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Import Demand Elasticities of Sri Lanka from January 2010 to March 2021 and the Change in Elasticities during the COVID-19 Pandemic

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Abstract

Elasticity of demand for imports of Sri Lanka in the post-Civil War period up to March 2021 and the change in them during the COVID-19 pandemic were estimated. (Relative) price elasticity, (production) activity elasticity and exchange rate elasticity were estimated for aggregate and disaggregated imports using Ordinary Least Squares (OLS) techniques with and without dummies, Autoregressive Distributed Lag (ARDL), and Error Correction Modeling. We found that price elasticity of aggregate import demand is inelastic. With the removal of fuel from aggregate imports, elasticities increase marginally. Activity elasticities of aggregate import demand, non-food consumer goods, intermediate goods and investment goods are inelastic over the short run and elastic over the long run while short run elasticity declined during the pandemic. Demand for food is elastic with respect to relative prices and the exchange rate and price elasticity declined during the pandemic. Intermediate goods are not significantly related to prices and exchange rates but are related to production activity. Our results are important for implementation of monetary, exchange-rate, fiscal, and trade policies of Sri Lanka.

Key Words: *Imports, Import elasticities, Sri Lanka*

JEL Classification: *F1, F4*

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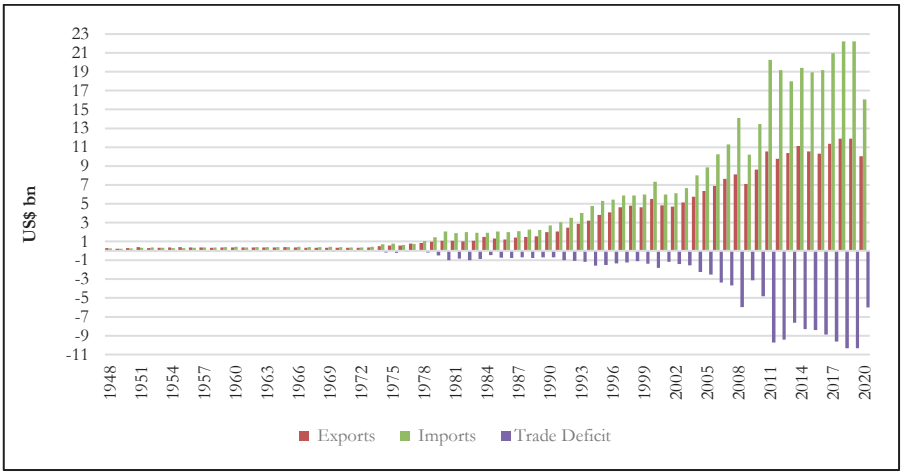
1. Introduction

Sri Lanka is a small open economy that espoused open economic policies in 1978 after about two decades of relatively closed economic policies. Throughout the entire post-independence history (i.e. since 1948), different policy regimes in respect of current account openness and exchange rate management affected the trade performance of Sri Lanka, together with various domestic and international socio-political factors. Trade deficits were recorded each year since the adoption of open economic policies in 1978, and almost every year before that as well (Figure 1). However, the period since 2010 is one distinct phase in the behaviour of imports in particular. Import expenditure increased significantly after the Civil War ended in 2009 and development activities escalated, and remained at high levels thereafter, without a commensurate increase in exports. This led to a gradual widening of the trade deficit and thereby widening of the current account deficit as well. This situation has created a burden on management of the exchange rate, international reserves, capital flows, and foreign debt of the Government. A high level of imports is also alleged by some to discourage local production. Therefore, it is of great interest to policymakers to understand how and why import demand behaved in the way it did during this period, as can be explained through import demand elasticities.

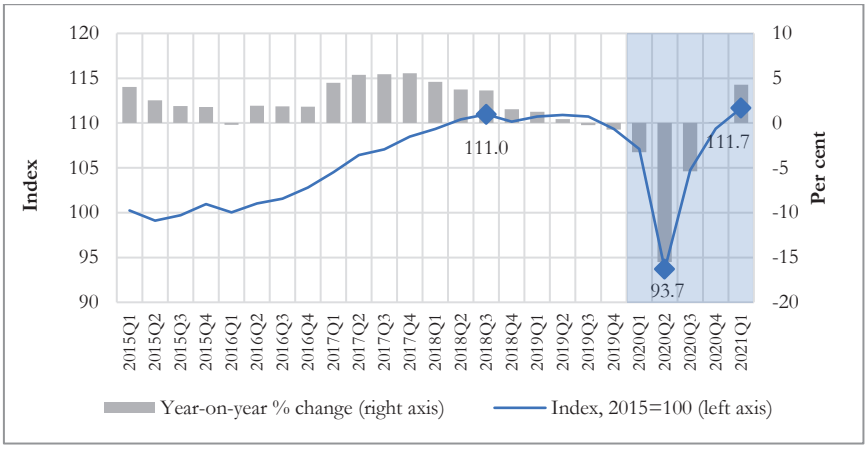
Figure 1: Exports, Imports and the Trade Balance of Sri Lanka from 1948 to 2020



Source: Central Bank of Sri Lanka

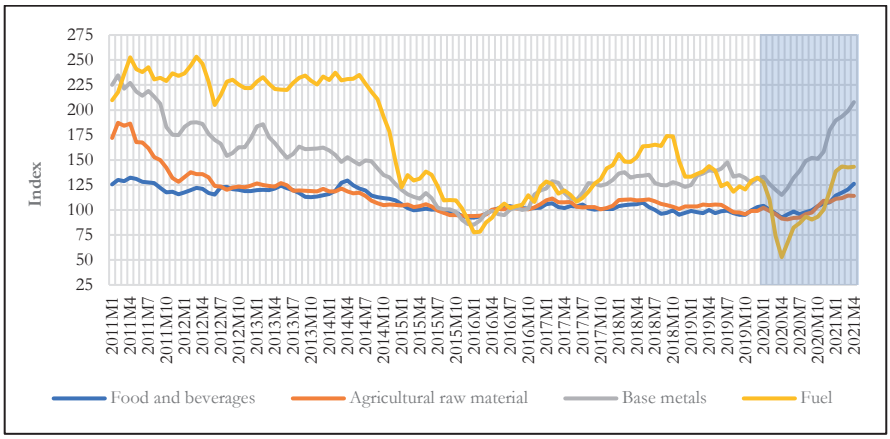
Meanwhile, the outbreak of the COVID-19 pandemic created different dynamics in global trade and trade of Sri Lanka. Global trade volumes decreased significantly as the uncertainties and speculations about the pandemic started to take toll in the tail end of 2019 (Figure 2). Trade volumes reached record low levels in the second quarter of 2020. Low economic activities due to lockdowns, reduction in incomes and demand, and disruption to maritime and logistical activities contributed to the reduction in global trade volumes. Further, commodity prices including prices of fuel plummeted as the pandemic started, reducing the cost of imports for importing countries in the year 2020 even though prices started to increase in the latter part of 2020 (Figure 3). However, trade volumes started to recover in the third quarter of 2020 as the effect of the economic stimulus measures implemented in almost all countries of the world started to take effect and trade started to adjust towards a "new normal".

