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THE STABILISATION PROPERTIES OF IMMOVABLE PROPERTY TAXATION: EVIDENCE FROM OECD COUNTRIES

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ABSTRACT/RÉSUMÉ

The stabilisation properties of immovable property taxation: evidence from OECD countries

This paper contributes to the scarce literature on the macroeconomic effects of property taxes, in particular on the relationships between property taxes, house prices and the wider economy. The paper first estimates a fiscal reaction function which analysis the reaction of property tax revenues to house prices. It then analyses a house price reaction function looking at the relation of how house prices react to changes in property taxes. For a set of OECD countries, the results suggest that property taxes tend to be a-cyclical or slightly pro-cyclical. They provide a stable revenue source for sub-central governments but do not stabilise the economy. The results also suggest that an increase in property tax revenues or in the tax revenue-to-GDP share slows down house price increases and that higher property taxation tends to reduce house price volatility.

JEL classification: E32; H50; H60

Keywords: Immovable property taxation, stabilisation, housing market

Les propriétés stabilisatrices de la fiscalité des biens immobiliers : données relatives aux pays de l'OCDE

Ce document vient compléter les rares travaux publiés sur les effets macroéconomiques des impôts immobiliers, en particulier sur la relation entre la fiscalité immobilière, les prix des logements et l'économie dans son ensemble. Nous estimons d'abord une fonction de réaction budgétaire permettant d'analyser la réaction des recettes d'impôts immobiliers aux variations des prix des logements. Nous analysons ensuite une fonction de réaction des prix des logements, permettant de déterminer comment réagissent les prix des biens immobiliers d'habitation aux variations des impôts immobiliers. Pour un ensemble de pays de l'OCDE, les résultats obtenus laissent à penser que les impôts immobiliers tendent à être acycliques ou légèrement procycliques. Ils constituent une source de recettes stables pour les administrations infranationales mais ne stabilisent pas l'économie. Les résultats obtenus laissent également à penser qu'une hausse des recettes d'impôts immobiliers ou du ratio recettes fiscales/produit intérieur brut (PIB) a pour effet de ralentir les augmentations des prix des logements, et qu'une fiscalité immobilière plus lourde tend à réduire la volatilité des prix des logements.

Classification JEL : E32 ; H50 ; H60

Mots clés : fiscalité des biens immobiliers, stabilisation, marché du logement

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THE STABILISATION PROPERTIES OF IMMOVABLE PROPERTY TAXATION: EVIDENCE FROM OECD COUNTRIES

By Hansjörg Blöchliger, Balázs Égert, Bastien Alvarez and Aleksandra Paciorek[1]

1. Introduction and conclusions

1. Real estate taxes can have a stabilising effect on house prices because they are themselves capitalised in house prices: the net present value of a house is given by the discounted stream of cash-flow (rents) or services (imputed rent) less maintenance costs and property taxes. As house prices rise, property taxes will represent an increasing share of (imputed) rents, thereby reducing the net present value and counteracting further house price appreciation. Also, the more important is property taxation as a share of house prices, the more it will help counteract housing demand shocks and limit house price fluctuations around the long-term house price trend. Finally, by stabilizing housing markets, property taxation may act as an automatic (counter-cyclical) stabiliser over the business cycle (Box 1).

2. Empirical research on the macroeconomic effects of property taxes is very scarce, even though the drivers of house prices, including taxation, have been assessed more thoroughly in the last few years. A particular driver of house price cycles is likely the favorable tax treatment of home-ownership (André, 2010 and Andrews, 2010). However, most studies deal with property and housing as part of the income tax system, while the effects of immovable property taxation are not assessed. Also, while the reaction of consumption, personal and corporate income taxes, and social security to the cycle were analysed in recent OECD work, property taxation was not (Égert, 2010). Against this background, this paper assesses the relationship between property taxes, house prices and the wider economy. The paper analyses empirically two relationships:

- A *fiscal reaction function* which assesses the reaction of property tax revenues to house prices, the business cycle and a set of structural and policy variables.

- A *house price reaction function* which assesses the reaction of houses prices to changes in property tax revenues, the business cycle and a set of structural and policy variables, analogous to measuring a tax multiplier for house prices. In addition, the extent to which the *volatility* of house prices is connected with the level and volatility of property tax revenues as a share of GDP will be investigated.

3. The main results of the paper can be summarised as follows:

1. Hansjörg Blöchliger and Balasz Egert are senior economists in the Economics Department of the OECD. Bastien Alvarez and Aleksandra Paciorek were interns when writing the paper. The authors would like to thank Bert Brys, Peter Hoeller, Pierre Leblanc, Jean-Luc Schneider, and the delegates of the OECD Fiscal Network for useful comments and suggestions. They also thank Celia Rutkoski and Violet Sochay for editorial assistance.

- First, the property tax reaction function shows a *neutral* to *negative* reaction to the cycle. As such, property taxes tend to be a-cyclical or slightly pro-cyclical. They provide a stable revenue source for sub-central governments, but are not stabilising the economy.

- Second, the house price reaction function suggests a *negative* relationship between house prices and property tax revenues: an increase in property tax revenues or in the tax revenue-to-GDP share slows down house price increases.

- Third, house price *volatility* is *negatively* associated with property tax revenues as a share of GDP. Hence, higher property taxation tends to stabilise house price fluctuations. Also, a higher volatility of taxes is associated with increased house price volatility.

- Fourth, the small budgetary effect of property taxation over the cycle may be the result of two countervailing forces: on one hand, property taxes may have a stabilising effect on the economy by lowering house price volatility; on the other, they may have a destabilising effect due to their inertia over the business cycle.

4. Country-specific estimates broadly confirm the panel estimates. They are generally robust, but results can be sensitive to different modelling choices including the use of various estimators, different economic specification and sample periods.

