Construction of the Dubai Consumer Price Index in the Time of Coronavirus Pandemic

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By

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The views expressed in this paper are those of the author and do not necessarily represent the views of the Dubai Department of Economic Development.

Abstract

The spread of the coronavirus has led to sweeping changes in the way households work, spend their time and shop, resulting in different shopping patterns and rapid price changes in some goods and services. The Dubai/UAE governments imposed strict measures on the movement of individuals which resulted in containing the virus and saved lives, but also triggered a slowdown in vital economic sectors. Though people's purchasing habits have changed quicklywhile the basket of goods and services used to calculate the consumer prices index remained the same. These restrictions on business activities left a profound impact on consumer behavior and the interpretation of the CPI.There are notable challenges with producing consumer price statistics during the Dubai/UAE lockdown.

These large fluctuations of shares in relative expenditures have a profound impact on data collection and calculation of the consumer price index. This paper discusses the Dubai Consumer Price index. Currently, the index is slated to adopt a 2019 basket reference year no earlier than 2021, which will already be badly outdated because of the pandemic when it is introduced. The next basket reference year would normally be 2024, when the pandemic will be over. It would make better sense to have a special survey for 2022, which would be the new basket reference year. The Dubai CPI would, breaking with tradition, be revised backward to 2020 incorporating the 2022 basket. Going forward, the Dubai CPI would continue to have its basket updated every five years, with revision of earlier years. The 2024 basket could be implemented going back to 2024, or to 2023 if the UAE economy had fully recovered by then. After that, the Dubai CPI would be calculated as much as possible following the mid-year basket approach. While this is not ideal, it is the most appropriate approach for a city like Dubai with limited resources for inflation measurement.

As we are living in an information era, the paper proposes that the Dubai Statistics Center examines different modes of collecting data to produce alternative measures for the consumer price index. By doing that the DSC and its data users would be able to evaluate the biasedness of the conventional measure of the CPI during the lockdown. To better calculate the consumer price inflation during the coronavirus pandemic, the paper recommends that Dubai Statistics Center examine calculating a chain index with a formula that satisfies the time reversal property. This can be either the Edgeworth-Marshall formula or a superlative formula (Fisher, Tornqvist or Walsh.)

Introduction

The Consumer Price Index is a critical input to economic policy making, particularly during periods of economic uncertainty and should continue to provide a reliable estimate of price change. The statistical programs for the consumer price index should remain dynamic and flexible in order to adapt to the ever-changing situation and ensure the continued dissemination of a reliable index. In normal times, the CPI measures how much the cost of purchasing a typical 'basket' of goods and services has changed over time, giving us a reasonable idea of how price increases are affecting households, or at least a 'typical' one. Currently, we do not live in a normal time as the whole world is witnessing a sweeping spread of the coronavirus pandemic.

> **Without the notion of price there would be no economic science. The concept is of absolutely central significance. It is not as easy and trivial a concept as it appears to be at first sight. A satisfactory measurement of price is, as a consequence, a difficult undertaking, and it is not surprising that price statistics, abundant as they are, have to be approached with utmost caution.**
>
> **Oskar Morgenstern, On the Accuracy of Economic Observations**

Dubai Statistics Center faces severe challenges in collecting prices for certain goods and services because social distancing measures made it harder to do in-person surveys; many shops have also closed, and some items were no longer stocked. All these obstacles contributed to the already existing problems in interpreting the CPI.

The Dubai government decided to restrict the movement of people through quarantine measures. This has interrupted statistical operations in which information is collected face to face in the field. These restrictions implemented to contain coronavirus presented unique challenges to the continued collection of prices. Thus, the Dubai Statistics Center, responsible for producing official statistics, must address these complex challenges in order to continue providing its authorities

and users with timely and high-quality statistics. It is also important to be transparent to ensure the public trust in the CPI. To this end, good practices for dissemination and communication of official statistics during the lockdown should be followed. This implies that expected changes should be communicated to users in advance, including information about possible delays of the publication of the CPI. All these important changes should be documentedwhen the CPI is released. For instance, if an alternative formula is used, imputations are made or products are left out of the calculation, these should all be documented.

Dubai Statistics Center may want to engage several National Statistical Offices as well as regional (Gulf Co-operation Council (GCC) Statistics) and international organizations such as the International LaborOrganization, the International Monetary Fund and Eurostat to understand how best to respond to the lockdown situation. Based on international recommendations and national statistical offices' best practices, DSC may adopt those suitable to the state's local context. I will discuss the impact of the coronavirus pandemic on the Dubai CPI as it continues to calculate the official CPI based on a fixed-basket approach. However, this exploratory work recognizes that an analytical CPI series that accounts for temporary extreme shifts in consumer purchasing patterns can provide additional insight into the impact of coronavirus on theDubai CPI (appendix B).

