rebalance these divergences? We leave these points for future research.

References

[1] Belke, A., Orth, W., and Setzer, R. Liquidity and the dynamic pattern of asset price adjustment: A global view. *Journal of Banking & Finance 34*, 8 (2010), 1933–1945.

[2] Bernanke, B. S., and Kuttner, K. N. What explains the stock market's reaction to Federal Reserve policy? *The Journal of finance 60*, 3 (2005), 1221–1257.

[3] Beyer, A., Doornik, J. A., and Hendry, D. F. Constructing Historical Euro-zone Data. *The Economic Journal 111*, 469 (2001), 102–121.

[4] Brounen, D., and Jennen, M. Local office rent dynamics. *The Journal of Real Estate Finance and Economics 39*, 4 (2009), 385–402.

[5] Carmichael, B., and Coen, A. Asset pricing models with errors-in-variables. *Journal of Empirical Finance 15*, 4 (2008), 778–788.

[6] Chiang, Y., Sa Aadu, J., and Shilling, J. Unconventional monetary policy and U.S. housing markets dynamics. *working paper University of Iowa*, march 2015 (2015).

[7] Clarida, R., Gali, J., and Gertler, M. Monetary policy rules in practice: Some international evidence. *European Economic Review 42*, 6 (1998), 1033–1067.

[8] Coën, A., Lefebvre, B., and Simon, A. International money supply and real estate risk premium: The case of the London office market. *Journal of International Money and Finance* (2018).

[9] Coën, A., and Racicot, F.-É. Capital asset pricing models revisited: Evidence from errors in variables. *Economics Letters 95*, 3 (2007), 443–450.

[10] Cragg, J. G. Making good inferences from bad data. *Canadian Journal of Economics* (1994), 776–800.

[11] Dagenais, M. G., and Dagenais, D. L. Higher moment estimators for linear regression models with errors in the variables. *Journal of Econometrics 76*, 1-2 (1997), 193–221.

[12] D'Arcy, E., McGough, T., and Tsolacos, S. National economic trends, market size and city growth effects on European office rents. *Journal of Property Research 14*, 4 (1997), 297–308.

[13] D'argensio, J.-J., and Laurin, F. The real estate risk premium: A developed/emerging country panel data analysis. *The Journal of Portfolio Management 35*, 5 (2009), 118–132.

[14] Davidson, R., MacKinnon, J. G., et al. *Econometric theory and methods*, vol. 5. Oxford University Press New York, 2004.

[15] De Wit, I., and Van Dijk, R. The global determinants of direct office real estate returns. *The Journal of Real Estate Finance and Economics 26*, 1 (2003), 27–45.

[16] Devaney, S., and Scofield, D. Time to transact: measurement and drivers. In *Investment Property Forum, September* (2014).

[17] Durbin, J. Weak convergence of the sample distribution function when parameters are estimated. *The Annals of Statistics* (1973), 279–290.

[18] Erickson, T., and Whited, T. M. Two-step gmm estimation of the errors-in-variables model using high-order moments. *Econometric Theory 18*, 3 (2002), 776–799.

[19] Erickson, T., and Whited, T. M. Treating measurement error in Tobin's q. *The Review of Financial Studies 25*, 4 (2012), 1286–1329.

[20] Farrelly, K., and Sanderson, B. Modelling regime shifts in the city of London office rental cycle. *Journal of Property Research 22* (2005), 325–344.

[21] Feldstein, M. Quantitative easing and America's economic rebound. *Project Syndicate 24* (2011).

[22] Fourçans, A., and Vranceanu, R. The ECB interest rate rule under the Duisenberg presidency. *European Journal of Political Economy 20*, 3 (2004), 579–595.

[23] Geltner, D., Miller, N. G., Clayton, J., and Eichholtz, P. *Commercial real estate analysis and investments*, vol. 1. South-western Cincinnati, OH, 2001.

[24] Giese, J. V., and Tuxen, C. K. Global Liquidity, Asset Prices and Monetary Policy: Evidence from Cointegrated VAR Models. *Nuffield College, University of Oxford, and Department of Economics, Copenhagen University* (2007).

[25] Hansen, L. P. Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the Econometric Society* (1982), 1029–1054.

[26] Hausman, J. A. Specification tests in econometrics. *Econometrica: Journal of the econometric society* (1978), 1251–1271.

