



Price dynamics in the Belarusian black market for foreign exchange[☆]



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ABSTRACT

Using unique data from an internet-based foreign-exchange trading platform, we show that the black market efficiently incorporated public information on the state of the Belarusian economy during the Balance of Payments crisis of 2011. Between May and October 2011, the government repeatedly devalued the Belarusian ruble and eventually abandoned its fixed exchange rate regime. Measures derived from black market transaction data have significant predictive power for these devaluations. The significance of these black market measures survives even when we include standard macroeconomic indicators in our forecasting model. In line with standard economic theory, activity in the black market has dried up subsequently.

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1. Introduction

We empirically investigate the interplay between black market and official exchange rates in Belarus. We use information from [Prokopovi.ch](http://prokopovi.ch), an internet platform that was launched in April 2011. [Prokopovi.ch](http://prokopovi.ch) allows Belarusian citizens to trade in a functioning two-way market which, as we show, incorporated publicly available information in an efficient manner. We were able to create a daily-level data set spanning a period of time which coincided with a currency crisis. An ongoing deterioration of the current account and diminishing official reserve assets in early 2011 led to increased dysfunction in the official foreign exchange market within Belarus, as banks increasingly refused to sell foreign currency at the official rates. Starting in May 2011, the Lukashenko regime repeatedly devalued the Belarusian ruble, and, in October 2011 finally abandoned fixed exchange rates that had significantly overvalued it. We use several statistical techniques to investigate how the official and black market exchange rates interacted during this

period. Our data suggest that the devaluations and the transition towards a free floating regime were anticipated by the black market.

Since buying or selling currency in a black market is, by definition, illegal, the participants in the web site could have been subject to prosecution by the police and the secret service. It would also have been possible for the government to manipulate postings, for instance through artificial orders at too high a rate. However, the web site's administrators are not aware of any, even anecdotal evidence of interference by the government. This is a common feature of black markets for foreign exchange: usually, they are tolerated by governments, which is why they are often referred to as parallel markets.

The course of events we describe over half a year mirrors what [Reinhart and Rogoff \(2004\)](#) observe for 153 countries over the half century that followed World War II. Fixed exchange rate regimes were an integral part of the Bretton Woods system, which had been agreed upon in 1944. However, the rigidities due to the Bretton Woods system led to the emergence of black markets. [Reinhart and Rogoff \(2004\)](#) showed that the rates in the black markets were predictors of devaluations. Free-floating exchange rate regimes have been in place since the collapse of Bretton Woods in 1971. But through interventions in foreign exchange markets, central banks still exert great influence on foreign exchange rates. Consequently, [Reinhart and Rogoff \(2004\)](#) argue that the labeling of the Bretton Woods period as one with fixed exchange rate regimes and of the current period as one with free-floating foreign exchange rates is misleading.

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The official decisions to devalue and to abandon the fixed exchange rate regime may have been affected by the source of our data. Contrary to Reinhart and Rogoff (2004), some of the existing literature on black markets for foreign exchange (e.g. Dornbusch et al., 1983) treats official exchange rates and interest rates as exogenous to black market activity. In the past, in certain settings, black markets may have been small enough to assume that their economic impact was negligible. But their role may have changed. There are two reasons why the decisions of policy makers in repressive economies have become more likely to be affected by activity in black markets. First, the internet has reduced the costs of transactions in black markets, leading to an increase in activity when the official rate is pegged. Second, the internet has made black market exchange rates observable to a broader public. Shortages of foreign currency indicated that the Belarusian ruble was overvalued, but the website made market-clearing values publicly available. This increased transparency seems to have reinforced people's doubts about the sustainability of the fixed exchange rate regime.

President Alexander Lukashenko has remained in power since 1994 on his mostly delivered promise of social stability and fast economic growth, achieved in part through the aggressive use of expansionary monetary policy. Central banks in industrialized countries have long used their control over short-term interest rates to stabilize the business cycle. However, such policies create economic distortions: not only do artificially low interest rates increase the medium-term risks of inflation, but they also represent a tax on savings and a subsidy on spending, which may lead to a misallocation of capital to potentially unproductive means. In repressive economies like Belarus, expansionary policies are typically used excessively and, given the rigidities related to central planning, ineffectively (Ding and Kovtun, 2010). Korosteleva (2007) describes the aim of Belarus' central bank as "maximizing seigniorage and inflation tax." While this bank has pursued an aggressive inflationary policy, it has, at the same time, tried to keep the country's currency stable on the foreign exchange market over an extended period. The fixed exchange rate significantly overvalued the ruble and distorted Belarus' trade balance, inducing a persistent current account deficit.