Challenges

Because of the lockdown, manynational statistical offices around the world did not release an overall consumer inflation reading for several months. The discontinuation of CPI releaseswas due to inadequate data collection. Social distancing and lockdown measures currently in place in Dubai are likely to have an effect on the Dubai Statistics Center's ability to physically collect price information using the traditional modality. For example, the closure of restaurants and hotels will mean that data for these items simply won't be available. Another challenge is the

conceptual frameworks, which have to adapt to address challenges related to new data collection methods, which might involve the use of new technologies, but also new data needs.

The importance of these challenges will depend on how long social distancing measures last and how long-lasting the impact is on people's spending patterns. If disruption is short-lived, and consumers' spending patterns return to normal soon, then annual measures of inflation will not be affected much. However, if disruptions last for longer, or if they have long-lasting impacts on people's behavior, this would lead to greater problems in measuring the CPI. For example, if people travel less for holidays over the coming years, then the weight for holiday spending may no longer be representative. The standard way that the weights of items in the representative basket are revised will not pick up these changes for up to two years, meaning that the CPI will no longer reflect changes in the prices of the basket even of the 'typical' person.

1. **Data Collection**

Consumer price indices are complex statistics and are compiled from a range of different sources and types of data, many of which are harder to collect using the traditional modalities given the current movement restrictions.Due to health precaution measures, price collection may be restricted due to closed outlets or price collectors may not be allowed to work or enter outlets. As a result, face to face collection of data from stores ceased from the beginning of the lockdown until now. Contacting business respondents was also more difficult under lockdown conditions.

Response outcomes for the commodities and services price survey (US)

Outcome and mode	April 2019	April 2020
Collected prices	86%	66%
Uncollected prices	14%	34%
Collection mode:		
Personal visit	66%	0%
Telephone	9%	15%
Online	14%	68%
Other	11%	16%
[1] Includes prices used in index collection not designed to be obtained by field collection, such as corporately provided data and sample collected by the national office.		

Source: https://www.bls.gov/covid19/consumer-price-index-covid19-impacts-april-2020.htm

Price data is collected in-store by field collectors for a large percentage of the CPI basket by weight. However, as part of the Dubai Statistics Center response to the coronavirus lockdown, we expect a temporary stop to in-store data collection from late February until early September 2020. While Dubai Statistics Center still obtain data, a small amount of data should be missing due to some goods and services not being sold for the entire period.   The remainder of prices are regular online collections which are collected through a mixture of web scraping (an automated process of gathering specific data from websites), and manually finding prices on websites. A small number of prices would be missing due to some goods and services not being sold for the entire quarter (such as airfares).

Main Aspects of CPI Price Data Collection During Lockdown

Percentage of prices collected	Effects of the health emergency	Categories affected by the health emergency
Below 65%	Restrictions on the movements of price collectors	All those sectors where prices are collected face-to-face
	Establishments closed	Recreation services: cinemas, theatres, sporting events, among others
	Products and services are temporarily unavailable	Food away from home services, hotel services
		Personal care and household cleaning products

The current focus on data collection is exciting and necessary. The need for high quality and timely data is more urgent than ever, but at the same time some of the traditional way for producing the consumer price index is made difficult as survey operations are disrupted, priorities are changed and budgets repurposed. The new methods and data sources will be the key to the future of official statistics. The coronavirus pandemic therefore gives Dubai Statistics Center the impetus to adapt and fast-pace the move towards more innovative data collection modes. Alternative modes of price collection may include telephone, e-mail, online prices, big data, web scrapping and scanner data. However, using these modes may lead to difficulties in ensuring a minimum coverage of all products (goods and services).

Dubai Statistics Center may also want to cooperate with Smart Dubai onusing debit and credit transaction records.

2. Imputation

Imputation is the process used to assign replacement values for missing, invalid or inconsistent data that have failed edits. This occurs after following up with respondents and manual review and correction of questionnaires. Imputation is typically used to treat item nonresponse and, occasionally, unit nonresponse. Unit nonresponse occurs when no usable information is collected for a given record while item nonresponse occurs when some but not all the desired information is collected.

