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Interconnectedness and contagion in the Czech financial system

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INTERCONNECTEDNESS AND CONTAGION IN THE CZECH FINANCIAL SYSTEM

Adam Kučera, Milan Szabo[1]

Interconnectedness in the financial system in the form of direct and indirect financial linkages is an aspect of systemic risk, primarily in its structural dimension. The financial linkages between economic agents enable shocks to transmit from one agent to another, causing contagion to spread gradually across the entire financial system. In the Czech financial system, domestic banks are the main source of direct interconnectedness as most of them are members of international financial groups and are simultaneously the counterparties for most domestic financial institutions. Indirect interconnectedness also plays a significant role in the Czech financial system, as domestic financial institutions hold identical or similar assets in their portfolios. Sectors of the real economy – especially the household sector, which is involved throughout the financial system – also naturally contribute to greater interconnectedness of the Czech financial system.

I. INTRODUCTION

Bank and non-bank financial institutions in advanced countries are interconnected. This interconnectedness stems from the natural economic needs of such institutions (such as making payments through bank accounts, investing in financial markets, seeking credit financing and providing financial products to the same customers). Interconnectedness is also affected by the ownership and credit organisation of the financial system through financial groups, which make it possible to achieve economies of scale and economic and financial diversification and to provide consumers with a comprehensive range of financial services.

The interconnectedness of the financial system thus has its merits. However, it also establishes a wide range of channels through which a shock can spread among economic agents by contagion (Glasserman and Young, 2016). Contagion can be defined as the spillover of an originally isolated (idiosyncratic) shock to the entire financial system and/or the amplification of a shock among the sectors of the financial system affected.[2] Interconnectedness is therefore an important dimension, or structural element, of systemic risk (Frait and Komárková, 2011). Identifying possible forms of interconnectedness and evaluating the associated network risks are thus an integral part of caring for financial stability. In recent years, an increasing effort has been made to monitor network risk (Abad et al., 2019; FSB, 2020; ESRB, 2019), and elements of interconnectedness have subsequently been implemented in stress tests of sectors of the financial system (Caccioli, Ramadiah and Ferrara, 2020).

This thematic article sets out to map the interconnectedness in the Czech financial system and communicate the main sources and forms of contagion risk in the Czech environment. The article follows up on previous work done by the CNB in this area, focused primarily on the banking sector.[3] It also describes the CNB's motives for the ongoing development and revision of its stress tests of individual sectors of the financial system, for which interconnectedness is a major source of shocks or a means of amplifying them. In the next section, we look at the interconnectedness of the Czech financial system as a whole through mutual exposures. We then provide a general description of the direct interconnectedness of the main sectors of the Czech financial system. Section IV likewise describes the indirect interconnectedness of the system. Section V contains an in-depth discussion of some important channels of shock contagion via direct and indirect interconnectedness and their implications for the structural element of systemic risk.

2 This article focuses on the adverse effects of the spread of a shock across the financial system. We should emphasise, however, that such spread can also have a favourable effect, for example by diluting the shock. The degree of interconnectedness can also affect the public sector's motivation to implement supportive measures in bad times. For more details, see, for example, Deutsche Bundesbank (2019), pp. 87–88.

3 See, for example, Dingová, Hausenblas and Komárková (2014), Komárková, Hausenblas and Frait (2012) and Plašil and Kubicová (2012).

II. AN AGGREGATE LOOK AT INTERCONNECTEDNESS

We began by mapping the interconnectedness of the Czech financial sector using the aggregate financial linkages between the individual sectors of the domestic economy and between the domestic economy and the rest of the world. The quarterly financial accounts were used for this exercise. The data from these accounts make it possible to map financial linkages in terms of physical exposures. They provide information on the counterparty and the financial asset establishing the linkage.

The interconnectedness of financial institutions operating in the Czech Republic as of 30 June 2020[4] through mutual exposures is summarised in a network chart (see Chart 1). Nodes in the network in the form of financial sectors are shown as red circles, while the blue circles represent non-financial sectors. The area of the circles corresponds to the amount of financial assets held by the nodes. The links between the nodes express gross exposures, with the width of the link corresponding to their size. The direction of interconnectedness is indicated by an arrow running from the owner/lender.

Chart 1: Interconnectedness of the Czech financial system, the real economy and the rest of the world
(arrow width and node size in CZK billions; data as of 30 June 2020)
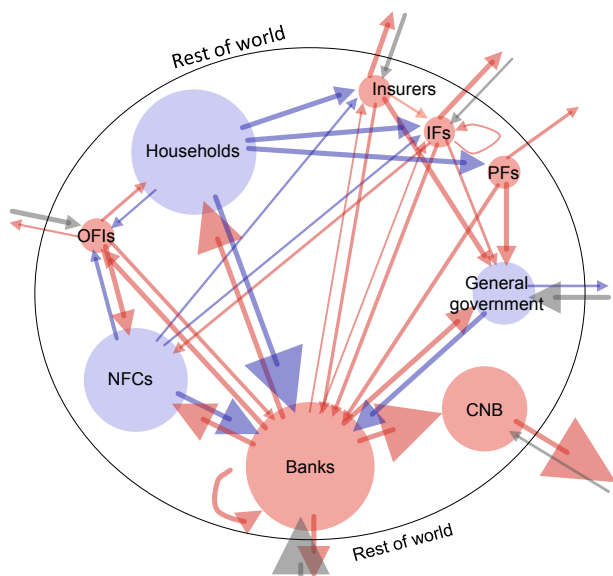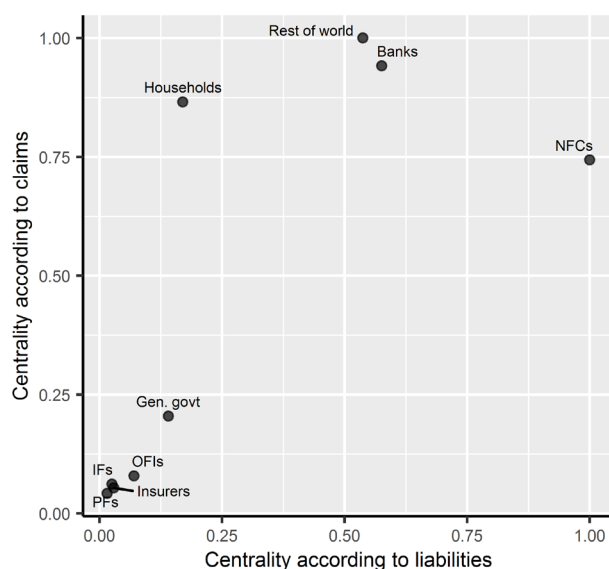

Source: CNB

Note: For clarity the chart excludes (1) links of less than CZK 20 billion, (2) links between non-financial sectors (households, NFCs and general government), (3) links of non-financial sectors to the CNB and the rest of the world. Captive financial institutions are included in the NFCs sector. NFCs = non-financial corporations, IFs = investment funds, PFs = pension funds, OFIs = other financial intermediaries.

