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Monitoring Vulnerabilities in the Residential Real Estate Sector in Poland**

Abstract: This paper applies a framework for monitoring vulnerabilities in the residential real estate sector to the case of Poland. The framework considers indicators across three dimensions of real estate-related vulnerabilities, i.e. valuation, household indebtedness and the bank credit cycle, and builds a composite model-free measure shown to have a significant forecasting performance for real estate crises. The paper shows how the monitoring can be implemented for the Polish market, discusses the developments from a historical perspective, and highlights remaining data gaps.

Keywords: real estate vulnerabilities, real estate market in Poland, risk monitoring, real estate crises

JEL classification codes: E32, R31

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Monitorowanie ryzyka na rynku nieruchomości mieszkalnych w Polsce

Streszczenie: Artykuł ten stosuje metodę monitorowania ryzyka związanego z sektorem nieruchomości mieszkalnych dla rynku polskiego. Metoda uwzględnia wskaźniki dotyczące trzech wymiarów ryzyka na rynku nieruchomości mieszkalnych: wyceny, zadłużenia gospodarstw domowych i cyklu kredytowego, oraz buduje zagregowaną bezmodelowo miarę ryzyka, która posiada właściwości wczesnego ostrzegania o kryzysie. Artykuł pokazuje, jak można zastosować omawianą metodę monitorowania dla rynku Polski, opisuje dynamikę wskaźników z perspektywy historycznej i ukazuje pozostające luki w danych.

Słowa kluczowe: ryzyka w sektorze nieruchomości, sektor nieruchomości mieszkalnych w Polsce, monitorowanie ryzyka, kryzysy w sektorze nieruchomości

Kody klasyfikacji JEL: E32, R31

Introduction

Real estate is one of the most important sectors of the economy, strongly interlinked with the financial and non-financial sectors. In particular, lending for house purchase is usually the largest position on banks' balance sheets, and real estate is a significant asset of households. Monitoring of the vulnerabilities related to this sector is therefore very relevant. For example, macroprudential authorities as well as other institutions are equipped with monitoring toolkits, as documented in a number of policy publications in recent years[1]. This paper focuses on a framework for monitoring vulnerabilities related to the residential real estate sector as developed in Bengtsson, Grothe and Lepers [2020], and applies this methodology to the case of Poland. The framework considers indicators across three dimensions, i.e. valuation, household indebtedness and the bank credit cycle, and builds a composite model-free vulnerability measure. The paper shows how the monitoring can be implemented for the Polish market and indicates remaining data gaps.

The indicators are selected based on the early warning literature and policy publications. They are standardised within a cross-country time-series panel and aggregated into one vulnerability measure based on equal weights. Despite its model-free character, the vulnerability measure is shown in Bengtsson, Grothe and Lepers [2020] to be a significant predictor of historical real estate crises, with a forecasting performance better than most advantageously in-sample calibrated model-based estimates. Another useful feature of this

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[1] See, e.g., European Systemic Risk Board [2019; 2016b; 2016a], Narodowy Bank Polski [2019], International Monetary Fund [2017], Organisation for Economic Cooperation and Development [2017], and European Central Bank [2015; 2016].

framework is the identification of vulnerabilities both in terms of levels and dynamics, which may be relevant from the policy perspective.

In this paper, the framework proposed in Bengtsson, Grothe and Lepers [2020] is applied to the case of Poland, introducing a set of monitoring tools, which can provide information about the level and the dynamics of vulnerabilities. In particular, the tools illustrate the vulnerabilities both at the aggregate level and within the three main dimensions of real estate-related vulnerabilities, i.e. valuation, household indebtedness and the bank credit cycle[2]. It is also possible to assess the vulnerabilities observed for Poland from the perspective of broader developments across the EU countries over time[3]. In order to avoid any references to the conjunctural assessment of the vulnerabilities related to the residential real estate conducted by various European and Polish authorities, the analysis presented in this paper is based on historical data for the 15-year period from 2000 to 2015. In particular, the approach used in this paper is not related to the methodology underlying the warnings and recommendations of the European Systemic Risk Board related to the residential real estate sector in some European countries – see European Systemic Risk Board [2016b; 2019]; or to the methodology for the assessment of the Polish residential real estate market as in Narodowy Bank Polski [2019]. Overall, this work adds to a recent strand in the financial stability literature which highlights the benefits of simple approaches to systemic risk monitoring, which serve to complement and cross-check signals derived from more complex approaches[4].

The remainder of the paper is structured as follows. Section 2 describes the data, also discussing their availability for Poland, as well as outlining the methodology of the monitoring framework. Section 3 presents a set of monitoring results for the case of Poland, as based on historical data. Section 4 concludes.

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[2]   As reviewed in Bengtsson, Grothe and Lepers [2020], downturns in real estate prices can be forecasted using general economic developments, changes in credit conditions and interest rates – e.g., Agnello and Schuknecht [2011], Alessi and Detken [2011], Borgy, Clerc and Renne [2009], Gerdesmeier, Lenarčič and Roffia [2012], Claessens, Kose and Terrones [2008]. Other early warning models rely on indicators more specific to the real estate sector, such as estimates of over-/undervaluation of residential property prices – European Systemic Risk Board [2016a]; the debt service ratio – Drehmann and Juselius [2012]; the price-to-rent and price-to-income ratios – Borio and Drehmann [2009], Drehmann et al. [2010], Mendoza and Terrones [2008], Riiser [2005]; and credit for house purchases – Büyükkarabacaka and Valev [2010]. The framework also includes additional indicators highlighted by various policy bodies as being important monitoring metrics for this sector. For a more detailed discussion of the choice of indicators, see Section 2.

[3]   For more detailed analyses of the functioning of the Polish real estate market, see, for example, Narodowy Bank Polski [2019], Kucharska-Stasiak [2018], and Siemińska [2012].

[4]   For example, the benefits of simple tools for policy purposes have been recently highlighted by the International Monetary Fund [2011]; Danielsson, Zhou [2015]; Bengtsson, Grothe, Lepers [2020].

Data and methodology

The approach to monitoring vulnerabilities in residential real estate markets is based on Bengtsson, Grothe and Lepers [2020]. It covers three main dimensions: valuation, household indebtedness and the credit cycle. The variables related to each dimension are standardised within a cross-country time-series panel and aggregated to one vulnerability measure. A detailed discussion of the selected indicators as well as the methodology can be also found in Bengtsson, Grothe and Lepers [2020].