If someone want to refer to the international Consumers Price Index Manual, it provides best practice advice on imputation under normal conditions, but doesn't give guidance on extreme situations, such as those experienced during the recent coronavirus lockdown. Moreover, the imputation techniques described in the DSC manual do not introduce bias into the index and in this case, we would expect DSC to follow recent specific guidance from international statistical organizations (for example, Eurostat and the IMF) and remain in contact with other National Statistical Organizationssuch as the Federal Competitiveness and Statistics Authority and the GCC Statistical Center to see how they are imputing missing items during this uncertain time.

1. Basket weights

The consumer price index is calculated as a weighted average of the price change of the goods and services covered by the index. The Dubai CPI weights used reflect the relative importance of the goods and services as measured by their shares in the total consumption of household survey conducted in 2014. The weight attached to each good or service determines the impact that its price change will have on the overall index. The expenditure weights that are used in the consumer price index have to be consistent with the conceptual framework of the index.When exploiting

this data source, the scope and the concept of the index will determine what should be included or excluded in the CPI weights.

The spread of coronavirus has led to sweeping changes in the way individuals spend their money. This has led to large changes in spending patterns and, in some cases, rapid price changes.It is noticeable that in-store and online prices of cough and cold medication shot up since March 2020. Prices across all 'high-demand products', including medicines but also nappies, pet food and bread rose significantly during the same period.
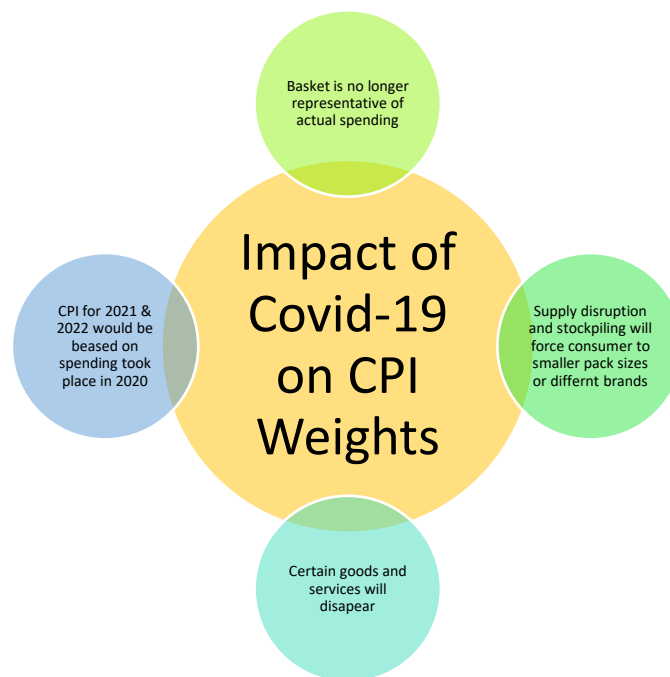
Dubai Statistics Center conducted the Household Income and Expenditure Survey Project in 2019 which targeted 3,960 households in Dubai, including 1476 Emirati households, 1572 non-Emirati households, 672 collective households and 240 collective laborers. The Center reweights the CPI every 5 years. The CPI basket quantities reflect the most recent basket weights introduced in the September 2014 quarter, but the 2019 survey results are not yet implemented. What is concerning now is that the expenditure patterns reflected by these weights have been influenced by coronaviruspandemic. However, the basket quantities for the CPI

remain those of the 2014 basket. Even when the 2019 basket weights are implemented, these new weights will be informed by the lower level 2018/19 household economic survey expenditure data, feedback from CPI price collectors, supermarket scanner data, retail transaction data obtained from market research company, and information provided directly by businesses and government organizations.

Due to the longer-term impacts coronavirus is having on some areas of the CPI basket, Dubai Statistics Center, for analytical purposes, may want to increase weights for health from .85%, communications from 5.22% and reduce the expenditure weights for the high relatively weights such as shelter from 43%, transportation from 10.62% and restaurants and hotels from 4%.

Weight for the DubaiCPI (2014)

Product	Weights	Direction change during coronavirus
Shelter	43%	⬇
Health	.85	⬆
Transport	10.62	⬇
Communication	5.22	⬆
Recreation and culture	2.33	⬇
Restaurants and hotels	4.0	⬇
Other products	76.92	⬇

Source: Dubai Statistics Center

In most of the G8 countries, consumer price series are calculated as chain Lowe or chain Laspeyres indices with a change in basket every year or every other year. For such countries, the special challenges posed by the pandemic may lead to a move to

monthly chained indices to deal with the very rapid monthly changes in expenditure patterns brought on by the pandemic and by lockdowns. While this would be desirable for Dubai as well, given the very modest resources now devoted to index weighting and index construction, such would probably be too big a change. Therefore, it would seem to make better sense to propose a refinement of the existing plan for basket updates every five years. However, for completeness, a possible formula for dealing with these rapid weight changes is sketched out in the appendix to this paper, which could be used if not in this pandemic, then in the next one, if there ever is one.

