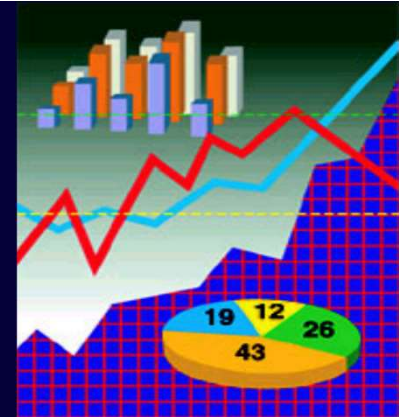


Business Outlook

Global Electronics Industry

(with emphasis on Europe)

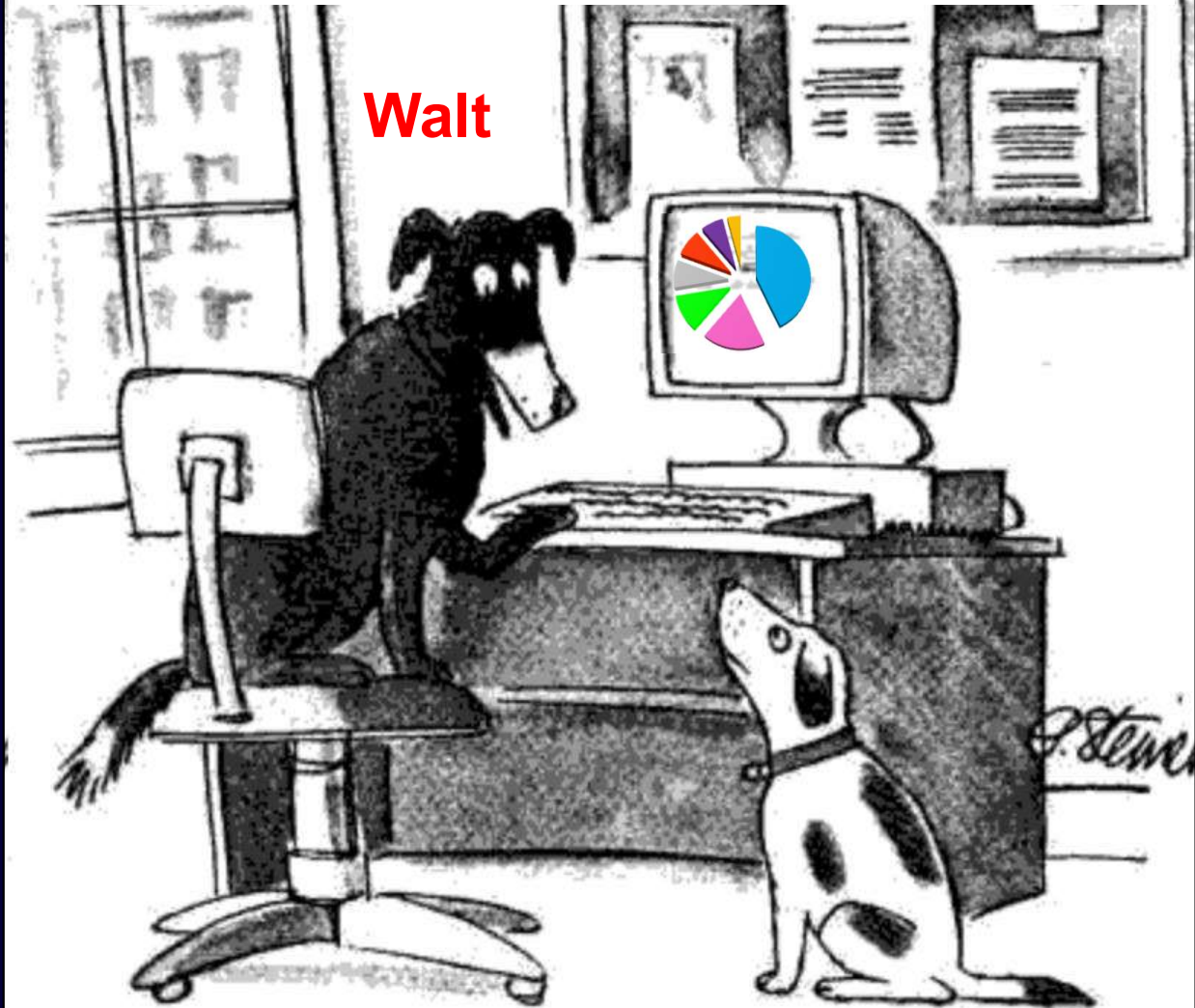


Custer Consulting Group
www.custerconsulting.com
February 2019

Custer
Presentation
given
by Alun

On the Internet no one knows
I am a dog

Walt



**Brace yourself
for some
sobering news**

2019 Situation

Global manufacturing growth is slowing based on PMI data.

Most sectors of the world electronic supply chain are now expanding slower or contracting.

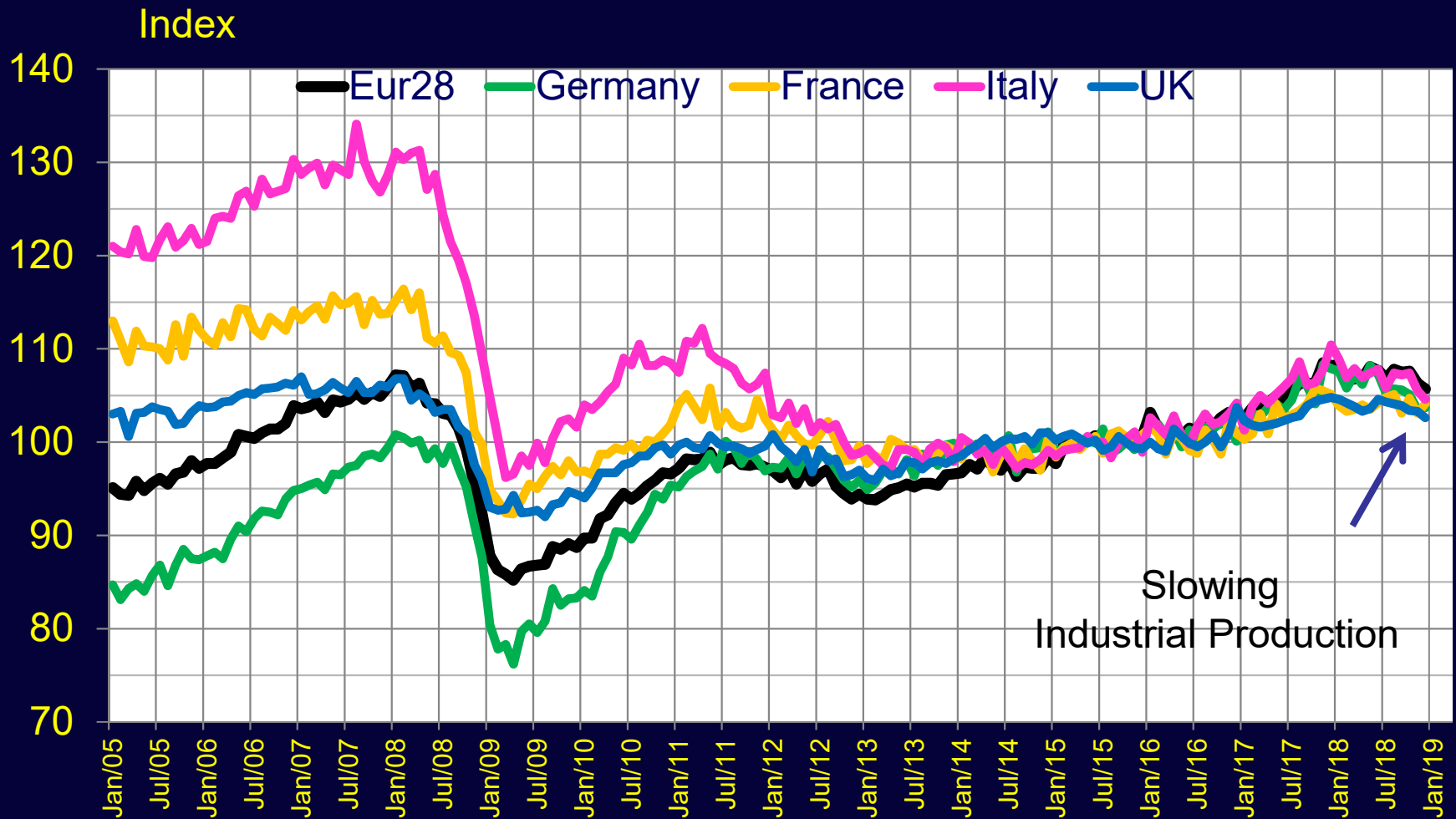
Inflation, tariffs, trade disputes and Brexit are key issues

Geopolitical concerns remain very significant.

European electronics sectors except instruments, medical electronics & aerospace declined in 4Q'18

Industrial Production – Europe Manufacturing

Index (2015 Avg. Month = 100, Seasonally Adjusted)



