

Forecasting Korean Manufacturing Performance, the Second Half of 2020

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1. Introduction

With much of the world now being battered by second waves of the COVID-19 pandemic and with no safe and effective vaccine in hand, it is reasonable to expect the economic impact of COVID-19 will linger over the global economy for quite some time. South Korea, which as a small open economy is heavily dependent on export-led economic growth, witnessed its exports and production plummet in the second quarter of 2020. While supply chain disruption was the main concern during the initial phase of the pandemic, its effects have now spilled over to all industries and sectors of the global economy. Eventually, daily lives interrupted by COVID-19 will help shape the post-pandemic economic paradigms and global value chains (GVCs) will have undergone significant structural changes.

As central banks and research institutes have lowered earlier forecasts for

the rest of 2020, it is of vital importance to study thoroughly how coronavirus-induced economic disruption affects major economic variables in the Korean manufacturing sector and quantify its impacts in a scientific way. In much the same way, this study aims to analyze the correlations between major macroeconomic variables and design a compact forecasting model to compute short-term forecasts based on those relationships. Specifically, based on the dynamic mechanism between business cycles, real variables, and policy tools, I attempt to forecast export and production performance of Korean manufacturing industries for the second half of 2020.

The second chapter reviews economic indicators and forecasts recently published by major institutes and studies economic trends. The third chapter details the econometric model and data set and the last chapter describes several methodological shortcomings with suggestions for the future and wraps up the study.

2. Major Economic Forecasts and Indicators

(1) Economic Forecasts

Major research institutes including KIET have predicted that even though the world economy will inevitably record a negative growth rate in 2020, the second half of 2020 will fare better than the first half. In September 2020, the Organization for Economic Co-operation and Development (OECD) forecasted that, the world economy reaches a nadir in the second quarter of 2020, global economic growth rate drops to negative 4.5 percent and will recover to 5.0 percent in 2021.¹ In the following month, the International Monetary Fund (IMF) projected a global growth rate of negative 5.6 percent for 2020 and a rate of 4.0 percent for 2021.²

With sporadic coronavirus infection cases re-emerging across the country in August 2020 the Bank of Korea (BOK) lowered earlier second half growth forecasts announced in May from 0.1 percent growth to a drop of negative 1.8 percent. It also revised its yearly growth projection from negative 0.2 percent

1 OECD, OECD Economic Outlook, September 2020.

2 IMF, World Economic Outlook, October 2020.

Table 1. KIET's Economic Forecast

Unit: year-on-year, %, Hundred Million U.S. Dollars

	2018	2019			2020		
	Year	H1	H2	Year	H1	H2	Year
Real GDP	2.7	1.9	2.2	2	-0.7	0.8	0.1
Private Consumption	2.8	2	1.9	1.9	-3.8	0	-1.9
Facilities Investment	-2.2	-12.2	-2.2	-7.5	1.2	2.4	1.8
Construction Investment	-3.9	-5.2	0	-2.5	-0.2	-1.4	-0.8
Exports	6,049	2,711	2,711	5,422	2,421	2,509	4,930
	(-5.4)	(-8.6)	(-12.0)	(-10.4)	(-10.7)	(-7.5)	(-9.1)
Imports	5,352	2,526	2,508	5,033	2,350	2,361	4,711
	(-11.9)	(-4.9)	(-7.0)	(-6.0)	(-6.9)	(-5.8)	(-6.4)
Trade Balance	697	186	203	389	71	148	219

Source: KIET (2020.6).

Table 2. BOK's Economic Forecast

Unit: %

Publication Date	GDP Growth Rate			Exports Growth Rate		
	H1	H2	Year	H1	H2	Year
2020.5	-0.5	0.1	-0.2	-0.4	-3.7	-2.1
2020.8	-0.8	-1.8	-1.3	-3.2	-5.6	-4.5

Source: BOK (2020.5), BOK (2020.8).

to negative 1.3 percent.^{3,4} The BOK also predicted that the severity of the resurgence and strict nationwide lockdowns will dampen overall economic sentiments and adjusted its domestic consumption and export forecasts accordingly: domestic consumption projections were downgraded from negative 1.4 percent to negative 3.9 percent and exports from negative 2.1 percent to negative 4.5 percent for 2020.

