



UNSW Business School
Centre for Applied Economic Research

“Price Index Measurement during Pandemics: What have we learnt from Covid-19?”

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November 9-11, 2021**

Drawing on:

Diewert, W.E. and K.J. Fox (2020), “Measuring Real Consumption and CPI Bias under Lockdown Conditions”, NBER Working Paper 27144, Cambridge, MA, 2020.

www.nber.org/papers/w27144

Canadian Journal of Economics, forthcoming.

Diewert, W.E. and K.J. Fox (2021) “Measuring Inflation under Lockdown Conditions,” *Journal of Official Statistics*, forthcoming.

Materials on Multilateral Methods and Reservation Prices:

Diewert, W.E. and K.J. Fox (2020) “Substitution Bias in Multilateral Methods for CPI Construction Using Scanner Data,” *Journal of Business and Economic Statistics*, published online at: <https://doi.org/10.1080/07350015.2020.1816176>

Diewert, W.E. (2021), “The Chain Drift Problem and Multilateral Indexes”, Draft Chapter 7 in *Consumer Price Index Theory*, Washington D.C.: International Monetary Fund, published online at: <https://www.imf.org/en/Data/Statistics/cpi-manual>.

Diewert, W.E. (2021), “Quality Adjustment Methods”, Draft Chapter 8 in *Consumer Price Index Theory*, Washington D.C.: International Monetary Fund, published online at: <https://www.imf.org/en/Data/Statistics/cpi-manual>.

What Happened During the Pandemic?

- 1. Millions of good and services become unavailable under lockdowns.**
- 2. Unprecedented situation – methods haven't been developed for this situation. Advice defaulted to standard treatment of non-available products.**
- 3. Consumer expenditure patterns clearly changed dramatically yet statistical agency practice is to use expenditure weights from a previous period.**
- 4. This situation risks the public and policy makers losing confidence in key economic statistics.**

What did we learn?

1. **NSOs that collect data electronically had least disruption**
 - **ABS only collected around 2% by value of the CPI basket through field collections**

1. **There is a stronger argument than before for continuous consumer expenditure surveys.**

2. **Collection of data from new sources is possible and helpful to NSOs: e.g. expenditures from credit card companies and “Homescan” data.**

3. **The ability to produce supplementary CPIs is valuable.**

4. **There are unresolved problems in matching prices at the elementary level and in linking today’s index level with previous index levels.**

International Advice to National Statistical Offices

Advice from Eurostat to European Union countries on how to calculate the EU's Harmonized Index of Consumer Prices (HICP):

The compilation of the HICP in the context of the COVID-19 crisis is guided by the following three principles:

- **Stability of the HICP weights,**
- **Compilation of indices covering the full structure of the European version of the Classification of Individual Consumption According to Purpose (ECOICOP),**
- **Minimizing the number of imputed prices and sub-indices.”**

The weights reflect “household consumption expenditure patterns of the previous year.

Advice was effectively to carry on with the standard methodology.

International Advice to National Statistical Offices

UNECE advice was similar, but noted:

In all cases, it is important to apply imputation methods that ensure the index reaches the correct level when again it becomes possible to collect prices and include them in the index.

Hence, it provides an explicit explanation for the carry on as usual methodology; i.e., when things return to “normal”, the post lockdown CPI indexes will be comparable to the pre-lockdown CPI index.

For products which disappeared, the International Monetary Fund (2020), the UNECE (2020) and the Intersecretariat Working Group on Price Statistics (2020) advice was to implement an inflation adjusted carry forward of missing prices methodology

International Advice to National Statistical Offices

ISWGP:

“While COVID-19 has affected expenditure patterns, current expenditure data are not available, and ad hoc adjustments to the weighting structure are therefore not recommended. Ad hoc weight adjustments are not consistent with the fixed basket approach used as the basis for compiling consumer price indexes.”

“Using established methods for imputation avoids affecting credibility issues that could result from implementing methods not normally used.”

Reaction by the Financial Press

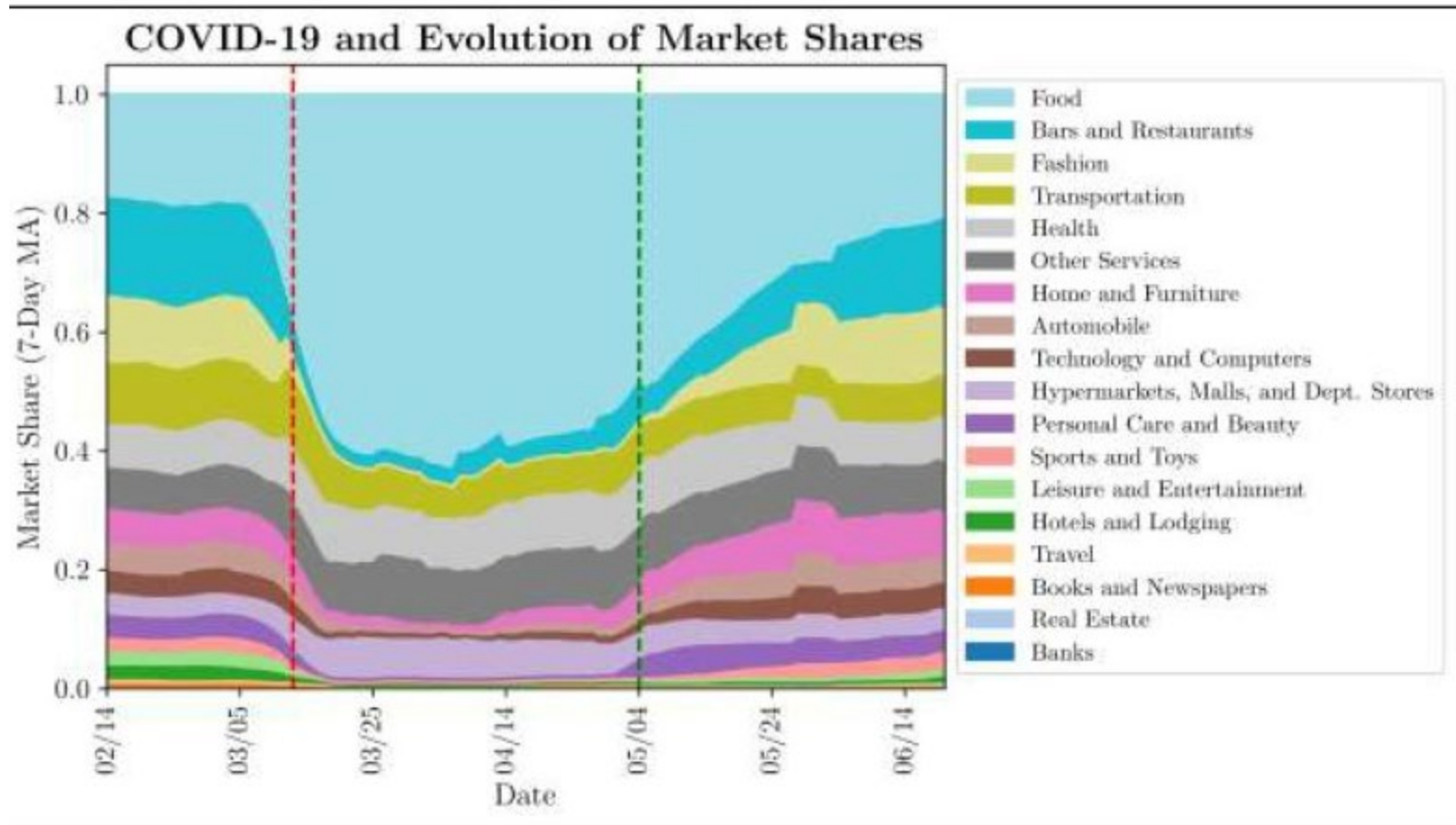
“Consumption patterns have changed so much that inflation indices are meaningless.”