Box 1. The stabilisation properties of immovable property taxation

The stabilisation effect of property taxation may be explained by capitalisation, i.e. the link between house prices, imputed rent and the property tax. Taxes are capitalised in house prices, i.e. the value of a house should equal the discounted present value of the stream of services it provides (the imputed rent) minus maintenance costs and property taxes. Formally:

$$HP = [(1+r)/r]*[IMPR–MAINT-TAX]$$

where HP is the price or capital value of a house, r the interest rate, IMPR is imputed rent, MAINT is maintenance cost, and TAX is the property tax liability (Muellbauer, 2005). As house prices rise, property taxes will represent an increasing share of imputed rent. The tax to imputed rent ratio (TAX/IMPR) will rise, dampening further increases in house prices relative to imputed rents and incomes. Lower house price fluctuations would in turn lead to lower GDP fluctuations, given the various channels between house price developments and GDP.

House price volatility may also depend on how housing demand shocks are absorbed by property taxation. The price sensitivity of housing demand tends to fall with an increasing property tax share (van den Noord, 2003). The starting point is the assumption that equilibrium in the market for existing owner-occupied houses requires that homeowners earn the same return on housing investment as on other assets. This requires that they equate the marginal value of rental services from owner-occupied housing with the user cost of capital attached to a marginal unit of housing:

$$R(H) = [r(1-t)+d-p]\ PH$$

where R is the marginal value of the rental services per period on owner-occupied homes, r is the nominal interest rate, t is the marginal property tax rate, d is the rate of depreciation, PH is the price of owner-occupied housing and p is the expected rate of house price inflation. Other things equal, a higher tax rate reduces the marginal value of rental services and makes demand for housing more elastic. Housing supply is very inelastic in the short run but becomes more elastic in the long run. Under these conditions, an exogenous permanent housing demand shock (an outward shift of the housing demand curve) leads to lower increase of house prices, followed by a smaller decrease, the higher property tax rates. As such, while the long-term elasticity of house prices with respect to income or GDP might be similar across countries, a higher ratio of property tax to GDP may dampen volatility along the long-term house price trend.

2. Empirical design

2.1. The cyclical properties of property taxation

5. The stabilisation properties of the property tax with respect to real house prices and the business cycle are assessed using a tax reaction function. It measures the reaction of property tax revenues or the share of property taxes to GDP to the economy's position in the business cycle (output gap or GDP growth), real house prices and a number of control variables:

$$PROPTAX_t = \beta_0 + \beta_1 CYCLE_t + \beta_2 PROPTAX_{t-1} + CX + \varepsilon_t \quad (1)$$

where PROPTAX is the property tax revenue variable, CYCLE is a measure of the business cycle and X represents the vector of control variables, with C representing the coefficient matrix of the X variables. The PROPTAX variable reflects cycle-induced changes and changes due to policy measures. No distinction will be made between the cyclical and the policy component of changes in property tax revenue as this would require data on property tax policy changes for each country. Since the CYCLE variables reflect the state of the overall economy, and since PROPTAX reflects growth of overall property tax revenue, the extent to which property tax revenues react to idiosyncratic shocks in individual sub-national jurisdictions cannot be assessed.

2.2. Property taxes as a determinant of growth and volatility of real house prices

6. Fluctuations in house prices may affect macroeconomic stability and welfare (for the channels running from house price fluctuations to GDP fluctuations see Muellbauer, 2005). House price fluctuations, in turn, may depend on property tax levels. In a high-tax environment demand for housing with respect to house prices is more elastic because house price increases are partially choked off by tax increases and because investment in alternative assets becomes relatively more attractive. The more elastic housing demand, the weaker the effects of an (exogenous) demand shock on house prices (Box 1). As such, volatility along a *given* house price trend is supposed to be lower in a high-tax environment

a) House price reaction function

7. In the house price reaction function, annual house price changes are the dependent variable and are regressed on property taxes (both the real change in total tax revenues and changes in the tax-to-GDP ratio) and a set of macroeconomic and structural variables.

$$HP_t = \beta_0 + \beta_1 PROPTAX_t + \beta_2 HP_{t-1} + \beta_3 MACRO_t + \beta_4 STRUCTURAL_t + \varepsilon_t \quad (2)$$

where HP is real house price growth, PROPTAX is the property tax variable, MACRO represents the set of macroeconomic fundamentals (real interest rates and variables reflecting the state of the economy: GDP growth, unemployment and others) and STRUCTURAL represents a set of structural variables (supply elasticity, banking regulation, the tax system other than property taxation etc.).

b) House price volatility

8. A complementary approach to the house price reaction function is to use house price volatility as a dependent variable and to link it to property taxes., and a set of macroeconomic and structural variables, along the lines of Andrews et al. (2011):

$$\sigma_{i,t}^{HP} = \beta_0 + \beta_1 PROPTAX_i + \beta_2 MACRO_{i,t} + \beta_3 STRUCTURAL_{i,t} + \varepsilon_{i,t} \quad (3)$$

9. The house price volatility variable ($\sigma_{i,t}^{HP}$) is constructed by calculating the standard deviation of annual real house price growth over five years. The vector MACRO contains the conventional macroeconomic factors and is constructed in the same way as the dependent variable. The STRUCTURAL vector contains a set of time-invariant variables such as the supply elasticity, tax relief on home ownership and others (Caldera Sanchez and Johansson, 2011). These variables may be replaced by simple country-fixed effect estimation. Finally, the PROPTAX variable encompasses both cyclical and policy-related changes to property tax revenues, since a distinction between the two cannot be made.

2.3. Variable selection and data sources

10. For property taxes, two variables are used: property tax revenue as a share of GDP, and real property tax revenue, calculated as nominal property tax revenue deflated by the consumer price index (CPI). The data are obtained from the OECD's Revenues Statistics. House prices are measured as nominal house prices deflated by the CPI. They are drawn from the OECD's House Price database (Box 1).

