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A New Smartphone for Every Fifth Person on Earth: Quantifying the New Tech Cycle

by Benjamin Carton, Joannes Mongardini, and Yiqun Li

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A New Smartphone for Every Fifth Person on Earth: Quantifying the New Tech Cycle

Prepared by Benjamin Carton, Joannes Mongardini, and Yiqun Li*

Authorized for distribution by Douglas Laxton

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Abstract

The enormous global demand for smartphones in recent years has created a new global tech cycle. In 2016 alone, global smartphone sales reached close to 1.5 billion, one for every fifth person on earth. In turn, this has engendered complex and evolving supply chains across Asia. We show that the new tech cycle cannot be captured by standard seasonality, but depends on smartphone product release dates. Decomposing cycle from trend, we also show that the sale of smartphones may have peaked in late 2015. Asia, however, continues to gain in importance as the global tech manufacturer.

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Author's E-Mail Address: bcarton@imf.org; jmongardini@imf.org; yli2@imf.org

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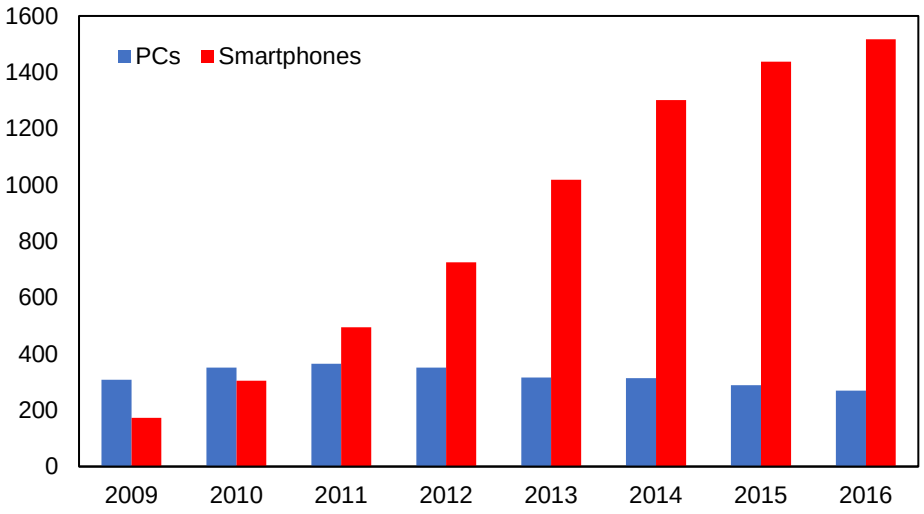
CONTENTS

I. INTRODUCTION

The huge increase in the demand for global smartphones since 2011 has created a new global tech cycle. Demand has been driven by the increasing use of smartphones as the main computing platform across the world. It is highly cyclical as it centers around the release date of new smartphone models by global producers, including Apple Inc. and Samsung Electronics. It has also engendered highly complex and evolving supply chains across Asia. Thus, production and trade in several Asian countries have become highly correlated and intertwined with the new tech cycle.

The new tech cycle can be defined as the production and export of electronics and software associated with the release of new smartphones by global producers. This definition differs from the traditional tech cycle prior to 2012, where it referred to the production and exports of personal computers (PCs) and related components. In those days, the tech cycle was not as pronounced and less centered around release dates for PCs. Since 2012, global sales of PCs have declined, while sales of smartphones have skyrocketed. In 2016 alone, global smartphone sales reached close to 1.5 billion units, equivalent to one for every fifth person on earth (Figure 1).

Figure 1. Global Sales of PCs and Smartphones
(Millions of Units)



Sources: Gartner, IDC.

The importance of the new tech cycle cannot be underestimated. In 2016, exports of electronic components for smartphone production at the peak of the cycle accounted for more than one third of total exports in Taiwan Province of China, 15 percent in Singapore and South Korea, and 11 percent in Malaysia. In addition, in the same year, China exported $107 billion worth of smartphones to the rest of the world, equivalent to 5 percent of its total exports. Data on value added of the new tech cycle is not readily available. However, OECD data on value added in GDP of the computer, electronic, and optical (CEO) sectors are

indicative of the magnitudes involved.[1] In South Korea, the CEO sectors accounted for 7.4 percent of total value added in 2013. In Japan and Ireland, the same ratio was 2.1 percent and 2.0 percent in 2012, respectively. Data for other Asian countries are not readily available. These ratios are likely though to have increased substantially in the last few years, thanks to the new tech cycle.

In this paper, we show that the new tech cycle cannot be captured by standard seasonality. Instead, it critically depends on the release dates for new smartphones by global producers. The cycle can be subdivided into two components. The first one is the pre-release cycle, which comprises the exports of all components from several Asian countries to China, which is de facto the final producer of most smartphones. The second is the post-release cycle, with shipments of smartphones from China to the rest of the world. Both pre- and post-release cycles have a very strong impact on growth and trade patterns in Asia.

We also show that the new tech cycle may have peaked in late 2015. By decomposing cycle from trend, we show that the trend is non-linear and reached its peak in September 2015, suggesting that the global market for smartphones may have become saturated. However, Asia continues to gain market share in other consumer electronics, including embedded automobile computers, smart appliances, and wearable devices. This is evident in the rising demand for South Korean semiconductors and, to a lesser extent, in Taiwan Province of China electronic export orders.

The paper is organized as follows. Section II provides a summary description of the tech cycle since 2012. The decomposition between cycle and trend is then discussed in Section III. Section IV provides some concluding remarks. Appendix I, II, and III present the Apple Inc. and Samsung Electronics release dates, the main regression results, and related data sources, respectively.

II. THE NEW TECH CYCLE

The new tech cycle has gained in importance as a key determinant of economic performance of several Asian countries since 2012. The global shift from PCs to smartphones (and tablets to a lesser extent) has led to the development of complex and evolving supply chains across Asia to provide electronic components necessary for final assembly of smartphones in China. Several Asian countries have been the main beneficiaries of these new supply chains, leading to increasingly strong correlations in export and growth performance around the release dates of these products.