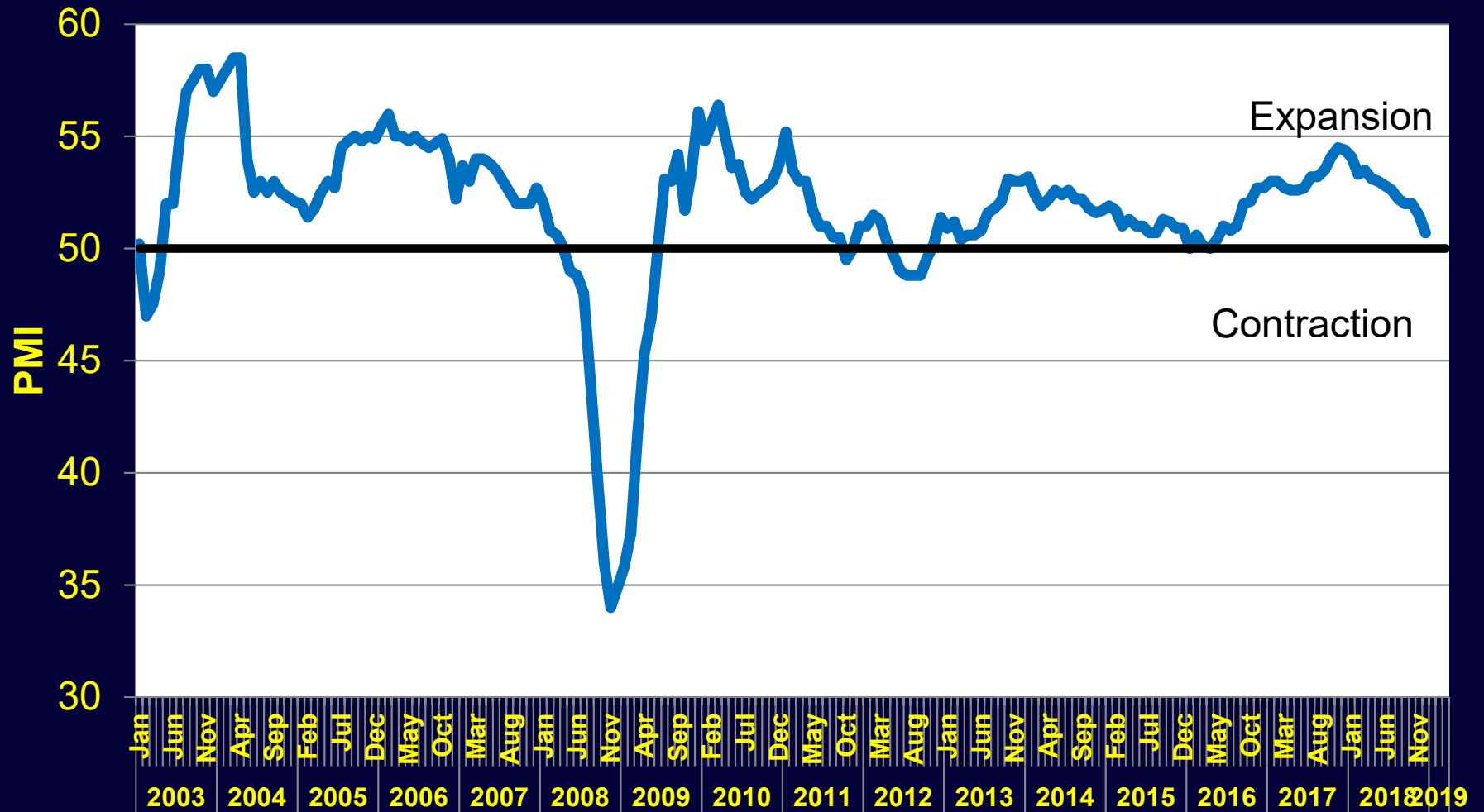
Purchasing Managers Indices

**Useful but Sobering
Leading Indicators**

20190203

Global "Purchasing Managers" Index

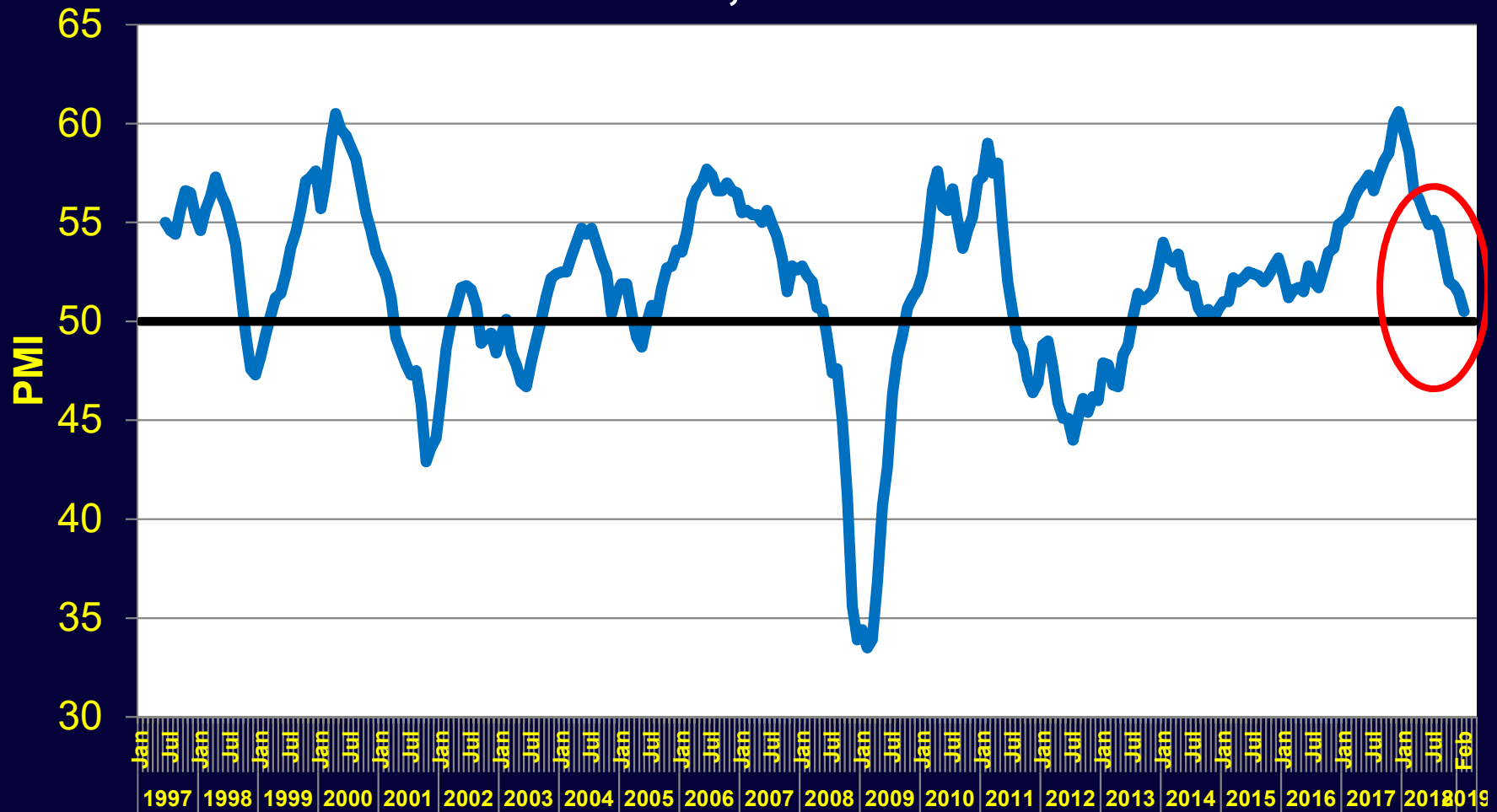
Diffusion Index, >50 = Growth



20190203

Eurozone Manufacturing "Purchasing Managers" Index

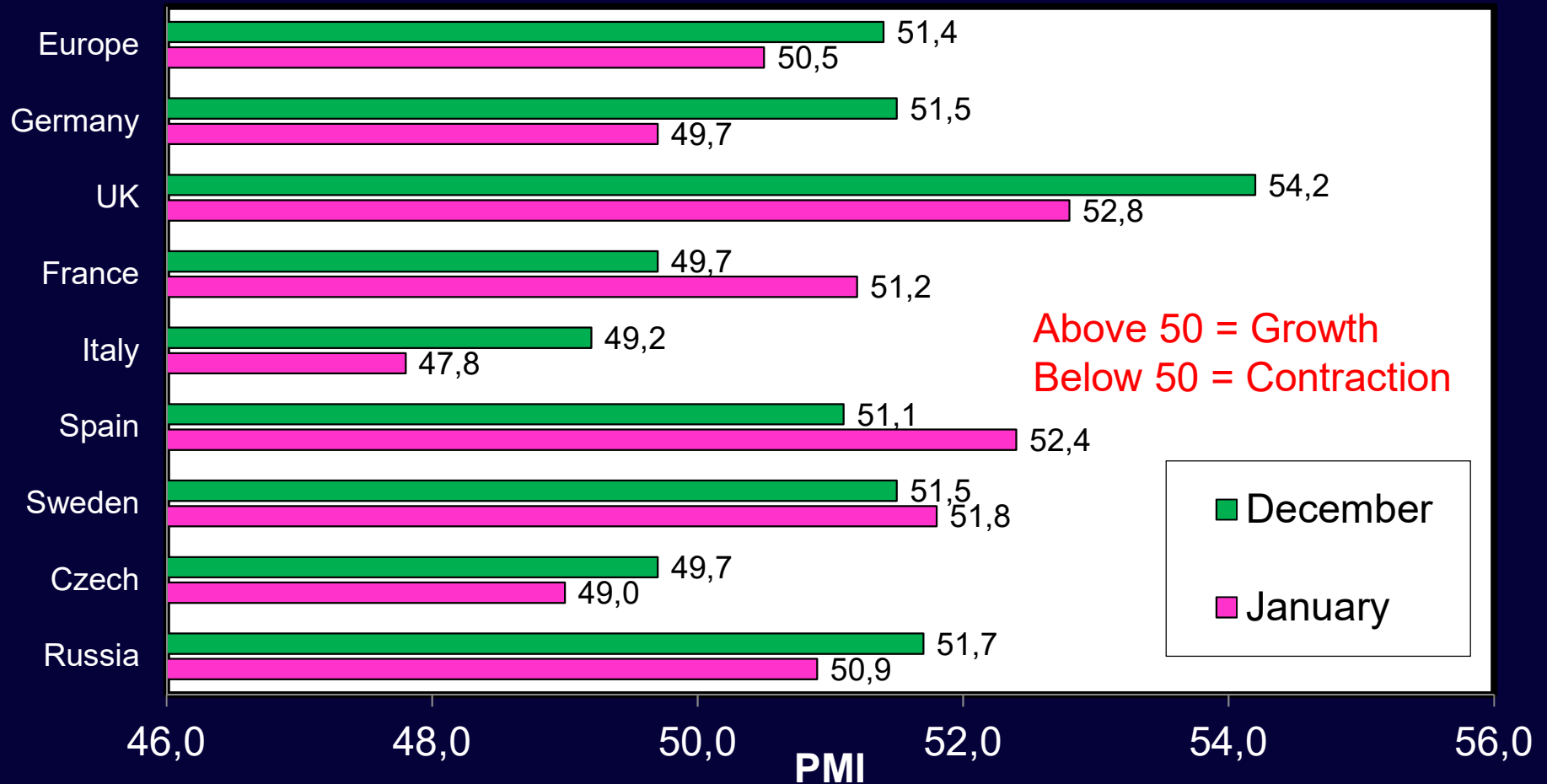
Diffusion Index, >50 = Growth



European Purchasing Managers' Indices

January 2019 vs December 2018

20190203



Electronic Equipment

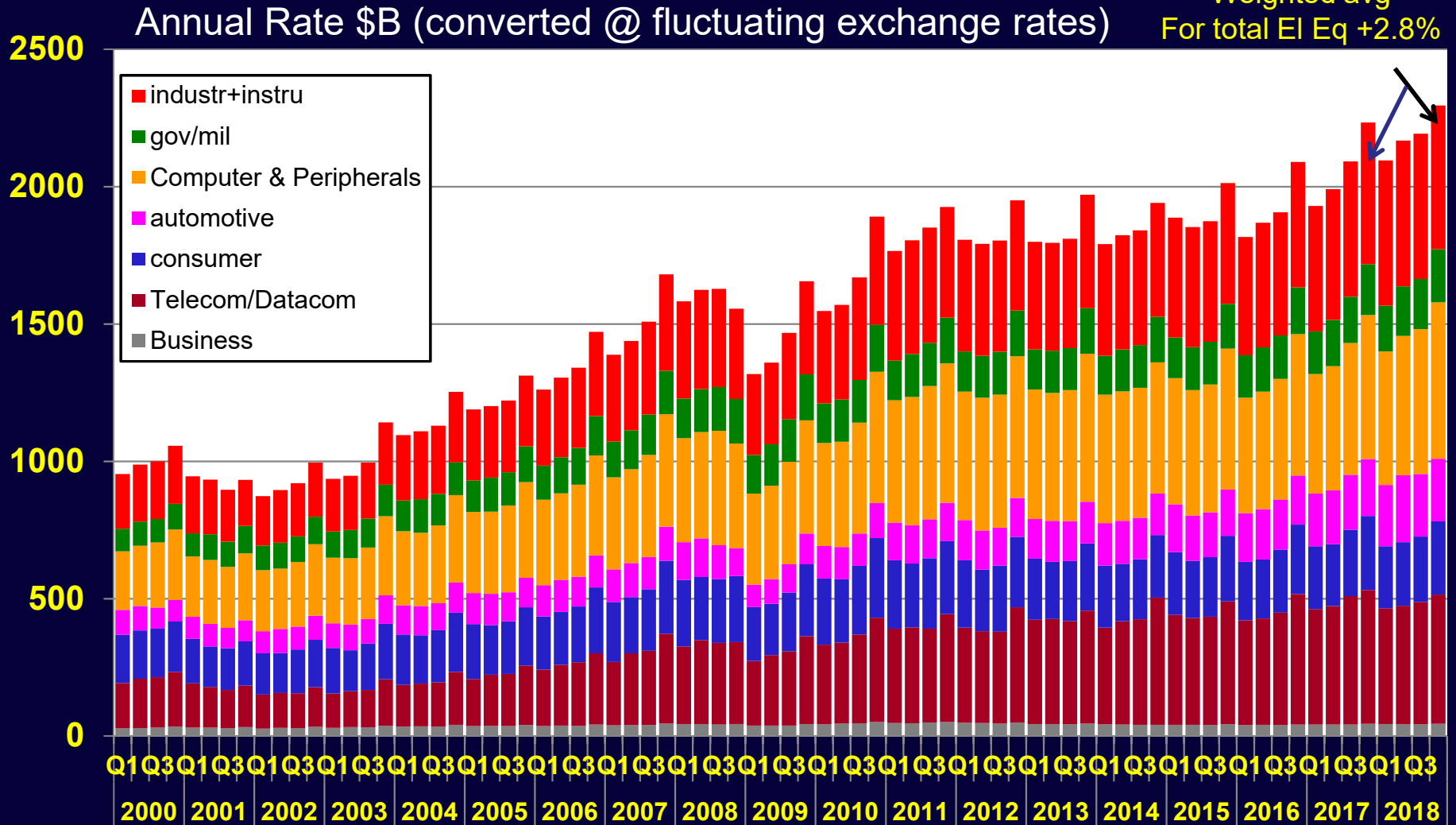
World

World Electronic Equipment Production

20190208

By Type

4Q'18 Prelim estimate
Weighted avg
For total EI Eq +2.8%



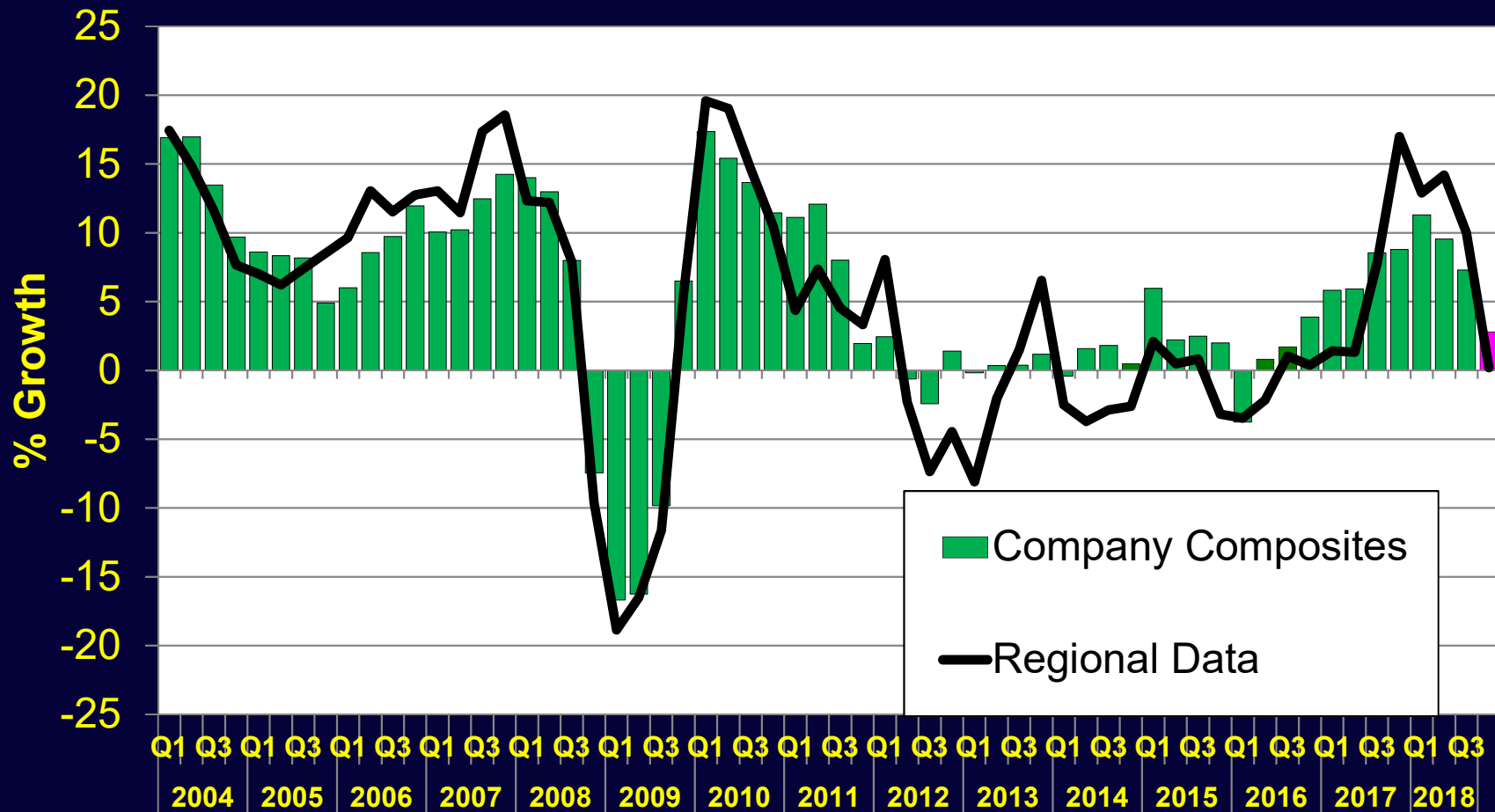
Two Measures of Electronic Equipment Growth

**Composite company sales by
sector from quarterly financial
reports**

Monthly regional data

Electronic Equipment Sales

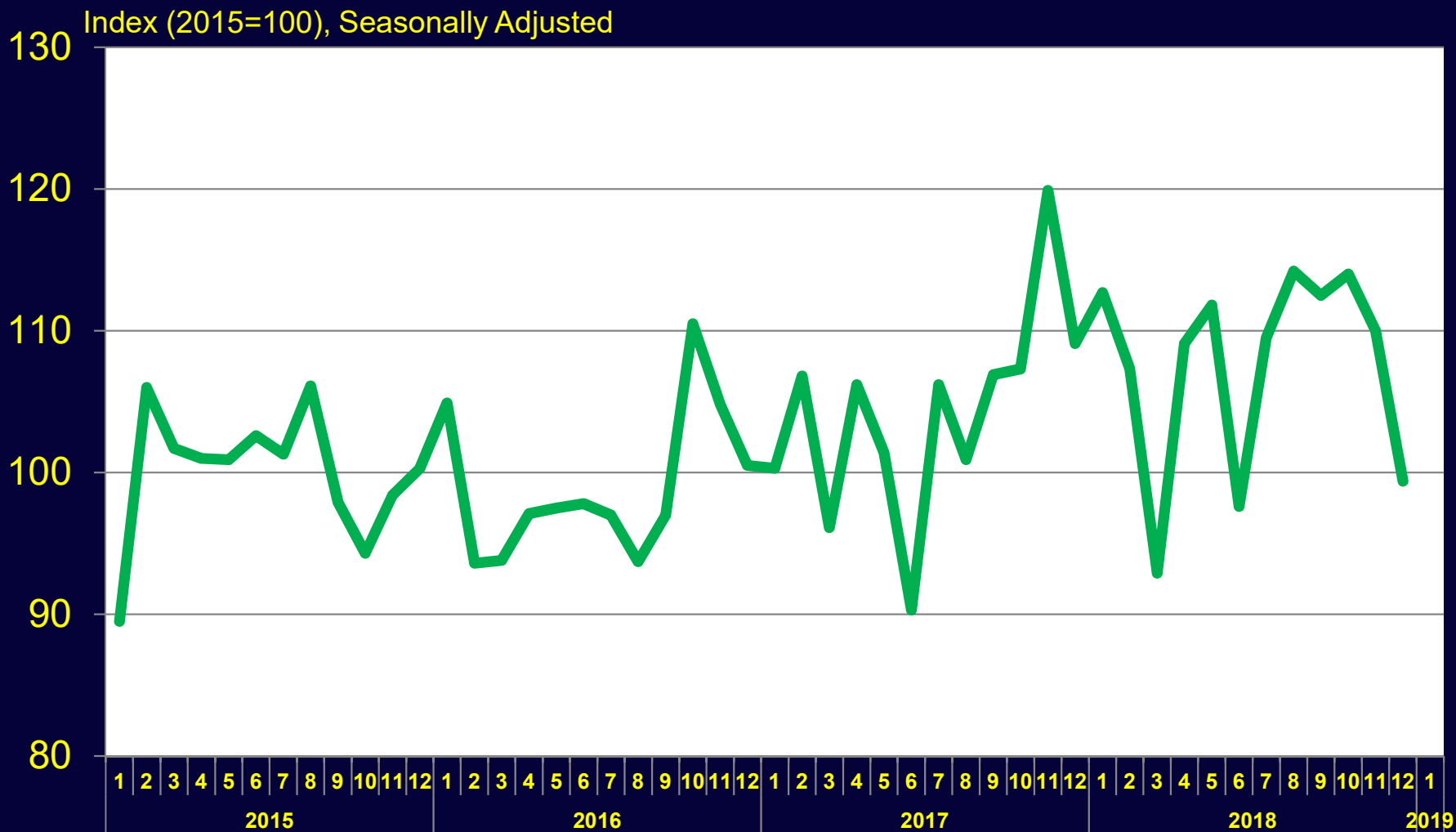
Weighted Average vs. Regional Model @ Fluctuating Exchange
 Quarterly Revenue Growth



213 OEM company sales composite (converted to weighted average by product sector) vs. Regional electronic equipment shipment model