Selected indicators

The set of indicators is based on variables used in the early warning literature on residential real estate vulnerabilities, also including additional data highlighted by various policy bodies as important monitoring metrics for this sector. Table 1 presents a detailed description of indicators, including data sources, related studies in the literature as well as the availability for Poland. The valuation dimension includes overvaluation, price-to-income and price-to-rent ratios[5]. The dimension related to the resilience of households covers the indebtedness ratios (households' debt service and debt-to-income ratios), as well as household leverage to incorporate information on the financial assets of households[6]. The credit cycle dimension captures information on the availability of mortgage funding as well as the importance of mortgage loans in bank books, thus including credit for house purchases to GDP, lending spreads and loan-to-deposit ratios[7].

In order to avoid any references to the conjunctural assessment of the vulnerabilities related to the residential real estate conducted by relevant authorities, the analysis in this paper is based on historical data for the 15-year period from Q1–2000 to Q2–2015, the same as in Bengtsson, Grothe and Lepers [2020]. In particular, the approach in this paper is not related to the methodology underlying the warnings and recommendations of the European Systemic Risk Board related to the residential real estate sector in some European countries – see European Systemic Risk Board [2016b; 2019]; or to the methodology for the assessment of the Polish residential real estate market as in Narodowy Bank Polski [2019]. A similar approach of using a historical

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[5]   For this aspect of real estate vulnerabilities, research has demonstrated the early warning abilities of various overvaluation metrics, including the price-to-income and price-to-rent ratios; see, e.g., Ferrari, Pirovano, and Cornacchia [2015], Himmelberg, Mayer, and Sinai [2005], Claessens, Kose, and Terrones [2008].

[6]   Drehmann and Juselius [2012] show that changes in the household debt service ratio provide accurate early warning signals of systemic banking crises, while the level of the ratio is related to the size of the subsequent output losses. Also, higher debt in relation to income is shown to negatively affect future house prices; see, e.g., Gerdesmeier, Lenarčič, and Roffia [2012].

[7]   For example, Büyükkarabacaka and Valev [2010] demonstrate that rapid household credit expansions generate vulnerabilities that often precede crises.

dataset is applied in Bengtsson, Grothe and Lepers [2020]. For illustrative purposes, the sample takes into account historical data for all EU countries, but the framework can be applied to any selected set of countries. For the case of Poland, the data availability is somewhat restricted, but the coverage is still relatively good (see Table 1). Four indicators (*DTI, HHLeverage, CreditForHP-toGDP*, and *LoanToDeposit*) are available since late 2003 or early 2004, one indicator (*LendingSpreads*) is available since 2005, one (*Overvaluation*) since 2007 and two indicators (*PTI* and *PTR*) are available since 2010. Correspondingly, the data covers each vulnerability dimension relatively well, with only one indicator (*DSR*) missing. For a more detailed description of the EU data coverage, see also Bengtsson, Grothe and Lepers [2020].

Table 1. Overview of indicators related to residential real estate vulnerabilities

Indicators	Description	Data source	Rationale	Available for Poland since...
Valuation				
Price-to-income (PTI)	Nominal house prices/nominal gross disposable income (Index 2010=100)	OECD	Highlighted by OECD – Focus on housing, ESRB (2016a). Strong indicator of forthcoming crises – Barrell *et al.* [2010]; Borio/Drehmann [2009]; Drehmann *et al.* [2010]; Claessens *et al.* [2011]; Mendoza/Terrones [2008]; Riiser [2005]	2010-Q1
Price-to-rent (PTR)	Nominal house prices/nominal rent (Index 2010=100)	OECD	Highlighted by OECD – Focus on housing, IMF – Global Housing Watch, ESRB [2016a]. Significant indicator of forthcoming crises – Barrell *et al.* [2010]; Borio/Drehmann [2009]; Drehmann *et al.* [2010]; Claessens *et al.* [2012]; Mendoza/Terrones [2008]; Riiser [2005]; Himmelsberger [2005]	2010-Q1
Estimates of the over/ undervaluation of residential property prices in selected EU countries (Overvaluation)	ECB [2015] computation, % deviation of actual house prices from model-based equilibrium—for methodological details, see ECB [2015]	Eurostat, national sources, ECB and ECB calculations, published in ESRB Risk Dashboard		2007-Q1

Indicators	Description	Data source	Rationale	Available for Poland since…
Household indebtedness				
Households debt to disposable income (DTI)	Ratio of household debt to the annual moving sum of household gross disposable income	MUFA and NFA Eurostat ESA 2010, published in the ESRB Risk Dashboard	Highlighted by ESRB [2016a]; Gerdesmeier *et al.* [2012]	2003-Q4
Debt service ratio – Households (DSR)	Ratio of interest payments plus amortisations to income	BIS	Highlighted by ESRB [2016a]; indicator of forthcoming crises – Drehmann/Juselius [2012]	-
Households debt to total financial assets (HH Leverage)	Ratio of household debt to household total financial assets	IEAQ – Quarterly Euro Area Accounts	Similar as debt to income ratio but also takes into account the asset side of household balance sheet (wealth of households relative to debt level)	2003-Q4
Credit cycle				
Credit for house purchases (Credit for HP to GDP)	Level: MFIs credit to domestic households for house purchase to GDP (monthly data); 1y change: year on year growth of credit for house purchase (monthly data)	ECB Balance Sheet Items, European National Accounts and authors' calculations	Highlighted by ESRB [2016a]; Büyükkarabacak/ Valev [2010]	2004-Q1
Lending spreads (Lending spreads)	Difference between lending rates for house purchases and money market rates	ECB MFI Interest Rate Statistics, Bloomberg and authors' calculations	Indicating banks' pricing of loans, as compared to the cost of money market funding	2005-Q1
Loan to deposit ratio (Loan to deposit)	Ratio of bank total loans to total deposits vis-à-vis the domestic and euro area households, NFCs and non-MFI residents excluding the general government	ECB, published in ESRB Risk Dashboard	Highlighted by Drehmann/ Juselius [2012], as well as in several publications of the Bank for International Settlements	2004-Q1

Note: The table presents an overview of indicators used in the analysis, including their description, data source, literature references and the availability for Poland.

Source: Bengtsson, Grothe and Lepers [2020] and own work.