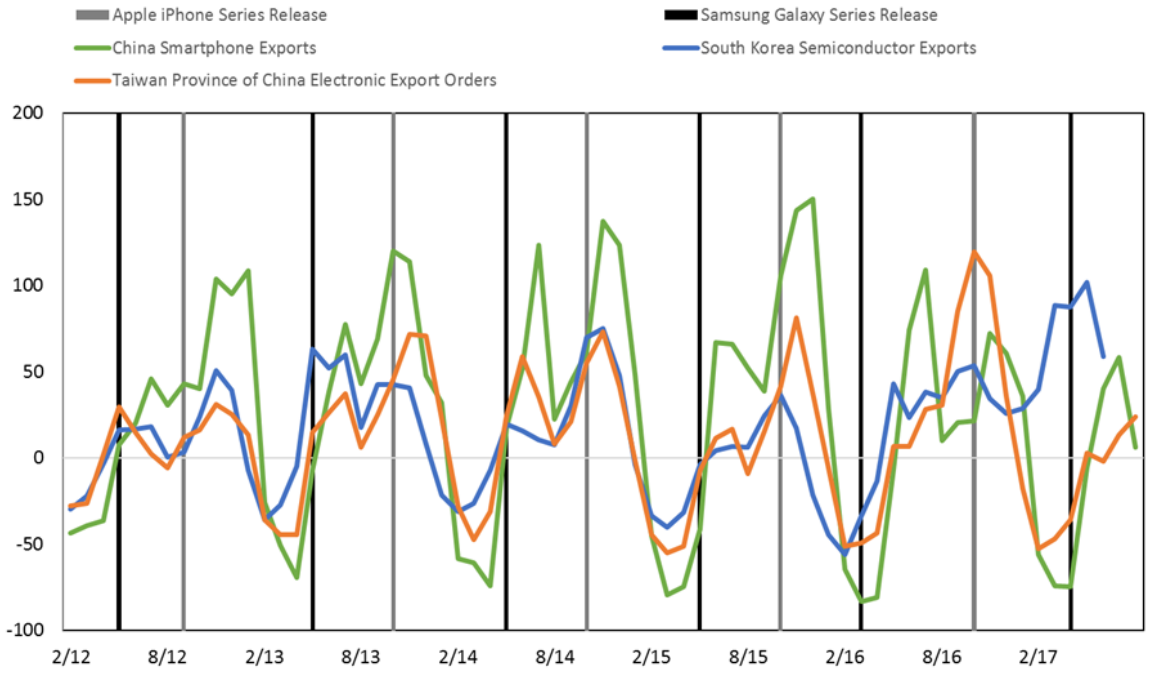
An intuitive way to present the new tech cycle is to chart the growth rates of exports of several countries involved in the supply chain across Asia. Figure 2 shows the main release dates for Apple and Samsung smartphones (the grey and black vertical lines), and the three-

[1] OECD (2015), Figure 2.4.

month moving average of monthly growth rates of Chinese smartphone exports, South Korea semiconductor exports, and Taiwan Province of China export orders.[2] The figure clearly demonstrates three things. First, it gives a visual depiction of the correlation of component exports from South Korea and Taiwan Province of China, and Chinese exports of smartphones. This holds true also as well for related electronic components from Malaysia, Singapore, and, to a lesser extent, Thailand. Second, the pickup in growth rates is concentrated around the release dates for Apple and, to a lesser extent, Samsung smartphones. Third, the high growth rates—up to 150 percent for Chinese smartphone exports—show that the tech cycle has a large cyclical impact on export and growth performance in Asia.

Figure 2. The New Tech Cycle: Apple and Samsung Phone Releases, China Smartphone Exports, South Korea Semiconductor Exports, and Taiwan Province of China Electronic Export Orders

(Percentage change, 3-month moving average-on-3-month moving average annualized, not seasonally adjusted)



Sources: KITA; Ministry of Economic Affairs, Taiwan Province of China; and TDM Data.

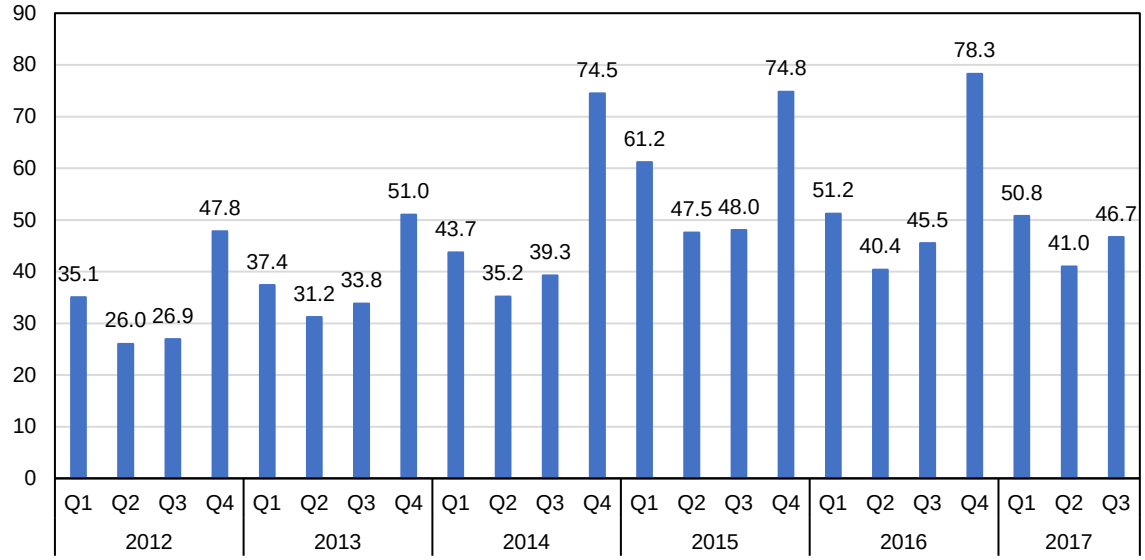
At this stage, the reader may ask why the tech cycle is not captured by seasonal adjustment methods. The reason is threefold. First, the recent nature of the new tech cycle (only six years so far) makes it hard to capture the cycle with standard seasonal adjustment as the latter would require a significantly longer time series to be statistically meaningful. Second, supply chains associated with smartphones have evolved and become more complex over time, which implies that several countries have experienced a higher impact of the new tech cycle in the last few years. Third, and more importantly, we will show below that the tech cycle

[2] We are indebted to Seok Gil Park (2017) for this chart and a useful introduction to the tech cycle.

critically depends on smartphone release dates, which can vary during the calendar year and can have a differential impact on production and exports depending on the success of global smartphone sales. This is likely to have been particularly relevant in the fourth quarter of 2017, when Apple Inc. released the iPhone 8/8 Plus in October and the iPhone X a month later (Appendix I).

