BUDAPESTI CORVINUS EGYETEM

Doctoral School of Economics and Business Informatics

THESIS SUMMARY
to the Ph.D. dissertation by

Klaudia Máténé Bella

Options for measuring and estimating

quarterly consumption

Supervisor:

Ilona Cserháti PhD
associate professor

Tibor Keresztély PhD
associate professor

Budapest, 2022

Department of Statistics

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Content

I. Research background and motivation for the topic

The most frequently discussed indicators describing macroeconomic processes are GDP and inflation. However, since the so-called Stiglitz – Sen – Fitoussi report (hereafter the Stiglitz report) (Stiglitz et al. (2010)), household consumption has been a major focus of international attention, an important element of the GDP from an expenditure approach. The recommendations in the Stiglitz report are that income and consumption should be given priority over production, and that income and consumption should be considered together with wealth. (Máténé Bella et al. (2018))

The OECD (2016) and the European Commission (2016) also point out that in analysing the material well-being or purchasing power of a country's population, it is better to consider the disposable income or final consumption of households rather than production. This is especially true when the increase in GDP and household disposable income due to cross-border transactions by multinational companies differ significantly, as was the case in Ireland in 2015. (Máténé Bella and Ritzlné Kazimir (2020a))

Data on household consumption is important not only for the well-being analysis. The time series of domestic

consumption by durability can also be considered as economic indicators, as they are good indicators for the development of business cycles. Calculating this data is a legal requirement. The time series of domestic consumption by durability recorded in national accounts have been available on a quarterly basis since 1995. Estimation of household consumption until 2020 was based on the dynamics of the data provided by the Household Budget Survey (later Household Budget and Living Conditions Survey) (HBS) which has existed since 1949. (Szabó (2004, pp. 480, 489-490))

In 2020, the Central Statistical Office decided to abolish quarterly and annual Household Budget Surveys (diary keeping) from 2021 for cost-benefit reasons and is expected to organize data collection only every five years in the future. In practice, this meant that a new estimation method had to be developed.

I.1. The aims of the research and the expected results

The aim of the research was to explore the most suitable data sources for estimating quarterly consumption and to develop an estimation method that is suitable for estimating the durability categories of domestic consumption with

sufficient accuracy, taking the requirements of the National Accounts into account.

The **expected results** of the research are the following:

EO1: Overview of the theoretical background of consumption, summary of quarterly estimation methods and data sources of domestic consumption according to durability, taking the requirements of national accounts into account

EO2: Exploration of possible explanatory variables, calculation of relevant indicators from them, organization of them in database

EO3: Fitting econometric models suitable for estimating domestic consumption

EO4: Making the estimate retrospectively (ex post) and in quasi real time for 2019, evaluation and validation of the results

The following **sub-goals** belong to achieving the results:

RO1: Which estimation methods are acceptable for official statistics to estimate domestic consumption?

RO2: Does the use of online data improve the estimation of domestic consumption?

RO3: Does the direct or the bottom-up approach result in a smaller revision in estimating domestic consumption?

I.2. Research questions

To achieve the results, the research formulated the following research questions:

RQ1: How can the quarterly domestic consumption in Hungary be calculated by durability if the data of the Household Budget Survey is not available?

RQ2: How much revisions will the new method of estimating domestic consumption result in?

RQ3: Is the amount of payment card purchases and cash withdrawals made in the acceptance network of Hungarian payment service providers suitable for estimating domestic consumption?

RQ4: How does the real value of the aggregate wages from the social security contribution report explain the development of domestic consumption by durability?

II. The methods used

Primary research is basically based on quantitative methods. The aim of the primary research is to develop the methodology for estimating the domestic consumption by durability, to explore the appropriate data sources, and to fit and test econometric models.

The classical literature review (secondary research) includes a mapping of the economic literature on consumption, national accounts standards, member state practices, and consumption forecasting models.

II.1. Economic background of consumption and possible estimation methods in official statistics

The research provides an overview of what aspects play a role in making consumption decisions. Consumption can be analysed from both a macro- and a microeconomic perspective. The microeconomic approach uses the rational consumer assumption, but behavioural economists emphasize that consumer decision is also influenced by other considerations. (Ariely and Kreisler (2018)) An overview of individual consumer preferences proved important in the research, as these preferences played a role in selecting some of the consumption item indicators.

