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# Is the Office Market Overvalued? A Simple Framework Applied to France

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We develop a simple framework to assess the position of office prices with respect to their fundamentals. Applying the model to France, we show that a constrained office supply and low interest rates mainly explain for the high and increasing trend of office prices in recent years. Nonetheless, we find that the office market is only slightly overvalued in France in late 2017: the deviation of office prices with respect to their fundamental determinants is between 0% and 10%, thus indicating that the market is close to fair value.

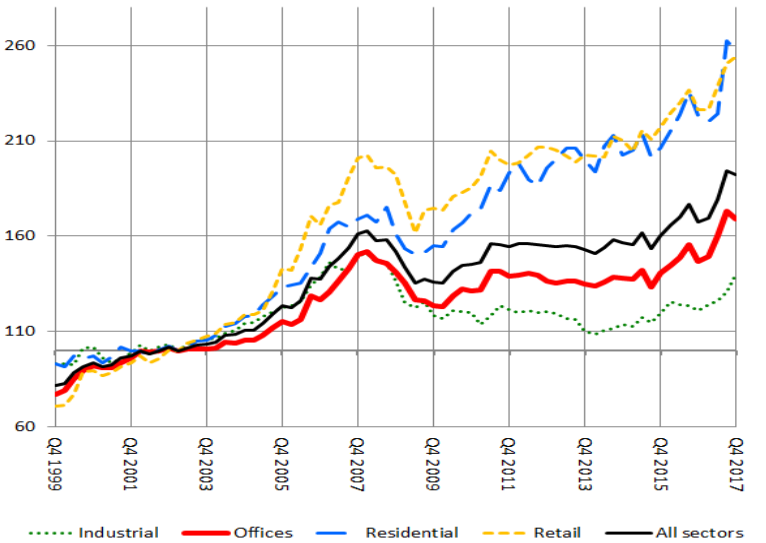
**Keywords**

Commercial Real Estate, Overvaluation, Office Market, Error-Correction Model

# 1. Introduction

The commercial real estate market gained renewed attention after the aftermath of the Financial Crisis of 2007-2008. Indeed, motivated by a strong correlation between commercial property prices and the banking crisis (Antoniades, 2015), several institutions that were responsible for financial stability launched projects with the aim to better understand the commercial real estate market (Dombret, 2013; European Systemic Risk Board, 2015). Among the four main sub-markets of commercial real estate (offices, retail, industrial buildings and residential properties), offices play a key role as their prices are strongly related to economic junctures and financial risks.

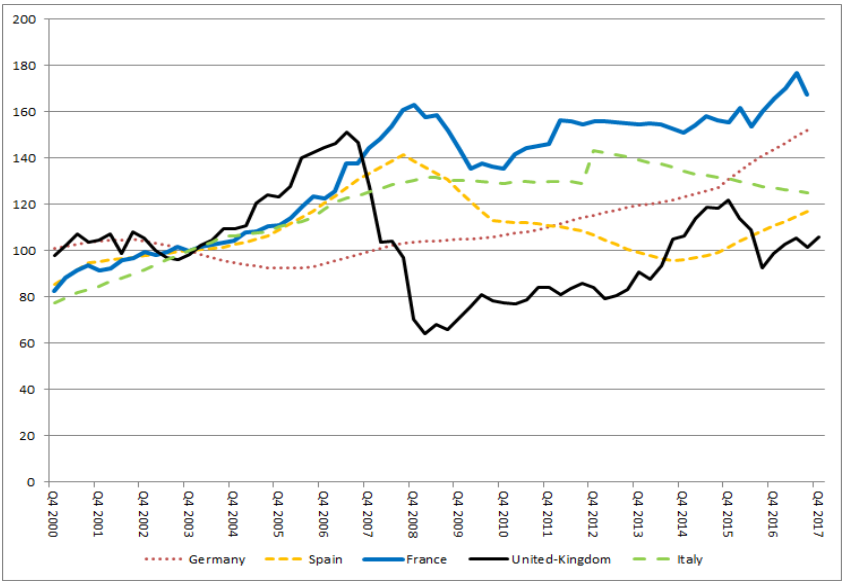
**Figure 1 Commercial Real Estate Price Index by Sector of Activity for France**




***Source***: ECB according to IPD
***Note***: base 100 = Q1 2003

Nevertheless, little attention has been given to understanding office price dynamics *per se*, in which the identification of booms and busts is likely to supplement standard financial stability assessments. In this paper, we propose a simple methodology for quantifying the valuation of office markets with respect to their fundamentals. We focus our assessment on a particular geographical market; that is, France, where office prices have increased very dynamically over recent years in comparison to other major European countries.

**Figure 2 Commercial Real Estate Price Index for Selected European Countries**



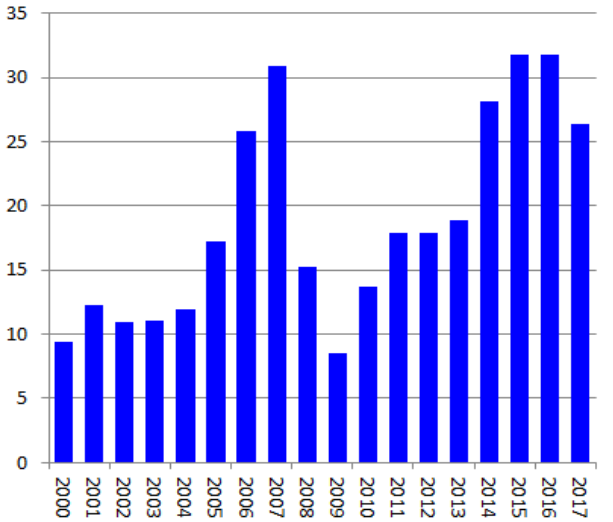

***Source***: BCE according to IPD (for France, Spain, and the UK), Bulwiengesa AG (Germany), and Banca d'Italia (Italy)
***Note***: Base 100 Q1 2003

Indeed, since 2011, investment in commercial properties in France has been buoyant and concentrated: market players (insurance, investment funds, sovereign funds, etc.) mainly invest in office spaces (61% of total investments in 2017), and to a lesser extent, in the retail sector (17%). Those investments are concentrated in the Paris region ('Ile-de-France'), which accounted for 76% of the total investments in 2017.

Understanding the office price dynamics in France makes for a very interesting case study to assess the relevance of a more general methodology, as some developments appear to be puzzling. For instance, the increase in vacancy rates from 2006 onwards should have led to lower prices, but has had only a small impact on prices. Moreover, office prices have been characterized since 2010 by a sustained upward trend while vacancy rate has stabilized since 2009. Moreover, the high vacancy of office properties for rent should drive rent down. However, over the recent juncture, rent seems to be relatively inert to vacancy rate developments. Finally, while prices fundamentally depend on the income generated by real properties, namely rent, over the recent years we observe simultaneously a strong upward trend in prices and stable rent levels. These paradoxes illustrate the complexity of office price formation and valuation. As a result, the office vacancy rate has remained high although it has decreased in

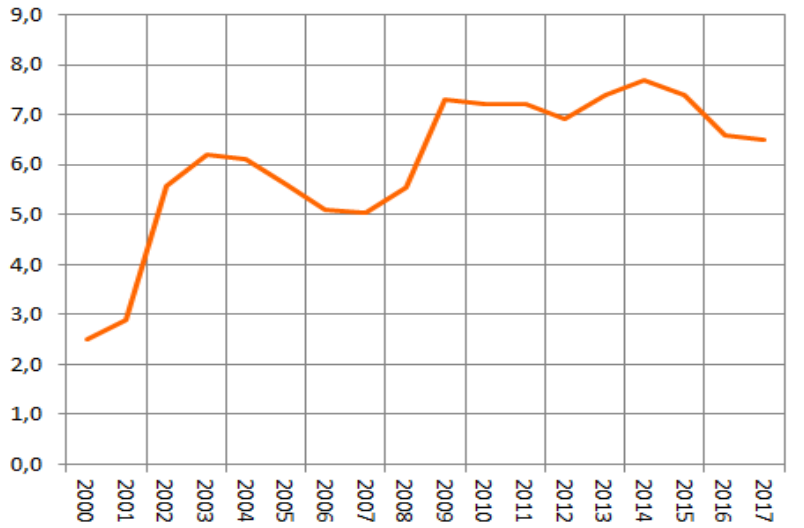
the last two years: 6.5% of the offices located in the Ile-de-France were vacant at the end of 2017.