To further elaborate on this point, it is worth looking specifically at the number of global Apple iPhone sales over the last five years (Figure 3). Reflecting a booming global demand, sales surged from 35.1 million units in the first quarter of 2012 to 78.3 million in the fourth quarter of 2016. While a clear quarterly pattern seems to be emerging, where the second and third quarter sales are usually weaker reflecting the expectations of another release in the fourth quarter, the amplitude of this quarterly pattern has only really been established since the release of the iPhone 6/6 Plus in September 2014. Moreover, there are clear spillovers from the fourth quarter of the previous year onto the first quarter of the following year.

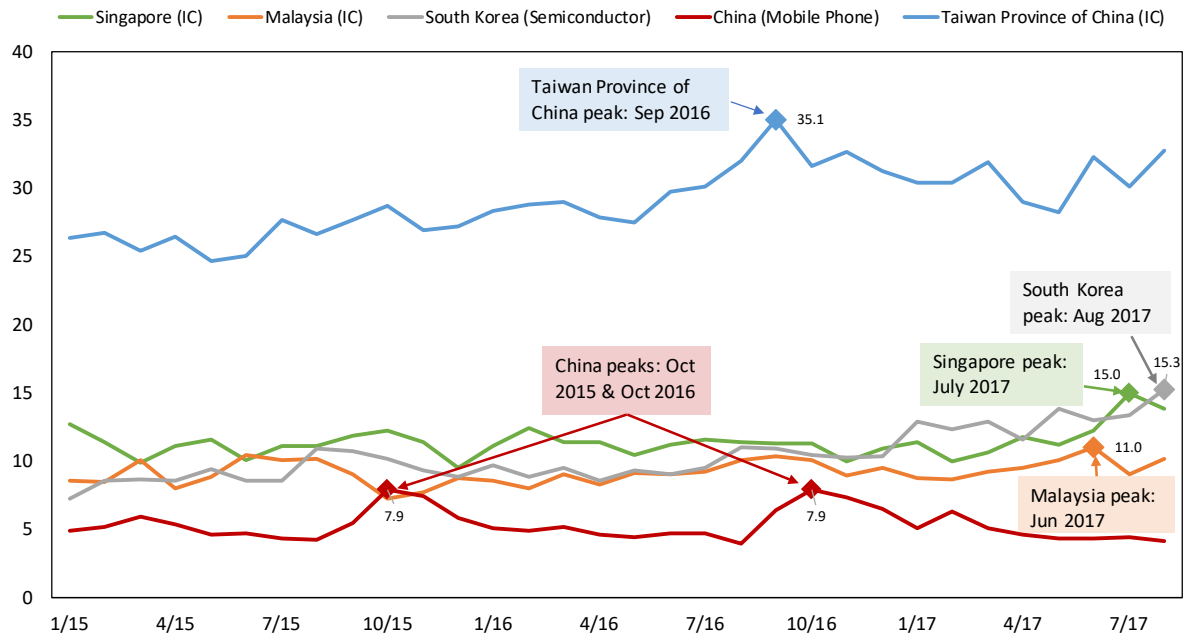
Figure 3. Global iPhone Sales
(Millions of units Sold Each Quarter)



Source: Apple Inc. quarterly financial statements (quarters shown are calendar and not fiscal year).

The large global demand for smartphones has a significant macroeconomic impact on several countries in Asia. At peak, the new tech cycle accounts for over one third of total exports in Taiwan Province of China, 15 percent in Singapore and South Korea, 11 percent in Malaysia and 8 percent in China (Figure 4). The significance of the new tech cycle has also grown over time as supply chains have become more complex and cover a larger number of countries across Asia. In the third quarter of 2017, for example, the new tech cycle was a major contributor to exports and growth in Malaysia, Singapore, South Korea and Taiwan Province of China. It is also likely to have a significant impact on growth performance in China in the fourth quarter of 2017.

Figure 4. Electronics Component Exports
(Percent of total monthly exports)



Sources: TDM Data and Haver Analytics.

The Pre-Release Cycle

Smartphone releases are predated by a significant ramp up of electronics component exports. This pre-release cycle is characterized by large shipments from several Asian countries to China, where final manufacturing and assembly of most smartphones takes place. This includes shipments of memory chips (DRAM and flash memory), mainly from South Korea and Vietnam; system chips (CPUs and app processors) and multichip packages (MCPs) from Japan, Malaysia, Singapore, South Korea and Taiwan Province of China; and displays from Japan and South Korea. For the operating system, the software for Samsung smartphones, the Google Android operating system, is open source from the US and thus free of charge. The operating system for iPhones comes from Ireland, where Apple Inc.'s intellectual property is currently located.[3]

[3] Per US Senate Permanent Subcommittee on Investigations (2013), Apple Inc. holds its intellectual property in a subsidiary in Ireland to take advantage of very low corporate income taxes there. At the same time, the same subsidiary has a manufacturing service agreement with the Chinese electronics manufacturer to produce iPhones. As such, global iPhone sales are recorded as Irish exports in line with the geographical location of the Apple's intellectual property, while the iPhone manufacturing is recorded as a manufacturing service import from China in the Irish balance of payments.

The supply chain has evolved over the last few years and become more complex. Figure 5 presents the geography of the pre-release cycle across Asia in 2016. It shows that the main contributors to this complex supply chain were Japan, Malaysia, Singapore, South Korea, and Taiwan Province of China. Newcomers to the supply chain are the Philippines, Thailand, and Vietnam, with growing shares of component exports in the tech cycles. The supply chain is likely to have evolved and become even more complex in 2017. Press reports indicate that Apple Inc. signed a contract with Samsung Electronics in April 2017 for the shipment of 70 million OLED screens for the iPhone X.[4] This contract is likely to boost Samsung exports further, particularly in the second half of 2017 and into 2018.

