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Nowcashing: Using Daily Fiscal Data for Real-Time Macroeconomic Analysis

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Abstract

Traditionally, fiscal data for policy analysis are derived from official reports that, depending on the country, are published either monthly, quarterly or annually, often with significant time lags. However, innovations in digitalization of government payments and accounting systems mean that real-time daily fiscal data exist in many countries. In this paper, we argue that these data contain valuable, but underutilized and underexploited information. Possible uses include (i) real-time fiscal surveillance which allows for much more timely responses to emerging signs of fiscal stress, and (ii) nowcasting economic activity, which is especially useful in countries where higher frequency GDP statistics are unavailable.

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I. INTRODUCTION

Increasingly, countries at all levels of income are consolidating their government banking arrangements and implementing information technology (IT) systems designed to automate the management of the public finances. These systems record information on thousands, and frequently millions, of government transactions, allowing construction of daily data series in a range of fiscal aggregates and indicators. This paper shows how these data can complement conventional data and statistics for governments and researchers, in particular, by enabling real-time macroeconomic analysis, which is not feasible using conventional fiscal statistics.

Fiscal data include information on revenue aggregates, such as revenue collected by tax type (such as income taxes, indirect taxes, and excises); public expenditure aggregates (such as the government wage bill, goods and services, and capital expenditure); and financing items (such as debt issuance and use of financial assets). Traditionally, analysis based on fiscal data is carried out using official fiscal statistics (monthly, quarterly, or even annual, depending on the country). These are frequently published with a significant lag. Even in those economies that produce monthly fiscal reports, publication delays can be long enough that it limits use for signaling imminent fiscal events or other macroeconomic shocks.

By contrast, using information from transactions processed through government financial management IT systems, fiscal data can be produced daily, and potentially even more frequently. In addition, reliability and accuracy of such high frequency data are typically very high when measured in terms of ex post revisions (which tend to be small, at least in cash terms).

To date, this data source has largely been underexplored and underexploited, despite the seemingly obvious value that it can provide for a variety of stakeholders, including governments and multilateral organizations. For example, trends in daily fiscal data can mirror a large array of macroeconomic developments in real time. However, usage hinges on data availability and on whether useful information can be extracted and aggregated, given that daily fiscal data are inevitably subject to significant noise and complex seasonal patterns, and sometimes come in a highly disaggregated format.

The paper makes two contributions to the public finance and relevant macroeconomic literature. First, it shows that due to the digitization of public finances daily fiscal data are available and relatively easily accessible for a diverse range of countries. For some countries, daily cash flow data are even public (such as the United States and Brazil). Second, the paper provides evidence that procedures to remove noise and seasonality from daily fiscal data are relatively easy to apply. As demonstrated through case studies, those procedures make such data useful for a variety of purposes, including (1) fiscal surveillance and management; (2) prediction of economic activity for the present, the near future, or the recent past, often referred to as *nowcasting*;[1] and (3) key analytical macro-fiscal work, such as research estimating the size of fiscal multipliers.

[1] As discussed in Banbura and others (2013), nowcasting relies on real-time updating of economic series, providing forecasting gains, particularly for very short time horizons. By contrast, *nowcashing* refers to the use of daily fiscal data which are mostly cash-based for various types of real-time macroeconomic analyses, including nowcasting.

Taken together, the revolution in the use of IT systems over the last 20 years has created an opportunity to take advantage of high frequency and reliable fiscal data. Availability will only increase in the future, as the digitization of public finances progresses and as more countries automate the recording and reporting of their fiscal activities. Ongoing improvements in technology and accounting and reporting standards will also improve the quality of high frequency fiscal data. Finally, increasing demand for greater transparency in government operations is leading a push for more daily data.

This paper first provides background information on the information technology generating daily fiscal data and broad characteristics of the data, then examines the characteristics of the data set. It follows with case studies, and finishes with a look at the future.

II. Generation of Daily Fiscal Data

Two significant innovations in public financial management that have taken place largely over the last 20 years have changed the landscape for the availability of high frequency fiscal data. First, the introduction of Financial Management Information Systems (FMIS) has significantly advanced the automation of government financial management processes. FMIS systems are used to manage public finances at each stage of the budget process, including formulation, execution, government payment systems, and accounting and financial reporting.[2]

Second, increasing efforts to consolidate government banking arrangements have accompanied these advances. The centralization of government cash balances and accounts through the establishment of a treasury single account (TSA) system—used to pool all available cash resources—has also been an important element of public financial management reform programs. Without such consolidation of government banking arrangements, the ability to introduce IT systems and processes such as FMIS would undoubtedly have been much more complex and likely unsuccessful in many instances.

A. Financial Management Information Systems

The backbone of most FMIS is the general ledger, which records details of all government financial transactions for preparing financial and fiscal reports on operations. FMIS solutions typically allow for automatic posting of all revenue, expenditure, and financing transactions flowing through the FMIS to the general ledger, making the quality of the data reliable (at least for cash-based transactions) and frequency extremely high. For most FMIS, daily reporting is

[2] Many countries use historical data for cash forecasting purposes but in many cases this data has not been available in real time. It is only with the advent of IFMIS systems that this has been feasible. Even so, many countries still do not take full advantage of the data in their systems and certainly not for broader fiscal policy analysis. The use of data for cash management purposes is also rarely published, although as the paper points out some countries are beginning to do this. It is time for more countries to start to do likewise.

likely to be feasible. And, dependent on the level of coverage of transactions flowing through the FMIS system, the capacity to produce data on the fiscal position is achievable.

While not yet ubiquitous, many countries have now introduced FMIS. A World Bank survey, (Dener and Min 2013), indicates the availability of 176 FMIS platforms across the globe, suggesting that the usage of such systems is now widespread. The degree to which many of these systems are fully operational and the breadth of coverage is less clear. As of January 2017, however, a World Bank FMIS database indicated that of 133 projects at least partially funded by the World Bank since 1984, and which included the implementation of a FMIS as a component, 97 have been completed, while 29 are still active and 7 are pending. This means that daily fiscal data could be available to a greater or lesser degree in at least 97 economies.[3]

The level of investment in these systems has also been high. World Bank funded projects alone have cost more than $2.2 billion during this period (Dener, Watkins, and Dorotinsky 2011), not counting projects funded by other donors and by national governments themselves.

The coverage of government by FMIS systems can be a constraining factor, especially in emerging markets and developing economies. Initially, many FMIS systems were limited in coverage to little beyond the central state budget and occasionally only to central ministries and agencies. However, increasingly, coverage is being extended to the entire central government and in some cases beyond. Central government, in addition to the state budget, can include extra-budgetary funds such as social security funds and subordinate agencies of line ministries (such as educational or health institutions). In some limited cases, the coverage of the systems has been extended to the general government and includes subnational government transactions (such as France or Kosovo).[4]

Another constraint of FMIS revenue and expenditure data is that, in many countries, it is cash-based and takes little account of noncash-based transactions, especially if public accounting standards are cash rather than accrual based.[5] This can be an issue in getting a full picture of government operations. These omissions could include details on accounts payable and receivables, the stocks of financial and nonfinancial assets and liabilities, and other stock and flow adjustments that could impact on the overall picture of the government's finances.