11. Four alternative measures are used to capture cyclical fluctuations: the output gap, real GDP growth and changes in these two variables, i.e. changes in the output gap and changes in real GDP growth.

12. For the tax reaction function, additional control variables were used such as the real share price index, general government debt, trade openness (exports plus imports over GDP) and the government spending to GDP ratio. These data were collected from the OECD's Main Economic Indicators and Economic Outlook databases.

13. For the house price equations, the following control variables were employed: the growth rate of real share prices, population growth, the real long-term interest rate, changes in the real construction cost index, changes in the private credit-to-GDP ratio, and finally, changes in the unemployment rate. These variables are mostly obtained from the OECD's Economic Outlook database, and from the World Bank's World Development Indicators (private credit-to-GDP ratio).

Box 2. Variable description

The variables used throughout this paper are defined as follows:

Property taxes:	
dlog_propgdp	differenced log of property tax revenues to GDP
dlog_propcurr_r	differenced log of real property tax revenues
Cycle:	
Gap	output gap
Dgap	differenced output gap
dlog_gdpv	differenced log real GDP
ddlog_gdpv	double differenced log real GDP
Control variables:	
dlog_sharep_r	differenced log of real share price index
dlog_pop	differenced log of population growth
irl_r	real long term interest rate
dlog_constr_cost_r	differenced log of real construction cost index
dlog_privcred	differenced log of private credit to GDP
dlog_unr	differenced log of unemployment rate
dlog_govgdp	differenced log of government spending in GDP

If the name of the variable is preceded by _lag_, then it is a one-year lag of the variable. If it is preceded by vol5, then it is the volatility of the variable based on the 5 closest years of data (overlapping windows). A5 and v5 are averages and volatilities of non-overlapping windows.

2.4. Estimation issues

14. The estimation approach follows broadly Égert (2010). Five estimation approaches are implemented. First, equations (1) to (3) are estimated using the Least Square Dummy Variable estimator (LSDV or country fixed effects OLS) without including the lagged dependent variable as a right-hand side variable. Second, a dynamic version including the lagged dependent variable is estimated using country fixed effect LSDV. To correct for the bias arising for the coefficient on the lagged dependent variable, the Kiviet estimator is used. The Kiviet estimator assumes that all the explanatory variables are exogenous. This may not always be the case, especially for the relations linking property taxes, house prices and the cycle. Therefore, two variants of the GMM estimator, the difference and the system GMM estimators are used to account for possible endogeneity of the regressors. It should be noted that the GMM estimator is designed for panels with a large cross-section dimension (N) and a short time dimension (T). Our dataset does not fulfill this criterion: N is small and T is relatively large. Three sets of estimations are conducted: i) a bivariate relationship between the variables of interest (eventually complemented by a dynamic term), ii) the cycle variable added to the basic specification, and iii) a set of additional control variables added.

15. The property and house price equations are estimated for an annual panel dataset of OECD countries from 1965 to 2012. Two sub-periods are also analysed to gauge the impact of the 2007 financial crisis: 1980 to 2006 and 1980 to 2012. It has to be noted that the house price series start in 2006 for most Central and Eastern European countries and Turkey. This implies that the sample split also entails a slightly different country coverage.

3. Estimation results

16. This section provides an overview of the estimation results. The section reports coefficient estimates obtained using mostly the Kiviet estimator (exceptions are the house price volatility models on five-year non-overlapping standard deviation models).

3.1. Property tax reactions to house prices

17. Real property taxation is negatively correlated with changes in house prices. A 1% increase in house price growth is associated with a 0.2 to 0.5 per cent decrease in property tax growth (Table 1). However, this relationship is statistically significant only when house prices are regressed on the property tax revenue-to-GDP ratio. For the real property tax revenue indicator, coefficients remain insignificant independently of the cycle variable or econometric technique used (not shown).

Table 1. Property tax reaction to house prices

Kiviet estimator

	Kiviet estimator without controls				Kiviet estimator with controls			
Dependent variable: Property tax/GDP								
1965-2012								
dlog_hprice_r	-0.374**	-0.179	-0.273**	-0.507**	-0.254*	-0.04	-0.157	-0.347**
gap	-0.004				-0.006*			
dgap		-0.013**				-0.022**		
dlog_gdpv			-1.227**				-1.682**	
ddlog_gdpv				-0.206				-0.446
Dependent variable: Real property taxes								
1965-2012								
dlog_hprice_r	-0.091	-0.045	-0.105	-0.209*	-0.099	0.036	0.033	-0.092
Gap	-0.001				-0.003			
Dgap		-0.003				-0.013**		
dlog_gdpv			-0.457				-1.098**	
ddlog_gdpv				0.159				-0.228

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively. Dlog_hprice_r=real house price growth, gap=output gap, dgap=change in the output gap, dlog_gdpv=real GDP growth, ddlog_gdpv=change in real GDP growth.
Source: Authors' calculations.

18. Table 2 reports the summary of country-specific coefficient estimates for different specifications.[2] For about half of the countries included in the sample, the relationship between real house prices and property tax growth tends to be negative. This is in line with the aggregate results obtained for the whole sample (Table 1). The negative correlation is very strong for some countries, such as the Czech Republic, where a 1% increase in real house prices decreases the growth rate of property taxes by up to 7%. Over time, the negative correlation between changes in property taxes and house prices became around three times larger in Greece for example (not shown). For some other countries, the coefficient switches sign, indicated by a large range in Table 2. At the same time, there are some exceptions: the coefficient is positive for Belgium, Korea and Turkey.

