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Credit Risk of FX Loans in Poland. Debt Service Burden and the Effect of Neutralization of Currency Depreciation by Foreign Interest Rates

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Abstract

This paper describes an analysis of the effects of both foreign exchange (FX) risk and interest rate risk on installments of the housing FX loan using classic comparative statics approach. By focusing on sensitivity of annuity with respect to infinitesimal changes of parameters it presents the impact of the interest rate and FX rate on installments in terms of their shares of the total outstanding in foreign currency, and illustrates using values, in Polish zlotys, for three example loans extended during the period when Poland saw its most intensive FX lending. This analysis represents an attempt to answer a question frequently raised in this country of late: does the issue of debt servicing housing FX loans matter for borrowers and therefore could affect banks' loan portfolio quality?

Keywords: credit risk, housing FX loans, FX lending, debt service

JEL Classification: G21, C02

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1 Introduction

The problem of FX lending strongly affects the Polish banking sector. Although this type of lending has slowed almost to a halt, in large part due to the recommendations of the Polish Financial Authority (KNF), a relatively large portfolio of these loans remains on banks' balance sheets and is serviced by borrowers who are exposed to FX risk and interest rate risk. Nearly 35% of all loans to the nonfinancial sector are denominated in foreign currency. Uncovered FX risk exposure for households will last for many years because it mainly comes in the form of housing loans (i.e., 25% of total loans). Therefore, so long as Poland uses its own currency, credit risk could remain for up to 20 years (more information in FSR of National Bank of Poland i.e. 2012, 2013, 2014).

Most of Poland's mortgage loans were extended when the value of the Polish zloty (PLN) was at historic highs (2006–2008). At the time, new loans were denominated mainly in Swiss francs and, to a lesser extent, in euros, with interest rates based on LIBOR 3M CHF or EURIBOR 3M. Since early 2009, when the zloty depreciated by more than 30%, reverse dependence on the FX rate and interest rate of FX loans has helped Poland avoid the materialization of credit risk in its banking system. What remains in question is how long this reverse dependence will hold.

The goal of this paper is to break down the effects of both FX risk and interest rate risk on installments of the housing FX loan using the first derivatives calculation. Such a tool allows one to decompose installment variability to the interest rate and FX rate effect, offering better control over the borrower's risk of default. The following analysis will attempt to answer a question frequently raised in Poland of late: does the problem of debt servicing of housing FX loans matter for borrowers?

Such approach can be classified as standard comparative statics, very commonly used in mathematical economics to report sensitivity of results with respect to infinitesimal changes of parameters in related variables. Very similar approach can be also found in mathematical finance, in case of sensitivity analysis of the price of derivatives such as options to a change in underlying parameters on which the value of an instrument or portfolio of financial instruments is dependent (so called 'Greeks').The most common 'Greeks' are first-order derivatives. Such measures allow to treat component risks in isolation in order to rebalance investment portfolio accordingly to achieve a desired exposure. Elementary approach to 'Greeks' can be found for example in Hull 2015, Alexander 2008 and more sophisticated applications in Dillman and Harding 1985, Pellser and Vorst 1994 and many more.

The contribution of the paper is an application of such approach to the problem of analyzing sensitivity of the FX credit risk in case of FX banking loans. To the best of our knowledge, this paper is the first attempt to investigate the sensitivity of FX credit burden to underlying parameters on which an installment of such loan is dependent.

Anecdotal evidence on FX housing loans in Poland suggest, that the value of loan installments did not raise significantly despite the depreciation of Polish zloty due to

decrease of interest rates. But this effect has not been quantitatively assessed yet, although the problem has been widely discussed in media. Therefore, we think, there is a need of measuring and comparing of both effects - the changes in installments connected with currency value with changes related to interest rates. If both effects (also cumulated) are almost equal, we can report the neutralization effect of currency depreciation.
The analysis is focused only on the debt servicing, i.e. how much the instalment burden has changed, also in real terms and regarding different vintages, for borrowers who took an FX loan.
In this paper we do not consider direct influence on lender's (banks) situation but indirectly, via conclusions on the households situation connected with lending burden. As the problem of FX lending is specific to the region, to the best of our knowledge not much literature exists on the subject (Haiss *et al.*, 2009; Brown and De Haas, 2010; Brown *et al.*, 2011; Wośko, 2013; and Financial Stability Reports of CEEC). Furthermore, few publications describe the tools necessary for monitoring the probability and the result of default on such specific types of loans (Glogowski, 2008). Therefore, both the subject of the analysis as well as the approach presented here are rather new.
The next section of this paper contains a short review of the phenomenon of lending in foreign currency across EU countries and section 3 includes the synthesis of the literature on the relationship between interest and FX rates that best explains the neutralization effect of both as it pertains to FX loans. Section 4 presents the methodology used to break down the borrower's installment relative to these two effects, and section 5 describes the results of applying the suggested tool to typical FX housing loans extended in Poland. Finally, the conclusions section will provide a summary of our key findings.