However, despite the absence of balance sheet information (which is also often absent in formal fiscal reports for countries that use a cash basis for public accounting), access to immediate and reliable cash-based data offers many benefits, including real-time information on major fiscal aggregates. In addition, many governments are transitioning from cash- to accruals-based

[3] The number is likely higher, as it does not include those systems that have been developed without World Bank assistance, including in the majority of advanced economies.

[4] However, most countries do not include subnational governments within the coverage of their FMIS systems, both for reasons of over-complexity and, in many cases, the difficulty of including what are frequently autonomous entities within the remit of a centrally controlled financial management system.

[5] For a definition of the different types and scopes of public accounting systems as well as their advantages and disadvantages, see Irwin (2015), for example.

accounting standards, facilitated by the availability of FMIS systems that have full accruals based accounting systems.[6] It is therefore likely that over time the ability to track all stocks and flows, more or less in real time, will steadily improve as this transition takes hold.[7]

B. Consolidation of Government Bank Accounts

A TSA is a unified structure of government bank accounts through which the government transacts all its receipts and payments, allowing for a consolidated overview of its cash position in real time or at least daily. This enables the government to manage its cash efficiently and ensure it has the resources to finance ongoing government operations (Gardner and Olden 2013). It also offers the opportunity to de-link control over expenditures from cash management operations. In most advanced economies, and increasingly in emerging market and developing economies, nearly all revenues are consolidated daily in a TSA. Typically, the main treasury account of the TSA system of accounts is held at the central bank and is used for receiving all government revenues and making government payments.[8]

Revenues and payments can be either centrally managed by a treasury or decentralized to individual agencies and line ministries. However, in both cases, all government financial resources are managed through a single account structure. Most advanced economies include all or most of the central government account within coverage of the TSA and the trend in other countries has been to continue to broaden the coverage. It has become international good practice to include many government-controlled trust funds and extra-budgetary funds within the TSA (Pattanayak 2010).

III. Characteristics of Daily Fiscal Data

Daily fiscal data as defined for the purposes of this paper include transaction-based data on various aggregates and indicators of revenue collected, government spending, financing flows (such as borrowing and debt repayment), and government cash balances for each business day.

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[6] Most countries continue to use cash-based accounting or some modified version for reporting rather than full accruals, although the number of countries adopting accrual standards is increasing. According to IMF 2016a, in 2015, 41 governments completed the transition to accrual accounting, while 16 governments account on a modified accrual basis, 28 governments are operating on a modified cash basis, and 114 governments still use pure cash accounting.

[7] Unexpected accumulation of expenditure arrears may also distort information on government activities using cash data (Flynn and Pessoa 2014). However, as discussed later, daily fiscal data can in fact help to identify patterns of arrears accumulation and even help the government improve its mapping of fiscal activities.

[8] While a full survey of country TSA coverage has yet to be carried out, regional studies have demonstrated that the implementation of TSAs is widespread. For example, IADB (2015) indicates that 13 out of 17 Latin American countries studied have legislated for a TSA. A similar situation exists in Europe, where the majority of advanced and emerging economies now operate a TSA of various levels of coverage. In Africa, except Nigeria and South Africa, while TSAs are nominally in place, the presence of multiple bank accounts outside the coverage of TSAs is widespread. Nevertheless, the situation is continually improving.

A. Advantages

Relative to official fiscal statistics published either monthly, quarterly, or even annually, daily fiscal data have several advantages.

- *Relatively low accessibility costs*: The significant investment that has already taken place in developing FMIS systems and consolidating government banking arrangements means that the infrastructure to provide high frequency fiscal data is already in place. Most FMIS systems can transfer the data easily into common data formats or into databases and portals that can be configured for analytical purposes at little or no cost. As outlined above, many countries already post significant volumes of data on their fiscal activities on their websites and some include daily data (such as the United States).
- *Timeliness*: At present, most formal fiscal statistics are published with a significant lag, which limits their usefulness even in economies that produce monthly fiscal reports, especially in periods of rapid economic change and imminent fiscal events. Access to timely and accurate data can better inform policy decisions needed to react quickly to unfolding events (Box 1).
- *Accuracy*: Because the data are transaction-based, and generated from accounting systems, they can be relied upon as an accurate picture of government activities in real time. Once the coverage of the FMIS is complete, there should be no ambiguity as to the accuracy of the data (at least in cash terms).
- *Fiscal Transparency:* Daily fiscal data also enhance fiscal transparency, thereby increasing the credibility of public finances (for example, see IMF 2007; Félix 2011; Poplawski-Ribeiro and Ruelke 2011; and Wang, Irwin, and Murara 2015). Making daily fiscal data publicly available is not technically challenging and governments are coming under increased scrutiny and face ongoing demands for greater transparency (for example, see Stiglitz 2001 and Darbishire 2009), which in turn led to an increase in the number of countries where high frequency fiscal data are published online (see Box 2 for a related discussion).

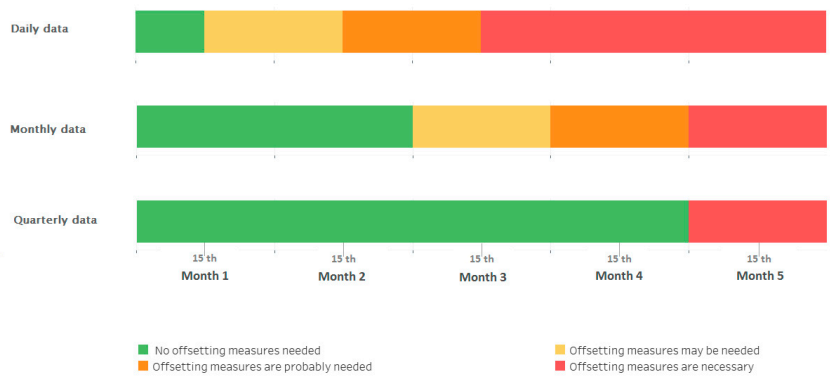
Box 1. Advantages of Daily Fiscal Data for Timeliness: The VAT Revenue Case

The advantage of daily fiscal data can be illustrated by observing how differences in the frequency of value added tax (VAT) revenue data can lead to different conclusions.

Consider a hypothetical scenario where VAT revenue underperforms expectations within a given quarter. Assume that all VAT revenue comes in on the due date—the 15th of each month—and that monthly and quarterly fiscal data are published one month after the end of the reporting period. The time it takes for signs of fiscal stress to first emerge under daily, monthly, and quarterly fiscal reporting can be quite striking.

Figure 1.1 illustrates the simulated "perceived" level of fiscal stress depending on the frequency of revenue data that are available. With daily data, the first warning signs appear immediately after the 15th of each month, suggesting that offsetting measures could be necessary. With monthly data, instead, the first warning signs take six weeks to materialize (that is, it takes 2 weeks to complete the month, and the publication delay is approximately another 4 weeks). After 10 weeks, that is, before the completion of the quarter, examining daily data already provides full certainty that VAT revenue performance within that particular quarter was poor and that offsetting measures are required. With monthly and quarterly data, the same insights and the same level of certainty are only available after 16 weeks.