**Figure 3** **Amounts Invested in Corporate Real Estate in France, Billion Euros**




***Source***: IEIF, BNP Paribas Real Estate

**Figure 4** **Office Vacancy Rates in Ile-de-France**




***Source***: IEIF, Immostat BNP Paribas Real Estate.

Our paper seeks to identify the empirical interrelationships between office prices and their fundamentals. Our specification is derived from a theoretical model proposed by Wheaton et al. (1997). In this context, the office price dynamics are explained by using the gross domestic product (GDP), rent, immediate office supply (i.e. vacant offices), office stock and interest rates. In order to quantify the overvaluation of office prices, we rely on the method found in Hansen (2005): overvaluation is calculated as the difference between observed office prices and the time-varying equilibrium rates derived from the dynamics of the fundamentals.

Many studies in the real estate literature have focused on the interrelationship between office prices and their determinants from a conceptual point of view (e.g. Wheaton et al., 1997). In this paper, we propose to apply theoretical models to actual data. Indeed, some papers examine the empirical relationship between the office market and its fundamentals (e.g. Davis and Zhu, 2011), but on the one hand, they focus on rent rather than prices, and on the other hand, do not include office market fundamentals such as immediate supply and stock. One reason for this scarcity of empirical evidence is the lack of unified and official data for the office market in general (European Central Bank, 2014) and France in particular as stated by the macroprudential authority (Haut Conseil de Stabilité Financière, 2016). In all cases, the existing literature does not taken their results and form a position to evaluate the sustainability of office prices.

Our contribution to the existing literature is threefold. First, after having carried out an accurate assessment and collection of the available data for France, we compile a dataset that includes not only both rent and price developments, but also real market variables such as immediate supply and market stock, which are the essence for policy purposes. Second, we identify the empirical relationships between office prices and their fundamental determinants, which allow us to understand recent upward trends in France driven by low interest rates and constrained supply. Third, we develop a simple and robust methodology for quantifying the overvaluation of office prices and show that the prices are close to their fair value.

The remainder of the paper is organized as follows: Section 2 develops the related literature and the variables of interest. Section 3 presents the data. Section 4 elaborates on the baseline model. Section 5 presents the overvaluation estimates and their interpretation. Section 6 concludes.

## 2. Related Literature and Variables of Interest

In the literature, different types of specifications are considered for modelling the office market and in particular, simultaneous equations models, in which the rent for offices, and not the price, plays a central role. Indeed, unlike the residential market, in which the markets of owners and tenants are coincident,

two commercial real estate markets co-exist (DiPasquale and Wheaton, 1992, Wheaton et al. 1997): a market of investors and a market of users.

These markets interact through two channels: rent and office buildings.

In the short term, the office stock is stable, hence the level of rent depends on the economic conditions and more specifically, the expected number of employees, which determines the demand for workspace of user companies;

Prices are set based on the investor market, but intrinsically linked to the interest rate and rent on the user company market. The investment decision alternatively depends either on the profitability of office investments with respect to other market investments, or the future income generated by rent with respect to the interest rate. Thus, a change in economic conditions causes variations in rent and consequently, prices;

Prices also influence rent through office construction. Building projects are launched only if they are deemed cost-effective, namely, if the expected selling prices are higher than the cost of construction. Therefore, an increase in prices results in more construction which increases the stock of available offices, thus resulting in a decline of rent. The dynamics of prices and rent are consequently closely interrelated.

These dynamics have been modeled and tested by Wheaton et al. (1997), Hendershott et al. (1999), Fuerst (2005), and Malle (2010) on the regional markets of London, New York and Paris. These models enable the understanding of the interactions between the various determinants of the office market but also simulate the paths of the endogenous variables for different scenarios. Nevertheless, no variable that accounts explicitly for office prices has ever been the modelled and prices appear only implicitly as an explanatory variable in the equations that model office supply. Hence, this branch of the literature does not allow for any empirical assessments on the level of prices, and specifically, the calculation of price overvaluations.

Different models in which office prices are involved as dependent variables have nevertheless been developed. Dobson and Goddard (1992) propose market equilibrium equations based on a theoretical model of supply and demand. Rent and prices are explained on the basis of contemporary lagged observations of employment, real interest rates and residential real estate prices. In order to model the office construction market, Tsolacos et al. (1998) consider market equilibrium equations for the markets of offices for users on the one hand and investors on the other hand. The rent is therefore explained by using GDP, employment and new constructions, whereas the office prices are explained by using rent, price of shares, real interest rates and new constructions. These models which apply to the markets in the West show that an increase in the volume of construction lowers rent while an increase in employment leads to

an increase in rent. In addition, the prices are positively correlated with rent and negatively with interest rate.

Finally, an empirical vector model based on macroeconomic variables (GDP, private sector investment and credit to the private sector) has also been tested by Davis and Zhu (2011) on 17 countries, including France. The changes in the GDP affect the prices of commercial real estate; the causality seems to be reversed for credit to the private sector.

Nevertheless, the question of the equilibrium prices of offices is scarcely dealt with: only rent is sometimes assessed in relation to their equilibrium value (Fuerst, 2005) but in simultaneous equation models based on strong assumptions.

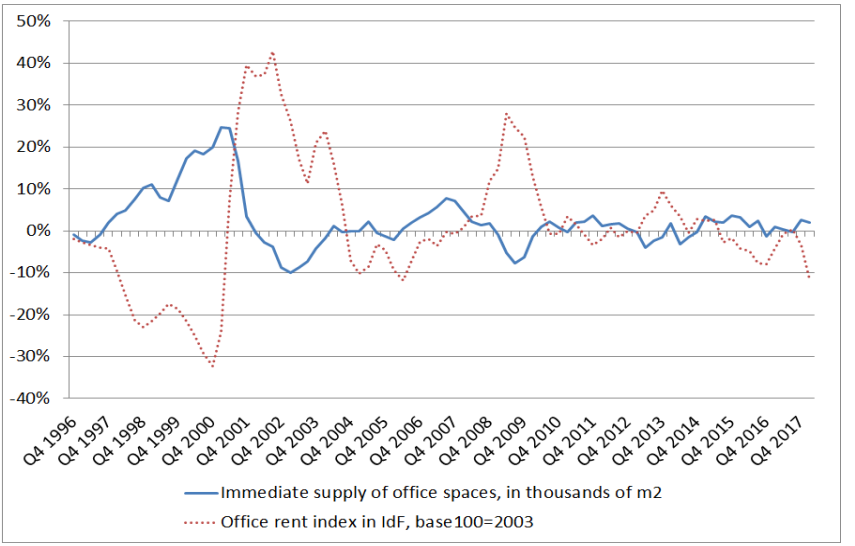
The dynamics theoretically modeled by Wheaton et al. (1997) are relevant to the office market in France:

> In terms of the office user market, the stock of occupied offices represents the demand for offices: the demand for offices in the long term depends positively on the number of employees and negatively on the previous levels of rent[1]. In France, the increase in real estate prices and rent over the 2000s coincides with the increase in employment. The increase in employment resulted in an increase in the stock of occupied offices, while the increase in rent did not seem to have significantly discouraged, at least in the short-term, companies to move to those places (for instance, it has not caused any substantial delocalization of company headquarters over that period of time);
>
> In terms of the office user market, the level of rent depends on the demand for offices, and thus the vacancy rate: a significant number of unoccupied offices in previous periods increase the negotiation margin of occupying companies and pull the rent downwards. Indeed, in France, the rent and the immediate supply of offices are negatively correlated; and
>
> The prices depend on the rent level and the nominal interest rate[2]. During the Financial Crisis, the relative persistence of prices is explained by the resilience of rent and the significant decrease in interest rates.

[1] Based on the assumption of working space of a constant size for each employee, an increase in the number of employees causes a proportional increase in office demand. This is nevertheless not verified in practice, as an increase in employment is generally accompanied by an increase in rent, the surface area of the work space for an employee decreases during periods of growth and increases during periods of crises. This phenomenon is in part attributable to the rigidity of the rental market. Indeed the leases that companies enter into are at least 9 years with the possibility for tenants to terminate the lease based on triennial periodicity.

[2] Some authors (Fuerst (2005) and Malle (2010)) also include the availability of capital measured by the spread of term (gap between a long-term and a short-term interest rate). This variable has a negative impact on new constructions.

**Figure 5** **Immediate Supply of Offices and Office Rent Index in Ile-de-France, Annual Growth Rate in %**




***Source***: Immostat and IEIF
***Note:*** *IdF is Ile-de-France.*

## 3. The Data

The logarithms of the GDP on volume, rent index of the offices in Ile-de-France, immediate supply of offices in Ile-de-France in $m^2$, office stock in Ile-de-France in $m^2$ and the 6-month Euribor interest rate are chosen as the determinant logarithms of the office price index.