Figure 2: World Merchandise Trade Volume Index (2015=100)



Sources: World Trade Organization United Nations Conference on Trade and Development

Figure 3: IMF Commodity Price Indices (2016=100)

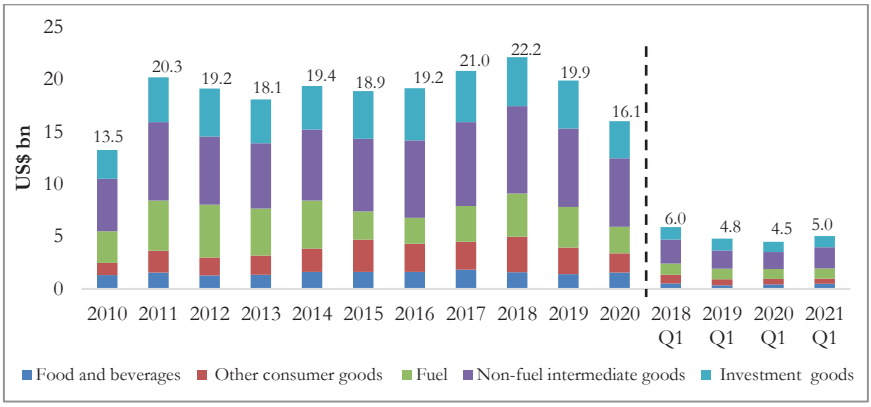


Source: International Monetary Fund

Sri Lanka's exports and imports broadly followed this pattern in global trade from 2020. Exports recorded a large decline during the first wave of the pandemic but started to recover thereafter. Import expenditure also plummeted in 2020 (Figure 4). In addition to the global supply chain issues, low global commodity prices and low economic activity in the country owing to lockdowns, import controls introduced by the Central Bank and the Government to curb non-urgent and non-essential imports to safeguard external sector stability in the face of compelling exchange rate and reserve management issues also contributed to reducing the import expenditure. However, imports displayed a lower inclination to stay low during the pandemic and a greater inclination to increase as the pandemic shock started to recede, when the aggregate import expenditure numbers are observed through the naked eye. For instance, although import expenditure during the first quarter of 2020 declined to US dollars 4.5 billion from the US dollars 6.0 billion and US dollars 4.8 billion recorded in the first quarters of 2018 and 2019 respectively, import expenditure during the first quarter of 2021 increased to US dollars 5.0 billion, despite the import controls, comparatively lower oil prices and the ongoing pandemic. This effect was more pronounced in some import categories than others. Therefore, credible estimations of import elasticities are necessary to understand import demand characteristics to devise economic policies, since the limited foreign exchange reserves and lack of foreign currency inflows have

made careful management of import expenditure and other outflows important, in order to maintain price, macroeconomic and financial system stability. Further, better understanding of import demand behaviour is also necessary to design trade, industrial, agricultural and development policies as well. Meanwhile, uncertainties created by the pandemic over economic activities, the exchange rate, and the policy environment may have changed import demand characteristics. Therefore, examining to what extent import elasticities changed since the outbreak of the COVID-19 pandemic is also of interest to policymakers, since the pandemic has aggravated external sector issues in the country.

Figure 4: Import Performance of Sri Lanka 2010 to 2021 Q1



2. Review of relevant and related past studies

The notion of elasticity of demand which was introduced to the technical literature of economics by Alfred Marshall, stipulates that quantity demanded of a product varies less or more with price, and its measurement is invariant to the measurement of quantities and prices. This concept has been applied in trade research in a widespread manner throughout the last several decades to gauge the degree of sensitivity of import and export quantities to factors affecting those quantities. Research points to the works of Joan Robinson (Robinson, 1937) as the origin of this application (Bahmani et.al., 2013; Eita, 2013), who explained the conditions under which devaluation of the exchange rate improves the trade balance and estimated trade elasticities. Her work formed the basis for estimating import and export

elasticities to research into numerous aspects of international trade, such as welfare effects of trade, direction of trade, exchange rate management and assessment of impact of trade policies such as tariff changes and preferential trade agreements.

However, it is the simple reduced form equations used by Houthakker and Magee (1969) that have become the workhorse model in import and export elasticity estimation. These equations present export and import quantities as a function of income and relative prices. Income is the gross value addition in the economy under concern or a reasonable proxy, while relative prices refer to import and export price indices in relation to some inflation measure. Income and relative prices encompass the main factors that theory identifies as affecting import demand, including tariff changes, global and local price levels, the exchange rate, and economic activity. There is a plethora of research that estimates import and export elasticities using these equations for various countries and for various time periods to determine whether the Marshall-Lerner condition and the J-Curve effect hold.[5] A lot of research also estimate elasticities for imports and exports with individual trading partners. It can be seen that the econometric techniques used in these research have gradually improved over time. Whereas earlier studies did not deal with the issue of stationarity, more recent research use cointegration approaches (mainly the Johansen and Juselius (1990) method), dynamic Ordinary Least Squares (OLS), Autoregressive Distributed Lag (ARDL) method of Pesaran et al. (2001) and Error Correction Modeling.

Neoclassical trade theory indicates that activity elasticity in the long run should be equal to about one based on marginal income propensity to consume and import of normal goods (Hong, 1999). However, results obtained by conventional methods as well as the new methods reveal that in some cases, it is higher than one for reasons such as new goods that are not included in the import price indices leading to underestimation of price elasticities and overestimation of income effects, the model in neoclassical theory applying more to final goods than intermediate goods, and greater intra-industry trade (Hong, 1999). The magnitude

[5] The Marshall Lerner condition states that the absolute value of price elasticities for imports and exports must sum to greater than one for a devaluation to be effective in improving a country's trade balance. The J-Curve effect states that a country's trade balance will initially deteriorate with the depreciation of its currency before improving.

of price elasticities, on the other hand is more difficult to predict as many factors can affect demand for imports through relative prices. However, price elasticity estimates are generally lower than unity (inelastic).

Import and export elasticities of Sri Lanka have been estimated in four previous published research papers to the best of our knowledge. Reinhart (1995) estimates import and export elasticities for twelve developing countries including Sri Lanka for the period of 1970 to 1991 using the Stock and Watson specification of estimating cointegrating relationships. His estimate for relative price elasticity for Sri Lanka is -0.304 while the income elasticity is 1.976. Subsequently, Sinha (2001) had estimated import and export elasticities for five Asian countries, including Sri Lanka. The period for imports under consideration for Sri Lanka in this research is 1950 to 1997 and an income elasticity of -0.39 and a relative price elasticity of -0.48 had been arrived at using ARDL techniques (both coefficients are statistically significant). It is noteworthy that the income elasticity of import demand is negative and inelastic in these findings, meaning that as income grows, imports decline by a magnitude less than proportionate. The negative sign is not consistent with conventional wisdom but the author presents this as a valid result. Further, it is concluded that the Marshall-Lerner condition does not hold for Sri Lanka and that devaluation as a strategy to reduce the trade deficit is unlikely to succeed in Sri Lanka.