Figure 1.1. Perceived Level of Fiscal Stress



Source: Authors' compilation.

B. Data Access and Data Collected

Table 1 shows the daily fiscal data collected for this paper, which has been sourced from four countries including Brazil, Kosovo, Slovenia, and the United States. Each of these has distinct characteristics. Except for Brazil and the United States, the data cover only relatively short and recent time series, which probably reflects (at least in part) the time when governments acquired the relevant technical capacity (such as relevant IT systems). Although many governments now have IT systems in place that collect high quality, transactional-level data, most countries do not make the data publicly available. Brazil and the United States are exceptions and provide online and unrestricted access to daily fiscal data.

Table 1. Overview of Data Sources

Country	Series Coverage	Access	Level of Disaggregation	Classification of Line Items	Coverage of Government
Brazil	Since 2013	Public	Highly disaggregated, requires calculating relevant aggregates	Economic	Central government
Kosovo	Since 2011	Non-public	Aggregated (most relevant fiscal aggregates contained in data)	Economic	General government
Slovenia	Since 2013	Non-public	Aggregated (most relevant fiscal aggregates contained in data)	Economic	Central government
United States	Since 1989	Public	Aggregated, but some aggregates are based on an institutional classification	Some economic, some institutional	Central government

Source: Brazilian Ministry of Transparency, Supervision and Control; Republic of Kosovo Ministry of Finance; Slovenian Ministry of Finance; U.S. Treasury Department; and authors' compilation.

In most cases, daily fiscal data come in a reasonably aggregated format, in that they contain a fairly limited number of line items that already sum up individual transactions from different government bodies and line ministries. Brazil is an exception, with data made public online through the *Transparency Portal*. This data are highly disaggregated and contain line items for each governmental body collecting or spending public money or by the classification of the revenue and spending item (Box 2). However, the availability of the data in aggregated form does not mean that they cannot be further disaggregated. The data have for the most part been generated from FMIS systems that contain transactional-based data that theoretically could be reported on an individual basis. The level of aggregation is, in principle, a user choice in determining the level of detail they wish to publish.

Box 2. Daily Fiscal Data and Fiscal Transparency: Brazil

The Brazilian government provides daily fiscal data publicly through the internet website *Transparency Portal,*[1] which is managed by the Ministry of Transparency, Supervision and Control and was launched in 2004 to increase the transparency of Brazilian public financial management.[2] It publishes a myriad of information about Brazilian central government public finances, federal civil servants (including organograms), and contractual companies working for the federal government, among others. In particular, the portal provides daily fiscal data series on:

- **Revenues**: budgeted, authorized, and realized daily nominal revenues organized by: (1) the *collecting unit*, categorized at three different hierarchical levels (that is, from the office level such as tax administration, government foundation, public federal universities, and so on, up to the ministerial level of the collecting office); and (2) the *revenue category*, classified at six distinct levels (that is, from the specific revenue items such as different royalties, taxes, fees, and up to the broad economic category of *current* and *capital* revenues).

- **Direct spending**: realized daily spending organized by: (1) *spending unit*, categorized into three distinct hierarchical levels (that is, from the entity level, including public federal universities and federal offices, and up to the ministerial level of the spending office); and (2) *spending category*, classified by six distinct levels (that is, from the specific action items and up to the broad economic classification of *financial investment*, *public investment*, and *other (current) spending*). The data also provide the names of companies and individuals receiving the payment.

- **Transfers**: public transfers to states and municipalities and other programs not managed by the federal government. It again provides the names of public bodies, private companies, and individuals receiving the federal transfers.

Revenue data series are available for consultation from 2004 onward and for download from 2013 onward, whereas the series for expenditure are available for consultation from 2009 and for download from 2011. They can be downloaded in a common data format. A single file, detailing revenue collected (non-cumulative), is created each business day. The information is uploaded to the site with a one-day lag and is highly disaggregated. As an example, the June 20, 2016 file contains 3,718 entries (rows). For expenditures, a single monthly file is created, which includes daily non-cumulative data, again, highly disaggregated. For example, the December 2015 file contains 1,563,737 entries (rows). Data on previous months are maintained on the site.

Finally, the website includes several user-friendly snapshots of the data by different categories, themes, and programs for public consultation (such as public spending related to the Bolsa-Familia pro-poor spending program or details of spending on the 2014 World Cup and the 2016 Rio de Janeiro Olympics).

[1] www.transparencia.gov.br.
[2] For more information on fiscal transparency in Brazil see Félix 2011. For information about the Brazilian public financial management and fiscal framework see Celasun and others (2015).

The classification of the line items differs across countries. For Kosovo and Slovenia, fiscal aggregates included in the data follow economic classification, which are broadly in accordance with international standards (such as the IMF's Government Finance Statistics Manual 2014),

allowing for international comparison. For the United States, some of the aggregates included in the data follow an institutional classification which complicates international comparisons. In the case of Brazil, for more aggregate categories of revenues and spending, the format is also in accordance with international standards.

In most cases, daily fiscal data are not available for subnational governments (or at least not provided by central governments), implying that coverage is here restricted to central government. In this respect, Kosovo is a notable exception in the sense that the central government has IT systems in place that also generate daily fiscal data for general government (which encompasses both central and subnational governments).

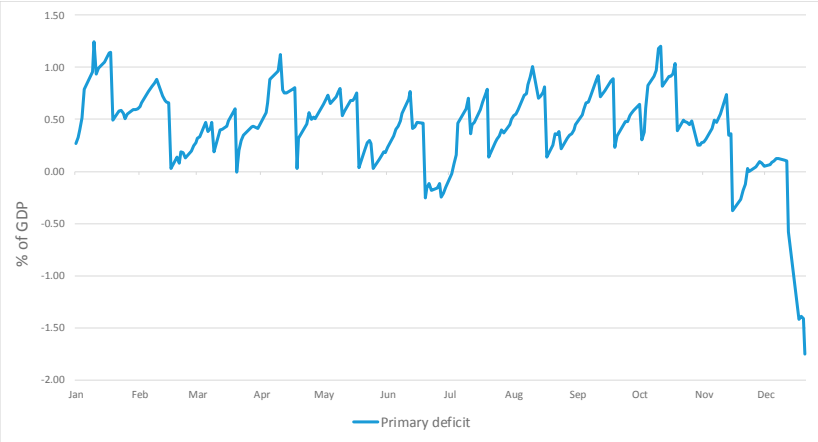
C. Volatility and Noise

As with any high-frequency data, daily fiscal data are inevitably subject to substantial noise and complex seasonal patterns. Noise in the data results from a variety of factors. On the revenue side, large one-off items such as dividends of state-owned enterprises, tax returns of particularly large taxpayers (such as the Brazilian oil company Petrobras), and the idiosyncratic time pattern of refunds paid to taxpayers often lead to significant day-to-day fluctuations in revenue collected. On the expenditure side, noise often results from public spending on large capital projects (such as one payment may represent a significant share of capital expenditure) or large purchases of goods and services.