201900214

European Computer, Electronic & Optical Products Production

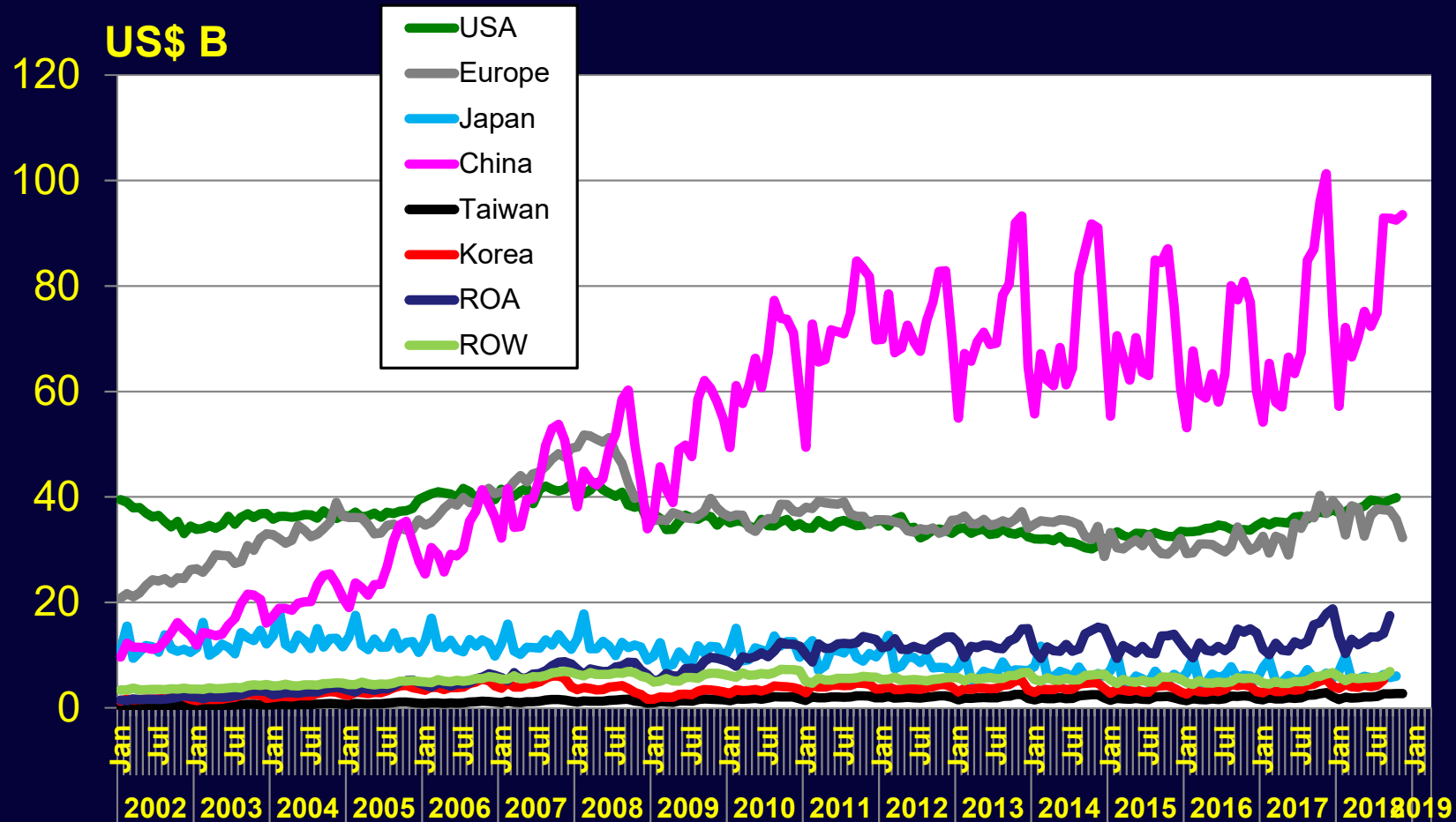


Eurostat, C26 category, EU 28 countries

World Electronic Equipment Monthly Shipments

20190213

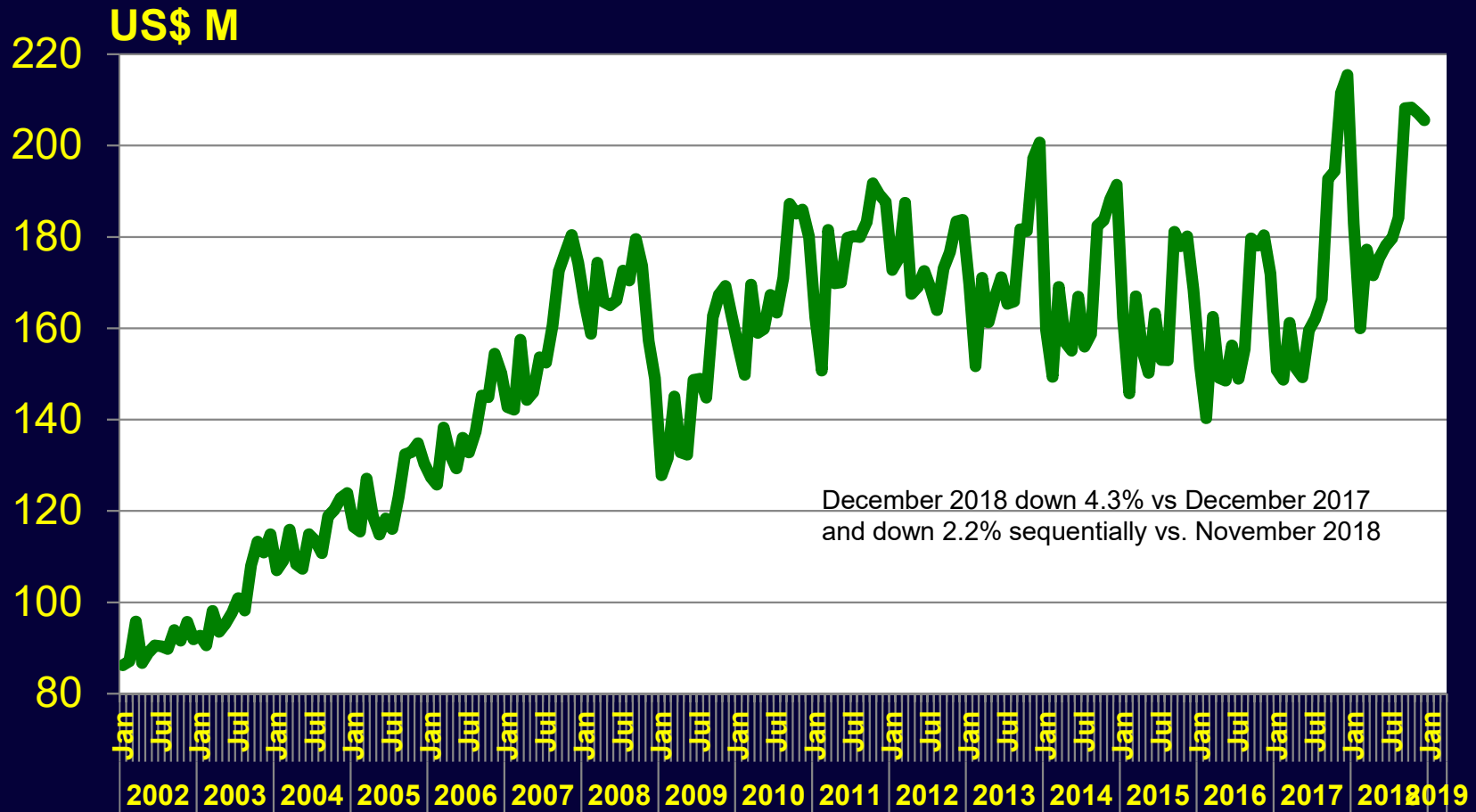
Converted @ Fluctuating Exchange Rates



Source: Custer Consulting Group

World Electronic Equipment Monthly Shipments

Converted @ Fluctuating Exchange Rates

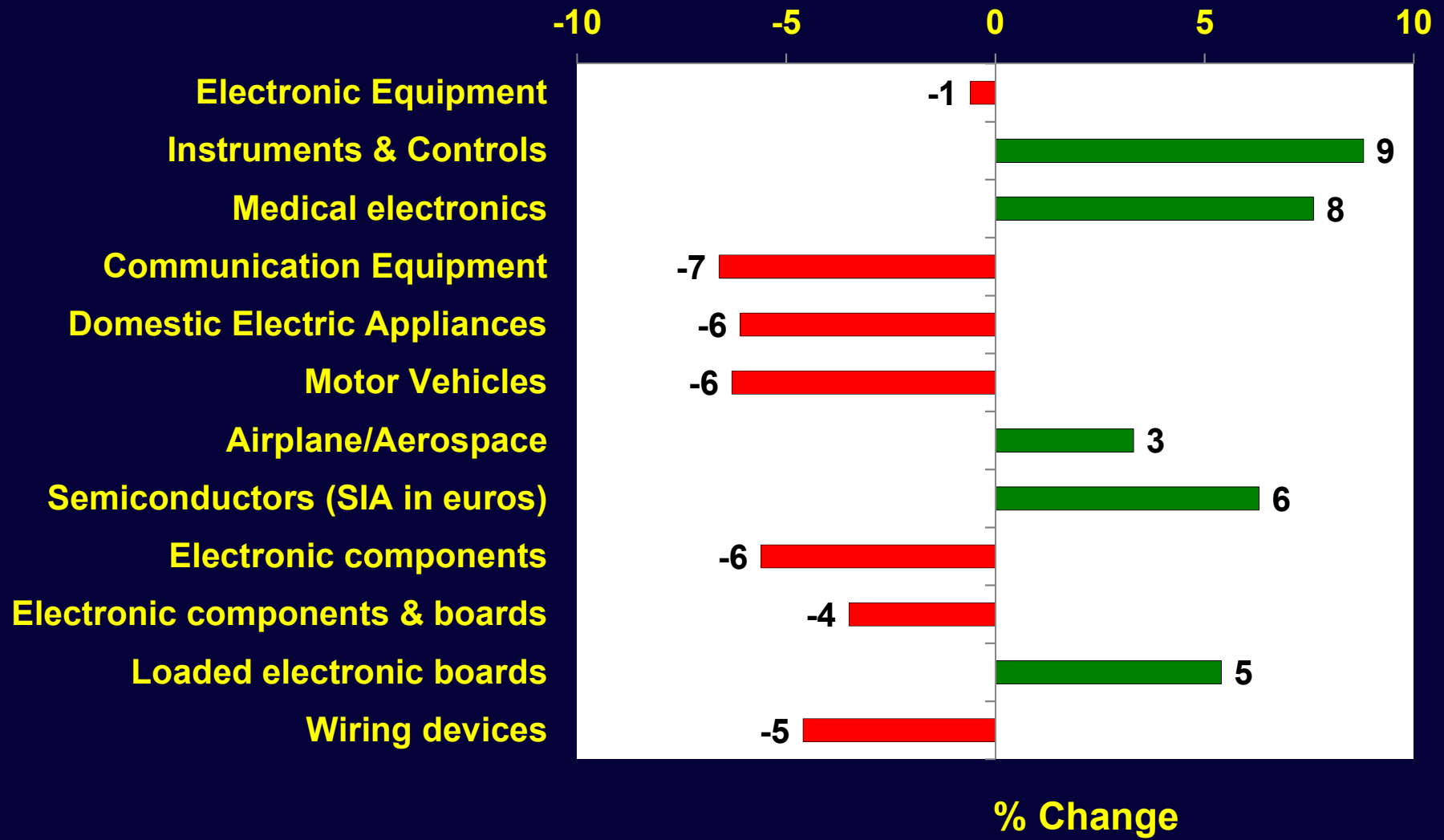


Electronic Supply Chain Growth

Europe & World

European Electronic Supply Chain Growth 4Q'17 vs 4Q'18

20190213

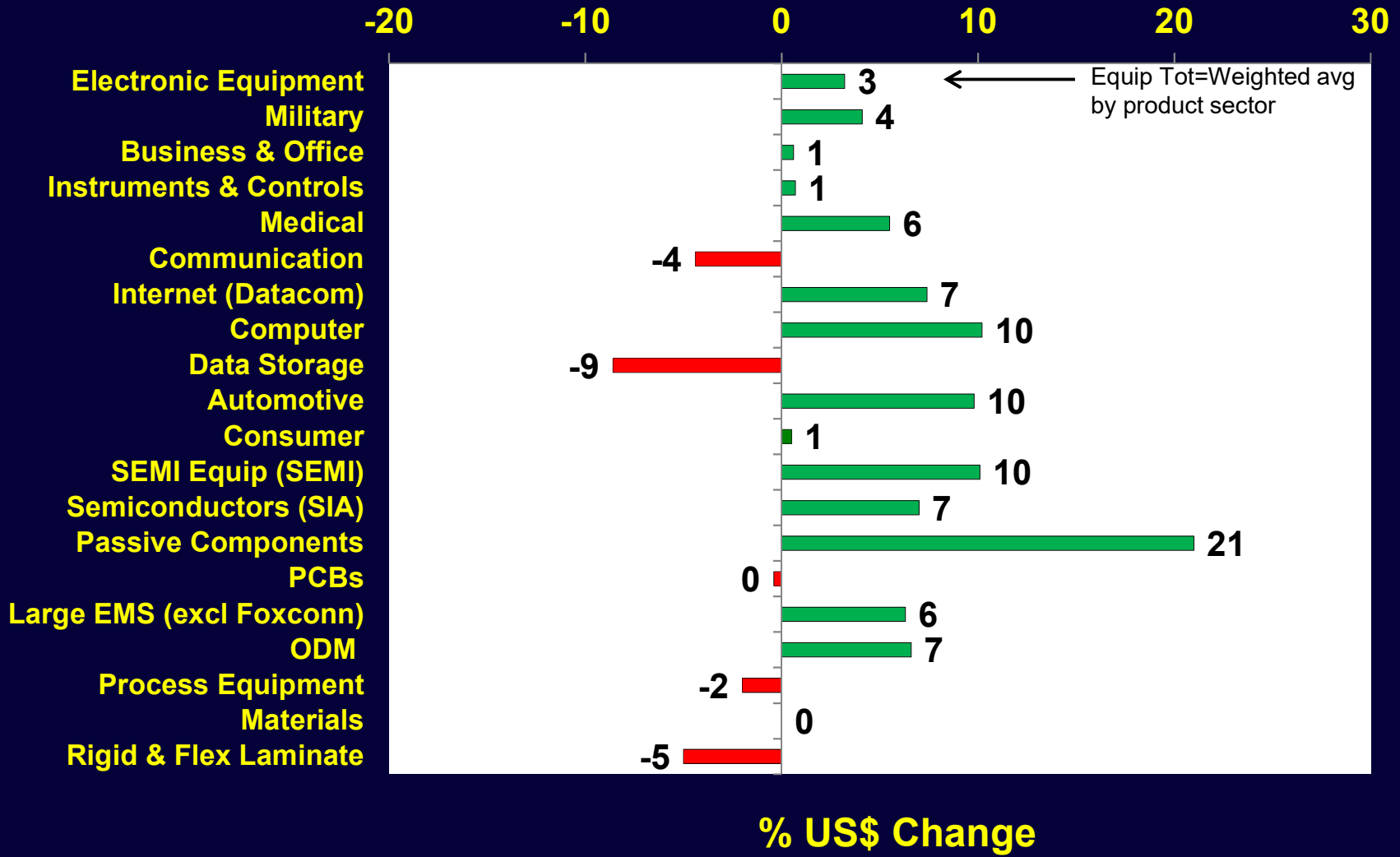


Euro denominated growth rates; Eurostat, SIA & Custer Consulting Group

Global Electronic Supply Chain Growth

20190203

4Q'18 vs. 4Q'17 (preliminary)



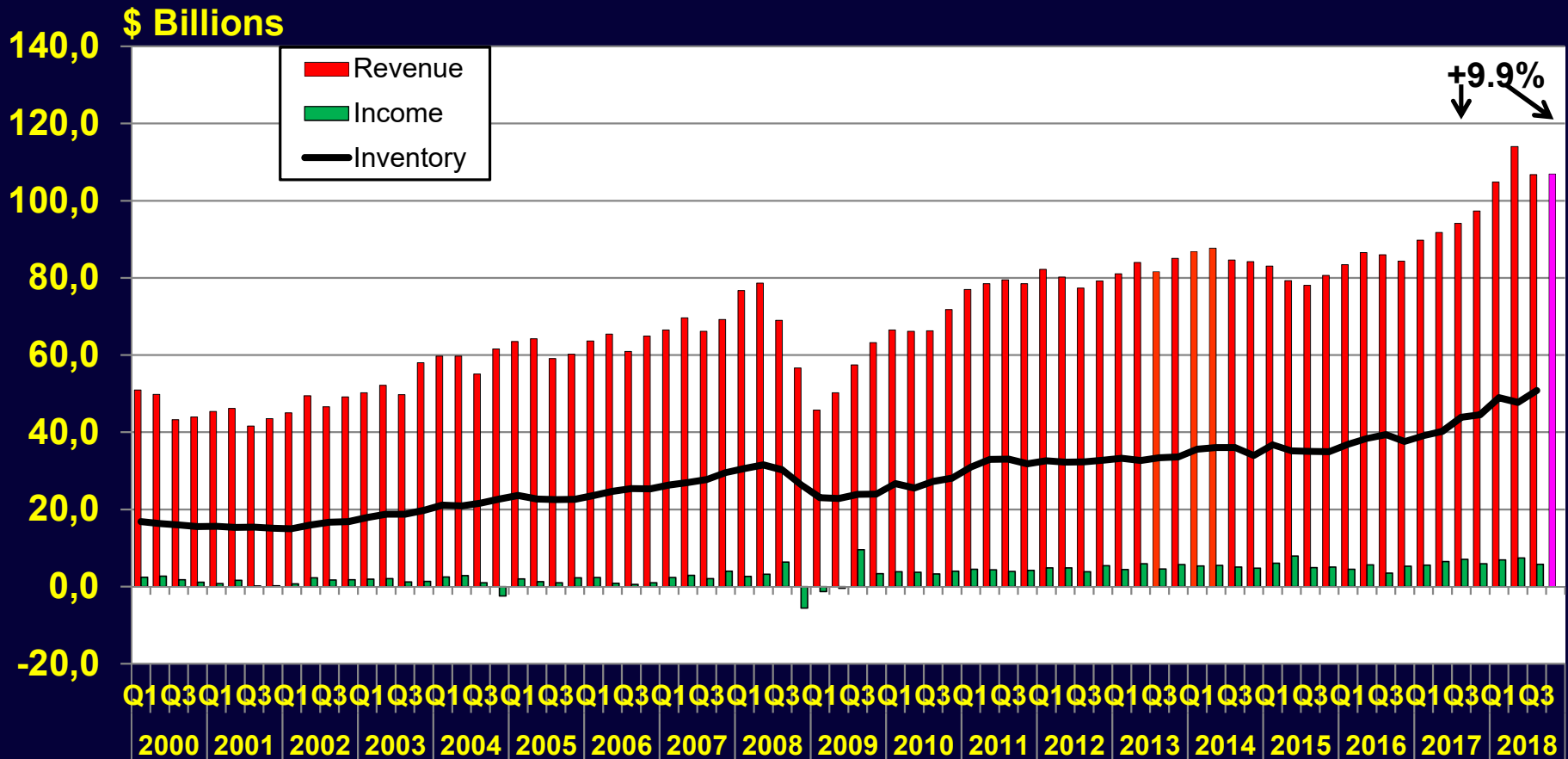
US\$ equivalent at fluctuating exchange; based upon industry composites including acquisitions

Markets of European Focus

20190208

Automotive Equipment Suppliers Composite of 15 Public Companies

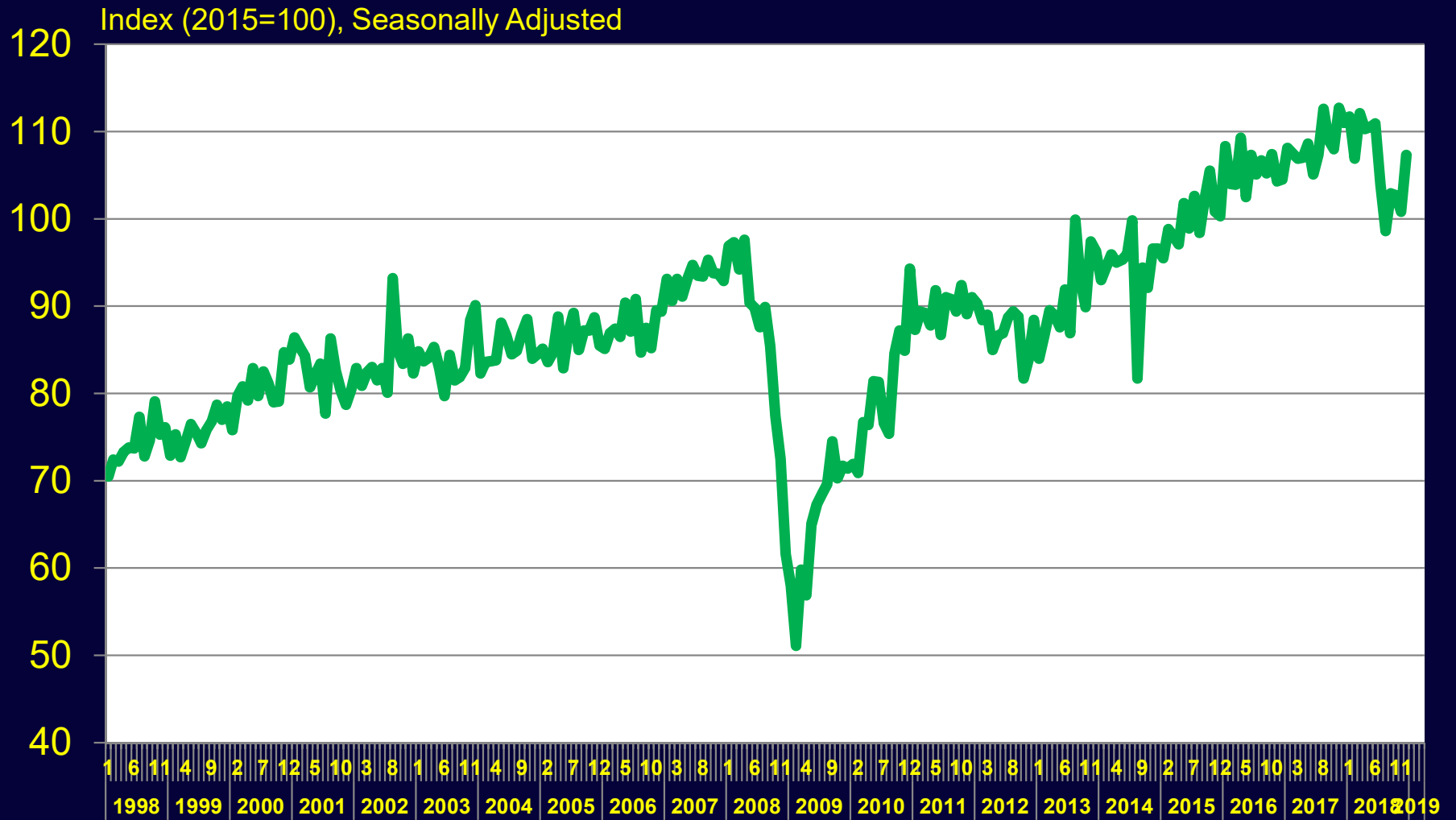
Revenue, Net Income & Inventory



Autoliv, Borg Warner, Continental AG, Delphi, Denso, Federal Mogul, Gentex, Hella, Johnson Controls, Lear, Magna, TRW Automotive, Valeo, Visteon, ZF Friedrichshafen