Growing activity in the shadow sector is often related to citizens feeling overburdened by restrictions imposed upon them by the state (Schneider, 2005). The emergence of a black market for foreign exchange is, therefore, only a logical consequence of Belarus' exchange rate policy and the resulting shortage of foreign exchange in the official market. The launch of Prokopovi.ch was likely beneficial for Belarusians as a whole: Rogoff (1998) mentions the possibility that the use of foreign currencies like the dollar or the euro may enhance efficiency because it offers greater price stability. However, he also mentions a potentially harmful effect: the possibility that if governments cannot use seigniorage anymore, they may resort to other, potentially even more distortive forms of taxation.

The paper is organized as follows. Section 2 describes the economic conditions in Belarus and the Belarusian foreign exchange policies during the time period under investigation. Section 3 describes the data sets used and summarizes the main features of the data. Section 4 investigates the time series properties of the underlying data and analyzes possible causal relationships between the time series. Section 5 discusses the results and concludes the paper.

2. Background

Along with fellow non-reformer Uzbekistan, Belarus was the only former Soviet economy that did not contract in the 1990s when the supply of financial resources allocated to heavy industry slowed (Shleifer and Treisman, 2005). The other transition economies of the former Soviet Union declined sharply after the collapse of the Soviet Union, although they have been expanding rapidly since around the year 2000. Belarus' centrally planned economy is still characterized by an emphasis on heavy over light industry and on industry over services (Ickes and Ofer, 2006).

The worldwide financial crisis has had a profound impact on Belarus' economy (Ding and Kovtun, 2010; Korosteleva, 2011; Ioffe and Yarashevich, 2011). After several years of rapid economic growth fueled by cheap, subsidized Russian energy imports, the country ran into severe troubles in late 2010 and early 2011. Several shocks in short order led to a currency crisis in the first half of 2011. First, following a year-long dispute over the price charged for its oil exports, Russia temporarily suspended oil shipments on Jan 1, 2011. In 2010, oil imports from Russia had totalled around 20 million tons, only seven of which were consumed domestically, while the rest was refined and sold in Western Europe, in particular to Poland and Germany at enormous profits, providing much-needed hard currency inflows. Second, as a consequence of the world-wide economic slowdown, the international demand for the heavy machinery that makes up a significant share of Belarus' exports collapsed. These economic problems were compounded by lavish public spending prior to the 2010 presidential election aimed at securing Lukashenko's reelection.

As a result foreign currency reserves fell to around \$3.8 bn and the current account deficit widened to 16% of the GDP. Following this substantial loss of reserves in the beginning of 2011, a heavily depreciated black market exchange rate emerged (Husain and Arora, 2012). In May 2011, Russia decided to keep Belarus afloat with a \$3 bn loan from the Eurasian Economic Community (Korosteleva, 2011), but at the cost of transferring the ownership rights to the all-important pipeline used to transport Russian gas to Western Europe, by some accounts the only strategic asset of the country. Following the disputed election of December 2010, Lukashenko's violent crackdown on protestors spoiled relationships with the U.S. and E.U., making it difficult for him to turn to them for help.

As noted by Zlotnikov (2011), in the beginning of 2011, the National Bank of the Republic of Belarus (NBB) tried to lessen public demand for foreign currency by limiting the access of private agents, and especially small- and medium-sized enterprises, to available cash. Although President Lukashenko insisted that foreign currency reserves would be sufficient to meet household demand, the broader public had begun to expect that there would be a devaluation coming. The Belarusian ruble exchange rate was maintained within 2% of its fixed value. Despite increasing expectations of devaluation, the regime announced that previously existing restrictions on foreign exchange trading would be lifted as of April 1, 2011. However, this proved infeasible. Due to the inevitable depletion of foreign exchange and gold reserves, on March 22, 2011, the NBB froze the sales of foreign currency to private agents and commercial banks. Despite the obvious shortage of foreign currency the devaluation could be avoided until May 24. On this day, Belarus devalued the ruble by 36% from 3156 to 4931 rubles per US dollar. Husain and Arora (2012) note that even after the first devaluation, a parallel (black) exchange market persisted, giving rise to a multiple exchange rate system. The first devaluation was followed by several adjustments for foreign exchange rates. The second devaluation occurred on September 21, 2011, when the ruble was brought down from 5413 to 7975. Over the preceding two weeks, the ruble had already fallen from 5220 to 5413. This second devaluation was announced two weeks in advance: on August 30, 2011, President Lukashenko said that the change would be implemented via special trading sessions at the currency exchange, which would kick off on September 12 (devaluation was, however, not allowed before September 21). The exchange rate would henceforth be "determined by supply and demand, like any other product."¹

During the special trading sessions, banks and companies were able to buy and sell foreign currency without limitation and banks were obliged to sell foreign currency to the population at the same rate. In addition, a separate preferential rate was applied to energy payments in ordinary trading. The NBB used the special foreign exchange sessions