The base scenario for this study is based on KIET (2020), which assumed that the pandemic situation would be resolved before the end of the second quarter of 2020 and government stimulus packages would help economies smoothly adapt to a new steady state.⁵ Hence, it presumed that economies would bottom out during the second quarter of 2020 and recover over the

3 Bank of Korea, Economic Outlook, August 2020.

4 Bank of Korea, Economic Outlook, May 2020.

5 KIET, Economy-Industry Forecast for the second half of 2020, June 2020.

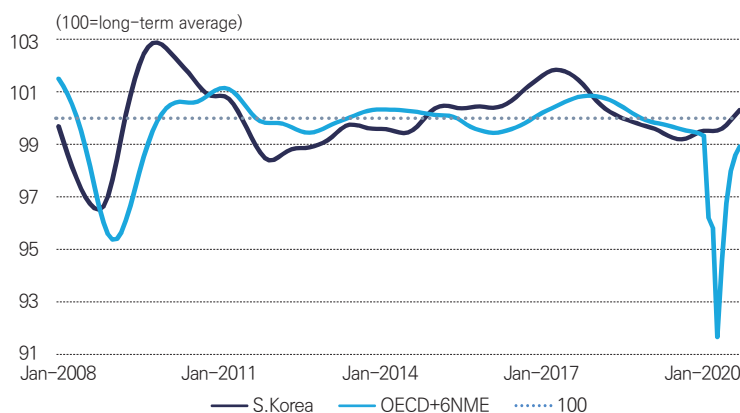
course of the rest of the year. A more pessimistic scenario assumes that the living-with-the-virus phase will drag on, with turning points for most economies coming after the third quarter of 2020.

(2) Major Economic Indicators

A thorough look at major leading and coincident indicators shows that the world economy sunk to its lowest point in May and June and is now on its way to recovering from the pandemic's shocks. According to OECD's Composite Leading Indicators (CLI) measure, the global economy and South Korea both began slowly recovering in April 2020. South Korea was stagnant at 99.5 from January to April but jumped to 100.3 in September. CLI for the OECD and six major non-member economies recovered from 91.7 in April to 98.9 in September.⁶ Other major economies and economic blocs followed similar patterns: China had plunged to 85.5 in February but recovered to 100.1 as of this September. The U.S. improved from 92.8 to 98.6 and Europe from 91.7 to 98.0, both from April and to September.

As for coincident indicators, according to the New York Federal Reserve's nowcast for the U.S., the GDP growth rate had plunged to minus 35.53 percent quarter-on-quarter on May 29 and it now hovers around 3.46 percent

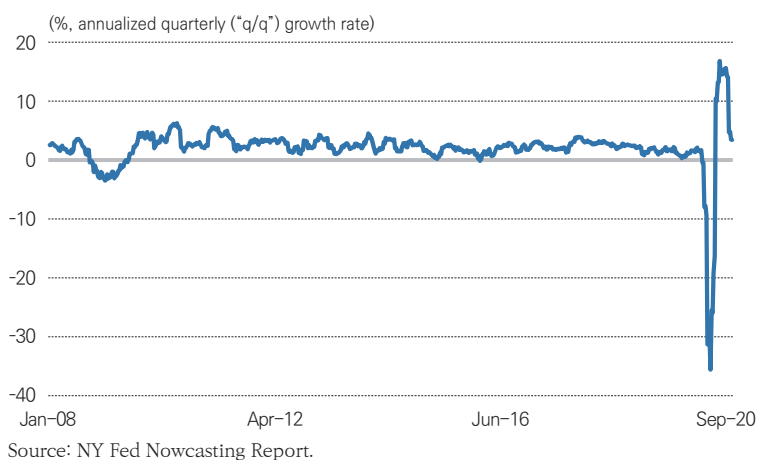
Figure 1. OECD's CLI



Source: OECD.

⁶ 100 as long-term average.

Figure 2. Nowcast for the U.S. Economy



as of October 23.⁷ For the Euro area, nowcasting estimates are negative 7.46 percent quarter-on-quarter for May 15 and 1.82 percent for October 23.⁸

(3) Korean Manufacturing Industry Trends

South Korea had controlled the pandemic situation relatively well in the first half with a major portion of the economic fallout stemming mostly from abroad. Hence, production performance of manufacturing industries fared pretty well despite prolonged social distancing even as export growth tumbled to negative 33 percent in April 2020. Once the government seemed to get a grip on COVID-19 and social distancing measures were over after the first wave, both production and exports began to pick back up around this June.