Table 2. Country-specific property tax reaction to house prices

Country-specific coefficient statistics

	Real property taxes				Property taxes/GDP			
	MAX	MIN	MEAN	MEDIAN	MAX	MIN	MEAN	MEDIAN
AUS	0.34	0.20	0.26	0.27	0.29	-0.04	0.12	0.11
AUT	0.00	-0.22	-0.12	-0.16	0.00	-0.32	-0.14	-0.13
BEL	2.82	0.62	1.84	2.08	2.44	0.44	1.66	1.91
CAN	0.16	0.00	0.03	0.00	0.00	-0.21	-0.03	0.00
CHE	0.00	-0.21	-0.05	0.00	0.00	-0.46	-0.23	-0.26
CZE	0.00	-7.25	-3.82	-4.52	0.00	-6.51	-3.37	-3.86
DEU	0.24	-0.25	-0.03	0.00	0.00	-0.68	-0.29	-0.29
DNK	0.00	-0.21	-0.06	-0.02	0.00	-0.32	-0.14	-0.15
ESP	0.00	-1.32	-0.46	-0.30	0.00	-1.53	-0.64	-0.46
EST	0.00	-0.16	-0.03	0.00	0.00	-0.48	-0.19	-0.10
FIN	-0.73	-1.02	-0.90	-0.90	-0.82	-1.29	-1.05	-1.01
FRA	0.00	-0.77	-0.29	-0.19	0.00	-0.87	-0.36	-0.25
GBR	0.81	0.24	0.49	0.48	0.68	0.06	0.34	0.32
GRC	-2.20	-2.98	-2.55	-2.53	-2.59	-3.42	-2.95	-2.94
HUN	2.25	-0.75	0.64	0.00	1.79	-1.40	0.08	0.00
IRL	0.45	-0.15	0.11	0.00	0.00	-0.55	-0.10	0.00
ISL	0.62	0.00	0.26	0.21	0.43	0.00	0.10	0.00
ISR	0.00	-0.05	-0.01	0.00	0.04	0.00	0.01	0.00
ITA	0.16	-0.21	0.00	0.00	-0.57	-1.36	-1.03	-1.08
JPN	0.54	0.00	0.34	0.43	0.43	-0.12	0.10	0.00
KOR	0.98	0.51	0.68	0.61	0.99	0.38	0.62	0.60
LUX	0.00	-3.28	-1.10	-0.50	0.00	-4.17	-2.44	-3.04
MEX	0.00	-0.31	-0.07	0.00	-0.80	-1.83	-1.26	-1.19
NLD	0.56	0.00	0.26	0.26	0.50	-0.32	0.15	0.15
NOR	0.19	0.00	0.07	0.05	0.11	0.00	0.03	0.00
NZL	0.22	0.00	0.12	0.16	0.14	-0.16	-0.01	0.00
PRT	0.62	0.00	0.09	0.00	0.00	-0.76	-0.20	0.00
SVK	0.00	-0.21	-0.05	0.00	0.00	-0.52	-0.20	-0.17
SVN	0.00	-0.56	-0.11	0.00	0.00	-0.87	-0.27	0.00
SWE	0.00	-2.21	-1.19	-1.25	0.00	-2.42	-1.34	-1.47
TUR	31.20	26.48	29.32	30.11	27.66	18.13	22.52	23.00
USA	0.40	0.22	0.28	0.25	0.28	-0.11	0.10	0.05

Note: Zero means that the coefficient is not significant at the 10% level. Min, max, mean and median are taken from the distribution of coefficient estimates obtained from estimations on the basis of various econometric estimators (LSDV, Kiviet, difference and system GMM) and alternative specifications.

Source: Authors' calculations.

2. Country-specific estimates are obtained in the panel context by interacting the variable of interest with country dummies.

19. The impact of the cycle on property taxes depends on the measure of the cycle: only changes in the output gap and real GDP growth are statistically significant (Table 1). The negative coefficient estimates suggest that property taxes are slightly pro-cyclical: they grow more slowly than GDP during economic expansions and more rapidly than GDP during slowdowns.

20. These results are robust to the inclusion of a variety of control variables (such as the real share price index, general government debt, trade openness and the government spending to GDP ratio), as well as to alternative econometric estimation methods (including the static and dynamic LSDV estimator, the corrected LSDV (Kiviet) estimator and the difference and system GMM estimators).

21. Control variables have mostly expected signs but are predominantly insignificant. Across different estimations, the change in the real share price index and the ratio of government spending to GDP are the most significant controls. Both are positively correlated with property taxation growth. However, all control variables are sensitive to the estimation technique used. The coefficient on lagged property tax growth is positive with a few exceptions, but it frequently loses its significance outside the 1980-2006 time period. This suggests that property taxes became less persistent over time (and during and after the crisis).

3.2. House price reactions to property taxes

22. How do house prices react to property tax changes? The results suggest that they are negatively correlated (Table 3). An *increase* in property taxes entails a *decrease* in real house prices. More precisely, a 1% rise in the growth rate of property taxes goes hand in hand with a 0.01 to 0.04 percentage point decrease in the growth rate of house prices. However, the results are statistically significant only when the growth rate of property tax revenues-to-GDP ratio is used as the regressor. As for the second property tax variable, the change in real property tax revenues does not have a statistically significant impact on the growth rate of house prices, suggesting that property taxation must increase in terms of GDP in order to affect house price developments.

Table 3. House price reaction to property taxes

Kiviet estimator

	Dependent variable: **Real house price growth** Independent policy variable: P**roperty tax-to-GDP ratio**							
	Without controls				With controls			
1965-2012								
dlog_propgdp	-0.036**	-0.002	-0.009	-0.024**	-0.009	-0.005	-0.014	-0.020*
gap	0.003**				-0.0003			
dgap		0.013**				0.005**		
dlog_gdpv			1.209**				0.762**	
ddlog_gdpv				0.790**				0.400**
Independent policy variable: **real property taxes**								
1965-2012								
dlog_propcurr_r	0.002	0.011	0.003	-0.004	0.006	0.007	-0.0005	-0.003
gap	0.003**				-0.0001			
dgap		0.013**				0.006**		
dlog_gdpv			1.222**				0.774**	
ddlog_gdpv				0.801**				0.393**

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively. (Dlog_hprice_r=real house price growth?), gap=output gap, dgap=change in the output gap, dlog_gdpv=real GDP growth, ddlog_gdpv=change in real GDP growth. For the description of other variables see Box 1.