Aggregate consumption as a result of individual decisions is associated with several macroeconomic theories and models, including those of Keynes (1965), Friedman (1957), Modigliani and Brumberg (1954), Barro (1974) and Hall (1978). These models have in common that household consumption is seen as a function of income (or wealth).

(Thaler (2016, pp. 121-131), Máténé Bella and Ritzlné Kazimir (2020b)).

George Katona combined the economic model with elements of economic psychology, and the model outlined in his writings served as a theoretical basis for the creation of economic forecasting models based on later confidence indicators (e.g., Carrol et al (1994), Vadas (2003)).

Expectations play a key role in Katona's model, but it also emphasizes other attitudes, such as socio-cultural norms and the importance of belonging to a group. Katona argues that sociocultural norms change slowly, while an individual's belonging to a given group changes much faster. (Katona (1960), (1964), (1968), (1974))

Nowadays, many researchers (e.g., Woodward et al. (2008), Verter, and Osakwe ˙ (2014)) have found empirical evidence that sociocultural norms of consumers are also changing as a result of globalization, which plays a role in consumer decision-making. In addition to changes in sociocultural norms, belonging to a group has also become increasingly important over the past two decades. Of course, in the past, an individual may have belonged to many communities (family, workplace, circle of friends, community of similar interests, etc.), but with the development of information technology, community

building and communication within the community has become easier. According to Pentland (2019), as a result of the information revolution, most people today have a smartphone, which accelerates the flow of information. The consumer can easily and quickly find out about the range of available products and services and can also make purchases and payments online. Not only the individual benefits from it, but so do researchers and the government as well, as more and more new types of data become available on human life and behaviour compared to traditional data sources. Tóth and Hajdu (2012) also found that the use of Google data improves the predictive power of consumption models.

Knowledge of macroeconomic theories on aggregate consumption is important for research, as there are fundamental economic connections behind the system of national accounts. (Vanoli (2005))

In national accounts, consumption is a key aggregate. The COICOP estimate of quarterly consumption in many countries is closely linked to the framework used by the annual estimate. A significant part of the EU member states, where HBS data is available only every 5 years, use the so-called supply method, and, using annual structures, data is estimated on a quarterly basis using an appropriate

indicator from surveys or administrative data sources. The current challenges also necessitate the use of new approaches. For example, metadata from EU member states showed that in 2020, several member states of the European Union used bank card data to estimate consumption. However, there is no uniform method for breaking down this estimation: each Member State is free to decide on their approach. Only the legal obligation to estimate the two main categories of quarterly domestic consumption, expenditure on durable goods and non-durable goods including services, has to be fulfilled. Many Member States, including Hungary, also perform a more detailed calculation according to the breakdown required for the annual estimate (expenditure on non-durable (ND), durable (D), semi-durable goods (SD) and services (S)).

In a new approach, the research considers the quarterly estimate of consumption to be a flash estimate that, once the annual data is available, is adjusted to an estimate based on a larger information base, like the flash estimate of GDP (Cserháti et al. (2009)).

II.2. Data and methods used in the research

In order to estimate the quarterly consumption in Hungary, the research used official statistical data, data from other

administrative data sources, and Google Trend data. The research used the following official statistical data: consumption time series at COICOP 4-digit level available in national accounts up to the third quarter of 2020, consumer price indices at COICOP 4-digit level, retail trade turnover data, catering volume index, number of tourist nights, passenger-kilometre data, the number of postal items, the number of conversations from mobile networks, the net increase in housing, the turnover data from short-term business statistics and demographic data (number of deaths). Data from other administrative data sources include the following data: electricity and gas consumption data from the Hungarian Energy and Public Utility Regulatory Authority, payment card and insurance data from the Hungarian National Bank, number of new passenger car registrations from ACEA, nursing days and GP cases from the National Health Insurance Fund of Hungary, as well as the turnover data of the online cash registers and the wage data of the social security contribution report from the National Tax and Customs Administration. Numerous terms from unofficial Google Trend data have been analysed, including apartment for rent, theatre, concert, cinema, festival, ticket office, swimming pool, family day care centre, retirement home, veterinary and travel agency time series. The monthly data

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- with appropriate outlier detection and imputation - was quartered by geometric averaging, in some cases by factor analysis (Hajdu (2003, p. 362)).