Table 3. Korean Manufacturing Industry Production and Export Growth Rate

Unit: %

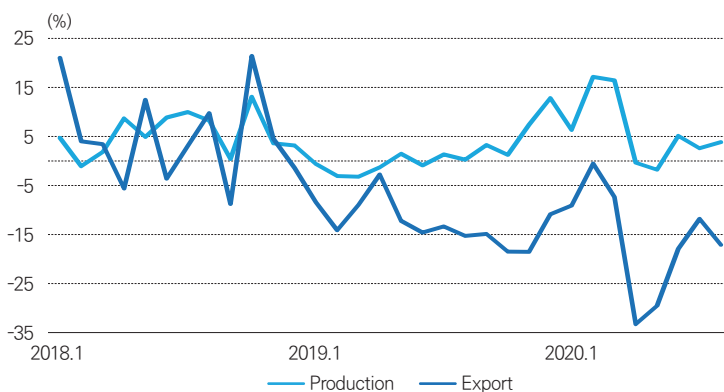
12 Manufacturing Industries	2019			2020								1-8
	H1	H2	Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	
Production	-1.39	4.25	1.43	6.5	17.33	16.62	-0.19	-1.64	5.29	2.74	3.99	6.03
Export	-9.27	-12.77	-11.02	-8.96	-0.39	-7.21	-33.23	-29.46	-17.82	-11.67	-16.98	-16.08

Source: KOSTAT and KITA.

7 New York Fed's Nowcasting Report, <https://www.newyorkfed.org/research/policy/nowcast.html>. Reported values are the annualized quarterly growth rate of GDP.

8 Now-Casting Economics Ltd., <https://www2.now-casting.com/countries/euro-area/weekly-chart>

Figure 3. Korean Manufacturing Industry Production and Export Growth Rate



Source: KOSTAT and KITA.

Export plunged again after the second wave broke out on August.

3. Econometric Forecasting

This study attempts to predict the future trajectory of Korean manufacturing industries exports and production via the dynamic relationship between the business cycle, policy tools, and two real variables in the manufacturing sector. That is, it aims to forecast the near-future values of Korean manufacturing exports and production based on the correlation between interconnected macro variables.

(1) Forecasting Model

Forecasting analysis utilizes VECM (Vector Error Correction Model) as the base forecasting model. VECM is based on the idea that, even though time series datasets exhibit transitory non-stationary fluctuations, if there exists a long-term equilibrium that runs through the underlying variables (cointegration), variables will eventually converge to an equilibrium that systemizes the mechanism. VECM provides a technical framework that corrects temporal deviations through error correction terms that smooth out non-stationary behaviors and ultimately ushers them into equilibrium.

The main reason why I adopt VECM is that it doesn't require any additional knowledge about model specifications. Hence, it is not necessary to formulate

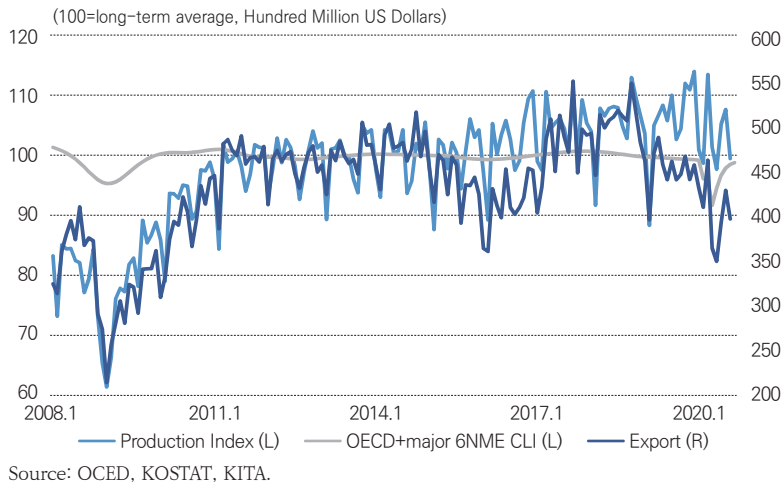
a structural relationship as any other reduced-forms and it captures well a dynamic system that regularizes the interrelationship of endogenous variables.⁹

This study assumes there is a stable long-term relationship that holds through four interconnected macro variables: Korean manufacturing production and exports, the global economy and national policy stances. It intends to scrutinize how endogenous variables would converge in the near future once the exogenous shock that has disrupted all economic sectors wanes. This approach implies that the underlying socioeconomic structure that governs the behavior of endogenous variables is stable in the long run, which is an inherent constraint of this approach. Therefore, one should be wary of this limitation when interpreting results.