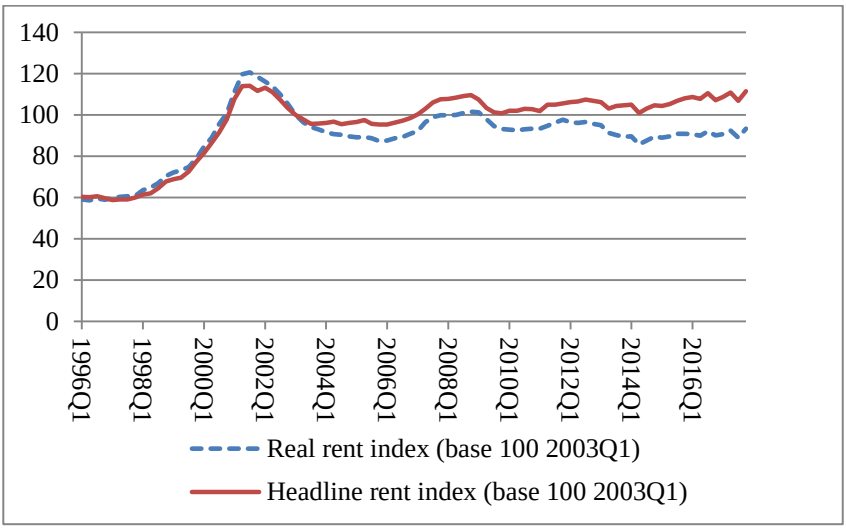
While GDP and employment appear to be strongly correlated in line with the aggregate output in Okun's law (Ball et al., 2017), we prefer to retain the GDP. Indeed, we need to take expected employment into account and it is recognized that GDP anticipates the changes in employment, as it constitutes a reasonable approximation of the business expectations of companies (European Central Bank, 2016). Several papers (McGough and Tsolacos, 1999; Davis and Zhu, 2011) recommend the use of GDP rather than employment in empirical frameworks. In addition, the index of construction costs is retained as this index is strongly correlated with prices.

The need for a historical series with a sufficient length of time leads to the use of different sources:

An index that mirrors the changes in the average real rent is constructed. For this purpose, the real rent index of offices in Ile-de-France is built from

different sources: the series are extracted from the Institut de l'Epargne Immobilière et Foncière (IEIF), publications of the BNP Paribas Real Estate time series patterns for the period of Q1 1996 to Q4 2012. For Q1 2013 to Q4 2017, the index is constructed by relying on headline rent values and the proportion of the accompanying measures (fiscal measures) in the headline rent, both of which have been actually published since 2012[3]. The use of real rent instead of headline rent allows the inclusion of economic-relevant prices. It is worth noting that no time series of this indicator is publicly available. Additional results that rely on headline rent will also be presented;

**Figure 6 Headline and Real Rent in Ile-de-France**



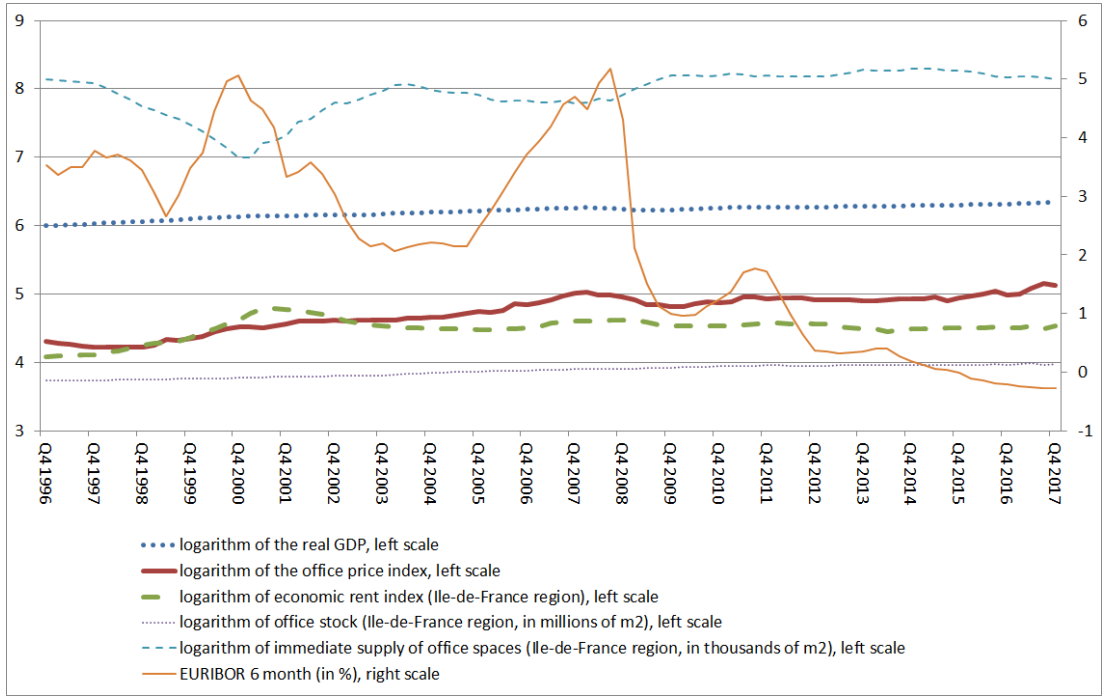

***Source***: IEIF from BNP Paribas Real Estate, Immostat (Estimated values)

The historical series of the immediate office supply and office stock in Ile-de-France is also rebuilt from publications of the IEIF, Immostat and BNP Paribas Real Estate;

The average office price index in France is based on the series released by the European Central Bank (ECB) and acquired from the MSCI/IPD (Investment Property Databank). The historical MSCI series for the period of Q1 1994 to Q4 1998 result from a quarterly smoothing of the annual index based on appraised values, while the quarterly MSCI index which also uses the prices of transactions is used from 1999 onwards;

3 http://www.immostat.com/single-post/2018/05/07/Les-mesures-daccompagnement-au-T1-2018

**Figure 7 Variables of Interest Considered in This Study**




***Source***: INSEE, Banque de France, IEIF, Immostat, CBRE, BNPP RE, BCE according to IPD

The quarterly GDP in volume corresponds to the series published quarterly by the Institut national de la statistique et des études économiques (INSEE; The National Institute of Statistics and Economic Studies); and

The series of 6-month Euribor interest rates is the quarterly average of the daily series published on the Banque de France website.

In order to ensure data reliability[4] and temporal consistency[5] we study the period from Q1 2003 to Q4 2017, which is quite short but reasonable for the chosen specifications, and realistically validates the stability of the model.

The correlations between the variables are consistent with intuition, and we especially find that the prices are slightly and positively correlated with the rent and GDP, and negatively and significantly correlated with the interest rate.

**Table 1 Correlations Among Variables of Model**

| | LGDP | LPRICE | LRENT | LSTOCK | LSUPPLY | EUR6 |
|---|---|---|---|---|---|---|
| LGDP | 1.000000 | | | | | |
| | ----- | | | | | |
| LPRICE | **0.920725** | 1.000000 | | | | |
| | 0.0000 | ----- | | | | |
| LRENT | -0.140126 | 0.175562 | 1.000000 | | | |
| | 0.2856 | 0.1797 | ----- | | | |
| LSTOCK | **0.932772** | **0.845777** | -0.109395 | 1.000000 | | |
| | 0.0000 | 0.0000 | 0.4054 | ----- | | |
| LSUPPLY | **0.599736** | **0.379482** | **-0.353357** | **0.767965** | 1.000000 | |
| | 0.0000 | 0.0028 | 0.0056 | 0.0000 | ----- | |
| EUR6 | **-0.530376** | **-0.262867** | **0.495035** | **-0.628579** | **-0.890426** | 1.000000 |
| | 0.0000 | 0.0424 | 0.0001 | 0.0000 | 0.0000 | ----- |

***Notes***: Coefficient at the top and p-value at the bottom of each cell.
Coefficients in bold are significant at the 5% level.

[4] Office prices relied on a debatable interpolation method prior to 1999.
[5] The dot-com speculative bubble is known to have affected real estate markets. In particular, office rents were strongly affected by phenomena that are beyond the scope of this paper because of the overcapacity of business premises, falling office rents and private housing prices, lay-offs and the newly unemployed. Hence, we decide to refrain from investigating the complex model of that period of time and exclude it from our sample.

## 4. Baseline VECM model

*Baseline Model Specifications*

An error correction model that incorporates the historical series of the determinants listed above over the period of Q1 2003 to Q4 2017 is envisaged.

These series are non-stationary and integrated in the order 1. The existence of a unit root is tested by using an Elliott-Rothenberg-Stock (ERS) and an Ng-Perron test.