2 FX loans across the countries

The prevalence of foreign exchange (FX) loans differs significantly among countries in the European Union (EU). The share of foreign exchange (FX) loans held within the non-financial private sector is higher in central and eastern European (CEE) countries and Austria, while in most western European countries the instance of lending in foreign currencies accounts for a negligible share of total loans.
The currency structure of FX loans also differs across EU countries. In the majority of countries (i.e., Bulgaria, Latvia, Lithuania, and Romania), FX loans have been extended primarily in euros (EUR)— a natural choice given their EU membership—and, more specifically, exchange rates have been fixed to the EUR. In some countries, however, other currencies have dominated, particularly the Swiss franc (e.g., Austria, Hungary, and Poland).
In countries with a high share of FX loans, both households and non-financial corporations have been recipients. However, in countries where FX lending accounts

for a relatively low share of total loans, non-financial corporations tend to borrow more in foreign currencies than households. This outcome would seem intuitive and might be linked to the presence of export-oriented companies, as well as to those nations' degree of trade openness and characteristics specific to their trading partners.
Banks engaged in FX lending are exposed to indirect exchange rate risk (as a component of overall credit risk) due to the potential for currency mismatches on their clients' balance sheets. A significant depreciation of the local currency would translate into an increase in the local currency value of outstanding debt (and in the value of collateral), as well as in the flow of payments to service the debt. As a consequence, the debt-servicing capacity of unhedged domestic borrowers would deteriorate in such a scenario, thus leading to significant deterioration in the financial condition of the private sector. This reduction in borrowers' loan-servicing capacities and a correspondingly lower recovery rate will affect loan portfolio quality, increase banks' loan losses, and place pressure on earnings and capital buffers (see Gizycki, 2001, Kearns, 2004, and Glogowski, 2008 for examples of macroeconomic variables negatively impacting banks' loan losses). Hence, we can see that risks to financial stability are higher in countries where large stocks of FX loans have been granted to unhedged borrowers. These unhedged borrowers (i.e., those exposed to a currency mismatch) tend to be households and some non-financial corporations – such as small and medium-sized enterprises active in a country's domestic market - as their income is generally tied to the local currency.
Beginning in December of 2004, the share of total FX loan lending increased across all EU countries except Austria. At the same time, the share of FX deposits held in the non-financial private sector of these countries increased only slightly, or, in some cases, even declined (with the exception of Latvia, where FX deposits rose notably). These asymmetric changes in favor of FX lending could serve as an indication of rising currency mismatches on balance sheets within the non-financial private sector.
In the mentioned above CEE countries, FX loans have been financed, in large part, by cross-border borrowing in the form of credit lines opened with parent institutions residing in other parts of the EU. These loans were mostly denominated in or indexed to foreign currency with funding in (or transformed into) foreign currency. However, borrowers received their loans in local currency. This means that institutions were selling FX funds, sourced from parent companies or wholesale markets or received under swap contracts, on the spot market, and this exerted an upward pressure on domestic currencies.
The causes of FX lending growth were almost the same in all mentioned countries, and they are as follows (see Haiss *et al.*, 2009; Brown and De Haas, 2010; Brown *et al.*, 2011).

> There is a lower stage of development within national capital markets in CEE countries (compared with euro area countries). Specifically, the relative scarcity of longer maturity local currency debt instruments – which could serve as pricing benchmarks or be used to raise long-term funding – might have discouraged

institutions from engaging in long-term local currency lending. The high costs of securitization for domestic currency instruments represented another factor, as it motivated banks to obtain their own funding for mortgage loans held in foreign currency.

Financing within an international financial group, which offered a relatively cheaper source of funding.

Significant interest rate differentials. One of the characteristics of economies undergoing the catching-up process is a higher equilibrium interest rate due to higher potential GDP growth. Borrowers preferred FX loans because of their lower cost, while institutions benefitted because they could set higher profit margins and fees compared with domestic currency loans and, thereby, improve their financial results.

3 The relationship between foreign interest rates and currency movements

In countries using the fixed/pegged regime, the exchange risk of FX loans has not materialized over the course of the recent financial crisis, as local currencies have retained their value and remain pegged to the euro. As a consequence, foreign exchange borrowers have not suffered from currency devaluation and have instead benefited from EUR interest rate cuts. In countries with floating exchange rates, the impact of domestic currency depreciation has depended heavily upon the pricing regimes followed by banks offering different types of loans.

Interaction with changes in domestic exchange rates and foreign interest rates was the result of specific situations in advanced economies and in global financial markets during the crisis. Had domestic currency depreciation combined with a rise in foreign interest rates, the floating exchange rate countries would have faced increased risk of borrower default regardless of their credit pricing regimes.