Overall, the pre-release cycle accounted for USD68.2 billion of imports of electronics components to China in 2016, equivalent to about 4.3 percent of total Chinese merchandise imports. The effect on gross trade flows across Asia is large, while the impact on net value added for China is small. Manufacturing and shipments of smartphones only create an estimated USD20 billion of value added in mainland China, equivalent to 0.2 percent of 2016 GDP. So, while the tech cycle has a significant impact on growth and trade for the smaller countries in Asia, it has a relatively small growth effect in China.

The Post-Release Cycle

The post-release cycle is global in nature (Figure 6). China is the de facto the final manufacturer for most smartphones. Shipments originate from China to regional distribution centers around the world and from there to consumers. In 2016, Chinese exports of smartphones amounted to USD106.9 billion (5.1 percent of total exports). The main destinations of smartphone shipments were the United States (28.0 percent), Europe (22.7 percent), South East Asia and India (15.4 percent), South Korea (7.6 percent) and Japan (7.1 percent). The large shipments to South Korea reflect the distribution of a portion of Samsung smartphones from there to the rest of the world.

It is worth noting that the pre- and post-release cycles do intertwine in the sense that, after a smartphone release, production continues to require significant electronics component through the Asian supply chain while China already is shipping the finished smartphones to the rest of the world. As such, both pre- and post-release cycles overlap, which adds to the interesting dynamics of the new tech cycle.

[4] Nikkei Asian Review (2017).

Figure 5. Geography of Pre-Release Cycle

(Annual exports of Integrated Circuits, Value and Percentage of Total Component Exports, 2016)

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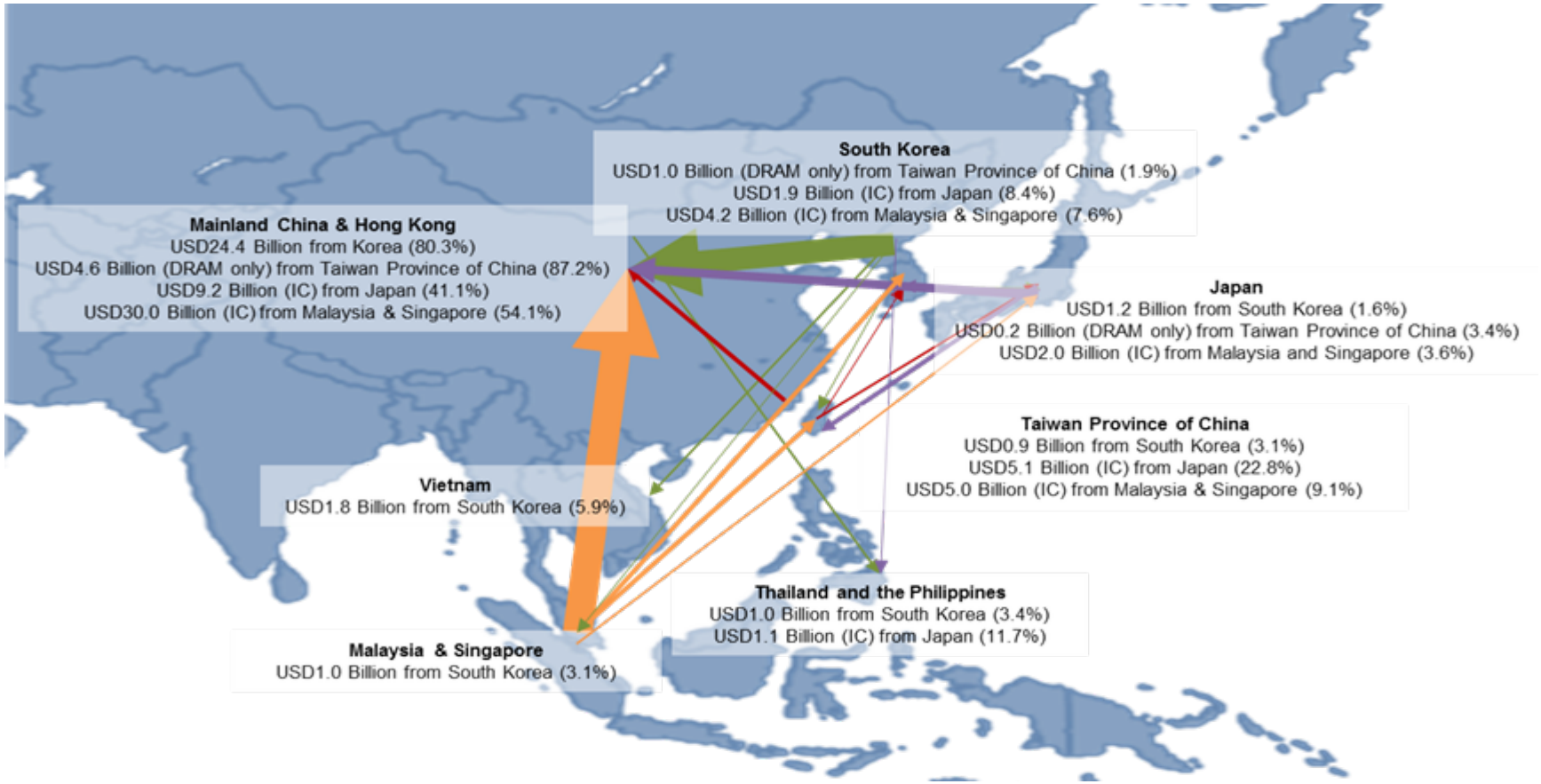
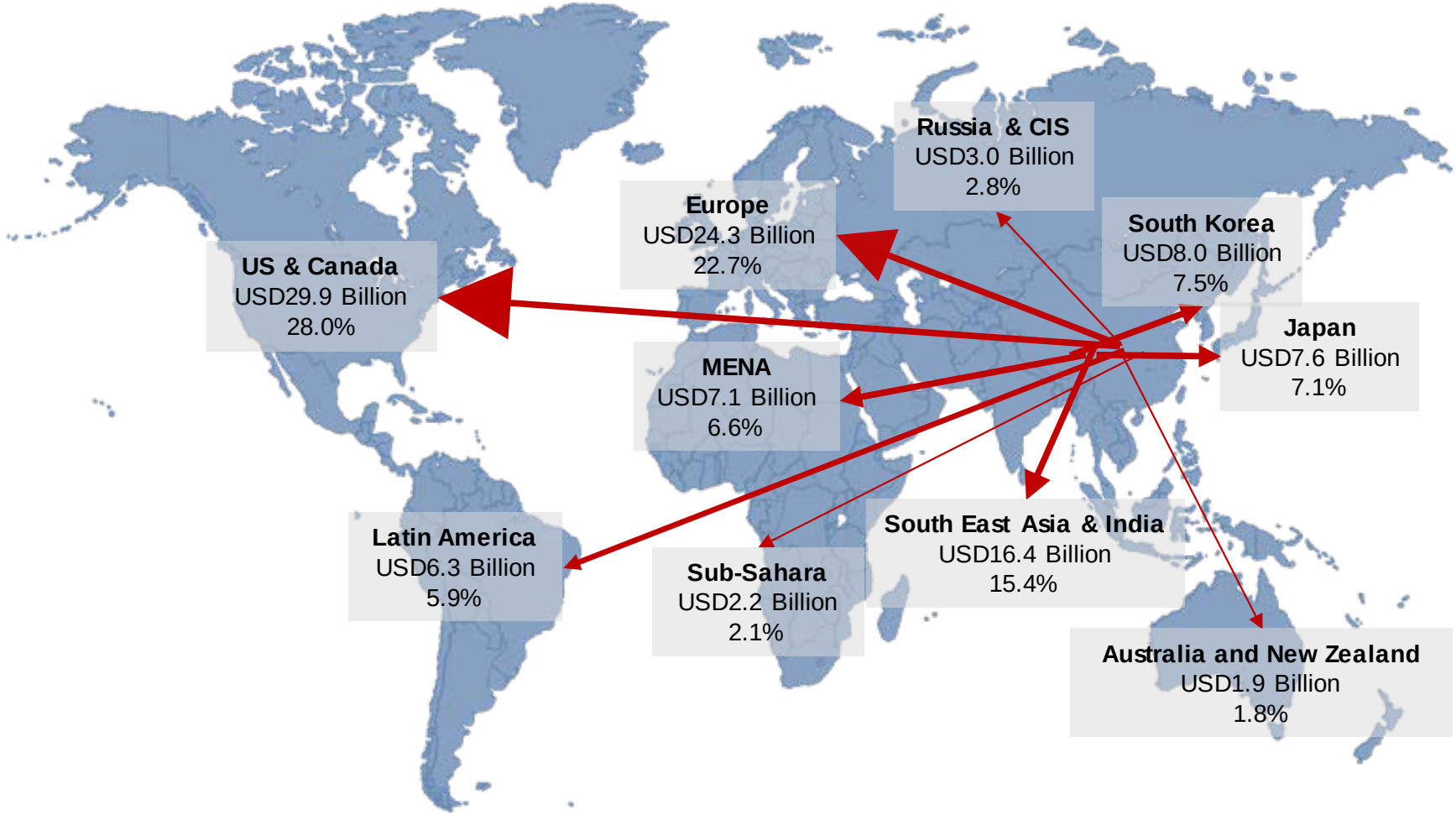