**Table 2 Stationarity Tests[6]**

| | LGDP | LPRICE | LRENT | LSTOCK | LSUPPLY | EUR6 |
|---|---|---|---|---|---|---|
| **ERS test** | | | | | | |
| **In level** | | | | | | |
| Stat | 92.77 | 57.43 | 9.83 | 812.32 | 26.03 | 7.71 |
| 10% critical value | 3.97 | 3.97 | 3.97 | 3.97 | 3.97 | 3.97 |
| **In first difference** | | | | | | |
| Stat | 1.28 | 0.91 | 3.85 | 0.46 | 3.96 | 1.38 |
| 10% critical value | 3.97 | 3.97 | 3.97 | 3.97 | 3.97 | 3.97 |
| **Ng-Perron test (MPT)** | | | | | | |
| **In level** | | | | | | |
| Stat | 35.70 | 37.06 | 5.70 | 13.33 | 5.23 | 5.59 |
| 10% critical value | 4.45 | 4.45 | 4.45 | 4.45 | 4.45 | 4.45 |
| **In first difference** | | | | | | |
| Stat | 1.31 | 0.85 | 3.65 | 0.69 | 3.71 | 1.32 |
| 10% critical value | 4.45 | 4.45 | 4.45 | 4.45 | 4.45 | 4.45 |

As a result, we cannot use conventional models. In order to circumvent this problem, it is generally recommended to work in first differences. Nevertheless, a model based only on differentiated series may be incomplete; in this case, the presence of common trends of several variables would be neglected. Vector error-correction models (VECMs) allow working with the first differences while preserving the information such as common trends, which is due to the estimation of the cointegration relationships.

In this framework, the chosen model is a VECM of order 2, as indicated by the selection criterion of the Akaike information criteria and Schwarz information criteria, with one cointegration relationship.

[6] We rely on ERS and Ng-Perron tests that are indicated especially for short time series. We also performed ADF and Phillips-Perron tests, which are less powerful in our specific case, and provide hence more ambiguous results on the order of integration of the series.

**Table 3 Akaike Information Criterion and Schwarz Information Criterion**

| Number of lags | AIC | SIC |
|---|---|---|
| 1 | -29.38 | -28.36 |
| 2 | -29.74 | -27.69 |
| 3 | -29.56 | -26.45 |
| 4 | -29.44 | -25.27 |

The number of cointegrations and the inclusion of non-deterministic relationships is determined by using a Johansen test. The Johansen test causes the favoring of a model with a constant added to a short term relationship, thus resulting in the assumption of a linear trend in the level of rent:

$$\Delta Y_t = c + \alpha\beta^T Y_{t-1} + \sum_{k=1}^{2} \Phi_k \Delta Y_{t-k} + u_t \quad (1)$$

where $Y_t$ represents the vector of the selected dependent variables: $Y_t$ = (log_GDP$_t$, log_PRICE, log_RENT, log_STOCK, log_SUPPLY, and EUR6$_t$) and $u_t$ the residuals[7]. The cointegrating relationship is represented by the term $\beta^T Y_{t-1}$ so that $\beta^T Y_t = \varepsilon_t$ where $\varepsilon_t$ is stationary. The rank of the co-integration is found to be equal to 1.

*Results from the Main Model*

In the cointegration long-term relationship, GDP depends positively on office prices and negatively on interest rates and office supply, which is consistent with the theory explained in Section 2 and economic intuition. Nonetheless, this long-run relationship does not represent all of the complexities of the interactions between the real estate market and economic conjuncture.

In the short-run, it is also interesting to note that office prices depend positively on the economic juncture through the GDP and on the rent among our variables of interest, which is consistent with the theory. The office rent depends positively on prices, and negatively on office stock and supply. The office stock depends positively on GDP. Office supply depends negatively on GDP and prices, and positively on interest rates.

[7] The autocorrelation of the residuals is tested with a portmanteau test. The hypothesis $H_0$ that residuals are independently distributed is not rejected when considering 12 lags at a 5% threshold.

**Table 4 Estimation Results for VECM model**

| **Cointegrating Relationship** | |
|---|---|
| LGDP(-1) | 1.000000 |
| LPRICE(-1) | -0.228522 |
| | [-6.40823] |
| LRENT(-1) | 0.065851 |
| | [ 1.73476] |
| LSTOCK(-1) | -0.055327 |
| | [-0.42900] |
| LSUPPLY(-1) | 0.109351 |
| | [ 4.91248] |
| EUR6(-1) | 0.024022 |
| | [ 9.71070] |
| C | -6.143404 |

***Note***: Coefficients of long-term relationship with t-stats in brackets

| **Short Term Equations** | | | | | | |
|---|---|---|---|---|---|---|
| Error Correction: | D(LGDP) | D(LPRICE) | D(LRENT) | D(LSTOCK) | D(LSUPPLY) | D(EUR6) |
| CointEq1 | -0.231792 | 0.053349 | 0.555492 | -0.009363 | -0.870648 | -0.666940 |
| | [-4.74900] | [ 0.13788] | [ 2.50208] | [-0.13768] | [-1.89963] | [-0.17515] |
| D(LGDP(-1)) | 0.286616 | 3.683149 | 0.831460 | -0.048098 | -0.458787 | 34.35011 |
| | [ 2.19889] | [ 3.56460] | [ 1.40237] | [-0.26485] | [-0.37483] | [ 3.37784] |
| D(LGDP(-2)) | 0.244781 | 3.320160 | 0.111227 | 0.446135 | -4.607253 | 22.35048 |
| | [ 1.50618] | [ 2.57718] | [ 0.15046] | [ 1.97032] | [-3.01900] | [ 1.76276] |

**(*Continued*…)**

**(Table 4 Continued)**

| Error Correction: | D(LGDP) | D(LPRICE) | D(LRENT) | D(LSTOCK) | D(LSUPPLY) | D(EUR6) |
|---|---|---|---|---|---|---|
| D(LPRICE(-1)) | -0.016632 | -0.243666 | 0.160894 | -0.048139 | -0.205537 | 0.894092 |
| | [-0.89988] | [-1.66313] | [ 1.91382] | [-1.86946] | [-1.18428] | [ 0.62006] |
| D(LPRICE(-2)) | -0.004802 | -0.221591 | 0.005548 | -0.007561 | -0.362683 | 1.824771 |
| | [-0.27051] | [-1.57459] | [ 0.06871] | [-0.30568] | [-2.17560] | [ 1.31748] |
| D(LRENT(-1)) | 0.065393 | -0.006062 | 0.067255 | -0.041306 | 0.494704 | 1.188230 |
| | [ 1.76445] | [-0.02063] | [ 0.39895] | [-0.79994] | [ 1.42149] | [ 0.41094] |
| D(LRENT(-2)) | 0.066974 | 0.489203 | -0.165164 | -0.004296 | -0.199738 | 0.269356 |
| | [ 1.96473] | [ 1.81038] | [-1.06519] | [-0.09046] | [-0.62399] | [ 0.10128] |
| D(LSTOCK(-1)) | 0.072562 | 0.601983 | -1.700674 | 0.060449 | -1.324078 | 4.613871 |
| | [ 0.62693] | [ 0.65612] | [-3.23034] | [ 0.37486] | [-1.21827] | [ 0.51095] |
| D(LSTOCK(-2)) | 0.034943 | -1.434497 | 0.613536 | 0.046192 | 1.382487 | -3.405348 |
| | [ 0.24762] | [-1.28237] | [ 0.95584] | [ 0.23495] | [ 1.04330] | [-0.30931] |
| D(LSUPPLY(-1)) | 0.001420 | -0.050048 | -0.081551 | -0.001422 | 0.380146 | -1.162091 |
| | [ 0.10415] | [-0.46310] | [-1.31508] | [-0.07484] | [ 2.96944] | [-1.09257] |
| D(LSUPPLY(-2)) | -0.006407 | -0.013564 | -0.106590 | -0.000850 | 0.203436 | -0.729545 |
| | [-0.57032] | [-0.15231] | [-2.08590] | [-0.05431] | [ 1.92846] | [-0.83238] |
| D(EUR6(-1)) | 0.004131 | -0.008093 | -0.003804 | -0.000114 | 0.016522 | 0.155865 |
| | [ 1.87026] | [-0.46224] | [-0.37866] | [-0.03695] | [ 0.79663] | [ 0.90455] |
| D(EUR6(-2)) | -0.002242 | -0.011359 | -0.005084 | -0.000118 | 0.065754 | -0.462520 |
| | [-1.15594] | [-0.73870] | [-0.57620] | [-0.04373] | [ 3.60972] | [-3.05609] |
| C | 0.002074 | -0.004130 | -0.003266 | 0.001594 | 0.028048 | -0.246206 |
| | [ 2.14698] | [-0.53929] | [-0.74317] | [ 1.18414] | [ 3.09162] | [-3.26638] |
| R-squared | 0.638465 | 0.503056 | 0.584390 | 0.173807 | 0.544911 | 0.616806 |

***Note***: Coefficients of short-term relationship with t-stats in brackets.

In this class of model specification, it is challenging to directly interpret the estimated coefficients. Thus, and more interestingly, the interactions between the different variables can also be approached by using impulse response functions. In the first step, it is necessary to perform an ordering of the variables in order to represent the residual variance matrix with a Cholesky decomposition. The considered order is the one above $Y_t$ = (log_GDP$_t$, log_PRICE$_t$, log_RENT$_t$, log_STOCK$_t$, log_SUPPLY$_t$ , and EUR6M$_t$)[8]. Thus, this ordering means that a shock on the GDP has no immediate impact on other variables but only after one or more quarters. Similarly, a shock on prices does not immediately impact neither rent nor office supply, but after one or more quarters. These assumptions are validated by using Granger causality tests.