¹ See <http://telegraf.by/en/2012/02/lukashenko-500-dollarov-eto-sovsem-nizkii-uroven-zarplat> and http://www.belta.by/ru/all_news/president/Kurs-beloruskogo-rublja-budet-opredeljetsja-sprosom-i-predlozheniem-Lukashenko_i_569998.html.

to test demand for the ruble to find the appropriate exchange rate level. This was not a de facto free float but an attempt to legalize the quasi-legal exchange that had flourished in the weeks before. The official exchange rate was not entirely flexible until a final adjustment that occurred on October 12, when the rate was moved again from 7720 to 8750. On October 20, Belarus finally officially integrated the foreign exchange market segments and moved the preferential exchange rate for energy payments to a full market free float. The market rate on that day was 8680, 52% weaker than the previous day's preferential rate had been. In April 2012, the ruble was trading at around 8070, and thus had stabilized in the floating exchange regime. It had actually gained around 10% since the all-time low of 9010 rubles to the dollar in mid-October 2011.

3. Data

For the empirical analysis we use data on exchange rates of the Belarusian ruble (BYR) versus three foreign currencies, namely the US dollar (USD), the euro (EUR) and the Russian ruble (RUB), from three different sources. The first source is the National Bank of Belarus (NBB).² The official NBB website provides official exchange rate data of the BYR versus foreign currencies set by the NBB on a daily basis. The second source of official exchange rate data is Bloomberg. Finally, the source of our black market data is the website Prokopovi.ch. The website Prokopovi.ch, named after Petr Prokopovich, then chairman of the NBB (Prokopovich lost his position in July 2011), was setup in April 2011.

People wanting to buy or sell foreign currency could post their ads on Prokopovi.ch. In these ads, they could specify the currency, the amount, the rate at which they want to trade, and the city. Potential trading partners could see these quotes and, after typing in a CAPTCHA code,³ contact the poster to arrange a meeting. The trade could take place anywhere. It should, however, be mentioned that very often it took place in official currency-trading booths – nominally at the official rate but including side payments. Unfortunately, we have no information about what happened after the quotes were posted and do not know whether actual transactions took place, i.e. in contrast to other financial markets, quotes were not enforceable.

The over-the-counter nature of foreign exchange markets makes it difficult to compare the sizes of the official and black markets. Additionally, the fact that we do not observe actual transactions in the black market but only posted quotes makes it even more difficult to determine the size of the black market. To assess the size of the black market, we use the information from May 19, 2011, on which black market activity via Prokopovi.ch peaked. Quotes posted by private individuals to trade dollars for Belarusian rubles or vice versa in Minsk added up to a volume of \$7.6 million. Multiplied by that day's black market exchange rate of 6769 Belarusian rubles per dollar, we get a volume of 51.6 billion Belarusian rubles. Together with the quotes for euros and for Russian rubles, the volume in the black market on May 19 was 64.8 billion Belarusian rubles. Since posted quotes do not necessarily coincide with actual transactions, and black market activity was highest on that day, this number can only serve as an upper bound for actual trading volumes. To gauge the size of the official foreign exchange market we use the Annual Report 2011 by the Belarusian Currency and Stock Exchange.⁴ The report states an average daily trading volume in the currency market of 388.6 billion Belarusian rubles (page 11). This daily average obscures all possible variation that there may have been throughout the year. Given that the Belarusian ruble was very volatile in 2011, it does not give enough information to quantify the size of

the market for the time period during which the black market was operating. Furthermore, since we only consider trades between private individuals in the black market, what we would need as a comparison is those foreign exchange transactions on the Belarusian Currency and Stock Exchange that were made by private individuals. However, it is very likely that only a smaller fraction of the foreign exchange transactions on the Belarusian Currency and Stock Exchange can be attributed to private individuals. Although we cannot infer about the ratio of the black market to the official market based on these figures, they clearly indicate that the black market is not ignorable relative to the official market.

We have information on all ads that were posted between the launch of the website on April 22, 2011 and January 21, 2012. This includes 145,246 entries in total. Black market activity virtually collapsed after the move towards a free-floating exchange rate regime. In our analyses throughout the paper, we, therefore, only use time series until November 15, for which we have a sufficient amount of data. This leaves us with 205 daily observations, a time interval that includes all dates that are of interest (three devaluations and a regime change) and continues for nearly a month after the regime change.⁵ We also discard ads which were for transactions that did not involve exchanges between Belarusian rubles and euros, dollars or Russian rubles. The entries in the database include information on whether quotes were posted by individuals or by corporations. Ads posted by corporations were disproportionately made in Minsk and specified extremely high volumes. We only used quotes posted by individuals for our analysis. This left us with 138,016 entries. 123,369 or 89.39% of these entries are for transactions in Belarus' capital Minsk, even though it is home to less than a fifth of Belarus population.⁶ In the following, we will, therefore, focus on black market activity in Minsk.