Sources: KITA; Ministry of Economic Affairs, Taiwan Province of China; TDM Data; and UN Comtrade Database.

Figure 6. Geography of Post-Release Cycle
China: Exports of Smartphones
(Value and Share of Total Smartphone Annual Exports, 2016)



Source: TDM Data.

III. DECOMPOSING TREND FROM CYCLE

In the previous section, we argued that the new tech cycle has a strong seasonal pattern around the release dates of major smartphones. In this section, we test this hypothesis by decomposing trend from cycle econometrically, based on the data shown in Figure 2. The main result is that shipments of smartphones seems to have peaked in late 2015, suggesting that the global market for smartphones may have saturated.

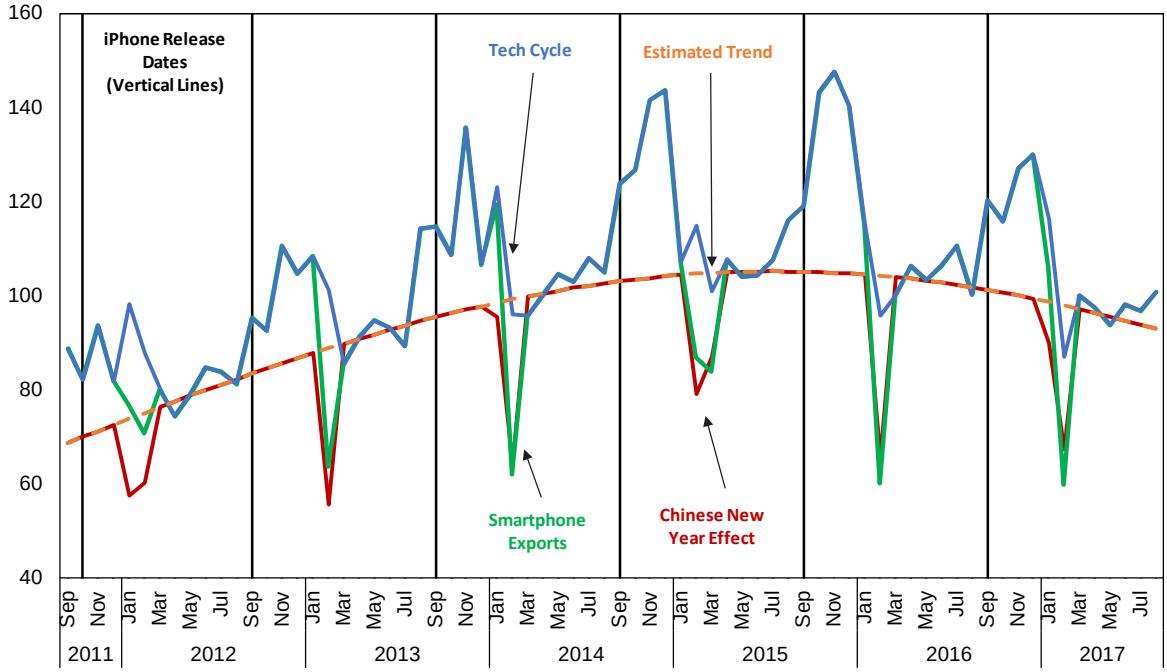
Major releases of Samsung smartphones are usually in the second quarter, while Apple iPhones are generally in the third or fourth quarter of each year. For iPhones, global sales in the fourth quarter have accounted for an average 35 percent of total annual sales. Part of the reason for this concentration relates to sales associated with the Christmas holidays. However, the strength of global sales usually spills over to the first quarter of the following year—albeit at a more subdued pace—until the Chinese New Year.