Chart 2: Eigenvector centrality for sectors of the Czech financial system
(degree of centrality, higher value means greater significance of sector in context of interconnectedness of Czech economy; data as of 30 June 2020)

Source: CNB

Note: Eigenvector centrality for lender and borrower links according to the sectoral financial accounts (excluding links due to cash and gold holdings). Given their dimensionless nature, the resulting values are scaled so that the maximum value equals 1. Captive financial institutions are included in the NFCs sector. The CNB is not shown, as its specific role means it is not a channel of contagion. NFCs = non-financial corporations, IFs = investment funds, PFs = pension funds, OFIs = other financial intermediaries.

Chart 1 illustrates the two types of interconnectedness between financial institutions operating in the Czech Republic: direct and indirect. **Direct interconnectedness is generally defined as the sum of the direct exposures between two financial institutions** (i.e. mutual debt and equity securities holdings, deposits, loans, financial derivatives, guarantees, etc.). In Chart 1, direct interconnectedness is illustrated with red arrows running between red nodes (see also Chart 3).

Unlike direct interconnectedness, **indirect interconnectedness** between financial institutions runs through factors common to them. Significant common factors include non-financial entities (households, non-financial corporations and general government – the blue nodes in Chart 1) and foreign entities.[5] Indirect interconnectedness is based on the fact

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4 For more details, see https://www.cnb.cz/en/statistics/fin-accounts-stat/.

5 For example, a credit-based link between a bank and a household is a direct link. In the context of interconnectedness in the financial system, however, a direct link between the same household and an investment fund (through units held) simultaneously establishes indirect interconnectedness between the bank and the investment fund.

that a change in the link between such an entity and a specific financial institution may be reflected in a change in the link between that entity and other financial institutions. Other important common factors include markets in financial and real assets, because financial institutions often invest in such assets or use them to collateralise their exposures.

Other common factors of indirect interconnectedness are not associated with exposures and hence cannot be quantified using data on financial linkages. These include the information channel of shock transmission associated with information asymmetries, where the common factor is economic agents' sentiment or similar patterns of behaviour (Iyer and Peydró, 2011; ESRB, 2016). Other possible common factors include technologies shared by multiple financial institutions or sectors and related cyber risk (ESRB, 2020c) and interconnectedness through the legal environment. Although these channels of interconnectedness are not trivial to understand and quantify, risks can propagate through them and may not be negligible.

The degree of eigenvector centrality (Bonacich, 1987) can provide a more comprehensive comparison of the significance of each financial and real sector node for network risk. According to this concept, a node in a network is more significant (central), the larger are its links to other significant nodes in the network. Chart 2 shows the aggregate significance of the lender position of foreign entities, banks and households along with the significance of the borrower position of non-financial corporations and banks in the Czech Republic. Under this method, these significant sectors can be identified as the potential main sources or intermediaries of network risk in the Czech Republic.

III. DIRECT INTERCONNECTEDNESS BETWEEN FINANCIAL INSTITUTIONS

Banks play a key role in the direct interconnectedness of the Czech financial system (see Chart 3), as **they are the most significant counterparties in transactions** executed in the Czech Republic. Other domestic financial institutions need to maintain some liquidity and therefore hold funds as bank deposits.[6] As of 30 June 2020, bank deposits totalled CZK 53 billion in the case of insurance companies, CZK 82 billion in the case of investment funds and CZK 83 billion in the case of pension funds.

Domestic banks are also interconnected with the rest of the world. The Czech banking sector's financial liabilities with counterparties in other countries stood at CZK 2.24 trillion as of 30 June 2020. This was the largest direct linkage in the Czech financial system in absolute terms. Deposits and debt securities accounted for 71% of these international financial liabilities, and 54% of those were intra-group liabilities (see Chart 4). The remaining 29% of domestic banks' international financial liabilities consisted mostly of equities, again held predominantly intra-group.

Chart 3: Direct interconnectedness
(arrow width and node size in CZK billions; data as of 30 June 2020)
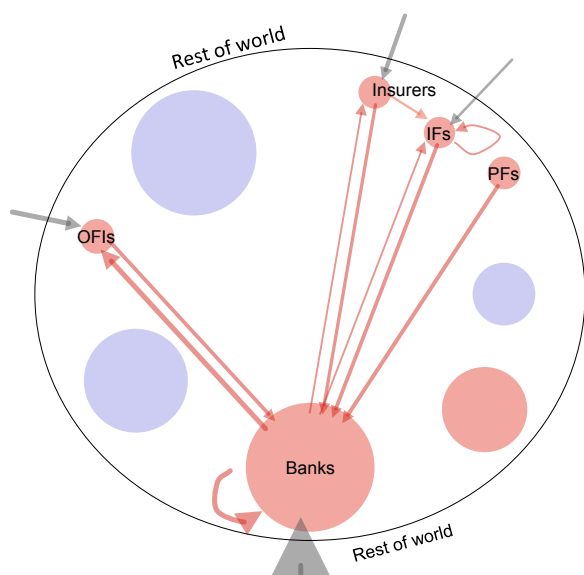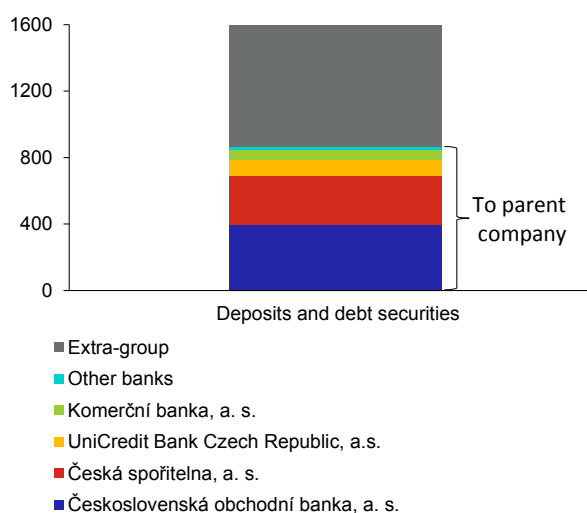

Source: CNB
Note: See Chart 1.

Chart 4: Domestic banks' international liabilities
(CZK billions; data as of 30 June 2020)

Source: CNB, public statements provided by banks under reporting duty
Note: Includes both koruna and foreign currency liabilities (converted into koruna)

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6 The relatively high interest domestic banks paid on institutional investors' deposits in 2019 also made current accounts a higher-yield alternative to government bonds, for example. This was particularly evident in pension funds' balance sheets.

Domestic banks are also mutually interconnected (see the loop by the bank node in Chart 3). The mutual exposures among banks are formed primarily through holdings of mortgage bonds (MBs), most often intra-group (for more details see, for example, CNB, 2020, Table 1). The extra-group linkages between banks are relatively insignificant. Chart 5 illustrates the direct interconnectedness between banks through deposits, loans and MBs. The chart shows that the widest links are intra-group ones between banks. The network is also specific in having a high number of isolated node pairs. This reflects the effect of certain foreign branches that have high-volume links to their foreign parent banks only (see the note under the chart). Only a few larger domestic banks are net debtors vis-à-vis foreign banks extra-group (see the black links in the concentrated part of the network); this primarily involves deposits.