Seasonal patterns reflect the institutional features of fiscal policy, such as due dates of tax returns; payment dates for social transfers, including unemployment benefits and pensions; and public wages. In addition, common features of budgetary management can exacerbate seasonality. For instance, capital expenditure is often heavily skewed towards the last month or even last days of the fiscal year. This is especially the case in countries in economies where there are restrictions on carryovers of budget appropriations to the next fiscal year, incentivizing a rush to spend so as not to forfeit allocated budget resources.

The primary budget balance, which represents the difference between total revenue and the sum of all expenditure (except for interest spending), reflects this seasonality and noise. For example, Figure 1 plots the cumulative primary balance for each business day (which is the difference between cumulative revenue minus cumulative expenditure up to that day) in percent of annual GDP for Kosovo in 2015. While Kosovo faced a primary deficit in 2015 based on annual data (that is, there was a primary deficit on December 31, 2015), the figure shows that for many months during that year, Kosovo was actually running a surplus. This seasonal pattern of the budget balance is fairly standard and driven by the disconnect between revenue collection—which is to some extent concentrated in the first couple of months of the fiscal year (when annual tax returns are due)—and expenditure, which is either spread relatively equally throughout the year (most types of current spending) are concentrated at the end of the fiscal year (capital spending).

Figure 1. Primary Deficit



Source: Republic of Kosovo Ministry of Finance and authors' calculations.

IV. PROCESSING AND SMOOTHING

In this paper, we adopt a fairly simple method to remove noise and seasonality in the main revenue and expenditure items (see in the section on "Applications of Daily Fiscal Data" and references therein for other statistical methods). Here, we only consider *year-over-year changes (growth rates)* in the *cumulative* sum of the values of a particular series (say, total expenditures in local currency) over a longer period (such as the rolling sum over the last few months, or sum from the beginning of the year).

If the period is sufficiently long, *cumulative* and *rolling* sums are less affected by idiosyncratic day-to-day differences in the amount of revenue collected or money spent by governments (also see Lachowska 2016, who uses moving averages to smooth a different type of daily data which is similar). Computing year-over-year changes is a common, albeit fairly basic, way of removing seasonality from macroeconomic data (see FED-Dallas 2014; and IMF 2014a). Here, it is important that data from a specific day is related to the same day in the previous year. The caveat of compiling year-over-year growth rates is that there are inevitably missing observations for some days if the same day of the previous year was not a business day, implying that no daily fiscal data in the previous year for that day are available. For this paper, this smoothing technique is applied to the different case studies investigated, generating the following:

- Kosovo—the year-over-year change in cumulative central government tax revenue since the beginning of the fiscal year.
- Brazil—the year-over-year change in cumulative public investment over a three-month rolling window.
- United States—the year-over-year change in cumulative payroll tax revenue over rolling windows of 60 and 180 business days.

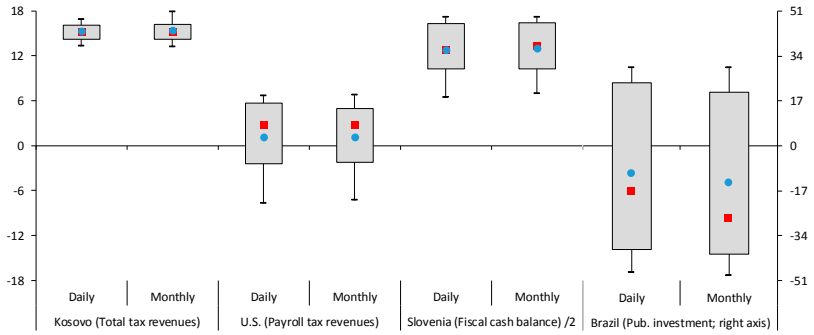
In the latter case, a 10-day moving average filter is used to further smooth the growth rates. Finally, the daily cash balances in percent of annual GDP in Slovenia are considered, but in this case, smoothing is not necessary as explained below. The annex provides descriptive statistics for those series, including more details on time span of the data. Figure 2 displays the box plots of

the distribution of each of those series. Importantly, once these techniques have been used, daily data are not significantly noisier than the same series at monthly frequency.

Figure 2 further compares the standard deviation of the same series discussed above using monthly data (also see annex table). Those series contain only observations of the last day of the month. The comparison shows that the standard deviation and the distribution for both monthly and daily data are of a similar order of magnitude. This again indicates that the approach used in the paper ensures that the level of noise in daily data is not higher than in monthly data.

Figure 2. Fiscal Data at Daily and Monthly Frequencies[1]

(Growth rates in percent; unless stated otherwise)



Source: Brazilian Ministry of Transparency, Supervision and Control; Republic of Kosovo Ministry of Finance; Slovenian Ministry of Finance; U.S. Treasury Department; and authors' calculations.

[1] Percentiles of the distribution: 10th, bottom line; 25th bottom of box; 75th, top of box; 90th top line. Blue circle reports the mean and red box reports the median.

[2] Cash balance is denoted in levels and as in percentage of GDP.

V. Applications of Daily Fiscal Data

A. Fiscal Surveillance and Management

This section presents several case studies that show how daily fiscal data can enhance fiscal surveillance and management. The benefits of using daily fiscal as opposed to lower frequency data for monitoring key revenue and expenditure aggregates as part of fiscal surveillance include, but are not limited to, the timeliness of the data.[9]

[9] At present, fiscal surveillance mechanisms do not even make use of quarterly fiscal data. Onorante and others (2010) and Asimakopoulos, Paredes, and Warmedinger (2013), for instance, discuss how quarterly or monthly fiscal indicators are already used by European policy makers but note that, albeit these indicators represent one of the main sources of publicly available intra-annual fiscal information in the European Union, they are not formally included in the European multilateral fiscal surveillance process. The authors then make the case for formal inclusion of Europe's surveillance process through either a mixed-frequency state-space econometric model (Onorante and others 2010) or through the employment of MIDAS (Asimakopoulos, Paredes, and Warmedinger 2013).

Tax revenue monitoring and forecasting

In the first case study, we demonstrate that the availability of daily fiscal data considerably improves the relevance and immediacy of the tax revenue trend and the end-of-year forecast analysis using Kosovo as an example. The obvious benefit of daily fiscal data in this context is the gain in greater timeliness (Box 1).

Another, less obvious, benefit concerns the increase in accuracy of tax revenue trends calculated using daily fiscal data. Revenue is typically only recorded on business days, which matters if (contrary to the current year), the last day of a given month in the previous year was not a business day. In this case, year-over-year growth rates of cumulative revenue (which is our measure of interest, see in the section on "Processing and Smoothing") based on monthly data essentially compare revenue collected for the full month of year *t* with revenue collected for the full month less one business day in year *t-1*. This can significantly distort revenue performance measures using monthly data (particularly if no data are available for the last couple of days in a given month in either year *t* or year *t-1*, for instance due to holidays). By contrast, with daily data, this effect does not arise, as we calculate year-over-year growth rates only for the exact same calendar days in year *t* and *t-1*.