(2) Data Description

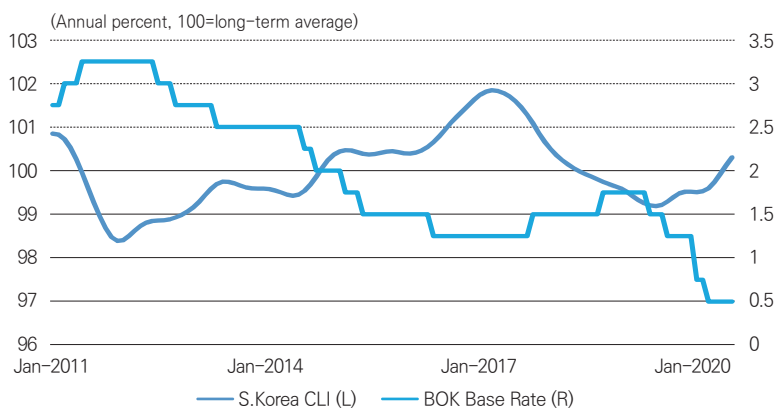
The dataset comprises observations of four presumably correlated macro variables from January 2012 to June 2020. Specifically, I use 1) the Korean manufacturing production index (KOSTAT) 2) Korean manufacturing export

Figure 4. Korean Manufacturing Industry and the Global Economy



9 It is possible to interpret VECM as constrained vector autoregression (VAR): that is, VECM is a variant of VAR that consists of $I(d)$ variables and has a built-in mechanism that corrects non-stationary time series and makes them converge towards their usual steady state. In this study I switched from VAR to VECM since macro variables abruptly plunged after the outbreak of COVID-19 and VECM provides a framework that can deal with $I(d)$ series.

Figure 5. South Korea’s CLI and BOK’s Base Rate



volumes (KITA) 3) OECD’s CLI for OECD plus six major NME (non-member economies) including Brazil, China, India, Indonesia, Russia and South Africa as indicators for global economic trends 4) BOK’s base rate as a proxy variable that represents the overall direction and stance of the Korean government’s monetary (and fiscal) policies. As expected, when I plot South Korea’s CLI and BOK’s base rate together, I can clearly see a co-movement pattern: when the base rate goes down, the Korean economy expands and vice versa.

(3) Forecasting Results

Before proceeding with the estimation, I conducted an Augmented Dickey-Fuller (ADF) unit root test to check the stationarity of each time series. After conducting the ADF test, I found that all four variables were stationary in first difference, hence $I(1)$. So in the analysis I utilized the original level data for VECM estimation. Johansen’s Cointegration test results show that one can reject the null hypothesis that the rank is less than and equal to zero at the one-percent significance level, indicating that there exists at least one cointegration relationship: thus, these endogenous variables have a tendency to regress toward equilibrium gradually whenever they are off equilibrium. VECM estimation results show that the three variables — exports, CLI and the base rate, — were found to be corrected by error correction terms. However, given that all adjusted coefficients don’t seem to be high enough, it seems that the overall system-

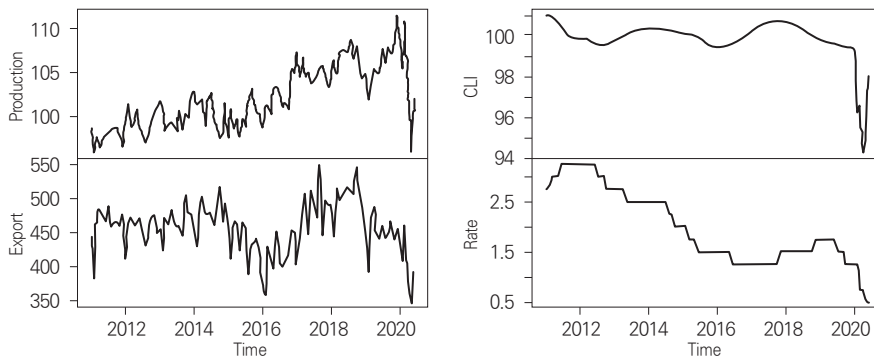
atic relationship holds but it looks like that those endogenous variables are also being influenced by other variables that are not included in the system.