Chart 5: Banks' balance sheet interconnectedness
(data as of 30 June 2020)
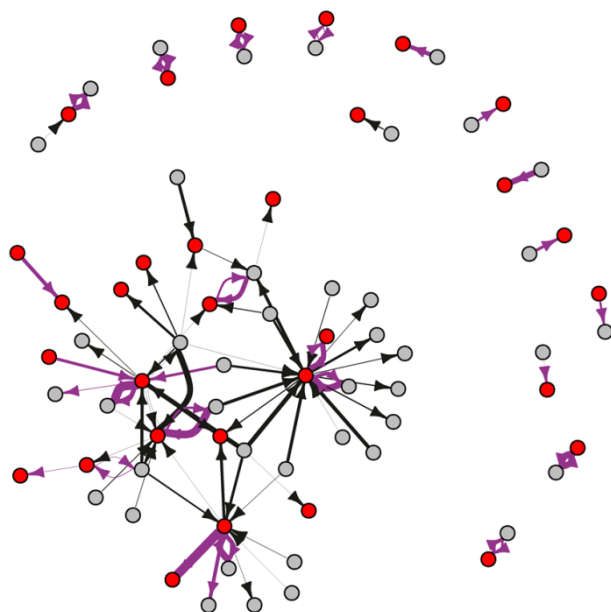
Source: CNB
Note: Links are shown only for exposures of more than CZK 1 billion. Red nodes represent banks and foreign branches operating in the Czech Republic. Grey nodes represent foreign banks. For reasons of data unavailability, links between grey nodes are not shown. The width of the arrows corresponds to the size of the exposures. Purple arrows indicate intra-group linkages and black arrows extra-group linkages.

Table 1: Domestic banks' assets vis-à-vis subsidiaries by activity of the subsidiary
(% of total liabilities to subsidiaries; data as of 30 June 2020)

Financial activity:	96.35
Investment fund	0.25
Investment fund (real estate)	0.86
Asset management company	7.36
Other (e.g. leasing and factoring)	18.69
Pension management company	2.52
Bank	66.67
Other non-financial activity	0.66
Real estate activity	2.99

Source: Public statements provided by banks under reporting duty

Loans made up 77% of domestic banks' exposures to other financial intermediaries (OFIs; see Chart 3), while bank deposits made up 97% of OFIs' exposures to banks. Here again, these were mostly intra-group linkages, with parent banks providing finance to their subsidiaries and subsidiaries depositing liquidity with their parents.

Investment funds form the largest node **in the direct interconnectedness of domestic non-bank financial institutions** (see Chart 6). Some insurance companies and pension funds hold shares in investment funds in order to invest their investment assets in the financial markets or to invest in property. The interconnectedness between investment funds is also relatively significant. This reflects, on the one hand, their investment strategy, with investment funds buying shares in other investment funds instead of making direct investments, and, on the other, the occasional use of specific fund investment structures.[7]

Although looking at financial account stocks allows us to capture the core of the direct interconnectedness and explain the key linkages between financial institutions, we should emphasise that it does not cover all the possible forms of direct interconnectedness. The stocks in the accounts do not provide complete information on the related financial flows. This applies particularly to the profits/losses of individual financial sectors. In this case, shocks are spread by intra-group dividend flows between financial institutions.

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[7] The "master-feeder" structure is such a fund investment structure. In simple terms, one or more "feeder" funds are used in a group of funds to obtain money from investors. This money is then placed in a "master" fund, which invests it in the financial markets.

Chart 6: Direct interconnectedness of individual domestic financial institutions

(data as of 30 June 2020)

- Investment funds
- Pension funds
- Insurance companies
- Banks
- OFIs
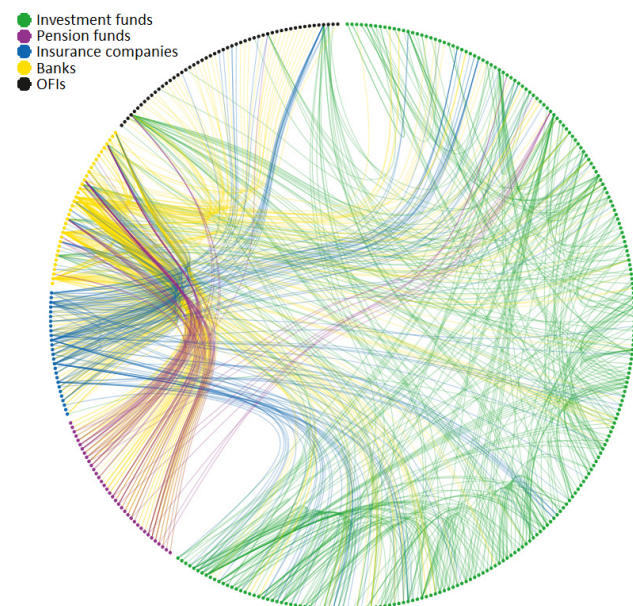
Source: CNB

Note: Each point on the circle represents an individual financial institution. Only institutions that are interconnected with other domestic financial institutions are included. Owing to a lack of data, the chart does not include (1) investment funds' bank deposits, (2) OFIs' assets, (3) links arising from insurance products and (4) links arising from financial derivatives and off-balance-sheet links (such as guarantees and commitments).

Chart 7: Indirect interconnectedness through non-financial entities

(arrow width and node size in CZK billions; data as of 30 June 2020)
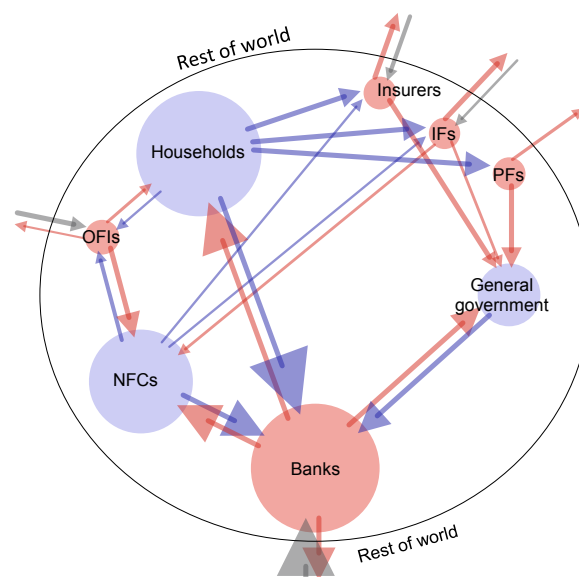
Source: CNB

Note: Data processed as in Chart 1.

IV. INDIRECT INTERCONNECTEDNESS BETWEEN FINANCIAL INSTITUTIONS

The household sector is naturally an important source of indirect interconnectedness in the Czech Republic (see Chart 7). Bank deposits are its strongest linkage to the financial system. Households also invest in products of insurance companies, investment funds and pension funds. The allocation of funds among these financial products by households is generally influenced by households' perceptions of their total wealth. For this reason, a change in the value of financial products can give rise to reallocation of households' financial resources and thereby affect other financial product providers. The information channel also plays a role in the reaction function of households and other non-financial entities allocating their funds into financial products, as potential contagion stems from changes in sentiment rather than changes in balance sheet values. Bank runs are one example of contagion through the information channel (Diamond and Dybvig, 1983).

