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Narodowy Bank Polski
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Joanna Niedźwiedzińska – Economic Analysis Department, Narodowy Bank Polski;
joanna.niedzwiedzinska@nbp.pl

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Abstract

The monetary policy response to COVID-19 was, in many ways, exceptional. This paper investigates some aspects of this exceptionality among 28 inflation targeters. Evidently, the reviewed central banks assessed the pandemic to be a clear-cut case for loosening by promptly announcing expansionary decisions, often at extraordinary meetings, using a possibly broad set of measures, with not much hesitation before reaching for unconventional ones. One of the key aspects of the analysed monetary policy response was also how quickly the authorities reacted to the shock. It turned out that, on average, advanced economies announced their initial policy actions within a month, whereas emerging market economies were twice as fast. This difference could be, however, to a great extent, explained by the timing of registering the first COVID-19 cases in a country, having room for policy manoeuvre with respect to nonstandard measures and being in need of liquidity provisions with a less deep financial system.

JEL Codes: E31, E52, E58, E61.

Key words: Monetary Policy, Central Banking, Policy Design.

1. Introduction

The outbreak of the COVID-19 pandemic in early 2020 and the related lockdown resulted in a collapse of economic activity virtually all over the world. This, in turn, prompted authorities to undertake exceptional measures aimed at mitigating the negative shock. Apart from unprecedented fiscal support – at least judged by peacetime standards –monetary policy also reacted decisively. There was clearly only one direction considered – loosening.

The actions of central banks were in many respects extraordinary, as evidenced by their timing and scope. The intensity of announcing new measures or extending the already introduced instruments was outstanding. Also notable was the wide acceptance of a much broader policy toolkit in countries previously following rather conventional monetary policy. This indicates that, for the foreseeable future, the distinction between conventional and unconventional measures has become largely irrelevant.

Given the uniqueness of the situation, it is worth reviewing in more detail the initial monetary policy response to COVID-19. In particular, the aim of this paper is to look at selected aspects of the decisions of central banks taken in the first half of 2020 – including their sequence and drivers.

28 inflation targeting countries were chosen for the analysis (14 advanced economies and 14 emerging market economies), which is already a relatively large and heterogenous group to look at. Moreover, such a selection offers the advantage of reviewing economies that pursue the same monetary policy strategy, which allows for a fair comparison of their reactions. Indeed, the distinction between advanced economy inflation targeters and emerging market economy inflation targeters has been helpful in detecting some similarities and differences in the responses of central banks to COVID-19.

The period investigated begins around the outbreak of the pandemic and ends in June 2020. Thus, all the monetary policy decisions related to COVID-19 that took place in the first half of 2020 are taken into account.

At the same time, apart from distinguishing between advanced and emerging market economies, another possibly important dividing line was introduced. Namely, depending on the timing when the first infections were reported in a given country (January, February, March), the analysed economies were put into three subgroups based on the month in which the pandemic hit them. The resulting pandemic waves also proved very useful in the analysis.

All information on monetary policy actions were collected from the central banks' websites (only official announcements were considered), whereas the data used in the estimations were mainly taken from the International Monetary Fund and the World Bank. Institutional arrangements of the reviewed central banks were assessed using indices proposed in Niedźwiedzińska (2020), i.e. were based on a unique dataset constructed by the author. For each country the dataset featured around 60 aspects referring to the main elements of the inflation targeting strategy as pursued in a country, e.g. legal provisions governing a given central bank, together with the key characteristics of its decision-making process, analytical framework and communication policy. The collected indicators were used to construct cross-country regressions aimed at identifying factors affecting the timing of the initial responses of the central banks to COVID-19.

A number of recent papers and publications touch on the indicated issues. Much relevant information and some takeaways from reviewing experiences of selected central banks in coping with the pandemic can be found, for example, in the IMF Policy Tracker, Arslan, Drehmann and Hofmann (2020), Cavallino and De Fiore (2020), Galí (2020), Grostal (2020), Hartley and Rebucci (2020), Lane (2020), Lu (2020), or Mühleisen et al. (2020). In particular, some observations on monetary policy reactions to COVID-19 in advanced economies were presented in Cavallino and De Fiore (2020), whereas findings on emerging market economies were reported in Mühleisen et al. (2020) and in Hartley and Rebucci (2020).

Nonetheless, to the author's knowledge this paper is one of the first attempts to look at the problem by comparing the initial response of monetary policy to the pandemic across a wide range of jurisdictions, including both advanced and emerging market economies. Interestingly, several researchers that dealt explicitly with actions

undertaken by the central banks of emerging market economies argued that those monetary authorities had somewhat limited room for manoeuvre given their dependence on external financing (Benigno et al., 2020, García-Herrero and Ribakova, 2020). Gelos et al. (2020) also pointed to the quality of institutional frameworks and inflation levels as factors influencing policy space. At the same time, some authors acknowledged that the monetary policy response of many emerging market economies was as decisive as that of advanced economies (Mühleisen et al., 2020, Hartley and Rebucci, 2020). It is therefore worth analysing more closely the comparison and empirically investigating factors affecting the way central banks addressed the crisis at its initial stage, with inflation targeters chosen as a relevant group to look at.

The paper has the following structure. First, several topics stemming from more theoretical considerations are noted that may affect the timing of the monetary policy response. Second, some indicative evidence on the exceptionality of central banks' reactions is presented. Third, the scope and sequence of the adopted measures are discussed, with this part being completed with a simple ranking of first-movers. Next, the timing of announcing the policy response is analysed in more detail. Finally, simple regressions aimed at showing which factors may have influenced the difference in the speed of inflation targeters' reactions to COVID-19 are constructed. The main findings are reported in the concluding part.

2. Some theory behind the timing of monetary policy response

When investigating the monetary policy of any central bank, one should be aware of time lags associated with it. In economics this topic is predominantly linked to issues concerning the transmission mechanism and the related lags with which monetary policy decisions find reflection in macroeconomic variables.[1]

Among inflation targeters, the transmission mechanism – in a very simplified form – can be seen as starting with changes in central bank's interest rates or in other instruments of the central bank that are followed by adjustments of market rates and other financial indicators. These, in turn, translate into looser or more stringent financing conditions for the private and public sectors, which ultimately affects consumer and investment decisions of economic agents. Finally, the decisions on how much to consume and how much to save impact economic activity and inflation. Thus, the process – even in its highly stylised version – is complicated and considerable time is needed for all those linkages to work.

Generally, when analysing monetary policy transmission lags, attentions is paid, in the first place, to the indicated relationships between the operational targets of the monetary authorities, some market indicators (e.g. deposit and credit rates offered by commercial banks to their clients) and the decisions of households, firms and the government (e.g. on spending and saving). However, even though the time necessary for those interdependencies to work their way through the economy is most likely responsible for the bulk of the overall delayed reactions, it is not the sole source of monetary policy lag. The other one – more relevant for the current analysis – is an inside lag in reaction to shocks, which comprises an information lag, a recognition lag and a decision lag (Bofinger, 2001, p. 74; Willes, 1967).

The reasons for a delay in arriving at any monetary policy action are due to various factors. In particular, they are influenced by the availability of incoming data – or more generally – relevant information on the ongoing processes, the necessity to observe and analyse certain developments for a longer period, or simply the frequency

[1] The monetary transmission mechanism is described in more detail, for example, in Bank of England (1999), and Mishkin (2012).

of decision-making meetings held in a given central bank. Although, in normal times, much less attention is devoted to these elements compared to the subsequent stages of the transmission process, they may play quite an important role in delaying monetary policy actions and should not be disregarded.

Another central topic related to the timing of the monetary policy response is the considerable degree of policy inertia in the reaction of central banks to shocks, as evidenced in a number of empirical studies (Bernanke, 2004). In times when interest rates were the main instrument used by monetary authorities, this phenomenon was also called interest rate smoothing (Coibion and Gorodnichenko, 2012). The most recognised concept capturing such a pattern would probably be a modified Taylor rule that explains the current level of the central bank's interest rate as a weighted average of a specified target for the central bank's interest rate (being a function of inflation and the output gap – contemporaneous or projected; Taylor, 1993) and a lagged value of the central bank's interest rate (Castelnuovo, 2003).

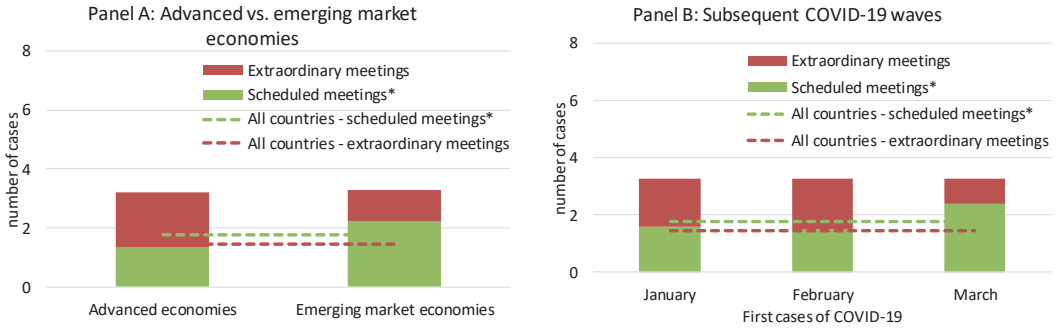
Looking at the past policies of inflation targeters, it is clear that for most of the time they favoured smaller or moderate, but more frequent instrument adjustments compared to larger and less frequent policy moves. The intuition behind it is that a more incremental approach allows for more calibrated actions.

There are various explanations of central banks' preference for gradualism. According to some authors, such behaviour can be seen as optimal. This point of view is based, among others, on stressing uncertainty about how the economy will react to changes in policy (Brainard, 1967; Sack, 1998). An alternative explanation follows from arguing that if monetary authorities can commit to follow an inertial rule, they gain more leverage over long-term rates for a given change in short-term rates (Woodford, 2003). In general, arguments raised in this context are grouped around such issues as uncertainties about data, parameters and models that may result in measurement or assessment errors, and more potential for learning and controlling the financial market's reaction when a stepwise approach to monetary policy is applied. Importantly, there are reasons to believe that the size of the shock significantly affects the importance of those factors, and that if major disturbances appear, they will not play a crucial role (FOMC, 2010).

3. Extraordinary scope of monetary policy response

The number of decision-making meetings held during the first few months of 2020 can be seen as the first proof that the monetary policy reaction to the COVID-19 pandemic has been extraordinary (Chart 1).[2] Whereas over the last decades it became standard practice among inflation targeters to announce in advance calendars of 8-12 decision-making meetings per year (Niedźwiedzińska, 2018), in early 2020, in very many instances, monetary policy meetings were much more frequent, with around half of them being unscheduled.

Chart 1 Monetary policy initial response to COVID-19 announced after scheduled and extraordinary decision-making meetings



Source: own compilation based on information from central banks' websites.
Notes: * Include rescheduled meetings if announced with prior notice.

The need to call extraordinary meetings was somewhat more apparent in advanced economies, and in countries where coronavirus hit first. The first observation can be explained by the fact that advanced economies – prior to the pandemic – were, in principle, holding fewer meetings. The second finding may follow from an initial uncertainty about how quickly COVID-19 would spread, and – in effect – how strongly the pandemic would affect economies.