Table 1 shows the numbers of quotes and total volumes of all quotes for all three currencies first for the whole country and then for Minsk only. Out of the 123,369 ads in Minsk, 92,139 (74.69%) involved exchanges between Belarusian rubles and US dollars, 15,868 (12.86%) involved exchanges between Belarusian rubles and euros and 15,362 (12.45%) involved exchanges between Belarusian rubles and Russian rubles. To make the volumes comparable, we converted Russian rubles and euros into US dollars using the exchange rates on April 22, 2011, which is the first day that we have data for. Since the volume of the quotes we observe in the black market for dollars is about eight times as high as in the markets for euros and for Russian rubles, we will concentrate on the black market for dollars. However, we also provide robustness checks using the other currencies in the online appendix.

For our analysis, we aggregated the black market exchange rates at the daily level. More precisely, we computed volume-weighted average exchange rates

$$\overline{XR}_t = \frac{\sum_{j=1}^{N_t} XR_{jt} q_{jt}}{\sum_{j=1}^{N_t} q_{jt}},$$

where XR_{jt} is the rate stated and q_{jt} is the quantity stated in the j th quote on day t . N_t is the total number of the quotes that are made on day t . Our data offer the possibility to distinguish between bid and ask quotes. Figs. B.3 to B.5 in Online Appendix B show daily volume-weighted average exchange rates for bid and ask quotes separately. The time series for bid and ask rates move together with a persistent positive spread, i.e.

⁵ The NBB assigned Mondays' official rates to the preceding weekends. Bloomberg does not provide exchange rates for the weekends. Therefore, we followed the same strategy as NBB to obtain observations of official exchange rates for each day in the Bloomberg time series, too.

⁶ While 19.3% of the Belarus population lives in Minsk, its share of Belarus' GDP was 24.8% in 2011 according to the Belarusian National Agency of Investment and Privatization. Online Appendix F shows additional descriptive statistics for activity in the country's six largest cities.

² See <http://www.nbrb.by/eng/statistics/rates/ratesDaily.asp>.

³ CAPTCHA is an acronym that stands for "Completely Automated Public Turing test to tell Computers and Humans Apart." A CAPTCHA code is meant to make sure that a response is generated by a person.

⁴ See http://bvfb.bcse.by/eng/2011_en.pdf.

Table 1
Descriptive statistics.

		USD	EUR	RUR	Total
Belarus	Number of quotes	101,885	17,756	18,375	138,016
	Volume (millions)	330.326	27.638	1,244.290	
	Volume (million USD)	330.326	40.248	44.418	
Minsk	Number of quotes	92,139	15,868	15,362	123,369
	Volume (millions)	310.251	24.407	1,071.189	
	Volume (million USD)	310.251	35.542	38.239	

Note: The data in this table cover all ads posted until November 15, 2012. Number of quotes, total volume of the quotes in terms of the requested currency, as well as the volume in USD are reported for Belarus and for Minsk separately. We used exchange rate between USD to EUR and RUR on April 22, 2011 to convert the volumes in USD. These exchange rates were 0.6867 euros per US dollar and 28.0130 Russian rubles per US dollar.

the rates for bids are higher than the rates for asks on most days in our data.

To examine how the daily range of quotes or volatility varies over time, we computed daily volume-weighted standard deviations

$$RANGE_t = \sqrt{\frac{\sum_{j=1}^{N_t} q_{jt} (XR_{jt} - \bar{XR}_t)^2}{\sum_{j=1}^{N_t} q_{jt}}}$$

In Fig. 1, the time series of the official exchange rate, the black market exchange rate, and the volume and range in the black market are shown for the time period from April 22, 2011 to November 15, 2011 for the US dollar (corresponding graphs for the euro and the Russian ruble can be found in Online Appendix A). Black market premia are stable in the absence of new information and increase in anticipation of future devaluations, which suggests that the black market operates efficiently (Dornbusch et al., 1983). The Bloomberg data and the NBB's official exchange rates are almost identical until September 21, 2011.

With the implementation of “special sessions as well as ordinary ones” as explained in the previous section, they deviate from each other. The rate during one session was allowed to operate under a managed float exchange rate regime to test supply and demand. This session is captured by the Bloomberg data, which can be seen by the convergence of the black market rates and the Bloomberg data during the one-month period during which two sessions existed. After the introduction of a free-floating exchange rate, the three series start to move together.