Indirect interconnectedness also arises on the asset side of financial institutions' balance sheets in the case where **assets are identical or at least similar (i.e. highly correlated in terms of value)**. Examples include exposures in the form of loans provided to, and bonds and equities issued by, entities in the real economy or counterparties in other countries. The degree of similarity of the assets determines the nature of this interconnectedness. In the case of **identical assets** held by a large number of financial institutions (such as shares in a single firm or government bonds from the same issue), the interconnectedness is very strong, especially in the case of listed securities, since all financial institutions put the same price on the exposure.[8] The degree of interconnectedness between financial institutions can also be high in the case of **different exposures to one or more counterparties** if those counterparties share a common characteristic and are vulnerable to a common shock. Examples include non-financial entities belonging to the same subsector (such as low-income households) or the same industry (such as the oil industry) and displaying a similar pattern of behaviour over the business cycle. Geographical concentration of financial institutions' portfolios can likewise give rise to relatively strong correlation of exposure values, the common characteristics here usually being geopolitical risks and exchange rate movements. Another common characteristic that can cause indirect interconnectedness of various counterparties or exposures is an identical rating (ESRB, 2020a). Relatively high correlation of exposures can

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8 Abstracting from different ways of classifying the asset in accounting terms.

also be found in the broadest sense at the asset type level. Comparatively high correlation emerged during the real estate crisis in the USA in 2007–2009, when common exposures secured by residential property together with financial derivatives were simultaneously repriced across the global financial market (BIS, 2009; mortgage-backed securities plunged in value across global markets).

As Chart 7 shows, at the aggregate level domestic financial institutions have common asset-side exposures to the government sector in particular. Bank loans provided to households and non-financial corporations and the simultaneous exposures of these sectors to non-bank financial institutions are also a relatively significant component of indirect interconnectedness. Certain other domestic financial institutions besides banks also contribute to the financing of domestic non-financial corporations at the aggregate level. All sectors of the Czech financial system also hold exposures to the rest of the world, which may also be correlated.

To map indirect interconnectedness in the form of identical securities holdings, the similarity of the portfolios of the Czech financial sectors can be quantified using cosine similarity (Girardi et al., 2018). The cosine similarity ($s_{i,j}$) between sectors i and j via individual exposures in a portfolio can be expressed as: $s_{i,j} = \sum w_{i,\alpha} w_{j,\alpha} / (\|w_i\| \|w_j\|)$, where $w_{i,\alpha}$ denotes the size of the exposure of sector i in security α and $\|w_i\|$ denotes the Euclidean size of the vector of the exposures of sector i over all securities (Diagram 1). The resulting values lie in the interval [0,1]. A higher value means greater portfolio similarity between the sectors under comparison.

Diagram 1: Network for the calculation of portfolio similarity
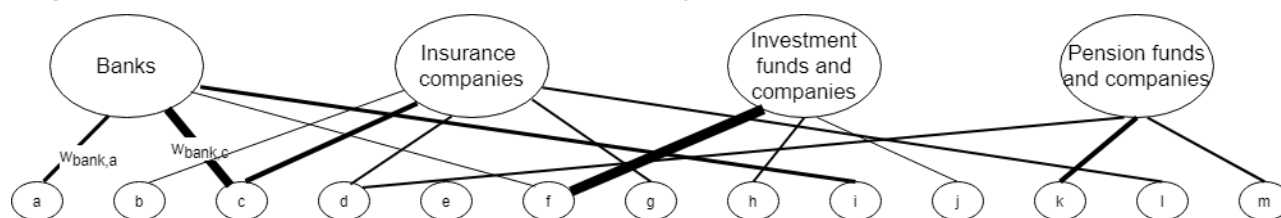
Source: CNB

Note: Simplified diagram of the portfolio network used. The individual sectors of the financial system are linked to individual securities (denoted a,b,c,…m). The thickness of a link corresponds to the amount held in the portfolio ($w_{sector,security}$).

At the level of the individual sectors of the Czech financial system, the securities portfolios of banks, insurance companies, pension management funds and bond funds are highly similar (see Table 2). This primarily reflects these sectors' investments in Czech government bonds. By contrast, the relatively low portfolio similarity of equity, real estate and other investment funds is due to high diversification of their portfolios. The securities held by these types of investment funds (often in the form of unlisted shares in non-financial corporations) do not feature very much in the portfolios of other sectors.

Table 2: Portfolio similarity

(%; data as of 30 June 2020)

|	Banks	Equity IFs	Bond IFs	Real est. IFs	Other IFs	Mixed IFs	Insurers	Partic. PFs	Transf. PFs
Banks	-	0.0	67.0	0.0	0.4	34.4	67.0	74.4	75.5
Equity IFs	0.0	-	0.7	0.0	2.5	10.6	1.1	1.5	0.0
Bond IFs	67.0	0.7	-	0.0	1.3	52.3	60.0	81.3	76.3
Real est. IFs	0.0	0.0	0.0	-	0.0	0.1	0.1	0.0	0.0
Other IF	0.4	2.5	1.3	0.0	-	3.1	0.7	0.6	0.7
Mixed IFs	34.4	10.6	52.3	0.1	3.1	-	30.8	44.0	38.3
Insurers	67.0	1.1	60.0	0.1	0.7	30.8	-	68.3	83.8
Partic. PFs	74.4	1.5	81.3	0.0	0.6	44.0	68.3	-	82.0
Transf. PFs	75.5	0.0	76.3	0.0	0.7	38.3	83.8	82.0	-

Source: CNB

Note: IFs = investment funds, PFs = pension funds.

The table above indicates the degree of indirect interconnectedness at the level of the sectors of the Czech financial system. The graphical matrix in Chart 8 offers a more detailed view based on cosine similarity distributions at the financial institution level. The graphs capture the similarity distributions of the portfolios of domestic financial institutions from sectors i (the row of the matrix) and j (the column of the matrix) at the individual security level. The diagonal charts show the similarity distributions for portfolios of institutions from the same sector. The chart only shows the lower triangle

of the matrix, as the matrix is symmetrical: the portfolio similarity distribution between banks and insurance companies is the same as that between insurance companies and banks. So, for example, the first panel describes the portfolio similarities between banks and shows a non-zero similarity concentration for securities even around higher values. This is caused primarily by banks, which invest mostly in Czech government securities and therefore have very similar securities portfolios. Second modes occur for other sector pairs, for example in the similarity between banks and transformed pension funds. The securities portfolio similarity between individual investment funds (the second diagonal panel) is concentrated near to zero, indicating significant diversification within the sector. However, a small number of highly similar investment fund portfolios can also be seen. These observations represent pairs of investment funds with highly similar securities, in particular funds investing in large ETFs tracking major equity indices.