Figure 1: Estimation method
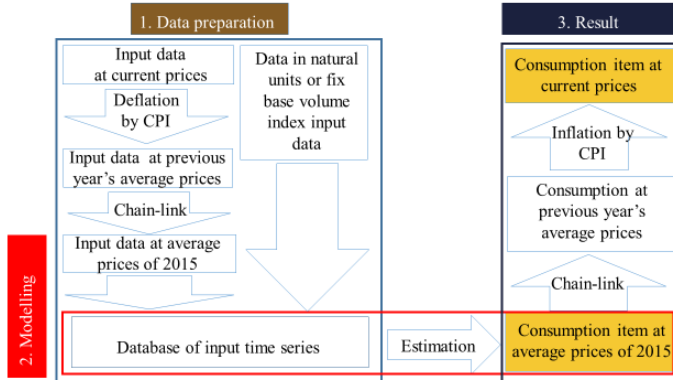
Source: own elaboration

In the Figure 1, in part 1. Data Preparation, shows what specific steps on the available data needs to be done before estimating. Some of the time series needed to estimate the domestic consumption by durability are fixed-base volume indices (e.g. catering volume index), but data in natural units (e.g. number of mobile calls per million minutes or per gigawatt hour of electricity consumption) also occur. A fixed-base index series needs to be calculated from the latter type of data. The other part of the time series is available at current prices and at previous year's average prices. The time series valued at the average prices of the

reference year are calculated using chain-link method (Anwar and Szőkéné Boros (2008)).

In Figure 1, in part 2. Modelling illustrates the modelling process. The target variable is the raw value of a given national consumption item valued at average prices of the reference year, while the explanatory variable is either an indicator valued at average prices of the reference year or a fixed-based volume index. In the models, seasonality is handled by dummy variables.

The estimate was made with ARIMAX and MIDAS models. The ARIMAX model is an ARIMA model that allows other exogenous explanatory variables in the model. This model has good short-term predictive power, on the other hand, the model is easy to interpret, not a "black box". The MIDAS model can be used to model the relationship between monthly explanatory variables and quarterly time series. The ARIMA (p, d, q) model contains the terms AR (p) and MA (q), where I (d) represents the degree of differentiation. (Box and Jenkins (1970, pp. 11-12)) For most time series, d takes on a value of 0, 1 or 2. In the ARIMA model, the variable to be predicted (Y_t) depends on previous lagged values as well as random factors from previous periods(ϵ_t). (Box and Jenkins (1970, pp. 9-10))

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Modelling was prepared according to the steps of the so-called Box-Jenkins method (Box and Jenkins (1970)), which is shown in Figure 2.

Figure 2: Steps of Box-Jenkins method
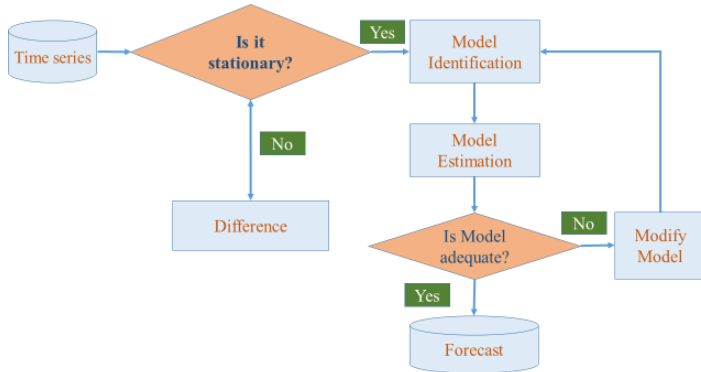
Source: own elaboration based on Box and Jenkins (1970, p.19), Jose and Lal (2013, p. 30)

The method can only be used on a stationary time series. If this is not the case, the time series must be made stationary by differentiation. The unit root test (Augmented Dickey Fuller test) was completed for each time series, and the first differentiation solved this problem. The Box-Jenkins method consists of four steps: identifying the model, estimating the model, diagnostic checking of the model, and forecasting with the model.