Some conclusions can be drawn by observing the patterns of interest rate variability in developed countries and comparing them with developing countries' foreign exchange rates. As Wośko (2013a) observed, in times of economic contraction such as were seen in 2001 and 2002, when stock market indices were at lower levels, developing countries experienced currency depreciation followed by decreases in interest rates. The reverse was true in more prosperous times, such as in 2006–2007, when currencies appreciated, followed by interest rates.

Wośko (2013a) suggested that the reverse correlation between the FX rates of emerging economies and the interest rates of advanced economies in the past might be explained by risk aversion. According to her hypothesis, when economies in global financial markets are dependent on one another, global recessions increase risk aversion and emerging economies' currencies (with floating FX rates) depreciate.

In advanced economies, on the other hand, recessions result in lower interest rates. The theory of real interest rate parity does not explain, and does not account for this reverse dependence. This theory suggests that real interest rates will equalize between countries and that capital mobility will result in capital flows that eliminate opportunities for arbitrage. Recent research on interest rate parity in emerging economies can be found, for example, in the work of Ferreira and Leon-Ledesma (2007), Singh and Banerjee (2006), Alper, Ardic and Fendoglu (2007), and Skinner and Mason (2011). The interest parity theory addresses the relationship between interest rate and FX rate, but not between foreign interest rate and FX rate, making inferences on the basis of the theory difficult.
Nonetheless, according to the interest rate parity theory, ceteris paribus, changes in the foreign interest rate influence the FX rate as described above.
Wośko (2013a) described the statistical assessment of certain characteristics of dependence between the interest rate of FX loans in Poland and the FX rate of the zloty against the Swiss franc (CHF) and euro using simple dependence measures as well as a copula approach. The sample considered included daily observations from July 2001 to April 2012, which revealed a relatively strong reverse dependence on the part of the zloty against Swiss currency and LIBOR 3M CHF. PLN/EUR and EURIBOR 3M dependence was relatively weaker, with the relationship reversed.
However tail (reverse) dependence was stronger in case of PLN/EUR and EURIBOR 3M (upper tail), which means that in times of high interest rates and relatively strong Polish currency, the variability of both series showed similar patterns.
These results are rather ambiguous. On the one hand, symmetry of tail dependence in cases using estimated copulas for LIBOR CHF – CHF/PLN supports the idea of an economically justified reverse relation. Yet, a zero value for tail dependence measured using the best fit copula indicates higher possible losses when it comes to CHF loans (no adverse effect of FX and interest rate). A more optimistic view, from a credit risk perspective, can be seen with the relationship between the EURIBOR and the EUR/PLN rate. A relatively strong adverse effect between the FX and interest rates in times when the zloty is weak would reduce the credit risk.

4 The effect of interest and FX rate movements on FX housing loans' installments – methodology

Our analysis assumes that a loan is serviced according to the schedule and until the end of the contract that was fixed from the outset. This means that there are no prepayments. However, interest and currency rates both influence borrowers' decisions regarding prepayments of the loan (see, for example, Green and Shoven, 1983).
The more popular type of debt servicing is annuity, where installments are equal. In the case of an FX loan with a floating interest rate, equal payments in foreign currency are made until the interest rate changes. When this occurs, the schedule

for future instalments is recalculated. Despite starting with higher interest payments rather than repayment of the capital, making for a less cost-effective loan, households prefer this type of schedule because household members' incomes do not change much from month to month. The annuity formula for an FX loan given in national currency can be written as follows (although an installment number is a discrete variable but is associated with a time, which is a continuous variable, moreover, according to Lagrange theorem, the increases in discrete variable can be well approximated using the derivative):

$$f(x,r,n,m) = Vx\left(1+\frac{r}{m}\right)^n \frac{\left(1+\frac{r}{m}\right)-1}{\left(1+\frac{r}{m}\right)^n-1} \tag{1}$$

where V is the value of the loan extended in CHF, x is the FX rate, with a value of 1 unit of foreign currency (CHF) in Polish zlotys (PLN), r is the interest rate, n is the number of installments, and m is the number of installments per year. For a constant m (usually $m = 12$), the total derivative can be described as the sum of partial derivatives as follows:

$$u(x,r,n) = \frac{\partial f(x,r,n)}{\partial r}dr + \frac{\partial f(x,r,n)}{\partial x}dx + \frac{\partial f(x,r,n)}{\partial n}dn \tag{2}$$

This formula is an approximation of the overall change of annuity in national currency over the given time period.