Before leaving the subject of monthly chain indices in the main body of this paper, it is worth remarking that of all the official consumer price series currently used for escalation, only the US C-CPI-U or the US chain CPI, adequately deals with the situation created by the pandemic, since it is already a monthly chained price index with a formula, Törnqvist, that passes the time reversal test.

The current plans for the Dubai CPI call for introducing a new basket every five years, with the new basket introduced with a lag following the basket reference year. (The previous basket was for 2014, the current basket is for 2019, and the next basket is to be 2024.) Astudy by Szulc (1998) has indicated that this practice compares poorly with the calculation of Laspeyres chain indexes, which compares even more poorly with chain indexes using mid-term baskets. A mid-term basket index with five-year links shows less inflation than its Laspeyres counterpart, coming much closer to the preferred chain Fisher index with annual links. (A chain Fisher index, or any index that satisfies the time reversal test, will largely eliminate upper-level substitution bias.)

There does not seem to be any official consumer price index that has adopted this mid-term basket approach. However, the United Kingdom's producer price index (PPI) practiced it for many years. The PPI changed had its basket updated every five years, but was calculated as a fixed-basket series for its most recent span of years. For a while, the basket reference year was the year prior to the base period. For example, for the 1985=100 series, the basket reference year was 1984. In other words, it was a Lowe price index. Starting with the 1995=100 series implemented in October 1998, so the 1995=100 series had a 1995 basket. The 1995=100 series was revised back to January 1993. Later the 2000=100 series was revised back to 1998, so the 1995 basket ultimately was the mid-year of the span of the historical series. Similarly, the 2000 basket used for the 2000=100 series was ultimately the central year of its historical span, 1998 to 2002. The 2005 basket was finally used for six years, from 2003 to 2008. The 2010 basket was used from 2009 forward, the 2010=100 series was the last PPI calculated as a Laspeyres index. It carried on until November 2020, when an annually chain-linked 2015=100 series replaced it. The 2010 basket was ultimately used over the span 2009 to 2013. While the ONS does not say why the 2010 basket was not taken back to 2008, it may have been due to the PPI moving to a new industry classification.

While no official consumer price series has adopted the mid-year basket approach, two G7 countries, Germany and Japan, calculate their CPIs as Laspeyres price indices over the most recent span, updating the index basket every five years. Each country also calculates a new series every five years, and both are now calculating 2015=100 series.

The 2015=100 series is only carried back to 2015 as a Laspeyres index, but there is no reason Germany or Japan could not revise back farther, using the 2015 basket for 2013 and 2014 as well, which would be consistent with the mid-year basket

approach. However, such a policy should not be applied blindly. The coronavirus pandemic illustrates perfectly the dangers of doing so. The year 2020 marks a dramatic break from the past, and it would make no sense when the time comes to move to a 2020=100 series to revise the German or Japanese CPI back to 2018 using the 2020 basket. On the other hand, when the time comes to move to a 2025=100 series, it may be a very good idea to carry the 2025 basket back to 2023, assuming both countries are back to normal by then.

In terms of dealing with the coronavirus epidemic, there would, of course, be no advantage in taking the new 2019 basket back to 2017, although it might be desirable to do so for other reasons. It would be surprising if consumer expenditures in 2017 or 2018 were not more like those in 2019 than in 2014.

Looking at the next planned basket, there would also be more to be gained from taking a 2024 basket back to 2022. Luckily, the roll-out of vaccines in the region is likely to be much faster than many other countries.

For this reason, there would be a lot of merit in having a special budget survey in 2022. The Dubai CPI could be calculated as a 2022=100 Laspeyres index with the 2022 basket carried back to 2020, except perhaps for those categories where experts believed the use of 2019 weights was more appropriate. The use of a mid-year basket approach would require the 2022=100 index to be calculated for another four or five years, before it was replaced by a 2027=100 index that would be revised back to 2025 to reflect the impact of the new 2027 basket. While this would be one option, it could well be inappropriate to be using the basket of a pandemic year even into 2028 when the pandemic was long past. So, it would probably be better to maintain plans for a 2024 budget survey. The 2024=100 index could be pushed back to 2023 if 2023 were more or less like a normal year. Going forward

from 2024 the Dubai CPI should be calculated as much as possible using the mid-year basket approach, until such time as resources were available to consider replacing it with an annually chained consumer price series.

