Data Science Report

Section 1

The dependent variable selected for this project report is “Imports of goods and services (BoP, current US$).”

One of the principal reasons for selecting this dependent variable is that it offers a direct assessment of the economic activities associated with imports, thereby providing a clear and well-defined research focus. It is directly influenced by several factors that facilitate the formulation of hypotheses, the analysis of data, and the discussion of linear relationships between independent and dependent variables. In contrast, other dependent variables, such as the current account balance and foreign direct investment, are sensitive to the indirect influence of numerous factors. As a result, it is challenging to justify a robust correlation between the independent and dependent variables.

Another justification for selecting this dependent variable is the simplicity of identifying independent variables with high availability and data quality. For instance, imports are closely associated with domestic national income, whereas exports are typically correlated with the income of foreign countries.

Section 2

The four independent variables selected in this project report are adjusted net national income (current US$), unemployment, total (% of total labor force) (modeled ILO estimate), inflation (consumer prices, annual %), and total reserves (includes gold, current US$).

The selection aims to avoid the issue of multicollinearity to some extent. For instance, fluctuations in the inflation rate may be strongly correlated with the price level and the exchange rate. Choosing them all may affect the regression model’s accuracy.

Moreover, some policy variables, such as tariffs, are not chosen. They may demonstrate considerable volatility in response to shifts in policy. In contrast, changes in reserves, as selected in this report, are typically the result of a country’s long-term economic well-being.

Section 3

The sample countries and periods selected for this project are based on two criteria: stability and impact. The chosen sample period is 2010-2019, representing a significant period of economic globalization, and the data are recent and reliable. Furthermore, this period is not affected by the subprime mortgage crisis or the COVID-19 pandemic, allowing for the formulation of more generalized conclusions.

The sample is comprised of 14 developed countries and one developing country. The rationale is that developed countries are usually highly engaged in international trade. In addition, developed countries are distinguished by their mature market economies, which exhibit less volatility. Lastly, developed countries typically exhibit a consistent policy. Implementing stable policies mitigates the impact of data noise resulting from abrupt policy shifts.

Table 1

A list of the sample countries, the sample period, the sample mean, and the sample standard deviation for each of the five variables

Country Name	Sample Period	Imports mean	Imports S.D.	Income Mean	Income S.D.	Unemployment Mean	Unemployment S.D.	Inflation Mean	Inflation S.D.	Reserves Mean	Reserves S.D.
Australia	2010-19	2.97926E+11	27246415787	1.07908E+12	1.09513E+11	5.508	0.366456606	2.117895558	0.652137982	52031210255	6707423693
Canada	2010-19	5.62553E+11	34128443353	1.39315E+12	97174614960	6.9309	0.769051429	1.74179924	0.569029223	75652558676	97408985461
Denmark	2010-19	1.62404E+11	14148456039	2.8355E+11	16018446737	6.5872	1.083307466	1.224152117	0.911374739	75765451696	93960522206
Finland	2010-19	1.00014E+11	9347138765	2.12665E+11	12049284326	8.161	0.788879092	1.293944699	1.077673744	10558170653	57944213.9.7
Germany	2010-19	1.45562E+12	1.2092E+11	3.09866E+12	1.92952E+11	4.7395	1.185055203	1.329248593	0.562887541	2.07076E+11	23275048216
Ireland	2010-19	2.72131E+11	9216536754	1.73839E+11	19797597601	10.6618	4.069626786	0.549165841	0.991152153	30061761541	15975018591
Italy	2010-19	5.6218E+11	47761979212	1.69317E+12	1.13888E+11	10.7566	1.497368596	1.172859442	1.068837993	1.54311E+11	17010723884
Japan	2010-19	8.98247E+11	88932706438	4.19028E+12	4.32135E+11	3.5795	0.921234588	0.465959263	0.956967849	1.25027E+12	58926371757
Netherlands	2010-19	6.16507E+11	58610619264	6.99206E+11	44908425558	5.5375	1.382058871	1.619042771	0.841176309	43503090079	60372597.82
Poland	2010-19	2.4327E+11	32362437863	4.38664E+11	37478769534	7.4346	2.703381677	1.600374334	1.714243329	1.07461E+11	11107136363
Singapore	2010-19	4.98974E+11	47937419108	2.47038E+11	19548599134	3.8113	0.313810293	1.655606373	2.029027663	2.64648E+11	20322644838
Spain	2010-19	4.07084E+11	32449668628	1.13508E+12	70113391484	20.4851	4.065396125	1.232717353	1.232056663	55769104310	13417146335
Sweden	2010-19	2.24739E+11	15951828624	4.62361E+11	28107344027	7.4734	0.719891844	1.125325463	1.025232705	57437532261	57069257.74
Switzerland	2010-19	3.98214E+11	29378554400	5.41881E+11	20447458360	4.6904	0.188009574	0.025099235	0.653085632	5.94868E+11	1.95323E+11
United States	2010-19	2.81134E+12	2.14386E+11	1.54036E+13	1.81648E+12	6.2263	2.158876923	1.771839163	0.796806232	4.69095E+11	59587396794
Sample	2010-19	6.3408E+11	6.7429E+11	2.07015E+12	3.77226E+12	7.50554	4.44141665	1.26166863	1.160557639	2.28097E+11	3.24592E+11