In the first step, let us assume no correlation between FX rate and interest rate. The partial derivatives' calculation of (1), omitting V and therefore considering the effect on the installment as the share of the CHF value of the loan, are as follows:

$$z_1(x,r,n) = \frac{\partial f(x,r,n)}{\partial r} \tag{3}$$

$$z_1(x,r,n) = \frac{x\left(\frac{r}{m}+1\right)^n}{m\sigma} + \frac{nrx\left(\frac{r}{m}+1\right)^{n-1}}{m^2\sigma} - \frac{nrx\left(\frac{r}{m}+1\right)^n\left(\frac{r}{m}+1\right)^{n-1}}{m^2\sigma^2} \tag{4}$$

where $\sigma = \left(\frac{r}{m}+1\right)^n - 1$

$$z_2(x,r,n) = \frac{\partial f(x,r,n)}{\partial x} \tag{5}$$

$$z_2(x,r,n) = \left(\frac{r}{m}+1\right)^n \frac{\left(\frac{r}{m}+1\right)-1}{\left(\frac{r}{m}+1\right)^n-1} \tag{6}$$

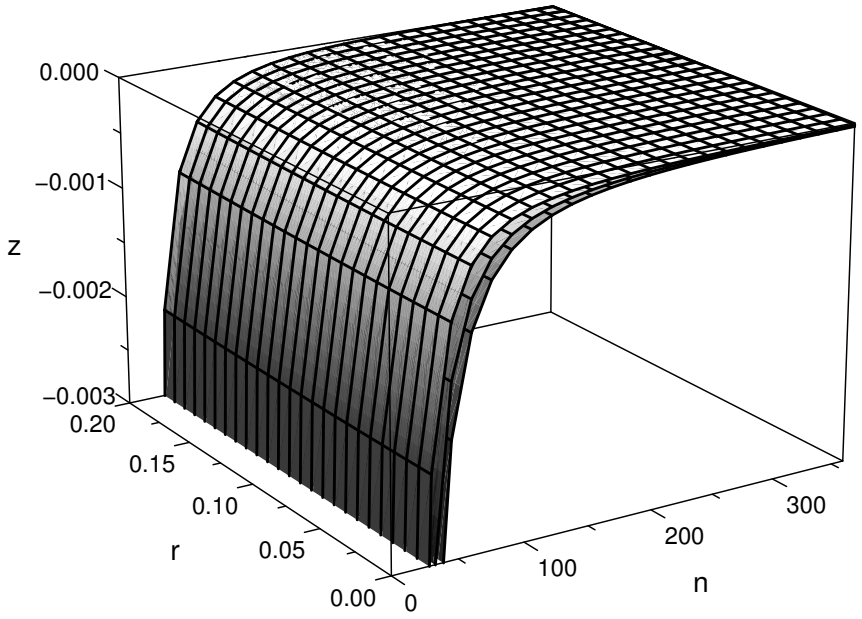
$$z_3(x,r,n) = \frac{\partial f(x,r,n)}{\partial n} \tag{7}$$

$$z_3(x,r,n) = \frac{rx\ln\left(\frac{r}{m}+1\right)\left(\frac{r}{m}+1\right)^n}{m\sigma} - \frac{mrx\ln\left(\frac{r}{m}+1\right)\left(\frac{r}{m}+1\right)^{2n}}{m^2\sigma^2} \tag{8}$$

As the influence of exchange rate is linear, the more attractive aspect of formula (1) is the influence of interest rate, which is not linear and contributes a less straightforward

effect. To understand this effect, one must first look at another variable — n, the number of outstanding installments.
The influence of n on the change of annuity value must be considered. In cases where a floating rate is used, this influence is not constant, as the interest rate changes (according to LIBOR or EURIBOR rates) each time the annuity is recalculated with a new value for n, as if the new loan were extended.
However, in the loan's first years, the influence of n is negligible compared to later years. In the case of a 30–year housing loan, this effect (i.e., the partial derivative on n) has an empirically visible result in the last decade for the last 100 installments (see the Figure 1).

Figure 1: The effect of n on the value of the installment, assuming $x = 2, \ldots, 8$