At the beginning of our sample period on April 22, 2011, there is a noticeable difference between black market rates and official rates. Before the first devaluation on May 24, 2011, we observe spikes in both volume in the black market and black market exchange rates. A bit before the devaluation, the two spikes, however, recede a bit. It may be that, based on available information, the black market initially overestimated the extent of the upcoming devaluation. Volume thereafter fluctuates between around one and three million US dollars per day until the announcement of the two-session system on August 30. Starting with the introduction of the two-session system in the foreign exchange market on September 12, the transaction volume gradually decreases and, as expected, falls to almost zero with the introduction of the free-floating exchange rate regime. The black market exchange rates, however, stay higher than official rates after the first devaluation because the devaluation fell short of the required adjustment implied by black market rates at the time. Another jump in the black market exchange rates occurred during the days before the announcement of the two-session system. The jumps in black market exchange rates before the devaluations suggest that the market participants anticipated the devaluations.

Reinhart and Rogoff (2004) provide evidence that proxies for the size of the black markets relative to the official markets are positively correlated with the size of the black market premia. We observe a similar pattern for the volumes of quotes posted on Prokopovi.ch (compare Fig. 1). The period before the second devaluation in September 2011 is an exception: black market premia went up, but activity did not. Since it

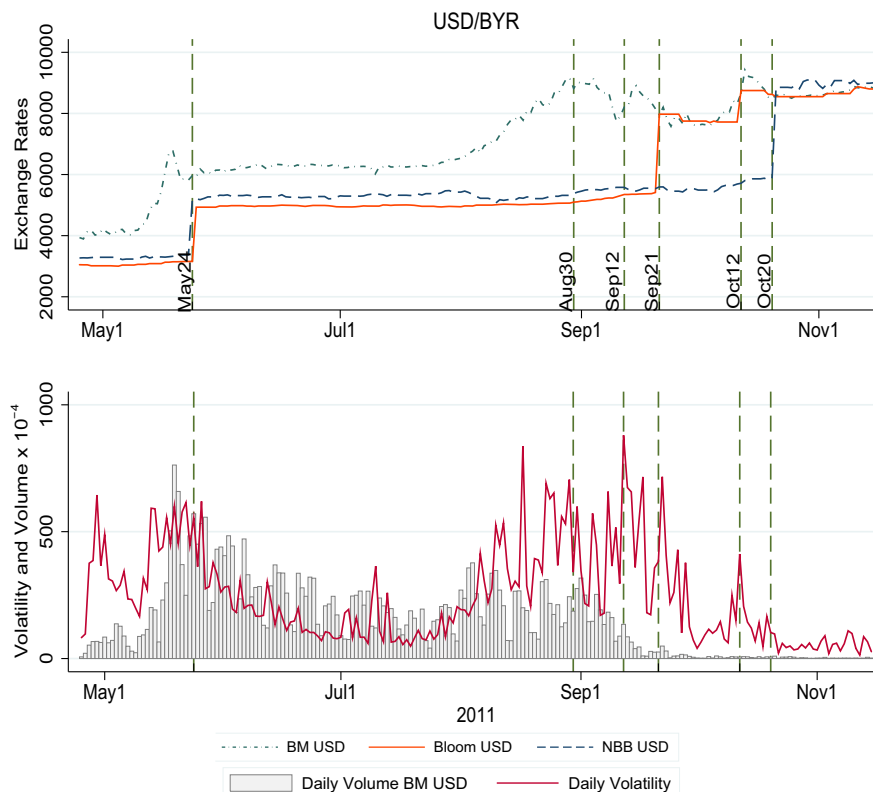


Fig. 1. Daily exchange rates, volumes and ranges for the US dollar.

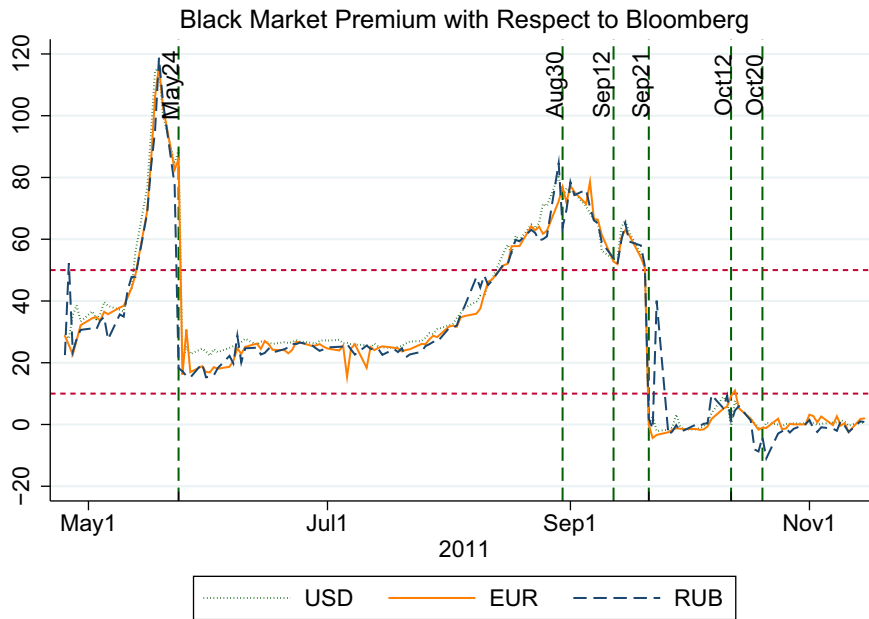


Fig. 2. Black market premia in percent with respect to Bloomberg official exchange rates.