Figure 3 compares changes in year-over-year tax revenue constructed using daily data with those using official monthly data, which are assumed to become available with a delay of one month.[10] The focus is on the last three quarters of the year, given that: (1) revenue trends in the first weeks and months of the year are generally volatile (as the cumulative sums only encompass data from a relatively small number of days); and (2) the authorities did not produce daily data for each business day during the first quarter of 2016. Since daily data are essentially available in real time, for monthly data, we also chose a real-time representation with the x-axis referring to the release date of the monthly data (and not to the period the data refer to). In other words, each observation of the monthly series represents the latest data point available at that time.

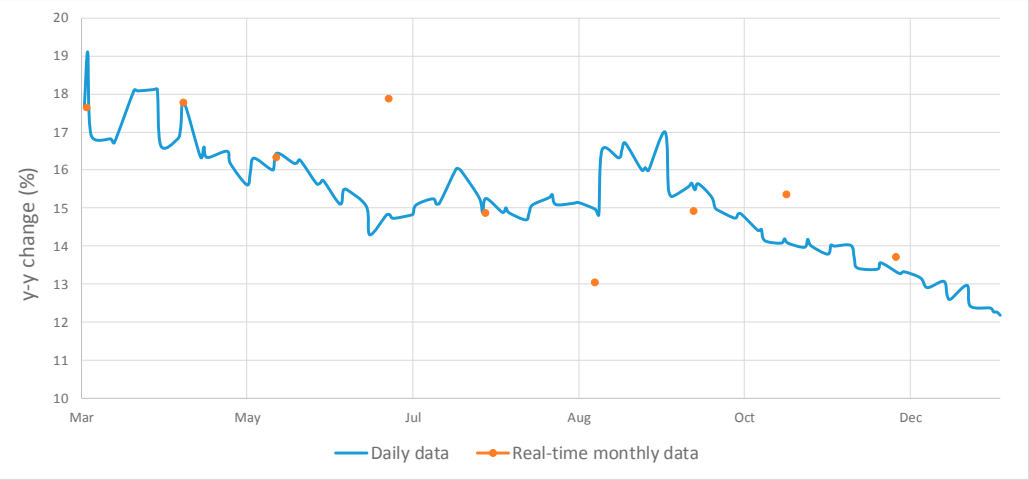
At particularly crucial months in the year, daily and monthly series significantly differ. That is the case, for instance, during the period when the budget was being prepared in September 2016. The latest monthly observations released in early September refer to July, showing a nominal revenue growth of 13 percent. This monthly revenue growth value was subsequently only updated a month later, when August data became available. On the other hand, daily data, showed a more accurate 15 percent growth rate for September 2016, significantly higher than the monthly estimates. These differences can be explained by factors discussed above, namely the publication lag of monthly relative to daily data; and the possibility that monthly year-over-year revenue growth rates can be distorted by differences in business days at the end of the month between the two years (*t* and *t-1*). These differences could result in significantly distinct policy responses from authorities, particularly in times of fiscal stress.

Another benefit concerns the increase in precision of revenue forecasts at the end of the fiscal year. With so many more data points, revenue forecasts can be updated and revised daily. This

[10] In some cases, the publication lag has deviated from that, but for consistency and simplicity, the assumption is that it has always been one month.

can improve the quality of the forecasts, which is particularly relevant for countries like Kosovo, where revenue trends calculated using monthly data significantly deviate from actual outturns. Moreover, by employing daily data, the number of forecasts also rises significantly. This, in turn, helps the forecaster to assess the reliability of the projection, allowing the variation or the trend in forecast errors to be considered more frequently, and thereby facilitates monitoring of fiscal policy implementation (Ley and Misch 2013; Lledó and Poplawski-Ribeiro 2013).

Figure 3. Kosovo: Monitoring Tax Revenue—March 30, 2016–December 31, 2016



Source: Republic of Kosovo Ministry of Finance; and authors' calculations.

Monitoring government expenditures during fiscal adjustment

Daily fiscal data also add value for monitoring changes in government expenditure patterns during fiscal consolidation. Daily fiscal data allow quicker detection of changes in the size and composition of public expenditure than conventional fiscal statistics. Despite long lags in implementation of policy measures, daily fiscal data can be useful in monitoring when such measures translate into changes in actual expenditure, that is, when policy decisions to adjust the composition of expenditure begin to have an impact so that there are turning points in actual spending trends. While fiscal adjustment measures based on cuts in current expenditures (such as wages or social benefits) become effective more quickly, thereby showing more immediate results, cuts in current expenditure are also often the most difficult measures to implement politically, implying that current expenditure is therefore often more rigid in times of fiscal crisis.

Consequently, governments typically turn to capital expenditures as the first port of call when looking for consolidation measures in times of economic hardship (for example, see Baldacci, Gupta, and Mulas-Granados 2012; or IMF 2014b). However, there can be significant lags in the timing between policy decisions to reduce the level of public investment and the effective implementation or impact of these policies on the fiscal position. These lags can be longer than in the case of current expenditure, which is primarily the result of the existence of contractual commitments that can only be wound down over time. While this would suggest that daily fiscal data are less useful in monitoring the immediate impact of changes in fiscal policies surrounding capital expenditures, use of this data can support analysis as to when these policy changes begin to bite and when the effectiveness of consolidation measures materializes over time.

For example, Figure 4 reports the evolution of public investment as well as overall economic activity using publicly available data for Brazil described in the section on "Data Access and Data Collected" and Box 2. Revenues declined sharply in 2014 and 2015 which were years of economic downturn in Brazil. This prompted the government to embark during this period on a program of fiscal consolidation, some of which included policies to reduce capital expenditure. By deflating daily data on public investment and the monthly series of the Brazilian general price index, and cumulating that data using a three-month rolling window,[11] this new series can be represented by

$$\sum_{d-90}^{d} i,$$

where d is a specific business day; and i is the aggregate public investment for that day. The *year-over-year* change of that series is then computed and smoothed by using the moving average over 90 days to remove seasonality and noise in the data as discussed in the section on "Processing and Smoothing". To measure economic activity, we use the year-over-year change of the Brazilian Central Bank's (IBC-Br) monthly economic activity index, a leading indicator of economic activity.[12]