Source: Authors' calculations.

23. Country-specific regressions indicate that the house-price-dampening effect is particularly strong for Slovakia, Slovenia and Estonia: a 1 percentage point increase in the growth rate of property taxes leads to up to 2.9 percentage point decrease in house price growth (Table 4). For several countries included in

the sample, such as Korea, Israel and the United Kingdom, the effect is estimated to be positive. However, results are sensitive to the estimation techniques used. The way coefficients change across time horizons depends on the estimator (static or dynamic LSDV), and on the measure of property taxation. Different specifications might even result in varying coefficient signs. By contrast, across the whole sample both in the panel of all countries and in country-specific regressions, results are generally quite constant throughout time periods. There is no major trend change as a result of the economic crisis.

Table 4. Country-specific house price reaction to property taxes

Country-specific coefficient statistics

	Real property taxes				Property taxes/GDP			
	MAX	MIN	MEAN	MEDIAN	MAX	MIN	MEAN	MEDIAN
AUS	0.77	0.27	0.51	0.49	0.00	-0.47	-0.20	-0.17
AUT	-0.40	-1.22	-0.76	-0.70	0.53	-0.22	0.17	0.19
BEL	0.07	0.05	0.06	0.06	0.07	0.04	0.05	0.05
CAN	0.42	0.19	0.27	0.25	0.20	-0.37	-0.11	-0.12
CHE	0.03	-0.05	-0.02	-0.03	0.00	-0.05	-0.03	-0.03
CZE	0.00	-0.04	-0.02	-0.02	0.00	-0.05	-0.02	-0.01
DEU	0.00	-0.21	-0.07	-0.04	0.16	-0.37	-0.08	-0.04
DNK	-0.03	-0.25	-0.17	-0.21	-0.25	-0.38	-0.30	-0.29
ESP	-0.05	-0.42	-0.23	-0.23	-0.06	-0.47	-0.26	-0.26
EST	-0.67	-0.95	-0.81	-0.81	-0.77	-1.20	-0.99	-0.99
FIN	-0.02	-0.09	-0.04	-0.04	-0.03	-0.11	-0.06	-0.05
FRA	-0.02	-0.10	-0.05	-0.05	-0.02	-0.14	-0.08	-0.07
GBR	0.24	0.13	0.19	0.20	0.09	0.03	0.06	0.06
GRC	0.00	-0.02	-0.01	0.00	0.00	-0.03	-0.01	-0.01
HUN	-0.08	-0.08	-0.08	-0.08	-0.18	-0.18	-0.18	-0.18
IRL	-0.13	-0.17	-0.15	-0.15	-0.27	-0.41	-0.33	-0.31
ISL	0.58	-0.25	0.14	0.11	0.24	-0.77	-0.18	-0.09
ISR	-0.04	-0.07	-0.06	-0.06	0.17	0.10	0.13	0.13
ITA	0.03	0.01	0.02	0.02	-0.03	-0.08	-0.05	-0.04
JPN	0.69	0.00	0.33	0.31	0.26	-0.17	0.08	0.11
KOR	0.17	0.03	0.09	0.08	0.13	0.00	0.04	0.02
LUX	-0.33	-0.43	-0.38	-0.38	-0.25	-0.28	-0.27	-0.27
MEX	-0.10	-1.58	-0.74	-0.65	0.67	-0.31	0.19	0.21
NLD	0.22	0.07	0.13	0.12	0.15	0.00	0.05	0.03
NOR	0.07	-0.04	0.02	0.02	0.04	0.00	0.02	0.02
NZL	0.27	0.00	0.14	0.14	0.00	-0.23	-0.11	-0.11
PRT	0.07	-0.17	-0.04	-0.03	-0.05	-0.17	-0.10	-0.09
SVK	-1.99	-2.89	-2.44	-2.44	-1.31	-1.40	-1.36	-1.36
SVN	-1.56	-2.18	-1.87	-1.87	-0.99	-1.18	-1.08	-1.08
SWE	-0.02	-0.04	-0.03	-0.02	-0.02	-0.04	-0.03	-0.03
TUR	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06
USA	0.30	0.19	0.24	0.24	0.32	-0.14	0.10	0.12

Note: Zero means that the coefficient is not significant at the 10% level. Min, max, mean and median are taken from the distribution of coefficient estimates obtained from estimations on the basis of various econometric estimators (LSDV, Kiviet, difference and system GMM) and alternative specifications.

Source: Authors' calculations.

24. For all countries, the correlation between a change in house prices and property tax growth is significant at the 5% level. The economic cycle has a positive and statistically significant impact on the growth rate of house prices, with all the measures of the cycle giving significant results. The results are robust to alternative econometric estimation methods and to the inclusion of control variables such as the

real share price index, population growth, the real long-term interest rate, the real construction cost index, the private credit-to-GDP ratio and the unemployment rate. The only exceptions are the regressions of the output gap with controls, when the measure of the cycle loses statistical significance. The estimated effect of the cycle is the largest when measured by real GDP growth. For changes in the output gap, the impact of changes in property taxation always loses significance. When the measure is the change in real GDP growth, the tax variable always remains significant.