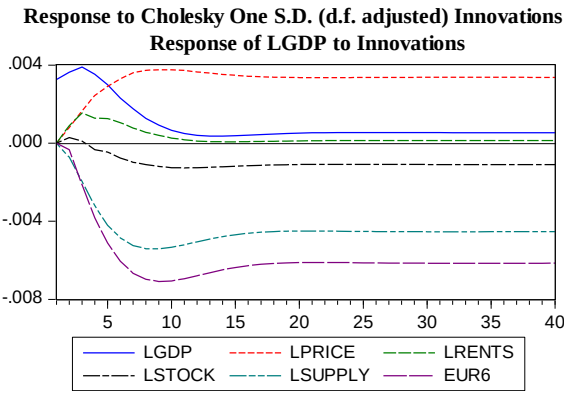
**Table 5 Causality Tests**

| | LGDP | LPRICE | LRENT | LSTOCK | LSUPPLY | EUR6 |
|---|---|---|---|---|---|---|
| LGDP → | | 0.00 | 0.14 | 0.47 | 0.10 | 0.00 |
| LPRICE | 0.07 | | 0.02 | 0.49 | 0.02 | 0.14 |
| LRENT | 0.02 | 0.02 | | 0.40 | 0.07 | 0.13 |
| LSTOCK | 0.59 | 0.24 | 0.00 | | 0.53 | 0.17 |
| LSUPPLY | 0.22 | 0.13 | 0.25 | 0.46 | | 0.05 |
| EUR6 | 0.00 | 0.00 | 0.03 | 0.60 | 0.01 | |

***Notes***: Table presents p-value of Granger causality test. Arrow denotes that LGDP does not Granger cause LPRICE with a p-value of 0.00.

After the impulse response is carefully carried out, the results provide interesting insights. Figure 8 shows the impact of a positive shock of 1 empirical standard deviation of each endogenous variable.

**Figure 8a Impulse Response Functions**

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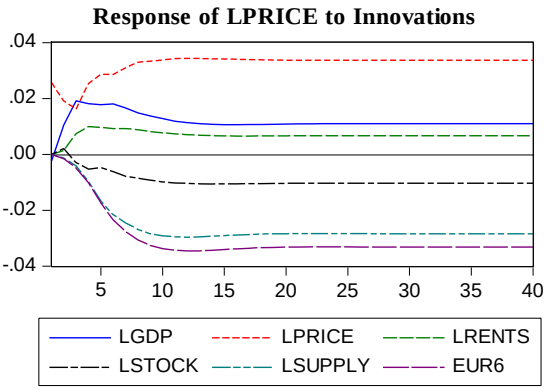
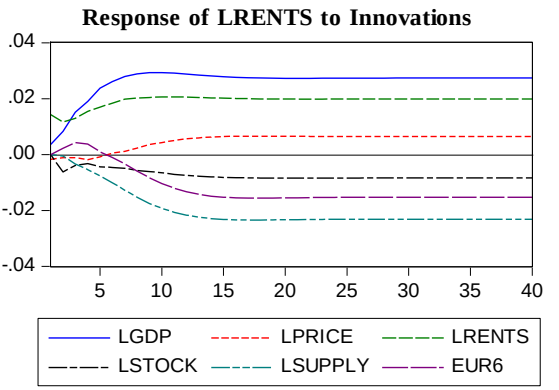
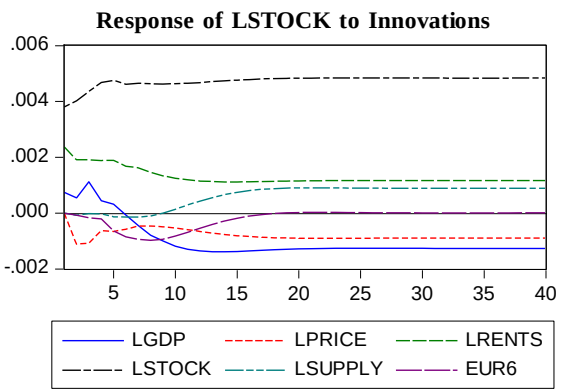
[8] Results are robust to changes in the ordering of variables. Additional results are available upon request.

**(Figure 8a Continued)**

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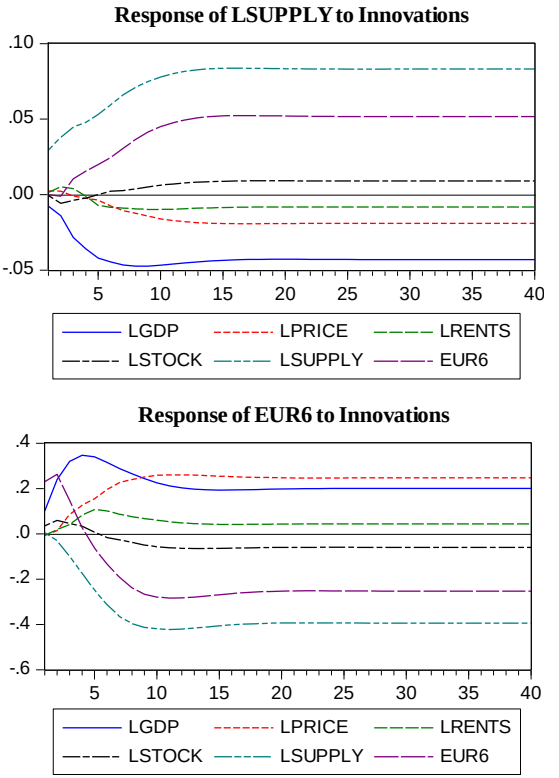
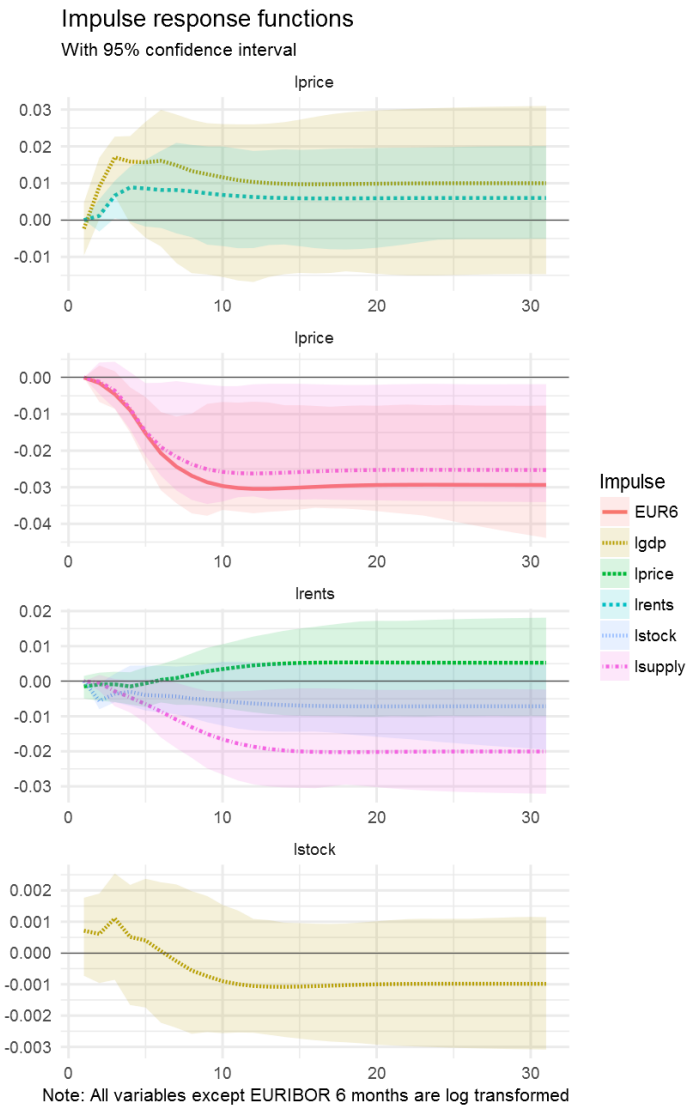
**(Figure 8a Continued)**