Importantly, not all the monetary policy moves were introduced after decision-making meetings. Many liquidity providing measures (repo, swaps, etc.) and operational

[2] Only meetings followed by a decision on applying or changing any of the monetary policy measures are considered. Whereas, in normal times, keeping the policy unchanged can also be regarded as an important decision, the approach adopted here is justified given that the focus of the analysis is on monetary policy response to the pandemic shock which required actions.

aspects[3] or extensions of previously proclaimed instruments (their timing, size, targeted asset classes, collateral requirements etc.) were announced in a form of press release without any formal meetings. It seems that the urgency of the situation required decisive moves that could be agreed without prior extensive discussions, or simply set at an operational level.

Looking only at the initial monetary policy response, i.e. the first announcement of any monetary loosening justified by the pandemic, a preference for introducing it after a formal discussion is, however, clearly visible. In 20 of the 28 analysed central banks such a response followed a decision-making meeting, with 50% of those meetings being unscheduled.

Table 1 Overview of monetary policy measures used in Q1-Q2 2020 in response to COVID-19

Country	First cases of COVID-19	First monetary policy response*	First response at extraordinary meeting	Cuts in interest rates	New asset purchase programmes (+ extensions)	New credit easing schemes (+ extensions)	Liquidity providing measures	Additional measures **
AU	25-01-2020	3-03-2020		yes	yes	yes	yes	yes
BR	26-02-2020	6-03-2020		yes			yes	
CA	26-01-2020	4-03-2020		yes	yes (+yes)	yes	yes	
CL	4-03-2020	12-03-2020		yes	yes (+yes)	yes	yes	
CZ	2-03-2020	16-03-2020	yes	yes			yes	yes
EA	25-01-2020	12-03-2020			yes (+yes)	(yes)	yes	
HU	5-03-2020	17-03-2020		yes	yes	yes	yes	
IS	29-02-2020	10-03-2020		yes	yes		yes	yes
IN	30-01-2020	12-03-2020		yes	yes	yes	yes	yes
ID	2-03-2020	20-02-2020		yes	yes		yes	yes
IL	24-02-2020	15-03-2020	yes	yes	yes	yes	yes	
JP	15-01-2020	16-03-2020			(yes)	yes	yes	
KR	20-01-2020	12-03-2020		yes	yes	(yes)	yes	yes
MX	29-02-2020	20-03-2020	yes	yes		yes	yes	yes
NZ	28-02-2020	16-03-2020	yes	yes	yes (+yes)	yes	yes	
NO	27-02-2020	12-03-2020	yes	yes			yes	yes
PH	30-01-2020	6-02-2020		yes	yes	yes	yes	yes
PL	4-03-2020	16-03-2020		yes	yes	yes	yes	
RO	27-02-2020	20-03-2020	yes	yes	yes		yes	
RU	1-02-2020	9-03-2020		yes		yes	yes	yes
ZA	6-03-2020	19-03-2020		yes	yes		yes	yes
SE	1-02-2020	12-03-2020	yes		(+yes)	yes (+yes)	yes	
CH	26-02-2020	19-03-2020				yes (+yes)	yes	yes
TH	13-01-2020	5-02-2020		yes	yes	yes	yes	
TR	12-03-2020	17-03-2020	yes	yes	(yes)	yes	yes	
UA	4-03-2020	10-03-2020		yes			yes	yes
GB	31-01-2020	11-03-2020	yes	yes	yes	yes (+yes)	yes	yes
US	21-01-2020	3-03-2020	yes	yes	yes (+yes)	yes (+yes)	yes	

Source: own compilation based on information from central banks' websites.

Notes: Countries ordered alphabetically based on the full name of the country in English. * Announcement dates. ** Mainly FX interventions and direct financing of government.

[3] The review includes announcements of new measures or extensions of previously introduced instruments. The subsequent press releases on operational details are not counted.

The scope of monetary policy measures that were introduced during the first few months of 2020 can be seen as the second proof of the central banks' unprecedented reaction to the pandemic (Table 1).

Considering the experience with dealing with past crises, i.e. the Global Financial Crisis and the European sovereign debt crisis, this time inflation targeters, especially – but not exclusively – from emerging market economies, turned out to be much more eager to reach for instruments regarded as unconventional, at least by pre-2008 standards.

This is no surprise, given the fact that even prior to COVID-19 many central banks were conducting loose monetary policies, with very limited or almost non-existent room for additional interest rate cuts in several jurisdictions. Under such circumstances, in order to make monetary conditions more accommodative, which was the only considered direction of monetary response to the pandemic, the use of other measures was necessary. Having said that, whoever could lowered the policy rates (and those who did not, already had interest rates at zero or in negative territory).

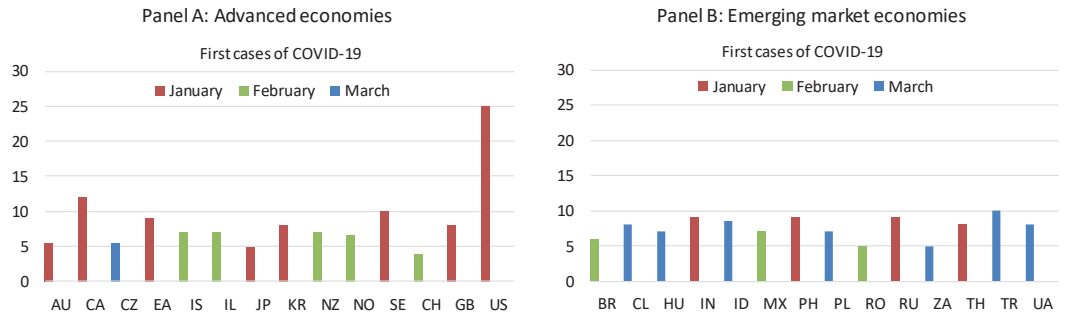
Moving to other instruments, with only rare exceptions, the analysed central banks used not one or two additional measures, but were resorting to as broad a policy toolkit as possible. Liquidity providing operations were a must, with repo transactions and currency swaps being one of the most popular instruments on offer. Asset purchase programmes and credit easing schemes also became widely applicable, with only single countries not making use of them.[4] Moreover, several central banks decided to reach for less common measures, which generally took the form of FX interventions or direct financing of government (predominantly short-term).

Taking into account that, in many instances, after initial actions, the authorities were gradually extending the already introduced measures, the wide scope of monetary policy response translated into quite a large number of overall announcements. Generally, most of the investigated inflation targeters issued between 5 and 10 policy statements from the start of the pandemic until the end of June 2020 (Chart 2).

[4] Announcing new asset purchase programmes or credit easing schemes was treated on an equal footing as extending the existing programmes or schemes.

Interestingly, in this regard, there were no major differences between advanced and emerging market economies, apart from the case of the US, where the announcements were visibly more frequent. Neither does the timing of recording the first cases of COVID-19 seem to matter much with respect to the number of policy announcements.

Chart 2 Number of monetary policy announcements related to new measures or their extensions in Q1- Q2 2020 in response to COVID-19



Source: own compilation based on information from central banks' websites.

Notes: Countries ordered alphabetically based on the full name of the country in English. Each announcement counted separately (e.g. each interest rate cut counted separetely).

Applying a purely mechanical approach, this means that, on average, announcing loosening measures (introducing new or extending the already proclaimed instruments) took place every 19 calendar days – again with no major differences between either advanced or emerging market economies, or between countries hit by COVID-19 in subsequent months.[5] In fact, however, the breaks between the announcements were much shorter, since the decisions on providing monetary policy stimulus were concentrated in March 2020, when it became apparent that the pandemic would have strongly negative effects on all the reviewed economies.

[5] The number of calendar days covered in the analysis (i.e. the number of days between the first COVID-19 cases in a given country until the end of June 2020) was divided by the number of announcements of any monetary policy moves in that country. Calendar days were used instead of working days for simplicity, but such an approach should not affect the results.

4. Sequence of adopting policy measures and first-movers

Analysing the sequence of adopting policy measures in response to a major shock can reveal central banks' preferences for using standard vs. nonstandard instruments, although – as already noted – the distinction between the two kinds of measures, given the widespread applicability of asset purchase programmes and credit easing schemes, became largely irrelevant and does not reflect their current status.

Table 2 Sequence of adopting monetary policy measures in Q1- Q2 2020 in response to COVID-19

			Sequence of monetary policy measures				
Country	First cases of COVID-19	First monetary policy response*	Cuts in interest rates	New asset purchase programmes (+ extensions)	New credit easing schemes (+ extensions)	Liquidity providing measures	FX interventions
AU	25-01-2020	3-03-2020	1	3	3	2	
BR	26-02-2020	6-03-2020	2			1	
CA	26-01-2020	4-03-2020	1	2	3	2	
CL	4-03-2020	12-03-2020	2	2	2	1	
CZ	2-03-2020	16-03-2020	1			1	
EA	25-01-2020	12-03-2020		1	1	1	
HU	5-03-2020	17-03-2020	2	2	2	1	
IS	29-02-2020	10-03-2020	1	2		1	
IN	30-01-2020	12-03-2020	3	2	3	1	
ID	2-03-2020	20-02-2020	1	3		2	
IL	24-02-2020	15-03-2020	2	1	2	1	
JP	15-01-2020	16-03-2020		1	1	2	
KR	20-01-2020	12-03-2020	1	1	1	1	
MX	29-02-2020	20-03-2020	1		2	1	
NZ	28-02-2020	16-03-2020	1	3	4	2	
NO	27-02-2020	12-03-2020	1			1	
PH	30-01-2020	6-02-2020	1	3	4	2	
PL	4-03-2020	16-03-2020	2	1	1	1	
RO	27-02-2020	20-03-2020	1	1		1	
RU	1-02-2020	9-03-2020	4		3	2	1
ZA	6-03-2020	19-03-2020	1	2		1	
SE	1-02-2020	12-03-2020		2	1	2	
CH	26-02-2020	19-03-2020			2	1	
TH	13-01-2020	5-02-2020	1	3	3	2	
TR	12-03-2020	17-03-2020	1	2	1	1	
UA	4-03-2020	10-03-2020	2			3	1
GB	31-01-2020	11-03-2020	1	2	1	3	
US	21-01-2020	3-03-2020	1	3	4	2	

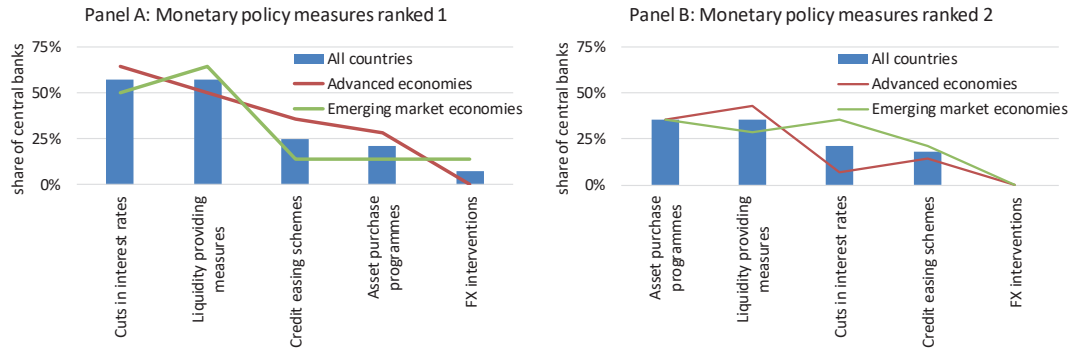
Source: own compilation based on information from central banks' websites.