Conclusion

The pandemic has brought prices data to the center of attention and it is pressing to accelerate innovation and think differently. Dubai Statistics Center is required to respond swiftly to the impact of coronavirus and remain strong by developing capacity in this direction. It is clear that there are two effects derived from this crisis. One on data supply, where DSC is expected to struggle to maintain data collection as planned because operational processes are being postponed or placed on hold. The second is that the demand for data is on the rise as policymakers and data users are requesting more and more granular data relevant for responding to the coronavirus pandemic.

Drastic changes in consumer spending may bias inflation during the coronavirus pandemic. As we know Dubai Statistics Center continued to update its CPI expenditure weights regularly and while this practice is reasonable in normal times, it makes inflation indices much harder to interpret during the coronavirus pandemic, as the underlying weighting scheme is no longer representative of what is being consumed or what can be consumed at all in the lockdown period, thus introducing a weighting bias in inflation. Dubai Statistics Center may want to measure the effects of the coronavirus-induced weighting bias on its consumer price index by quantifying the changes in consumer spending using public data from debit and credit card transactions. DSC may also want to form a basket using expenditure on essential products and service during the lockdown to create current weights so as to construct alternative consumer price indexes. More detailed real-time data on

both prices and quantities could help to resolve some of these problems in future, and also allow cost-of-living indices to be published for different income groups and household types.

In this paper, we did not recommend any structural changes to the household survey weights. However, it would be better to explore new sources and different modes for data collection and produce an alternative formula that satisfies the time reversal (see appendices A and B). Dubai Statistics Center may also want to undertake transformation programs to modernize the measurement of consumer price statistics in Dubai through use of alternative data sources and new methods. The use of these new data sources will enable the center to understand price movements during times of economic uncertainty.

We argue that there doesn't seem to be much difference between the various formulas in the reduction of upper level substitution bias as compared to the Lowe formula. Given an either-or choice we would prefer that the official CPI for Dubai switched to a superlative index, although DSC would have to reinstate an annual Survey of Household Spending or create a basket of essential products and services in order to do this properly.

We would prefer the use of the Edgeworth-Marshall formula and will leave that for future consideration because the main difference between each index willbe the calculation method used, rather than the underlying 2019 basket of goods and services.This exploratory analysis is experimental and should not be used instead of the official measures of consumer price inflation until proven satisfactory and reliable. Dubai Statistics Center should be cautious against using the CPI during this pandemic to model rational consumer behaviors and inflation.

All of the problems we have discussed affect interpretation of the CPI in normal times as well. The current crisis has simply brought these issues to the fore, and

users of the CPI from the academia, central bankers and the financial media will therefore need to take extra cautions when deciding how to apply it.

Recommendation:

1. Dubai Statistics Center must build the necessary capacities in its teams quickly, in order to implement remote collection modalities using digital technologies instead of traditional methods.
2. Cooperate with Smart Dubai to obtain debit and credit transaction data to produce current weights
3. Explore alternative price mechanisms, by constructing different CPI's based on different formulas and compare them to the conventional CPIto see the degree of biasedness(Marshal Edgeworth, Fisher and Tornqvist and annually-linked chained Lowe index)
4. Calculate a retroactive true cost of living price index for research purposes
5. Using the Laspyres formula, DSC may want to collect a minimum of prices for the most important or the most representative productsand use their weights from the 2019 basket to produce an alternativemeasure for the CPI (call it Dubaicoronavirus CPI).
6. Methods and procedures should be documented to assist continuing production of the CPI and for information of users.

Appendix A: Technical and basic index formulae and terminology

The CPI published by many statistical offices, nevertheless, adhere to the fixed basket approach. This is because the CPI is a monthly index. The expenditure shares used in the formula is obtained from the annual survey. However, the calculation of the CPI involves the annual quantity weights from a previous year and the prices from the two executive months. On the practical side, many index formulae have been proposed by various authors. An early attempt was a tabular standard in Massachusetts in the mid eighteenth century (Fisher, 1913). This tabular standard often called a Lowe index, is what is know as the fixed basket, or cost of goods index. Other formula often involves the price and quantity vectors of the two periods. The consumer price index nevertheless adheres to the fixed basket approach. This is because the CPI is a monthly index. The expenditure shares used in the formula, however, are obtained from an annual Household Expenditure Survey. Therefore, the calculation of the CPI involves the annual quantity weights from a previous year and the prices from the two consecutive months.