The interrelationship between rent and prices is in line with the work in DiPasquale and Wheaton (1992) and Wheaton et al. (1997), among others. Regarding office prices, we find that a positive shock on the GDP (via the rise in demand for offices), as well as a positive shock on the rent (through the investment channel), have a positive effect on office prices, both in the short and long-term, like the findings of Davis and Zhu (2011). An increase in the supply of offices yields a negative impact on rent and prices both in the short-run and long-run: as the projects are financed by investors only if they are deemed cost-effective, if the selling prices are higher than the cost of construction, and increases in construction consecutive to an increase in price increases the stock of available offices thus causing a downward trend in rent, and therefore prices. The dynamics of prices and rent are therefore closely related. Finally, an increase in the interest rate leads to a decrease in the office prices in the long-term because it lowers the value of the investment in offices in comparison to other market products. The results on rent are quite similar to the ones on prices, and support Tsolacos et al. (1998); namely, we find that a positive effect of the economic juncture leads to an increase in the demand for offices and hence an increase in rent, and higher interest rates weighs on the

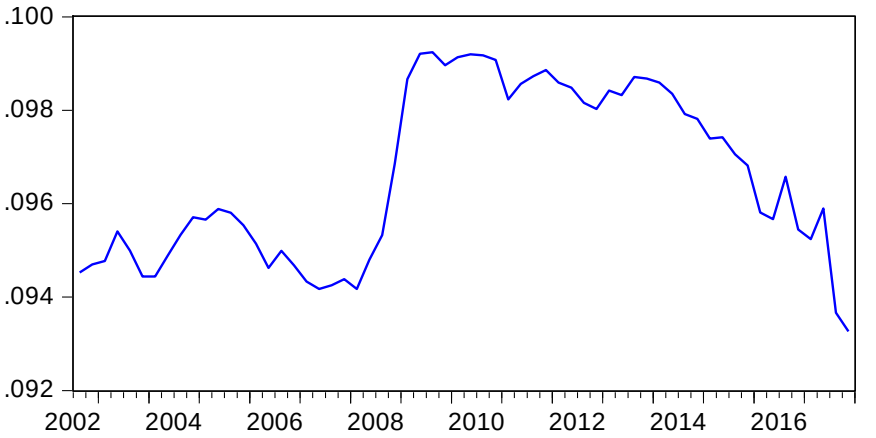
long-term levels of rent but proves more neutral in the short-term because it might be compensated by fiscal measures. We also find that an increase in prices (which causes an increase in construction) would lead to a decrease of rent, but the effect would be very small and limited to the very short-term. Finally, in terms of the office user market, a significant number of unoccupied offices in previous periods have increased the negotiation margin of occupying companies and pull the rent downwards.

**Figure 8b Impulse Response Functions with Confidence Intervals (+/- One Standard Deviation)**



Regarding the effect of different variables on the real variables of the office market, our results confirm those of Wheaton et al. (1997) to a large extent. For instance, we find that a positive shock on GDP and hence employment, which conveys an increase in the demand for offices, has a positive effect on office stock. Nonetheless, this effect is only observed for the short-term. We must recognize that the period under study is quite different from the ones studied in seminal papers, and the interrelationships between variables might prove different. Digitalization of labour processes, and new methods for office space optimization, notably in the manufacturing and services industries, may have triggered, in the long-run, a negative effect on office stocks. In addition, given the inertia of the office market adjustment, a positive growth shock may also cause a decrease in the office surface for each employee, which is observed in practice over the period Q1 2003 to Q4 2017. Regarding the other impulse response functions, a positive shock on rent makes the office market more profitable and sustains investment, and hence is an office stock increase, but does not discourage firms to move there, and especially does not facilitate delocalization. Moreover, increasing the office supply causes an increase in office stock in the long-term.

**Figure 9** **Unit pf Office Stock Per Unit of Real GDP Over Period of Q1 2003– Q4 2017**



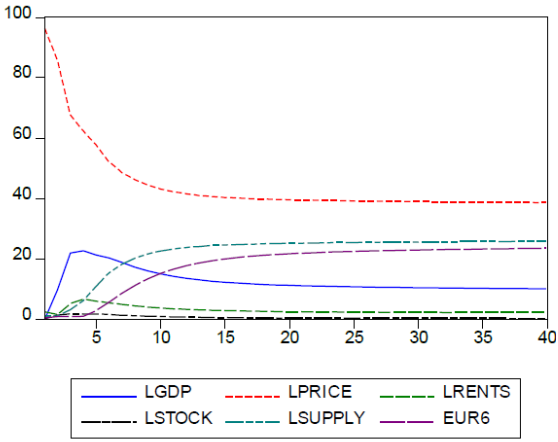

***Source***: INSEE and IEIF, calculations of authors

*Interpretation of the Results*

We also carry out a variance decomposition of the different variables with the same specification assumptions. Regarding the office prices, rent and GDP explain for a large proportion of the variance in the short-run, while the interest

rates and office supply dominate in the long-run. The GDP also appears as the main driver of rent over the short-run, and office supply over the long-term.

**Figure 10 Variance Decomposition for Office Prices (%)**




As a result, it appears that with the combination of persistent low interest rates and stable and even decreasing interest rates at the end of the studied period, office supply may have been the source of a robust increase in office prices.

The impulse response dynamics provide quantification of the results. We find that, all other things kept equal, a 100 basis point permanent increase in the interest rate would result in a -9% permanent decrease in the office prices, with the maximum effect attained after 10 quarters. The effect of an exogenous GDP shock is quite massive: a decrease of the GDP by 1% results in the long run, a decrease in office prices by 6%, with the maximum observed after 6 quarters.

Two other scenarios could also impact price levels. The first scenario would be a macroeconomic downturn and sudden entry into a recession. This scenario could, for example, result from the materialization of global economic risks that have been apparent for a few months (escalation of protectionist measures, geopolitical risks, and increase in oil prices). This situation would penalize demand for commercial real estate and force investors to lower their rental forecasts. This would translate into lower prices for commercial real estate. In the context of the office pricing model described earlier, the effect of lower rent on the price level would be relatively low, in the range of 1: 1: a 1% decrease in rent would result in a decrease in office prices by 1% over four quarters, and would continue thereafter.

An alternative scenario would be a runaway construction sector. The existence of excessive price levels discourages the incentives of agents for these assets and the sub-optimal allocation of capital. This is exacerbated by the mismatch

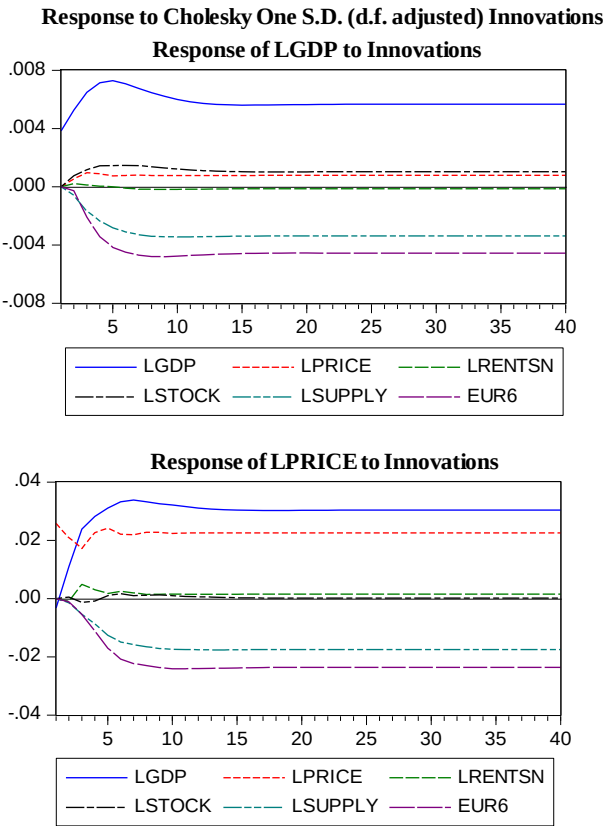
between the order and delivery of a project that can lead to massive overinvestment - this was the case in Spain during the global financial crisis. This could lead to oversupply and downward revision of rent paths. This in turn would affect price levels and could spread to all real estate sectors and their owners. The model shows that the 1% increase in the supply of offices - all things being equal - would very gradually lead to a decrease of the prices of 0.9% at a relatively distant horizon, in the order of 10 quarters.