Notes: Countries ordered alphabetically based on the full name of the country in English. Numbers indicate the sequence of applying certain instruments. Several instruments could be announced contemporaneously, resulting in an equal rank.* Announcement dates.

Clearly, cutting interest rates and introducing liquidity providing measures were the first lines of defence – both for advanced economy inflation targeters and for emerging market economy inflation targeters (Chart 3; Table 2). Asset purchase programmes (new or extended) and credit easing schemes (new or extended) were much less popular at the initial phase of dealing with the economic consequences of COVID-19,

especially in emerging market economies. Two countries – Russia and Ukraine – chose FX interventions as the first instrument to use.

Chart 3 Order of adopting certain monetary policy measures in Q1-Q2 2020 in response to COVID-19

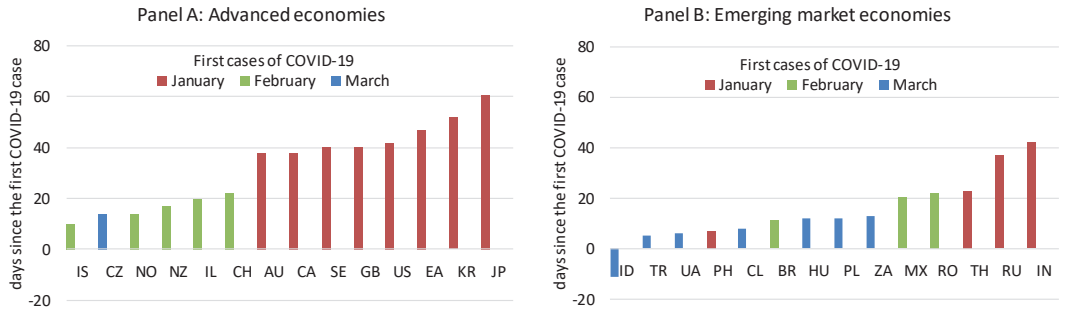


Source: own compilation based on information from central banks' websites.

Notes: Asset purchase programmess – new and extended programmes grouped togehter. Credit easing schemes – new and extended schemes grouped together. Several instruments could be announced contemporaneously, resulting in an equal rank.

Considering the monetary policy response to the pandemic, one of its key aspects is also how promptly monetary authorities recognised the risks and reacted with providing monetary accommodation. One of the possible ways to look at the collected data is to simply rank inflation targeters according to the speed at which they provided monetary stimulus (Chart 4; Chart 5). Evidently, this does not take into account many of the potentially important issues, but can very clearly illustrate the already discussed findings, i.e. the generally quicker reaction of emerging market economies and those of the March group.

Chart 4 Overall monetary policy response lag to COVID-19 in individual countries

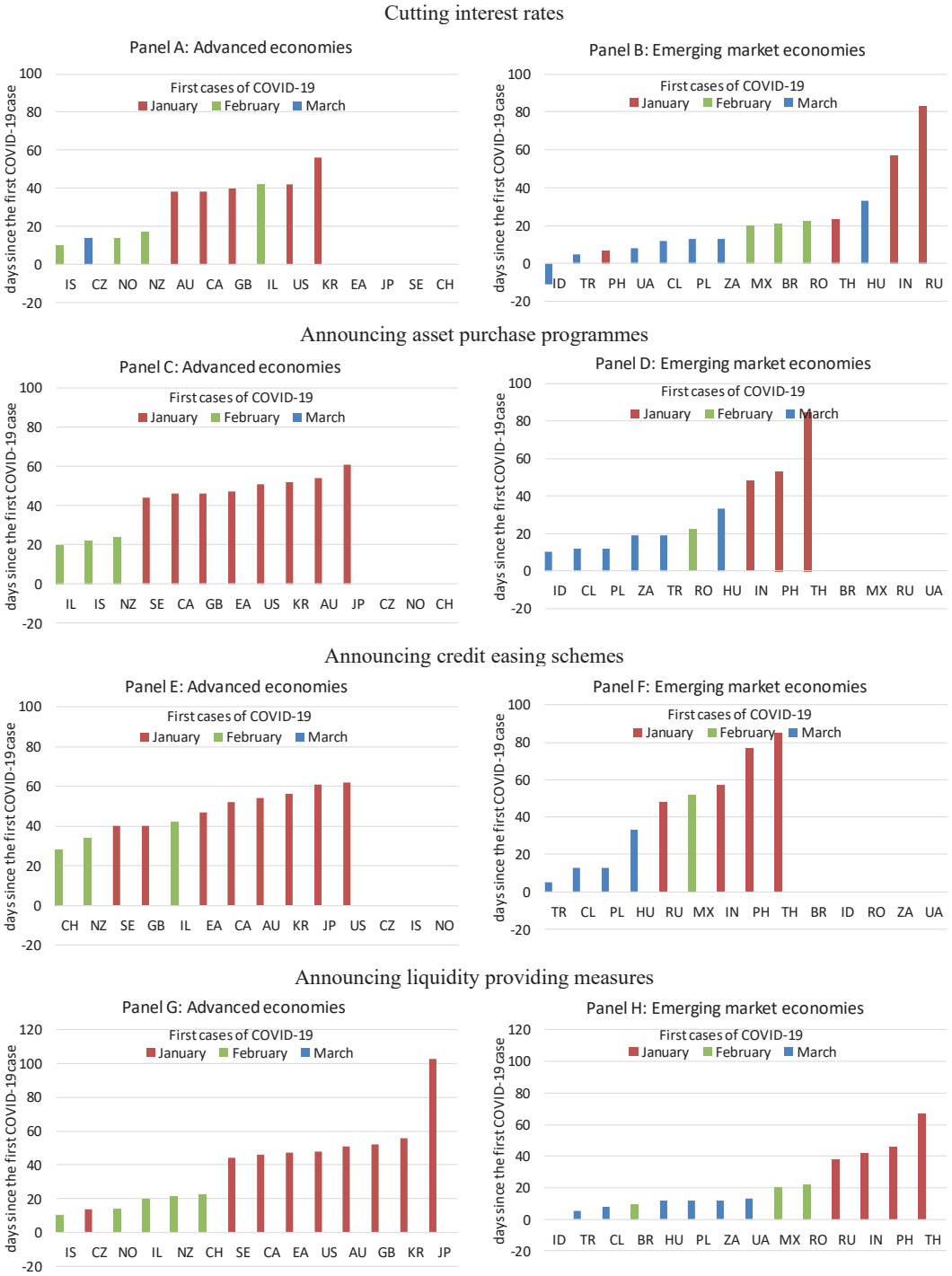


Source: own compilation based on information from central banks' websites.

Moreover, the ranking also indicates countries keeping to more traditional policy measures – such as Brazil, the Czech Republic, Norway and Ukraine, which did not

reach for asset purchases, nor credit easing, at least in their initial response to the pandemic.

Chart 5 Monetary policy response lag to COVID-19 in individual countries by the type of monetary policy instrument used



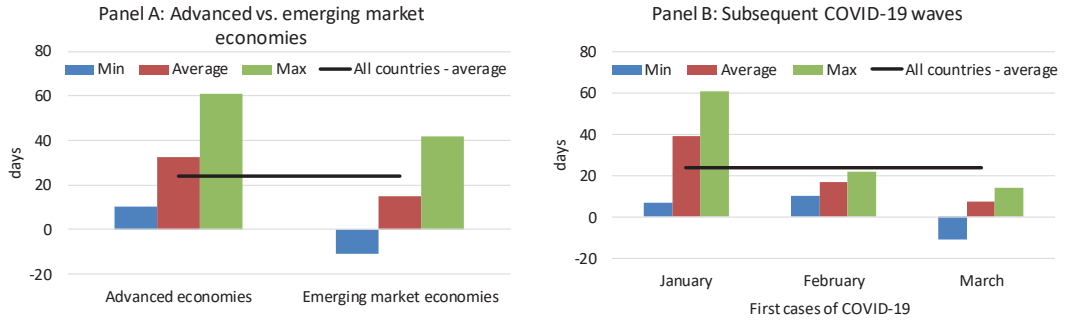
Source: own compilation based on information from central banks' websites.

5. Timing of adopting monetary policy measures

When analysing the timing of adopting monetary policy measures, it is useful to compare response lags among different country groups. Moreover, when discussing the monetary policy reactions to COVID-19, apart from considering the first announced response, subsegment policy moves should also be of importance.

Looking at the overall picture, i.e. taking into account any monetary policy measure used, on average, advanced economy inflation targeters announced their initial policy actions within a month, whereas emerging market economies were twice as fast.

Chart 6 Monetary policy response lag to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

There may be several ways in which the difference can be explained. Firstly, it can be partly driven by the fact that – among the reviewed countries – the first waves of COVID-19 were reported predominantly in advanced economies (Table A 2 in the Appendix). This, in turn, means that in advanced economies some more time had elapsed before it became clear that coronavirus would spread very broadly and exert a significantly negative impact on all affected economies, calling for decisive monetary stimulus. The arguments behind this reasoning are presented below. Another possible explanation for emerging market economies being quicker in responding to the pandemic may be related to their bigger – compared to advanced economies – room for manoeuvre with respect to both conventional interest rate cuts that could be applied easier than designing more complex policy measures, as well as to using nonstandard measures of relatively simple form. Some tentative indications of such a relationship are also noted later. Lastly, since in many instances the initial reaction of central banks took the form of liquidity-providing operations, it may be

the case that emerging market economies were more in need of urgent access to funds, not least due to the higher role of external financing and FX indebtedness in those economies. The third hypothesis seems plausible given the already discussed sequence of adopting individual measures by the reviewed countries. Although the difference was not massive, evidently, liquidity providing operations ranked first in most of the analysed emerging market economies, whereas they came second among advanced economies.

Moving back to the first hypothesis explaining the difference in the speed of monetary policy actions, some support for the importance of the pandemic waves may be offered by the gradually decreasing time lag between the first infections of COVID-19 reported in a given country and the monetary policy reaction when one distinguishes country groups based on months when the pandemic hit them (Chart 6). For countries of the January wave, the average time needed for adopting decisions on loosening monetary policy was close to 40 days, for the February group it stood at around 17 day, and for the March sample it dropped to only 7 calendar days. One country – Indonesia, where the first COVID-19 cases were reported in March 2020, reacted truly preemptively, i.e. 11 days before the first registered infections. Although the averages indicate some tendencies, the divergence among countries within distinguished groups is notable.

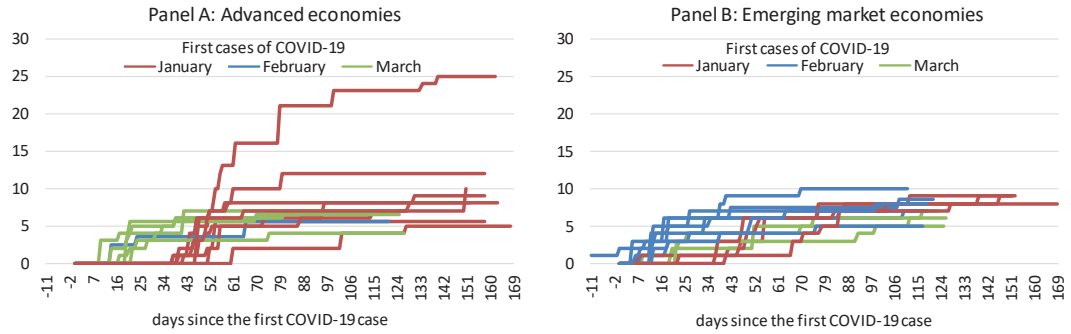
As a rule, central banks announced additional monetary policy loosening stepwise (Chart 7). Moreover, the later a country was hit by the COVID-19 pandemic, the more concentrated was its response to the worsened economic prospects. In turn, the countries of the January group caught up with providing adequate monetary policy support once it became clear that the risks to economic stability were real.