25. Control variables are mostly significant and have the expected sign, with the exception of the real long-term interest rate and population growth, which change sign depending on the specification and frequently lose significance. An increase in the unemployment rate results in a lower growth of house prices. On the other hand, a more rapid growth of the real share price index and of the real construction cost index leads to a stronger rise of house prices. Finally, the coefficient on the lagged growth rate of house prices is always positive and significant, implying that changes in house prices are persistent over time.

3.3. House price volatility and property taxes, non-overlapping windows

26. This section reports estimation results on five-year non-overlapping data for the volatility of house prices and the volatility of and changes in real estate taxes (Table 5). The estimations do not include a lagged dependent variable (as persistence is very low at this frequency). It is therefore sufficient to use the LSDV estimator. Regressing real house price volatility (measured as standard deviations of 5-year non-overlapping windows) on the volatility of property taxes and other controls shows that the volatility of the property tax revenue-to-GDP ratio is positively correlated with real house price volatility. A 1% increase in the volatility of property taxes increases the volatility of house prices by 0.04 to 0.05%. This result is robust to the inclusion of control variables.

Table 5. House price volatility and volatility of property taxes/GDP

LSDV static estimator, dependent variable: house price volatility (five-year non-overlapping windows)

	LSDV, no dynamics, no controls	LSDV, no dynamics, with controls
Volatility of property tax/GDP	0.043*	0.046**

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Source: Authors' calculations.

27. Country-specific estimates (Table 6) indicate a positive relation between real house price volatility and property tax volatility, which confirms for most countries in the sample, that a change in the property taxes volatility is related to a positive reaction of house prices volatility. This relationship is statistically significant for almost all countries, although in some cases the coefficients are very low or lose their significance once the controls are included in the regression. Three countries in the sample exhibit a negative correlation between house price and property tax volatility. A weak negative correlation was observed for France, followed by a stronger negative relationship in Japan. Finally, an exceptionally strong negative correlation was found for Israel, where the coefficients range from -3.8 to -6.1, if the post-crisis years are excluded from the estimation horizon.

Table 6. House price volatility (five-year non-overlapping windows) and volatility of property taxes/GDP

Country-specific coefficients

	MAX	MIN	AVERAGE	MEDIAN
AUS	0.78	0.63	0.71	0.71
AUT	0.96	0.00	0.48	0.48
BEL	0.06	0.00	0.03	0.03
CAN	0.78	0.41	0.60	0.60
CHE	0.60	0.21	0.41	0.41
DEU	0.09	0.00	0.05	0.05
DNK	0.48	0.47	0.47	0.47
ESP	0.61	-0.01	0.30	0.30
FIN	0.13	0.10	0.12	0.12
FRA	0.00	-0.03	-0.01	-0.01
GBR	0.59	0.00	0.29	0.29
GRC	0.21	0.00	0.11	0.11
IRL	0.32	0.28	0.30	0.30
ISR	-6.08	-6.08	-6.08	-6.08
ITA	0.09	0.08	0.08	0.08
JPN	-1.30	-1.61	-1.45	-1.45
KOR	0.28	0.16	0.22	0.22
NLD	0.26	0.26	0.26	0.26
NOR	0.37	0.16	0.26	0.26
NZL	0.00	-0.10	-0.05	-0.05
PRT	0.04	0.00	0.02	0.02
SWE	0.01	0.01	0.01	0.01
USA	0.15	0.00	0.07	0.07

Note: Min, max, mean and median are taken from the distribution of coefficient estimates obtained from estimations on the basis of various econometric estimators (LSDV, Kiviet, difference and system GMM) and alternative specifications.

Source: Authors' calculations.

28. But does the *level* of property taxes (as a share of GDP) have an influence on house price volatility? Estimation results show that a *higher* 5-year average of the tax-to-GDP ratio is indeed associated with *lower* volatility of house prices (Table 7). The estimated coefficients range from -0.04 to -0.01, depending on the specific cycle variable and the inclusion of the control variables. This means that property taxes have a smoothing effect on house prices. A higher property tax-to-GDP ratio reduces house price volatility, while lower taxation is associated with higher house price volatility. Table 8 provides country-specific estimates, which mostly are negative in a range of about -0.1 to -0.2. The negative correlation is particularly strong for Israel, where a 1% increase in the tax-to-GDP ratio leads to 1 to 1.7% decrease in the volatility of house prices. This relationship has strongly deepened since the financial crisis started. Several countries in the sample such as Australia, Canada and the United States, exhibit a positive correlation between changes in property taxation and house prices volatility.

Table 7. House price volatility regressed on the tax/GDP share

LSDV static estimator

	Dependent variable: real house price volatility (five-year non-overlapping windows)							
	LSDV without controls				LSDV with controls			
1965-2012								
Level of property taxes/GDP	-0.033**	-0.040**	-0.009*	-0.010*	-0.031**	-0.036**	-0.007	-0.007
Volatility of output gap	0.008**				0.006**			
Volatility of the change in the output gap		0.005**				0.0003		
Volatility of real GDP growth			0.867**				0.215	
Volatility of the change in real GDP growth				0.353**				-0.056

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Source: Authors' calculations.

29. The volatility of economic cycles is positively correlated with the volatility of house prices, although it tends to lose its significance once the control variables are included in the regression. The only cycle measure which is robust to the inclusion of controls is the volatility of the output gap. As for the other controls, regardless of whether the 5-year non-overlapping standard deviation of real house prices is regressed on the volatility or the average level of property taxes, volatility of house prices is positively correlated with the volatility of the unemployment rate, and negatively with the volatility of the real share price index and population growth. The real construction cost index has a strong positive influence on the volatility of house prices but it loses its significance in country-specific regressions. Other control variables, in particular private credit-to-GDP ratio and real long-term interest rates have a negligible impact on the volatility of house prices.