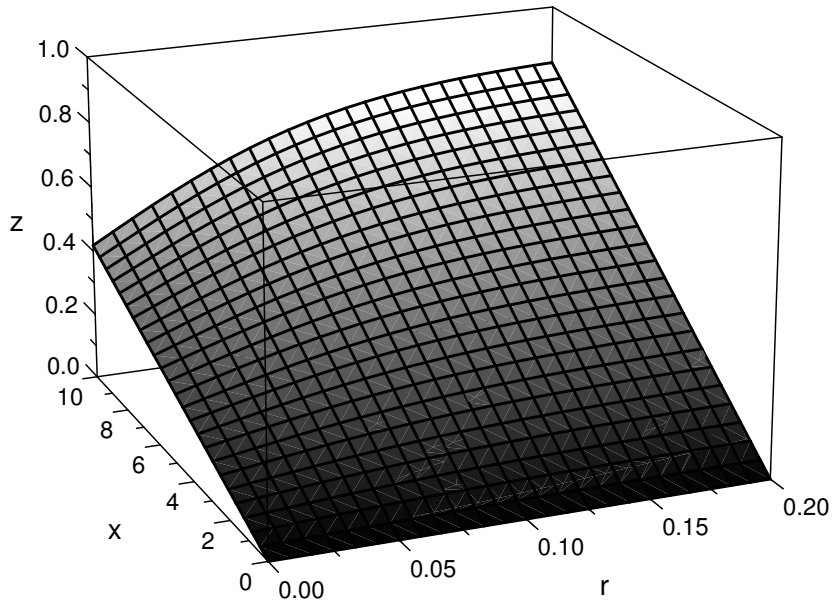


Note:
Variable z represents the change of the installment measured as a percentage of the loan's FX value (V). In the Figure, the level of interest rate (r) ranging from 0 to 20 p.p. seems to have no influence on z, but according to formula (8) the effect is minimal.

As this paper examines the decomposition of installments of FX housing loans, particularly those which were serviced beginning in 2006, and the analysis considers the first 10 years of the loan agreement, the effect of n can actually be omitted. Using this method, the effect of interest rate on installments can be presented as it is in

Figure 2. What happens when n decreases? After 10 years of debt servicing, such a function becomes more flat (see Figure 3).

Figure 2: The effect of interest rate on the value of annuity (in PLN). For simplicity, $n = 360$



Note:
Variable z represents the change of the installment measured as a percentage of the loan's FX value (V).

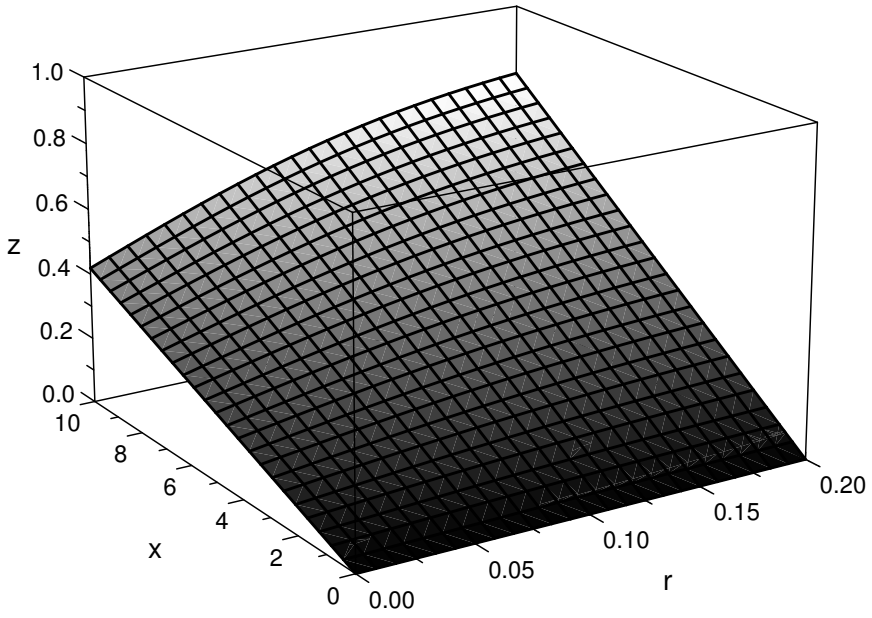
5 Historical decomposition of CHF housing loan installments

Our empirical analysis focuses on the period beginning in 2006, when a boom in housing loans denominated in Swiss francs occurred in Poland. Apart from annuity, we rely on several other assumptions:

Data on foreign interest rates (LIBOR CHF 3M) and exchange rates are sourced on the 15th of each month (or the following day, if the 15th is not a trading day) — see Figure 4;

No fees and commissions are included;

Figure 3: The effect of interest rate on the value (in PLN) of annuity. For simplicity, $n = 240$



Note:
Variable z represents the change of the installment measured as a percentage of the loan's FX value (V).

No exchange spread is included;

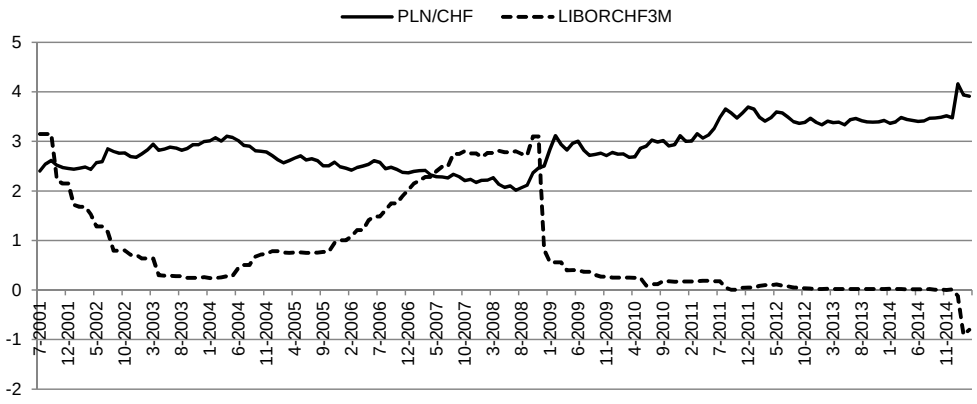
Nominal data are used (inflation not considered);

Margins are calculated based on the interest rate statistics of the National Bank of Poland;

No discount rate is included (change in time of the value of cash flows).