Table 2 reports the correlation and autocorrelation of the variables for the EU sample (upper panel), as well as for Poland (lower panel). Some indicators can be expected to be correlated, for example price-to-rent (*PTR*) and price-to-income (*PTI*) by having the same numerator. The correlation pattern for Poland is broadly similar to that for the whole EU sample, with the exception of some indicators (e.g., *CreditForHPtoGDP* or *DTI*). Overall, considering several indicators within the monitoring approach is important for describing different dimensions of real estate-related vulnerabilities, as well as for a consistency check within each dimension.

Table 2. Correlation among the indicators included in the monitoring framework

	EU								
	PTI	PTR	Overval.	DSR	DTI	HH lev.	Credit HP/ GDP	Lending spreads	Loan / deposit
PTI	1.00								
PTR	0.94	1.00							
Overvaluation	0.50	0.48	1.00						
DSR	0.28	0.25	0.20	1.00					
DTI	0.21	0.18	0.14	0.96	1.00				
Household leverage	0.38	0.38	0.12	0.48	0.50	1.00			
Credit for HP to GDP	0.30	0.29	0.14	0.82	0.87	0.59	1.00		
Lending spreads	–0.04	–0.06	0.00	0.20	0.22	–0.12	0.21	1.00	
Loan to deposit ratio	0.19	0.17	0.09	0.45	0.54	0.59	0.62	–0.23	1.00
Autocorrelation	0.98	0.99	0.96	1.00	1.00	0.99	1.00	0.93	0.99
	Poland								
	PTI	PTR	Overval.	DSR	DTI	HH lev.	Credit HP/ GDP	Lending spreads	Loan/ deposit
PTI	1.00			–					
PTR	0.99	1.00		–					
Overvaluation	0.93	0.90	1.00	–					
DSR	–	–	–	–	–	–	–	–	–
DTI	–0.81	–0.76	–0.88	–	1.00				
Household leverage	0.63	0.65	–0.51	–	0.93	1.00			
Credit for HP to GDP	–0.85	–0.81	–0.92	–	0.99	0.91	1.00		
Lending spreads	–0.19	–0.23	–0.45	–	0.73	0.73	0.72	1.00	
Loan to deposit ratio	0.39	0.47	0.80	–	–0.42	–0.29	–0.47	–0.55	1.00
Autocorrelation	1.00	0.99	0.99	–	1.00	0.97	0.99	0.93	0.90

Note: The table presents correlation coefficients among the indicators included in the monitoring framework, with the autocorrelation coefficients shown in the last row. The upper panel presents the results for the whole sample of EU countries, the lower panel refers to Poland.
Source: Bengtsson, Grothe and Lepers [2020] and own work.

Determining the vulnerability scores

The calculation of the composite vulnerability measures for Poland follows Bengtsson, Grothe and Lepers [2020] and is conducted in two steps. Step 1 determines the vulnerability levels and changes for each indicator relative to the historical cross-country data. Step 2 aggregates the standardised indicators for Poland to one composite "vulnerability score," which is useful for the cases when an overall summary is needed.

The vulnerability assessment for each indicator (step 1) is based on the percentiles of pooled panel data from all analysed countries; see, e.g., Crocker and Algina [1986]. Each country i is attributed a "level score" and a "flow score" in each period t for each indicator k, ranging from 0 to 1 (1 being the highest historical value in the panel sample), defined as their percentile rank in the distribution as follows:

$$L_{k,i,t} = \frac{\sum_{j,\tau} I\left(l_{k,j,\tau} \leq l_{k,i,t}\right)}{N_k} * 100\% \tag{1}$$

and

$$C_{k,i,t} = \frac{\sum_{j,\tau} I\left(c_{k,j,\tau} \leq c_{k,i,t}\right)}{N_k} * 100\% \tag{2}$$

where $L_{k,i,t}$ and $C_{k,i,t}$ denote the percentile ranks of the level and the change of an indicator k for a country i at time t, according to the percentile in the full historical distribution of the indicator. $l_{k,i,t}$ and $c_{k,i,t}$ denote the value and the quarterly change, respectively, of the indicator k for a country i at time t, and N_k denotes the number of all country-period observations for a given indicator k. To illustrate this approach, Figure 1 shows an example of a full distribution of one of the indicators: the household debt-to-total financial assets ratio. The dots mark the position of EU countries within the historical distribution as of end-2006. The percentile rank of the level of the indicator for country i at time t ($L_{k,i,t}$) can be interpreted as the area under the curve to the left of a given point, e.g., marked for Poland in Figure 1. For this particular example, the level of the related vulnerability for Poland as of end-2006 was relatively low from the historical and cross-country perspectives, as around 80% of the data in the panel recorded higher values. As shown in Figure 1, the percentile rank only depends on the cross-country and time-series distribution and is not related to any economically motivated thresholds or the probability of crisis events.

Computing composite vulnerability scores (step 2) for Poland's vulnerability levels and flows is based on the percentile ranks $L_{k,i,t}$ and $C_{k,i,t}$ calculated in the previous step. A "composite level score" and a "composite flow score,"

$L_{i,t}$ and $C_{i,t}$, are determined for each date and computed as the equally-weighted average of the scores in each indicator at that date:

$$L_{i,t} = 1 / N \sum_k L_{k,i,t} , \quad C_{i,t} = 1 / N \sum_k C_{k,i,t} \tag{3}$$

where N denotes the number of all indicators.

Figure 1. Example of historical panel distribution for one of the indicators and calculation of the percentile rank
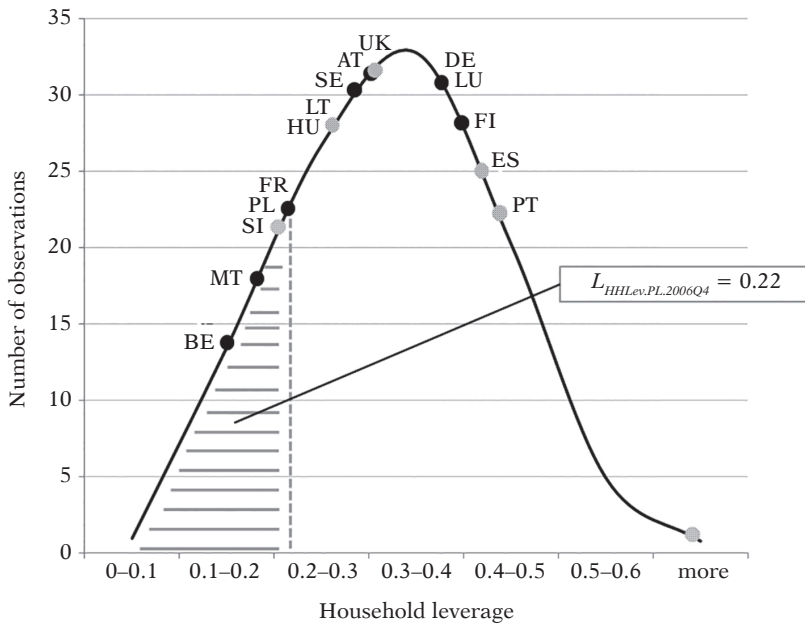
Note: The figure shows an example of a distribution of the household debt-to-total financial assets ratio (*HHLev*) across countries and time between 2000 and 2015. X-axis denotes the buckets of the values of *HHLev*, as observed historically across all countries. Y-axis denotes the frequency of observations in percentages of all observations. Total number of quarterly observations: 1111. Points indicate the position of countries as of end-2006. Grey dots denote countries that experienced a real estate crisis several quarters after Q4–2006. The percentile rank for a given country at a given date can be interpreted as the percentage of the area under the curve. The area marks an example for Poland, $L_{HHLev,PL,2006Q4}$.
Source: Bengtsson, Grothe and Lepers [2020] and own work.