Note. S.D. = Standard Deviation. Data were obtained from the World Bank (2024). (https://databank.worldbank.org/reports.aspx?source=world-development-indicators). CC BY-4.0.

Section 4

H0: β=0

H1: (adj) Adjusted net national income positively affects (adj) imports of goods and services (BoP, current US$) ($\beta_1>0$)

The hypothesis is principally based on Keynesian consumption function, income elasticity of import demand, and the variety-seeking behavior in consumption.

Keynes (1936) proposed that consumption is a function of disposable income. This concept is expressed in linear functional form as C = a + bYd, where b represents the

marginal propensity to consume, which falls between 0 and 1. In other words, the demand for goods and services increases as net national income rises. As a result, imports of goods and services will also increase as part of consumption.

For normal goods and services, the income elasticity of import demand is greater than 0. A positive income elasticity of demand means that the quantity demanded increases with income. Furthermore, studies have demonstrated a positive correlation between income levels and the elasticity of import demand (El-Shagi et al., 2021; Hummels & Lee, 2018).

It is frequently observed that consumers will select a diverse range of products to satisfy their psychological and emotional needs (Zhang, 2022). Consumers' tendency to seek variety may be a typical decision-making strategy when making purchasing decisions. The marginal utility of a product is diminished by repeated purchases or consumption, which reduces its attractiveness and may result in consumer boredom (McAlister, 1982; McAlister & Pessemier, 1982). Imported goods and services give consumers more choices and satisfy their variety-seeking behavior. Thus, net national income positively affects imports.

H2: (adj) Total unemployment negatively affects (adj) imports of goods and services (BoP, current US$) ($\beta_2<0$)

The hypothesis is principally based on the Keynesian consumption function, the permanent income hypothesis, and unemployment's impact on exchange rates.

One of the primary reasons unemployment negatively affects imports is the reduction in national income. An increase in unemployment leads to a part of the population being deprived of their source of income. Based on the Keynesian function, this reduction in disposable income leads to decreased consumption. Therefore, the overall demand for imports declines as domestic consumption demand contracts.

The permanent income hypothesis assumes individuals base their consumption on expected long-term average income (Friedman, 1957). High unemployment can lead to a pessimistic outlook, reducing current consumption of imported goods. Even those who remain employed may fear job loss, leading them to increase savings and reduce spending as a precautionary measure.

Rising unemployment can also indirectly affect imports through its impact on exchange rates. High unemployment may lead to monetary easing policies, such as lower interest rates, to stimulate the economy (Board of Governors of the Federal Reserve System (U.S.), 2021). These policies can devalue the national currency, making imports more expensive and less attractive.

H3: (adj) Inflation (CPI) positively affects (adj) imports of goods and services (BoP, current US$) ($\beta_3>0$)

One primary effect of inflation is the increase in the domestic price level. As the cost of locally produced goods and services rises, imported goods may become relatively cheaper. Unless the exchange rate changes, a higher price level in the country encourages imports and discourages exports (Davis & Sagnanert, 2024).

One study argued that there's no significant correlation between inflation rates and imports (Islam, 2013). This insignificant correlation is because an inflationary environment typically depreciates currency, rendering a country's imports more expensive. However, in the short run, the connection between exchange rates set by the market and sudden changes in inflation is complex. In developed countries, when inflation surprises are higher

than anticipated, the country's national currency tends to appreciate (Davis & Sagnanert, 2024). The increased exchange rate may be because, in countries where monetary policy is more transparent, markets consider the expected response of the central bank. Suppose investors expect the central bank to respond to inflation by increasing the policy rate. In that case, the initial reaction will not alter views on the long-term price level. However, it will influence expectations regarding the policy rate soon. Higher interest rates in the domestic country will lead to capital inflows that appreciate the currency.

In conclusion, inflation leads to an increase in the price level within the country, resulting in a rise in imports. The inflationary pressures also lead to a depreciation of the currencies of some countries, thereby offsetting some of the increased imports. However, inflation generally positively affects imports, notably in advanced economies where inflation may cause currency appreciation.