20190213

European Motor Vehicle Production

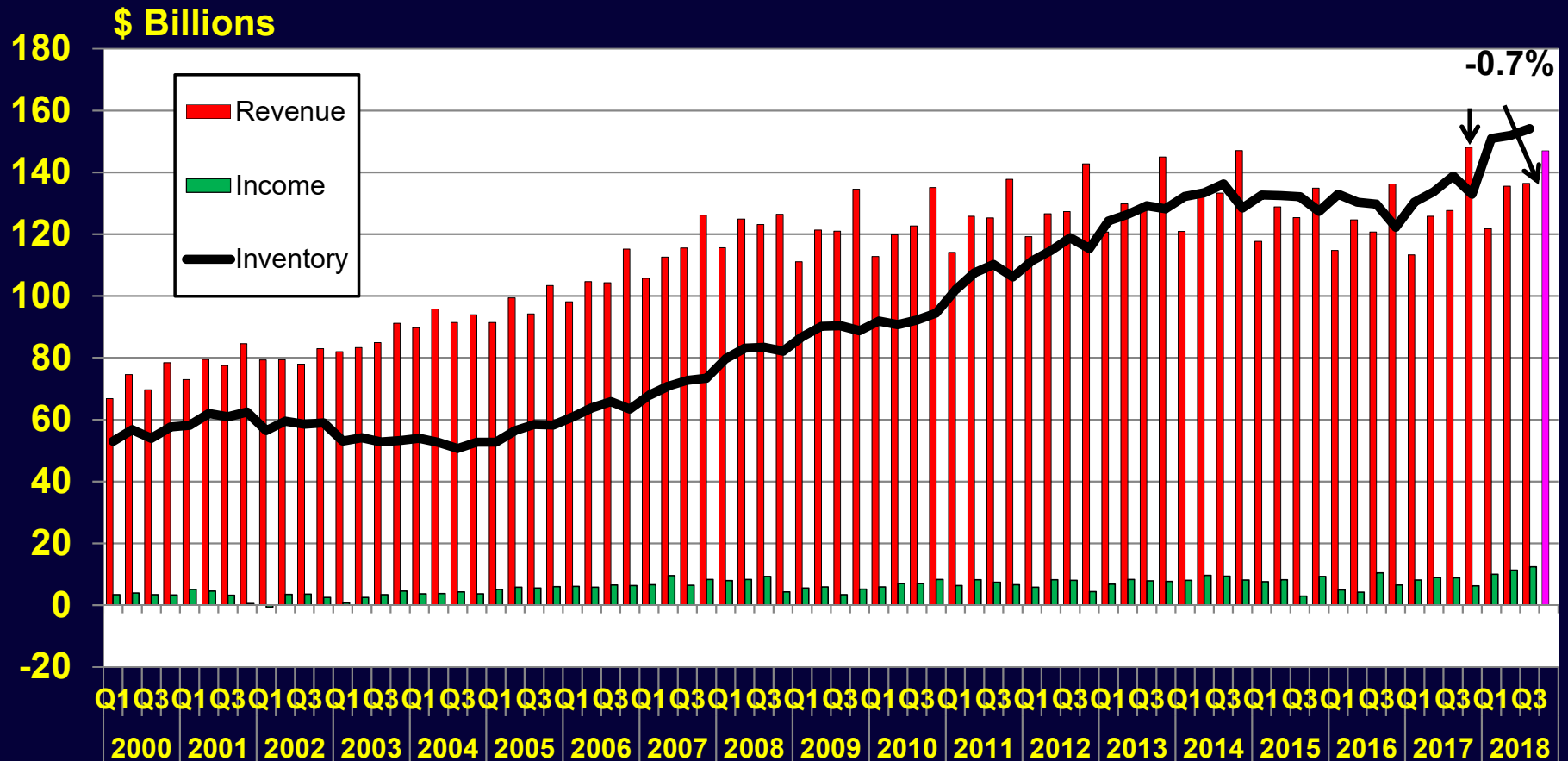


Eurostat, C291 category, EU 27 countries

Military & Aerospace

Composite of 22 Public Companies

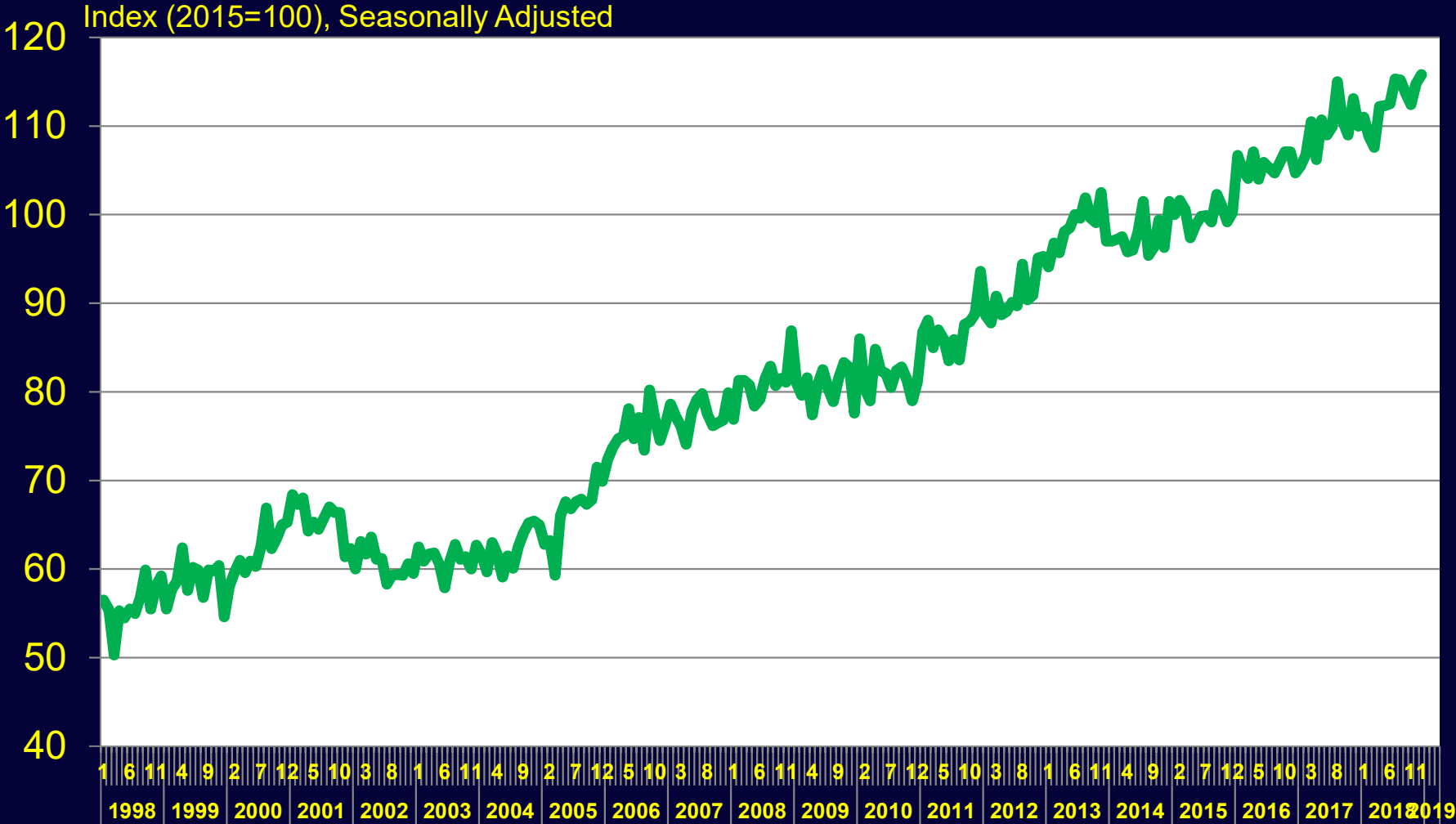
Revenue, Net Income & Inventory



Boeing, Bombardier, EADS (Airbus), Finmeccinica, General Dynamics, Halliburton, Harris, Honeywell (military portion), L-3 Communications, Lockheed, Moog, Northrop Grumman, Raytheon, Rockwell Collins, Textron, Thales, United Technology

European Production - Aircraft, Spacecraft & Related Equipment

20190213

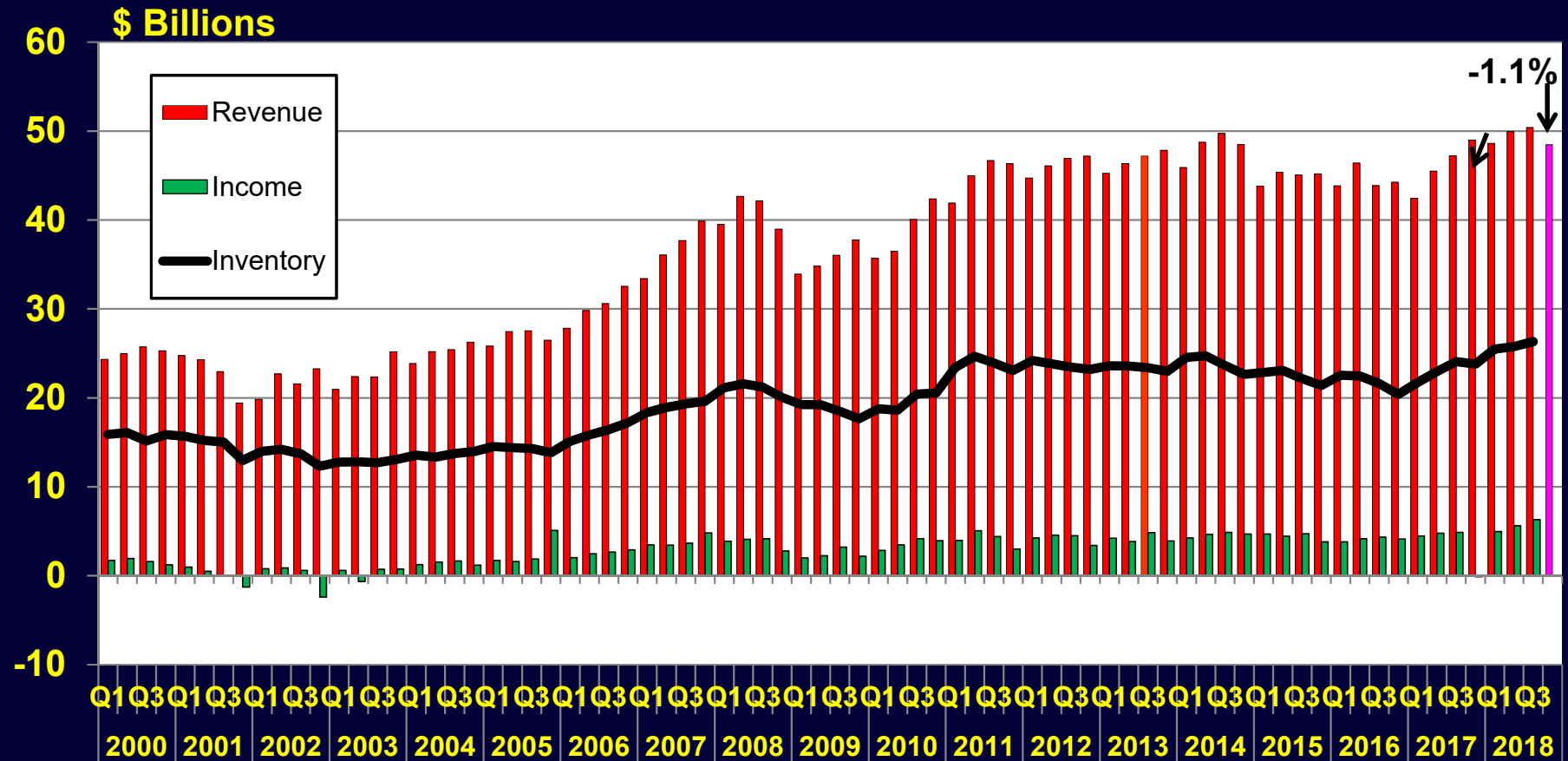


Eurostat, C303 category, EU 27 countries

20190208

Instruments & Control Equipment Composite of 16 Public Companies

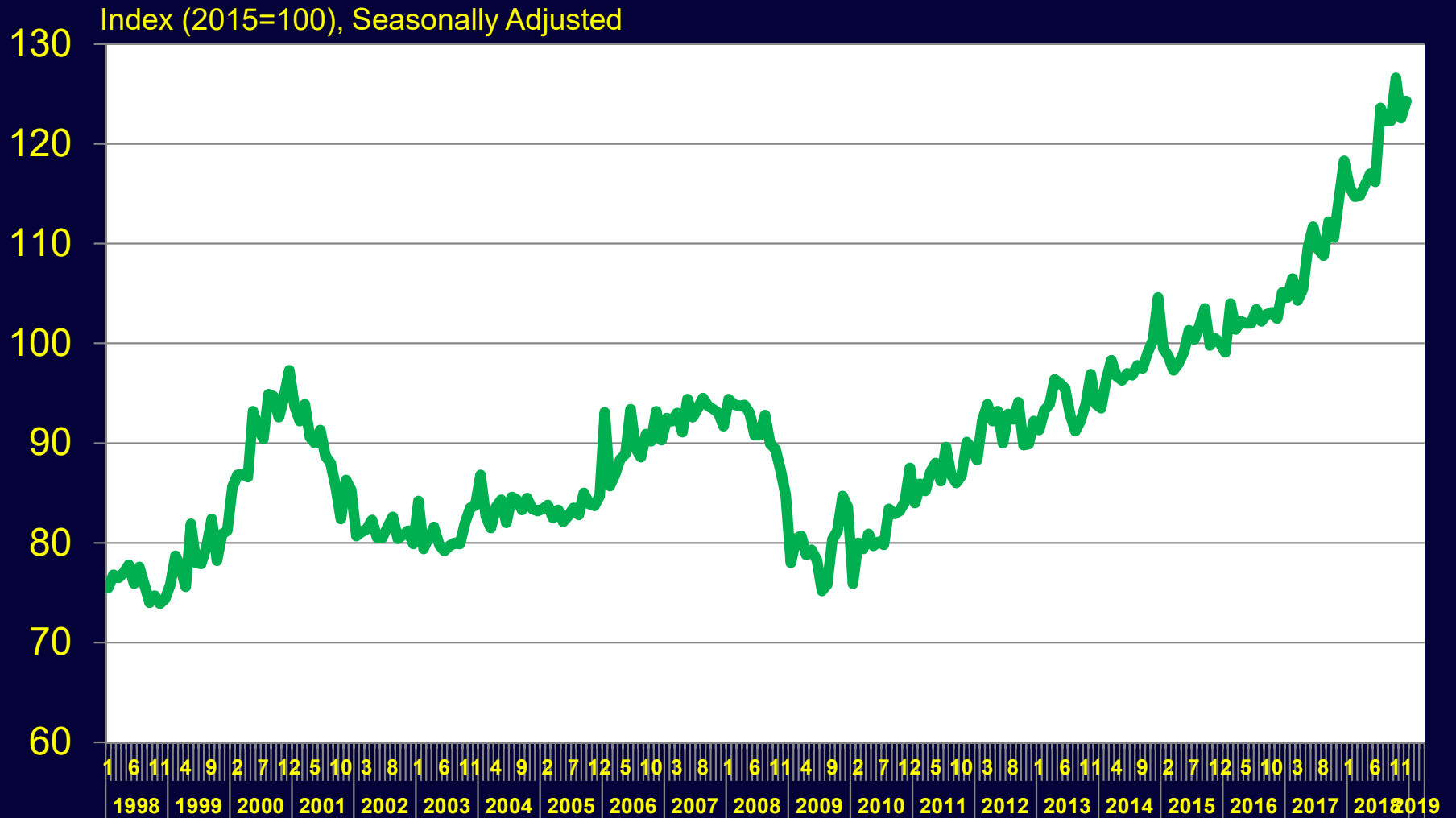
Revenue, Net Income & Inventory



ABB, Agilent, Ametek, Emerson, Itron, Keysight, National Instruments, PerkinElmer, Rockwell Automation, Rotork, Teledyne, ThermoFisher, Woodward Governor

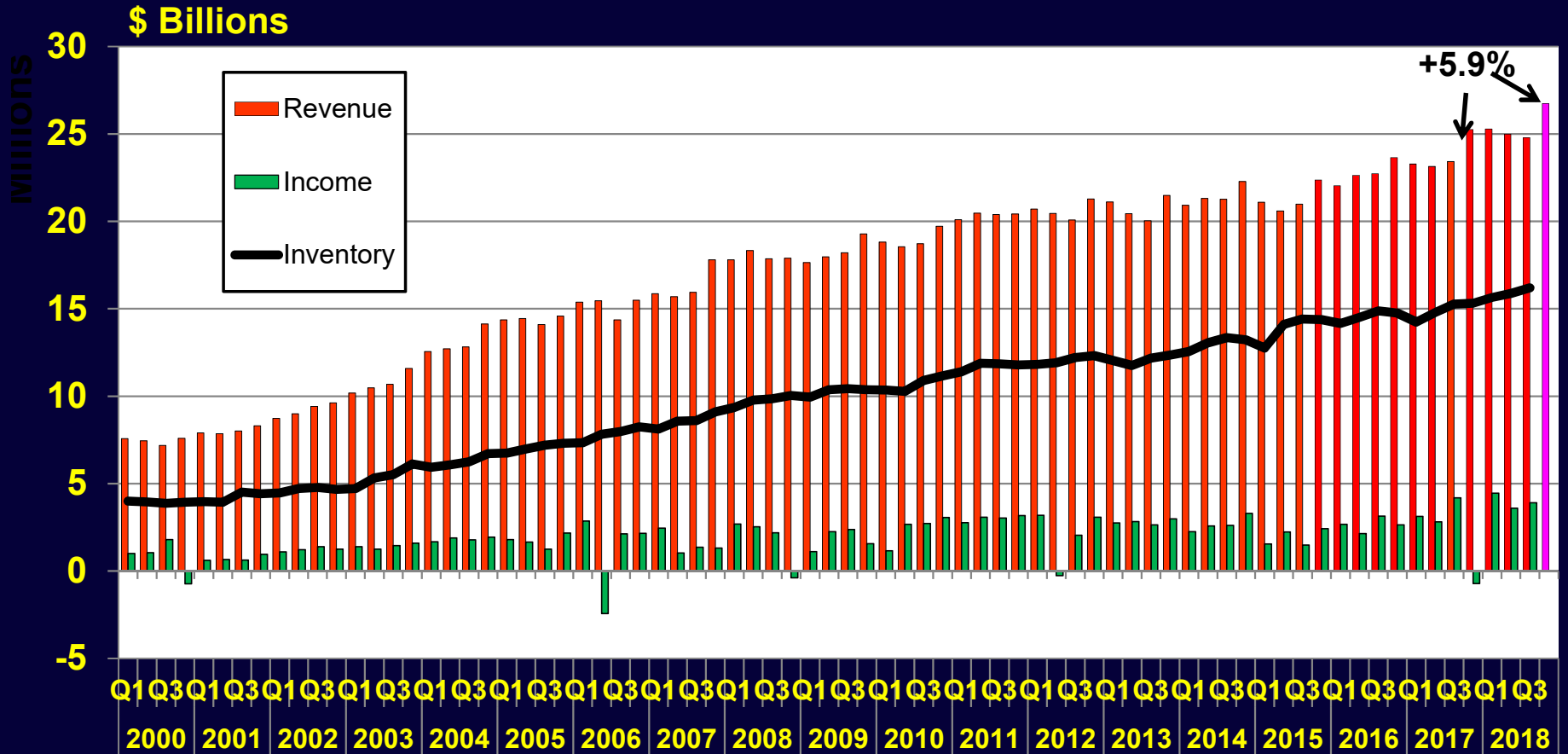
20190213

European Production - Instruments & Appliances for Measuring, Testing & Navigation



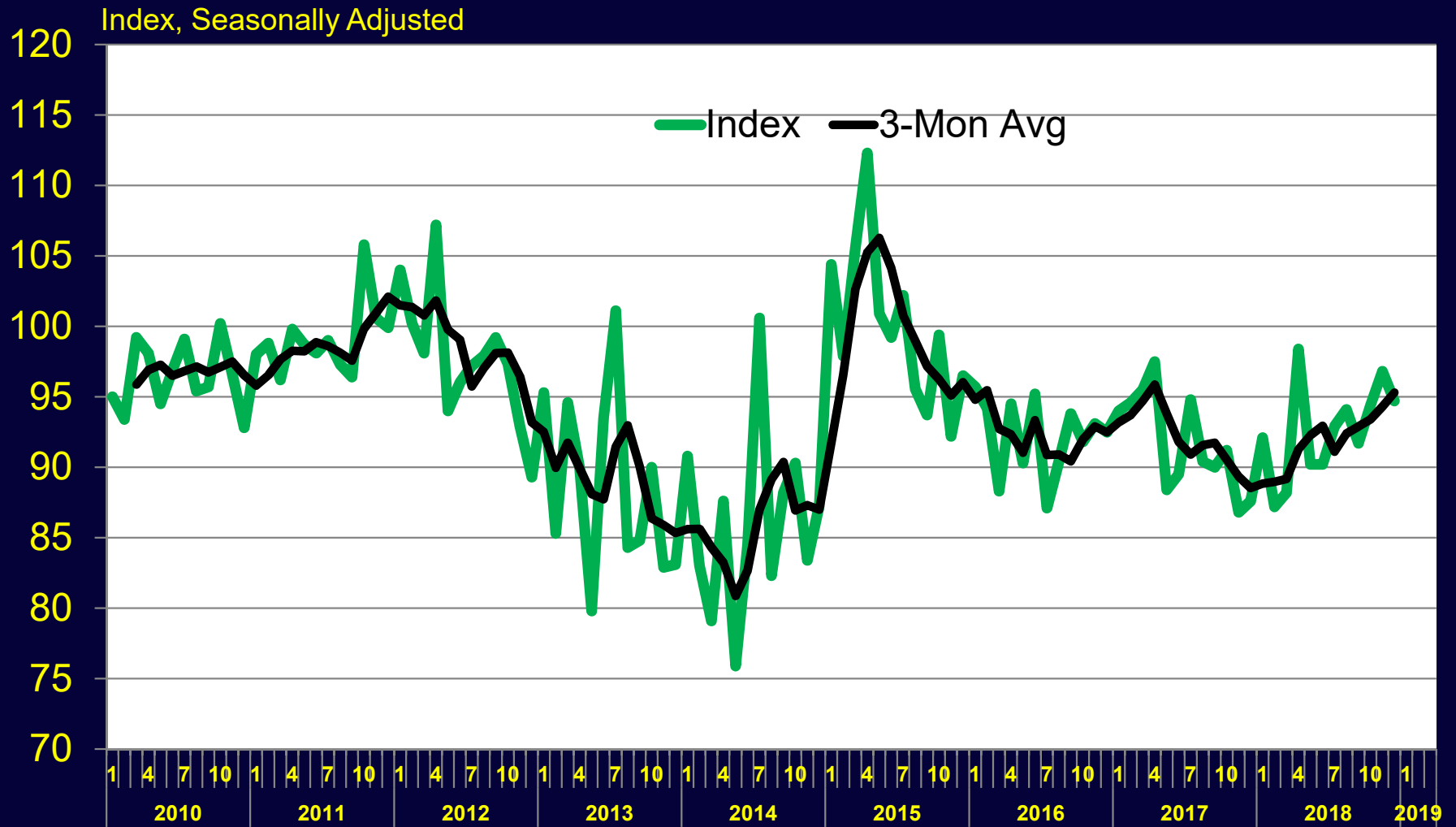
Eurostat, C2651 category, EU 27 countries