While defining the model, the t-statistics and p-values of the explanatory variables were also examined in each case. A variable was considered to be a suitable explanatory

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variable if the p-value was less than 0.050 (in some cases less than 0.100). During the diagnostic verification of the model, the evolution of the residues was examined in each case with the help of a graph, which also helped identify the outliers. The normal distribution of residues was examined with the Jarque-Bera test, while its homoscedasticity was examined with the Breusch-Pagan test. Each model set up fulfills the requirement that the residues are normally distributed and homoscedastic. In analysing the usability of Google Trend data, a MIDAS model was also fitted in addition to the ARIMAX model. For quartering the higher frequency time series, the Beta method was selected in modelling.

The estimation results are shown in Figure 1 in part 3. Results. As a result of the model estimation, the data of the given consumption item valued at average annual prices of the reference year is obtained. With the technique of chain-link, the average price value of the previous year can be calculated from this. With the help of the corresponding consumer price index, the current price data of the given consumption item can also be produced by inflation of the previous year's average price value. This is important because consumption sub-items are only additive at current prices and the previous year's average prices. In order to calculate the volume index of a larger aggregate (durability

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categories of consumption and total domestic consumption), the constituent items must first be added at current prices and the previous year's average prices, and then the reference year's average price of the aggregate must be determined by chain-link. The most important aggregate is, of course, the total domestic consumption, whose growth rate (volume index) and current price data are both very important.

Metadata from EU member states showed that in 2020, several member states of the European Union used bank card data to estimate consumption. Bank card data is one possible data source for the so-called top-down approach. Among the transactions made with payment cards issued domestically and abroad, the amount of purchases and cash withdrawals (hereinafter payment card transactions) was analysed. The current price data of payment card transactions and domestic consumption move closely together, and the value of the correlation between them was 0.988 between 2014 and 2020. Although payment card transactions are not broken down into retail and business transactions, there is a significant level difference between domestic consumption and payment card transactions in favour of domestic consumption, in which the following factors may play a role (see Figure 3):

Figure 3: The relationship between domestic consumption and payment card transactions
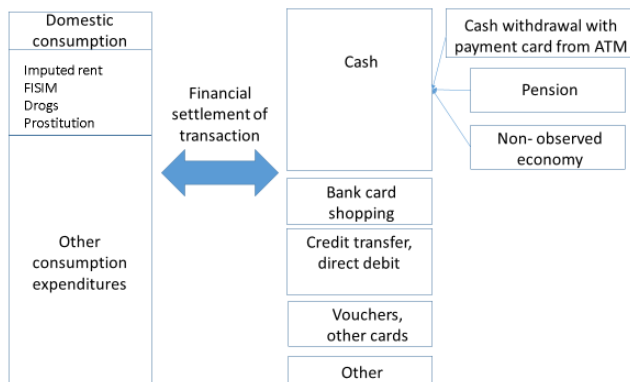
Source: own elaboration

Domestic consumption contains several special national accounts items. Examples include items related to the unobserved economy, such as drug use, prostitution, or imputed rents and FISIM. Domestic consumption also includes items behind which there are no payment card transactions, among others:

- Nearly half of pensioners receive their pension in cash, so in their case the use of a bank account and bank card is not related to the pension.

- In some households, certain consumption items (e.g. utility invoices, children's school meals, home renovation invoices) are settled by credit transfers or direct debit transactions.

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\-   Cash purchases as a source of income from unobserved economic activity (e.g. VAT fraud).

However, based on the high correlation, it seemed justified to analyse whether the bank card data are suitable for estimating domestic consumption.

III.   Results of the dissertation

The research provided the following answers to the research questions asked:

RQ1: How can the quarterly domestic consumption in Hungary be calculated by durability if the data of the Household Budget Survey is not available?