Interest rate and foreign exchange rate data are presented in Figure 4, which shows the highest FX risk occurring in the last quarter of 2008 and the first quarter of 2009. Throughout this time a sudden depreciation of Polish currency was followed by a significant decrease in the LIBOR CHF 3M interest rate.
Figure 5 shows the decomposition of monthly changes in the value of installments according to formula (4) and (6) as a percentage of the total outstanding, assuming the beginning of the loan agreement (i.e., the first 10 years). This graph represents all CHF housing loans as well as hypothetical loans that could be extended over the given period.

Figure 4: PLN/CHF exchange rate and LIBOR CHF 3M monthly



Source: Reuters.

However, it is difficult to draw the conclusions about credit risk basing only on general formulas. Therefore more concrete results are presented in Figures 6, 7 and 8, which assume three typical loans extended year by year. Decomposition is measured in PLN, which means that the total change of the installment from month to month is decomposed to the part of FX effect in PLN and interest rate effect in PLN. The results here confirm, as expected, that the effect of interest rate is infrequent but quite significant when it does appear. The effect of the FX rate can be seen almost every month and is variable, with many periods lacking a significant change but with a noticeably cumulative cost.

Comparing all three loans, the effect of mitigation of FX rate by the interest rate was most beneficial in the case of the second loan extended in 2007.

Cumulated effect of change in currency value calculated basing on formulas derived in chapter 4 compared to interested rate change effect is included in Table 1.

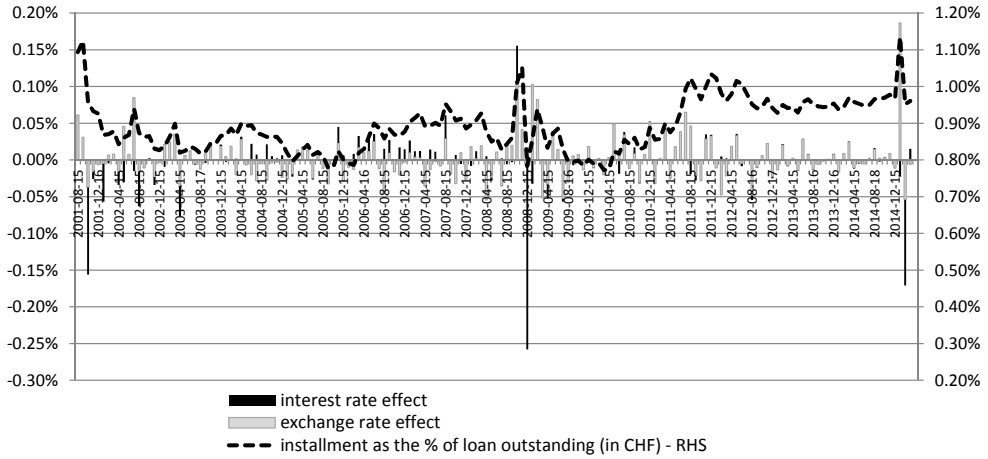
From the beginning of the loan agreement the recipient only had to pay 199.45 PLN more compared to the primary installment in the case of same month interest adoption. The effect of the interest rate is even more neutralizing in the case of a loan with next month interest adoption. This 2007 loan is still the most favorable when compared with the corresponding PLN housing loan (see Figure 9).

The worst-performing loan was the one extended in 2008. The Polish currency's historically high value at the beginning of this credit, together with the still relatively high interest margins of the loan, make it less favorable than comparable PLN loans (see Figure 9). However, there are exceptions, as in 2008 some banks offered margins as low as 0.9 p.p., which was not an option in other periods.

As Figures 5, 6 and 7 show, the value of installments of CHF housing loans has increased recently, and the relative value of these payments is dropping as average salaries gradually raise, increasing total household incomes (see Figure 10). Therefore,

despite the increased FX risk, the monthly burden on households remains relatively acceptable compared to previous periods.

Figure 5: Value of installments as percentage of total outstanding (in CHF). FX and interest effects on the change of the installments



Note:
FX and interest rate effects calculated based on partial derivatives. This presentation of the results (as percent of total outstanding) assumes the first installment ($n = 360$), no margin on LIBOR interest rate, and the interest rate of loan adopt immediately in the same month to LIBOR.