The Laspeyres Price Index

The Laspeyres price index compares the consumer expenditure of the reference period (base year) with the consumer expenditure of the comparison period (current year) using the base year's quantities as follows:

$$CPI_L = \frac{\sum_i P_{it}Q_{i0}}{\sum_i P_{i0}Q_{i0}}$$

Where:

P_{i0} is the price of item i at time 0 (the base period)

P_{it} is the price of item i at time t

Q_{i0} is the quantity consumed of item i at time 0

The Paasche Price Index

The Paasche Price Index is a consumer price index used to measure the change in the price and quantity of a basket of goods and services relative to a base year price and observation year quantity. It was developed by a German economist Hermann Paasche. The Paasche Price Index is commonly referred to as the current weighted index.

$$CPI_P = \frac{\sum_i P_{it} Q_{it}}{\sum_i P_{i0} Q_{it}}$$

Where:

P_{i0} is the price of item i at time 0 (the base period)

P_{it} is the price of item i at time t

Q_{it} is the quantity consumed of item i at time t

The Fisher Price Index

The Fisher price index helps overcome the problem of item substitution bias. The Fisher price index is calculated by taking the geometric mean of the Laspeyres and the Paasche indices:

$$CPI_F = \sqrt{CPI_L \times CPI_P}$$

The Superlative Price Index

The superlative index is designed to solve the problem of fixed weights by revising the basket in every period, and then taking an average of the two expenditureweights (the base year and the current year) instead of basing theindex on one fixed base year. Because the weights are not fixed in the finalestimates, there is little possibility of substitution bias.

The Tornqvist Price Index

Like the Fisher index, the Tornqvist index can help overcome item substitution bias. The superlative index formula by Tornqvist is an extension of the geometric mean formula where the weights are replaced by the average weights such that:

$$index = \prod_i \left(\frac{P_{it}}{P_{i0}}\right)^{0.5\left(\frac{P_{i0}Q_{i0}}{\sum P_0 Q_0} + \frac{P_{it}Q_{it}}{\sum P_t Q_t}\right)}$$

Here the weight is an arithmetic average of the base-year weight and the current-year. Averaging the two weights solves the problem of the base year vs.the current year. Thus, there is no "fixed basket" in the superlative index determination. The basket changes in every period and weights (the share of the item in total consumption) are equal to the arithmetic averages of twoconsecutive periods.

The Marshall-Edgeworth Price Index

The Marshall-Edgeworth Price Index credited to Marshall (1887) and Edgeworth (1925), is a weighted relative of current period to base period sets of prices. This index uses the arithmetic average of the current and based period quantities for weighting. It is considered a pseudo-superlative formula and is symmetric. The use of the Marshall-Edgeworth index can be problematic in cases such as a comparison of the price level of a large country to a small one. In such instances, the set of quantities of the large country will overwhelm those of the small one.

$$
\begin{aligned}
P_{01}^{ME} &= \frac{\sum p_1\left(q_0 + q_1\right)}{\sum p_0\left(q_0 + q_1\right)} \times 100 \\
&= \frac{\sum p_1 q_0 + \sum p_1 q_1}{\sum p_0 q_0 + \sum p_0 q_1} \times 100
\end{aligned}
$$

Walsh Price Index

The Walsh price index is the weighted sum of the current period prices divided by the weighted sum of the base period prices with the geometric average of both period quantities serving as the weighting mechanism:

$$
index = \frac{\sum_i \left(P_{it}\sqrt{Q_{i0}Q_{it}}\right)}{\sum_i \left(P_{i0}\sqrt{Q_{i0}Q_{it}}\right)}
$$

Appendix: B Monthly-Analytical Chain CPI for Dubai

Although there is reason to doubt that a monthly analytical chain CPI for Dubai is feasible, it is nevertheless worthwhile to outline how such an index might be calculated in ideal circumstances if reliable information were available.

Unfortunately, this may not be the last global pandemic and even if it is not pertinent to this particular situation, it could have some value to outline how an analytical CPI could be calculated when the DSC were better resourced and had more data at its disposal.

It is assumed that the Dubai CPI would be calculated from at least March forward on a February 2020 base. This would be useful even if the pandemic only hit the emirate later than that, for comparison with similar efforts in other countries (e.g. Canada or the UK), where the analysis begins with the March 2020 (Canada) or April 2020 (the UK) movement. There would be some value in having a series that could be compared with counterparts in other countries over the full estimation period.