Martin Wolf, Financial Times , May 19, 2020.

“But did you notice something about the big price drops quoted? ...Great deals are available but no one can take advantage of them. In fact, they’re available precisely because no one can take advantage of them.... We have deflation across the basket of goods we usually buy but inflation across the much narrower range of goods we’re buying now.”

William Watson, Financial Post , May 21, 2020.

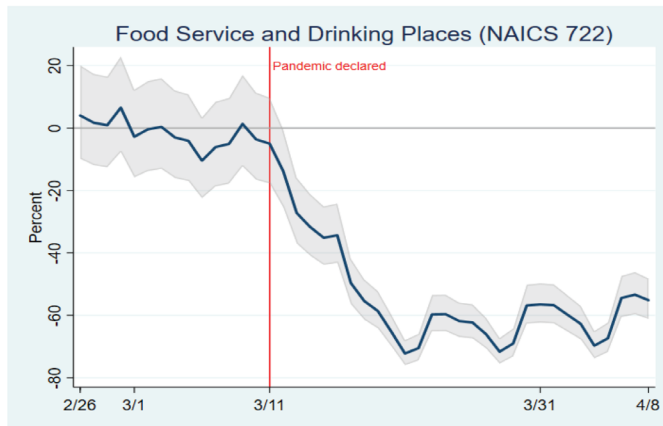
Empirical Evidence of Changing Expenditure: From Credit Cards in Spain



Carvalho, V.M., J.R. Garcia, S. Hansen, Á. Ortiz, T. Rodrigo, J.V. Rodríguez Mora and J. Ruiz (2020), "Tracking the COVID-19 Crisis with High-Resolution Transaction Data", Cambridge-INET Working Paper Series No: 2020/16, University of Cambridge.

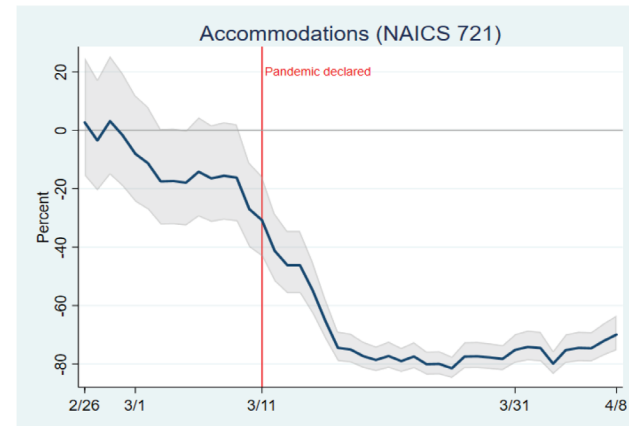
Empirical Evidence of Changing Expenditure: US

Figure 3. Event Study for Restaurants



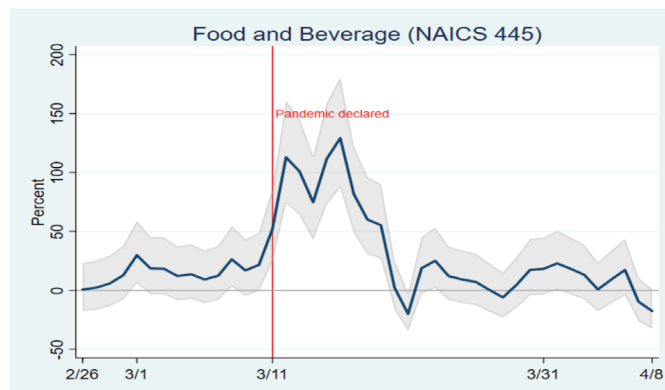
Notes. The estimates shown here have been transformed from log scale to percentages by using the exponential of the point estimate minus one, multiplied by 100. The vertical red line represents March 11, the date on which WHO declared a global pandemic. Deviations away from 0 indicate the change in the sector associated with the timing of the event. The bars represent the 95 percent confidence interval bands around the point estimate.