Subsequently, Emran and Shilpi (2010) undertake research into import demand elasticities of Sri Lanka and restrict their analysis only to Sri Lanka. According to the paper, studies that undertake cross-country comparisons ignore implications arising from changes in policy regimes and hence could give biased results. In this research, the aggregate imports of Sri Lanka from 1960 to 1995 have been analysed using a structural econometric model of a two-good representative agent economy that incorporates a binding foreign exchange constraint at the administered prices of imports. Dummy variables have been used to distinguish the Civil War period from 1983 to 1989 and the period with protectionist policies prior to 1978. Using ARDL and Dynamic Ordinary Least Squares (DOLS) methods, they find that income elasticity is in the range of 0.96 and 1.09, while the price elasticity estimate is -0.78. They argue that they

found a higher (or different) price elasticity estimate compared to Reinhart (1995) and Sinha (2001) because those two studies did not take into account the differences in the policy regime that existed before 1978 with more trade and exchange rate interventions. As for foreign exchange availability as a binding constraint, they argue that if foreign exchange availability is used as a regressor when the foreign exchange constraint is binding, it alone determines the volume of imports completely, resulting in a near identity problem. This research also estimates that the magnitude of inter temporal elasticity of substitution of Sri Lanka is only slightly higher for home goods consumption (0.92 to 1.04) compared to imports (0.78), whereas some other research has found that it is 2 times as higher compared to the USA. This paper concludes by calling for more in depth country studies that take into account policy changes and other specific factors affecting imports and exports of the countries during certain periods of times, as studies which do not take into account such country specific factors produce biased results.

Tennakoon (2010) is a more recent research paper that contributes to the literature on trade elasticities of Sri Lanka by estimating import elasticities for total imports as well as three broad categories of imports, i.e., consumer goods, intermediate goods and investment goods. The period under concern is 1977 to 2007. Further, in addition to relative prices and incomes, this research also uses foreign exchange availability as one of the regressors. Using OLS techniques, it has been estimated that relative price elasticity for consumer goods, intermediate goods and investment goods are -0.99, -0.46 and -0.75, respectively, while foreign exchange elasticity for intermediate and investment goods is 0.497 and 0.705, respectively. Income elasticity estimates had not been statistically significant for all three types of imports. This shows that elasticities for different types of imports can be different. However, the results of this paper are contrasting with those of previous research to some extent and the differences could be due to the use of OLS as the analytical method, the inclusion of foreign exchange availability as an explanatory variable and the difference in time periods under concern. These differences have led to contrasting interpretations about import demand characteristics of Sri Lanka. In addition to the above four research, Sri Lanka is among a study carried out on 152 importing countries that uses a database covering the universe of exporters, importers and products at the 6-digit level of the Harmonised System (Fontagné, Guimbard and Orefice, 2020). This

research shows that when homogenous (or country-level) trade elasticities are used, a downward bias in the estimation of welfare gains from trade for developing countries can result, particularly for countries with high import penetration in less elastic sectors.

Past research shows that import demand elasticities need to be estimated again using the latest data, if they are to be used in policy decision making in the current context. Past research also provides guidance by showing that different types of imports can have different demand characteristics, and that differences in policy regimes should be accounted for while using robust empirical methods based on time series properties of data.

Since international trade was severely affected by the COVID-19 pandemic, there are numerous studies that investigate the size and nature of the pandemic's impact on trade and economic growth of individual countries and regions. The International Finance Corporation (2020) surveyed policy research carried out by other international organisations and trade data of individual countries in the first few months of 2020 and forecasted that in the short term, global trade will fall. The IFC publication has also noted that in the medium term, trade can help expedite economic recovery for many countries. It is also expected that global inventory management strategies may change and innovations in trade digitalization will continue while trade corridors may shift offering opportunities for high potential countries to take on greater leadership roles in regional trade networks (International Finance Corporation, 2020). Trade patterns and import demand are in fact shifting towards a "new normal". To the best of our knowledge, there are no published research papers that estimate import elasticities for any country for the COVID-19 pandemic period, or the change in import elasticities for this period. Most of the studies that are currently published were undertaken in the initial phase of the pandemic and aim to simulate and predict the pandemic's effects, taking into account that the pandemic brought both demand and supply shocks to trade. Since most of the projections on trade and GDP outcomes of the pandemic in 2020 are realised and measured by now, these studies are useful to determine the best methodologies to carry out predictions in the future.

In a seminal study that attempted to gauge the impact of the COVID-19 pandemic on trade, Hayakawa and Mukunoki (2020) investigate trade among 186 countries in the first quarter of

2020 and conclude that the pandemic had a negative effect on exporting countries, particularly developing countries, but not importing countries. Further, these negative effects had been more salient in some industries including textile, footwear and plastic industries. Textiles is a main import of Sri Lanka. A simulation using a Global Trade Model with early 2020 data that assumes global GDP and trade will be affected through three channels, viz, reduced labour supply, reduced demand and supply in specific sectors, and rising trade costs, predicted a decline in global GDP growth and trade in 2020 and 2021 (Bekkers & Koopman, 2020). Meanwhile, a simulation exercise on a General Equilibrium Model with trade cost and an endogenous trade imbalance structure using 2018 data for China, the EU and USA has found that the pandemic will hurt global trade and exports, though trade diversion and price increases will lead to an increase in imports of some countries (Li & Lin 2021). This simulation has assumed that COVID-19 will increase the trade cost between countries and decrease labor supply in production. Trade carried out by Commonwealth countries is also expected to be affected, though with greater effect on developed countries based on the duration and severity of the pandemic, according to simulations that use variations from the pre-pandemic trend in intra and extra Commonwealth trade in goods; and consensus, pessimistic and optimistic scenarios developed using macroeconomic forecasts published by the International Monetary Fund, World Bank and World Trade Organisation in the third and fourth quarters of 2020 (Escaith & Khorana, 2021). Meanwhile, the negative impact of the pandemic has been found to be greater for countries that were members of regional trade agreements before the pandemic, while the impact of the pandemic is negative and significant when indicators related to governmental actions are considered (Barbero et al. 2021). This negative effect has been found to be more intense when the exporter and importer countries share identical income levels, and the highest negative impact is found for exports among high income countries. The results have been derived using export data for 68 countries between January 2019 and October 2020.

Many countries responded to the pandemic with trade policy measures. Trade policy responses to the pandemic upto October 2020 had amounted to about 701 policy measures across 135 customs territories and had been substantially varied across countries (Evenett et. al., 2021). Trade policy measures are mainly export restrictions and import liberalisations on medical and

food products with measures targeting medical products accounting for two-thirds of such trade measures, amounting to US dollars 135 billion of export restrictions and US dollars 165 billion of import liberalisations. The comparable totals for food products had been US dollars 39 billion and US dollars 42 billion, respectively (Evenett et. al., 2021). Based on product level trade elasticities in global trade estimated by Fontagné et.al. (2020), the export restrictions had resulted in a 0.7 per cent increase in food prices and a 3.3 per cent increase in prices of medical products. Sri Lanka is among the countries that imposed certain export restrictions (oxygen) and import liberalisation (face masks). Import restrictions imposed on certain non-urgent non-essential goods in Sri Lanka from March 2020 are interpreted as Covid-19 policy responses in some contexts while not being interpreted so in others as they were imposed to manage external sector issues that prevailed for some time and got aggravated by the pandemic.

In this background of the related and relevant past studies, our research attempts to provide more up-to-date estimates of import elasticities of Sri Lanka for disaggregated imports and to do so using more rigorous econometric techniques than previous studies on Sri Lanka. In doing so, we also aim to give guidance to the policy decision making process on management of foreign currency flows of Sri Lanka. Our research also addresses contrasting results found by previous research on Sri Lanka. Building on the research findings that the pandemic affected international trade significantly, and that the magnitude differed according to country characteristics, we also estimate the import demand elasticities for Sri Lanka for the pandemic period up to the first quarter of 2021. Our study is the first that estimates import demand elasticities taking into consideration a period of time that was affected by different supply and demand characteristics in international trade created by a global pandemic, to the best of our knowledge.