Medical Equipment Composite of 21 Public Companies Revenue, Net Income & Inventory

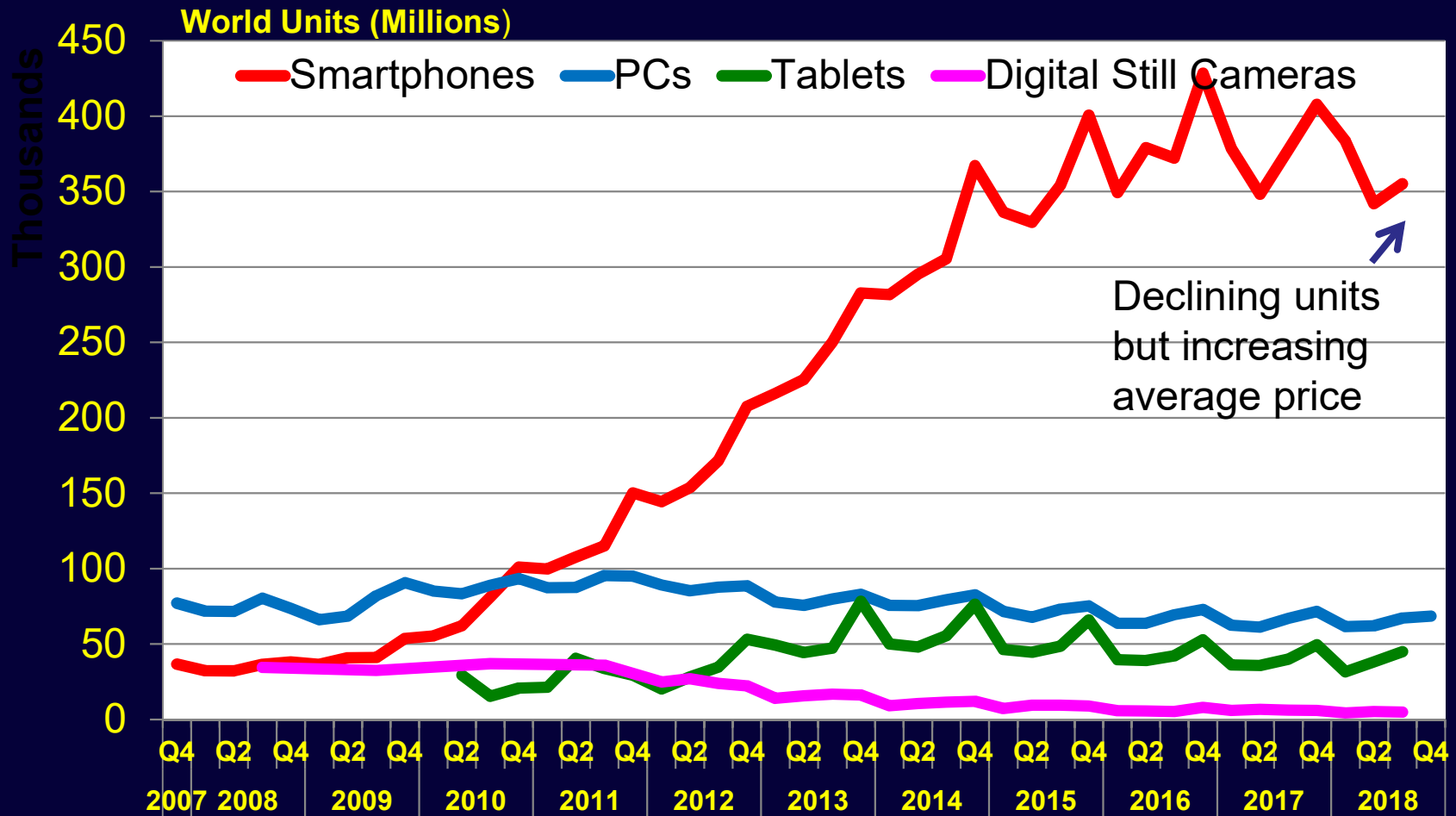


Analogic, Bio-Rad Laboratories, Boston Scientific, Bruker, CareFusion, Covidien, Draeger, Guidant, Hill-Rom, Intuitive Surgical, Invacare, Medtronic, ResMed, St Jude Medical, Smith & Nephew, STERIS, Stryker, Varian Medical, Waters, Zimmer

European Production - Irradiation, Electromedical & Electrotherapeutic Equipment



Volume Markets are Flat



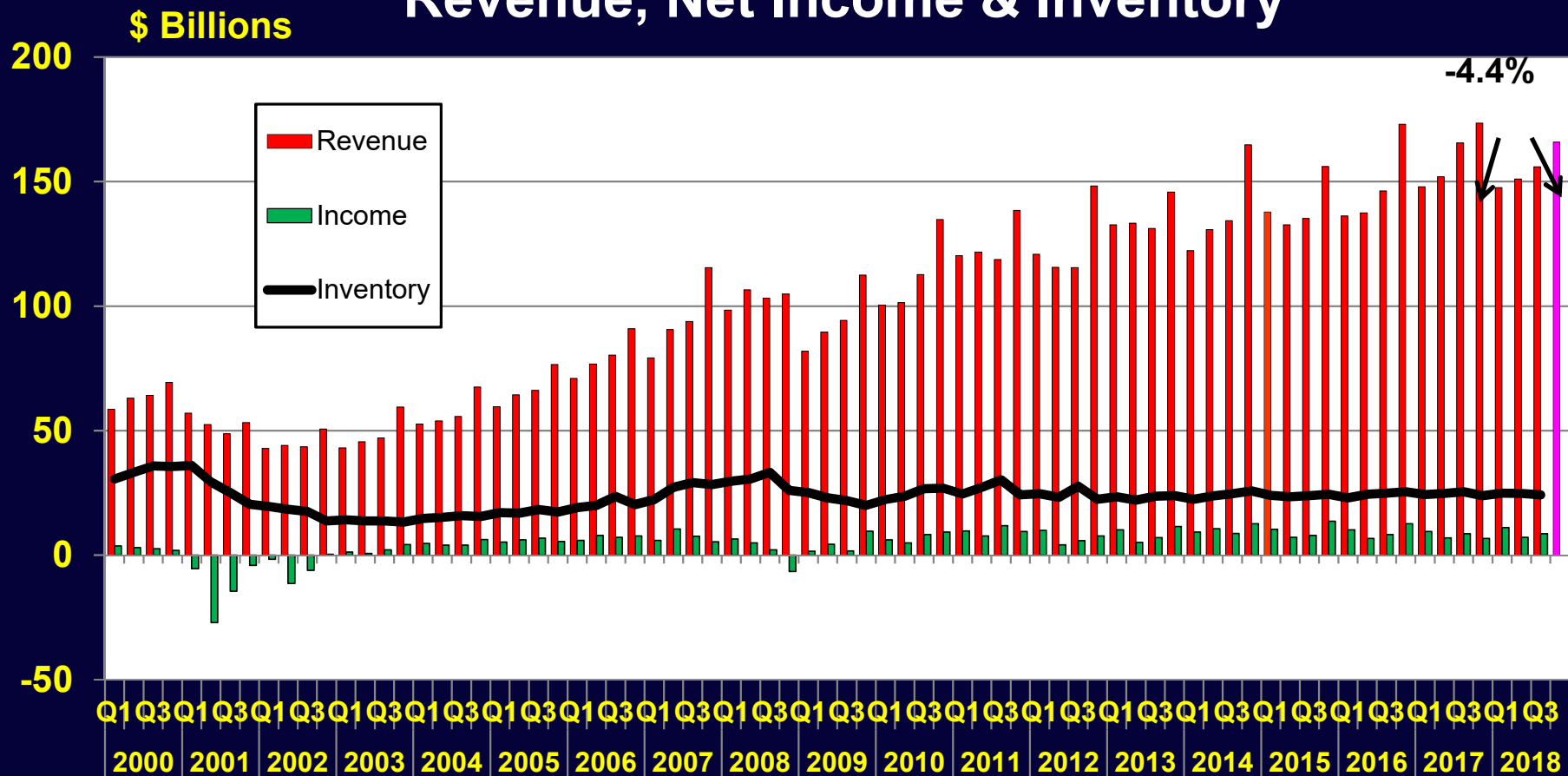
Communication Equipment Suppliers

20190203

Composite of 30 Companies

10 mobile phone makers, 20 other telecom equipment makers plus estimate of other mobile makers

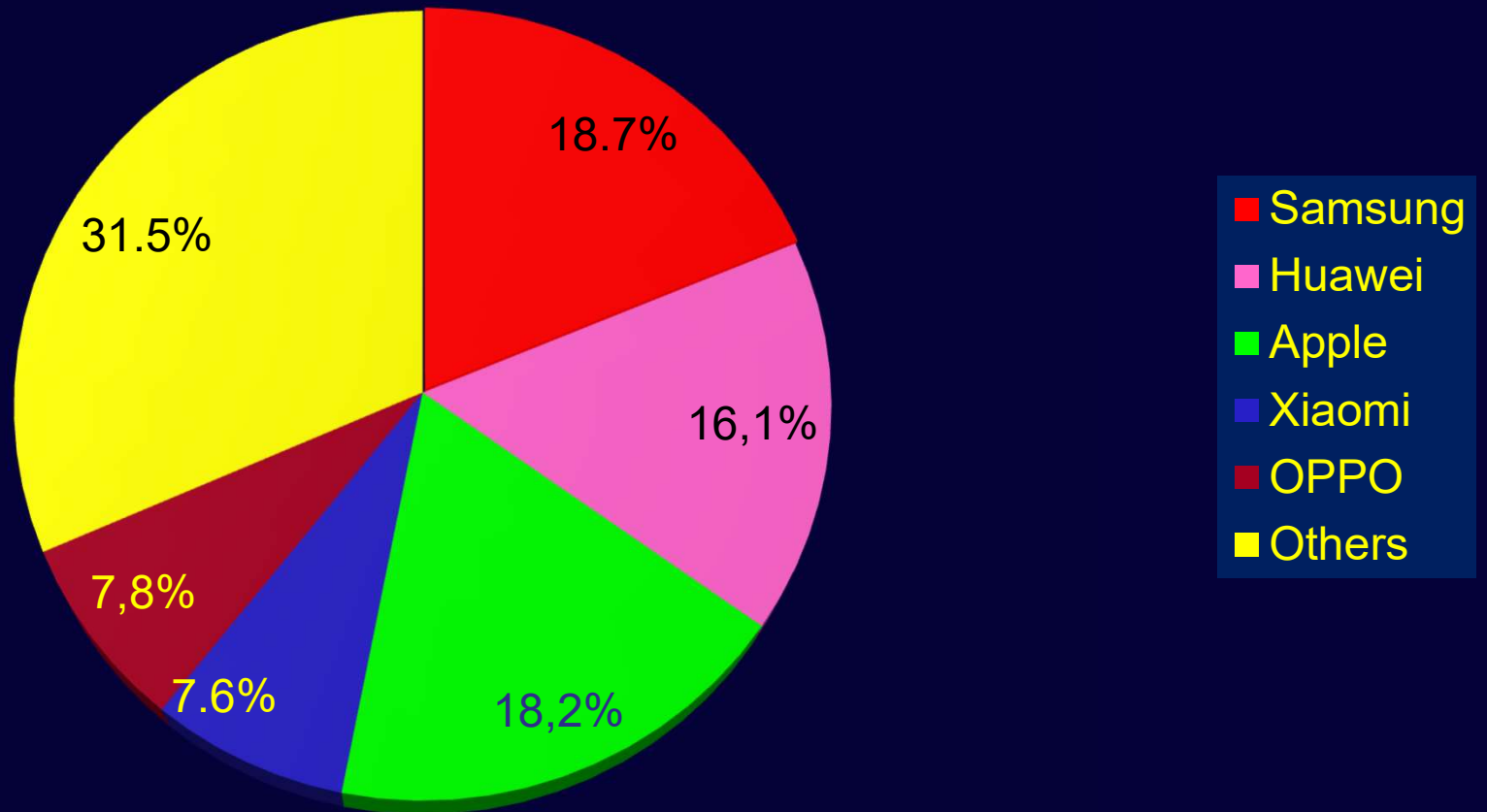
Revenue, Net Income & Inventory



3COM, ADC Telecom, Alcatel+Lucent, Ciena, Ericsson, Motorola Solutions,, Nokia, Polycom, TellLabs, Palm, Adva Optical Networking, Arris Group, AudioCodes, Broadsoft, Fabrinet, Gigamon, Infinera, Ixia, Neophotonics, Radware ; Apple iPhone, HTC, Huawei Device, LG, Motorola Mobility, Nokia, RIM, Samsung, Sony Mobility, ZTE; Euros & Krona converted at fluctuating exchange; mobile phone volumes from company reports & Gartner Dataquest quarterly unit shipment estimates; historical data included for acquired companies

World Smartphone Sales 4Q'18

20190203



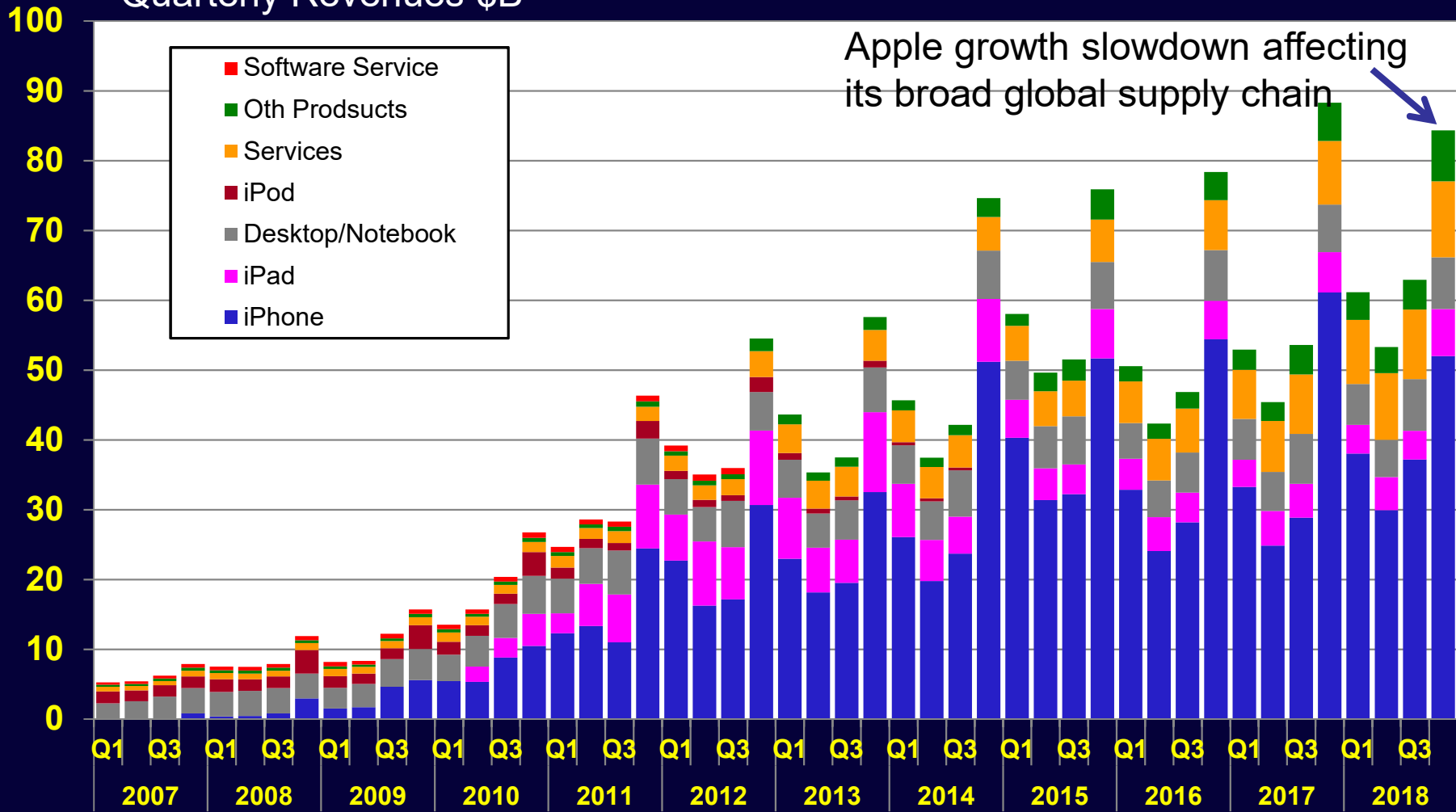
4Q'17
394.6M

4Q'18 TOTAL: 375.4 Units

Apple Product Mix

20190201

Quarterly Revenues \$B



Emerging Volume Markets

Autonomous cars

Internet of Things (IoT)

Industrial Internet of Things (IIoT)

Cloud storage

5G Handsets & Infrastructure

Virtual & Augmented Reality

AI/Machine Learning

Smart Cities, Smart Agriculture

Drones

Robots

Wearables

3D Printing

Health Care

Semiconductors

Monthly Semiconductor Shipments \$ Billions (3-month avg in US\$)

20190204

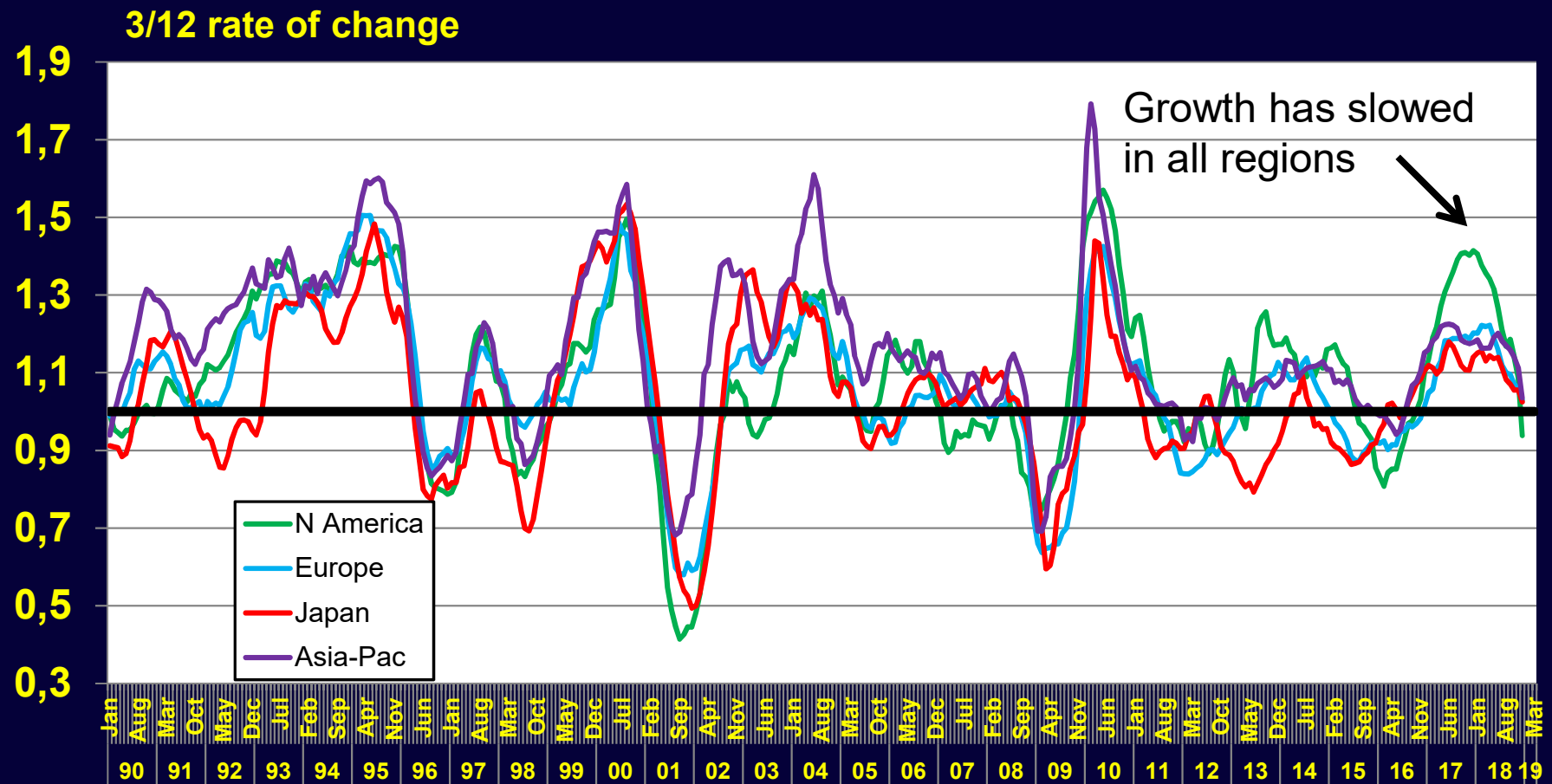
	<u>12/17</u>	<u>12/18</u>	<u>% CH</u>
Americas	8.95	8.40	- 6.2%
Europe	3.37	3.47	+ 2.8%
Japan	3.24	3.32	+ 2.3%
China	12.01	12.71	+ 5.8%
Asia Pacific / All Other	10.41	10.33	- 0.7%
Total	37.99	38.22	+ 0.6%