Figure 4. Event Study for Accommodations



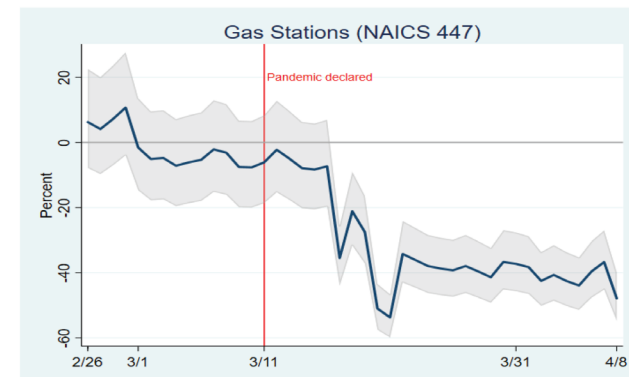
Notes. The estimates shown here have been transformed from log scale to percentages by using the exponential of the point estimate minus one, multiplied by 100. The vertical red line represents March 11, the date on which WHO declared a global pandemic. Deviations away from 0 indicate the change in the sector associated with the timing of the event. The bars represent the 95 percent confidence interval bands around the point estimate.

Figure 5. Event Study for Food and Beverage



Notes. The estimates shown here have been transformed from log scale to percentages by using the exponential of the point estimate minus one, multiplied by 100. The vertical red line represents March 11, the date on which WHO declared a global pandemic. Deviations away from 0 indicate the change in the sector associated with the timing of the event. The bars represent the 95 percent confidence interval bands around the point estimate.

Figure 6. Event Study for Gas Stations



Notes. The estimates shown here have been transformed from log scale to percentages by using the exponential of the point estimate minus one, multiplied by 100. The vertical red line represents March 11, the date on which WHO declared a global pandemic. Deviations away from 0 indicate the change in the sector associated with the timing of the event. The bars represent the 95 percent confidence interval bands around the point estimate.

Dunn, A., K. Hood and A. Driessen (2020), "Measuring the Effects of the COVID-19 Pandemic on Consumer Spending using Card Transaction Data," U.S. Bureau of Economic Analysis Working Paper WP2020-5.

Empirical Evidence of Changing Expenditures in Canada

Table 1. COVID-19 Budget Shares in Canada in March-April, 2020
(Percentages)

	Derived weights, February	COVID-19 Basket in March	COVID-19 Basket in April	April-February Difference
Food (including away from home)	16.54	20.68	20.84	4.30
Alcoholic beverages, tobacco and cannabis	2.60	3.15	3.55	0.95
Clothing and footwear	5.00	3.30	2.22	-2.78
Shelter	27.70	31.23	37.12	9.42
Household operations, furnishing, and equip.	12.66	13.04	13.99	1.33
Health and personal care	4.85	5.61	4.96	0.11
Transportation	19.04	15.01	12.14	-6.90
Recreation, education and reading	11.62	7.97	5.18	-6.44

Notes: Expenditures on shelter are imputed from general spending.

Source: Statistics Canada, as reported in Mitchell et al. (2020).

Reinsdorf (2020), "COVID-19 and the CPI: Is Inflation Underestimated?" IMF Working Paper No. 2020/224

Changing Expenditure Shares in the US

Table 2. COVID-19 Budget Shares in the United States, April 2020

	CPI Weight	COVID Basket Weight	COVID-19 Weight difference from CPI Weight
Food at home	7.6	11.3	3.7
Alcoholic Beverages (at home) ^a	1.0	1.5	0.5
Apparel	2.8	2.2	-0.6
Housing ^b	42.1	55.8	13.7
Medical	8.8	5.6	-3.2
Transportation	15.7	6.3	-9.5
Recreation	5.8	2.2	-3.6
Education and Communication	6.8	9.0	2.2
Food away from Home	6.2	3.1	-3.1
Other	3.1	3.0	-0.1

a. Change in alcoholic beverages inferred from change in food as measured by grocery store spending

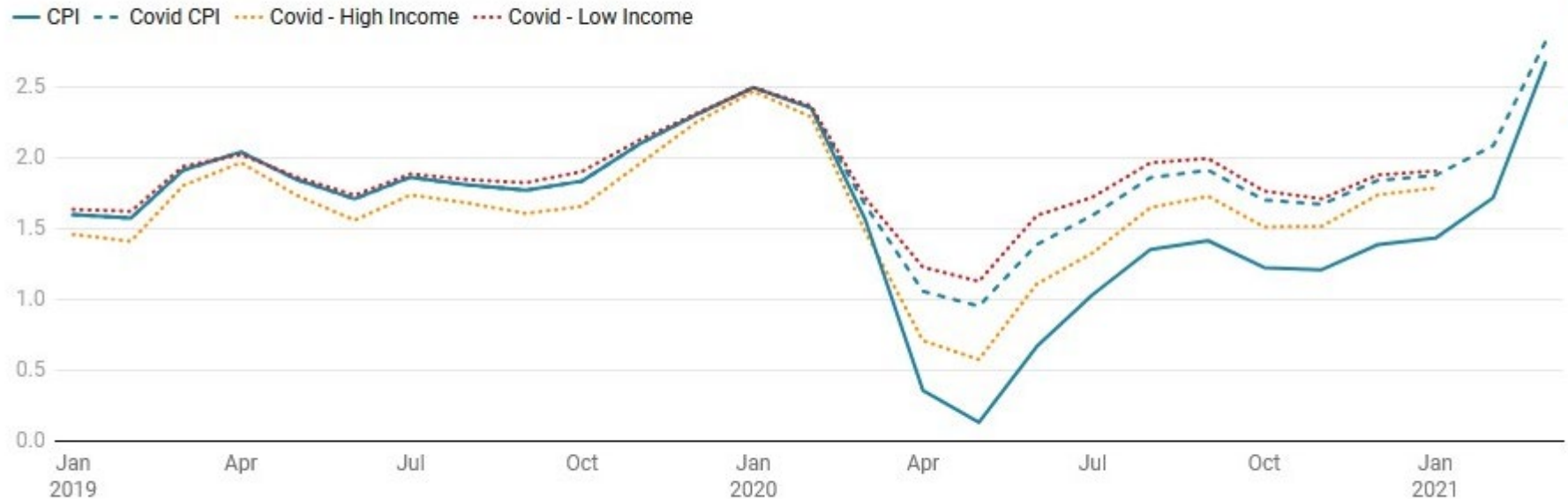
b. Housing adjustment is based on an assumption of stable expenditures.

Source: Cavallo (2020).

Reinsdorf (2020), "COVID-19 and the CPI: Is Inflation Underestimated?" IMF Working Paper No. 2020/224

Cavallo's Research Using Credit Cards and Debit Cards in US

US Covid Inflation (All-items, 12-month changes)



Note: The high-income and low-income series are not updated in real time because the data from opportunityinsights.org required to construct them are not publicly available.