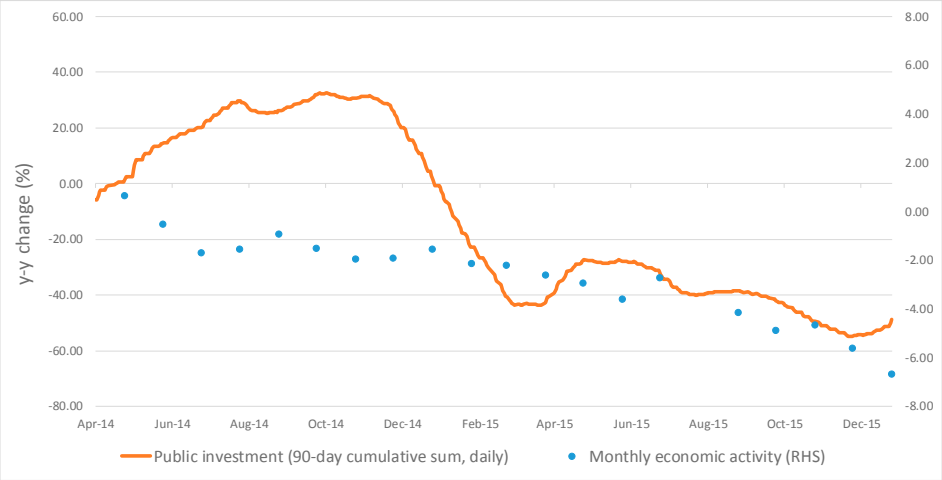
Figure 4 plots the two series between April 2014 through December 2015, where the right-hand x-axis contains the scale for the year-over-year change in economic activity.[13] In 2015, when economic activity plummeted, public investment also declined significantly, suggesting that the government cut capital expenditure in the wake of lower revenue (see shaded area which represents a turning point for capital expenditure trends). However, that decline came with a lag, as public investment was still increasing in 2014, even though economic activity was already falling. This again suggests that public investment growth in Brazil—as in other countries (IMF 2014b)—seems to follow economic activity with some lag, which has also been indicated by other studies (Celasun and others 2015; IMF 2016b).

[11] The Brazilian General Price Index (*Índice Geral de Preços do Mercado—IGP-M*) from the Fundação Getulio Vargas in Brazil is also used as a deflator. This is a hybrid index composed of the producer price index (*IPA*, weighting 60 percent of the total IGP-M index), the consumer price index (*IPC*, weighting 30 percent of the total IGP-M index), and the construction price index (*INCC*, weighting 10 percent of the index). The results are similar if we deflate the public investment by the CPI series (*Índice de Preços ao Consumidor Amplo—IPCA*).

[12] This monthly and seasonally adjusted index was created in 2010, but has retroactive information since 2003. It includes activity estimates for the agriculture, industry, and services sectors, as well as an estimation of indirect (products) taxation. Other indicators of economic activity in Brazil were also used, but did not produce qualitatively different results.

[13] We exclude the first three months of 2014 given the still high volatility in the public investment series for those months even after applying the smoothing techniques discussed above.

Figure 4. Brazil: Public Investment and Economic Activity
April 4, 2014–December 31, 2015



Source: Brazilian Ministry of Transparency, Supervision and Control; and authors' calculations.

Monitoring government cash balances

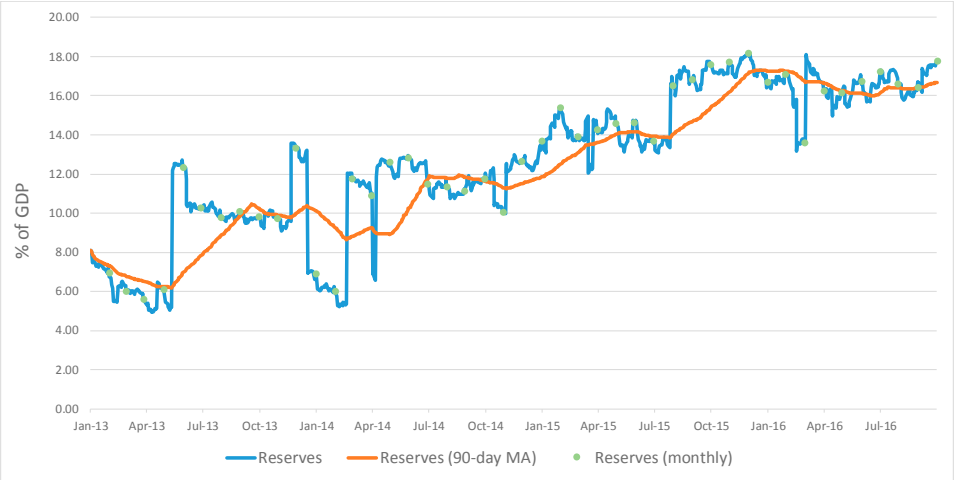
Monitoring aggregate daily government cash balances data can offer insights into the government's level of available liquidity, its ability to meet its obligations on an ongoing basis, and, more generally, the potential fiscal vulnerability faced by individual economies. Most governments make efforts to smooth out the balances on the TSA to ensure sufficient resources to meet ongoing obligations, implying that changes in the cash balance can also offer signaling information. Sharp reductions in liquidity buffers may also be a sign that the government is beginning to experience signs of fiscal stress and warrants further analysis (see Baldacci and others 2011; and IMF 2016a). Having access to daily data can allow more rapid response than reliance on monthly or quarterly reports, as is often currently the case.

Equally, gradual increases in the level of cash on deposit can imply that the government is starting to hoard cash.[14] This could be an indication that policy makers are anticipating possible fiscal stress in the future and attempt to build up buffers. This was witnessed in many countries in the lead up to and during the great recession when cash levels in many advanced economies increased dramatically. In more recent years, countries such as Slovenia (Figure 5) have seen their cash balances drift up over time. This could possibly signal an expectation of fiscal stress or at least a great degree of uncertainty as to the direction of the economy.[15] Having access to this information daily can better inform policy makers and multi-lateral institutions such as the IMF during their ongoing surveillance discussions.

[14] In some cases, increases in the level of cash balances could also reflect opportunistic debt management operations when interest rates are low, but are expected to increase.

[15] However, this is not necessarily the explanation for the upward drift witnessed in the case of Slovenia since 2013. The upward drift should only be regarded as an indicator that warrants further analysis.

Figure 5. Slovenia: Cash Balances, January 1, 2013—September 30, 2016



Source: Slovenian Ministry of Finance; U.S. Treasury Department; and authors' calculations.
Note: MA = moving average.

Improving cash planning

Access to daily data on government cash balances can also help countries develop cash management and analysis capacities. As discussed, many countries tend to smooth their cash flows and to reduce the amount of cash lying idle in the TSA. They do this to increase the efficiency of asset and liability management, helping reduce debt and debt service levels and maximizing the efficiency of management of liquid assets—the less cash you need the less you need to borrow.

Having access to high frequency data on historical cash balances helps in two ways. First, daily data can be used to assess the true volatility on cash balances, which is a measure of how sophisticated cash management is, whereas monthly data can potentially hide much of the volatility. Second, historical daily data on cash balances are a significant input to efforts to develop accurate cash forecasts. The more accurate the forecasts the less cash needed to ensure the government can meet ongoing commitments.

While many advanced economies have now developed sophisticated cash planning systems, that is not the case in some emerging market economies and most low-income developing countries. Advanced economies, such as those in the euro area, have information on their daily cash balances and can use this to determine with a high degree of accuracy how much cash they need daily. This allows them to maintain relatively low levels of cash (the great recession being an exception in which threats to the banking systems in many advanced economies and fears about lack of availability of market access led many countries to hoard cash, notably Ireland and France). However, in some emerging market economies and many low-income developing countries over-borrowing and a lack of understanding of the true level of government liquidity is still common.