had been announced two weeks before that a free floating system would be installed, users seem to have postponed their activity to trade later on in the official market.

Another way of describing the black market rates with respect to the official rates is to look at the black market premia as in Reinhart and Rogoff (2004). Reinhart and Rogoff classify black markets into three different categories according to the sizes of the black market premia: they classify under 10% as low, between 10% and 50% as moderate and 50% and above as high. Fig. 2 plots the black market premia for three currencies in Belarus with respect to Bloomberg foreign exchange rates over the period under consideration.⁷ According to Reinhart and Rogoff's classification, black market premia in Belarus were "moderate" most of the time, and became "high" just before the devaluations. They vanished entirely with the implementation of the free-floating system.

4. The relation between black and official markets

In economies with price controls it is common that black markets emerge as parallel markets, in which people are able to trade at rates that differ from official rates. The reason why black markets emerge is excess demand for the good whose price is regulated. This is also what happened in Belarus' foreign exchange market before the website was launched. Ioffe and Yarashevich (2011) note that demand for foreign currencies exceeded supply at the official rates right before the website was launched: "Belarusian banks [...] reported a shortage of hard currency. In late March 2011, hard currency altogether disappeared from the country's exchange outlets, whereupon the end of unobstructed access to hard currency provoked a consumer panic with Belarusians promptly stocking up on such necessities as sugar, salt, and vinegar." Since, for regular Belarusians, it had become difficult to trade in the official market at official rates, the emerged black market acted as a substitute to the black market.

Economically, however, black markets are not only relevant as substitutes for official markets, Reinhart and Rogoff (2004) show that in most of countries that enacted price controls (pegs) in the foreign exchanges market after WWII, black market exchange rates were better indicators of monetary policy and economic conditions than the official

foreign exchange rates were. This made black markets an indirect factor for exchange rate-setting behavior.

Following Reinhart and Rogoff (2004), we perform probit regressions in which we regress dummies (which are equal to one during the seven days before the three devaluations and zero otherwise) on two different sets of variables. The first set of variables consists of average black market premia, average volume, average range and the average bid-ask spread during the preceding seven days. We use the black market premia with respect to the Bloomberg and NBB exchange rates separately. The corresponding estimation results of this specification are given in columns (1) and (3) in Table 2. The two estimation results are qualitatively very similar but quantitatively slightly different. The estimated coefficients indicate that black market premia and range are positively correlated with upcoming devaluations, whereas volume is negatively correlated with upcoming devaluations. The coefficient on black market premia is, however, not always statistically significant. The negative sign on the effect of volume is probably due to the decrease in black market activity after the announcement of the free-floating regime and the special trading sessions with two segments in the official exchange rate market on August 30. The spread is not statistically significant in most specifications, which is not surprising given its stability.

Note that, since black market premia depend crucially on official exchange rates, the dependent variable in our probit regressions is to some extent defined based on one of the right-hand side variables. This does not imply that black market premia have explanatory power by construction (black market rates might jump simultaneously). But it is remarkable that black market volume and range display even higher levels of statistical significance than black market premia. Robustness checks for the less active black markets for euros and Russian rubles can be found in Online Appendix C. In the market for Russian rubles, black market premia are the most significant predictors of upcoming devaluations.

The question arises whether the black market just captures information that is available in other fundamental data. To investigate this question, in specifications (2) and (4) of Table 2 we include four macroeconomic variables in our probit regressions: (i) the lagged refinancing rate (Refinancing Rate), (ii) the lagged value of monthly growth rate of balance of payments (BOP), (iii) the lagged value of monthly GDP growth rate (GDP) and (iv) the lagged value of the

⁷ Fig. C.6 in the Online Appendix presents the black market premia with respect to NBB exchange rates.

Table 2
Probit estimation results.