Based on the results of the research, it can be stated that the development of the durability categories of domestic consumption can be estimated even without the HBS data. It assumes that the quarterly consumption estimate can also be used as a flash estimate, which is adjusted to the annual estimate once the annual data is available. The research used ARIMA models containing indicator(s). The durability categories of domestic consumption at current prices and the previous year's average prices should be further subdivided into sub-items, whose values at average prices of the reference year, calculated by the chain-link method, can be modelled. Each

model contains (a) fixed-base indicator(s) closely related to the given consumption item. **The indicators were obtained from surveys, administrative and unofficial statistical data sources (Google Trend). Based on literature review, it can be stated that this method is acceptable for official statistics as it is sufficiently detailed and uses a number of indicators. This also provides an answer to the question of sub-goal RO1. The use of online data as an explanatory variable significantly improved the predictive power of ARIMA models, which answers the RO2 sub-goal question.** The estimated consumption value of the model is the average price value of the reference year. From this, the average price data of the previous year can be calculated using the chain-link technique, and then the current price data can be obtained using the appropriate consumer price index. The sub-items at current prices and previous year's average prices are additive, so the current price and previous year's average price data of the larger aggregates (the categories of durability and total domestic consumption) can be easily calculated, and after that the data valued at average prices of the reference year can be determined using the chain-link technique.

RQ2: How much revision will the new method of estimating domestic consumption result in?

The performance of the models should be examined using two methods, ex-post and quasi-real-time estimation. In the ex-post estimation, a retrospective estimate was made for the whole year of 2019 using the time series available at the time of the research in the 3rd quarter of 2020.

The error of the bottom-up models proved to be small in ex post estimations, the deviation from the published volume index ranged from -0.3 to 0.2 percentage points in some categories of durability, while the deviation for consumption as a whole was 0.0 percentage points. The results are shown in the column labelled 2020Q3 in Table 1.

Table 1: Estimated and published growth rates of domestic consumption by durability category for 2019

	Period of calculation					
	2019Q4			2020Q3		
	% or percentage points					
Cate-gory	publ.	estim.	dev.	publ.	estim.	dev.
ND	3.7	4.4	0.7	3.5	3.5	0.0
D	16.4	13.7	-2.7	14.5	14.2	-0.3
SD	8.1	10.2	2.1	9.4	9.6	0.2
S	4.2	4.6	0.4	3.6	3.6	0.0
Total	**5.2**	**5.2**	**0.0**	**4.8**	**4.8**	**0.0**

Source: own calculation, Hungarian Central Statistical Office

In the quasi-real-time estimation, time series for national accounts consumption were taken into account until the fourth quarter of 2018, and consumption was forecast for each quarter of 2019 using the available explanatory variables. The results are shown in the 2019Q4 column of Table 1. **The bottom-up models estimated consumption for the whole 2019 well with little error in the quasi-real time estimation. In some categories of durability, the deviation from the published volume index ranged from -2.7 to 0.4 percentage points, while the deviation for total consumption was 0.0 percentage points. Regarding the current price data, the difference in each category of durability compared to the published data was between -2.3% and 0.6%, resulting in a difference of -0.1% for total consumption.** The results are shown in Table 2.

Table 2: Estimated and published current price values of domestic consumption by durability category for 2019

Cate-gory	Period of calculation					
	2019Q4			2020Q3		
	billion HUF or %					
	publ.	estim.	dev.	publ.	estim.	dev.
ND	9 439	9 498	0.6	9 327	9 327	0.0
D	1 730	1 689	-2.3	1 734	1 726	-0.5
SD	1 855	1 897	2.2	1 907	1 914	0.4
S	10 008	9 916	-0.9	10 759	10 749	-0.1
Total	**23 033**	**23 000**	**-0.1**	**23 727**	**23 717**	**0.0**

Source: own calculation, Hungarian Central Statistical Office

The deviation in the quarterly data proved to be higher than this, however, the models approximated the annual consumption data well. Direct models using mainly retail data, and models with earnings data from the social security contribution report performed worse in most categories of durability than bottom-up models, which result also provides an answer to question RO3. **Based on this result, it can be concluded that a direct estimate of the durability categories of consumption is not suitable for an official statistical estimate.**

RQ3: Is the amount of payment card purchases and cash withdrawals made in the acceptance network of Hungarian payment service providers suitable for estimating domestic consumption?