Source: Cavallo (2020) [Inflation with Covid Consumption Baskets](#) • [Get the data](#) • Created with [Datawrapper](#)

Cavallo (2020) "[Inflation with Covid Consumption Baskets](#)".

<https://projects.iq.harvard.edu/covid-cpi/home>

Reinsdorf's Endorsement for Producing a Supplementary CPI using Current Weights

“A supplementary COVID-19 index could provide useful information on the inflation experienced by consumers during the pandemic.

A COVID-19 index could also *provide insight into inequality*, as it would give larger weights to food and housing, which are important determinants of the cost of living of low-income households.”

Reinsdorf (2020), “COVID-19 and the CPI: Is Inflation Underestimated?” IMF Working Paper No. 2020/224

Diewert and Fox (May 2020): An Outline

- 1. Measurement of real consumption.**
- 2. Measurement of the CPI.**
- 3. Advantages and disadvantages of using various “practical” approaches that NSOs were likely to implement, taking into account different levels of data constraints.**
- 4. Construction of elementary indexes with a lack of matching product prices.**
- 5. Other practical measurement problems facing NSOs in CPI construction under pandemic conditions.**

Key Findings

- 1. Using carry-forward prices (either unadjusted or adjusted for inflation) will lead to:**
 - An overestimation of real consumption growth.**
 - An underestimation of changes in consumer inflation.**

- 2. Fixed basket indexes, such as the Lowe index used in most countries to construct the CPI, are inadequate when there are dramatic changes in consumer expenditure.**

- 3. Need new expenditure weights for the lockdown period. Once the lockdown ends, price change comparisons should be made with the pre-lockdown period using pre-lockdown weights.**

- 4. A revisable or supplementary CPI is needed during the Covid period. Statistics Canada is producing such a supplementary index.**

Real Consumption and CPI Biases

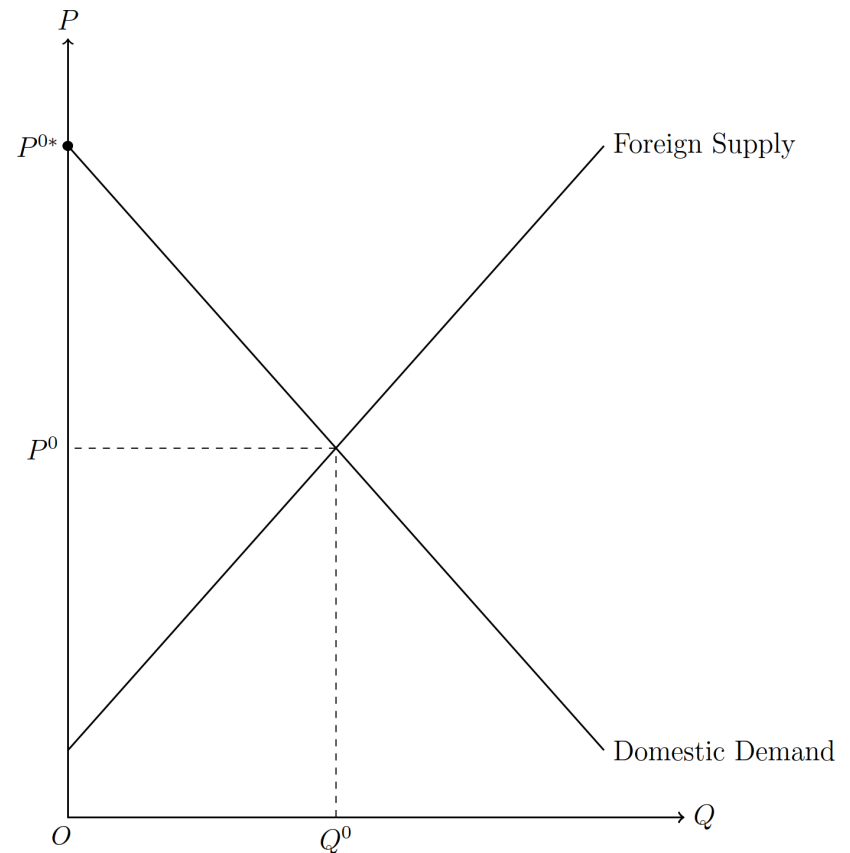
How to think about missing prices?

- Quantities can be zero, but does that mean that prices are as well? **No!**
- Or should missing prices be modelled as being those of the previous period? (Carry forward prices). **No!**
- Or those of the previous period but adjusted by some modelling decision, such as an adjustment for the price inflation of other goods? (Inflation adjusted carry forward prices). **This is better but not perfect.**
- If we take the economic approach to index number theory, then an appropriate price for a missing price is the product's reservation price. This is the price which is just high enough to induce the consumer to want to consume 0 units of the good or service. The reservation price idea dates back to Hicks (1940). **But the main problem is that difficult econometrics is required in order to estimate sensible reservation prices. Also, the reservation price concept assumes that consumer preferences remain constant before and after Covid which is problematic.**