[27] Hekman, J. S. Rental price adjustment and investment in the office market. *Real Estate Economics 13*, 1 (1985), 32–47.

[28] Hendershott, P. H., Lizieri, C. M., and MacGregor, B. D. Asymmetric adjustment in the city of London office market. *The Journal of Real Estate Finance and Economics 41*, 1 (2010), 80–101.

[29] Hendershott, P. H., Lizieri, C. M., and Matysiak, G. A. The workings of the London office market. *Real Estate Economics 27*, 2 (1999), 365–387.

[30] Hendershott, P. H., and MacGregor, B. D. Investor rationality: evidence from UK property capitalization rates. *Real Estate Economics 33*, 2 (2005), 299–322.

[31] Hendershott, P. H., MacGregor, B. D., and Tse, R. Y. Estimation of the rental adjustment process. *Real Estate Economics 30*, 2 (2002), 165–183.

[32] Iacoviello, M. Financial business cycles. *Review of Economic Dynamics 18*, 1 (2015), 140–163.

[33] Jon Faust and John H. Rogers and Jonathan H. Wright. An empirical comparison of Bundesbank and ECB monetary policy rules. International Finance Discussion Papers 705, Board of Governors of the Federal Reserve System (U.S.), 2001.

[34] Lewbel, A. Estimation of average treatment effects with misclassification. *Econometrica 75*, 2 (2007), 537–551.

[35] Lizieri, C. *Towers of capital: office markets & international financial services*. Wiley-Blackwell, 2009.

[36] Lizieri, C., and Pain, K. International office investment in global cities: the production of financial space and systemic risk. *Regional Studies 48*, 3 (2014), 439–455.

[37] McGough, T., and Tsolacos, S. Forecasting office rental values using vector autoregressive models. In *The Proceedings of the Cutting Edge Property Research Conference* (1994), pp. 303–20.

[38] Micossi, S. The monetary policy of the European Central Bank (2002-2015). Tech. Rep. 109, CEPS Special Report, 2015.

[39] Mishkin, F. S. Housing and the monetary transmission mechanism. Tech. rep., National Bureau of Economic Research, 2007.

[40] Mouzakis, F., and Richards, D. Panel data modelling of prime office rents: a study of 12 major European markets. *Journal of Property Research 24*, 1 (2007), 31–53.

[41] Pal, M. Consistent moment estimators of regression coefficients in the presence of errors in variables. *Journal of Econometrics 14*, 3 (1980), 349–364.

[42] Patelis, A. D. Stock return predictability and the role of monetary policy. *the Journal of Finance 52*, 5 (1997), 1951–1972.

[43] Rozeff, M. S. Money and stock prices: Market efficiency and the lag in effect of monetary policy. *Journal of financial Economics 1*, 3 (1974), 245–302.

[44] Rudebusch, G. D. Term structure evidence on interest rate smoothing and monetary policy inertia. *Journal of monetary economics 49*, 6 (2002), 1161–1187.

[45] Sassen, S. *The global city: New York, London, Tokyo*. Princeton University Press, 2001.

[46] Sauer, S., and Sturm, J.-E. Using Taylor rules to understand European Central Bank monetary policy. *German Economic Review 8*, 3 (2007), 375–398.

[47] Sivitanidou, R., and Sivitanides, P. Office capitalization rates: Real estate and capital market influences. *The Journal of Real Estate Finance and Economics 18*, 3 (1999), 297–322.

[48] Sturm, J.-E., and Wollmershäuser, T. The stress of having a single monetary policy in Europe. CESifo Working Paper Series 2251, CESifo Group Munich, 2008.

[49] Taylor, J. B. Discretion versus policy rules in practice. In *Carnegie-Rochester conference series on public policy* (1993), vol. 39, Elsevier, pp. 195–214.

[50] Taylor, J. B. Housing and monetary policy. Tech. rep., National Bureau of Economic Research, 2007.

[51] Wheaton, W. C., Torto, R. G., and Evans, P. The cyclic behavior of the Greater London office market. *The Journal of Real Estate Finance and Economics 15*, 1 (1997), 77–92.

[52] Zhu, B., and Lizieri, C. Connected markets through global real estate investments. *Real Estate Economics* (2020 (forthcoming)).