Figure 6: Example housing FX loan, extended in July of 2006, with typical terms for this particular period (PLN value of installment on left axis)

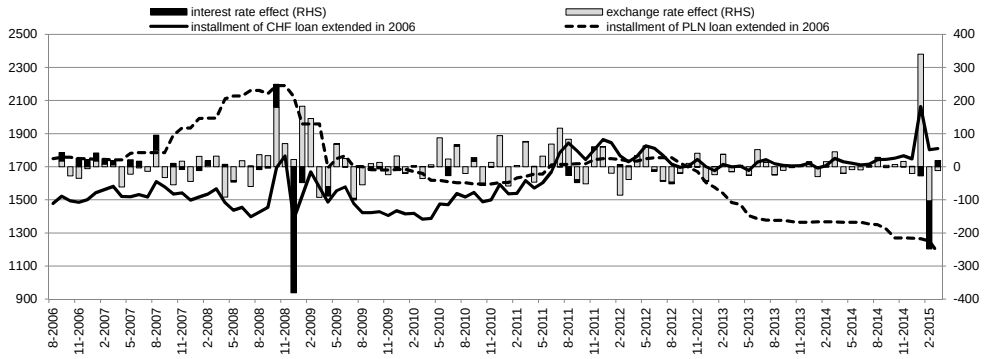


Figure 7: Example housing FX loan, extended in July of 2007, with typical terms for this particular period (PLN value of installment on left axis)

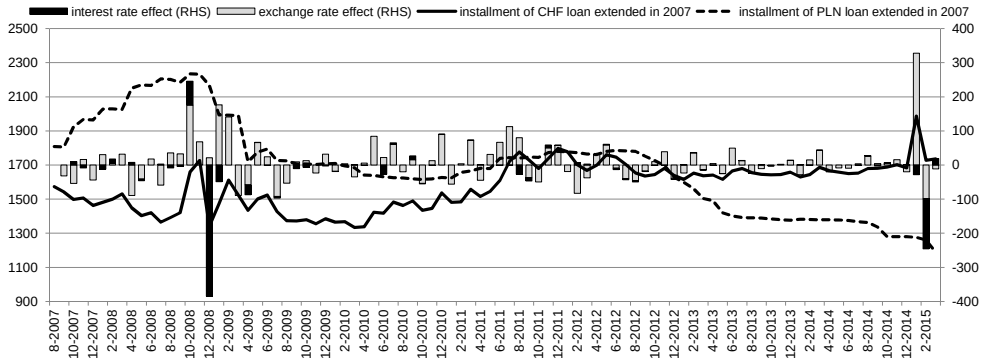


Figure 8: Example housing FX loan, extended in July of 2008, with typical terms for this particular period (PLN value of installment on left axis)

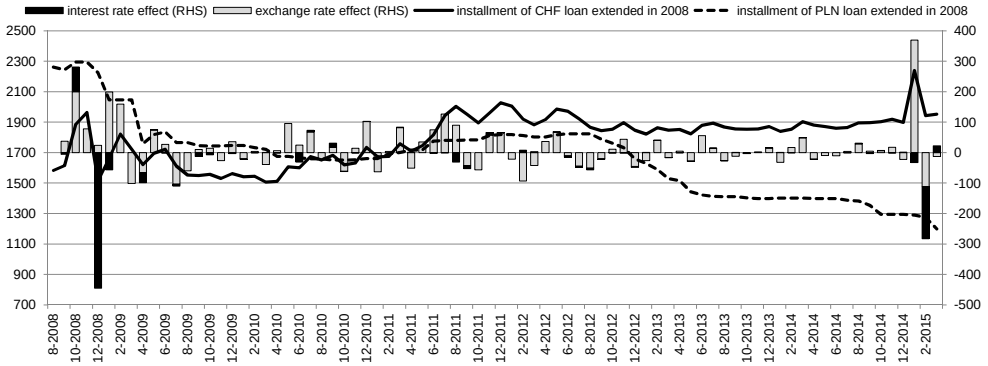


Figure 9: Accumulated installments of three typical FX housing loans, extended year-by-year and compared with the corresponding housing loan in PLN