Chart 8: Non-zero similarity distributions for the portfolios of individual financial institutions
(x-axis: portfolio similarity in %; y-axis: probability density; data as of 30 June 2020)
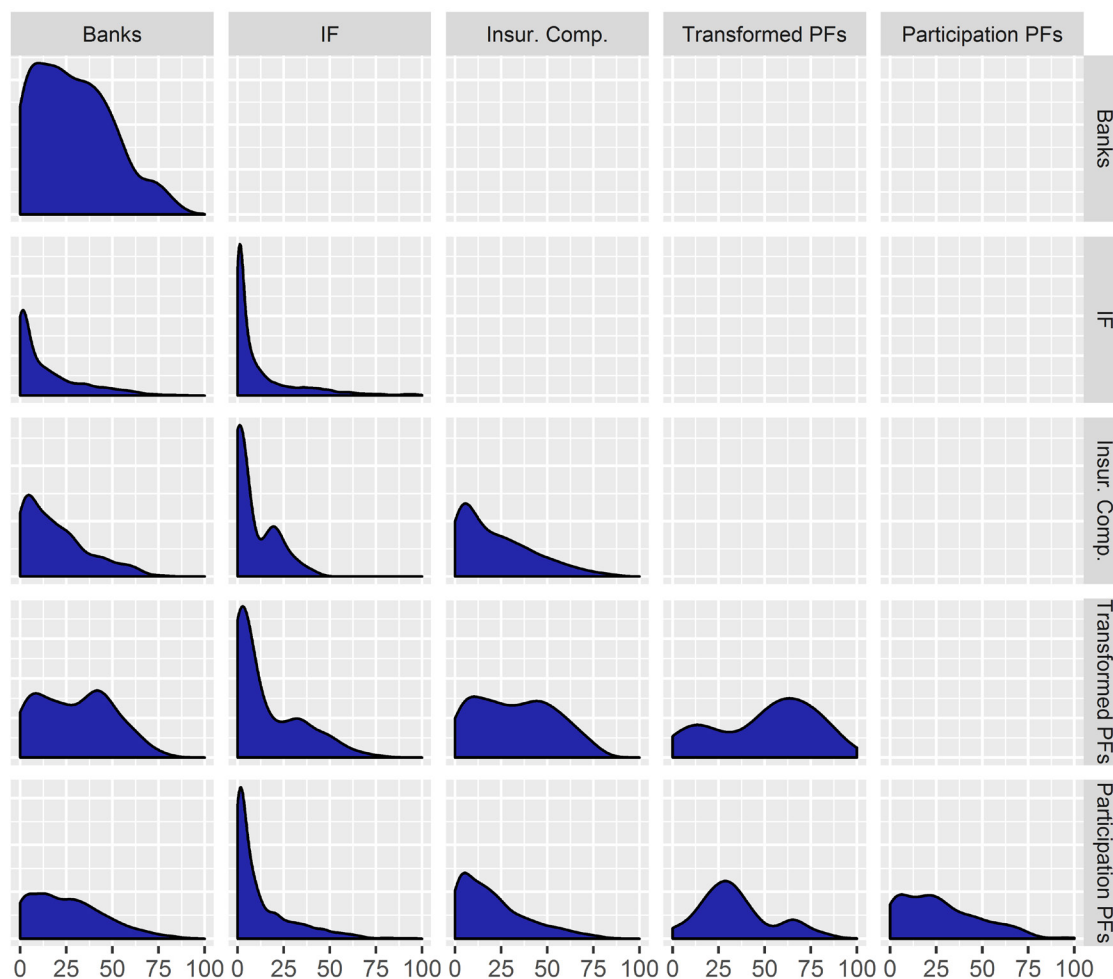
Source: CNB

Note: The chart presents the matrix of similarity distributions for the portfolios of individual financial institutions. For clarity, the y-axis (probability density) is not shown. IFs = investment funds, PFs = pension funds.

Chart A.1 indicates indirect interconnectedness via correlated securities broken down by sector/economic activity of the issuer. Domestic institutional investors hold relatively large amounts of foreign financial institutions' assets and foreign government bonds, the prices of which can be highly correlated, especially in certain situations (such as a financial crisis or a change in sovereign risk perceptions). Investment funds are particularly exposed to concentration with respect to individual sectors of the real economy through unlisted shares in non-financial corporations.

V. SELECTED CONTAGION SCENARIOS AND IMPLICATIONS FOR SYSTEMIC RISK

This section discusses selected contagion scenarios, emphasising the implications for systemic risk in the Czech financial system.

V.1 CONTAGION IN FINANCIAL GROUPS

The above-described linkages between domestic banks and other domestic financial institutions and foreign institutions, including parent companies, could become the main channel of spread of a foreign shock across the Czech financial system. A change in the foreign interest rate environment or a movement of exchange rates could affect the parameters of interbank deposits (such as time to maturity and interest rates) and other assets used in intra-group financing, thereby indirectly affecting domestic banks' cost of funds and liquidity position. Spreading losses where risk materialisation and related losses in one institution are covered by the capital of another institution and both institutions move close to or even below their regulatory capital requirement can also be regarded as shock transmission in a financial group. Another scenario that could be considered an adverse consequence of direct interconnectedness in the long run is an intra-group dividend policy that limits the potential for some financial institutions to grow or develop further due to the provision of capital support to inefficient institutions in the group. Such "sharing" of the impact of a shock via intra-group financing or capital management parameters may occur in domestic financial groups as well. The information/reputation channel is a relatively significant channel of indirect contagion through financial groups. If the financial condition of one institution in a group worsens, perceptions at the single group or brand level in the real and financial sectors of the economy can cause a shock to transmit to other financial institutions in the group (a "reputational crisis"). This can occur even when the direct linkage or shock size alone would not give rise to material contagion.

V.2 PORTFOLIO SIMILARITY: FIRE SALES AND SPREAD OF LOSSES

Portfolio similarity between financial institutions can give rise to contagion in two ways: (1) through a downward spiral between market and liquidity risk in the form of fire sales of financial assets from portfolios, and (2) through losses spreading due to repricing of credit risk.

The onset of contagion in the first case is relatively rapid. Where the assets held are identical or similar, a drop in their price may show up almost instantly in the portfolios of virtually all their holders. The losses arising from revaluation of the assets may in turn be reflected in financial institutions' behaviour due to a deterioration in their solvency or liquidity position. In the case of financial institutions that invest for their own account, the asset revaluation loss affects their solvency position. A major loss here may give rise to a need to reduce leverage (debt financing of assets), and financial institutions may sell off their assets (excessive leverage risk; Adrian and Shin, 2010). In the case of investment funds, investors may react to the fall in the value of their units by fleeing the fund.[9] This will generate a need for liquidity in the fund due to unit redemption, and therefore, also funds may sell off their assets (see also the stress test of investment funds presented in CNB, 2020).