SIA www.semiconductors.org/

Semiconductor Growth Rates

20190213

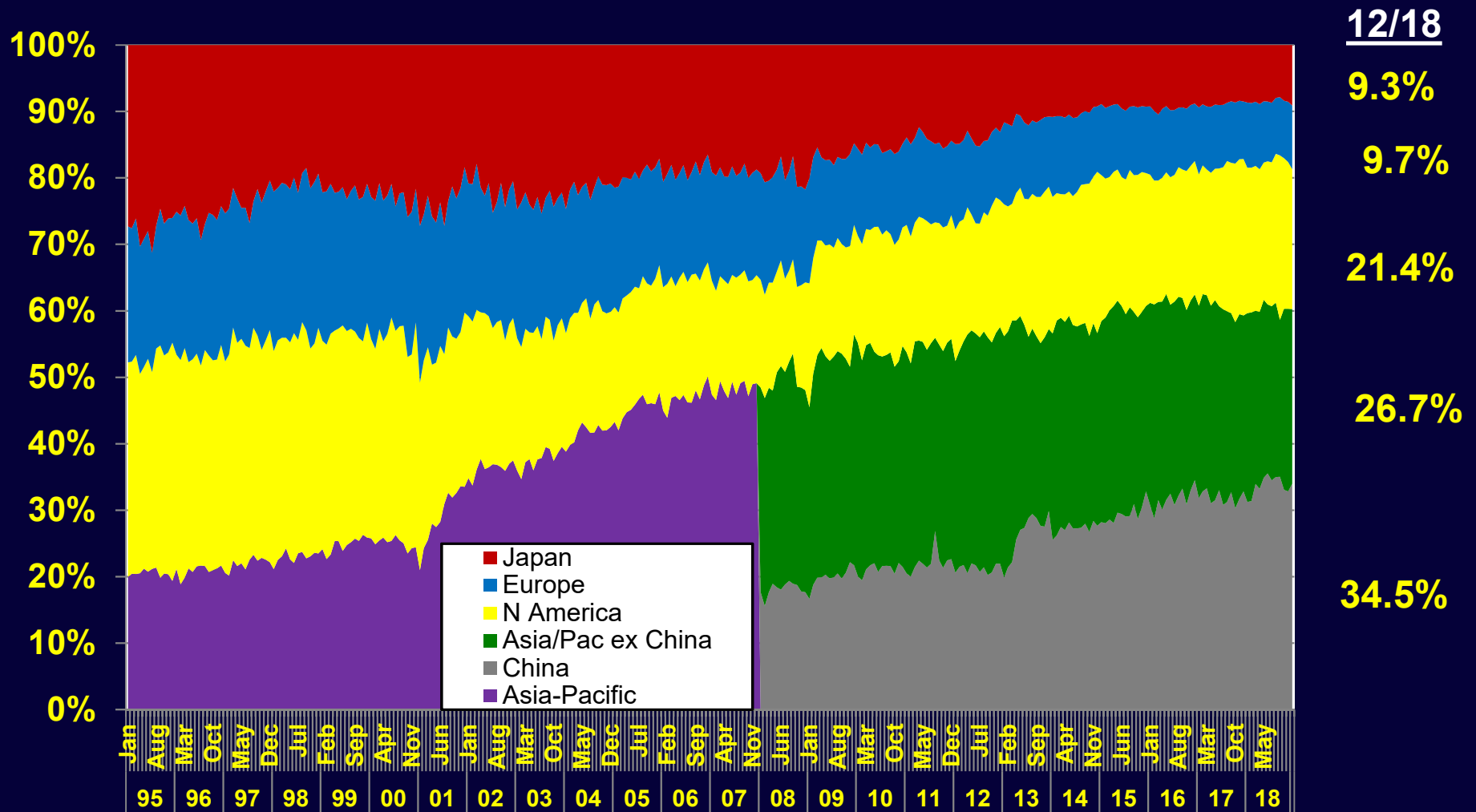
Total \$ Shipments to an Area



Total \$ Shipments from All Countries to an Area
SIA website: www.semiconductors.org/

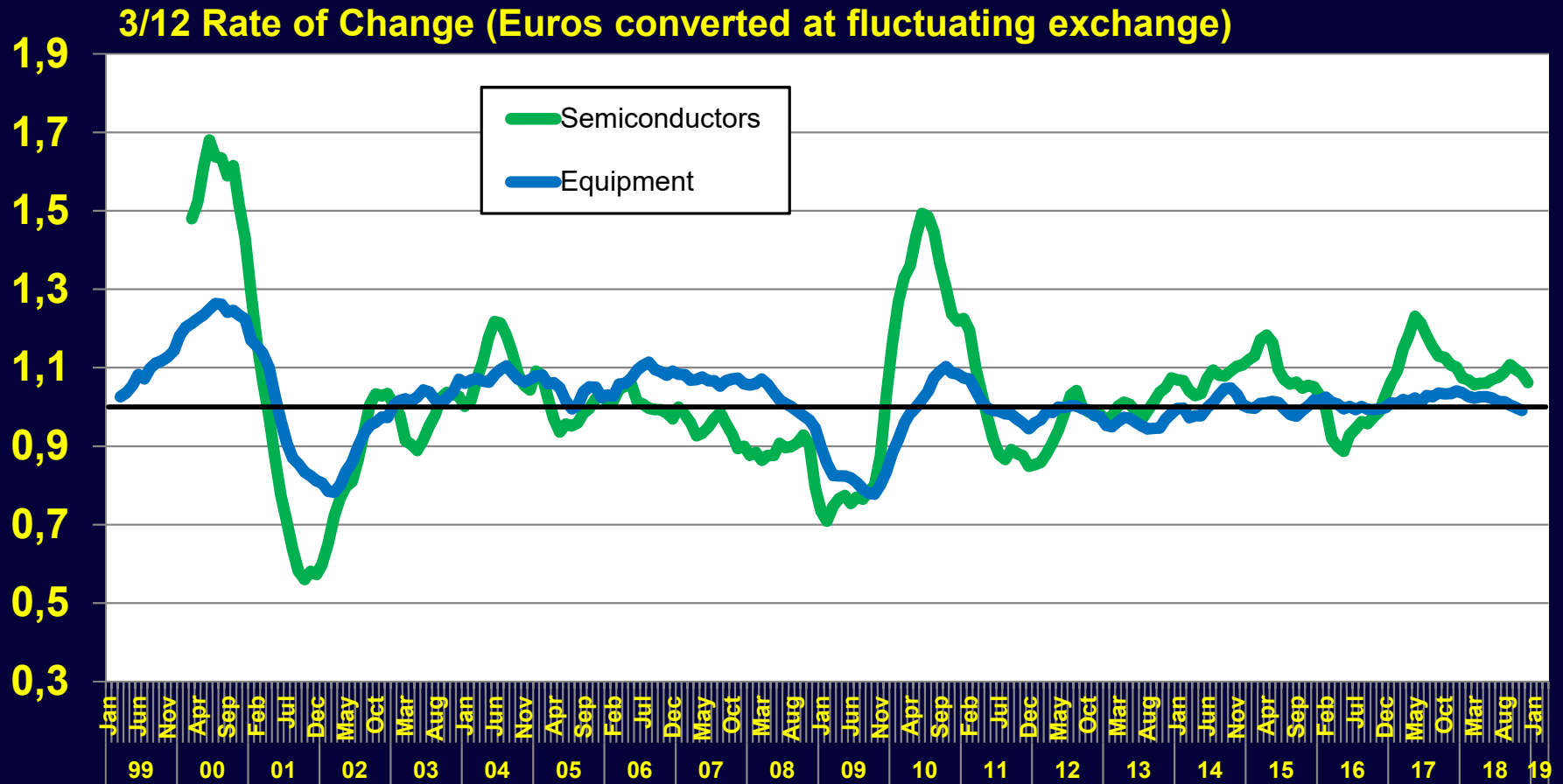
Total Semiconductor Shipments to an Area

Monthly Shipments - Reporting Firms (showing China)



20190204

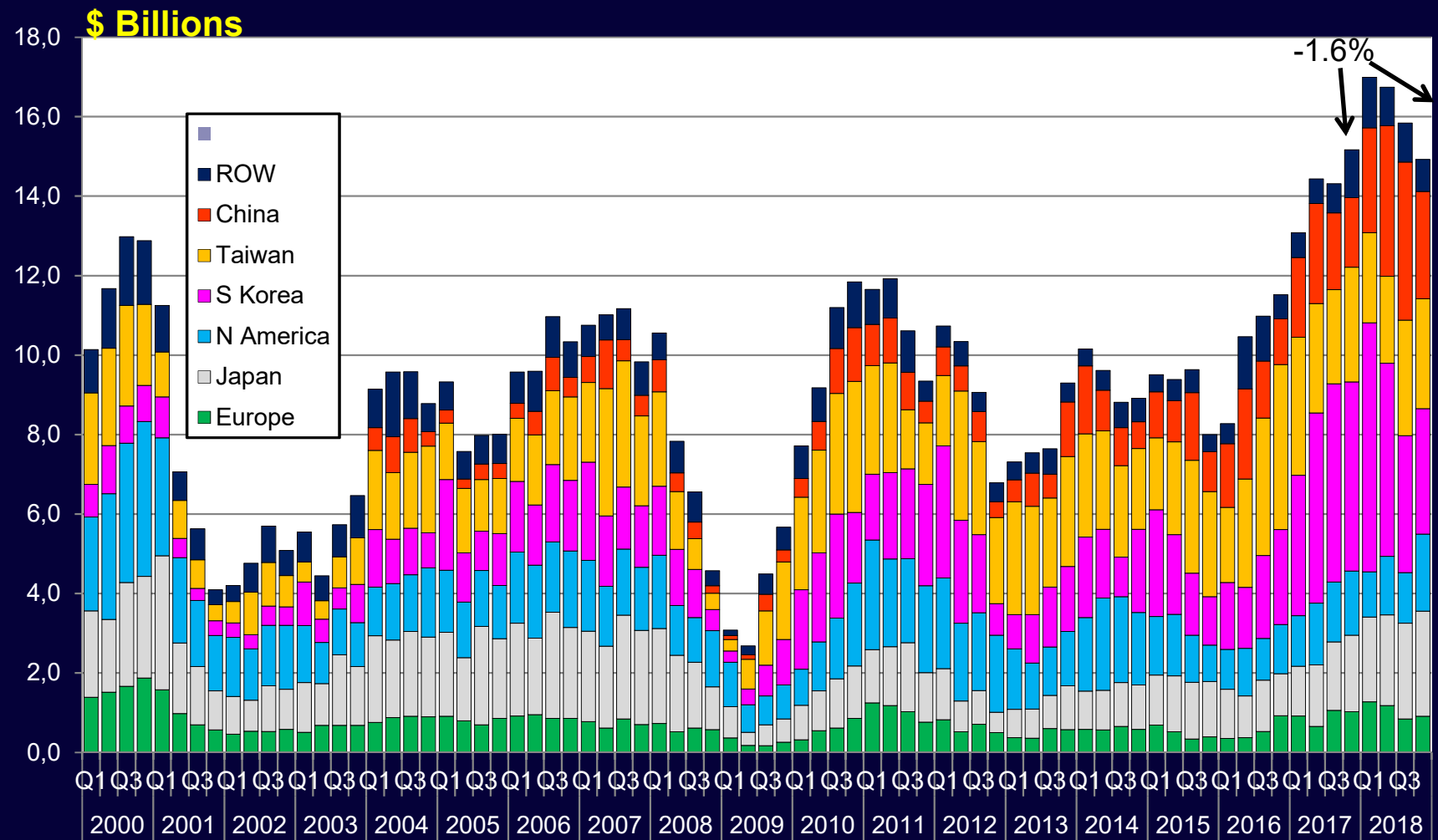
Semiconductor Shipments to Europe vs. European Electronic Equipment Production



Total \$ Semiconductor Shipments from All Countries to Europe www.sia-online.org/, Eurostat class C26, EU27, European Computer, Electronic & Optical products Production

Semiconductor Capital Equipment

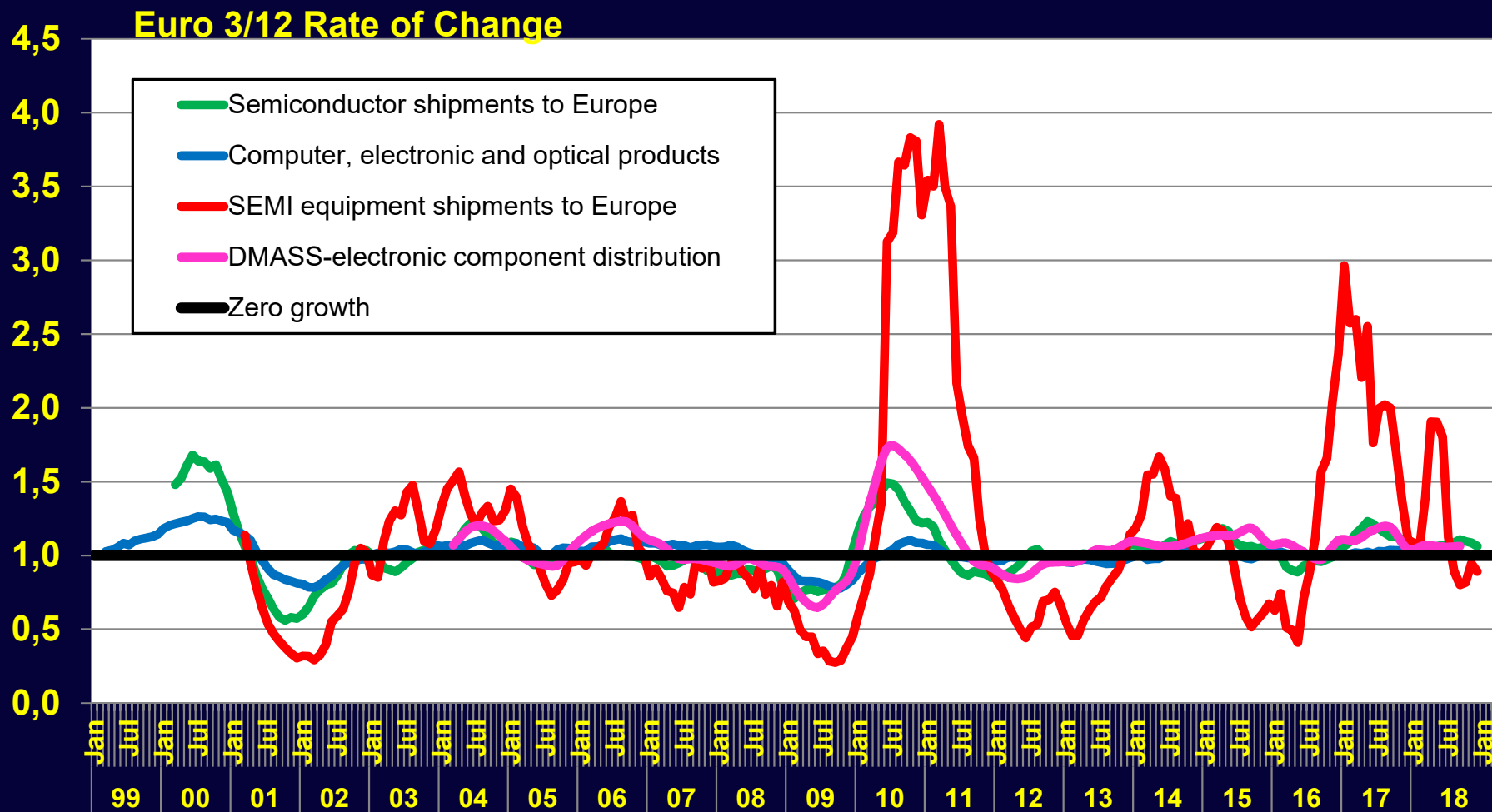
Semiconductor Capital Equipment Shipments by Area



Europe Supply Chain

European Computer, Electronic and Optical Products, Semiconductors, & SEMI Equipment Shipments

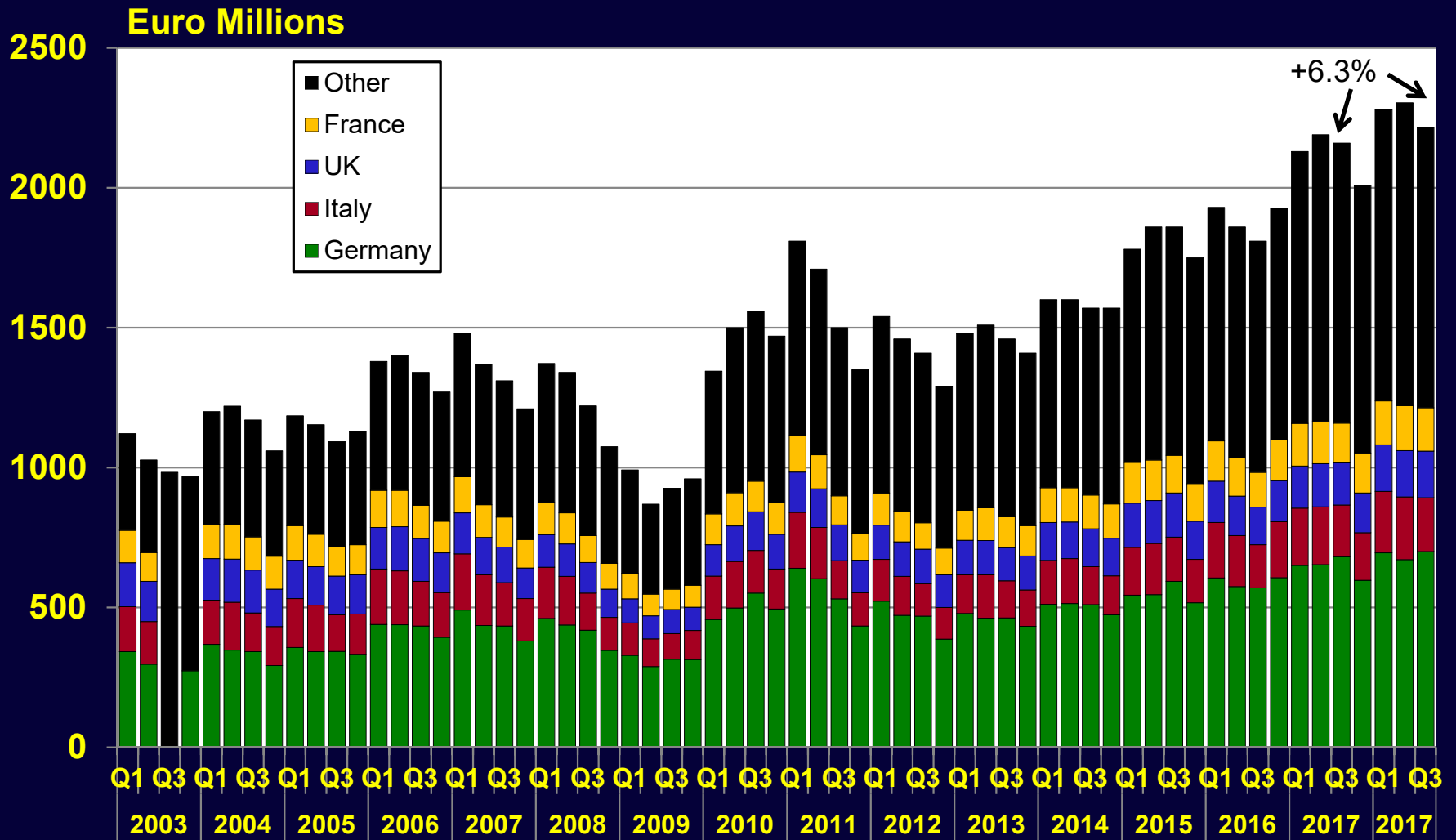
20190204



Total \$ Semiconductor Shipments from All Countries to Europe www.sia-online.org/,
Eurostat class C26 & SEMI, CCG Extrapolation of SEMI growth