We use a standard methodology to decompose trend from cycle. We use monthly dummies before and after the release dates to capture the cycle, while time and the square of time ($time^2$) are used to capture a potentially non-linear trend. We also include a dummy to capture the 15 days of the Chinese New Year, when most factories in China are closed including the major smartphone manufacturers. Given that the Chinese New Year follows the lunar calendar, the holiday period shifts by roughly 11 days each year in the Gregorian calendar. To capture this shift, the dummy is equal to the number of vacation days for the Chinese New Year in each month.

The econometric results for exports of Chinese smartphones show that the cycle is mainly determined by the release dates of iPhones, while the trend is non-linear with a peak in September 2015 (Figure 7 and Table 2 in Appendix II).[5] The coefficients on one month before the release date and up to four months after are statistically significant. The fitted value is shown in the blue line below. The coefficients on the trend variables (time and $time^2$) are both statistically significant, with a negative coefficient on $time^2$, suggesting that global sales of smartphones may have peaked (orange line in Figure 7). However, these results are partly driven by the lack of data for the second half of 2017, which may overstate the amount of the recent downturn in the trend. The coefficient on the Chinese New Year dummy is negative and highly significant as expected, given the shutdown of smartphone manufacturing during these holidays (red line in Figure 7). Overall, the decomposition between cycle and trend explains about 92 percent of Chinese smartphone exports (green line in Figure 7).

[5] Samsung smartphone release dates were not statistically significant, which may partly reflect the fact that they are not associated with the holiday season in the fourth quarter of each year.

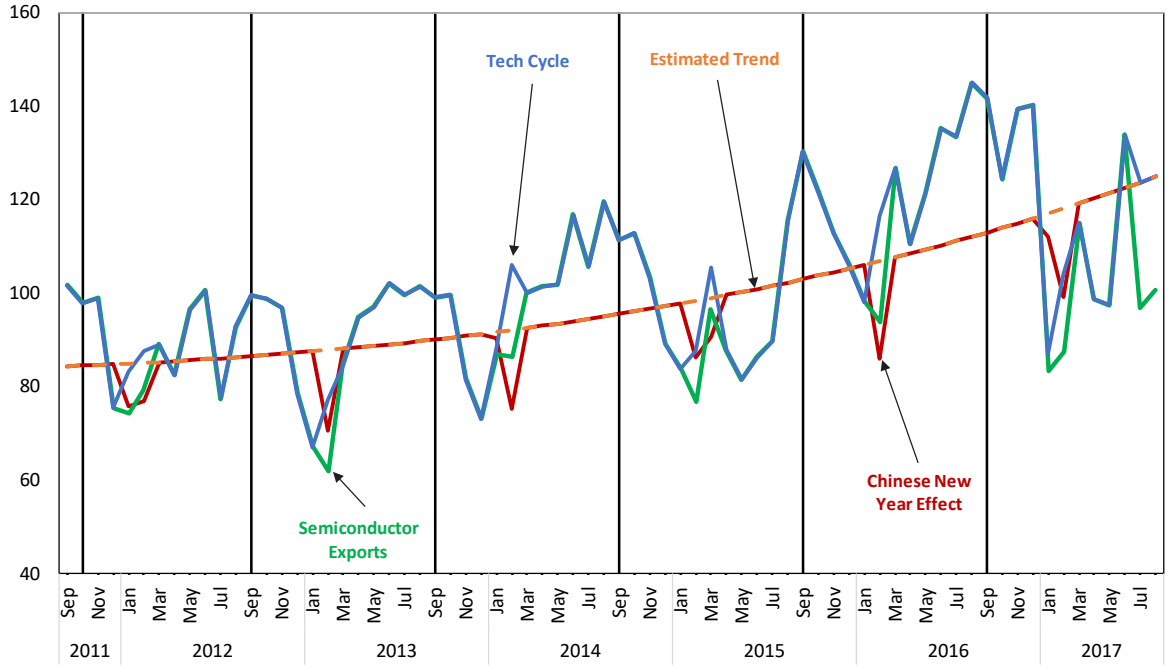
Figure 7. China: Smartphone Export Cycle
(Millions of Units Exported Per Month)



Sources: TDM Data, Haver, and authors' regression results.