The highest number of decisions on monetary stimulus was evidently reported in the United States, where the Federal Reserve repeatedly extended previously announced measures, e.g. by including new asset classes in the purchase programmes or relaxing terms of certain operations.[6] Apart from this prominent case of a very active central

[6] Importantly, the number of monetary policy announcements reported for the United States does not include announcements on offering swap lines, since swaps were aimed at providing additional USD

bank, the others announced significantly fewer policy moves. However, applying any pre-pandemic standards one should still consider the reaction of inflation targeters as vigorous, with most of them increasing accommodativeness of their monetary policy between 5 to 10 times in a relatively short period of time (with an average of around 8 decisions until the end of June 2020).

Chart 7 Number of monetary policy measures used and their timing in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

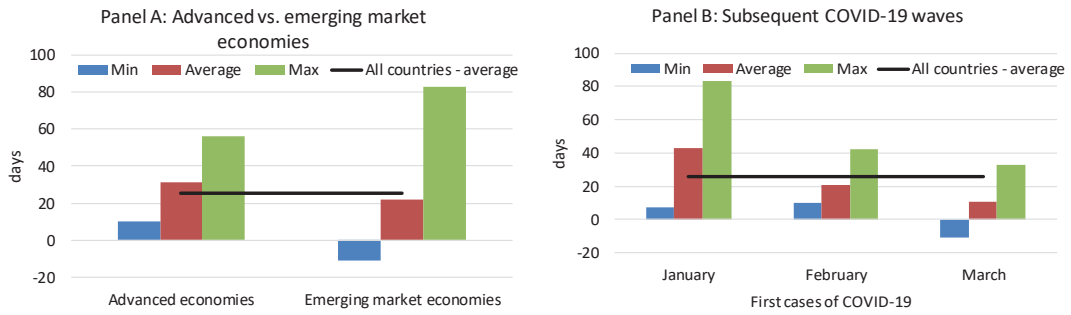
Distinguishing between the individual measures adopted by the analysed central banks, a similar picture can be seen – a higher level of economic development and being among the first countries to report the COVID-19 cases, in principle, extended the time lag of policy response. The divergence between countries in the investigated groups with respect to the speed of their reaction was, however, high for most of the instruments considered.

In particular, cuts in interest rates were applied somewhat quicker in emerging market economies (on average, after around 22 days) compared to advanced economies (on average, after around 31 days), which, to a great extent, follows from a higher initial level of interest rates in the first group of countries (Chart 8). This speaks in favour of the second hypothesis explaining the swifter reaction of emerging market economy inflation targeters to the pandemic. At the same time, the divergence in timing among emerging market economies was massive, and there were a few advanced economies,

liquidity to countries outside the United States. Thus, swap lines were not treated as loosening monetary conditions domestically in the United States. In turn, for countries being beneficiaries of swap lines, that kind of instrument was classified as proving monetary policy accommodation and was taken into account in the analysis.

like Iceland, the Czech Republic and Norway, that cut their interest rates faster than some emerging market economies. Thus, an average lag is clearly not telling the whole story.

Chart 8 Lag in cutting interest rates in response to COVID-19 in different sub-groups of inflation targeters

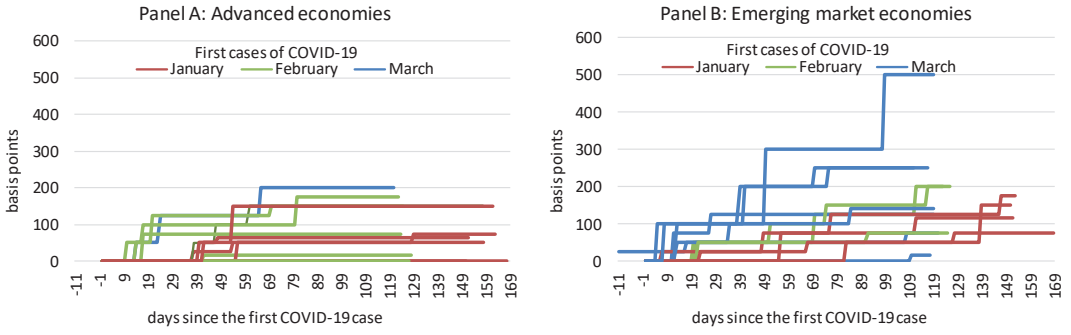


Source: own compilation based on information from central banks' websites.

Looking at the waves of the first infections, central banks of the March sample needed much less time to arrive at the decision to lower the rates than countries of the January group (on average, around 11 vs. 43 days).

Moreover, the scale and the number of interest rate decreases were much more pronounced in emerging market economies (on average, they applied 2.7 cuts by a cumulative 168 basis points, compared to the average for advanced economies of 1.7 cuts by a cumulative 79 basis points) and in countries of the March group (that, on average, lowered the rates 2.6 times by a cumulative 194 basis points) (Chart 9). This is, however, again, simply due to the higher initial level of interest rates in the respective economies.

Chart 9 Cumulated interest rate cuts and their timing in response to COVID-19 in different sub-groups of inflation targeters

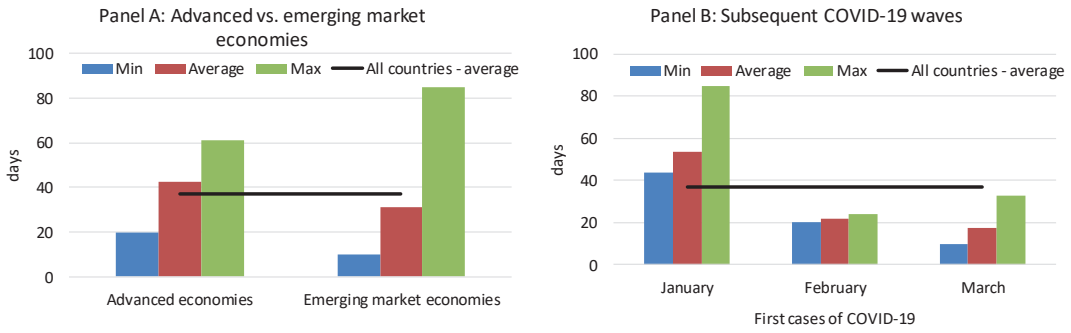


Source: own compilation based on information from central banks' websites.

Asset purchase programmes were also announced somewhat earlier in emerging market economies (on average, after around 31 days, compared to around 43 days for

advanced economies) – though there were exceptions to that rule, since the divergence in timing among emerging market economies was, again, very high. Reaching for asset purchases was also visibly quicker in countries hit by the COVID-19 pandemic later (the March wave needed, on average, around 18 days to announce them, whereas the January group needed around 53 days) (Chart 10).

Chart 10 Lag in announcing asset purchase programmes (new or extended) in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

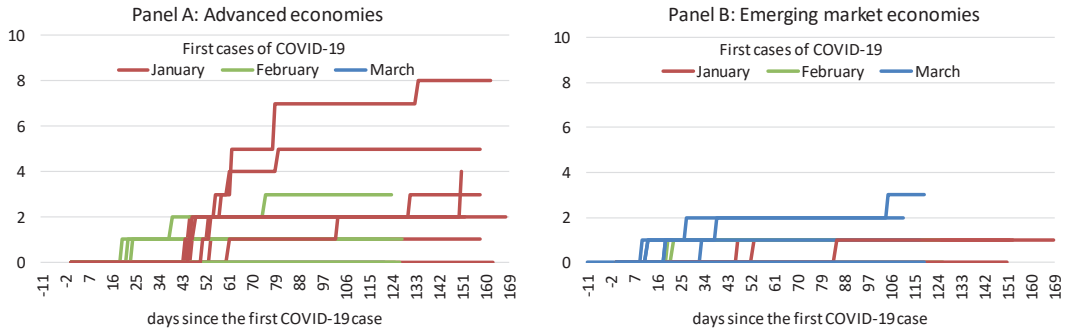
What is noteworthy, the already mentioned significant discrepancy among emerging market economies in the timing of announcing asset purchase programmes does not stem from the fact that some of them were more experienced in applying those measures than the others. In fact, among the fastest to react by launching asset purchases were Chile, Indonesia and Poland, which in the past had not used that instrument. Thus, it rather points to the importance of having potential policy space, with countries already pursuing purchases needing more time to analyse what asset classes or what envelope value of programmes would offer adequate support for the economy, while the newcomers swiftly decided to target the main market segment, i.e. the market of government bonds. This, again, offers some support for the second hypothesis explaining the faster reaction of emerging market economy inflation targeters to COVID-19.

When analysing the number of adjustments to asset purchase programmes[7], it was much higher in advanced economies (on average 2.8 decisions per advanced economy vs. 1.3 per emerging market economy) (Chart 11). This may be explained by an

[7] The number encompasses both announcements on launching new programmes as well as on extending the existing ones, e.g. by including additional asset classes.

observation that providing additional accommodation by central banks already present in the main market segments – which was the case for many of the reviewed advanced economy inflation targeters – required choosing different asset classes and those decisions were often taken stepwise.

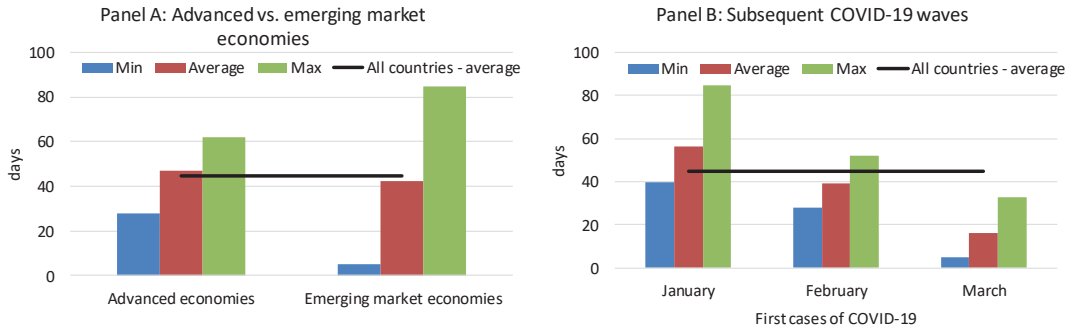
Chart 11 Number of decisions on asset purchase programmes (new and extended) and their timing taken in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

Regarding credit easing schemes, there was virtually no difference in timing of announcing them between advanced and emerging market economies (on average, the decision to use that instrument took 47 vs. 43 days, respectively), even though among the latter group the divergence of how quickly a country reached for that policy measure was, again, very big (Chart 12). Moreover, like with asset purchase programmes, those were not necessarily the most experienced inflation targeters to adopt that instrument, with Turkey, Chile and Poland – that previously had no credit easing schemes in place – leading the ranking of first-movers.