Table 8. House price volatility (five-year non-overlapping windows), regressed on the tax/GDP share

Country-specific coefficient statistics

	MAX	MIN	AVERAGE	MEDIAN
AUS	0.29	0.00	0.16	0.14
AUT	0.17	-0.18	0.00	0.00
BEL	0.00	-0.02	-0.01	0.00
CAN	0.14	0.00	0.09	0.12
CHE	0.00	-0.10	-0.06	-0.07
DEU	0.00	-0.08	-0.02	0.00
DNK	0.12	-0.06	0.04	0.05
ESP	-0.01	-0.09	-0.06	-0.07
FIN	-0.02	-0.05	-0.03	-0.03
FRA	0.02	0.00	0.01	0.00
GBR	0.00	-0.16	-0.04	-0.02
GRC	0.00	-0.22	-0.07	0.00
IRL	0.00	-0.05	-0.02	-0.03
ISR	-1.10	-1.70	-1.33	-1.26
ITA	0.02	-0.02	-0.01	-0.01
JPN	-0.18	-0.34	-0.25	-0.24
KOR	-0.11	-0.14	-0.12	-0.12
NLD	0.18	-0.10	0.04	0.04
NOR	0.00	-0.07	-0.05	-0.06
NZL	0.00	-0.10	-0.02	-0.02
PRT	0.00	-0.01	0.00	0.00
SWE	0.00	-0.09	-0.03	0.00
USA	0.20	0.00	0.07	0.03

Note: Min, max, mean and median are taken from the distribution of coefficient estimates obtained from estimations on the basis of various econometric estimators (LSDV, Kiviet, difference and system GMM) and alternative specifications.

Source: Authors' calculations.

3.4. House price volatility and property taxes, overlapping windows

30. In addition to non-overlapping volatility estimations, measures of real house price volatility calculated for five-year *overlapping* windows are regressed on the level of property taxation. Again, the results indicate a negative correlation between the two variables (Table 9). However, no statistically significant results were obtained without including the measure of the economic cycle in the model. The property taxation variable is significant only when regressed on the volatility of the output gap or with the volatility of a change in the output gap, but not with the other volatility measures of economic cycles. Corresponding coefficients then hover around -0.01. This result is also sensitive to the econometric technique used: the property taxation variable loses its statistical significance when the coefficients are estimated using the difference or system GMM estimator.

Table 9. House price volatility regressed on the level of property taxes/GDP

Kiviet estimator

	Dependent variable: real house price volatility (five-year overlapping windows)							
	Kiviet estimator without controls				Kiviet estimator with controls			
1965-2012								
Property taxes/GDP	-0.007**	-0.006**	-0.002	-0.002	-0.011**	-0.007**	-0.002	-0.002
Volatility of output gap	0.002*				-0.0007			
Volatility of the change in the output gap		0.004**				0.001		
Volatility of real GDP growth			0.363**				0.209	
Volatility of the change in real GDP growth				0.027				-0.155*

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.
Source: Authors' calculations.

31. Country-specific results underpin the panel-wide findings (Table 10). For the majority of the countries, the relationship between the two variables is negative and statistically significant at the 5% level. However, this result is not very robust to alternative econometric estimation methods (static or dynamic LSDV), as well as to alternative measures of the economic cycle and the inclusion of control variables. Depending on the specification, the coefficients might even change sign. At the country level the relationship between changes in property taxation and house price volatility is thus ambiguous. The coefficients are, however, quite similar across different time horizons which implies that the crisis did not change the relationship between the two variables.

32. The volatility of the economic cycle is positively associated with real house price volatility. Across the estimations the coefficients range from 0.01 to 0.9 with no control variables. This relationship grows stronger when real GDP growth volatility is used as a measure of the cycle. When the regressions are run with control variables, the cycle indicator loses its significance (except for the change in the growth rate of real GDP, which remains significant but becomes negative).

Table 10. House price volatility (five-year overlapping windows), regressed on the level of property taxes/GDP

Country-specific coefficient statistics

	House price volatility, no cycle				House price volatility, with cycle			
	MAX	MIN	AVERAGE	MEDIAN	MAX	MIN	AVERAGE	MEDIAN
AUS	-0.05	-0.09	-0.07	-0.08	-0.05	-0.15	-0.10	-0.11
AUT	0.10	-0.03	0.05	0.07	0.13	0.00	0.08	0.08
BEL	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00
CAN	0.03	-0.04	0.00	0.00	0.05	-0.05	0.01	0.01
CHE	0.03	-0.03	0.00	0.00	0.03	-0.03	0.00	0.00
CZE	0.01	0.01	0.01	0.01	0.20	-0.26	-0.09	-0.14
DEU	0.03	0.00	0.01	0.00	0.03	-0.03	0.00	0.00
DNK	0.03	-0.05	-0.01	-0.01	0.05	-0.05	0.00	0.00
ESP	0.00	-0.09	-0.03	-0.02	0.00	-0.09	-0.04	-0.04
EST	0.50	-0.25	0.13	0.13	0.52	-0.28	0.12	0.12
FIN	-0.01	-0.02	-0.01	-0.01	-0.01	-0.04	-0.02	-0.02
FRA	0.01	0.00	0.01	0.01	0.04	0.00	0.01	0.01
GBR	0.06	0.04	0.05	0.05	0.09	0.04	0.06	0.06
GRC	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
HUN	0.09	-0.03	0.03	0.03	0.23	0.00	0.14	0.16
IRL	0.02	-0.01	0.00	0.00	0.02	-0.02	-0.01	-0.01
ISL	0.52	-0.15	0.11	0.03	0.52	-0.18	0.09	-0.05
ISR	-0.04	-0.05	-0.04	-0.04	0.00	-0.05	-0.01	0.00
ITA	-0.01	-0.01	-0.01	-0.01	0.05	-0.01	0.01	0.01
JPN	0.00	-0.15	-0.08	-0.08	0.06	-0.18	-0.07	-0.07
KOR	-0.02	-0.04	-0.03	-0.03	-0.02	-0.04	-0.03	-0.03
LUX	0.13	0.02	0.08	0.08	0.15	-0.11	0.00	0.00
MEX	0.12	-0.09	0.00	-0.03	0.25	-0.11	0.00	0.00
NLD	-0.02	-0.05	-0.04	-0.04	0.00	-0.05	-0.03	-0.03
NOR	0.01	-0.02	0.00	0.00	0.01	-0.02	0.00	0.00
NZL	0.02	0.00	0.01	0.01	0.02	-0.01	0.01	0.01
PRT	-0.01	-0.02	-0.01	-0.01	0.00	-0.02	-0.01	-0.01
SVK	-0.42	-0.58	-0.50	-0.50	-0.36	-0.58	-0.44	-0.42
SVN	2.15	-0.03	1.06	1.06	2.71	0.00	0.76	0.33
SWE	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	0.00
USA	0.04	0.00	0.01	0.01	0.07	-0.03	0.01	0.00