It is assumed that the CPI will be calculated with monthly expenditure weights unadjusted for seasonal variation. (It would be very burdensome to seasonally adjust so many detailed series, which would in many if not most cases, be too short for reliable seasonal adjustment anyway). This being the case, the formula used should pass the time reversal test, so that there is no danger of the chain index showing serious upward drift due to the expected negative correlation between relative expenditure changes and relative price changes. A monthly-linked chain Laspeyres price index would be the worst choice that could be made. (A monthly-linked chain Paasche price index would be just as bad in the opposite direction, but since it could not be published with the same timeliness as its chain Laspeyres counterpart, would be much less likely to be calculated.)

The only official consumer price series now calculated as a monthly-linked chain CPI series is the US C-CPI-U, more commonly known as the chained CPI. Diewert and Fox(2020) write that the chained CPI "can be labeled as an analytic CPI and can be used by economic analysts who require more accurate historical information on

inflation." This is misleading, as since the US 2017 tax reform it has been used for upratings of income tax brackets and other elements of the federal tax code. The Office of Management and Budget is also studying a proposal to use the chained CPI to be used for escalation of the Official Poverty Measure (OPM). Much earlier, in February 2004, US Fed Chairman Allan Greenspan touted the chained CPI in congressional testimony, noting that had it been used instead of alternative inflation measures as an escalator that it would have cut the cumulative deficit of the US government by $200B.

Similarly misleading is their statement: "The example set by the BLS shows that it is not impossible to produce household expenditure information in real time." What is really relevant is if this information can be quickly converted into updated basket shares for components of consumer price series. As the authors own paper indicates, the BLS is still a long way from this: "The March 2020 weights will be incorporated in the final March 2020 chained CPI indexes, which are released in February 2021." In fact, a fuller enunciation of the revision policy would have been helpful: "Indexes are issued as initial estimates. Indexes are revised each quarter with the publication of January, April, July, and October data as updated expenditure estimates become available. The C-CPI-U indexes are updated quarterly until they become final. January-March indexes are final in January of the following year; April-June indexes are final in April of the following year; July-September indexes are final in July of the following year; October-December indexes are final in October of the following year." So in general the monthly basket pertaining to a given month is only implemented, not with the initial release of data for that month, but 12 months later. This applies to January, April, July and October. The situation is a little better for February, May, August and November, where the lag is reduced to 11 months, and better still for March, September and December, where it is reduced to 10 months. This suggests,

although it is not necessarily so, that the lags reflect a publication strategy rather than operational lags, and it would be possible to reduce the lag to 10 months for all months of the calendar year, but possibly this is not so. In any case, the BLS is still a long way from real time calculation of a monthly-linked series with appropriate basket shares.

However, it could be that a monthly chained consumer price series for a city like Dubai, with 3 million people, would not need to have such a long lag as 10 months for implementing monthly baskets. It doesn't have a population of 330 million people, with household budget estimates to reconcile over 50 states and hundreds of municipalities.

The Swedish CPI is an annually chained consumer price series that offers another model for better reflecting the influence of the pandemic on inflation. For both 2019 and 2020, the monthly movements of the Swedish CPI are those of a Laspeyres CPI with a 2018 basket, and so in no way reflect the impact of lockdown, which was not so severe in Sweden as in most other developed countries. With the January 2021 update of the Swedish CPI, 2020 will be revised, and its monthly movements will be those of a Laspeyres CPI with a 2019 basket, still very divorced from the pandemic reality. However, with the January 2022 update, the monthly index numbers for 2020 will be revised and finalized based on a Walsh formula with a 2019-20 basket and a 2019 base period. This is undeniably a suitable measurement of the annual price change, although one might question whether it sufficiently reflected the strong variations in basket shares within the year 2020.

Note that the Swedish model imposes a much higher tolerance for revisions than the US C-CPI-U. The initial March 2020 CPI estimate will not be finalized until the

January 2022 update, so in general the revision period for estimates will vary between 24 months (for January) and 13 months (for December).

The Swedish CPI is remarkable for its annual links, rather than linking at December as do most official consumer price series. Previously it did have December links and used the Edgeworth-Marshall formula rather than the Walsh formula. The switch to annual links and the Walsh formula were made at the same time in 2005. There was never really a good justification given for the change in formula. Both the Edgeworth-Marshall formula and the Walsh formula pass both the time reversal test and the additivity test. If you tend to favor a test approach to choosing formulas, this gives them an advantage over alternative formulas like Fisher and Törnqvist, which also satisfy time reversal, but don't satisfy additivity.

The Walsh index may have been chosen over the Edgeworth-Marshall formula since it is a superlative formula, and so appeals to theorists who prefer to take a COLI perspective on formulas rather than using a test approach. We don't really know if there is a collective cost-of-living function but the Törnqvist formula approximates a collective cost-of-living function that is translog.