Chart 12 Lag in announcing credit easing schemes (new or extended) in response to COVID-19 in different sub-groups of inflation targeters

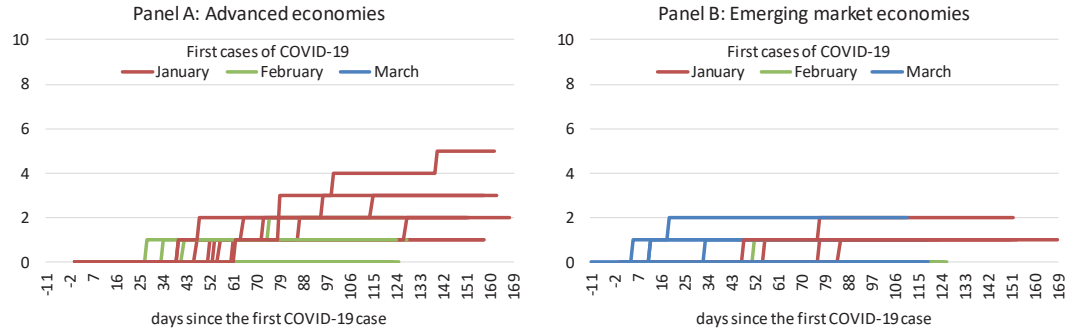


Source: own compilation based on information from central banks' websites.

As with other policy measures, inflation targeters of the March wave outpaced the others (on average, they reached for credit easing schemes within around 16 days vs. around 57 days for the January group).

Similarly as with asset purchases, advanced economies were more active in announcing changes to their credit easing schemes (with, on average, 2.1 decisions per advanced economy vs. 1.2 per emerging market economy) (Chart 13). The reasoning behind that difference can be analogous as in the case of asset purchase programmes.

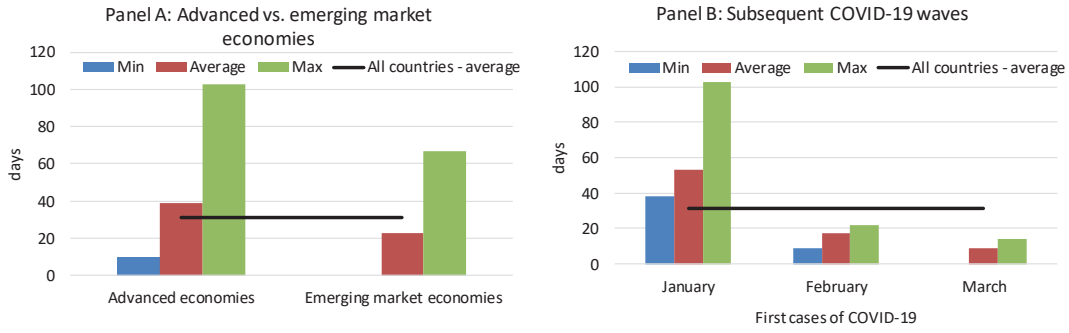
Chart 13 Number of decisions on credit easing schemes (new and extended) and their timing taken in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

Moving to liquidity providing measures, the general conclusions remain the same as for most other instruments analysed. Emerging market economies were somewhat faster in adopting them compared to the rest of the sample (with, on average, 23 days vs. 39 days for advanced economies), and those reporting COVID-19 infections later were much quicker than countries hit by the pandemic earlier (with, on average, 9 days needed for a decision for the March wave vs. 53 days for the January group) (Chart 14). Possibly one notable feature is much larger divergence of time lag in providing extra liquidity among advanced economy inflation targeters compared to emerging market economy inflation targeters, but for both groups the divergence was rather large.

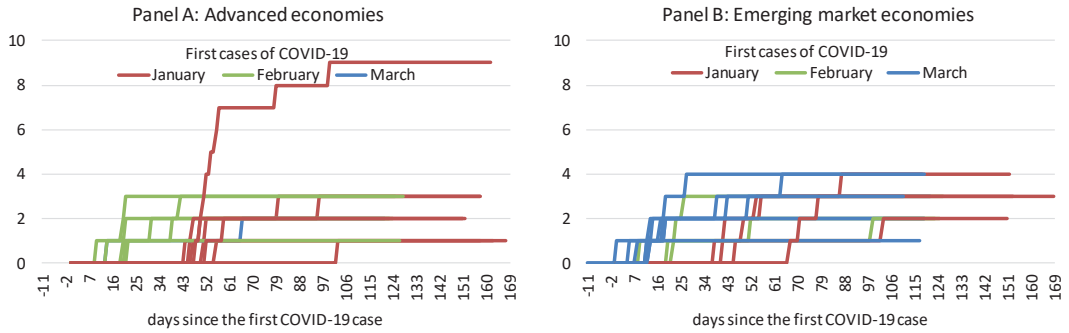
Chart 14 Lag in announcing liquidity providing measures in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

As already noted, liquidity providing operations were among the first measures to be announced. Like with other instruments, they were also quite frequently modified, in order to cope with changes in the market situation. At the same time, the number of announcements on liquidity providing measures was comparable in most of the reviewed countries (with an average of around 2.6 decisions), with a prominent exception of the United States, where the number was more than three times higher than the overall average (Chart 15).

Chart 15 Number of decisions on liquidity provisions and their timing taken in response to COVID-19 in different sub-groups of inflation targeters



Source: own compilation based on information from central banks' websites.

Importantly, one should not mechanically associate a higher number of monetary policy announcements with looser monetary conditions. Some central banks only gradually relaxed the terms of their operations, while others designed their policy measures from the very beginning in a much more flexible form, which simply eliminated the need of their subsequent adjustments.

6. Factors influencing the timing of monetary policy response

The final part of the analysis is to formulate simple cross-country regressions trying to capture factors that influence the timing of the monetary policy response. The proposed models are to show what kind of variables may have mattered, if any, and in particular, to investigate the reasons behind the difference in the speed of reaction between advanced and emerging market economies. Even though the number of the reviewed countries is already quite large for the purposes of a descriptive analysis, when moving to quantitative methods it must be assessed as limited. Therefore, given the number of observations, the results should be interpreted as tentative.

The sample includes 28 economies – half of which are advanced economies and the other half emerging market economies (Table A 1in the Appendix). The dependent variable is the number of days between the first COVID-19 cases reported in a given country and the initial announcement by the central bank of any policy measure loosening monetary conditions justified by the pandemic. Models explaining time lags of applying individual measures (e.g. separately interest rate cuts, or asset purchase programmes) were also constructed, but since not all the reviewed countries used all the instruments, the related specifications were based on ever fewer observations, and therefore are not reported.

Since the main hypothesis explaining the difference between advanced and emerging market economies in how quickly they reacted to the shock refers to the timing of registering COVID-19 infections, having room for manoeuvre with respect to monetary policy measures and experiencing more or less urgent need of liquidity provisions, a number of regressors related to those issues were taken into account. Thus, explanatory variables – apart from the level of economic development (Advanced_economy dummy) – also include a variable related to the subsequent waves of COVID-19 (Start_of_COVID19 ordinal variable), indicators characterising the country's past monetary policy (e.g. the level of interest rates, dummies referring to past experience with asset purchases or credit easing), and measures of financial depth (e.g. monetary aggregates, market capitalisation).

Control variables encompass various sets of indicators: those referring to the current macroeconomic situation of an economy and its medium-term outlook assessed as of

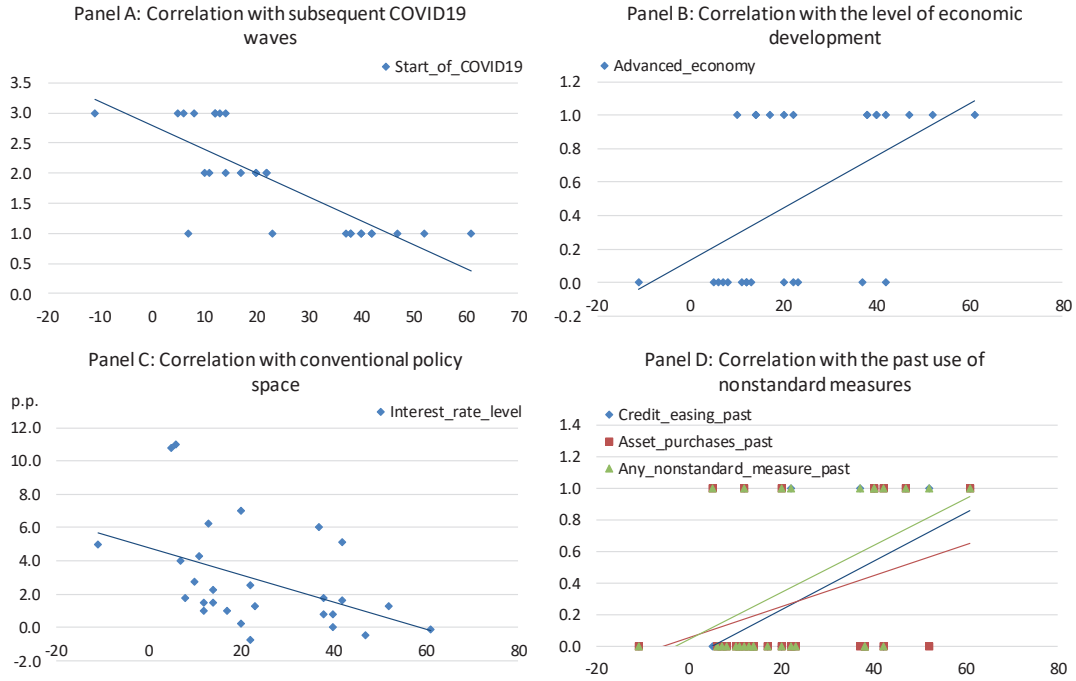
late 2019 (e.g. inflation, GDP growth, unemployment, fiscal balance, forecasted inflation, forecasted GDP growth), those capturing more structural features of a country (e.g. public debt, trade openness), and those describing institutional arrangements of the reviewed central banks (e.g. indices of central bank independence, transparency, accountability). Regressors also include a variable considered as potentially crucial for the analysed problem, i.e. a very simplified proxy for easiness of contagion (measured as the distance between a given capital city and Beijing).

Most indicators – as listed in the Appendix (Table A 1in the Appendix) – were collected from databases of the International Monetary Fund and the World Bank, while institutional characteristics of the reviewed central banks were assessed by applying indices proposed in Niedźwiedzińska (2020). The regressors used in the exercise, in principle, covered 2019, though for a few variables some missing observations for 2019 were substituted with 2018 values. Forecasts were supposed to show the medium-term perspectives of economies as assessed prior to the pandemic, and were therefore taken from the IMF World Economic Outlook – October 2019. They encompassed both 2020 and 2021, with an emphasis on 2021 as a more relevant horizon for forward-looking monetary policy of inflation targeters.

Indices of institutional set-ups were constructed to capture several potentially important aspects affecting the way monetary policy has been conducted in the analysed economies. The indices were built using a unique database produced by the author. Of interest were around 60 elements related to the institutional arrangements that allowed for a very broad and detailed analysis. In particular, it was investigated: (1) how experienced the country had been in pursuing an IT strategy, (2) how much independence had been granted to the central bank, (3) how well-informed decision-makers had been, (4) how understandable the decision-making process had been, (5) how transparent monetary policy had been, and (6) how high accountability standards had been employed by the central bank. All these elements were thought as helpful in evaluating the credibility of the central banks, and translated into a summary index, being the average of the individual indices. Indices referred to 2018 (the latest available data), although the institutional arrangements change rather slowly and –

especially in a cross-country set-up – considering 2018 numbers should not affect the results in any visible way.

Chart 16 Correlations between monetary policy response lag and various regressors



Source: own compilation based on data indicated in Table A 1in the Appendix.
Notes: Lines in the Charts are line trend fitted lines.