*Robustness Checks*

In order to make the results as robust as possible, we run two robustness checks.

First, instead of using real rent, we estimate exactly the same model but with headline rent. The impulse response functions obtained tend to confirm our primary results.

**Figure 11 Impulse Response Functions - Robustness with Headline Rent**

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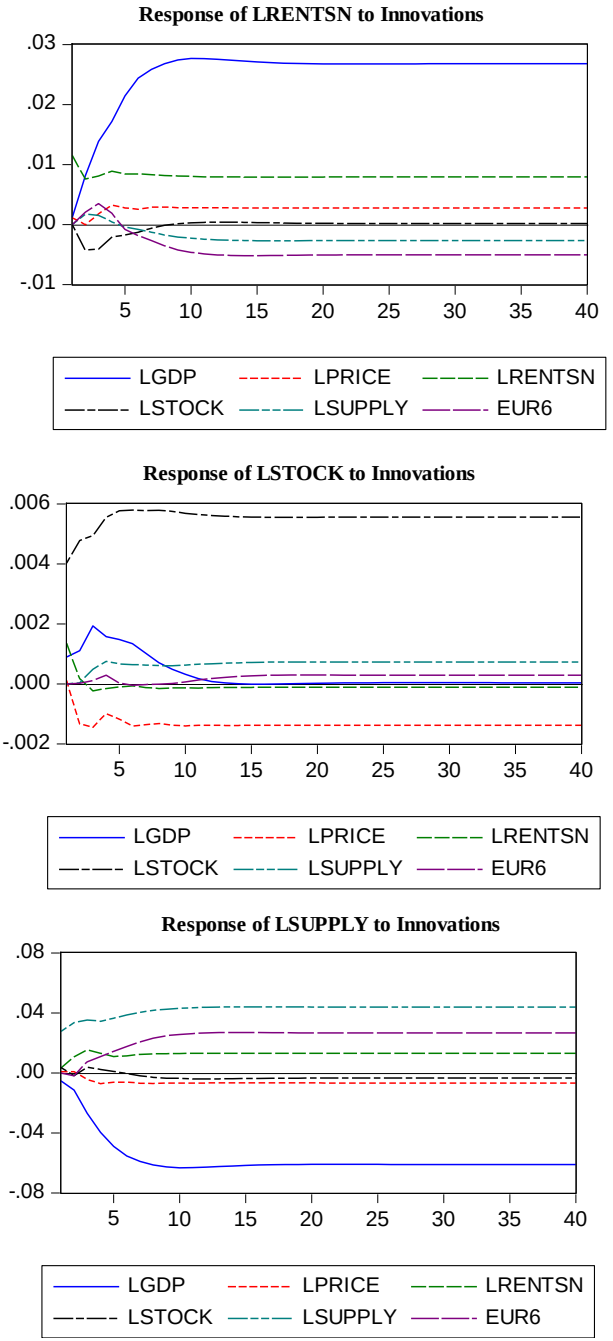
**(Figure 11 Continued)**

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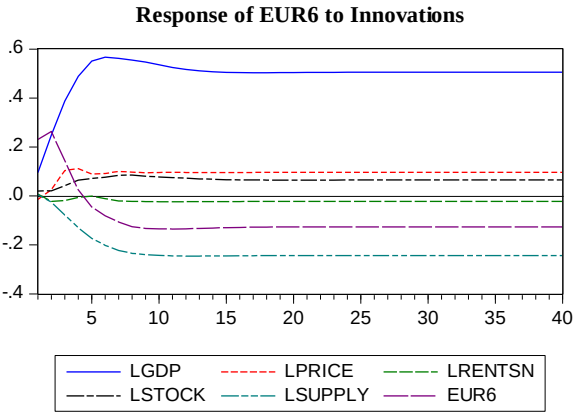
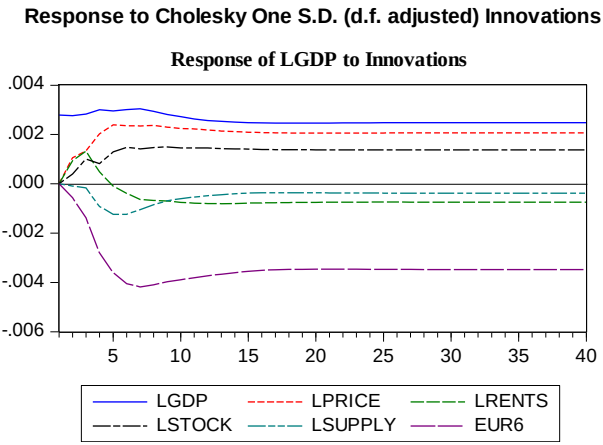



Second, we re-estimate the VECM model on the same period but with an exogenous dummy variable and account for the financial crisis period (Q3 2008 – Q4 2017). We draw the same impulse response function as in the main results and obtain in general the same results, which tend to support the robustness of our main results.

**Figure 12 Impulse Response Functions - Robustness with Crisis Dummy**

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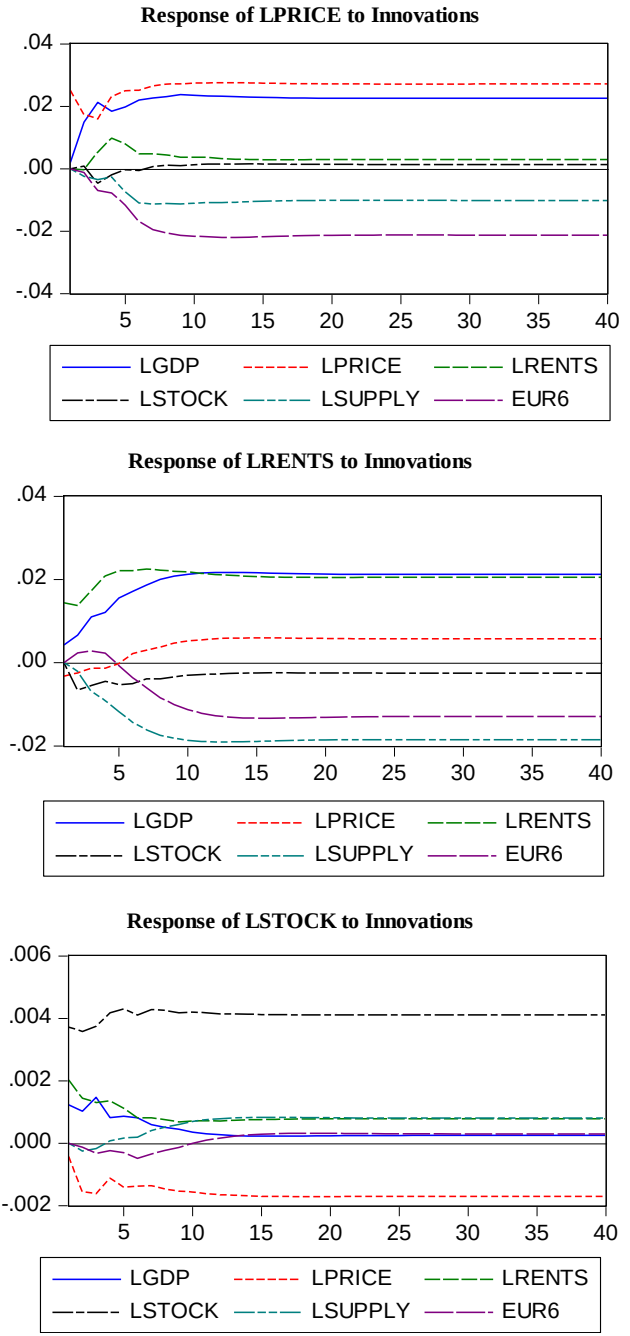
**(Figure 12 Continued)**

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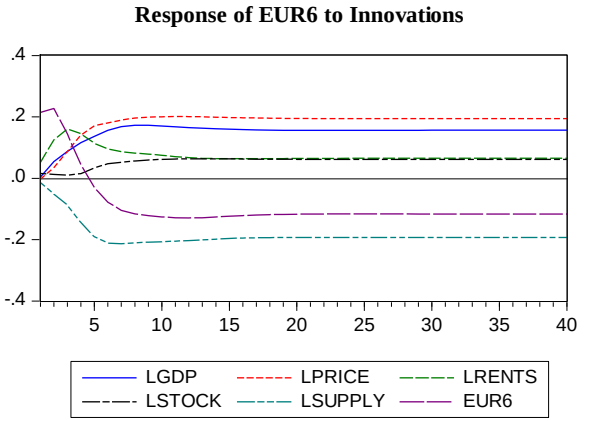



## 5. Office Price Overvaluation

*Measurement of Overvaluation of Office Prices*

The Granger representation permits us to rewrite Equation (1) so that the variables are represented not in first differences but levels. This representation has been found in Engle and Granger (1987) and Johansen (1991), while the exact definition of the closed formula is attributable to Hansen (2005). This representation consists of decomposing the series into trend and cyclical components. The former is composed not only of a constant term and a deterministic component that can grow linearly over time, but also a stochastic component, which represents the non-stationary variables. The cyclical component represents the transitional impact of shocks. The formula proposed by Hansen (2005) is written as:

$$Y_t = T_t + C_t \tag{2}$$

The trend component T is defined by:

$$T_t = C \sum_{s=1}^{t} u_s + \tau(t) + A_0 \tag{3}$$

The first term represents the stochastic component. The second represents the deterministic component and the third represents the constant. The matrix C, term $\tau$ and matrix $A_0$ can be calculated from the parameters estimated for the VECM.