Ongoing TSA and FMIS reforms are gradually addressing these issues and with the help of ongoing capacity building, consolidated data may become available and help improve cash management in low-income developing countries.

B. Monitoring and Forecasting Real Economic Activity

Background

This section illustrates that daily tax revenue data can enhance efforts to *nowcast* economic activity. As Banbura and others (2013) discusses, nowcasting (or real-time updating) can be defined as the prediction of output (GDP) in the present, the near future, or the recent past. This technique has been used for a long time in meteorology and is becoming more common in economics (Giannone, Reichlin, and Small 2008). It relies on real-time updating, providing forecasting gains, particularly for very short time horizons, and becomes progressively more accurate as the end of the forecasting horizon approaches and relevant information accumulates (Babura and others 2013). Mixed-frequency data, another tool for forecasting and surveillance in real time, rely on different techniques such as Kalman filters or MIDAS (Mi(xed) Da(ta) S(ampling)) regressions.

Using tax revenue for nowcasting

The main hypothesis is that changes in the tax base of major taxes broadly reflect economic activity and trigger changes in tax revenue, which in turn can be observed. Obviously, changes in tax revenue may also reflect changes in tax policy, which may need to be corrected for if they have important revenue implications in the context of nowcasting.

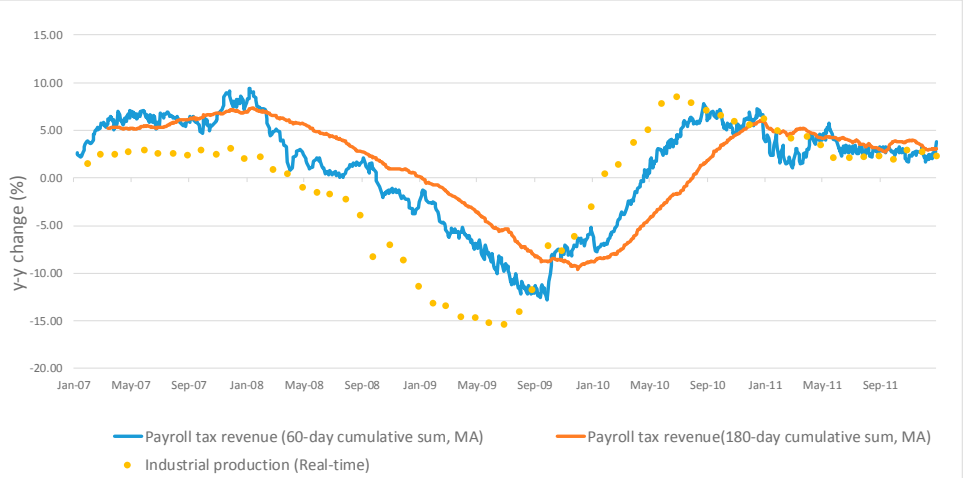
VAT and payroll taxes are particularly suitable for such exercises as they are often filed at a higher frequency, implying a small lag between say changes in tax revenue trends and changes in the tax base. They can also be expected to mirror private consumption (for VAT) and economic activity more broadly (payroll tax). Hence, this is especially useful in countries where daily fiscal data are available but national accounts statistics are poor—that is, quarterly GDP data are either unavailable, unreliable, or significantly delayed, and other monthly indicators of economic activity (such as industrial production) are likewise not provided by the authorities.

To illustrate how to use daily fiscal data for nowcasting, we use year-over-year growth rates of cumulative payroll tax revenues constructed using daily data from the United States. Here, payroll tax in the United States has desirable features as its payment frequency is very high (some employers have to file once every fortnight); and because the due dates for payroll tax differ significantly across firms (on many days in a given month, there are significant amounts of revenue collected even if most taxpayers pay exactly on the due date).

Figure 6 shows three smoothed series of daily data on payroll tax revenue, differing in the length of the rolling window considered for the construction of cumulative sums (60 and 180 days). The series also diverge on the moving average filter applied (5 or 10 days) on the year-over-year changes to further smooth the series. Considering a longer rolling window results in a smoother

but also more backward-looking series, which picks up changes in economic conditions with a longer lag.[16]

Figure 6. United States: Nowcasting Economic Activity
January 1, 2007—December 31, 2011



Source: U.S. Treasury Department; and authors' calculations.
Note: MA = moving average.

The example shows that daily fiscal indicators relatively accurately mirrored key features of the U.S. business cycle before, during, and after the global financial crisis. Figure 6 includes a seasonally adjusted indicator of industrial production, providing a proxy for the business cycle in the United States. Importantly, the peak of the recession in 2009 is picked up by the 60-day payroll tax indicator with a lag of only a few weeks relative to the industrial production benchmark.[17]

C. Other Applications for Macro-Fiscal Analytical Work

Recently, offering further support to the important role that high frequency fiscal data can play, economic literature has begun to examine different research questions related to fiscal policy using daily fiscal data. For example, Auerbach and Gorodnichenko (2015) constructed two daily

[16] Statutory personal income tax rates remained unchanged during 2003–12, and the tax rebates sent out to individuals under the Economic Stimulus Act of 2008, described in greater detail in Broda and Parker (2014), did not affect gross payroll tax revenue, which are used here. By contrast the American Recovery and Reinvestment Act of 2009 increased tax credits and deductions, which had an impact on gross payroll tax revenue in 2009 and in subsequent years, implying that year-over-year changes in tax revenue were not solely driven by changes in economic conditions. However, the magnitude of the changes in the payroll revenue-based indicators in 2009 and 2010, and the fact that most of the revenue losses were ex ante estimated to occur in 2010 when the indicators were showing significant year-over-year growth, imply that this tax reform is unlikely to distort our analysis (see https://www.jct.gov, publication JCX-19-09, for details on the *ex-ante* estimated revenue effects).

[17] Note that the real-time representation of industrial production is not shown and the indicator of industrial production is subject to a publication lag normally of at least one month.

series of government spending to analyze their effects on exchange rates. One of the daily fiscal series refer to payments to defense contractors reported in the daily U.S. fiscal data discussed above. The other series compiles the announced volume of contracts awarded daily by the U.S. Department of Defense. They show that announcements about future spending cause a significant and real-time appreciation of the U.S. dollar. They claim that this contrasting result with the previous literature is due to the use of daily data, which allows for a much finer precision in the timing of fiscal shocks and other economic variables' responses.[18]

Hebous and Zimmermann (2016) study the effects of U.S. federal purchases on firms' investment, and use daily fiscal data from U.S. federal procurement contracts, combined with key financial firm-level information. Several restrictions were included to ensure that firms did not anticipate the fiscal demand shock, and they found that $1 of U.S. federal spending increased firms' capital investment by 7–11 cents, but with significant variation around this average.[19] Effects are stronger for firms that face financing constraints, while they are close to zero for unconstrained firms. In line with the financial accelerator model, their findings indicate that the effect of government purchases works through easing firms' access to external borrowing (see also IMF 2015; and Correa-Caro and others forthcoming). Furthermore, industry-level analysis suggests that the increase in investment at the firm level translates into an industry-wide effect without crowding-out capital investment of other firms in the same industry.