Yes, it is suitable. Due to the coronavirus pandemic, several EU member states have started to use bank card data in their estimation, as a result of which research has also examined the possibility of using bank card data. Based on the results, the bank card data overestimated the growth rate of domestic consumption in all quarters of 2019 compared to the bottom-up models if deflated by the consumer price index. **At the same time, the current price values of the bank card data, similarly to the bottom-up models, predicted the development of the**

current price value of domestic consumption with a small error (-0.4%) based on the quasi real-time estimate.

RQ4: How does the real value of the aggregate wages from the social security contribution report explain the development of domestic consumption by durability?

Based on the results of the models, it can be concluded that there is a high correlation between the wages data and the consumption categories by durability. This relationship exists only for semi-durable products at the same time, with a lagged relationship in the other categories. In the case of non-durable goods and services, the value of wages data one year earlier, while in the case of durable goods the value of wages data five years earlier explains the development of the given consumption category.

IV. Practical application

The specific use of the data sources and fitted models during the research has already been implemented in practice, as from the first quarter of 2021 the consumption is estimated at the Department of National Accounts of the Hungarian Central Statistical Office using bottom-up models. The quarterly estimation method presented assumes that the annual consumption estimate is made

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using a different method, to the result of which the model estimate can be adjusted. The method described in the research is suitable for estimating quarterly consumption, however, the data sources may change continuously, therefore the data sources that can be used as indicators should be examined in the future as well.

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VI. List of publications

VI.1. List ot own (or-co-authored) publications on the topic

VI. 1.1. Journal papers

1. Máténé Bella, Klaudia, Ritzlné Kazimir, Ildikó (2021): A távközlés történeti fejlődése és hatása a magyar GDP-re STATISZTIKAI SZEMLE 99: 5 pp. 401-426

2. Máténé Bella, Klaudia, Ritzlné Kazimir, Ildikó (2020a): A multinacionális nagyvállalatok stratégiai döntéseinek hatása a termelés oldali GDP alakulására STATISZTIKAI SZEMLE 98: 3 pp. 212-241

3. Máté-Bella, Klaudia, Ritzl-Kazimir, Ildikó (2019): Analysis of the Hungarian insurance sector's gross value added from 2003 to 2017 HUNGARIAN STATISTICAL REVIEW: JOURNAL OF THE HUNGARIAN CENTRAL STATISTICAL OFFICE 2: 2 pp. 79-105

4. Máténé Bella, Klaudia; Ritzlné Kazimir, Ildikó; Sugár, András (2019): A magyarországi konjunktúrakutatás rövid történeti áttekintése STATISZTIKAI SZEMLE 97: 6 pp. 521-545

5. Máténé Bella, Klaudia, Komolafe, Magdolna, Földvári, Mónika (2018): A háztartások jövedelmére, fogyasztására és megtakarítására vonatkozó mikro-és makrostatisztikák lefedettségi arányai STATISZTIKAI SZEMLE 96: 8-9 pp. 794-817

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VI. 1.2. Proceedings

7. Máténé Bella Klaudia - Ritzlné Kazimir Ildikó (2020b): A magyarországi fogyasztás tartósság szerinti vizsgálata 2005 és 2019 között In: Temesi József (szerk.) XVI. Gazdaságmodellezési Szakértői Konferencia: Előadások Pécs, Magyarország: Gazdaságmodellezési Társaság, pp. 109-117

VI.2. Other publications

VI. 2.1. Journal papers

8. Mátéiné Bella, Klaudia, Ritzlné Kazimir, Ildikó, Anwar, Klára, Cseh, Tímea (2022): A rövid távú gazdaságstatisztikák története: a „gazdasági jelzőtáblától" a negyedéves szektorszámláig STATISZTIKAI SZEMLE 100:2 pp.167-203

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14. Ritzlné Kazimir, Ildikó, Mátéiné Bella, Klaudia (2020): A gazdasági és a szabályozási környezet változásának hatása

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VI. 2.3. Other conference publications

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