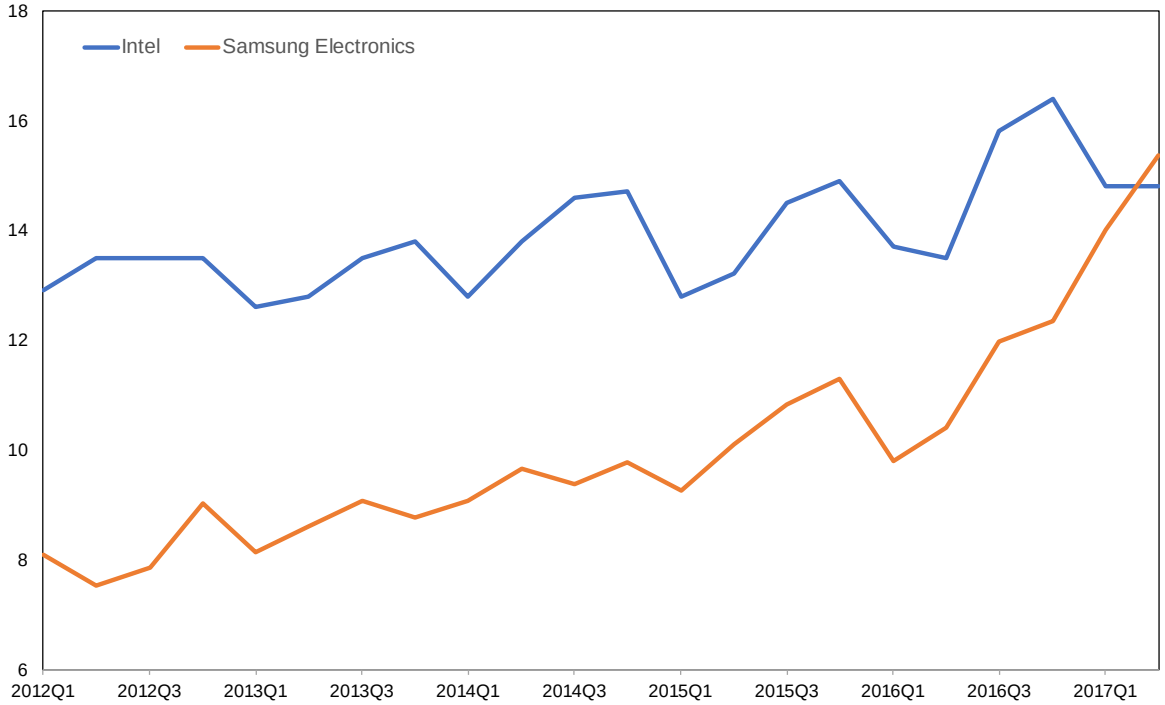
Using the same methodology, we find a rather different story for South Korean semiconductor exports. The coefficients on the dummies up to one month ahead of the release date and one month after the release date are significant, suggesting that production rumps up just before the release date (blue line in Figure 8 and Table 3 in Appendix II). In addition, while not statistically significant, the trend terms (time and time^2) are both positive, which may be an indication that demand for South Korean semiconductors continued to rise during 2011-17, despite the possible saturation in the global smartphone market (orange line in Figure 8). This is consistent with the fact that Samsung Electronics has overtaken Intel Corporation as the largest semiconductor producer in the world in the second quarter of 2017 (Figure 9). Finally, the Chinese New Year dummy is negative and statistically significant as expected (red line in Figure 8). The regression explains about two thirds of the variation in South Korea's semiconductor exports (green line in Figure 8).

Figure 8. South Korea: Semiconductor Export Cycle
(Millions of Units Exported Per Month)



Sources: TDM Data, Haver, and authors' regression results.

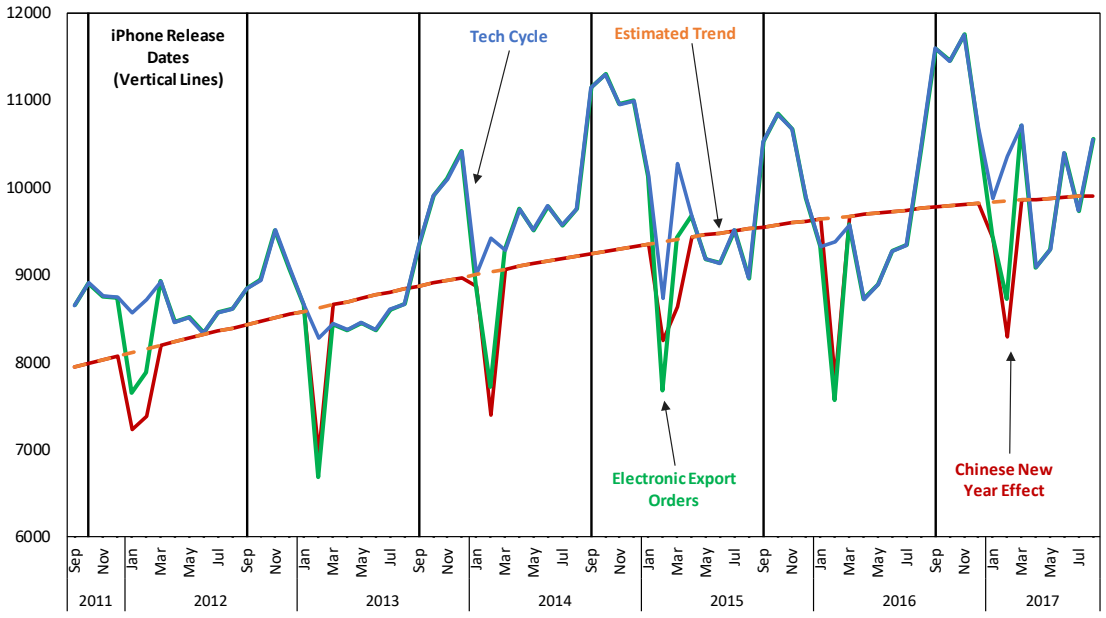
Figure 9. Intel and Samsung: Sales of Semiconductor Chips
(Billions of USD)



Sources: Intel and Samsung Electronics Quarterly Financial Statements.

Finally, the same methodology for Taiwan Province of China electronics export orders produces similar results, although the data are in value terms (volume data are not available) The release month and subsequent three months are statistically significant in explaining the cycle (blue line in Figure 10). These results suggest that Taiwan Province of China electronics export orders are contemporaneous with the smartphone export cycle in China, pointing to a very short lead-time component production. Moreover, the time coefficients (time and time^2), while borderline statistically significant, show that export orders may be in the process of peaking. This, however, may reflect the lack of data for the second half of 2017. Finally, the dummy on the Chinese New Year effect is negative and statistically significant as expected. Overall, the regression explains about 80 percent of the variation in Taiwan Province of China's electronic export orders.

Figure 10. Taiwan Province of China: Electronic Export Orders Cycle
(Millions of USD, monthly export orders)



Sources: Ministry of Economic Affairs, Taiwan Province of China; and authors' regression results.

These three decompositions of the new tech cycle provide an interesting insight into the dynamics of supply chains for smartphones. The regressions clearly show that iPhone release dates have driven the tech cycle in the last five years, both in terms of Chinese smartphone exports, South Korean semiconductor exports, and Taiwan Province of China export orders. While there is a clear indication from the China exports decomposition that the global demand for smartphones may have peaked in late 2015, the global demand for South Korean semiconductors seems to be on an upward trend, suggesting that other electronic products are driving the acceleration (e.g., automobile computers, smart appliances, and wearable devices). In line with these results, the underlying trend in Taiwan Province of China electronic export orders remains strong, albeit at a more moderate rate in the first half of 2017.