Results

This section presents the results of the monitoring framework for Poland, which enables an easy illustration of the scope and changes of vulnerabilities in the aspects of residential real estate valuation, household indebtedness and the credit cycle. An important feature of the monitoring is that the signals

delivered by the tool need to be interpreted in relative terms from the historical cross-country perspective. Therefore, the interpretation of the developments for policy purposes needs to be accompanied by an analysis of structural aspects and country-specific characteristics.

In the first step, the topology of vulnerabilities across dimensions at a certain point in time can be analysed. Figures 2 and 3 present two possible approaches to a disaggregated analysis of signals from the set of indicators for Poland at three selected equally-distant points in time (mid-2007, mid-2011 and mid-2015). For both examples, taking a relative perspective for the EU panel, the developments of most variables for Poland do not seem to point to overly increased vulnerabilities prior to the global financial crisis. Later, in 2011, three variables related to valuation pressures and household indebtedness signalled relatively high vulnerabilities, as compared to the developments observed in other countries over the sample period. These vulnerabilities seem to have receded, in relative terms, towards 2015.

Figure 2. Overview of vulnerability measure for Poland across dimensions, indicators and over time (2007, 2011 and 2015)
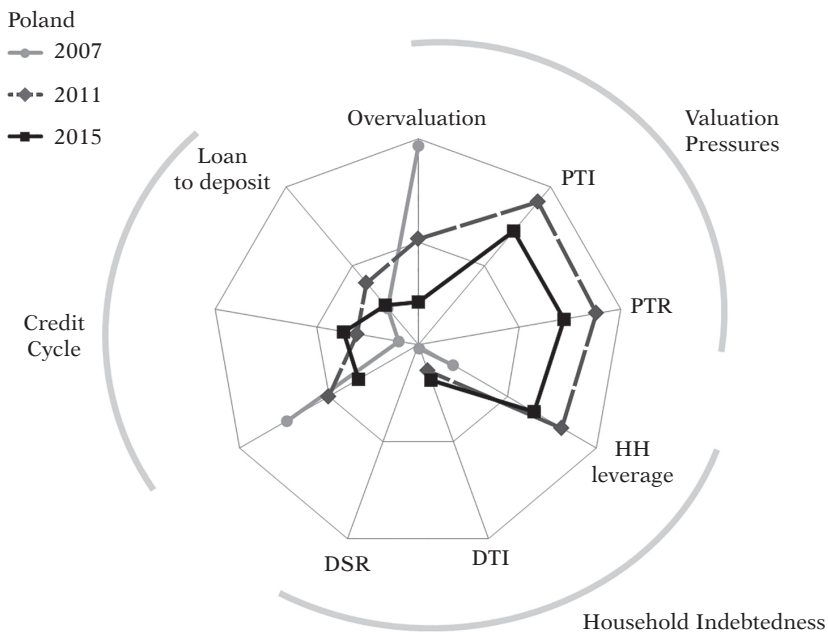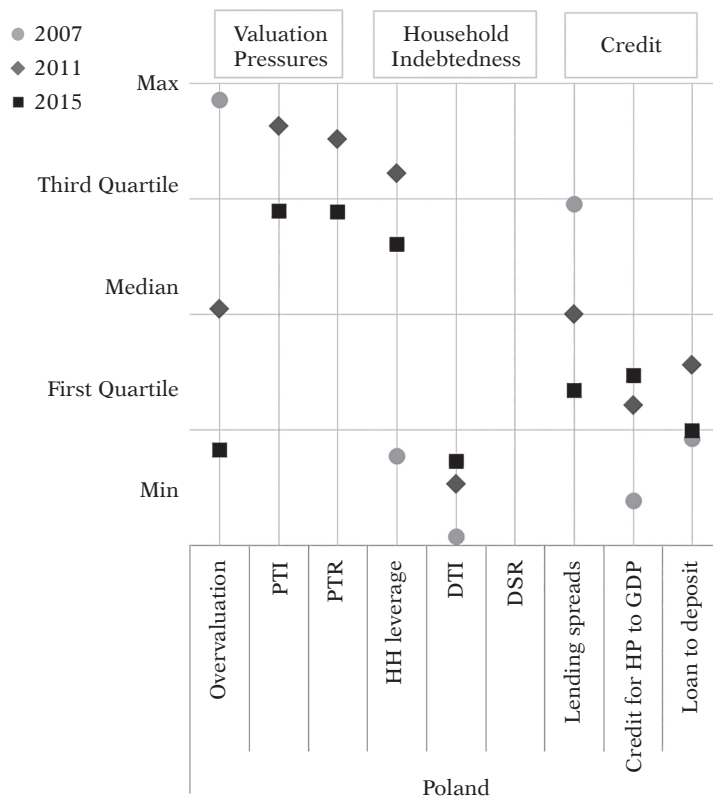

Note: Illustration of indicators across three main dimensions of vulnerabilities related to the residential real estate: valuation, household indebtedness and credit cycle. Data as of mid-2007, mid-2011 and mid-2015 for illustrative purposes.
Source: own work, as based on Bengtsson, Grothe and Lepers [2020].

In terms of the consistency of signals among indicators, the results show that it is very useful to analyse several indicators per vulnerability dimension.