Table 4. ADF Test Statistic and p-values

	ADF test statistic	p-values
Production	0.156	0.876
Export	-0.345	0.731
CLI	-0.718	0.474
Base Rate	-1.862	0.0653
D (Production)	-10.745***	2.70E-13
D (Export)	-13.015***	2.00E-16
D (CLI)	-4.907***	3.26E-06
D (Base Rate)	-6.323***	5.78E-09

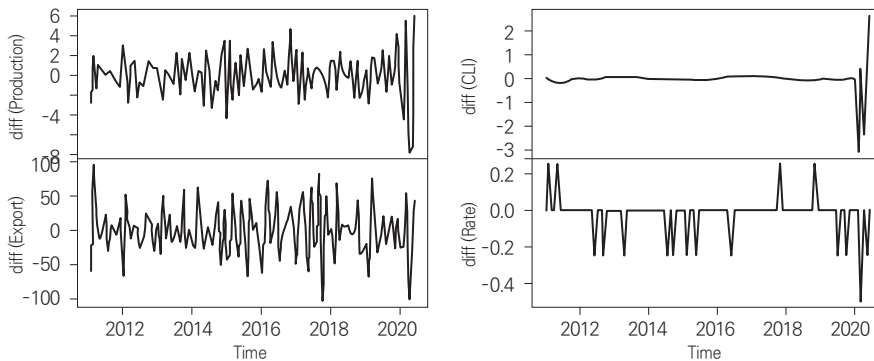
Note: *, **, *** denotes a rejection at 10%, 5%, 1% significance level each.

Figure 6. Plot for the Raw Level Data



Note: From top left, production, exports, CLI and Rate are plotted in a counter-clockwise direction.

Figure 7. Plot for the First Differenced Data



Note: From top left, production, exports, CLI and Rate are plotted in a counter-clockwise direction.

Table 5. Johansen’s Cointegration Test Results

Null Hypothesis	Test statistic	5% Critical Value
rank=0	84.27***	48.28
rank≤1	37.27***	31.52
rank≤2	15.79 [†]	25.32
rank≤3	5.36	12.25

Note: *, **, *** denotes a rejection at 10%, 5%, 1% significance level each.

$$\Delta Export_t = -1.746e+03 - 7.165e-01 * ECT_{1,t-1} + 2.623e+00 * ECT_{2,t-1}, \quad \overline{R^2}=0.3728 \quad (1)$$

(-3.762) (-6.262) (2.785)

$$\Delta Production_t = -0.42206 * \Delta Production_{t-1}, \quad \overline{R^2}=0.1295 \quad (2)$$

(-3.673)

$$\Delta CLI_t = -0.0563 * ECT_{2,t-1} + 25.5089 + 1.1977 \Delta Rate_{t-1}, \quad \overline{R^2}=0.2136 \quad (3)$$

(-4.196) (3.856) (0.008)

$$\Delta Rate_t = 0.0061 * ECT_{2,t-1} + 0.1146 \Delta CLI_{t-1}, \quad \overline{R^2}=0.2483 \quad (4)$$

(2.113) (4.704)