3. Analytical framework

Elasticity of import demand in respect of three types of factors that affect import demand were estimated in this study, namely, relative prices, economic activity and the nominal exchange rate. Elasticity is defined as the percentage change in the quantity demanded, for a 1 per cent change in the factor affecting demand. Whereas most of the previous research estimate relative price elasticity and income elasticity, we decided to add the nominal exchange

rate as a separate variable, on account of the sizable exchange rate depreciation, speculation on the exchange rate and the policy measures aimed at managing the exchange rate that took place in Sri Lanka after the outbreak of the pandemic. Monthly data from January 2010 up to March 2020 were used. The period that was impacted by the pandemic was taken as the 12 months from April 2020 to March 2021. April 2021, rather than January, February or March 2021 was regarded as the first month of the pandemic period because rapid spread of COVID-19 and mobility restrictions in Sri Lanka commenced in late March 2021. Most of the economic policy measures were also implemented during March 2020. Thus, the impact of COVID-19 on the economy was more salient from April 2021.

Since the demand for the four major types of imports according to the Central Bank trade classification system could be different from each other as suggested by previous research findings, the analysis was conducted separately for the four main types of imports, namely, food; non-food consumer goods; intermediate goods; and investment goods, in addition to total imports. Since fuel imports amounted to about 20 per cent of total import expenditure (in US dollars) from 2010 to 2020, and since fuel imports have different demand characteristics than other imports, the analysis was carried out for total imports excluding fuel as well.

We were unable to estimate "income elasticity" as previous research had done, since we were considering monthly changes in import demand in this research. Although we tried to interpolate quarterly GDP numbers, time series properties of this series were not appropriate to use in our analysis. Therefore, we estimated "production activity elasticity" or "activity elasticity" by using data on industrial production instead of GDP. Since economic activities in the agricultural, services, mining and construction sectors are strongly linked to industrial production activities, our "activity elasticity" is a reasonable proxy for "income elasticity". Further, since industrial production activities require imports to be used as intermediate and investment goods, our "activity elasticity" gauges elasticity of import demand for industrial production needs in the country as well.

Real import demand (the dependent variable) was proxied by import quantity indices for the import categories mentioned above. To calculate relative prices, import unit value indices (in

Rupee terms) for the above categories of imports were divided by the Colombo Consumer Price Index (CCPI). For the exchange rate, the Nominal Effective Exchange Rate (NEER-24) index was used while the Index of Industrial Production (IIP) which was backcasted with the Factory Industry Production Index (FIPI) for the pre-2017 months was used for (production) activity elasticity estimation.

Negative coefficients are expected for relative price and exchange rate elasticities since increase in prices or the depreciation of the Sri Lankan Rupee against the US dollar should reduce quantity of imports demanded. Positive coefficients are expected for production activity elasticity since an increase in income or production level should increase quantity demanded of imported goods. Since Sri Lanka is a small open economy that is not much industrialised, it is not expected that import substitution has a considerable effect leading to negative elasticity of import demand in relation to production activity.

4. Methodology

We followed three empirical methods, namely, Ordinary Least Squares (OLS) regressions, OLS regressions with dummy variables, and Auto-Regressive Distributed Lag Modelling/Error Correction Modelling. Non-stationarity is a common property of time series data and different methods, including the above, can be employed when such properties are present. Since elasticity is defined as the percentage change in the quantity demanded for a 1 per cent change in the factor affecting demand, in an OLS regression, the coefficients derived when both dependent and explanatory variables are in log form can be interpreted as elasticities as defined above.

We tested whether our time series are stationary using Augmented Dickey-Fuller (ADF) unit root tests. Typically, for estimation of long run relationships, the stationarity property can be disregarded (though not for estimation of short run relationships). If there is a long run relation among variables, we can incorporate both short run and long run relations to the models. To explore the long run relationship among variables, we used the bounds test as an extension to the ARDL (defined below) which assesses the trend/first order stationarity of an underlying time series.

As our first empirical method, we ran OLS regressions first from January 2010 to March 2020 to estimate the elasticities in the pre-pandemic period, and subsequently for the full period from January 2010 to March 2021 to gauge how the elasticities had changed with the addition of the 12 months which were impacted by the pandemic. The generalised equation is as follows.

$$D\ log\ Y_t^i = \alpha_0 + \alpha_1 D\ log\ R\ P\_Y_t^i + \alpha_2 D\ log\ I\ IP_t + u_t$$

Where Y_t^i is import quantity, RP_Y_t^i is the relative price applicable for Y_t^i and IIP_t is the industrial production index. *D* denotes the first difference operator. $\alpha_{1,2}$ are elasticities.

Though OLS regressions for the pandemic period were also estimated, they were not used for interpretation of results since results were statistically non-significant in most cases, mainly due to the lack of data points.

As our second empirical method, we ran OLS regressions with intercept dummies and interactive dummies. The intercept dummies gauge how much import demand is higher/lower in the pandemic period when compared with the pre-pandemic period, holding all other factors constant, while the regressions with interactive dummies (slope dummies) for industrial production and relative prices for the pandemic period give how much a 1 per cent increase in industrial production or relative prices affect import demand in relation to the pre-pandemic period, holding other factors constant. However, when conducting the analysis as well as when interpreting results, we weighed on the fact that when a variable which is already used in the model as an explanatory variable is reconsidered to be used along with a dummy variable in the same model, concerns of multicollinearity could arise.

Two models were used to estimate relative price and production activity elasticities using the following generalised equation.

$$Y_t = \alpha + \gamma D + \beta X_t + \delta X_t D + u_t$$

Where, Y_t refers to import quantities (dependent variable) and X_t refers to independent variables. D denotes dummy variables.

Dummy variables are defined as follows;

D
- 1; if t represents a month from April 2020 to March 2021 (pandemic period)
- 0; if t represents a month prior to April 2020 (pre-pandemic period)

If D=0,

$$Y_t = \alpha + \gamma\,(0) + \beta X_t + \delta X_t\,(0) + u_t$$

$$Y_t = \alpha + \beta X_t + u_t$$

Considering variables in their log first difference form, elasticities for the pandemic period can be determined as follows.

If D=1,

$$Y_t = \alpha + \gamma\,(1) + \beta X_t + \delta X_t\,(1) + u_t$$

$$Y_t = (\alpha + \gamma) + (\beta + \delta) X_t + u_t$$

Since the coefficients of the slope dummy variable is interpreted as the change in elasticities over the base period, the above allows us to identify the change in elasticities in the pandemic period in relation to the non-pandemic period.

Non-stationarity is a common property of time series data, including the type of data used in our study, and different models can be employed when such properties are present in the data. We estimated elasticities using the ARDL modelling approach, in addition to the abovementioned methods, because of its ability to estimate the long run and short run parameters simultaneously. This econometric method is also commonly used in research papers on trade elasticities published in the recent years. We tested whether our time series are stationary using ADF unit root tests.