Moreover, the cyclical component is written:

$$C_t = C(L)\, u_t = \sum_{=0}^{\infty} C_i L^i u_t \qquad (4)$$

With C(L), a polynomial delay, previously as the term $C_i$, can be calculated from the parameters estimated for the VECM. In the following estimation, we consider a range of values for the lagged polynomial, which ranges from 8 to 14 quarters, to provide the confidence interval for the overvaluation estimate.

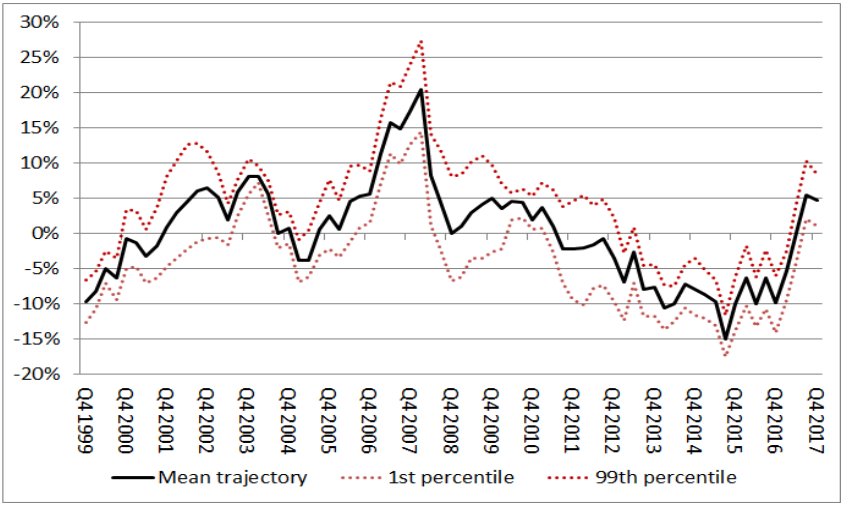
Within this framework, the overvaluation of the price is defined as the stochastic component of the first term of Equation (3), which captures the variation that cannot be explained by the trend and the cyclical variation alone.

*Estimate of the Overvaluation*

Prices are considered to be overvalued when the gap between the logarithm of the index and its trend component is positive. Under this assumption, prices would have been overvalued between 2005 and 2009. Since then, prices appear to be close to the equilibrium.

At the very end of the sampling, the estimate is no longer undervalued, and even significant in the last observation, which points out some new risks for the sustainability of the office market, but at a magnitude that appears, to a large extent, reasonable (5% on average and 10% for the 5th percentile).

**Figure 13 Overvaluation of Office Prices in France – Main Result**



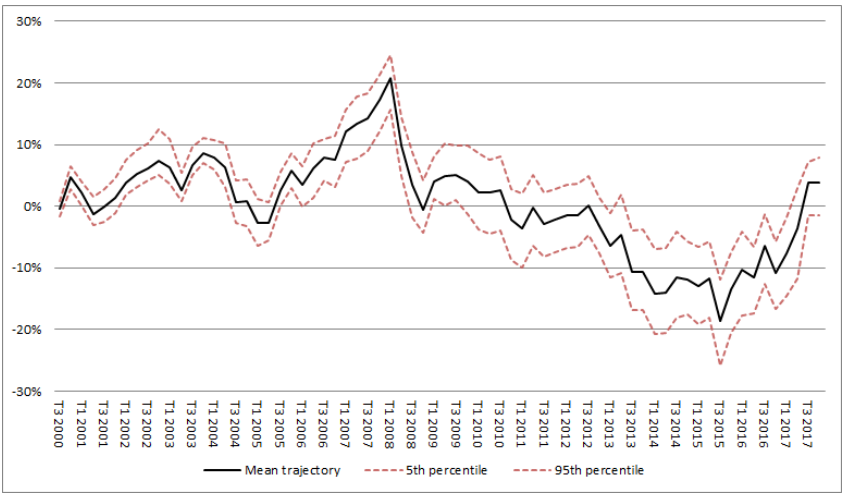
*Robustness of the Overvaluation*

Nevertheless, these results should be taken with great caution, as looking at the estimated parameters over the different samples considered, we can see that the estimated values of the parameters of the model have changes since 2008, so that a model that takes into account this structural change should be considered.

The results could be due to the learning of the model. Indeed, we strongly suspect that prices have been overvalued since 2008, but the part of the sample in which prices may be overvalued continues to increase, thus causing changes in the estimated parameters and the path of the estimated trend.

To evaluate this point, we estimate the same model but on truncated samples, considering that the specification, a VECM of order 2 with 1 cointegration relationship, still holds. The first sample considered for estimation is the sample up to Q3 1998, the following ones include an additional quarter until we reach the full sample (Q2 2000). From the 8 simulated trajectories for the price overvaluation, we build an interval. From these results, it seems that office prices may have been overvalued since 2006, with the largest spreads between prices and their trend observed in 2007 and 2015. The spread between the lower limit of the interval and the office rent prices was around 25% at the end of 2015. In late 2017, this spread became positive, thus indicating a very recent surge in overvaluation, at around 4% in Q4 2017.

**Figure 14 Overvaluation of Office Prices in France – Robustness**



## 6. Conclusion

In this paper, we first develop a VECM model which allows an understanding of the functioning of the office commercial real estate market in the particular case of France. We find that, consistent with common wisdom, the office prices depend positively on the GDP and rent, and negatively on interest rate, with the effect of the latter being especially low. In light of these results, we estimate the overvaluation of office prices in France to be between 0% and 10% of the equilibrium price in Q4 2017.

The simultaneous phenomena of high office prices and low overvaluation would then be the result of continuously low interest rates and limited supply, which would have sustained equilibrium prices.

Our simple and tractable model also allows us to study the impact of Brexit on office prices in Ile-de-France through the relocation of employment in the city (cf. Appendix). We find that this effect would be significant but manageable from a policy point of view.

Looking forward, it could be interesting to envisage a regime-switching VECM model, although the time span is very short, in order to better take into account the structural changes in the market over the recent period of time. In addition, an improvement in the data used could be envisaged, as they are at this point a merger of several heterogeneous sources.

## Acknowledgement

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# Appendices

## Appendix 1: A Case Study: Effect of Brexit on Office Prices in Ile-de-France

The model in Section 4 is then applied to Ile-de-France. In this variant, the GDP growth is replaced by the increase in number of employees. The reason for this change is twofold. First, this variable is linked to growth, thus enabling the model robustness to be assessed one more time. Second, the change allows quantitative predictions of the impact of Brexit –which is proxied as a positive labor shock - on the office market in Ile-de-France. This also provides a model in which the full range of the data is homogeneous as far as the geographical area is concerned.

The specification retained in this exercise is the same as the one in Section 4. On this basis, the model is estimated over the period of Q1 2005 - Q2 2018. The impulse response functions thus obtained make it possible to validate the model: a shock on employment, as well as a shock on rent, have a positive effect on prices, while a positive shock of supply or interest rates puts downward pressure on prices.

Given the empirical standard deviation actually observed in the series, it is inferred that an employment shock of 1 percentage point would result in an increase in office prices of 2.3% over the next five year horizon.

A shock of about 100,000 jobs, which represent 2.5% (respectively 3.6%) of all jobs in the Paris *Petite Couronne* (Paris and Hauts-de-Seine respectively) would produce a positive shock on office prices of about 6 points (8 percentage points) respectively.