	Premia w.r.t. Bloomberg		Premia w.r.t. NBB	
	(1)	(2)	(3)	(4)
7d premium	−0.072 (0.72)	20.806* (11.65)	17.807*** (4.14)	21.108* (11.43)
7d volume	$-3.7 \times 10^{-7***}$ (0.00)	$-4.5 \times 10^{-6**}$ (0.00)	$-1.99 \times 10^{-6***}$ (0.00)	$-4.5 \times 10^{-6**}$ (0.00)
7d range	0.004*** (0.00)	0.037*** (0.00)	0.001 (0.00)	0.044*** (0.01)
7d bid/ask spreads	4.942 (3.68)	−56.402 (56.42)	37.415 (9.34)	−36.802 (55.83)
Refinancing rate		2.997*** (0.76)		1.428*** (0.20)
BOP		9.804*** (2.62)		6.601*** (1.53)
GDP		−12.067*** (3.44)		−6.211*** (1.83)
FCA		672.507*** (187.65)		330.342*** (95.81)
Constant	−2.284*** (0.35)	−60.173*** (13.88)	−10.075*** (1.99)	−37.179*** (2.61)
Log likelihood	−51.83	−15.15	−27.46	−12.14
Number of obs.	200	200	200	200

Note: The dependent variable is an indicator that becomes one during the seven days before each of the three major devaluations that occurred on May 24, September 21 and October 12 (beginning of the free-floating regime). The independent variables for (1) and (3) are averages of black market premia, volumes and ranges measured using volume-weighted standard deviations over the preceding seven days. Specifications (2) and (4) also include macroeconomic indicators. All macroeconomic variables are measured at the monthly level; we always use the preceding months' growth rates. The time period spans from April 29 to November 15, 2011. Specifications (1) and (3) show robust standard errors in parentheses, specifications (2) and (4) show standard errors clustered at the monthly level.

monthly growth rate of foreign currency assets (FCA).⁸ Our three measures of black market activity remain statistically significant predictors of devaluations even when we control for fundamental data.

Fundamental variables are known to be of little use in predicting changes in free-floating exchange rates (Meese and Rogoff, 1983b, 1983a). In our setting with a fixed exchange rate regime, however, fundamentals are statistically significant predictors of devaluations even in the short run. Asset pricing models of exchange rates (Engel and West, 2005) explain both, the Meese–Rogoff puzzle and why it does not apply in our context: current fundamentals were priced in the black market but not in the fixed official exchange rates.

The findings in Table 2, however, do not necessarily mean that policy makers based their decisions on black market activity. The coefficients would be significant even if the black market were small and if black market activity were exogenous (Dornbusch et al., 1983). But they imply that the black market efficiently anticipates the devaluations and regime changes that we observe in our data.

Following the probit regressions, we conduct several additional statistical analyses to establish the time series properties and examine whether the black market is helpful in forecasting the devaluations. Similar investigations have been conducted by Akgiray et al. (1989), Booth and Mustafa (1991), Moore and Phylaktis (2000), Dawson et al. (2007) and Caporale and Cerrato (2008).

We first test for the presence of unit roots in our exchange rate time series. Augmented Dickey–Fuller tests indicate that all series are integrated of order one (see Online Appendix Table D.3). However, it has been shown that in the presence of structural breaks, which we are likely to have in our data due to the devaluations and the regime change (see Fig. 1), unit-root tests too often fail to reject the null hypothesis (Glynn et al., 2007). We thus apply the Lagrange multiplier unit root test with two structural breaks by Lee and Strazicich (2003) where the break dates are endogenously determined.⁹ The results of these

two-break LM unit root tests with estimated break dates can be found in Online Appendix Table D.4.

In Fig. 3, we plot the time series of exchange rates in the black market for dollars with the estimated break dates and devaluations. The solid vertical lines indicate the estimated dates of the two structural breaks, and the dashed vertical lines indicate the devaluations.¹⁰ The first structural break happened slightly before the first devaluation, while the second structural break happened approximately one month before the second devaluation. The timing of these estimated structural break dates in the black market exchange rate time series indicates that the black market was able to efficiently process information about upcoming devaluations.

The results of tests for Granger causality, which can be found in Appendix E further support this interpretation. To apply the Granger causality tests, we first removed all trends in our time series according to the results of the LM unit root tests. We find that black market exchange rates Granger cause Bloomberg official exchange rates (see Online Appendix Table E.8), but only weak evidence of Granger causality in the opposite direction. This does not necessarily imply economic causality, i.e. it is not necessarily the case that the Belarusian authorities devalued in response to the black market premium. But the black market rates reflected market conditions, to which the official exchange rates were adjusted only with some lag.

The analysis in this section builds on the argument that, while the official foreign exchange rates were still fixed, the black market processed available information efficiently whereas the official foreign exchange market did not. Additional evidence for efficiency in the black market, besides the stability of black market premia during normal times, can be found in Appendices E and F. Using tests for Granger causality (Granger, 1969) we show that information flowed from markets, in which there was more activity to less active markets. In Online Appendix E, Table E.5, we demonstrate that information spreads from the black market for dollars to the black markets for euros and Russian rubles. In Appendix F, we demonstrate that information spreads from the country's economic center, Minsk, to the five next largest cities in Belarus.