An ARDL representation of $Y_t = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + u_t$ is formulated as follows.

$$DY_t = \alpha_0 + \sum_{k=1}^{p} \alpha_{1,k} DY_{1,t-k} + \sum_{j=0}^{q} \alpha_{2j} DX_{1,t-j} + \sum_{j=0}^{r} \alpha_{3j} DX_{2,t-j} + \beta_1 Y_{t-1} + \beta_2 X_{1,t-1} + \beta_3 X_{2,t-1} + \varepsilon_t$$

Where, Y_t is the dependent variable and X_t refers to the independent variables. D denotes the first difference operator. α_0 is the interceptor (drift) and ε_t is the white noise residual. The coefficients β_1 to β_3 correspond to the long run relationship, whereas the coefficients α_1 to α_3 represent the short run relationship.

Three models were used to determine the relative price, production activity and exchange rate elasticity[6] using ARDL. If there is a long run relation among the variables, we can incorporate both short run and long run relations to the models. To explore the long run relationship among variables, we used the bounds test. If there is a cointegration relation, then the ARDL model above can be represented as the error correction form of the ARDL model, as follows.

$$DY_t = \alpha_0 + \sum_{k=1}^{p} \alpha_{1,k} DY_{1,t-k} + \sum_{j=0}^{q} \alpha_{2j} DX_{1,t-j} + \sum_{j=0}^{r} \alpha_{3j} DX_{2,t-j} + \lambda ECM_{t-1} + \varepsilon_t$$

Where $\boldsymbol{\lambda}$ is the speed of the adjustment parameter.

5. Results of the estimation

5.1.1 Interpretation of results

We have reported below results from all above regressions we ran for the seven categories of imports. In most cases, results from all types are similar, yielding the same coefficient sign, similar magnitudes of the coefficients and similar levels of statistical significance. Therefore, our results are reasonably robust.

Even in previous published research, different econometric techniques used by different researchers, even for the same country and the same time period have yielded different levels of elasticities. Therefore, an exact value of elasticities cannot be specified for any country and any time period. Yet, our analysis answers whether the negative relationship of import demand with relative prices and exchange rates and the positive relationship with income/production activity that are postulated by economic theory holds for Sri Lanka for the January 2010 to

[6] Since all the variables are in the log form, the regression coefficient can be reported as the elasticity.

$$e_{y,x} = \frac{dy}{dx}\frac{y}{x} = \frac{d\ ln\ y}{d\ ln\ x}$$

March 2021 period, and if so, what their general magnitudes are. Our analysis also provides an understanding of how these elasticities changed because of the COVID-19 pandemic.

In the OLS regressions, although the exchange rate was not statistically significant in most cases, we did not re-run the regressions excluding the exchange rate, since it is an important variable in determining import demand elasticities. However, for some ARDL models, the estimations were performed without the exchange rate to improve the efficiency/predictive capacity of the model, taking into account time-series properties of the data.

5.1.2 Results of unit root tests

Graphical view of the data is provided in Appendices. Results of the ADF unit root tests on whether our time series (in logs) are stationary are given in Table 1 below.

Table 1: Results of unit root tests

Variable	Level (in logs)		First Difference (in logs)		Order of integration
	Statistic	Probability	Statistic	Probability	
Import quantity index - total imports	-2.665*	0.083	-17.477***	0	I(1)
Import quantity index - non fuel imports	1.081	0.927	-6.971***	0	I(1)
Import quantity index - food	-3.647***	0.006			I(0)
Import quantity index- non food consumer goods	-2.756*	0.068	-17.018***	0	I(1)
Import quantity index - intermediate goods	0.548	0.833	-17.097***	0	I(1)
Import quantity index -investment goods	-2.707*	0.076	-12.946***	0	I(1)
Relative prices for total imports	-1.115	0.239	-2.422**	0.016	I(1)
Relative prices for food imports	-5.666***	0			I(0)
Relative prices for non-food consumer goods	-2.307	0.172	-2.307	0.172	I(1)
Relative prices for intermediate goods	-1.387	0.587	-5.080***	0	I(1)
Relative prices for investment goods	-0.01	0.955	-8.897***	0	I(1)
Relative prices for fuel	-1.243	0.655	-10.907***	0	I(1)
Nominal Effective Exchange Rate-24	0.037	0.96	-7.795***	0	I(1)
Index of Industrial Production/Factory Industry Production Index	-2.385	0.148	-3.718***	0.005	I(1)

***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level

5.1.3 Elasticities for total imports

Our results presented in Table 2 show that, as expected, there is a negative relationship of import demand with (relative) prices, and a positive relationship with (production) activity. However, there is no statistically significant relationship with exchange rates.

Import demand is inelastic to prices. In the short run, price elasticity ranges from -0.32 to -0.39 while in the long run, it records a value around -0.51. In the OLS regressions for the full period (both pre-pandemic and pandemic) price elasticity is higher than that recorded for the pre-pandemic period. Although the OLS regression with dummy variables to capture the change in price elasticity also indicate an increase in elasticity in the pandemic period over the pre-pandemic period, this result is statistically non-significant.

Activity elasticity on the other hand is inelastic in the short run and elastic over the long run. Activity elasticity in the pre-pandemic period ranged between 0.61 to 0.63 in the short run while recording a value of 1.1 in the long run. This is in consistency with the neoclassical trade theory and findings for other countries, that long run income elasticity of import demand is about 1 (Hong, 1999). In the OLS regressions for the full period, activity elasticity is lower than the pre-pandemic period and a similar outcome is shown in the OLS regressions with dummy variables as well. This indicates that the sensitivity of import demand to production activity declined in the pandemic period. However, in the ARDL model, the long run activity elasticity for the full period is 1.42.

Table 2: Elasticities for total imports

	OLS		ECM		ARDL	
	Pre-pandemic period	Full period	Pre-pandemic period		Full period	
			Short run	Long run	Short run	Long run
Price elasticity	-0.321***	-0.368***	-0.320**	-0.511***	-0.328***	-0.429**
Activity elasticity	0.614***	0.399***	0.630***	1.085***	0.448***	1.419***
Exchange rate elasticity	-0.145	-0.901	-0.332	-0.688***	Removed (note)	-0.347

	OLS with dummies			
	Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-0.394***		-0.309**	-0.688
Activity elasticity	0.624***	-0.514***	0.383***	
Exchange rate elasticity	-0.525		-0.853	

Note: Removed since it was not statistically significant in OLS models, in order to improve the efficiency of this model.
*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

5.1.4 Elasticities for non-fuel imports

According to the results given in Table 3, both (relative) price and (production) activity elasticities increase when fuel (which represented about 20 per cent of import expenditure in US dollar terms from 2010 to 2020) is removed from total imports. This may be due to the low sensitivity of fuel imports to prices as fuel needs to be imported for electricity generation, transport sector operations, factory operations and for exporting as bunker and aviation fuel

apart from other uses. Further, fuel imports are also less sensitive to production activity in the country, as fuel imports are used for electricity generation for non-production purposes, exporting as bunkering and aviation fuel and to maintain fuel stocks. Exchange rate elasticity remains statistically non-significant.

When total imports excluding fuel is considered, price elasticity in the short run for the pre-pandemic period increases to about -0.53 to -0.56 while the long run elasticity increases to about -0.36 (marginally lower than total imports). When the pandemic period is also added, the short run elasticity stays at similar magnitudes. As in the case of total imports, production activity is elastic in the long run and inelastic in the short run. Activity elasticity of non-fuel imports in the pre-pandemic period lies between a 0.74 to 0.82 range in the short run, and at about 2.08 in the long run. Activity elasticity when the pandemic period is added reduces, according to OLS with and without dummy variables and the ARDL model for the short run and the long run, though still remaining higher than elasticities for total imports. The long run activity elasticity for the full period is 1.54.