Simultaneous fire sales by multiple institutions may result in a need to sell the assets concerned at prices far below fundamental value, on account of a lack of trading counterparties and insufficient market depth (Shleifer and Vishny, 2011). The further fall in asset prices thus amplifies the original market shock and may trigger a self-fulfilling downward spiral between the drop of the prices of the assets on sale or similar assets and further fire sales. The decline in prices may also affect the value of collateral in financial transactions or derivatives. The fall in collateral value in turn reduces the ability of financial institutions to use secured transactions to raise additional funds and generates a need to increase margins.[10]

Fire sales may also be caused by regulations or by binding investment strategies in investment funds' statutes. Such a strategy may, for example, limit investment in low-rated bonds. If a bond's rating is downgraded below the band permitted in the investment strategy, the fund may make increased efforts to sell it (Ellul et al., 2011). The risk of losses associated with corporate bond downgrades has been increased for many years now by rising holdings of bonds with borderline investment-grade ratings in the portfolios of major global institutional investors, which have been seeking

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9 A similar risk exists for providers of other investment products – unit-linked life insurance where the investment risk is borne by the policyholder, and pension fund investment. An investor exodus is less likely in this case given the related loss of tax benefits and government support.

10 See, for example, Brunnermeier and Pederson (2009), Georgescu (2015) and ESRB (2020b). However, the good liquidity position of domestic financial institutions means that the risks of a deterioration in access to financing and a need to increase margins are not of systemic significance in the Czech environment (CNB, 2020).

riskier investments in the low-yield environment (IMF, 2019). These bonds are more sensitive to potential fire sales, because a downgrade would mean a switch to speculative grade.

As Chart A.1 shows, bonds issued by the Czech government sector (see Section V.3 for more details), domestic financial institutions (the direct interconnectedness discussed above) and foreign financial institutions have the largest shares in financial institutions' bond portfolios. Chart A.1 reveals no other excessive concentration of financial institutions' securities in other sectors.[11] Total domestic corporate bond holdings (banks – due to mortgage bonds – CZK 373 billion, investment funds CZK 20 billion, insurance companies CZK 33 billion and pension funds CZK 15 billion as of 31 March 2020) are far smaller than holdings of government securities, but fire sales of corporate bonds could amplify the losses in the financial system. Chart 9 illustrates the rating distribution for the long-term corporate bonds held in the Czech financial system. A relatively large share of lower-investment-grade bonds (A–BBB, i.e. including the rating just above speculative grade) is apparent for pension funds and insurance companies. The high share of unrated bonds held by investment funds, insurance companies and banks (see Chart 9) is due on the one hand to the high share of mortgage bonds held by domestic banks and in some cases by insurance companies, and on the other hand to holdings of non-financial corporations' bonds, with domestic issues in particular being unrated (see Chart 10).

Chart 9: Distribution of long-term corporate debt security ratings by holder

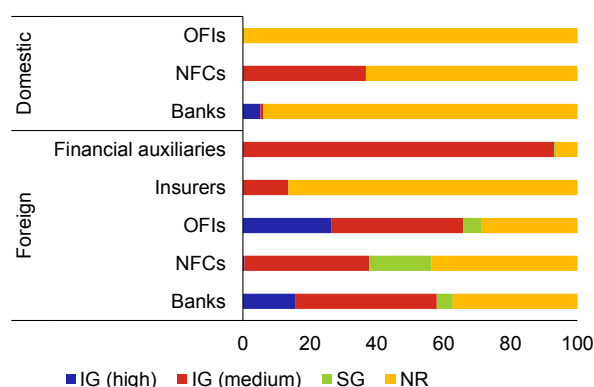(% of market value; data as of 30 June 2020)
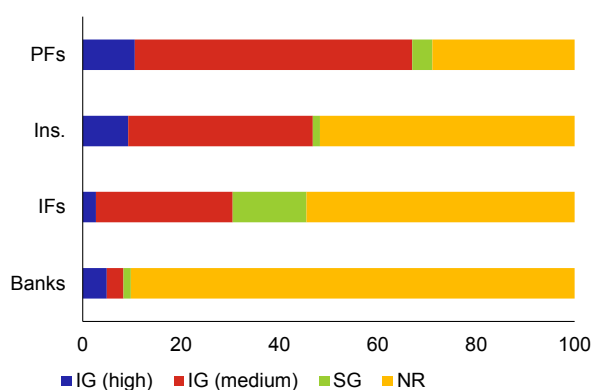
Source: Moody's, CNB

Note: IG (high) = investment grade, composed of ratings AAA–AA. IG (medium) = investment grade, composed of ratings A–BBB. SG = speculative grade (BB–C). NR = no rating.

Chart 10: Distribution of long-term corporate debt security ratings by issuer

(% of market value; data as of 30 June 2020)

Source: Moody's, CNB

Note: The chart shows sectors of issuers with a value of more than CZK 1 billion. For the rating grades, see the note under Chart 9.

The second way in which indirect interconnectedness can cause contagion is through the aforesaid spread of credit risk. The situation where one entity runs into difficulty making payments on a loan to one bank can lead to reclassification of the entity's loans with all other banks. The same goes for bonds. Credit risk may also spread at the level of correlated exposures – assets representing a particular sector, asset class or risk category may be revalued due to growth in credit risk. This may trigger a large-scale change in the risk aversion of banks or bondholders and revaluation of risk premia and assets across a whole group of institutions. The original shock is thus amplified, potentially taking on a systemic dimension.

In the case of the Czech financial system, the risk of contagion through indirect interconnectedness in the form of portfolio similarity is linked primarily with holdings of Czech government bonds and, in some cases, risky corporate bonds. In the broader sense of portfolio similarity in respect of a particular asset class, growth in exposures linked to the domestic property market is also apparent in the Czech Republic. Banks are linked to the property market through the provision of loans secured by real estate (CNB, 2020) and indirectly also through the financing of property development projects. In the low-yield environment, the last decade has seen growing investment by non-bank institutional investors in property, which can offer more attractive returns than financial investments. A temporary decline in demand for, or high supply of, real estate in recession could cause a price correction on the property market. This could be partially amplified by simultaneous property sell-offs by banks, households, institutional investors and developers and could lead to losses being made on property holdings.

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11 Sector concentration in banks' credit portfolios is investigated in Holub, Nyklíček and Sedlář (2014). Limited data availability precludes a full assessment of concentration risk for all financial institutions. For example, it would be appropriate to evaluate domestic financial institutions' investments in foreign investment funds broken down by the assets held by the fund concerned, but this information is often unavailable.

V.3 PORTFOLIO SIMILARITY: THE CASE OF CZECH GOVERNMENT BONDS

The structure of domestic financial institutions' aggregate portfolio is characterised by a high share of government securities, holdings of which amounted to CZK 1,435 billion as of 30 June 2020. Of this total, 95% was allocated to financial assets issued by Czech government institutions.[12] Domestic banks held a relatively large proportion of this amount (CZK 847 billion), as did insurance companies (CZK 166 billion) and pension funds (CZK 357 billion). The preference for government bond holdings in the balance sheets of domestic financial institutions is motivated by, among other things, the preferential regulatory treatment of such exposures[13] and the low level of risk involved. The government bond market is meanwhile liquid and government bonds are subject to low haircuts when used as financial collateral.[14] However, the concentration of a portfolio in a single asset is generally not desirable and can contribute to the transmission of shocks across the financial system (Komárková, Dingová and Komárek, 2013).