At some points in time, signals from the indicators within a dimension are relatively homogenous (e.g., credit cycle developments after the global financial crisis). This may suggest that vulnerabilities related to a given dimension are indeed building up or receding. Still, a more detailed analysis of the underlying drivers and factors, along with structural features of the economy, is always warranted before drawing conclusions. In other cases, the monitoring unveils periods where the indicators within a dimension deliver relatively different signals (e.g., the development of household indebtedness after the global financial crisis). In such instances, a further in-depth analysis of the selected and other indicators may be needed. In general, a broader analysis of supply and demand factors, the structural features of the economy and more general economic trends is always useful to understand the broader underlying dynamics of vulnerabilities.

Figure 3. Overview of vulnerability measure for Poland across dimensions, indicators and over time (2007, 2011 and 2015)
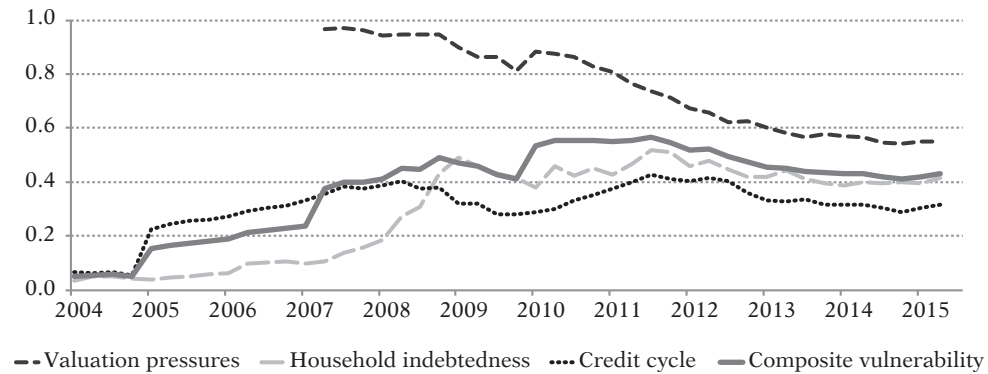

Note: Illustration of indicators across three main dimensions of vulnerabilities related to the residential real estate: valuation, household indebtedness and credit cycle. Data as of mid-2007, mid-2011 and mid-2015 for illustrative purposes.
Source: own work, as based on Bengtsson, Grothe and Lepers [2020].

In the second step, the evolution of vulnerabilities across dimensions throughout the sample period can be analysed. Figures 4–7 present the vulnerability dynamics for Poland over time, in levels and changes correspondingly, from the aggregated and disaggregated perspectives (see also Figures A-1 and A-2 in the Annex for time series of all individual indicators). For Poland, the overall vulnerability indicator increased ahead of the global financial crisis, yet from the relatively low levels, and remained broadly stable afterwards.