H4: (adj) Total reserve positively affects (adj) imports of goods and services (BoP, current US$) ($\beta_4>0$)

Total reserves are a cornerstone of economic stability and international trade facilitation. By ensuring exchange rate stability and potentially increasing import demand, reserves positively affect the imports of goods and services.

Total foreign reserves are vital for maintaining exchange rate stability. The impact of exchange rate volatility resulting from capital flows can be reduced by a country with substantial reserve holdings through the intervention of the foreign exchange market. Stable exchange rates reduce uncertainty for importers regarding the cost of foreign goods and services, facilitating trade by allowing businesses to plan and budget more effectively (Arize & Malindretos, 2012). Lower uncertainty-induced import costs are likely to reduce the prices of imported goods and services to some extent, which may increase imports.

Besides, increasing foreign reserves may positively affect import demand since it theoretically relaxes the excess demand liquidity restriction (Abri et al., 2023). In other words, the domestic country has more financial flexibility to finance imports, potentially boosting the volume of goods and services it can purchase abroad.

Section 5

Table 2

Results of Fixed Effects Regression Analysis: Imports of Goods and Services, Net National Income, Unemployment, Inflation, and Reserves

			95% CI		
Variable	β	SE	LL	UL	p
(adj) Intercept	0.00001	3.7×10^{9}	-9.7×10^{9}	7.3×10^{9}	1
(adj) National income	0.10064	0.00839	0.07873	0.11723	2×10^{-23}
(adj) Unemployment	-1.2×10^{9}	2.1×10^{9}	-1.7×10^{10}	-8.2×10^{9}	4×10^{-8}
(adj) Inflation	1.1×10^{10}	3.6×10^{9}	3.6×10^{9}	1.8×10^{10}	0.00337
(adj) Reserves	0.1918	0.070273	0.0529	0.33069	0.00713

Section 6

H1 is supported: (adj) Adjusted net national income has a significantly positive effect on (adj) imports of goods and services (BoP, current US$)

The β of (adj) net national income on (adj) imports of goods and services (BoP, current US$) is around 0.1, which means that for every unit increase in (adj) adjusted net national income, (adj) imports of goods and services (BoP, current US$) increase by 0.1 units. Besides, the p-value is about 2×10^{-23}, less than 0.1, suggesting that the probability of committing a Type 1 error is only 2×10^{-23}. Thus, we can reject the null hypothesis at the 1% significance level. (adj) Adjusted net national income has a significantly positive effect on (adj) imports of goods and services (BoP, current US$).

In addition, the sample used, mainly comprised of developed countries, may have increased the significance of this relationship. One study has shown that the income elasticity of demand for imports in high-income countries is approximately twice as high as that in low-income countries (Devarajan et al., 2023).

H2 is supported: (adj) Total unemployment has a significantly negative effect on (adj) imports of goods and services (BoP, current US$)

The β of (adj) total unemployment on (adj) imports of goods and services (BoP, current US$) is around -1.2×10^{9}, which means that for every unit increase in (adj) total unemployment, (adj) imports of goods and services (BoP, current US$) decrease by 1.2×10^{9} units. The p-value is about 4×10^{-8}. Thus, we can reject the null hypothesis at the 1% significance level. (adj) Total unemployment has a significantly negative effect on (adj) imports of goods and services (BoP, current US$).

The outcome is foreseeable. Rising unemployment always accompanies all economic downturns (Galí, 2010). There will inevitably be a decline in imports as a direct consequence of changes in economic performance.

H3 is supported: (adj) Inflation (CPI) has a significantly positive effect on (adj) imports of goods and services (BoP, current US$)

The β of (adj) inflation (CPI) on (adj) imports of goods and services (BoP, current US$) is around 1.1×10^{10}, which means that for every unit increase in (adj) inflation, (adj) imports of goods and services (BoP, current US$) increase by 1.1×10^{10} units. The p-value is about 0.00337. Thus, we can reject the null hypothesis at the 1% significance level. (adj) Inflation (CPI) has a significantly positive effect on (adj) imports of goods and services (BoP, current US$).

As stated in Section 4, a sample comprising primarily developed countries may exhibit a more significant correlation between inflation and imports than in the world.

H4 is supported: (adj) Total reserve has a significantly positive effect on (adj) imports of goods and services (BoP, current US$)

The β of (adj) total reserve on (adj) imports of goods and services (BoP, current US$) is around 0.1918, which means that for every unit increase in (adj) total reserve, (adj) imports of goods and services (BoP, current US$) increase by 0.1918 units. The p-value is about 0.00713. Thus, we can reject the null hypothesis at the 1% significance level. The (adj) total reserve has a significantly positive effect on (adj) imports of goods and services (BoP, current US$).

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