Table 3: Elasticities for non-fuel imports

	OLS		ARDL			
	Pre-pandemic period	Full period	Pre-pandemic period		Full period	
			Short run	Long run	Short run	Long run
Price elasticity	-0.543***	-0.517***	-0.534***	-0.358*	-0.565***	-0.512**
Activity elasticity	0.738***	0.444***	0.816***	2.081***	0.542***	1.542***
Exchange rate elasticity	0.065	-0.7	Removed (note)	-0.198	Removed (note)	-0.424**

	OLS with dummies			
	Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-0.562***		-0.521***	0.037
Activity elasticity	0.742***	-0.684***	0.438***	
Exchange rate elasticity	-0.2		-0.62	

Note: removed to improve the efficiency of this model since it was not statistically significant in OLS models

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

5.1.5 Elasticities for food imports (subcategory of consumer goods)

Table 4: Elasticities for food imports

	OLS		OLS with dummies			
			Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period	Full period	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-1.786***	-1.651***	-1.619***		-1.771***	2.421**
Activity elasticity	0.347	0.188	0.353	-0.285	0.271	
Exchange rate elasticity	-2.776**	-2.820**	-2.915**		-3.099**	

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

As seen in Table 4, since both the food import quantity and relative price are stationary at level, we used linear regression models to determine the elasticities of food import demand. We found that exchange rate elasticity of food imports is statistically significant while activity elasticity of food imports is not. Further, the demand for food imports with respect to the exchange rate and prices is elastic (and in the expected direction). Elasticities are higher with respect to the exchange rate than prices. In the pre-pandemic period, price elasticity of food imports is around -1.62 to -1.79 while exchange rate elasticity for food imports lie between -2.78 to -2.91. In the pandemic period, the magnitude of price elasticity reduces in relation to the pre-pandemic period, while also suggesting a change in the direction by the outcome of the model with a dummy variable for prices. When the full period is considered, exchange rate elasticity has increased, indicating that demand for food became more sensitive to changes in the exchange rate.

5.1.6 Elasticities for non-food consumer goods

According to results given in Table 5, price elasticity of import demand before the pandemic was inelastic at about -0.46 to -0.54 in the short run. Meanwhile, activity elasticity was about 1. Statistically significant results are not provided for the models considered to determine long run elasticity for the pre-pandemic period, as there is no evidence of cointegration. Price elasticity has reduced when the pandemic period is also taken into account, according to outcomes of all models (short run).

Meanwhile, activity elasticity declined substantially in the short run when the pandemic period is also considered, and according to OLS regressions with dummies, even turned into a negative relationship. Non-food consumer goods were subjected to import controls to some extent in the pandemic period. Imports of personal-use vehicles that are categorised under non-food consumer goods were restricted as the pandemic broke out. Medical and pharmaceutical goods, which is also a large item in this category became less sensitive to prices. It may also be the case that, when domestic production was restricted due to lockdowns, import demand for these goods increased. Exchange rate elasticity is not statistically significant.

Table 5: Elasticities for non-food consumer goods

	OLS		ARDL		ECM	
	Pre-pandemic period	Full period	Pre-pandemic period		Full period	
			Short run	Long run	Short run	Long run
Price elasticity	-0.540***	-0.468***	-0.527***	No Cointegration	-0.460***	-0.372*
Activity elasticity	0.919***	0.379***	1.064***		0.475***	1.742***
Exchange rate elasticity	0.207	-0.789	Removed (note)		Removed (note)	Removed (note)

	OLS with dummies			
	Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-0.522***		-0.463***	-0.072
Activity elasticity	0.915***	-1.181***	0.376***	
Exchange rate elasticity	-0.082		-0.746	

Note: removed in order to improve the efficiency of this model, since it was not statistically significant in OLS.

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

5.1.7 Elasticities for intermediate goods

As seen in Table 6, activity elasticity of import demand for intermediate goods is statistically significant under all methods, while the other two types of elasticities, i.e. relative price and exchange rate elasticities are not. Activity elasticity is inelastic with values from 0.43 to 0.55 before the pandemic and has decreased when the pandemic period is also taken into account

under OLS regressions with and without dummy variables. Meanwhile, the long run elasticity is higher than the short run elasticity, and is about unitary elastic.

In the short run, price elasticity of intermediate goods is not statistically significant, but becomes so when the pandemic period is also considered. Exchange rate elasticity is also not statistically significant in most of the cases but is significant when the full period is considered. This shows that demand for intermediate goods is less sensitive to exchange rates and to relative prices and is more sensitive to production levels.

Table 6: Elasticities for intermediate goods

	OLS		ARDL			
	Pre-pandemic period	Full period	Pre-pandemic period		Full period	
			Short run	Long run	Short run	Long run
Price elasticity	-0.054	-0.286	-0.076		-0.01	-0.321**
Activity elasticity	0.546***	0.364***	0.430***	No cointegration	0.442***	1.045***
Exchange rate elasticity	-0.31	-1.171	-0.758		-1.644**	-0.588***

	OLS with dummies			
	Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-0.236		-0.086	-2.549***
Activity elasticity	0.553***	-0.440*	0.458***	
Exchange rate elasticity	-0.811		-0.904	

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

5.1.8 Elasticities for investment goods

Elasticities for investment goods are given in Table 7. Price elasticity of import demand for investment goods is inelastic and is of a magnitude between -0.64 to -0.68 in the short run. Meanwhile, when the pandemic period is also added, or the change in the pandemic period over the pre-pandemic period is considered, there has not been a significant change in elasticities. However, for the long run, price elasticity is slightly higher at about -0.77.

Activity elasticity in the pre-pandemic period in the short run is between 0.56 to 0.75. When the full period is considered in the short run, activity elasticity reduced to some extent. In the OLS regressions with dummy variables, the change in activity elasticity in the pandemic period over the pre-pandemic period is also less. Exchange rate elasticity is not statistically significant for import demand for investment goods. Investment goods were also affected by import restrictions to some extent.

Table 7: Elasticities for investment goods

	OLS		ARDL			
	Pre-pandemic period	Full period	Pre-pandemic period		Full period	
			Short run	Long run	Short run	Long run
Price elasticity	-0.642***	-0.650***	-0.677***		-0.656***	-0.773***
Activity elasticity	0.561***	0.367***	0.748***	No cointegration	0.522***	1.855***
Exchange rate elasticity	0.462	-0.257	0.864		No cointegration	No cointegration

OLS with dummies

	Estimation of activity elasticities with dummies		Estimation of relative price elasticities with dummies	
	Pre-pandemic period (a)	Change in pandemic period over (a)	Pre-pandemic period (b)	Change in pandemic period over (b)
Price elasticity	-0.664***		-0.633***	-0.124
Activity elasticity	0.566***	-0.475*	0.345***	
Exchange rate elasticity	0.196		-0.16	

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

5.2 Comparison of results with some previously published research on Sri Lanka

Our results for relative price elasticity are comparable with results stated in Tennakoon (2010) to some extent. We estimated relative price elasticities for the two components of "consumer goods", viz., "food" and "non-food consumer goods" (as per the Central Bank of Sri Lanka trade classification system) separately. Whereas Tennakoon (2010) reported a price elasticity of -0.99 for all of consumer goods, we found a higher (elastic) value of elasticities for food and a lower elasticity for non-food consumer goods. It is possible that the elasticities reported in Tennakoon (2010) is averaging the elasticities for the two types of imports. On price elasticity for intermediate goods, our findings were non-significant in the pre-pandemic period. However, the long run elasticity for the full period was estimated at -0.3. The estimate in Tennakoon (2010) is -0.46. On investments goods, our price elasticity estimate of -0.6 to -0.8 is about the same as -0.75 found in Tennakoon (2010). As for income elasticity/activity elasticity, we found statistically significant results. However, using GDP to estimate income elasticity, no statistically significant estimates had been derived in the study conducted by Tennakoon (2010).