Figure 4. Vulnerability measure for Poland across dimensions and indicators
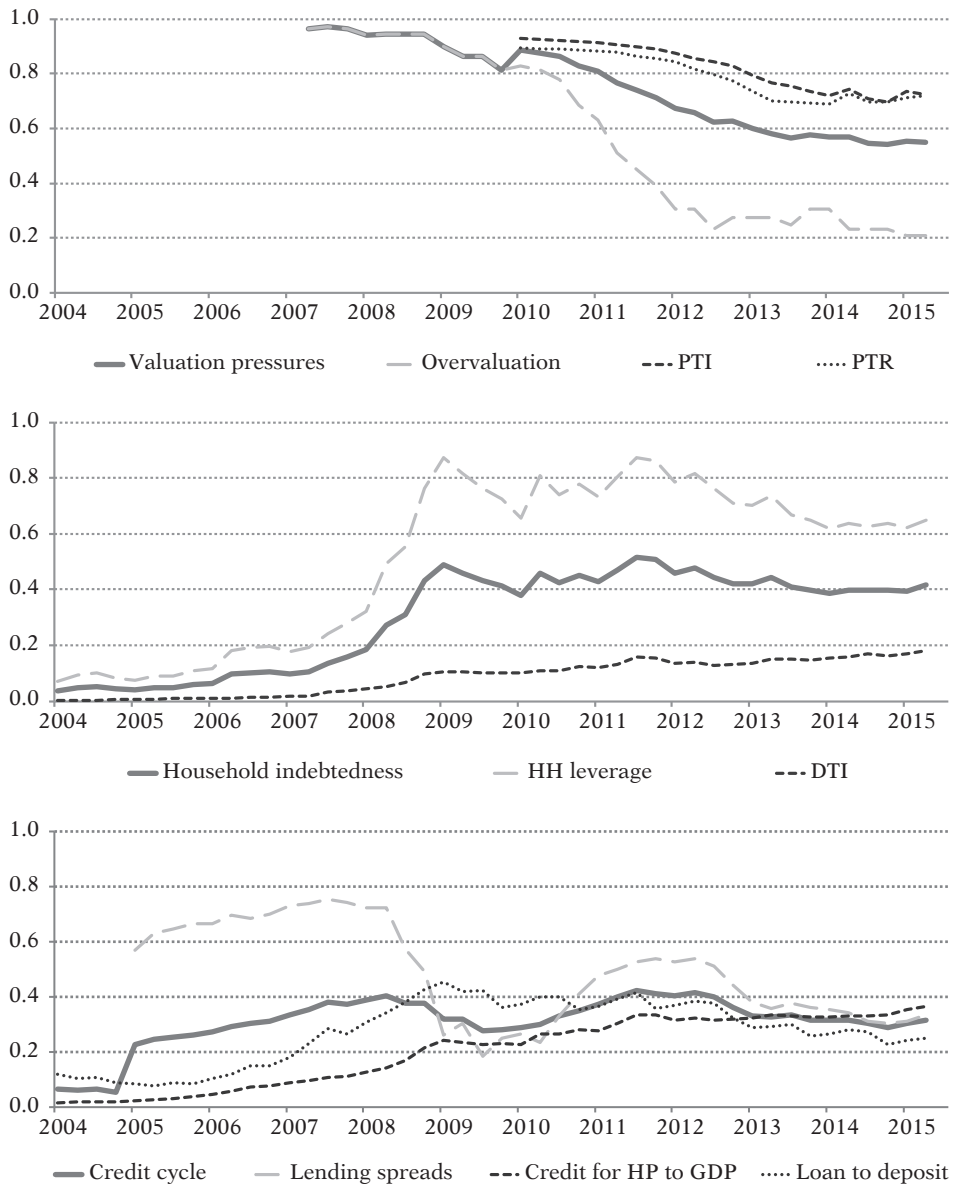
Note: Illustration of indicators across three main dimensions of vulnerabilities related to the residential real estate: valuation, household indebtedness and credit cycle.
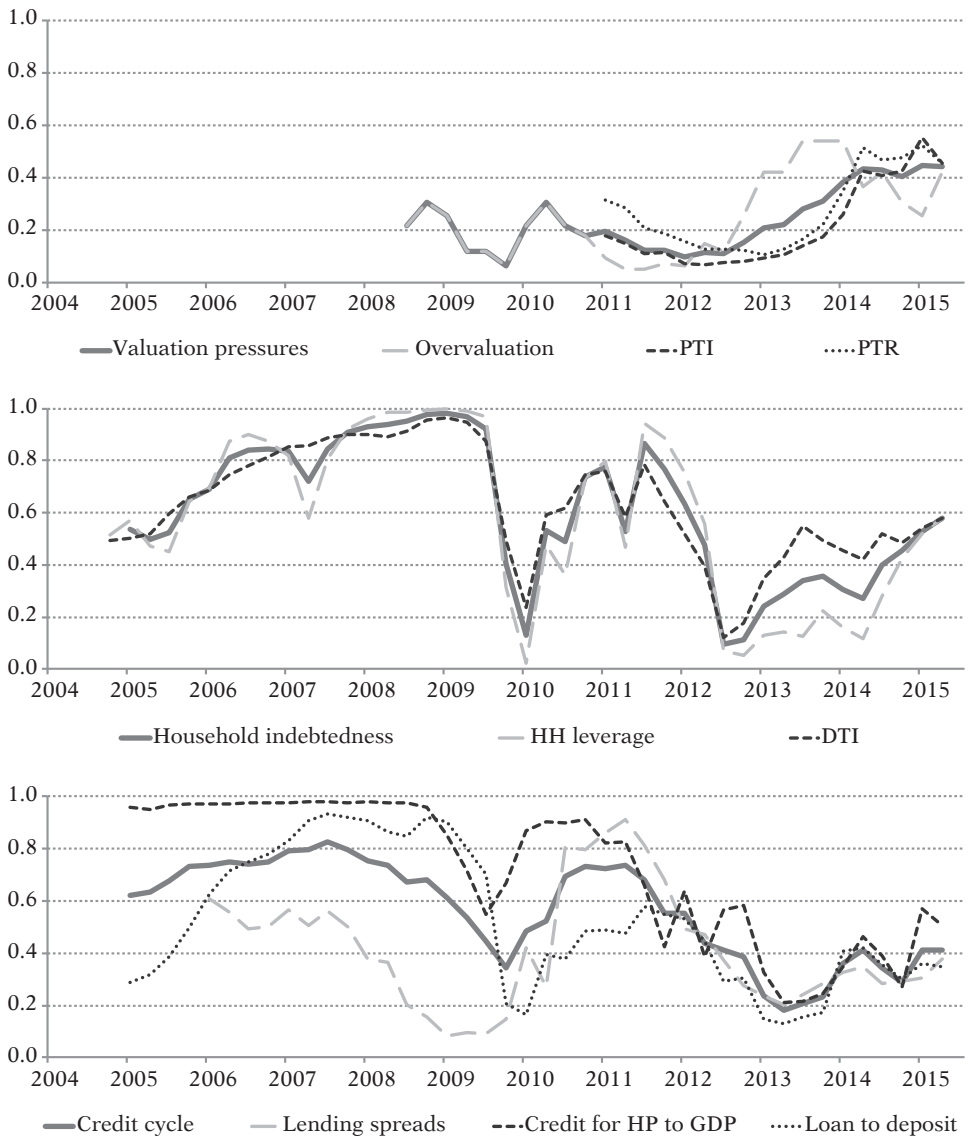Source: own work.

Within this aggregate dynamics, the evolution of three vulnerability dimensions was somewhat different. Valuation pressures fell in relative terms over time. The developments in the credit cycle oscillated between the 20% and 40% of the whole panel during most of the time. Household indebtedness increased to around 40%–50% during 2008, from the relatively low levels, and remained in this region afterwards. In terms of the contributions of indicators to the overall vulnerability score, Figure 6 shows that the vulnerability level is driven largely by credit cycle-related indicators at the beginning of the sample, and increasingly more by valuation-related indicators since 2008. The time series analysis disaggregated to the indicator level offers further, more granular, insights and also shows that some indicators may deliver volatile results at certain periods (e.g., HHLeverage during 2009–2010), which is a useful cross-check when analysing the topology of vulnerabilities for a given quarter (see examples in Figures 2 and 3).

Monitoring the time series developments in terms of changes can add further, more granular, insights on the current dynamics of the indicators. Figure 5 shows that at certain points in time the acceleration in some of the indicators is exceptionally high, from the historical and cross-country perspectives. For example, while the vulnerabilities related to credit provision and household indebtedness were not exceptionally high before the crisis in terms of levels, their dynamics up to 2009 was one of the highest in the panel. Correspondingly, these indicators contribute substantially to the overall vulnerability dynamics before 2009 (see Figure 7), with a somewhat increasing role of valuation indicators towards the end of the sample.

In the third step, the topology of the aggregate vulnerability level and dynamics across EU countries at a certain point in time can be analysed. Figure 8 illustrates an example of positioning of Poland in terms of the levels (y-axis) and the dynamics (x-axis) of the real estate-related vulnerabilities across EU countries at a selected point in time (mid-2007, i.e., several