IV. CONCLUSIONS

The new tech cycle is an important new feature of the global economy. Over the last six years, the enormous global demand for smartphones has changed the export and growth performance of several Asian countries through complex and evolving supply chains that involve several countries in the region.

In the paper, we show that the release date of iPhone products has a significant impact on related electronics exports of three major Asian countries, namely China, South Korea, and Taiwan Province of China. In addition, the decomposition of trend from cycle shows that the global smartphone market may have saturated in late 2015. However, the demand for other electronics products continues to boost production of semiconductors, particularly in South Korea. Thus, Asia continues to gain in importance as the global tech manufacturer.

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Appendix I. Apple Inc. and Samsung Electronics Smartphone Release Dates

Table 1. Apple Inc. and Samsung Electronics Smartphone Release Dates

Release Date	Smartphone Model
2012 May	Samsung Galaxy S3
2012 Sep	Apple iPhone 5
2013 Apr	Samsung Galaxy S4
2013 Sep	Apple iPhone 5s
2014 Apr	Samsung Galaxy S5
2014 Sep	Apple iPhone 6/6 Plus
2015 Apr	Samsung Galaxy S6/Galaxy S6 Edge
2015 Sep	Apple iPhone 6s/6s Plus
2016 Feb	Samsung Galaxy S7/Galaxy S7 Edge
2016 Sep	Apple iPhone 7/7 Plus
2017 Mar	Samsung Galaxy S8/Galaxy S8+
2017 Oct	Apple iPhone 8/8 Plus
2017 Nov	Apple X

Source: Apple, Inc. and Samsung Electronics.

Appendix II. Regression Results

Table 2. Regression Results for China Smartphone Exports

Dependent Variable: Volume of China Smartphone Exports (in log)				
	Coefficient	**Std. Error**	**t**	**P>|t|**
Explanatory Variables:				
Months before/after phone release:				
M-3	0.02238	0.029	0.77	0.45
M-2	0.03710	0.029	1.27	0.21
M-1	0.05686	0.032	1.80	0.01
M	0.15978	0.032	5.10	0.00
M+1	0.17295	0.032	5.50	0.00
M+2	0.29625	0.031	9.41	0.00
M+3	0.24075	0.029	8.36	0.00
M+4	0.14691	0.029	5.16	0.00
Other variables:				
Constant	-70.04554	9.640	-7.27	0.00
Time	0.26577	0.029	9.06	0.00
$Time^2$	-0.0002	-0.000	-8.94	0.00
Chinese New Year dummy*	-0.03106	0.002	-13.96	0.00
Statistics:				
R-squared	0.922			
Adjusted R-squared	0.907			
F-statistic	60.35			
Durbin-Waston d-statistic	2.434			

Source: Authors' estimation.
*This dummy takes the value of the number of Chinese New Year holidays in a month.

Table 3. Regression Results for South Korea Semiconductor Exports

Dependent Variable: Volume of South Korea Semiconductor Exports (in log)

	Coefficient	Std. Error	t	P>|t|
Explanatory Variables:				
Months before/after phone release:				
M-3	0.11220	0.060	1.86	0.07
M-2	0.03441	0.060	0.57	0.57
M-1	0.16054	0.602	2.67	0.01
M	0.16968	0.060	2.82	0.01
M+1	0.12721	0.060	2.12	0.04
M+2	0.06735	0.060	1.12	0.27
M+3	-0.03859	0.055	-0.70	0.49
M+4	-0.13387	0.055	-2.45	0.02
Other variables:				
Constant	40.34612	19.815	2.04	0.62
Time	-0.07255	0.060	-1.20	0.24
$Time^2$	0.00006	0.000	1.29	0.20
Chinese New Year dummy*	-0.01446	0.004	-3.41	0.00
Statistics:				
R-squared	0.673			
Adjusted R-squared	0.606			
F-statistic	10.09			
Durbin-Waston d-statistic	1.038			

Source: Authors' estimation.
*This dummy takes the value of the number of Chinese New Year holidays in a month.

Table 4. Regression Results for Taiwan Province of China Electronic Export Orders

Dependent Variable: Value of Taiwan Province of China Electronic Export Orders (in log)	Coefficient	Std. Error	T	P>|t|
Explanatory Variables:				
Months before/after phone release:				
M-3	-0.01319	0.025	-0.52	0.61
M-2	0.01082	0.025	0.42	0.67
M-1	0.01387	0.027	0.50	0.62
M	0.11080	0.027	4.03	0.00
M+1	0.12798	0.027	4.66	0.00
M+2	0.13684	0.027	4.98	0.00
M+3	0.09003	0.025	3.59	0.00
M+4	0.02103	0.025	0.84	0.40
Other variables:				
Constant	-6.52886	8.403	-0.78	0.44
Month	0.04467	0.026	1.75	0.09
$Month^2$	0.00003	0.000	-1.63	0.11
Chinese New Year dummy*	-0.01427	0.014	-7.36	0.00
Statistics:				
R-squared	0.809			
Adjusted R-squared	0.771			
F-statistic	21.54			
Durbin-Waston d-statistic	1.158			

Source: Authors' estimation.
*This dummy takes the value of the number of Chinese New Year holidays in a month.

Appendix III. Data Sources

Variables	Source
Global Sales of PCs and Smartphones	Gartner/IDC
Global iPhone Sales	Apple Inc.
China Total Merchandise Exports	Haver Analytics
South Korea Total Merchandise Exports	Haver Analytics
Taiwan Province of China Total Merchandise Exports	Haver Analytics
Singapore Total Merchandise Exports	Haver Analytics
Malaysia Total Merchandise Exports	Haver Analytics
Singapore IC Exports	UN Comtrade Database
Malaysia IC Exports	UN Comtrade Database
Thailand IC Exports	UN Comtrade Database
Philippines IC Exports	UN Comtrade Database
Volume of China Smartphone Exports	TDM Data (Trade Data Monitor)
Volume of South Korea Semiconductor Exports	TDM Data (Trade Data Monitor)/KITA
Value of South Korea Semiconductor Exports	TDM Data (Trade Data Monitor)/KITA
Value of Taiwan Province of China Electronic Export Orders	Ministry of Economic Affairs, Taiwan Province of China