European Component Shipments by Country

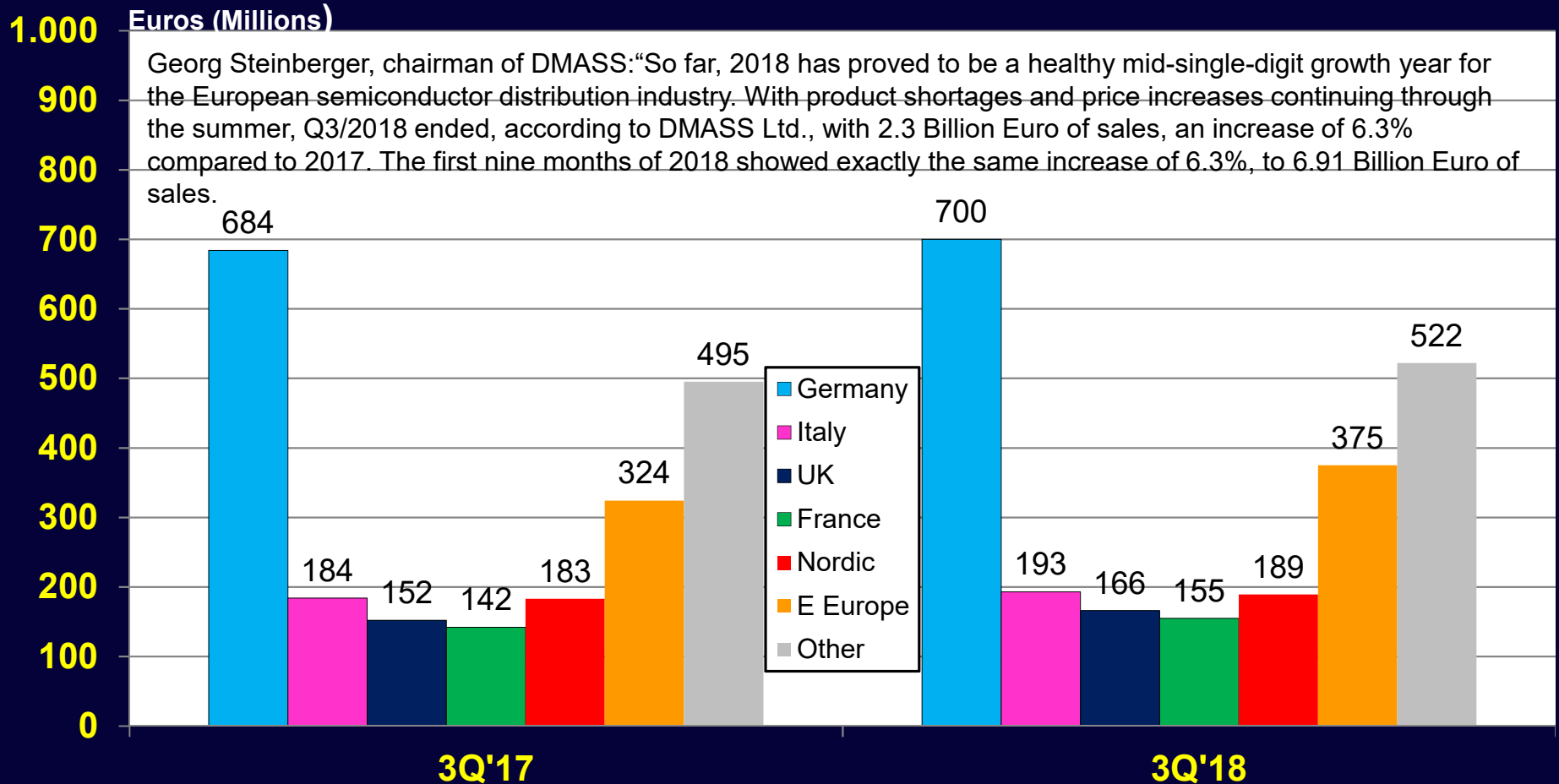
DMASS - European Semiconductor Distribution Industry



20180820

DMASS

European Semiconductor Distribution Industry



"Compared to the double-digit projections we keep seeing for the total European semiconductor market from WSTS and others, European distribution does not seem to enjoy the same dynamics. However, most of their total projections are in US Dollars. Stated in US Dollars as well, DMASS grew by 14% in the first nine months of 2018."

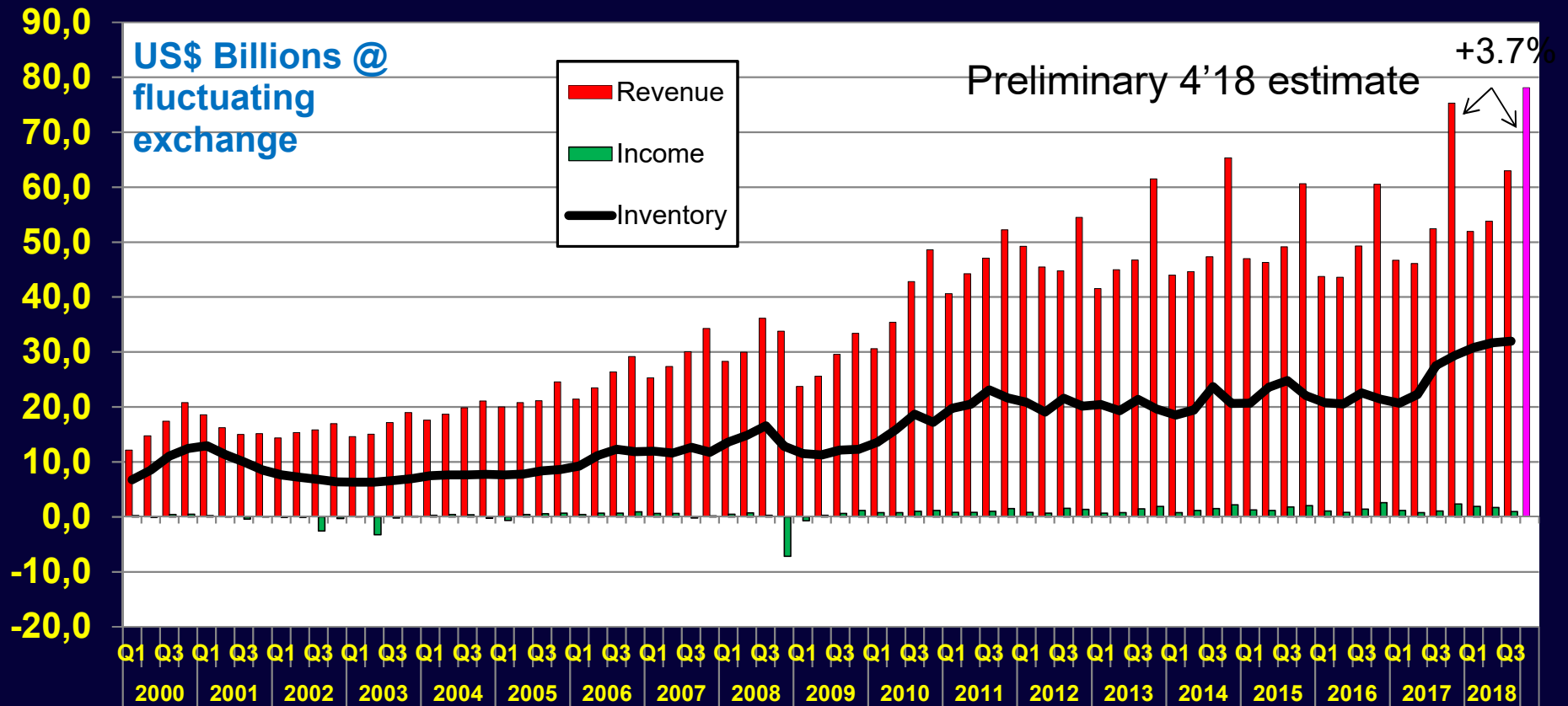
DMASS 11/18; <http://dmass.com/>

EMS & ODM Companies

Large EMS Providers

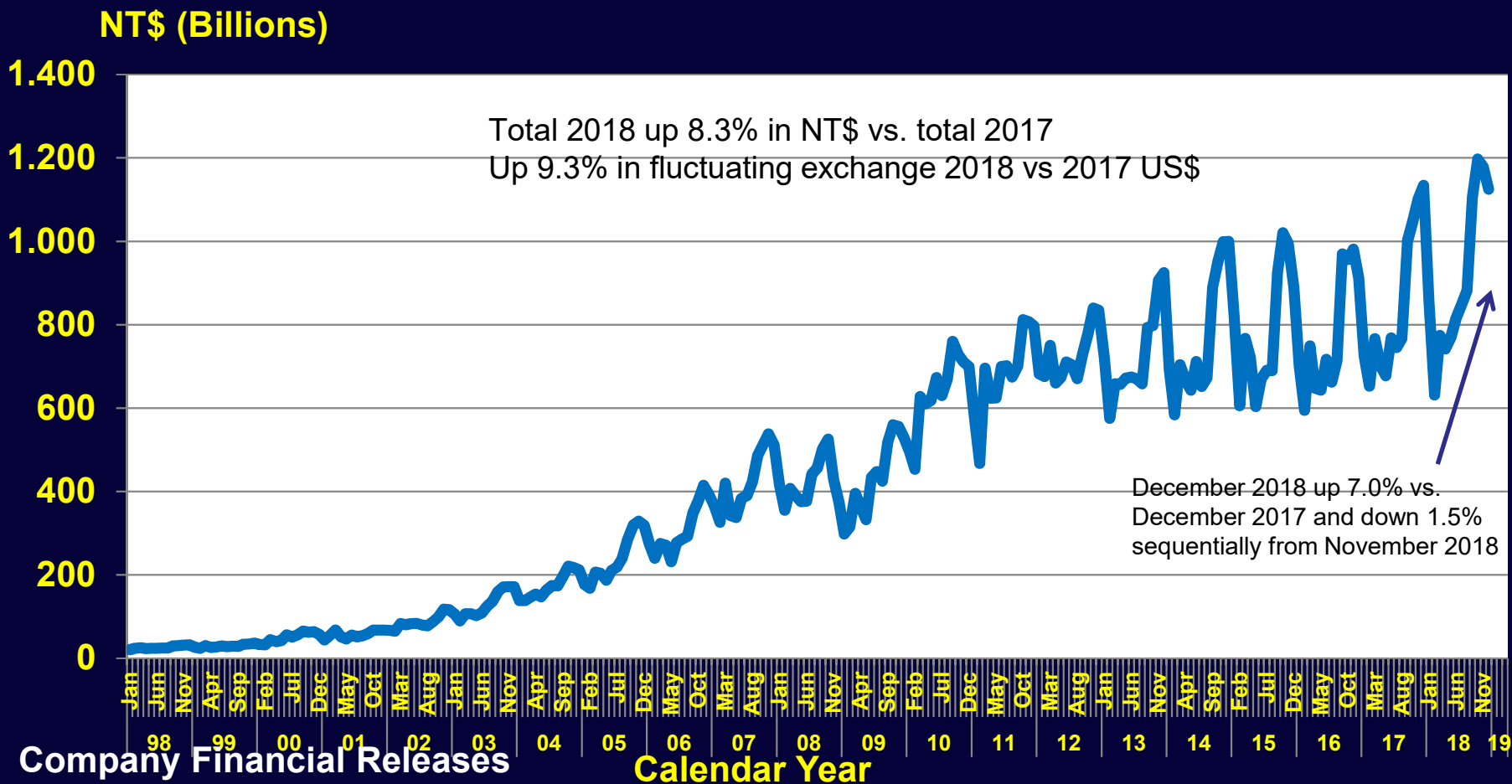
Composite of 9 Public Companies

Revenue, Net Income & Inventory



Benchmark+Pemstar, Celestica, Flextronics+Solectron, Foxconn, Jabil, Plexus, Sanmina, Sypris, Venture Mfg

Taiwan ODM Companies Composite Sales of 11 Large Manufacturers

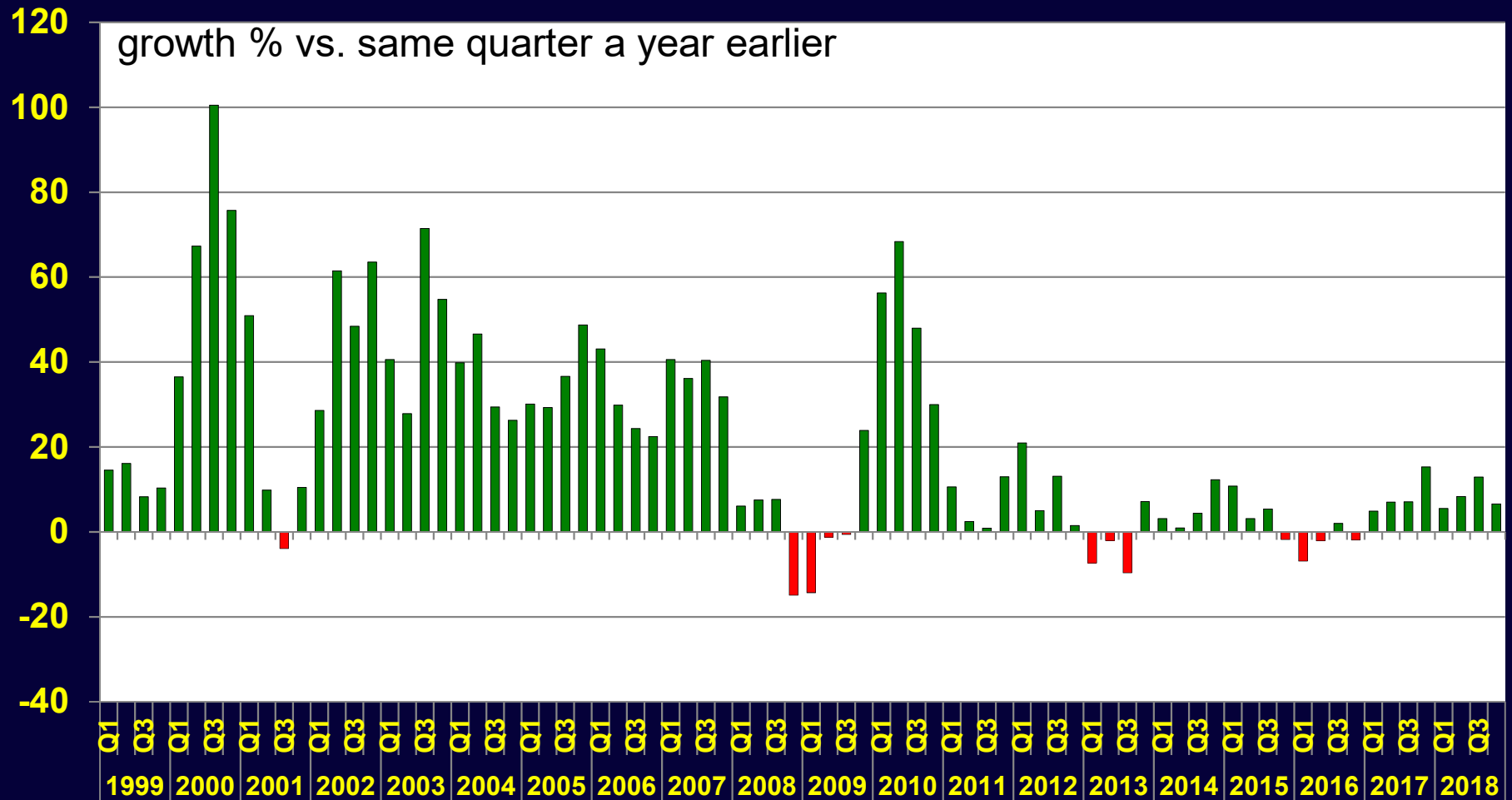


Asustek Computer, Chei Mei, Compal Electronics, Foxconn, Chimei Innolux, Inventec, Inventec Appliance, Lite On Technology, Mitac International, Pegatron, Quanta Computer, Wistron, Chei Mei Display replacing Chei Mei & Innolux Display 3/10 & later

Large ODM Companies

Composite of 11 Taiwan-listed Manufacturers

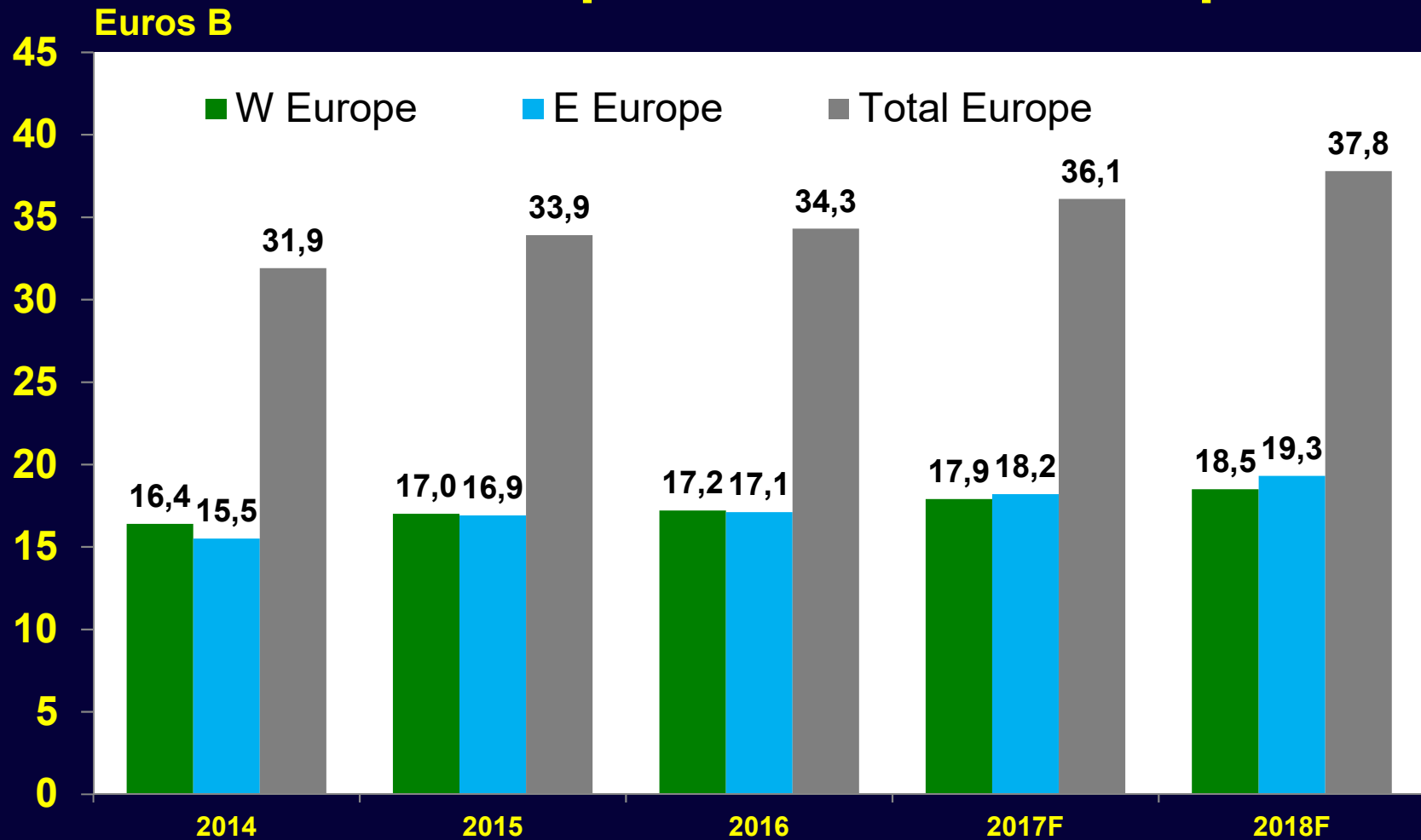
Quarterly Revenue Growth in NT\$



Asustek Computer, Compal Electronics, Foxconn, Chimei Innolux, Inventec, Inventec Appliance, Lite On Technology, Mitac International, Pegatron, Quanta Computer, Wistron