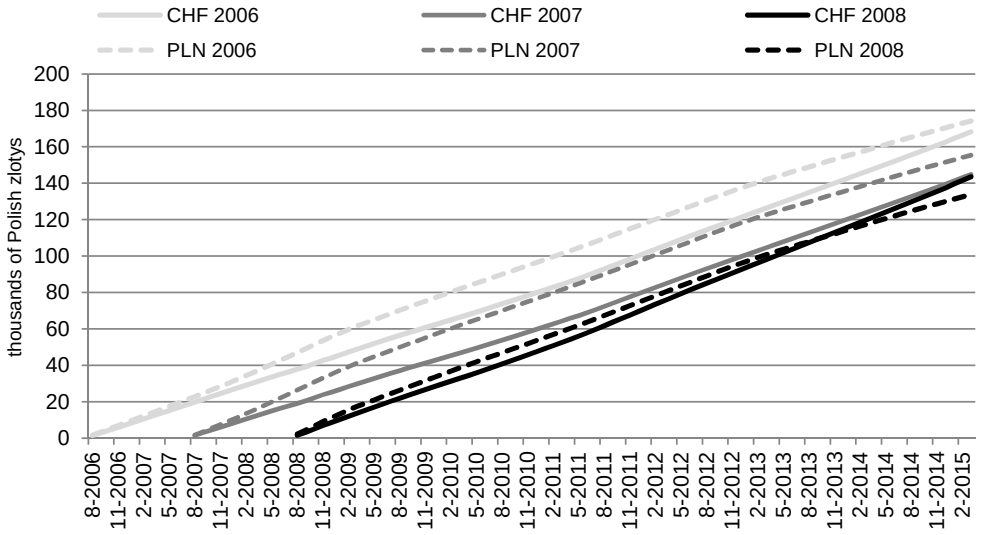


Figure 10: The value of the installments of three typical FX housing loans in relation to monthly average gross salary

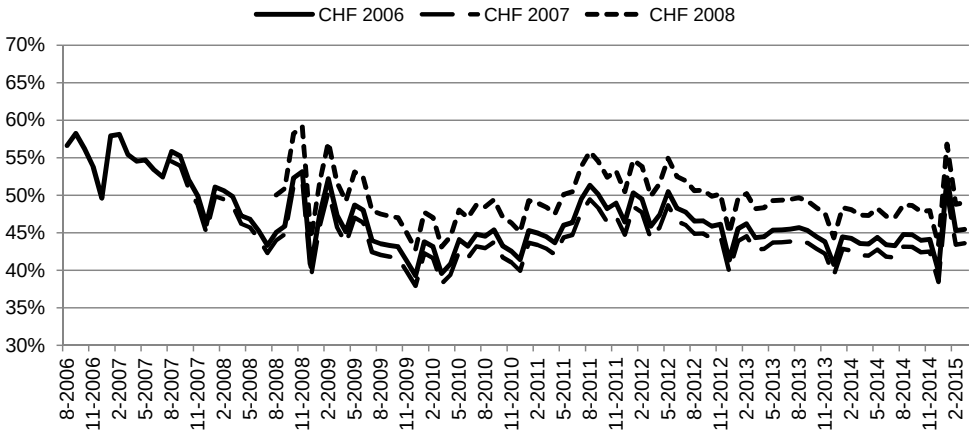


Table 1: Cumulated effect of the FX and interest rate effects in the case of three typical CHF loans extended year by year in Polish zlotys

CHF housing loans	Net effect of FX changes	Net effect of interest rate changes	Total effect
extended in 2006, same mth interest adoption	764.23	-439.74	324.49
extended in 2006, next mth interest adoption	660.07	-498.85	161.23
extended in 2006, after 2 mths. interest adoption	764.59	-137.97	626.62
extended in 2006, after 3 mths. interest adoption	868.78	-293.91	574.87
extended in 2007, same mth interest adoption	823.88	-624.43	199.45
extended in 2007, next mth interest adoption	826.56	-818.30	8.27
extended in 2007, after 2 $m$ths. interest adoption	885.19	-423.00	462.20
extended in 2007, after 3 $m$ths. interest adoption	929.54	-332.65	596.89
extended in 2008, same mth interest adoption	1139.58	-725.79	413.80
extended in 2008, next mth interest adoption	1141.14	-818.48	322.66
extended in 2008, after 2 $m$ths. interest adoption	1208.53	-442.80	765.74
extended in 2008, after 3 $m$ths. interest adoption	1256.81	-610.60	646.20

6 Conclusions

This paper presented an analysis of the effects of FX risk and interest rate risk on installments of housing CHF loans using first derivatives calculation. The effect of interest rate and FX rate on installments was presented as a share of the total outstanding in foreign currency and, in particular, as the value in Polish zlotys for three example loans extended in the period of Poland's most intensive FX lending.
The results gathered here confirm the idea that the effect of the interest rate is rarely an issue, as this rate hardly varies at all over some periods.
However, when it appears it is quite significant. The effect of the FX rate is seen almost every month without significant month-to-month variability over many periods but with a noticeable cumulative cost. Comparing all three loans, the effect of mitigation of the FX rate by the interest rate was most beneficial in the case of the second sample loan, extended in 2007. The least beneficial situation was seen with the loan extended in 2008.
Despite the recent increase in FX risk, the monthly burden on households remains acceptable compared to previous periods. However, the total outstanding in PLN has increased due to currency depreciation and a corresponding rise in absolute household debt, thus increasing the loan-to-value ratio. Therefore, the risk connected with FX loans remains a significant factor jeopardizing financial stability.

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