Figure 8. Fan Chart for Korean Manufacturing Exports

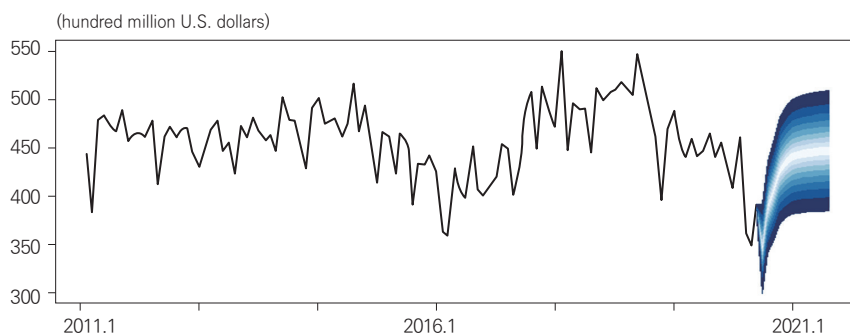


Figure 9. Fan Chart for Korean Manufacturing Production Index

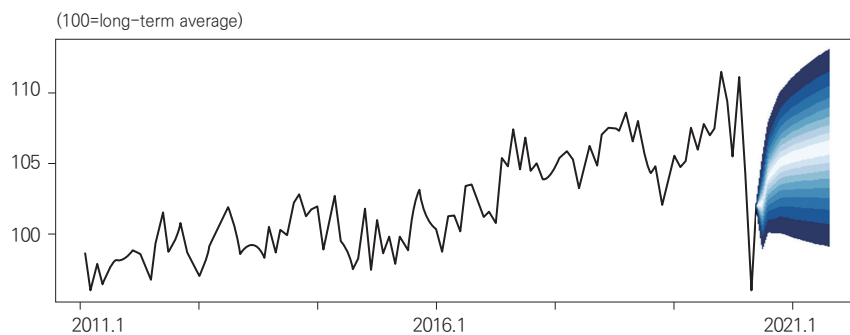


Figure 10. Forecasting Results for Production Index

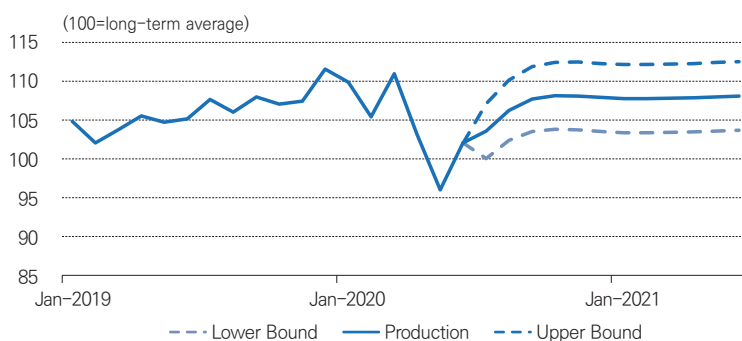
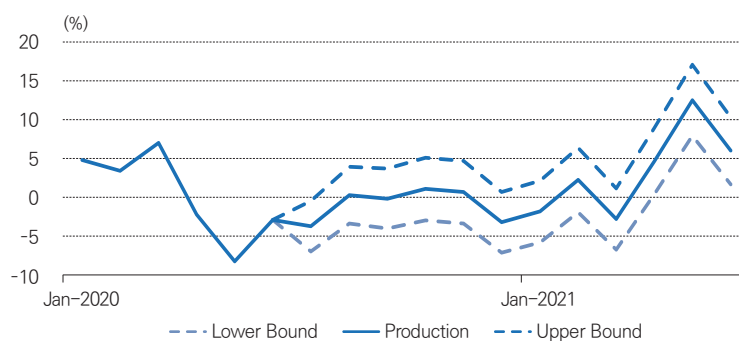


Figure 11. Forecasting Results for Production Index Growth Rate



Forecasting results show that the average of production index for the year of 2020 is expected to be 104.5 and, when it comes to the negative scenario, it is expected to stay around 101.8. Year-over-year growth is predicted it will decline by 1.52 percentage points on average in 2020 and by 4.1 percent in the negative scenario.

The 2020 monthly average for the export variable is 40.4 billion USD in the base scenario and 37.29 billion dollars in the negative scenario. When converted to growth rates, it is expected to fall by 10.48 percent on average and by 17.47 percent in the negative scenario.

Therefore, given the current holding patterns, with no vaccine available and untraceable infections being continuously reported, the economic shocks emitted by the coronavirus pandemic will continue to exert downward pressure on exports and production during the remainder of 2020. Overall, exports decline more than production, as has thus far been observed since the

Figure 12. Forecasting Results for Korean Manufacturing Exports

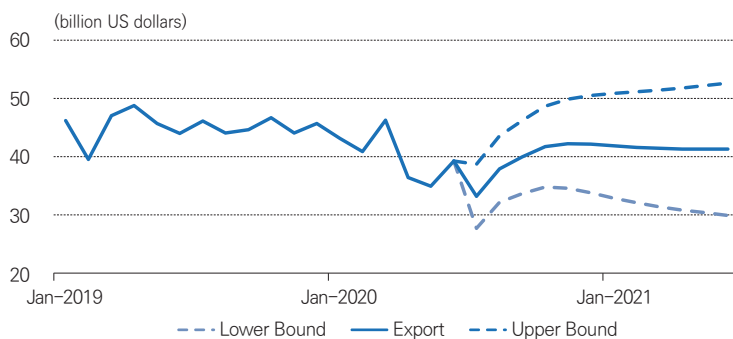
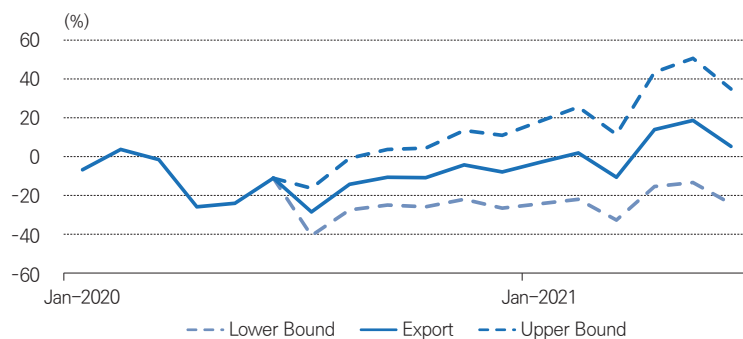