As of 30 June 2020, foreign investors held almost CZK 788 billion of Czech government bonds and thus had a 35% share in the total amount of debt issued. The decomposition of foreign investors' holdings of Czech government bonds (see Chart 11) reveals that foreign banks have a substantial share. The relatively high proportion of foreign holders of Czech government debt represents a potential risk to domestic financial stability. Foreign investors tend to be more sensitive to market volatility and sentiment, take exchange rate uncertainty into account, are geared more towards short-term profits and have correlated investment strategies. Their preferences can change relatively quickly (if they find better investments) and their risk perceptions can shift abruptly. Given their current share of the debt, any major sell-offs of Czech government bonds by such investors could destabilise the market prices of these bonds and thereby transmit a shock to domestic financial institutions' portfolios. A sudden drop in government bond prices coupled with a rise in their volatility could additionally trigger a wave of necessary increases in margin accounts for derivatives positions and repo operations (in which government bonds are used as collateral), thereby contributing to a deterioration in the liquidity position of some domestic institutions. At the same time, an increase in volatility and uncertainty on the government bond market could be expected to lead to growth in the bid-ask spreads quoted by secondary market makers (primary dealers), i.e. to a reduction in the market liquidity of such bonds and potentially also a further decline in their prices.[15]

Chart 11: Non-residents' Czech government bond holdings
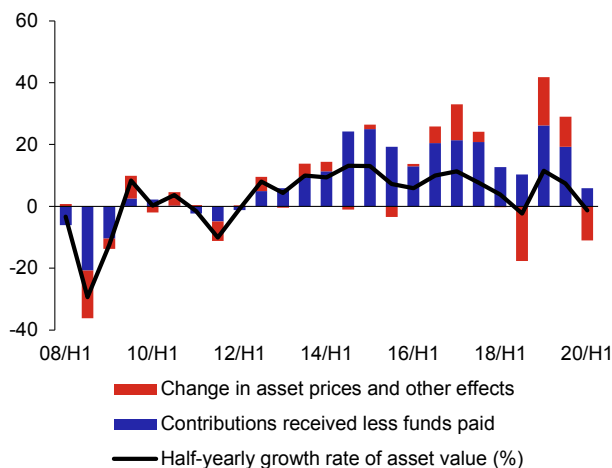
(%, data as of 30 June 2020)
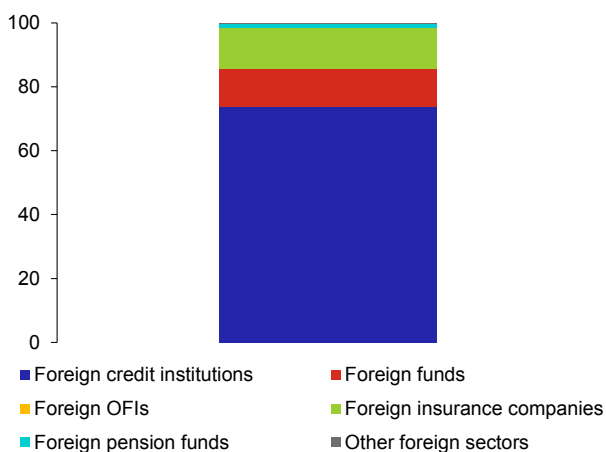
Source: CNB

Chart 12: Decomposition of the change in the value of collective investment funds' assets

(% of assets at end of previous period)

Source: CNB

Note: The chart depicts half-yearly changes.

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12 Primarily Czech government bonds (CZK 1,356 billion). This category also includes Treasury bills (CZK 78 billion).

13 See, for example, the regulatory status of sovereign exposures under CRD IV/CRR, Solvency II and the Act on Supplementary Pension Savings. Article 10 of Commission Delegated Regulation (EU) 2015/61 additionally requires banks to hold highly liquid assets, the definition of which covers government bonds.

14 An amendment to the Act on the CNB passed in the first half of 2020 allowed the CNB to temporarily expand the list of eligible counterparties in liquidity-supplying repo operations, for which government bonds are the usual collateral. The amendment also temporarily allowed the CNB to conduct open market operations with no restrictions as regards instruments, maturities and counterparties. As a result, the CNB can enter the Czech government bond market in order to bolster its stability where necessary.

15 These risks were partially reduced by the amendment to the Act on the CNB introduced in the first half of 2020, which temporarily allowed the CNB to intervene in the Czech government bond market in order to stabilise it where necessary.

The high concentration of Czech government bonds in domestic financial institutions' balance sheets also reinforces the already strong link between the health of public finances and the health of the financial system.[16] A loss of confidence in the risk-free nature of government bonds, caused, for example, by doubts about public finance sustainability, could result in a rise in the perceived riskiness of domestic financial institutions, which hold the bulk of the government debt. The CNB is aware of these risks and each year assesses the sovereign exposure concentration risk in the balance sheets of credit institutions based in the Czech Republic. Exposures to domestic government institutions have long been regarded as systemically significant. As a result of these findings, the CNB conducts stress tests of Czech public finances (CNB, 2020). If the test results are unfavourable, the CNB has the option under Pillar 2 to set an additional capital requirement to cover this concentration risk.[17]

V.4   WORSENING SENTIMENT AND RISING LOSSES OF HOUSEHOLDS

Households are a key source of funding and profit generation for domestic financial institutions. Households often allocate their financial resources with regard to changes in their income and wealth and to the risks they perceive. Chart 7 shows the dominant role of bank deposits in the allocation of households' financial resources (41% of the total). However, the proportion of their financial resources invested in investment fund, pension fund and insurance company products is also not negligible (18%).

Households can react to adverse changes in their income and wealth by altering their behaviour and can contribute to the formation of contagion across the financial system by reallocating funds linked directly to financial institutions. The risk of contagion stems primarily from changes in the allocation of funds between various financial products. If, for example, households make losses on non-bank investment products, they may curtail their demand for those products or even surrender them (runs on funds; surrenders of certain types of investment insurance) and move into bank deposits. The interconnectedness via households is magnified by the information channel and by the role of sentiment. Households may withdraw en masse even from investment products that have been affected to only a limited extent by adverse developments in financial markets.[18]

In terms of financial stability, this may result in the financial market segments concerned incurring a short-term need for additional liquidity to redeem the units of exiting investors, a need which may spill over to fire sales of financial institutions' assets (see Section V.2). In the longer term, these segments may see a decline in profitability due to reduced demand for their products. For some households, the loss of part of their investments in financial markets and the decline in their dividend and interest income may also mean a decrease in the reserve buffer that would prevent them from defaulting on their loans were they to lose their primary source of income. Contagion through this channel may thus imply market risk spilling over into credit risk in lenders' balance sheets.

The Czech experience with the reaction of households to financial market turbulence over the past 12 years indicates a decrease in households' sensitivity to financial market developments. The exodus of investors from domestic collective investment funds in 2008 was significant, whereas the December 2018 and March 2020 financial market slumps did not trigger major outflows (see Chart 12 and CNB, 2020). Even during the relatively sizeable price correction in financial markets seen during March 2020, households did not cancel their investment products to any great extent. On the contrary, they viewed the correction as temporary and as an opportunity to up their investments. The experience in the spring months nonetheless indicated a partial shift from bond funds to other investment fund categories. This shows that contagion via households' reactions may apply to individual financial institutions or financial subsectors, while the impact on the non-bank financial sector as a whole may be only modest.