Appendix 1: Summary statistics (2009-2019): annual data

		PR	VR	Emp	Stock	Price Index	MI-Global	MI-Euro
		(local currency)	%	million	index	index	index	index
Amsterdam	Max	460	20.2	9.572	604.6	142.1	233.4	224
No. of obs.	Min	345	6.2	8.725	312.5	84.2	151.4	151.4
(11)	Average	379	14.7	8.968	430.3	101.5	187	180.9
Barcelona	Max	342	17.1	20.266	27790	147.5	208.5	224
	Min	210	6.7	17.803	17157.8	91.9	144.4	151.4
(11)	Average	257	12.6	19.023	22557.8	112.6	170.7	180.9
Berlin	Max	480	7.6	45.27	6122.3	105.6	217.1	224
	Min	242	1.5	40.905	3346.1	70.7	137.4	151.4
(11)	Average	320	4.5	42.889	4830.4	79.3	172.4	180.9
Brussels	Max	315	11.5	4.894	3977.9	98.2	208.7	224
	Min	265	7.1	4.464	2083.4	82	138	151.4
(11)	Average	282	9.8	4.634	3122	87.9	170.5	180.9
Dusseldorf	Max	342	12	45.27	12917.6	100	220.2	224
	Min	282	7.6	40.905	5898.4	84.9	137.7	151.4
(11)	Average	313	10.4	42.889	9144.1	90.5	173.9	180.9
Frankfurt	Max	540	13.8	45.27	6122.3	94.6	233.7	224
	Min	420	6.8	40.905	3346.1	73.7	131.8	151.4
(11)	Average	463	10.9	42.889	4830.4	79.3	180.7	180.9
Hamburg	Max	372	8	45.27	6122.3	115.7	213.1	224
	Min	276	4.1	40.905	3346.1	90.8	137.4	151.4
(11)	Average	308	6.1	42.889	4830.4	96.5	168.7	180.9
Lisbon	Max	300	13.2	4.952	8463.9	99.4	237.9	224
	Min	216	5.2	4.45	4679.2	84.8	151.4	151.4
(11)	Average	237	10.1	4.73	5807.8	90.8	187.5	180.9
Lyon	Max	320	7	28.481	5978.1	175.1	223.4	224
	Min	230	4.7	26.819	3159.8	126.1	147.6	151.4
(11)	Average	290	6	27.442	4421	141.3	179.1	180.9
Madrid	Max	435	12.8	20.266	27790	133.5	212	224
	Min	288	8.4	17.803	17157.8	84.5	137.1	151.4
(11)	Average	350	11	19.023	22557.8	103.8	172.1	180.9
Milan	Max	600	13.2	25.503	23506.4	104.9	238.1	224
	Min	480	9.5	24.339	15089.7	94.4	149.6	151.4
(11)	Average	521	11.2	24.857	19736.5	99.8	188.6	180.9
Munich	Max	474	9	45.27	6122.3	138.8	229.6	224
	Min	360	2.3	40.905	3346.1	88.9	144.6	151.4
(11)	Average	417	5.6	42.889	4830.4	102.5	181.7	180.9
Paris	Max	880	8.5	28.481	5978.1	194.8	243.4	224
	Min	710	4.9	26.819	3159.8	123.2	141.3	151.4
(11)	Average	806	7.1	27.442	4421	151.1	189.7	180.9
Roma	Max	450	8.7	25.503	23506.4	115.4	222	224
	Min	400	5.8	24.339	15089.7	97.7	148.1	151.4
(11)	Average	416	7.2	24.857	19736.5	105.4	179.4	180.9
Vienna	Max	318	6.6	4.539	3420.1	120.3	228.3	224
	Min	264	4.7	4.067	1891.7	99.3	151.3	151.4
(11)	Average	300	5.8	4.28	2615.3	107.6	184	180.9
London	Max	1480	11.2	35.695	7687.8	215.9	372.9	224
	Min	807	4.3	31.529	5412.9	97.8	198.3	151.4
(11)	Average	1213	6.7	33.371	6494.7	165.4	282.3	180.9

As we use annual data for the post Global Financial Crisis period (2009-2019), we have 11 observations for each market and for for each variable. No. of obs: number of observations into parentheses.Notes: PR: Prime rental value; VR: Vacancy rate; Emp: National employment; Stock: Stock index; MI-Global: Global Monetary index; MI-Euro: European Monetary index.