Note: Min, max, mean and median are taken from the distribution of coefficient estimates obtained from estimations on the basis of various econometric estimators (LSDV, Kiviet, difference and system GMM) and alternative specifications.

Source: Authors' calculations.

33. When house price volatility is regressed on the *volatility* rather than the *level* of property taxation, the relationship between them becomes positive (Tables 11 and 12). A 1% increase in the volatility of property taxes results in a very small increases in house price volatility. However, this relationship is statistically significant only when using the difference GMM estimator or the static LSDV estimator without controls (independently on whether the measure of property taxes is measured by the property tax revenue-to-GDP ratio, or by real property tax revenues). For all the other estimators, the property taxation variable loses its significance.

Table 11. House price volatility regressed on the volatility of property taxes/GDP

Kiviet estimator

	Dependent variable: real house price volatility, (five-year overlapping windows)							
	Kiviet estimator without controls				Kiviet estimator with controls			
1965-2012 Volatility of property taxes/GDP	0.003	0.0002	0.001	0.002	0.0009	-0.002	-0.0007	-0.004
Volatility of output gap	0.0009				-0.0009			
Volatility of the change in the output gap		0.002**				0.0006		
Volatility of real GDP growth			0.260**				0.196	
Volatility of the change in real GDP growth				-0.003				-0.213**

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.
Source: Authors' calculations.

Table 12. House price volatility regressed on the volatility of real property taxes

Kiviet estimator

	Dependent variable: real house price volatility, five-year overlapping windows							
	Kiviet estimator without controls				Kiviet estimator with controls			
1965-2012 Volatility of real property taxes	0.004	0.0009	0.002	0.003	0.002	-0.004	0.001	-0.003
Volatility of output gap	0.0008				-0.001			
Volatility of the change in the output gap		0.002**				0.0006		
Volatility of real GDP growth			0.237**				0.169	
Volatility of the change in real GDP growth				-0.011				-0.218**

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.
Source: Authors' calculations.

34. As regards the economic cycle variable, the impact of the cycle on house price volatility is positive. The coefficients of the economic cycle are lower than in the regressions taking the property tax level (in static LSDV, when the measure of the cycle is the change in the growth rate of real GDP, they even become negative), ranging from -0.07 to 0.13. The cycle variable remains statistically significant when regressed with controls, whether the measure of the cycle is the output gap or the change in the output gap.

35. Regardless of whether house price volatility is regressed on the volatility or the level of property taxes, volatility of house prices is positively correlated with the volatility of the unemployment rate, the real share price index and the real construction cost index, and negatively with the volatility of the private credit-to-GDP ratio and population growth. However, all the controls are sensitive to the econometric estimation methods and frequently lose statistical significance. The only exception is the lagged dependent variable, which consistently remains positive and significant, indicating persistence of house price volatility over time. Across all the estimations, the real long-term interest rate appears to have a negligible impact on the volatility of house prices.

36. Results of all regressions are summarized in Table 13.

Table 13. Summary of results

	GROWTH RATES		VOLATILITY	
	Property tax reaction function	House prices equation	House price volatility	House price volatility
			Overlapping windows	Non-overlapping windows
Cycle	Negative	Positive	Positive except with change in GDP volatility	Positive
	Change in GDP most significant predictor (second best is change in output gap)	Significant (except for output gap in regressions with controls), strongest influence when the change in GDP is the cycle variable	Significant quite often (especially when regressing without controls)	Mostly significant (sometimes losing significance when regressed with controls) volatility of the ouptut gap and change in volatility of GDP growth are most significant
House prices	Negative	*Not applicable*		
	Only significant when the property tax-to-GDP ratio is the dependent variable (and change in output gap or change in real growth as cycle variable)			
Property taxation (real property tax revenue or property tax-to-GDP ratio)	*Not applicable*	Negative	Negative when regressing on property tax-to-GDP ratio	Negative when regressing on property tax-to-GDP share. Positive with volatility of that share
		Significant only when estimating with the property tax-to-GDP ratio	Significant sometimes, only with volatility of the output gap or volatility of changes to GDP growth as cycle variables. Significance doesn't depend on the choice of the property tax variable	Almost always significant. A bit more with output gap and changes in output gap
Lagged dependent variables	Positive, except with output gap and changes in output gap	Positive	Positive	Not applicable
	Most significant in the period 1980-2006	Always significant	Always significant	
Individual country results	Sign is changing according to the specification and the country			
	Almost always significant in short specifications, most of the time in long ones			
Controls	Real share price index and government spending-to-GDP best controls and both positive	Unemployment rate, (negative), real share prices and real construction index (positive) are best controls	Unemployment rate best control (positive), private credit-to-GDP second best	Real share prices and population growth (negative), real construction cost and unemployment rate (positive) are often significant

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