Emran and Shilpi (2010) found that price elasticity for the total import demand function of Sri Lanka for 1960 to 1995 is -0.78 using an ARDL model, along with an income elasticity for the same period of about 1. While the price elasticity we found is somewhat lower, the income elasticity of these authors is comparable to our activity elasticity estimate. Our price elasticities are closer to those found by Sinha (2001) and Reinhart (1995) but the periods of time under consideration in these studies are much older than ours.

5. Conclusion

Table 8 provides the summary of the elasticity estimation exercise. As discussed in the previous section, in some cases, different models provided somewhat diverging outcomes. However, by comparing the models, the levels of statistical significance, outcomes in related model specifications, economic theory, behaviour of underlying data and other information known about trade outcomes of Sri Lanka, the following conclusions can be arrived at, with regard to elasticities and the change in elasticities during the pandemic.

Import demand of Sri Lanka in the post-Civil War period (i.e. from January 2010) up to the beginning of the pandemic (March 2020) or present (March 2021) was characterised by negative inelastic price elasticity (short run and long run) and positive inelastic activity elasticity in the short run that becomes elastic in the long run. Due to the pandemic, activity elasticity declined (became less sensitive) in the short run for total imports and for the three types of imports other than food. Meanwhile, import demand for food displayed a reduction in price elasticity during the pandemic period while other categories of goods did not.

Demand for imports of Sri Lanka (in total) in the post-Civil War period up to present (January 2010 to March 2021) was characterised by price elasticity of -0.3 to -0.5, short run activity elasticity of 0.6 in the pre-pandemic period that declined to 0.4 /0.5 with the pandemic, long run activity elasticity of 1.1 that increased to 1.4 with the pandemic and inelastic negative exchange rate elasticity. When elasticities are estimated excluding fuel imports, which accounted for about 20 per cent of import expenditure in the pre-pandemic period and which has unique demand characteristics, the abovementioned elasticities increase by small amounts, indicating that the demand for goods other than fuel is more sensitive to changes in relative prices and the level of economic activities. The long run activity elasticity of import demand of 1 to 2 we found is consistent with empirical results found by other researchers for other countries as well as economic theory.

Import demand for non-food consumer goods and investment goods basically have the same pattern of elasticities as total imports or total non-fuel imports, with inelastic price elasticity, inelastic activity elasticity in the short run and elastic activity elasticity in the long run. Further, short run activity elasticity declined for both non-food consumer goods and investment goods because of the pandemic, similar to total imports and total non-food imports. Statistically significant long run price elasticities and activity elasticities were also found for the full period that are comparable to those for total imports and total non-fuel imports.

On the other hand, import demand for food and intermediate goods displayed some different elasticity patterns. Import demand elasticity for food in relation to relative prices is elastic. Moreover, elastic demand was also found in relation to exchange rates. This indicates that the sensitivity of import demand for food to prices and exchange rates is higher than other goods.

Table 8: Summary of Results

Type of import	Pre-pandemic period (Jan 2010 to Mar 2020)						Change in elasticities during the pandemic period (Apr 2020 to Mar 2021)			Full period (Jan 2010 to Mar 2021)					
	Price elasticity		Activity elasticity		Exchange rate elasticity		Price elasticity	Activity elasticity	Exchange rate elasticity	Price elasticity		Activity elasticity		Exchange rate elasticity	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Short run	Short run	Short run	Long run	Short run	Long run	Short run	Long run
Total imports	-0.3	-0.5	0.6	1.1	NS	-0.7	NCD	Decreased	-	-0.3 to -0.4	-0.4	0.4 to 0.5	1.4	NS	NS
Total non-fuel imports	-0.5	-0.4	0.7 to 0.8	2.1	NS	NS	NCD	Decreased	-	-0.5 to -0.6	-0.5	0.4 to 0.5	1.5		-0.4
Food	-1.6 to -1.8	-	NS	-	-2.8 to -2.9	-	Decreased	-	NCD	-1.6		NS		-2.8	
Non-food consumer goods	-0.5	-	0.9 to 1.1	-	NS	-	NCD	Decreased	-	-0.5	-0.4	0.4 to 0.5	1.7	NS	NS
Intermediate goods	NS	-	0.4 to 0.5	-	NS	-	-	Decreased	-	NS	-0.3	0.4	1.0	-1.6	-0.6
Investment goods	-0.6 to -0.7	-	0.6 to 0.7	-	NS	-	NCD	Decreased	-	-0.6	-0.8	0.4 to 0.5	1.8	NS	

Note: NCD = No considerable deviation
NS = Not Significant
S= Significant

Meanwhile, price elasticity of food had declined because of the pandemic. This could be because of food security concerns, due to which sensitivity of import demand for food for prices declined. Furthermore, import demand for food is not significantly related to production activities. Import demand for intermediate goods differed in that, significant relationships were not found in respect of prices and exchange rates, but a short run activity elasticity of 0.4 to 0.6 and a long run elasticity of 1 were found. Thus, demand for intermediate goods is sensitive to production activity, possibly because a significant amount of imports are used in production processes.

Short run activity elasticity declined for total imports as well as non-food consumer goods, intermediate goods and investment goods. This reflects the rigidity of import expenditure on these goods to decline when economic activity declined during the pandemic.

6. Policy implications

Sri Lanka is a small open economy with a low industrial base, heavy dependence on imports, persistent current account deficits, low international reserves, a high level of foreign debt commitments, and high fiscal deficits. Careful management of foreign currency outflows is necessary not only when the economy is undergoing an external shock, but also during more benign periods of time. Our results help explain the behaviour of imports of Sri Lanka in the post-Civil War period against key factors affecting import demand, taking into account the fundamental changes to import demand characteristics brought about by the COVID-19 pandemic. Our results also put in perspective the rigidity of import expenditure to decline, though the nominal exchange rate depreciated over a long period of time.

Tax policies in respect of imports should take into account import elasticities of different types of goods, and tax policies should be designed appropriately, based on whether the Government's aim is to increase import tax revenue or the curtailment of importation of certain goods. Meanwhile, monetary and exchange rate policy will have a significant bearing on determining relative prices of imports and thereby, import demand. Since import demand for food is elastic in relation to relative prices, price/tariff increases of even a small magnitude can help to bring down food imports and encourage their production domestically to improve

food security in the country. Meanwhile, low sensitivity of import demand to relative prices especially of non-food consumer goods and investment goods may require significant increase in prices through import taxes or other methods of curtailment of import quantities, if policymakers are trying to rationalise importation of goods that are non-essential or that can be produced in Sri Lanka. Therefore, at a time of economic crisis, our findings on import elasticities lend support to policy choices that placed direct quantity restrictions on certain imports such as personal use vehicles and luxury goods as a temporary measure to manage foreign currency outflows.