Real Consumption and CPI Biases

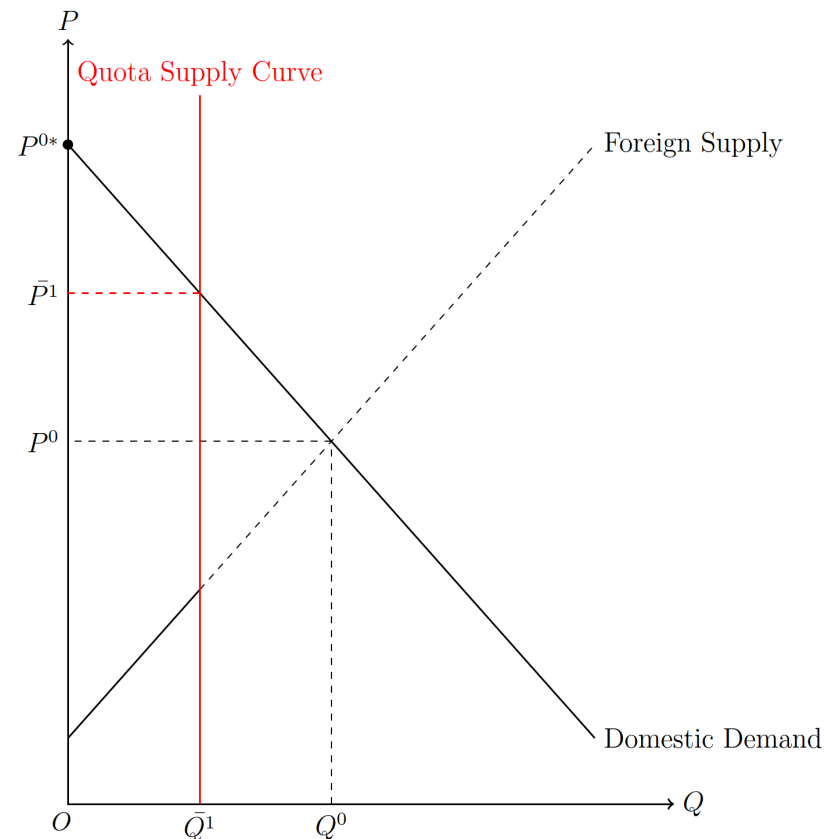
Simple Demand and Supply Diagram Approach to Explaining the Reservation Price Concept

- Consider a simple example of an import quota on a good that is only imported. (Large country case.)
- Here's a simple supply and demand diagram for before the quota.
- Q^0 is traded at price P^0 .
- Notice the price P^{0*} , the price at which demand goes to zero.



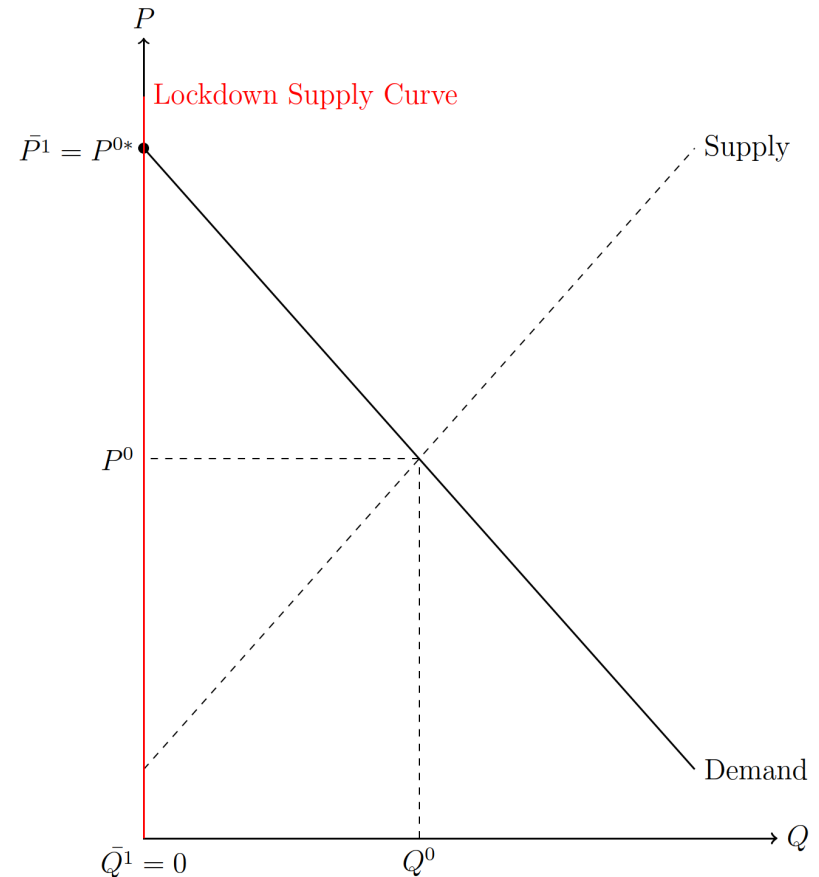
Real Consumption and CPI Biases

- Now a quota is introduced, changing the supply curve.
- Less is traded at a higher price.
- There is a loss of welfare (consumer surplus goes down).



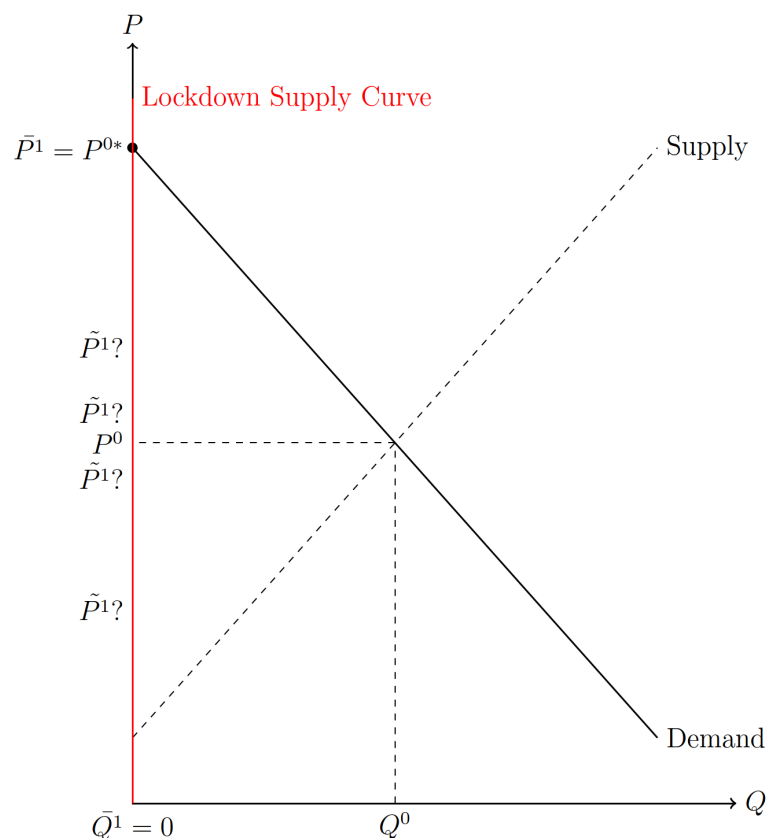
Real Consumption and CPI Biases

- Under a lockdown, the “quota” for a good is set equal to zero.
- The demand and supply curves intersect on the y-axis, at the price for which demand is zero, P^{0*} , which is the **reservation price**.
- There is a loss of welfare (consumer surplus is zero).