A first look at the data shows that, indeed, simple correlations would support the claim that being hit later by the pandemic speeds up the reaction time (Chart 16). Likewise, more policy space measured as the level of interest rates is negatively correlated with monetary policy response lag, signalling that higher rates prompted central banks' decisions. In turn, belonging to the group of advanced economies and having past experience with using nonconventional instruments – either in the form of asset purchases or credit easing schemes – hampered central banks' actions, if assessed by analysing correlations only.

When investigating cross-correlations (Table A 3 in the Appendix), it turns out that the Advanced_economy dummy is visibly correlated with the interest rate level, and some measures of financial depth and – less strongly – with the Start_of_COVID19 ordinal variable and dummies informing on the past use of asset purchase programmes or credit easing schemes. At the same time, Start_of_COVID19 is somewhat correlated with the interest rate level, the past use of credit easing schemes and

measures of financial depth. Although these interdependencies are, in many instances, not very strong, they may influence relationships between variables indicated by simple correlations. Thus, an attempt is undertaken to construct regressions that would capture, even if only tentatively, the directions of underlying linkages.

Since the number of observations is rather limited, the number of regressors included in any specification is also restricted. For that reason, based on three initial specifications (first, regressions including only a constant and one of the investigated explanatory variables at a time, second, models encompassing a constant, Start_of_COVID19 and one additional regressor, and third, specifications considering a constant, Advanced_economy and one additional regressor), a set of the most relevant explanatory variables was identified. Regressors taken into account at this stage were selected following the findings of the descriptive analysis and looking at correlations. Thus, predominantly, the level of economic development, timing of registering the first COVID-19 cases, having room for policy manoeuvre and the level of financial depth as factors affecting the speed of central banks' responses were considered. Those variables constituted the basis for the main version of the model that was later extended with control variables (Table 3).

A simple ordinary least squares procedure was applied.

The baseline model is a regression of the following form: $y_i = \alpha + \beta X_i + \varepsilon_i$, where $i = 1, \dots, N$ corresponds to individual countries included in the analysis, y is the dependent variable, X is a matrix of explanatory variables that are likely to affect the dependent variable, α is a constant, and β is a vector of coefficients.

An overview of the estimation results and some robustness checks are reported in full below (Table 3; Table 4), with some additional regression outputs included in the Appendix (Table A 4; Table A 5; Table A 6 in the Appendix).

The main findings are as follows.

Clearly, the single most relevant indicator is the variable related to the start of COVID-19 in a country, followed by the past use of credit easing schemes and the level of financial depth measured as the ratio of money to GDP. Those indicators are

statistically significant across almost all the considered specifications and contribute to explaining a fair share of the dependent variable variability.

The estimations confirm that being among the countries hit later by the pandemic visibly shortened the reaction time – by around 9-11 days for every month without COVID-19, depending on the specification. In turn, making use of credit easing in the past lengthened the lag by around 9-12 days, possibly signalling the need to design more extensive measures than those already applied. That observation may imply that what really mattered was room for policy manoeuvre, understood as the possibility to apply simple nonstandard measures. Lastly, a deeper financial system, measured by looking at the ratio of broad monetary aggregate to GDP, may have decreased the urgency of policy actions by 0.1 days, i.e. by a few hours, for each percentage point difference in the considered ratio. At the same time, taking into account that the sample includes countries characterised by wide-ranging values of the money to GDP indicator, the difference in time lag needed to arrive at any decision between economies with the deepest and most shallow financial system rises to around 22 days.

Table 3 Estimation results – overview

Explanatory variables	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)	(A7)	(A8)
Constant	29.91 ***	29.11 ***	29.25 ***	30.08 ***	30.41 ***	25.06 ***	31.34 ***	31.34 *
	(3.93)	(3.75)	(3.46)	(3.87)	(3.98)	(3.19)	(4.09)	(1.77)
Start_of_COVID19	-10.43 ***	-10.09 ***	-10.51 ***	-10.54 ***	-11.02 ***	-9.21 ***	-10.86 ***	-10.43 ***
	(-4.26)	(-4.02)	(-4.14)	(-4.2)	(-4.36)	(-3.5)	(-4.42)	(-4.16)
Credit_easing_past	10.42 **	10.42 **	10.49 **	9.45 *	10.54 **	11.91 **	10.44 **	10.5 **
	(2.25)	(2.22)	(2.2)	(1.82)	(2.27)	(2.6)	(2.27)	(2.17)
Money_to_GDP	0.11 **	0.1 *	0.12 **	0.11 **	0.12 **	0.12 **	0.06	0.11 **
	(2.41)	(1.93)	(2.26)	(2.27)	(2.52)	(2.7)	(0.95)	(2.34)
Advanced_economy		3.25						
		(0.78)						
Interest_rate_level			0.14					
			(0.2)					
Asset_purchase_past				2.02				
				(0.44)				
CPI_deviation_from_target					1.1			
					(0.96)			
Unemployment_rate						0.1		
						(0.28)		
Public_debt_to_GDP							0.07	
							(1.15)	
Fully_fledged_IT								-0.22
								(-0.09)
No. of observations	25	25	25	24	25	25	25	25
R-squared	0.78	0.78	0.78	0.78	0.79	0.8	0.79	0.78
Adjusted R-squared	0.75	0.74	0.73	0.74	0.75	0.76	0.75	0.73
F-statistic	24.59 ***	18.25 ***	17.61 ***	17.79 ***	18.61 ***	19 ***	19.04 ***	17.57 ***
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own computations based on data collected from sources indicated in Table A 1in the Appendix.
Notes: Significance codes: '***' 0.01, '**' 0.05, '*' 0.1. T-statistics in parenthesis.

The findings held also when a number of robustness checks were conducted. First of all, considering various modifications of the Start_of_COVID19 indicator (by assuming increasing or decreasing importance of belonging to different waves of

infected countries or by substituting ordinal variable with two dummies) was not affecting estimates of other coefficients in any visible way. Moving to variables related to policy space, in regressions where – instead of Credit_easing_past – Any_nonstandard_measure_past was added, it turned out to be relevant, acting in the same vein as Credit_easing_past.[8] Such a substitution was, however, not working for the interest rate level, which was consistently insignificant in the investigated specifications. This could imply that after controlling for other factors, the interest rate level was not affecting the monetary policy reaction time. In turn, allowing for alternative measures of financial depth was neither helpful nor harmful for the estimation results, with credit to GDP ratio and market capitalisation to GDP (with fewer observations) performing similarly – although somewhat more poorly – when compared to the money-to-GDP indicator, without invalidating the relevance of other variables included in the respective models.

Moving to control variables, considering them was not affecting the results by much, and thus, was not changing the main conclusions. In particular, the Advanced_economy dummy was not found significant in the model if account was taken of the above discussed factors. The same was true when the Advanced_economy dummy was replaced with GDP per capita when conducting robustness checks.

Analysing variables describing current macroeconomic conditions of a given country and their outlook assessed prior to the pandemic suggests no significance of those indicators. Such a conclusion held irrespective of whether the level of variables was taken into account, or – what could be considered more adequate in the case of inflation targeters – when gap variables were used, namely the deviation of inflation from the target and unemployment rate. This could signal that – given the magnitude of the shock – considerations related to those factors were not relevant. It seems that

[8] An alternative interpretation of the positive sign of those coefficients could be that some of the economies classified as having past experiences with using nonconventional measures were, in fact, still making use of them when hit by the pandemic. This, in turn, could indicate that those central banks could be seeing those instruments as already working, thus not necessitating any extensions. However, after including a variable explicitly capturing those cases, i.e. indicating central banks that were active in applying asset purchases and credit easing, such an interpretation had to be dropped.

the analysed central banks simply assessed that monetary stimulation was needed, regardless of past inflation or GDP developments or prospects prior to COVID-19.

None of the considered structural indicators proved useful in explaining differences in central banks' response lag, since neither variables referring to fiscal situation nor indicators of trade openness were found relevant.

Finally, considering institutional factors, likewise, not much impact of their quality could be found, since the indices of central banks' institutional arrangements proved obsolete in most specification. The only exception was the index referring to accountability, which turned out to be significant, decreasing reaction time by around 3.4 days for every score rewarding higher accountability standards. Otherwise, it seems that being a more experienced inflation targeter, enjoying more independence, setting store in informed decisions, putting emphasis on comprehensive explanations of undertaken actions and praising transparency of the conducted policy was not helpful in quickly responding to the pandemic.

Table 4 Robustness checks – overview

Explanatory variables	(A1)	(R1)	(R2)	(R3)	(R4)	(R5)	(R6)	(R7)
Constant	29.91 ***	23.28 ***	34.9 ***	-0.85	28.81 ***	33.84 ***	45.46 ***	26.25 ***
	(3.93)	(3.52)	(4)	(-0.2)	(3.75)	(4.49)	(7.18)	(3.12)
Start_of_COVID19	-10.43 ***				-10.61 ***	-11.12 ***	-14.37 ***	-10.09 ***
	(-4.26)				(-4.36)	(-4.46)	(-5.58)	(-4.09)
Start_of_COVID19_decreasing		-6.45 ***						
		(-4.02)						
Start_of_COVID19_increasing			-13.92 ***					
			(-4.22)					
Start_of_COVID19_January				21.06 ***				
				(4.17)				
Start_of_COVID19_February				4.62 *				
				(1.98)				
Credit_easing_past	10.42 **	11.79 **	9.25 *	9.95 *		14.21 ***	12.38 **	9.83 **
	(2.25)	(2.5)	(1.96)	(1.99)		(3.25)	(2.39)	(2.11)
Any_nonstandard_measure_past					8.81 **			
					(2.24)			
Money_to_GDP	0.11 **	0.12 **	0.11 **	0.11 **	0.12 **			0.11 **
	(2.41)	(2.55)	(2.33)	(2.3)	(2.67)			(2.27)
Credit_to_GDP						0.07 *		
						(1.81)		
Market_capitalisation_to_GDP							0.02	
							(0.63)	
GDP_per_capita_PPP								0
								(1.03)
No. of observations	25	25	25	25	25	26	23	25
R-squared	0.78	0.77	0.78	0.00	0.78	0.77	0.71	0.79
Adjusted R-squared	0.75	0.73	0.74	0.78	0.75	0.74	0.66	0.75
F-statistic	24.59 ***	22.99 ***	24.3 ***	-87.21	24.58 ***	24.85 ***	15.5 ***	18.75 ***
Prob(F-statistic)	0.00	0.00	0.00	17.67	0.00	0.00	0.00	0.00

Source: own computations based on data collected from sources indicated in Table A 1in the Appendix.
Notes: Significance codes: '***' 0.01, '**' 0.05, '*' 0.1. T-statistics in parenthesis.

Generally, the instrument-specific versions of the model were broadly supporting the above conclusions, even though – due to the smaller number of observations – their specifications did not allow to include more than 2-3 variables at a time.

7. Conclusions

As evident for the followers of central banks' actions, the monetary policy response to COVID-19 was, in many ways, exceptional. This papers investigated in a more systematic way some of the aspects of this exceptionality, allowing for the formulation of several observations.

The number of decision-making meetings held during the first few months of 2020 can be seen as the first proof that monetary policy reaction to the pandemic was extraordinary. And while not all monetary policy measures were introduced after decision-making meetings (many liquidity providing operations or extensions of previously proclaimed instruments were announced in a form of press releases without any meeting), central banks preferred introducing the initial monetary policy actions after a formal discussion at decision-making meetings, with 50% of those meetings being unscheduled ones.