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16 This consists, among other things, in the government's usual position as the floor for credit ratings in the economy. A downgrade of the government's rating can thus often trigger additional downgrades of the ratings of other firms in the economy.

17 See https://www.cnb.cz/en/financial-stability/stress-testing/public-finance-sector/

18 For example, in the event of equity market turbulence, the media may focus primarily on the hardest hit sectors and on the losses of households with investments in those sectors. Influenced by this information, households with more conservative investment strategies may temporarily withdraw funds from investment products even if their portfolios have been affected only moderately by the turmoil and even if they would have considered the loss to be immaterial had they not been influenced by the information channel.

VI. CONCLUSION

Interconnectedness is an important element of the structural dimension of systemic risk. Monitoring network risk and evaluating the risk of contagion in the financial system is therefore an integral part of caring for financial stability and is also an input into stress tests of financial institutions. This thematic article offered a closer look at direct and indirect interconnectedness and at the channels through which a shock can be amplified in the Czech financial system (contagion).

Banks play a key role in the direct interconnectedness of the Czech financial system. This significant position is due to their strong network links to individual financial sectors, primarily through deposits. The Czech banking sector also has strong ownership links to foreign parent companies and domestic subsidiaries. All these links can constitute a channel of shock transmission inside the system.

The indirect interconnectedness on the liability side of financial institutions' balance sheets arises mainly in relation to the allocation of households' funds. Households may reallocate their funds in response to a decline in income or wealth or a deterioration in sentiment, and that in turn may cause contagion within the financial system. However, the recent experience with households' reaction to financial market turbulence indicates that the degree of contagion caused by the change in their behaviour was low.

The wide range of forms of indirect interconnectedness on the asset side of domestic financial institutions' balance sheets is closely linked with Czech government bond holdings. Given the relatively high share of foreign investors in Czech government debt holdings, the price volatility of such bonds could increase. A sudden drop in Czech government bond prices could affect the solvency and liquidity position of financial institutions that have a high proportion of such bonds in their investment portfolios, potentially further amplifying the decline in prices. Sovereign risk, together with excessive concentration risk, also reflects the link between the health of public finances and the health of the financial system. In the event of rising sovereign credit risk, this strong link could result in a deterioration in the perceived riskiness of government bond holders and thereby contribute to a change in sentiment, acting as an additional channel of indirect contagion.

The findings regarding interconnectedness and the potential contagion scenarios outlined above argue for extending the macro-stress tests of certain sectors of the Czech financial system to include the structural component of systemic risk. In this regard, the CNB is currently working on incorporating the direct linkages between financial institutions. It is also expanding the fire sale-testing model used in the macro-stress test of investment funds in 2020 (CNB, 2020).

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APPENDIX

Chart A.1: Securities holdings broken down by issuer's economic activity
(% of total volume; data as of 30 June 2020)

Banks   **IFs**   **Insurance companies**   **PFs**
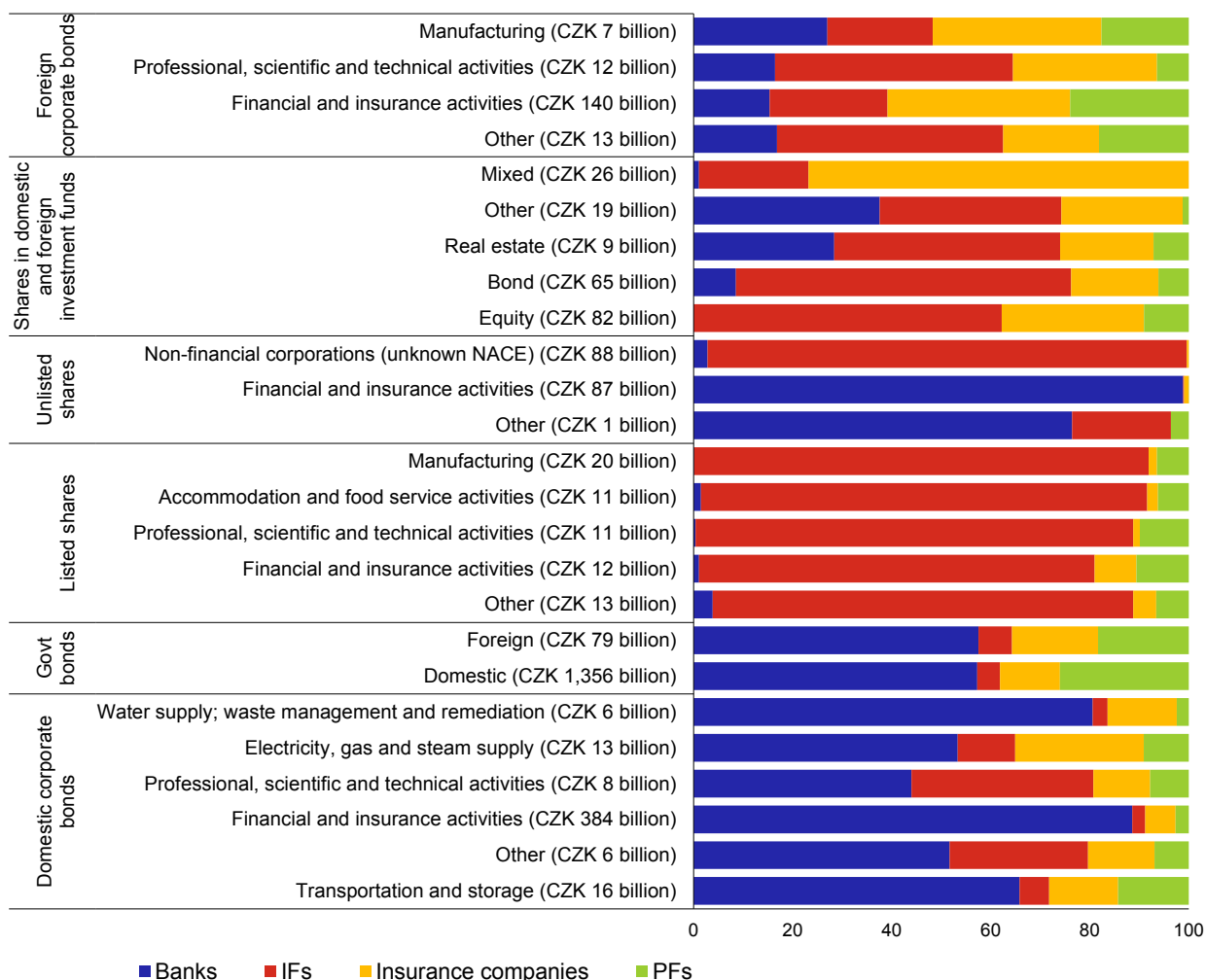
Source: CNB

Note: "Bonds" means long-term debt securities (F.32 in ESA2010). Breakdown of economic activities by CZ-NACE code of issuer where available. "Other" comprises sectors of various activities with a total volume of less than CZK 5 billion. Figures in parentheses represent the total volume across all monitored sectors of the financial system. Listed and unlisted shares comprise both domestic and foreign securities.