Figure 13. Forecasting Results for Korean Manufacturing Export Growth Rate



first half of the year. However, once confirmed infection cases peak and decline and economies get back on track, it is expected the usual virtuous cycle, aided by governments' expansionary policies, to help economies to converge to another steady state with both exports and production eventually recovering in 2021.

Impulse response simulations yielded expected results: a one-unit exogenous shock to CLI prompted a statistically significant drop in exports. Production also fell in response to the exogenous shock imposed on the CLI variable, but its result was not statistically significant.

As for robustness testing, residuals exhibited white noise-like characteristics, absent both autocorrelation and serial correlation patterns. Portmanteau test results produced the same conclusion. JB test results indicated that residuals didn't seem to follow a normal distribution, but Arch test results confirmed no arch effect.

4. Concluding Remarks

In this concluding section, I want to point out several methodological limitations. While many organizations have further lowered earlier forecasts announced in the first half of 2020, the latest data set of production and export available does not completely capture the second wave situation that prompted the implementation of prolonged nationwide lockdowns and the discussion of more government stimulus packages. Export has gained its momentum, bouncing back incrementally from 34.85 billion USD in May to 39.23 billion USD in June, 42.83 billion USD in July, and 39.66 billion USD in August 2020. Considering the number of business days, growth rates compared to the same month of 2019 have consistently improved since April 2020. In the meanwhile, manufacturing initially recovered from the shock, from 97.8 in May to 107.6 in July, and then dropped to 99.6 in August again. Therefore, the latest data set available sends out mixed signals.

Next, times series analysis and forecasting is about predicting future values based on the study of past time series patterns. Hence, it is based on the assumption that the current economic paradigm that governs the contemporary economic relationships will not change in the near future and that future values of macroeconomic variables will behave within bandwidth reasonably expected by the current standard. However, the coronavirus as an exogenous shock has shaken economies to their core and also has influenced the speed and patterns of economic paradigm shifts that were underway before the pandemic.¹⁰ Given that post-COVID-19 economies will face different challenges which in return will gradually induce structural changes in economies, forecasting the post-COVID-19 period based on prior economic relationships can be misleading. To overcome this limitation, finding variables that can reflect shifting paradigms is an option.

10 As BOK (2020) pointed out, this pandemic crisis precipitated the introduction of the digital economy and untact economy. In addition the current pandemic situation has made people consider the introduction of telemedicine more favorably in South Korea where the constructive discussion about the issue has staggered for several years upon opposition from parties involved. In addition, the current pandemic also has sped up the deglobalization movement prominently evident in the U.S.-China trade war, structural changes in GVCs and the low-carbon economy. (Bank of Korea, Economic Structural Changes after the COVID-19 and its implications, June 2020).

However, the purpose of this paper is to predict the near-future trajectory of Korean manufacturing exports and production based on the interrelationship between the global economy, policy stances and manufacturing activities. I conducted the analysis under the basic assumption that this core relationship between the four variables holds in a broader sense.

Finally, Big data approaches can provide a framework that enables to handle more data, especially where mathematical algorithms are needed most to screen and weigh a bulk of variables automatically. However, its estimation results don't deliver intuitive interpretations while other parsimonious reduced-forms including VECM and VAR can. Therefore, given that there is no clear winner in terms of forecastability between big data approaches and reduced-form approaches, it will make more sense to adopt big data forecasting models as an alternative while comparing with the forecasting results of other reduced-form analysis. This comes down to finding good high-frequency variables that illustrate real-time economic activities and ongoing paradigm shifts well.

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