quarters before the onset of real estate crises in many countries). To visualise the possible informativeness of such an approach in an early warning context, the map marks the countries which experienced a real estate crisis several quarters after mid-2007. At the same time, for some countries the results may be volatile due to the lack of several time series (also marked in the figure). This overview shows that most of the countries flagged as having high vulnerability levels, according to the simple aggregated measure, indeed experienced residential real estate crises in the quarters that followed.
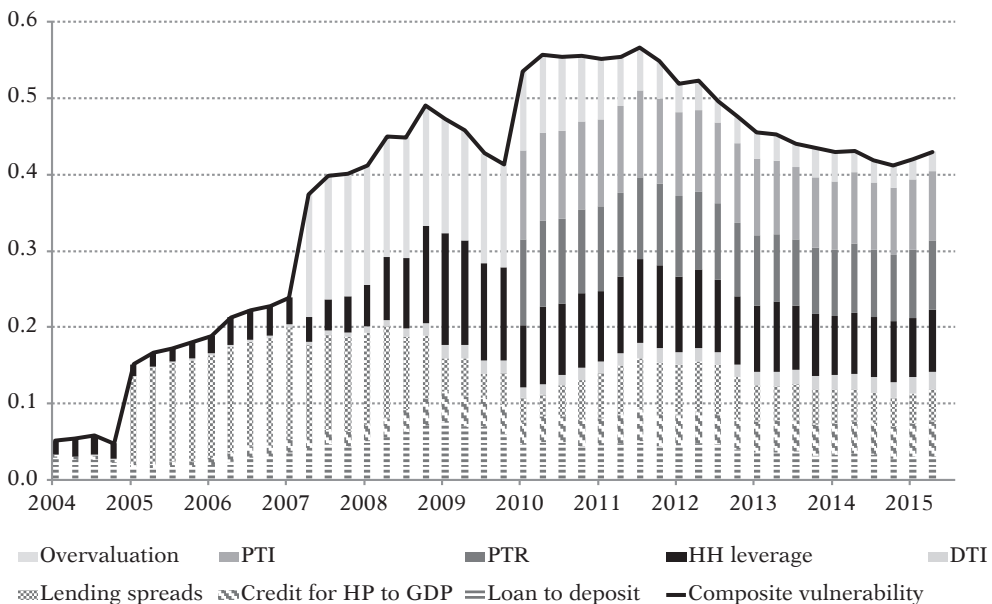
Figure 5. Vulnerability dynamics for Poland across dimensions and indicators
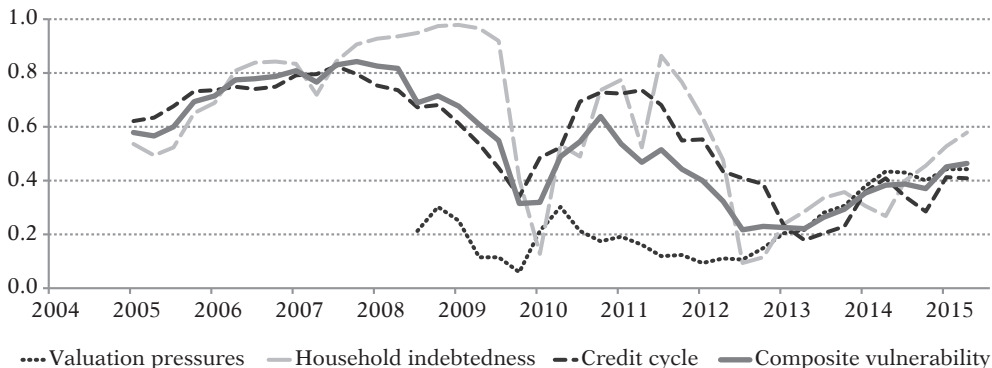
····Valuation pressures   —Household indebtedness   ‑‑‑Credit cycle   ▬Composite vulnerability

Note: Illustration of indicators across three main dimensions of vulnerabilities related to the residential real estate: valuation, household indebtedness and credit cycle.
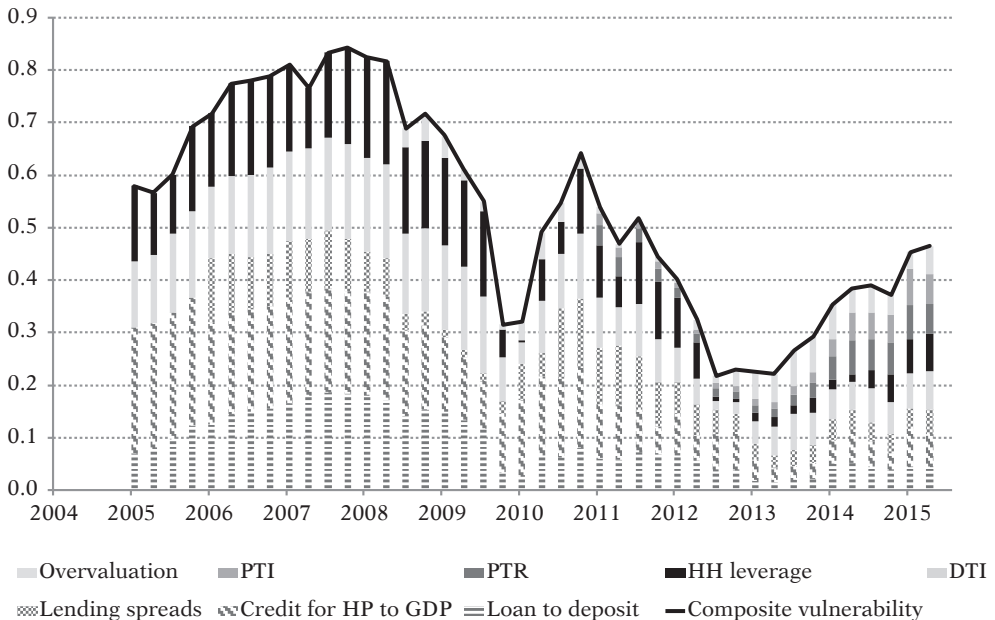Source: own work.

Figure 6. Decomposition of the vulnerability level for Poland

▨Overvaluation   ▦PTI   ▦PTR   ■HH leverage   ▦DTI
▨Lending spreads   ▧Credit for HP to GDP   ═Loan to deposit   ▬Composite vulnerability

Note: Contributions of indicators to the aggregate vulnerability measure for Poland.
Source: own work.

Moreover, some countries with vulnerabilities flagged as rising very fast also experienced subsequent real estate-related crises. Poland does not appear to indicate elevated vulnerability levels on this map, while being around the middle in terms of the dynamics, close to some countries that experienced a residential real estate crisis in the quarters afterwards.

**Figure 7. Decomposition of the vulnerability dynamics for Poland**

Note: Contributions of indicators to the aggregate vulnerability measure for Poland.
Source: own work.