⁸ The data on refinancing rate and foreign currency assets were retrieved from Bloomberg, whereas data on GDP and BOP were retrieved from the NBB's Bulletin of Banking Statistics (2012).

⁹ The technical details of the test can be found in (Lee and Strazicich, 2003). A brief summary of the implementation is given in the Online Appendix D. For our application of the test, we used GAUSS codes shared with us by the authors.

¹⁰ Corresponding graphs for euros and Russian rubles, as well as for official exchange rates can be found in the Fig. D.7 in the Online Appendix.

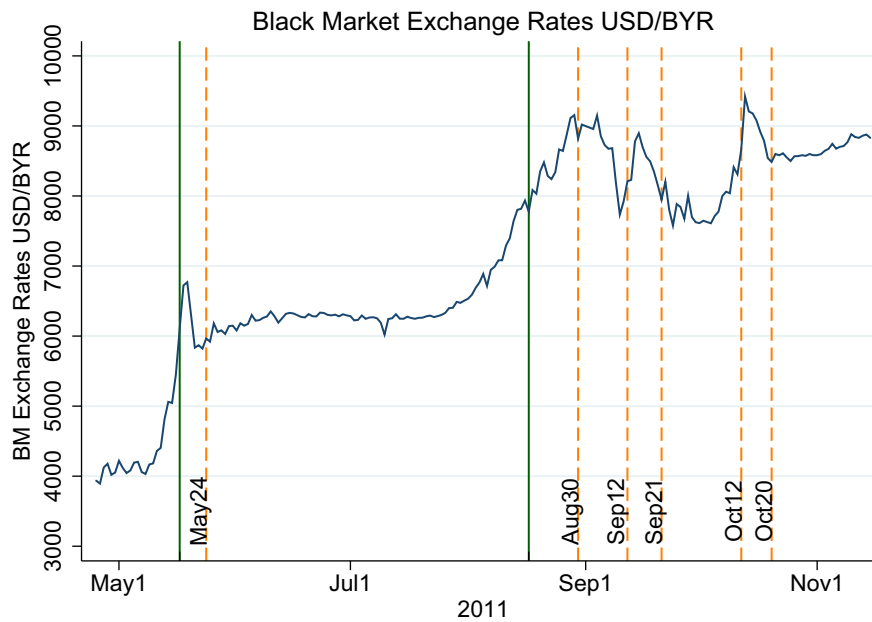


Fig. 3. Exchange rates and estimated break points: Dashed vertical lines are estimated break points. Solid vertical lines are the important dates; May 24: first devaluation, September 21: second devaluation, October 12: final devaluation.

5. Conclusion

Using data from the website Prokopovi.ch, we investigate the relation between black market and official exchange rates during the Belarusian currency crisis of 2011. Prokopovi.ch, which was set up in April 2011, allowed Belarusian citizens to find potential trading partners in the black market for foreign exchange. Technological progress has, thus, helped Belarusians get around government restrictions more easily: the creation of a website like Prokopovi.ch, which reduced transaction costs in the black market, would not have been possible a few years earlier.

During the time interval under consideration, Belarus experienced three devaluations, a period with fixed exchange rates in two segments and an exchange rate regime change. Various statistical tests suggest that the devaluations of the Belarusian ruble in the official market were anticipated by the black market. It is hardly necessary to repeat that we are dealing with highly interdependent forces. On the one hand, black market activity reflected adverse economic conditions during the crisis. These economic developments would have occurred even in the absence of a black market, but they made the black market more valuable as an alternative for Belarusians who wanted to trade foreign exchange. On the other hand, the emergence of the black market may have worked as a catalyzer which accelerated the course of events that ultimately resulted in a move to free-floating exchange rates.

The episode we describe resembles developments that took place in many other countries around the world earlier and over a longer period (see [Reinhart and Rogoff, 2004](#)). [Gwartney et al. \(2006\)](#) and [Shleifer \(2009\)](#) document that black markets for foreign exchange have vanished in nearly all countries (Belarus being an exception) between 1980 and 2005. This was preceded by a broad move to free-floating exchange rate regimes, at first glance a sign of financial liberalization. Regular interventions in the foreign exchange market, however, suggest that, like many other central banks in the rest of the world, the National Bank of Belarus has merely switched towards more subtle measures to maintain control over foreign exchange rates. The NBB would not be able to afford getting the exchange rates back to the levels of the first half of 2011, which had highly overvalued the Belarusian ruble. It has, however, been able to keep the exchange rates within relatively narrow ranges since November 2011.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.jinteco.2014.06.002>.

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