Real Consumption and CPI Biases

- Could choose some model to estimate period 1 price so that it's not equal to the reservation price.
- Such prices are likely to be less than the reservation price.
- For example, an inflation adjusted carry forward price.
- Problem is how to think about such prices and how to choose between them.



Real Consumption and CPI Biases; Reservation Prices Explained using Indifference Curve Analysis

From the economic approach to index number theory, a price index is a ratio of expenditure functions with changing prices but fixed utility.

That is, consumers must have preferences over the same set of products in both periods being compared.

In the context of new goods, Hicks (1940) proposed **reservation prices: the prices that drove demand to zero** in the period before they are observed.

We adapted this to the disappearing goods context. This approach allows us to identify biases from the carry-forward prices approach.

Real Consumption and CPI Biases

A lockdown is like being sent to jail – deprived of products and confined to a particular place.

People are prepared to pay a lot of money to avoid jail, indicating that lockdowns decrease welfare.

To capture such declines in welfare using normal consumer theory or the theory of exact index numbers, need estimates for the reservation prices for the unavailable products. We expect these imputed prices to be much greater than the corresponding prices in the previous period.

Real Consumption and CPI Biases

- 1. A theoretical (Allen) quantity index is the ratio of two expenditure functions with prices held constant and utility allowed to change. Hence, it is a measure of welfare change.**
- 2. As (in ratio terms) we want value change = price change x quantity change, then for a fall in welfare (i.e. the quantity index) we need an increase the corresponding price index (as $Q = V/P$).**
- 3. Inflation adjusted carry forward prices will not accurately measure this price increase.**
- 4. Hence, need reservation prices for the lockdown period, which we expect will be much higher than carry forward prices.**

Digression: Do Reservation Prices Matter for an Inflation Targeting Central Bank?

Argument: A Cost of Goods Index (COGI) is appropriate. Don't need to target a Cost of Living Index (COLI) which is based on economic theory and leads to a case for reservation prices.

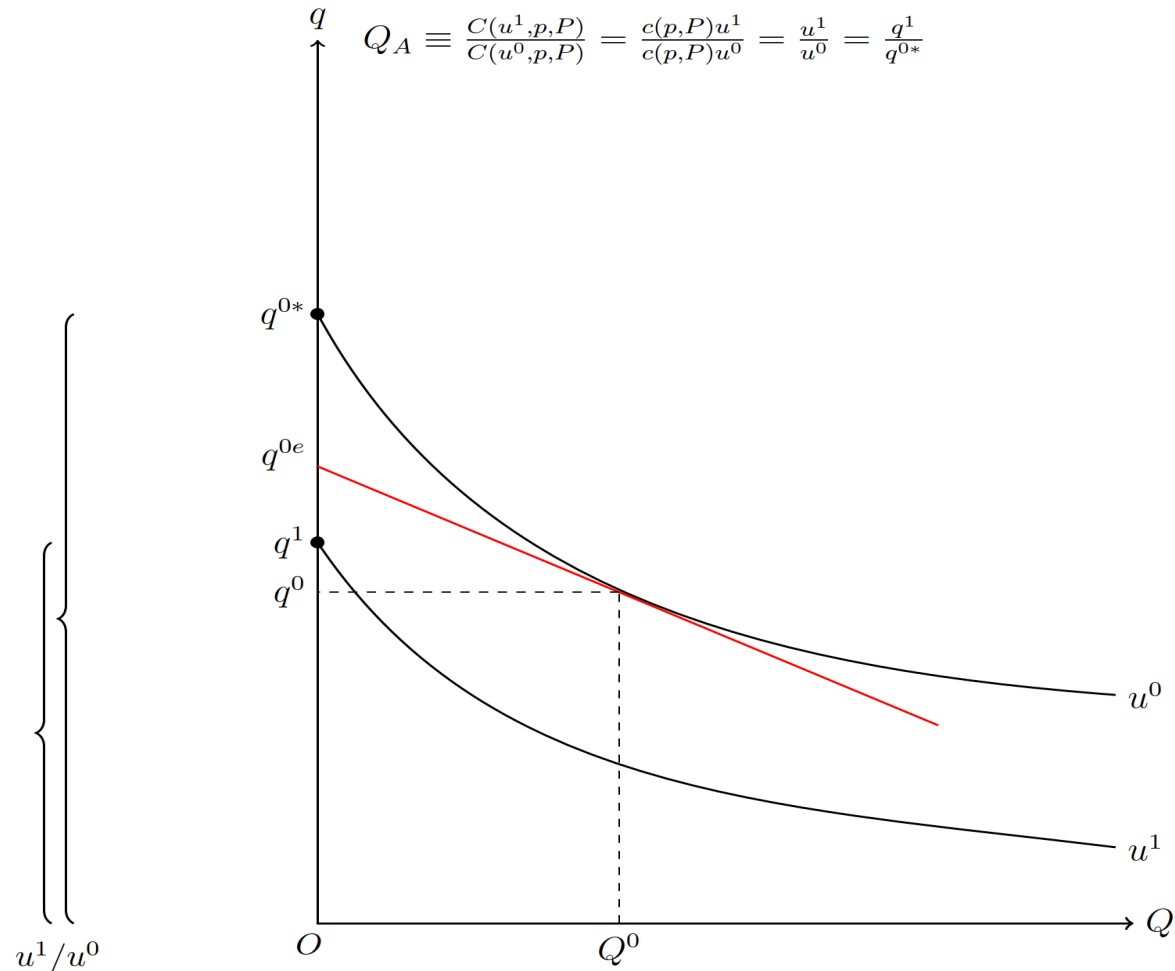
Response:

- If there's any **quality adjustment used in constructing the price index** (implicitly or explicitly), then after using the price index to deflate a value change, the quality change is reflected in the quantity index. That is, **the quantity index is capturing welfare change from quality change.**
- As the CPI in every country incorporates some kind of quality adjustment, we already have a framework where the price index is measuring changes in the cost of living (constant utility price index).