Overall, the results presented in this section suggest that a disaggregated and aggregated analysis of residential real estate-related vulnerabilities from cross-country and historical perspectives may provide useful, potentially policy-relevant, signals. The framework allows for a quick consistency analysis of signals from several indicators within one vulnerability dimension and accounts for changes in the data availability over time. The time series developments may be relevant to monitor and provide useful early warning signals. Bengtsson, Grothe and Lepers [2020] show that the composite model-free measure has a significant forecasting performance for real estate crises, outperforming most advantageously in-sample calibrated model-based estimates. Moreover, in addition to analysing the levels of the indicators, the results based on the cross-country panel offer a relative perspective in the EU-wide context. From the policy perspective, the monitoring may be quite useful, since the choice of macroprudential instruments can be related to the nature of the vulnerability (e.g., vulnerabilities related to the banking or household sectors). Also, framing the analysis of vulnerabilities along both dimensions, i.e. levels and dynamics, as shown in Figure 8, might be relevant for policy makers, as some policy tools are better suited to address either the levels or the dynamics of vulnerabilities. At the same time, any interpretation of the vulnerability developments for policy-related purposes should be accompanied by the analysis of structural differences among countries and over time.

Figure 8. Poland on mid-2007 map of composite vulnerability scores for levels (y-axis) and changes (x-axis)
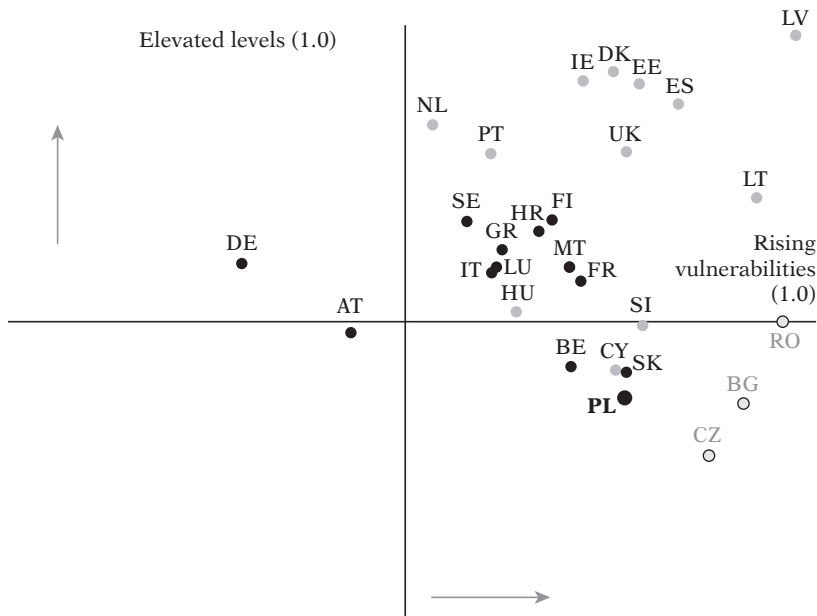
Note: The y-axis denotes the level of vulnerability for the composite score. The x-axis denotes the change in the level over the previous year. Grey dots denote countries that experienced a real estate crisis several quarters after mid-2007. The scores for BG, CZ, RO (marked light grey) are not considered comprehensive enough for analysis due to missing indicators in 2007. MT also has some missing indicators, which should warrant some caution when interpreting the results. Source: own work, as based on Bengtsson, Grothe and Lepers [2020].

Conclusion

In view of the importance of real estate in the balance sheets of households and credit institutions, as well as experiences of real estate-related crises in a number of countries in the past years, this paper applies the vulnerability monitoring framework of Bengtsson, Grothe and Lepers [2020] to the case of Poland. The framework uses indicators derived from the early warning literature and policy publications across three dimensions of real estate sector vulnerabilities: valuation, household indebtedness and the bank credit cycle. To provide transparent and intuitive signals, the indicators are aggregated in a model-free way to a composite vulnerability measure, shown by Bengtsson, Grothe and Lepers [2020] to be a significant predictor of historical residential real estate crises. This paper illustrates a range of applications to the case of Poland, discussing the results of the topology of vulnerabilities across dimensions at selected points in time, their evolution throughout the sample period as well as the topology of the aggregate vulnerability level and dynamics for Poland across EU countries.

The results of this paper might have policy-relevant applications. The availability of monitoring tools which deliver accurate, timely, reliable and easily interpretable signals of existing or increasing vulnerabilities may be useful from the policy perspective. The monitoring framework with simple aggregated vulnerability scores may be a complement to model-based approaches for analysing vulnerabilities in the residential real estate sector. Future research could try to further understand the lead properties of the particular indicators in the context of anticipating real estate crises. This paper shows that the proposed monitoring enables to track the vulnerabilities in both, aggregated and disaggregated context, analysing the signal consistency and dynamics from a cross-country perspective. Still, the interpretation of the developments for policy-related purposes needs to be accompanied by an analysis of structural aspects and country-specific characteristics.

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Annex: Components of composite vulnerability measures

Figure A-1: Time series of the vulnerability measure and its components for Poland
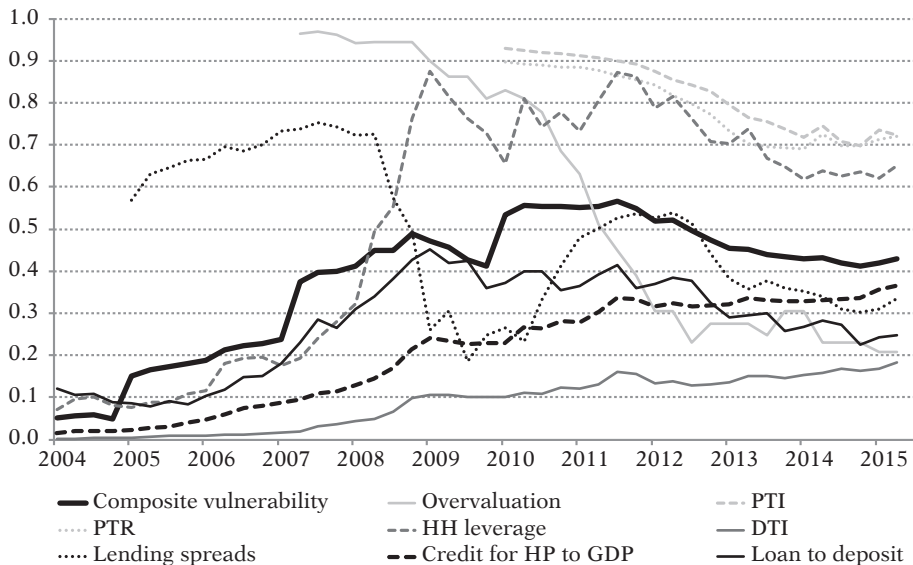

Figure A-2: Time series of the vulnerability dynamics and its components for Poland