The wide scope of monetary policy measures introduced during the first half of 2020 can be seen as another evidence of unprecedented central banks' reaction to the pandemic. This time, unlike during the Global Financial Crisis and the European sovereign debt crisis, almost all inflation targeters turned out to be ready to reach for instruments regarded as unconventional in the past. Moreover, given the fact that the authorities were often gradually extending the already introduced measures, since the start of the pandemic until the end of June 2020, most of the analysed central banks issued between 5 and 10 policy statements on the monetary stimulus, which speaks for assessing their reactions as vigorous.

In turn, investigating the sequence of policy measures adopted revealed central banks' preferences for using standard measures as the first line of defence – to the extent possible – although, given the widespread applicability of asset purchase programmes and credit easing schemes, calling them unconventional seems not to reflect their current status.

When analysing the monetary policy response to the COVID-19 pandemic, clearly one of its key aspects is how quickly monetary authorities reacted to the shock. Looking at the overall picture, on average, advanced economy inflation targeters

announced their initial policy actions within a month, whereas emerging market economies were twice as fast. Moreover, being among the first countries to report the COVID-19 cases, in principle, extended the time lag of policy response. The ranking of first-movers among inflation targeters provides a clear evidence of those findings.

Considering the results of simple cross-country regressions, several factors potentially useful in explaining differences in the speed with which the monetary policy stimulus was provided turned out to be significant, though the results should be treated as tentative. Evidently, the best-performing indicator referred to the waves of the COVID-19 pandemic. The importance of belonging to countries hit later by coronavirus possibly stems from the advantage of already being aware of the gravity of the situation. Some evidence was also found for the relevance of having policy space with respect to nonstandard measures that allowed for a swift adoption of relatively simple unconventional instruments. In turn, among factors delaying monetary response were some measures of financial depth, signalling less urgency for adopting liquidity providing operations in countries with deeper financial system. After controlling for those factors, the level of economic development, captured either by the Advanced_economy dummy, or by the GDP per capita indicator, was not found significant.

The presented analysis constitutes a review of the initial central banks' responses to the pandemic – their timing, sequence and scope. Its major advantage is a wide coverage of countries that follow the same monetary policy strategy, which makes it fair to compare their reactions. When thinking about monetary policy in the context of COVID-19, it would be interesting to see also the magnitude of the response and its effectiveness. The problem with the first issue is that it is difficult to quantify the strengths of the provided accommodation given a wide range of instruments used. The problem with the second question is the difficulty to disentangle the effects of monetary policy loosening from massive fiscal expansion applied in most countries almost simultaneously. The above topics are therefore not covered in this paper.

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Appendix

Table A 1 Overview of data analysed

Variable	Description	Source
Monetary_policy_response_lag	days between the first COVID-19 case reported in a country and the first announcement of monetary policy measures (any) by a given central bank	own calculation based on information from central banks' websites
Lag_in_cutting_interest_rates	days between the first COVID-19 case reported in a country and the first announcement of a respective monetary policy measure by a given central bank	
Lag_in_announcing_asset_purchase_programmes		
Lag_in_announcing_credit_easing_schemes		
Lag_in_announcing_liquidity_providing_measures		
Start_of_COVID19	ordinal variable: 1 for countries where the first COVID-19 cases were reported in January, 2 - for February, 3 - for March	own calculation based on information from https://covid.ourworldindata.org/data/owid-covid-data.csv
Start_of_COVID19_January	dummy variable: 1 for countries where the first COVID-19 cases were reported in January, 0 – otherwise	
Start_of_COVID19_February	dummy variable: 1 for countries where the first COVID-19 cases were reported in February, 0 – otherwise	
Start_of_COVID19_increasing	ordinal variable: 1 for countries where the first COVID-19 cases were reported in January, 2 - for February, 4 - for March	
Start_of_COVID19_decreasing	ordinal variable: 1 for countries where the first COVID-19 cases were reported in January, 2 - for February, 2.5 - for March	
Advanced_economy	dummy variable: 1 for countries cliassified as advanced economies by the IMF, 0 – otherwise	own calculation based on IMF classification
GDP_per_capita_PPP	GDP per capita, PPP (current international dollars)	World Bank, World Development Indicators
Distance_from_Pekin	distance between Pekin and the capital of a given country (for the euro area disctance to Brussels)	https://www.google.com/maps
Interest_rate_level	main policy interest rates	information from central banks' websites
Asset_purchases_past	dummy variable: 1 for central banks using asset purchases in the past, 0 – otherwise	
Credit_easing_past	dummy variable: 1 for central banks using credit easing in the past, 0 – otherwise	
Any_nonstandard_measure_past	dummy variable: 1 for central banks conducting asset purchases or credit easing in the past, 0 – otherwise	
CPI	average annual consumer price inflation	IMF WEO, April 2020
CPI_end	end-of-year consumer price inflation	IMF WEO, April 2020
CPI_forecast_2020	average annual consumer price inflation forecast for 2020	IMF WEO, October 2019
CPI_forecast_2021	average annual consumer price inflation forecast for 2021	IMF WEO, October 2019
CPI_deviation_from_target	difference between end-of-year consumer price inflation and inflation target (midpoint)	own calculation based on IMF data and information from central banks' websites
GDP_rate	annual GDP growth rate	IMF WEO, April 2020
GDP_rate_forecast_2020	annual GDP growth rate forecast for 2020	IMF WEO, October 2019
GDP_rate_forecast_2021	annual GDP growth rate forecast for 2021	IMF WEO, October 2019
Unemployment_rate	unemployment (% of total labor force)	IMF WEO, April 2020
Unemployment_rate_forecast_2020	unemployment rate forecast for 2020	IMF WEO, October 2019
Unemployment_rate_forecast_2021	unemployment rate forecast for 2021	IMF WEO, October 2019
Fiscal_balance_to_GDP	general government overall balance (% of GDP)	IMF, Fiscal Monitor Database
Public_debt_to_GDP	general government gross debt (% of GDP)	IMF, Fiscal Monitor Database
Trade_to_GDP	trade (% of GDP)	World Bank, World Development Indicators
Current_account_balance_to_GDP	current account balance (% of GDP)	IMF WEO, April 2020
Money_to_GDP	broad money (% of GDP)	IMF WEO, April 2020
Credit_to_GDP	domestic credit to private sector (% of GDP)	World Bank, World Development Indicators
Market_capitalisation_to_GDP	market capitalisation of listed domestic companies (% of GDP)	World Bank, World Development Indicators
Mature_IT	index describing how mature is an IT strategy as in Niedźwiedzińska (2020)	own calculation based on information from central banks' websites
Independent_IT	index describing how independent is a central bank as in Niedźwiedzińska (2020)	
Informed_IT	index describing how well informed are monetary policy decisions as in Niedźwiedzińska (2020)	
Explicatory_IT	index describing how transparent is a monetary policy decision-making process as in Niedźwiedzińska (2020)	
Transparent_IT	index describing how transparent is a central bank as in Niedźwiedzińska (2020)	
Accountable_IT	index describing how accountable is a central bank as in Niedźwiedzińska (2020)	
Fully_fledged_IT	index summarising all institutional features of an IT strategy as in Niedźwiedzińska (2020)	

Source: own compilation.

Table A 2 Overview of countries analysed

First caces of COVID-19 reported in:								
January*			February			March		
Economy	Country	Country code	Economy	Country	Country code	Economy	Country	Country code
A	Australia	AU	E	Brazil	BR	E	Chile	CL
A	Canada	CA	A	Iceland	IS	A	Czech Republic	CZ
A	Euro Area	EA	A	Israel	IL	E	Hungary	HU
E	India	IN	E	Mexico	MX	E	Indonesia	ID
A	Japan	JP	A	New Zealand	NZ	E	Poland	PL
A	Korea	KR	A	Norway	NO	E	South Africa	ZA
E	Philippines	PH	E	Romania	RO	E	Turkey	TR
E	Russia	RU	A	Switzerland	CH	E	Ukraine	UA
A	Sweden	SE	No. of cases		8	No. of cases		8
E	Thailand	TH	No. of advanced economies		5	No. of advanced economies		1
A	United Kingdom	GB	No. of emerging market economies		3	No. of emerging market economies		7
A	United States	US						
No. of cases		12						
No. of advanced economies		8						
No. of emerging market economies		4						

Source: own compilation.

Notes: * Russia and Sweden were included in the January groupe (the first cases of COVID-19 in those two countries were reported on 1st February 2020, while for other coutries included in the February group the first cases of COVID-19 were reported in late February). A denotes advanced economies, while E denotes emerging market economies.

Table A 3 Correlations between monetary policy response lag and various regressors

	Monetary_policy_ response_lag	Advanced_ economy	Distance_from_ Pekin	Start_of_ COVID19	Interest_rate_ level	Asset_purchases _past	Credit_easing_ past
Monetary_policy_ response_lag	1.00						
Advanced_economy	0.53	1.00					
Distance_from_Pekin	-0.29	-0.12	1.00				
Start_of_COVID19	-0.80	-0.43	0.34	1.00			
Interest_rate_level	-0.45	-0.65	0.06	0.41	1.00		
Asset_purchases_past	0.37	0.32	-0.12	-0.18	-0.24	1.00	
Credit_easing_past	0.57	0.32	-0.33	-0.37	-0.40	0.48	1.0
CPI	-0.40	-0.50	0.05	0.45	0.85	0.07	-0.2
CPI_deviation_from_ target	-0.25	-0.33	0.08	0.36	0.47	0.19	-0.2
CPI_forecast_2021	-0.43	-0.55	0.11	0.47	0.81	0.08	-0.3
GDP_rate	-0.33	-0.32	-0.42	0.13	0.01	-0.09	-0.2
GDP_rate_forecast_2021	-0.33	-0.50	-0.29	0.04	0.29	-0.30	-0.3
Unemployment_rate	-0.23	-0.34	0.40	0.34	0.48	-0.03	-0.1
Unemployment_rate_ forecast_2021	-0.21	-0.31	0.37	0.34	0.45	-0.04	-0.1
Fiscal_balance_to_GDP	0.02	0.36	-0.27	-0.09	-0.30	-0.18	0.3
Public_debt_to_GDP	0.55	0.26	-0.09	-0.32	-0.24	0.47	0.2
Trade_to_GDP	-0.20	0.00	-0.20	0.33	-0.19	0.00	0.2
Current_account_balance _to_GDP	0.20	0.34	-0.45	-0.25	-0.28	0.04	0.4
Money_to_GDP	0.69	0.51	-0.25	-0.52	-0.52	0.31	0.4
Credit_to_GDP	0.51	0.62	0.06	-0.43	-0.49	0.22	0.1
Market_capitalisation_to _GDP	0.23	0.34	0.14	-0.15	-0.28	-0.06	0.1
Mature_IT	0.28	0.51	0.01	-0.22	-0.71	0.08	0.2
Independent_IT	-0.23	-0.14	-0.42	0.23	0.09	0.09	0.2
Informed_IT	0.26	0.24	-0.13	-0.36	-0.19	0.12	-0.0
Explicatory_IT	0.26	0.25	-0.01	-0.14	-0.38	0.17	-0.0
Transparent_IT	0.39	0.32	0.03	-0.16	-0.48	0.44	0.2
Accountable_IT	-0.16	0.14	-0.38	0.08	-0.07	0.00	0.1
Fully_fledged_IT	0.23	0.38	-0.26	-0.15	-0.51	0.27	0.2

Notes: See next page.