Digression: Do Reservation Prices Matter for an Inflation Targeting Central Bank?

- Normally we assume that the COGI is a reasonably good approximation to the COLI, but that's unlikely to be true at the moment.
- This reservation price is exactly capturing the demand-supply pressures that central banks are interested in; any lower price than the reservation price means that the market is not clearing.

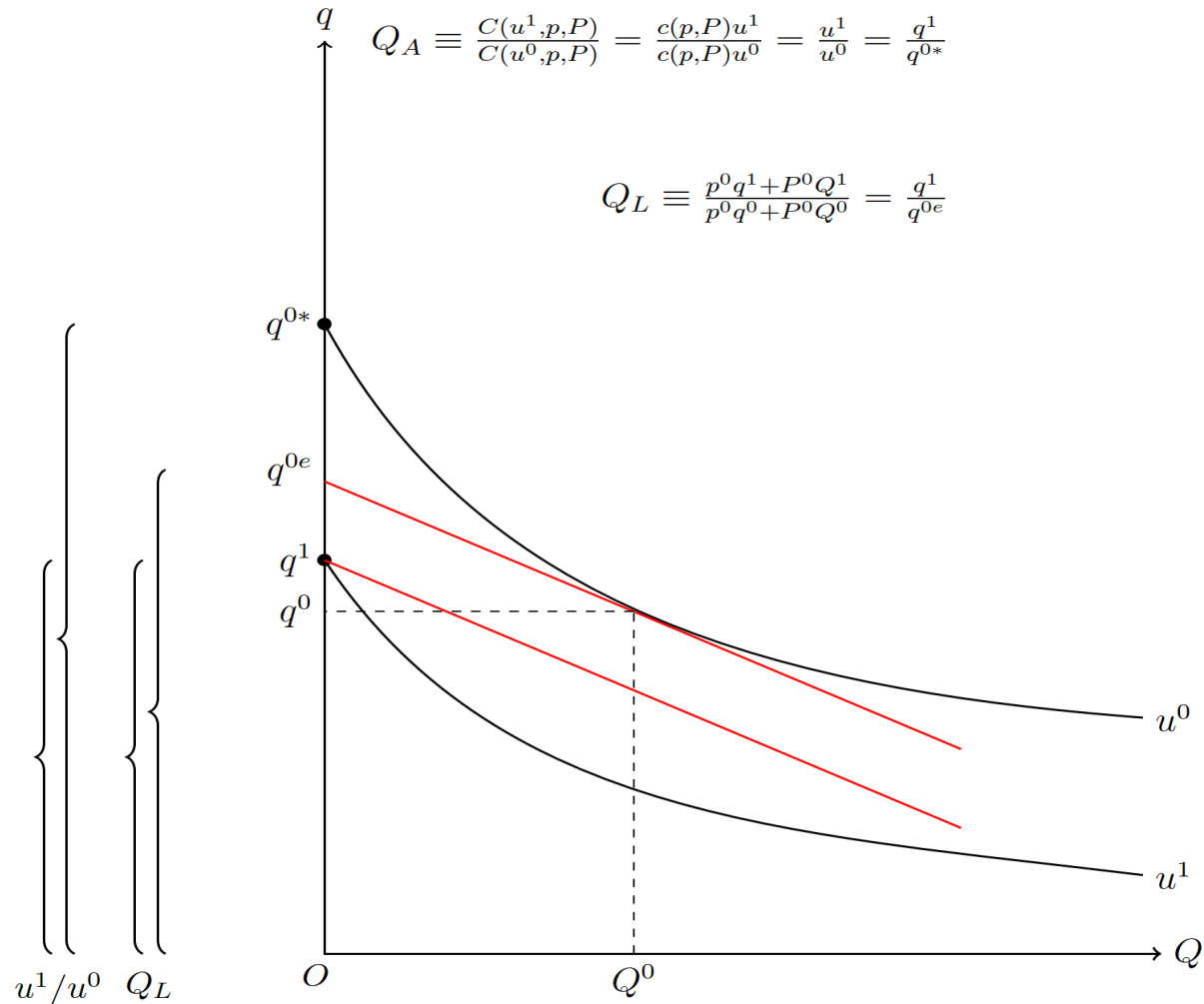
Theoretical Allen Quantity Index



q available in both periods, Q available only in period 0

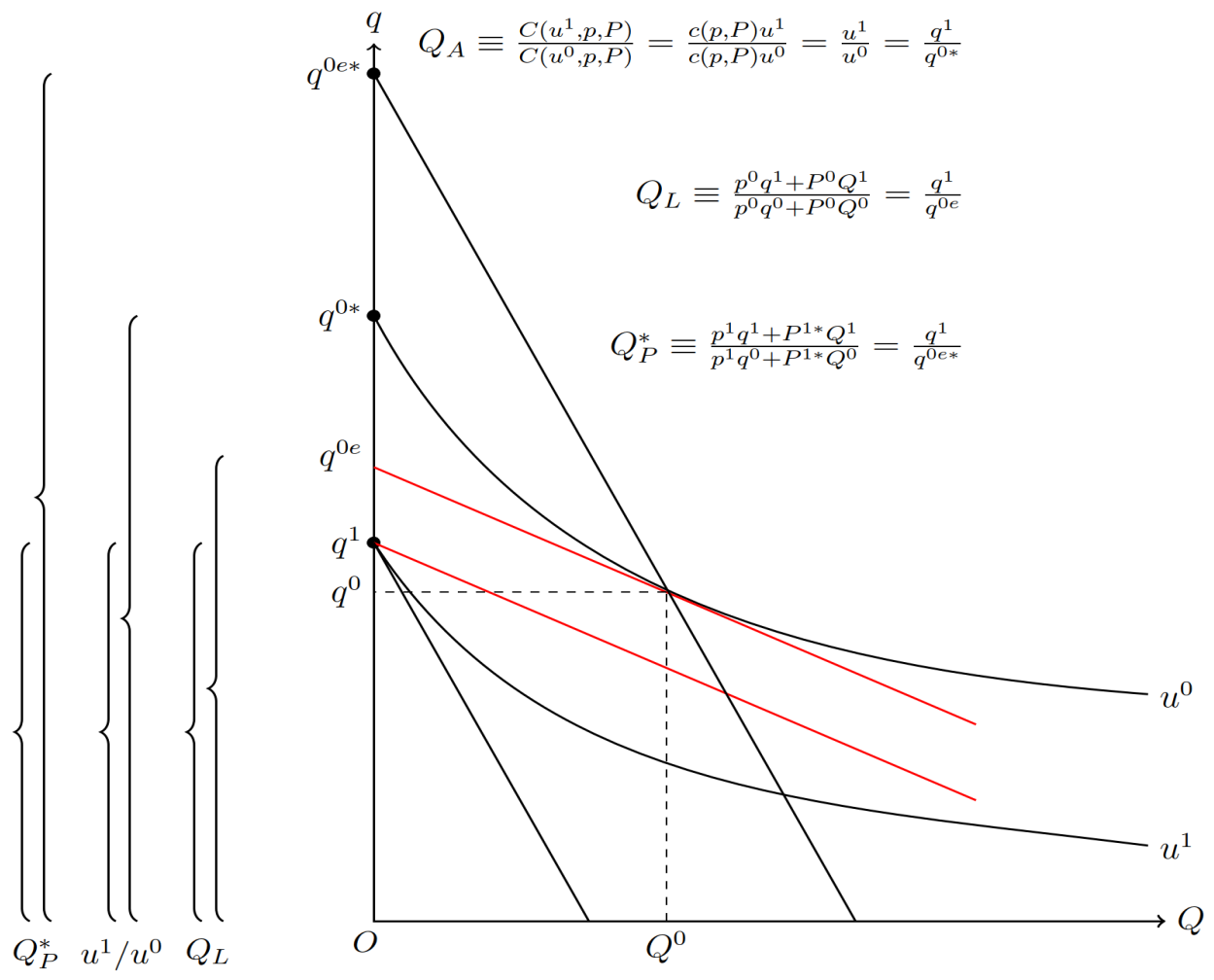
Laspeyres Quantity Index

This index understates the utility drop.



True Paasche Quantity Index (requires the res. Price)

**This index overstates the utility drop.
The (true) Fisher index is just right!**



Real Consumption and CPI Biases

- 1. The theoretical true quantity index is bounded from below by the empirical Paasche quantity index and from above by the empirical Laspeyres quantity index.**
- 2. Note that reservation prices only appear in the Paasche index.**
- 3. If the reservation prices are replaced by inflation adjusted carry forward prices, then in this two-good example the resulting Paasche and Laspeyres indexes are identical and hence understate the utility drop.**
- 4. Hence, the true Allen real consumption growth will be overstated by both Laspeyres and Paasche indexes using carry forward prices.**
- 5. Geometric mean of these is the Fisher index which will be equal to the Laspeyres index – it won't get us closer to the true Allen index.**

Real Consumption and CPI Biases

6. **Real consumption is usually calculated as value change deflated by a Laspeyres price index. Hence it is a Paasche quantity index.**
7. **The target index for an NSO in calculating real consumption is then the Paasche quantity index, not the true Allen index.**
8. **The true Paasche quantity index under lockdown conditions is the one calculated with reservation prices. The Paasche quantity index calculated with inflation adjusted carry forward prices will overestimate the true utility ratio.**
9. **See Diewert and Fox (2020) for the general multi-good case..**

Some Other Practical Problems Considered

No NSO employee price collection:

- **Use web scraping and other non-traditional methods, but need to make sure that only collect prices for products that were actually consumed by any household.**

Stockpiling Problem:

- **Look at what to do about goods that enter and exit the consumption basket as supply-chain issues/lockdown rules change.**
- **CPI is constructed (mainly) on an acquisitions approach rather than a consumption approach – should it be changed to reflect consumption not taking place in the period of acquisition?**

In preparation for the next extreme event, recommend that NSOs:

- Collect current prices and expenditure weights from **non-traditional sources**.
- Start a program looking at alternative price imputation methods e.g. **reservation prices**.
- Look at alternative methods for linking current prices to the prices of previous periods; i.e., look at linking the prices of the present period to a previous period where the price structure is **similar**.