Rahal (2016), in turn, analyzes disaggregated daily public payments data from the UK, constructing a database of almost 25 million local government payments. With these data, the author examines several types of public spending, such as: (1) which third-sector organizations in the UK receive local government funding; (2) which schools receive most public money; (3) what types of public body receive funding; and (4) which sports are funded at an amateur level in the United Kingdom.

Finally, Hoopes and others (2016) study the heterogeneity in investors' propensity to sell stocks during the global financial crisis using a unique daily data set of sales of stocks and mutual fund shares in the population of U.S. taxable individual investors. The data are extracted from the universe of (anonymized) tax returns filed with the Internal Revenue Service, allowing them to match asset sales reported for capital gains taxation purposes with some demographic information on each taxpayer. While the authors do not observe asset purchases in these tax records, they present indirect evidence from dividend receipts and a supplementary brokerage

[18] As Auerbach and Gorodnichenko (2015) argue, such a response of exchange rates to fiscal spending is important to policy makers and researchers, given their implications to (1) the size of fiscal multipliers (Ilzetzki, Mendoza, and Végh 2013; and Mineshima, Poplawski-Ribeiro, and Weber 2014); (2) the degree of fiscal spillovers (Beetsma, Giuliodori, and Klaassen 2006), and (3) the potential benefit of fiscal policy coordination (Beetsma, Debrun, and Klaassen 2001).

[19] Hebous and Zimmermann (2016) include restrictions in the contracts investigated to enable them to filter out potential anticipation effects, focusing only on unexpected changes to a firm's future cash flows.

account data set, suggesting that individuals with high levels of gross sales are also, to a substantial extent, net sellers of stocks.[20]

VI. CONCLUSION

This chaper makes two contributions. First, it addresses a common prejudice, namely that analysis based on fiscal data is essentially slow moving and heavily backward looking, compared to, say, analyses involving monetary or financial markets data, because higher frequency data are unavailable. Given recent technological advances, daily fiscal data are now indeed widely available and easily sourced, even though the data are not published in most countries and some (modest) upfront investment is necessary to convert it into a useable format. Second, it demonstrates noise and seasonality inherently present in daily fiscal data can be removed relatively easily to make it useful. The paper argues that daily fiscal data have significant advantages relative to conventional monthly or quarterly fiscal statistics in the areas of fiscal surveillance and management, nowcasting economic activity, and macro-fiscal analytical work.

Despite these benefits, many countries make inadequate use of daily fiscal data as an input for policy-relevant analysis, implying that such data remain heavily underutilized. Addressing this underutilization could be of benefit both to fiscal authorities and multilateral organizations in their surveillance and advisory roles. So far, there is only limited evidence that authorities are beginning to see the benefits and opportunities offered through greater utilization of this rich data source (see Félix 2011), in part because potential caveats need to be taken into account when operationalizing working with daily fiscal data.

First, care needs to be taken that this high frequency and largely unaudited data are fully understood, and that steps are taken to ensure that noise and seasonality in the data are adequately adressed and taken account of. This includes that safeguards are needed to ensure that false alarms are not triggered through misinterpretation of short-term data glitches or volatility in the data. This concern could be addressed through capacity building with technical assistance from bilateral and multilateral institutions including the IMF. This, in turn, would help countries to build their data analytics capacity in order to ensure that high frequency data can be interpreted correctly, thereby allowing them to reap tangible and significant benefits.

Second, daily fiscal data reflect for the most part only cash-based transactions and may therefore not capture all government operations, especially accumulations of payment or revenue arrears to meet their cash targets. The increased use of daily fiscal data may also result in a reversion to

[20] The papers discussed in this section only illustrate some areas in which daily fiscal data could be employed. There are many areas of use, though. For example, daily fiscal data could facilitate comparisons of the levels of cash reserves held by countries. Information on the cash reserves would also allow government cash and debt management activities to be benchmarked, an area that has gained much traction outside the IMF recently (see Faraglia and others 2010, and Greenwood and others 2015). Several other papers recently have started using other types of daily data (not fiscal) to analyze economic questions. For example, Lachowska (2016) employs daily data to understand what can be learned about the dynamics of consumer confidence and spending, finding that the estimated relationship between daily consumer confidence and daily spending is weak. This indicates that on a day-to-day basis, consumers are rationally inattentive and do not react to small and temporary fluctuations in consumer confidence.

an emphasis on cash-based analysis at a time when governments are being encouraged to move to a richer and more informative balance sheet approach to fiscal policy making. As indicated in the section on "Characteristics of Daily Fiscal Data," these concerns should decline as governments begin to implement reforms that focus on accruals-based accounting standards, but this is still some time off in the majority of countries.

Future research could examine the benefits of forecasting fiscal aggregates based on daily fiscal data in a more rigorous way, for instance by comparing the characteristics of forecast errors based on daily and monthly data. In addition, furture research could discuss whether there are any lessons that can be drawn from liquidity forecasting by central banks that are also based on high frequency data.

Taken together, there is a strong business case for much wider use and exploitation of daily fiscal data in governments and multilateral institutions alike. This will most likely disrupt the way surveillance operations are carried out, but that is not a reason to slow down this juggernaut. Instead, authorities and multilateral institutions need to consider how best to leverage this opportunity to better serve their citizens and member states, respectively. That could be done by adopting increasingly nimble responses to fiscal shocks and other unexpected events and to better inform their discussions with stakeholders.

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Annex 1. Descriptive Statistics

(Percent; unless otherwise shown)

Country	Series	Period	Frequency	10th	90th	Median	Mean	Standard Dev.
Kosovo	Tax revenue (year-over-year) change of cumulative sub since beginning of fiscal year)	03/30/2016 to 12/31/2016	Daily	13.3	16.8	15.1	15.2	2.0
			Monthly	13.2	17.9	15.1	15.3	1.4
United States	Payroll tax revenue (year-over-year change of 60-business day cumulative sum, 5-day MA applied)	01/01/2007 to 12/31/2011	Daily	-7.8	6.7	2.7	1.1	5.6
			Monthly	-7.4	6.7	2.7	1.0	5.5
Brazil	Public investment (year-over-year change of 90-business day cumulative sum, 90-day MA applied)	04/04/2014 to 12/31/2015	Daily	-47.9	29.7	-16.9	-10.1	30.9
			Monthly	-48.9	29.6	-27.3	-13.6	31.8
Slovenia	Cash balance (percent of GDP)	01/01/2013 to 09/30/2016	Daily	6.4	17.2	12.8	12.7	3.6
			Monthly	6.9	17.2	13.3	12.9	3.7

Source: Brazilian Ministry of Transparency, Supervision and Control; Republic of Kosovo Ministry of Finance; Slovenian Ministry of Finance; U.S. Treasury Department; and authors' calculations.
Note: 10th = 10th percentile; 90th = 90th percentile, MA = moving average.