The very dramatic changes seen from month to month in expenditures on certain goods due to the pandemic and to lockdowns risks creating a mental bias towards the American model rather than the Swedish model in discussing the reform of inflation measures. This is regrettable, as the Swedish model is more practically feasible, both for developing and developed countries, and also has the conceptual advantage that it is much better suited to dealing with seasonal products. Here, the classic example is the Christmas tree, where household purchases in volume only occur in December, at least in Western Europe. There is no real November-December or December-January link possible, so such a good simply cannot be

accommodated with monthly chain links. It could by imputing last December's price to the current month of November, but this is an ugly imputation since an annual price movement is being assigned to a single month. For the Swedish model, this is not a problem, especially since the links are at the year, not the month of December. Flowering plants and trees can be treated as a seasonal good, with monthly-basket weights, and the December annual price movement will also define the annual price movement based on the calendar year. Although the Christmas tree is the most famous of plants that is extremely seasonal in its purchase pattern, it is not alone. In France, May 1st, the traditional Labour Day, is also *le jour du muguet* (the day of the lily-of-the-valley), when it is customary to offer friends bouquets of lilies-of-the valley with the greeting "Bonne Fête du Muguet!". This is virtually the only date for which they are purchased in France.

In countries that do adopt a monthly-basket approach to seasonal goods in their CPIs, the scope is usually highly restricted. In Japan, for example, it is limited to seasonal food items (fresh fruit, fresh vegetables and fresh fish, the latter broadly defined, including, for example, cuttlefish). A broader scope would take in intercity travel by air and passenger train or bus, traveler accommodation and motor gasoline, i.e. some of the components whose monthly expenditure patterns were most dramatically affected by the pandemic and shutdowns. A more appropriate seasonal pattern could be assigned for the special year of 2020. This would be the easier to do since the index for 2020 would be revisable up to and including the January 2020 update.

The most likely formula to use for calculating a monthly-basket formula for seasonal goods would be the Rothwell formula, which would impose a fixed seasonal pattern, generally over a number of years. However, an alternative would be the Balk formula, which would reflect the seasonal pattern of the year in question. If the Balk formula

were used, one would, in the natural course of things, be reflecting the special monthly patterns in 2020, the first year of the pandemic, as in every other year. There are two points to make about this. First, the Balk formula is, in a sense, enabled by the use of an annually-linked chain formula on the Swedish model. It requires a long revision period, unlike the Rothwell formula, which is consistent with a no-revision policy. This is normally a big drawback, but would not be a problem if Swedish-style chain links were used, since the revision period that would already be in place would be more than adequate to accommodate the use of the Balk formula. Second, for predominantly-Muslim regions, like Dubai, the use of the Balk formula has the big advantage that it does not assume a fixed seasonal pattern, and can easily accommodate the moving seasonality one would find related to dates of the Muslim calendar.

Retail sales for categories like personal care supplies would not be considered seasonal even in the broadest scope of the term. However, it would certainly be possible to change the weighting of an item like hand sanitizer within a basic aggregate to reflect exceptional purchases due to the pandemic. Again, this would be easier to do because there would be such a long revision period for the index.

Finally, calculating a household budget survey for all categories of household spending for every month of the year makes extraordinary demands on a country. These are onerous even for a country like the US model that requires a continuous monthly household budget survey large enough to provide reliable expenditure weights for every month for all household categories. This would be very difficult to do for any country that was not both rich and populous, like the United States. Even for the United States it is problematic. There is now a debate going on about whether Social Security payments in the US would be better escalated using the CPI-W, the chained CPI or CPI-E, a special CPI calculated using the same chained

Lowe formula as the CPI-W, but with elderly people as its target population. An obvious alternative to the chained CPI would seem to be an obvious alternative, but it is questionable whether, even for the United States, the household budget sample size of elderly people is large enough to provide for reliable monthly expenditure weights for every month of the year.

The Swedish model seems more appropriate to a smaller country in population or resources or both. The American model has undoubted advantages in a special situation like the COVID-19 pandemic where there are sudden dramatic changes in spending not just from one year to the next, but from month-to-month within a given year. However, it would be a mistake to gear index number design too much to events that, if not quite one-off, are likely to be very rare. There hasn't been a pandemic like COVID-19 since the Spanish flu in 1918-19, just when the first consumer price indices were being created. While these events may become more common in the future they will still be rare, and shouldn't really dictate national statistical institutes' decisions about how consumer price inflation is measured.

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