Table A 3 Correlations between monetary policy response lag and various regressors (continued)

	CPI	CPI_deviation_from_target	CPI_forecast_2021	GDP_rate	GDP_rate_forecast_2021	Unemployment_rate	Unemployment_rate_forecast_2021
Credit_easing_past							
CPI	1.00						
CPI_end	0.94						
CPI_deviation_from_target	0.81	1.00					
CPI_forecast_2021	0.97	0.81	1.00				
GDP_rate	-0.03	0.08	-0.02	1.00			
GDP_rate_forecast_2021	0.18	0.22	0.21	0.74	1.00		
Unemployment_rate	0.44	0.24	0.56	-0.31	-0.10	1.00	
Unemployment_rate_forecast_2021	0.41	0.22	0.53	-0.30	-0.11	1.00	1.00
Fiscal_balance_to_GDP	-0.31	-0.35	-0.39	-0.14	-0.31	-0.45	-0.44
Public_debt_to_GDP	-0.22	-0.17	-0.23	-0.20	-0.34	-0.03	-0.04
Trade_to_GDP	-0.06	0.04	-0.14	0.19	-0.09	-0.27	-0.24
Current_account_balance_to_GDP	-0.22	-0.32	-0.27	-0.23	-0.22	-0.32	-0.32
Money_to_GDP	-0.45	-0.32	-0.43	-0.30	-0.33	-0.19	-0.19
Credit_to_GDP	-0.42	-0.34	-0.36	-0.50	-0.47	0.03	0.04
Market_capitalisation_to_GDP	-0.33	-0.36	-0.23	-0.42	-0.32	0.43	0.46
Mature_IT	-0.65	-0.36	-0.64	-0.11	-0.33	-0.43	-0.38
Independent_IT	0.13	0.07	0.03	0.40	0.15	-0.41	-0.40
Informed_IT	-0.08	0.00	-0.16	-0.04	-0.14	-0.30	-0.32
Explicatory_IT	-0.40	-0.19	-0.46	0.01	-0.03	-0.34	-0.35
Transparent_IT	-0.32	0.02	-0.32	-0.02	-0.08	-0.17	-0.18
Accountable_IT	-0.07	-0.06	-0.13	0.06	-0.05	-0.44	-0.45
Fully_fledged_IT	-0.41	-0.14	-0.49	0.10	-0.13	-0.60	-0.59

	Fiscal_balance_to_GDP	Public_debt_to_GDP	Trade_to_GDP	Current_account_balance_to_GDP	Money_to_GDP	Credit_to_GDP	Market_capitalisation_to_GDP
GDP_rate							
GDP_rate_forecast_2021							
Unemployment_rate							
Unemployment_rate_forecast_2021							
Fiscal_balance_to_GDP	1.00						
Public_debt_to_GDP	-0.27	1.00					
Trade_to_GDP	0.39	-0.30	1.00				
Current_account_balance_to_GDP	0.51	-0.05	0.33	1.00			
Money_to_GDP	-0.02	0.73	-0.24	0.25	1.00		
Credit_to_GDP	0.14	0.36	-0.33	0.19	0.66	1.00	
Market_capitalisation_to_GDP	-0.09	0.22	-0.08	0.31	0.36	0.62	1.00
Mature_IT	0.35	0.10	0.20	0.25	0.23	0.21	0.17
Independent_IT	0.31	-0.29	0.54	0.37	-0.45	-0.65	-0.52
Informed_IT	0.23	0.06	0.25	0.15	0.23	0.25	-0.23
Explicatory_IT	0.05	0.37	0.01	-0.12	0.42	0.39	-0.19
Transparent_IT	0.00	0.42	0.01	-0.14	0.43	0.37	-0.12
Accountable_IT	0.51	-0.16	0.28	0.20	0.14	0.06	-0.45
Fully_fledged_IT	0.41	0.14	0.38	0.21	0.26	0.14	-0.41

	Mature_IT	Independent_IT	Informed_IT	Explicatory_IT	Transparent_IT	Accountable_IT	Fully_fledged_IT
Public_debt_to_GDP							
Trade_to_GDP							
Current_account_balance_to_GDP							
Money_to_GDP							
Credit_to_GDP							
Market_capitalisation_to_GDP							
Mature_IT	1.00						
Independent_IT	0.24	1.00					
Informed_IT	0.05	0.00	1.00				
Explicatory_IT	0.25	-0.11	0.43	1.00			
Transparent_IT	0.24	-0.13	0.31	0.84	1.00		
Accountable_IT	0.10	0.27	0.16	0.26	0.14	1.00	
Fully_fledged_IT	0.57	0.41	0.52	0.75	0.69	0.53	1.00

Source: own compilation based on data indicated in Table A 1.

Table A 4 Additional estimation results – part 1

Explanatory variables	(A1)	(A2)	(A2.1)	(A3)	(A4)	(A5.1)	(A5.2)	(A5)
Constant	29.91 ***	29.11 ***	28.69 ***	29.25 ***	30.08 ***	29.06 ***	29.3 ***	30.41 ***
	(3.93)	(3.75)	(3.5)	(3.46)	(3.87)	(3.61)	(3.6)	(3.98)
Start_of_COVID19	-10.43 ***	-10.09 ***	-10.75 ***	-10.51 ***	-10.54 ***	-10.73 ***	-10.64 ***	-11.02 ***
	(-4.26)	(-4.02)	(-4.15)	(-4.14)	(-4.2)	(-4.13)	(-4.04)	(-4.36)
Credit_easing_past	10.42 **	10.42 **	10.94 **	10.49 **	9.45 *	10.35 **	10.43 **	10.54 **
	(2.25)	(2.22)	(2.25)	(2.2)	(1.82)	(2.19)	(2.2)	(2.27)
Money_to_GDP	0.11 **	0.1 *	0.11 **	0.12 **	0.11 **	0.12 **	0.12 **	0.12 **
	(2.41)	(1.93)	(2.36)	(2.26)	(2.27)	(2.38)	(2.35)	(2.52)
Advanced_economy		3.25						
		(0.78)						
Distance_from_Pekin			0					
			(0.47)					
Interest_rate_level				0.14				
				(0.2)				
Asset_purchase_past					2.02			
					(0.44)			
CPI						0.29		
						(0.42)		
CPI_forecast_2021							0.24	
							(0.26)	
CPI_deviation_from_target								1.1
								(0.96)
No. of observations	25	25	25	25	25	25	25	25
R-squared	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.79
Adjusted R-squared	0.75	0.74	0.74	0.73	0.74	0.74	0.73	0.75
F-statistic	24.59 ***	18.25 ***	17.81 ***	17.61 ***	17.79 ***	17.76 ***	17.64 ***	18.61 ***
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own computations based on data collected from sources indicated in Table A 1.
Notes: Significance codes: '***' 0.01, '**' 0.05, '*' 0.1. T-statistics in parenthesis.

Table A 5 Additional estimation results – part 2

Explanatory variables	(A1)	(A6.1)	(A6.2)	(A6)	(A7.1)	(A7)	(A9.1)	(A9.2)
Constant	29.91 ***	35.31 ***	38.07 ***	25.06 ***	28.85 ***	31.34 ***	30.35 ***	30.59 ***
	(3.93)	(4.12)	(3.73)	(3.19)	(3.79)	(4.09)	(3.64)	(3.91)
Start_of_COVID19	-10.43 ***	-10.65 ***	-11.31 ***	-9.21 ***	-10.47 ***	-10.86 ***	-10.28 ***	-10.81 ***
	(-4.26)	(-4.41)	(-4.46)	(-3.5)	(-4.32)	(-4.42)	(-3.8)	(-4.21)
Credit_easing_past	10.42 **	10.18 **	8.78 *	11.91 **	12.2 **	10.44 **	10.7 **	10.73 **
	(2.25)	(2.23)	(1.83)	(2.6)	(2.52)	(2.27)	(2.09)	(2.26)
Money_to_GDP	0.11 **	0.1 *	0.09 *	0.12 **	0.10 **	0.06	0.11 **	0.11 **
	(2.41)	(2.02)	(1.93)	(2.7)	(2.21)	(0.95)	(2.28)	(2.39)
GDP_rate		-1.48						
		(-1.3)						
GDP_rate_forecast_2021			-1.56					
			(-1.19)					
Unemployment_rate				0.1				
				(0.28)				
Fiscal_balance_to_GDP					-0.69			
					(-1.18)			
Public_debt_to_GDP						0.07		
						(1.15)		
Trade_to_GDP							-0.01	
							(-0.15)	
Current_account_balance_ to_GDP								-0.36
								(-0.6)
No. of observations	25	25	25	24	25	25	25	25
R-squared	0.78	0.80	0.79	0.80	0.79	0.79	0.78	0.78
Adjusted R-squared	0.75	0.75	0.75	0.76	0.75	0.75	0.73	0.74
F-statistic	24.59 ***	19.48 ***	19.16 ***	19 ***	19.13 ***	19.04 ***	17.59 ***	17.97 ***
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own computations based on data collected from sources indicated in Table A 1.
Notes: Significance codes: '***' 0.01, '**' 0.05, '*' 0.1. T-statistics in parenthesis.

Table A 6 Additional estimation results – part 3

Explanatory variables	(A1)	(A8.1)	(A8.2)	(A8.3)	(A8.4)	(A8.5)	(A8.6)	(A8)
Constant	29.91 ***	27.83 **	34.08 **	30.15 *	23.16 **	20.61 *	51.2 ***	31.34 *
	(3.93)	(2.34)	(2.84)	(1.94)	(2.15)	(1.89)	(4.68)	(1.77)
Start_of_COVID19	-10.43 ***	-10.39 ***	-10.29 ***	-10.44 ***	-10.45 ***	-10.81 ***	-9.54 ***	-10.43 ***
	(-4.26)	(-4.14)	(-4.1)	(-3.94)	(-4.25)	(-4.42)	(-4.29)	(-4.16)
Credit_easing_past	10.42 **	10.38 **	11.29 **	10.41 **	10.69 **	9.5 *	12.93 ***	10.5 **
	(2.25)	(2.18)	(2.21)	(2.16)	(2.29)	(2.04)	(3.02)	(2.17)
Money_to_GDP	0.11 **	0.11 **	0.10 *	0.11 **	0.10 *	0.09 *	0.12 ***	0.11 **
	(2.41)	(2.3)	(1.85)	(2.34)	(1.88)	(1.83)	(2.91)	(2.34)
Mature_IT		0.29						
		(0.23)						
Independent_IT			-0.63					
			(-0.46)					
Informed_IT				-0.03				
				(-0.02)				
Explicatory_IT					1.43			
					(0.89)			
Transparent_IT						1.63		
						(1.18)		
Accountable_IT							-3.38 **	
							(-2.49)	
Fully_fledged_IT								-0.22
								(-0.09)
No. of observations	25	25	25	25	25	25	25	25
R-squared	0.78	0.78	0.78	0.78	0.79	0.79	0.83	0.78
Adjusted R-squared	0.75	0.73	0.74	0.73	0.74	0.75	0.8	0.73
F-statistic	24.59 ***	17.62 ***	17.8 ***	17.56 ***	18.46 ***	19.13 ***	24.55 ***	17.57 ***
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: own computations based on data collected from sources indicated in Table A 1.

Notes: Significance codes: '***' 0.01, '**' 0.05, '*' 0.1. T-statistics in parenthesis.

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