- In addition to the non-revisable CPI, produce revisable CPIs as **analytical** or **supplementary series** that can be revised and updated as new methodology is developed and new data sources are exploited.
- Explain to the public and policy makers that the usual measures of real consumption and inflation are compromised in extreme circumstances such as a pandemic...**and budget increases may be necessary to address these measurement problems**.

Implications of Covid on the ICP (1)

Several possible implications of the pandemic for the ICP come to mind:

Implications at the elementary level:

- It may be more difficult than usual to obtain price quotes for some elementary categories; i.e., some categories may have no quotes at all.
- Forming annual average prices for 2020 and 2021 may be tricky because some months may have monthly quotes for the same product but not for all months due to variable degrees of lockdowns.
- The target elementary index for a country for a specific product should be the annual unit value. But expenditure information by month will not be available so it will not be possible to properly weight the available monthly price quotes. Sparseness of quotes will surely lead to some unrepresentative annual averages for some countries and some categories.
- Different customs and different climates across countries mean that not all products are available across all countries. We do not worry too much about this **lack of matching problem** under normal conditions; i.e., we just match what we can and do not worry about the fact that many products are not available across all countries. However, our emphasis on reservation prices brings home the fact that differing degrees of product availability matters for welfare and price measurement. The pandemic just makes the problem **worse**.

Implications at the elementary level: What can be done?

- A possible solution to the lack of matching problem at the elementary level might be to explore similarity linking of the elementary indexes. Thus countries which had the most similar structure of prices of products in the common list of products for a particular category would be linked first. The **modified predicted share method** for linking time series observations has a penalty built into the method for a lack of matching of prices so that the use of this method should be more reliable than say GEKS-Jevons or the Country Product Dummy method which does not penalize a lack of matching.

Implications of Covid at higher levels of aggregation

- It is very likely that the national accounts estimates of country GDP will become more unreliable due to the effects of the pandemic. Thus there may be more anomalous results than usual for the ICP for the years 2020 and 2021.
- Given that the regions want to preserve their own PPPs within each region, we think that the ICP should experiment with alternative ways for linking the regions. Some forms of similarity linking should be looked at.