There is no clear-cut reason as to why activity elasticity of import demand and price elasticity of food declined in the pandemic period. One possible explanation is that, due to high uncertainties created by the pandemic in the world and the domestic markets, disturbing supply chains and distorting prices, and the undue speculation that occurred during this period on the exchange rate and foreign currency reserves, import demand for relatively durable items or those that can be stocked were high during the downturn as well as the revival phase of economic activity. Meanwhile, concerns over food security and tendency to import and stock certain food items by consumers as well as importers may have reduced the price sensitivity of import demand for food during the pandemic, while food prices in the world market also increased. However, restrictions on importation of certain food items may also have had a bearing on this outcome.

Our results indicate that an increase in economic activities in the country will put pressure on imports to increase because of the positive activity elasticity of demand for imports with high elasticity values. Therefore, policymakers should expect an increase in import expenditure when implementing growth policies and should design industrial, developmental and trade policies to ensure that the increase in import expenditure is compensated by an increase in earnings from export of goods and services that are benefited through such economic growth. Furthermore, higher domestic value addition for exports should be encouraged, while developing import substituting industries for finished and intermediate goods as well.

References

Bahmani, M., Harvey, H., & Hegerty, S. W. (2013). Empirical tests of the Marshall-Lerner condition: a literature review. *Journal of Economic Studies*.

Barbero, J., de Lucio, J. J., & Rodríguez-Crespo, E. (2021). Effects of COVID-19 on trade flows: Measuring their impact through government policy responses. *PloS one*, *16*(10), e0258356.

Bekkers, E., & Koopman, R. B. (2020). Simulating the trade effects of the COVID-19 pandemic: Scenario analysis based on quantitative trade modelling. *The World Economy*.

Bhaskara Rao, B. (2007). Estimating short and long-run relationships: a guide for the applied economist. *Applied Economics*, *39*(13), 1613-1625.

Eita, J. H. (2013). Estimation of the Marshall-Lerner condition for Namibia. *International Business & Economics Research Journal (IBER), 12(5),* 511-518.

Emran, M. S., & Shilpi, F. (2010). Estimating an import demand function in developing countries: A structural econometric approach with applications to India and Sri Lanka: *Review of International Economics*, *18*(2), 307-319.

Escaith, H. and S. Khorana (2021), "The Impact of the COVID-19 Pandemic on Merchandise Trade in Commonwealth Countries", *International Trade Working Paper* 2021/02.

Evenett, S., Fiorini, M., Fritz, J., Hoekman, B., Lukaszuk, P., Rocha, N., ... & Shingal, A. (2021). Trade policy responses to the COVID-19 pandemic crisis: Evidence from a new data set. *The World Economy*.

Fontagné, L. G., Guimbard, H., & Orefice, G. (2020). Product-Level Trade Elasticities: Worth Weighting For.

Hayakawa, K., & Mukunoki, H. (2020). *Impacts of covid-19 on international trade: evidence from the first quarter of 2020* (No. 791). Institute of Developing Economies, Japan External Trade Organization (JETRO).

Houthakker, H. S., & Magee, S. P. (1969). Income and price elasticities in world trade. *The review of Economics and Statistics*, 111-125.

Hong, P. (1999). Import elasticities revisited: *DESA Discussion Paper*. No. 10. United Nations.

International Financial Corporation (2020), "When Trade Falls – Effects of COVID-19 and Outlook".

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and statistics,* 52(2), 169-210.

Li, C., & Lin, X. (2021). COVID-19 and trade: Simulated asymmetric loss. *Journal of Asian Economics*, *75*, 101327.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16(3), 289-326.

Reinhart, C. M. (1995). Devaluation, relative prices, and international trade: evidence from developing countries. *Staff papers*, *42*(2), 290-312.

Robinson, J. (1937). *Essays in the Theory of Employment*. Macmillan.

Sinha, D. (2001). A note on trade elasticities in Asian countries. *The International Trade Journal*, *15*(2), 221-237.

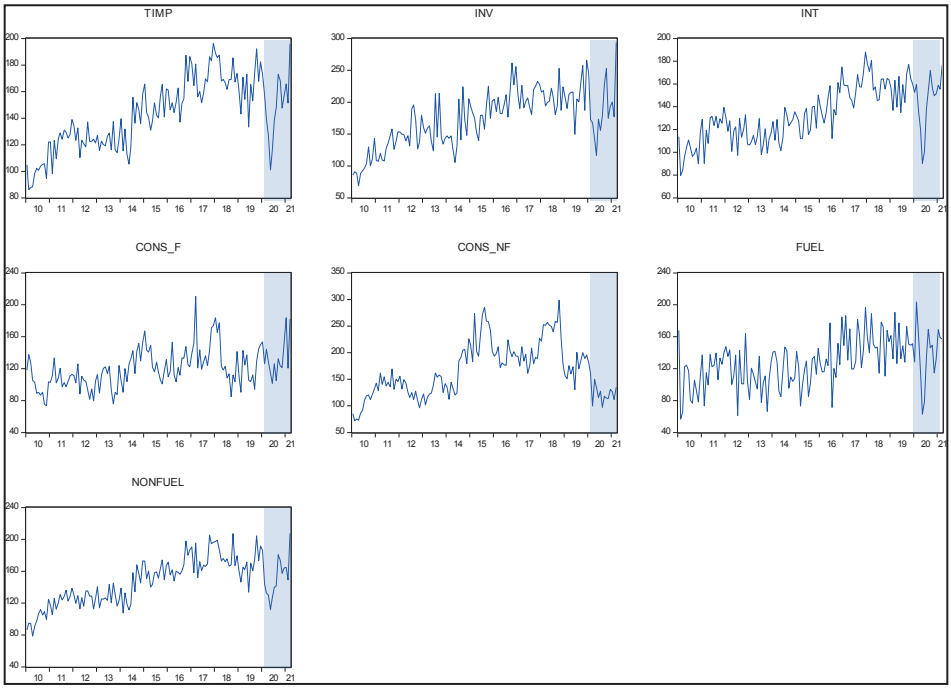
Tennakoon, T. U. (2010). Price and income elasticities of disaggregated import demand in Sri Lanka. *Staff Studies—Central Bank of Sri Lanka*, *40*(1-2), 59-77.

Appendices

Dependent variables: Import quantity indices for the following:

TIMP: Total imports
INV: Investment goods
INT: Intermediate goods
CONS_F: Food
CONS_NF: Non-food consumption goods
FUEL: Fuel
NONFUEL: Total imports except fuel

Figure A1: Graphical view of dependent variables



Independent variables

RS_CONS_F: Relative prices of food
RS_CONS_NF: Relative prices of non-food consumer goods
RS_FUEL: Relative prices of fuel
RS_INT: Relative prices of intermediate goods
RS_INV: Relative prices of investment goods
RS_NONFUEL: Relative prices of total imports except fuel
RS_TIMP: Relative prices of total imports
NEER24: Nominal Effective Exchange Rate – 24
IIP: Index of Industrial Production/Factory Industry Production Index

Note: Unit value indices (in Rs. terms) divided by the Colombo Consumer Price Index gives the relative price

Figure A2: Graphical view of independent variables