European EMS Market

Western Europe and Eastern Europe



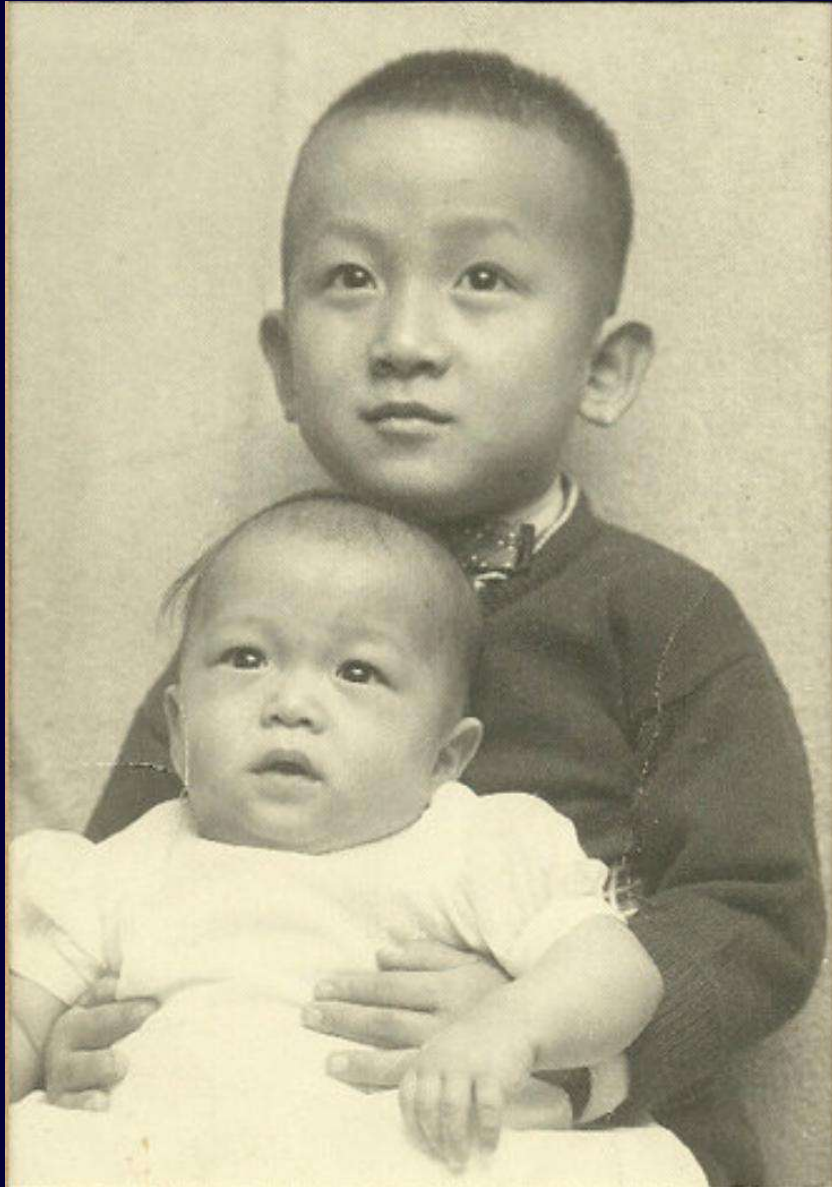
Source: In4ma d.g.weiss@gmx.de

Summary of 1,576 individual EMS entities plus 2.9% added to estimate to bring Europe 35.5 billion Euro for 2016. MENA not included

EIPC

Thoughts

EIPC & its Members have Matured



**Trump is not
too popular**





**Europeans are
strong**



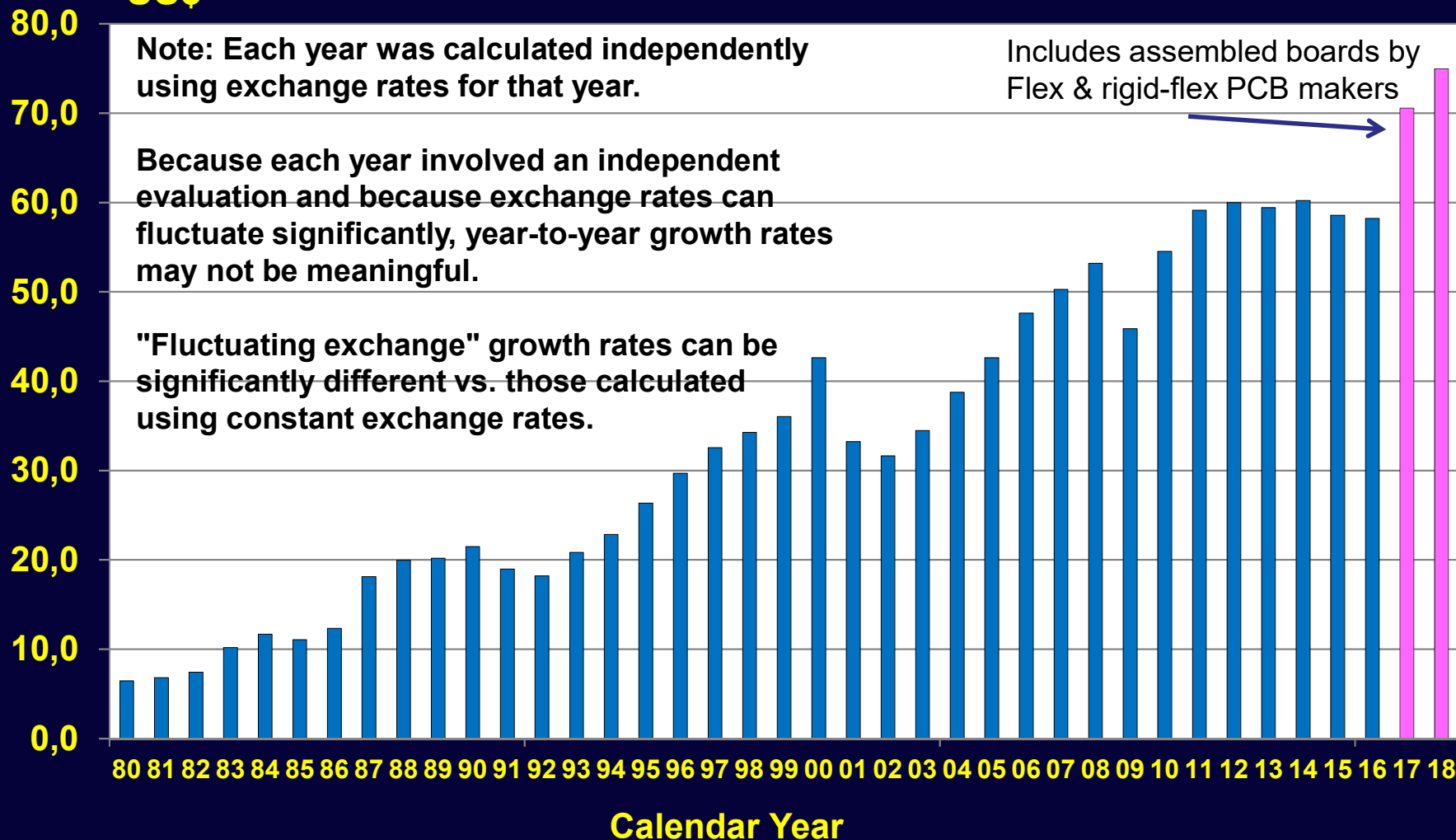
**Walt Cursiter
supports
Europe**



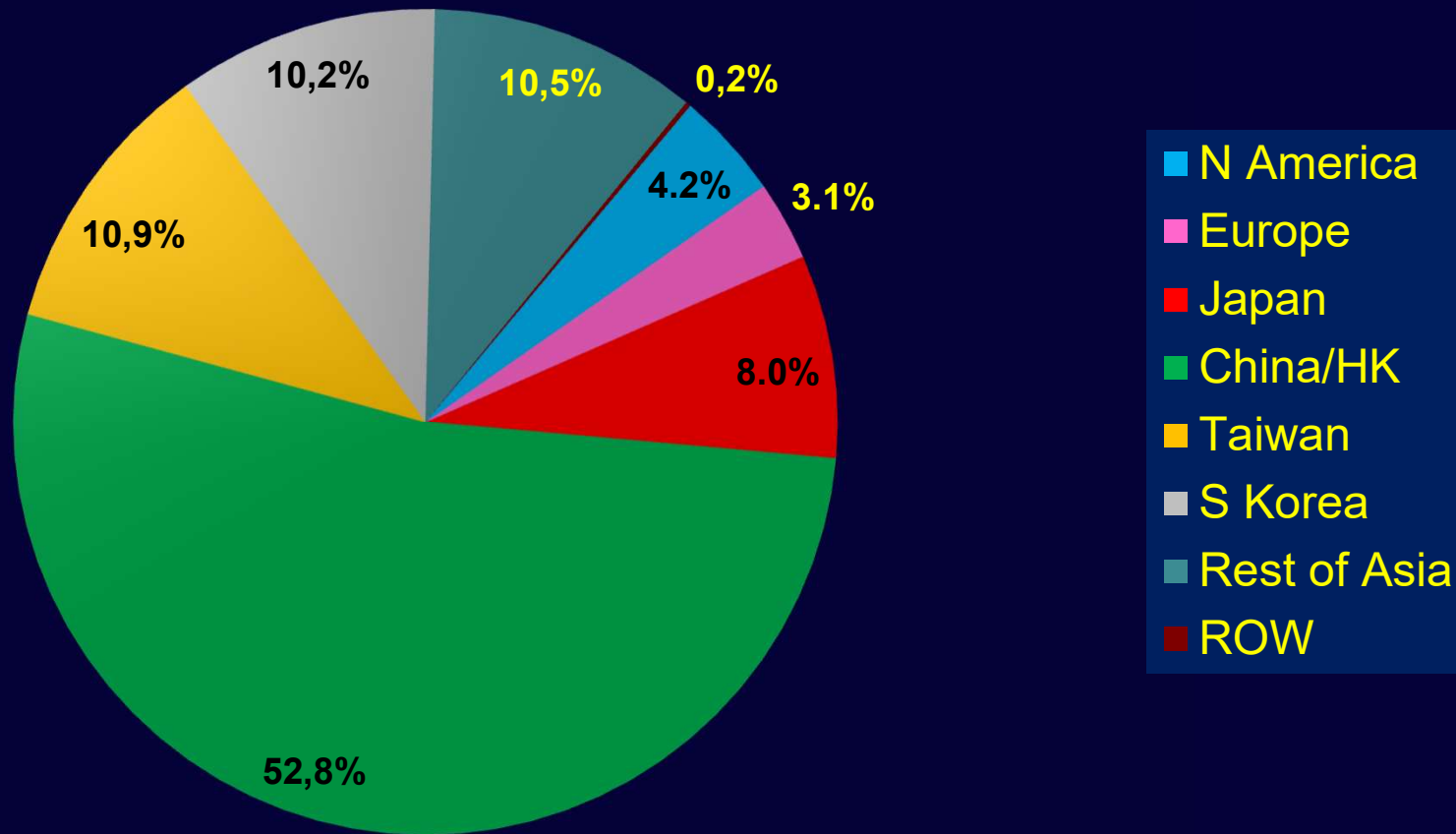
PCB Market

World PCB Production 1980-2018

US\$



2017 World Total PCB Production by Geographical Area

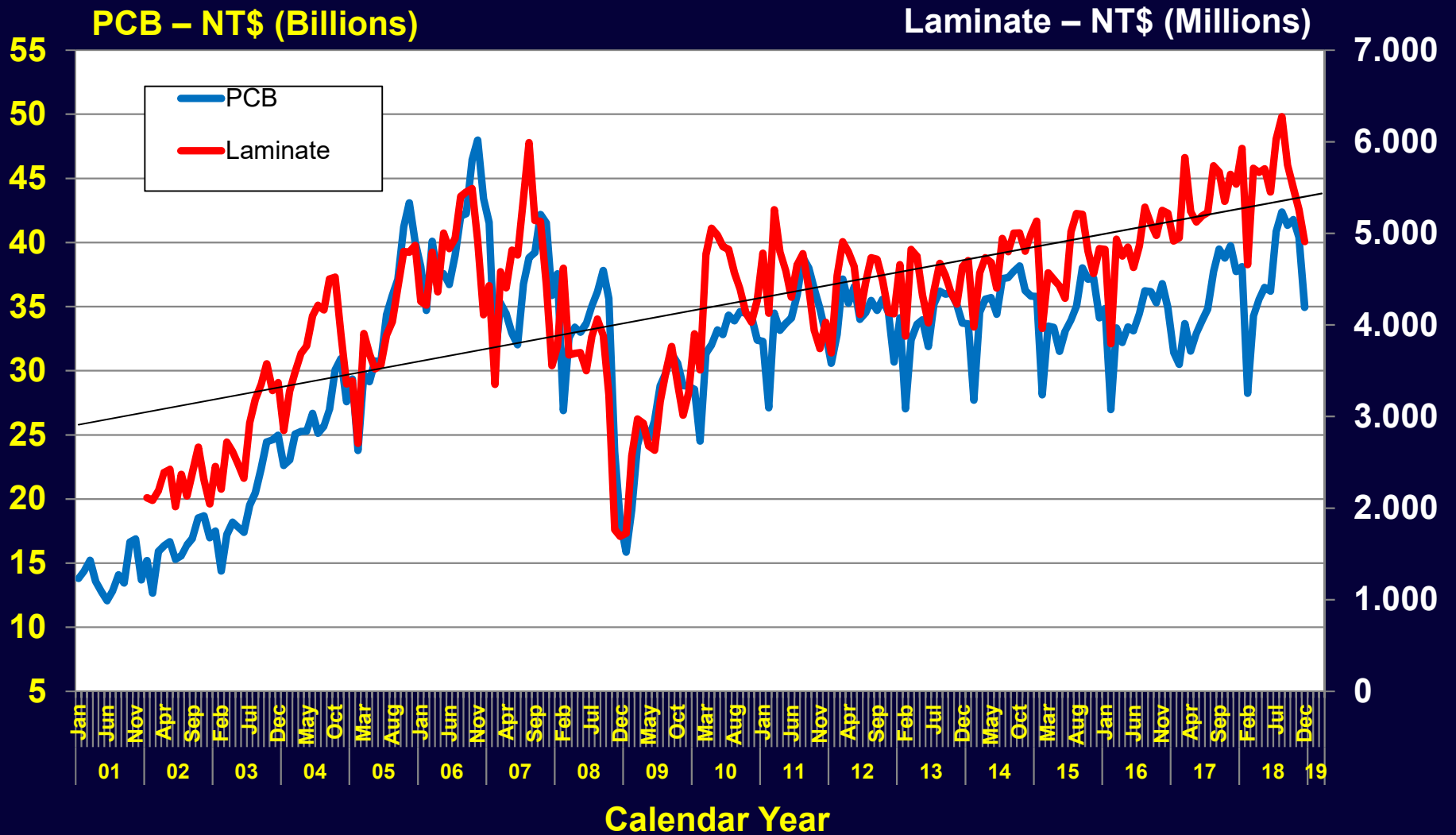


Total: \$70.5 Billion

20190112

Taiwan Listed Vendor Shipments

42 Rigid PCB & 8 Laminate Manufacturers

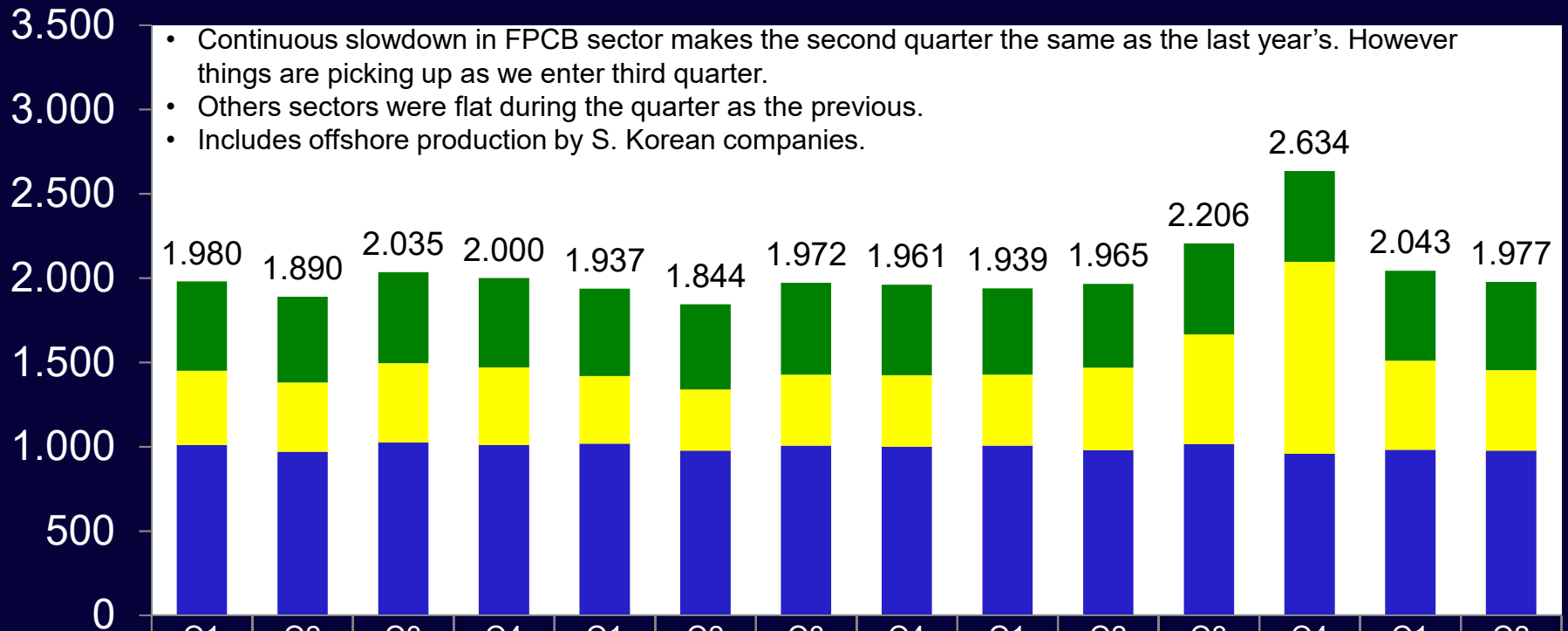


Company Financial Releases

S Korean Companies' Global PCB Production

20180729

US\$ millions (converted at 1150 won/\$)



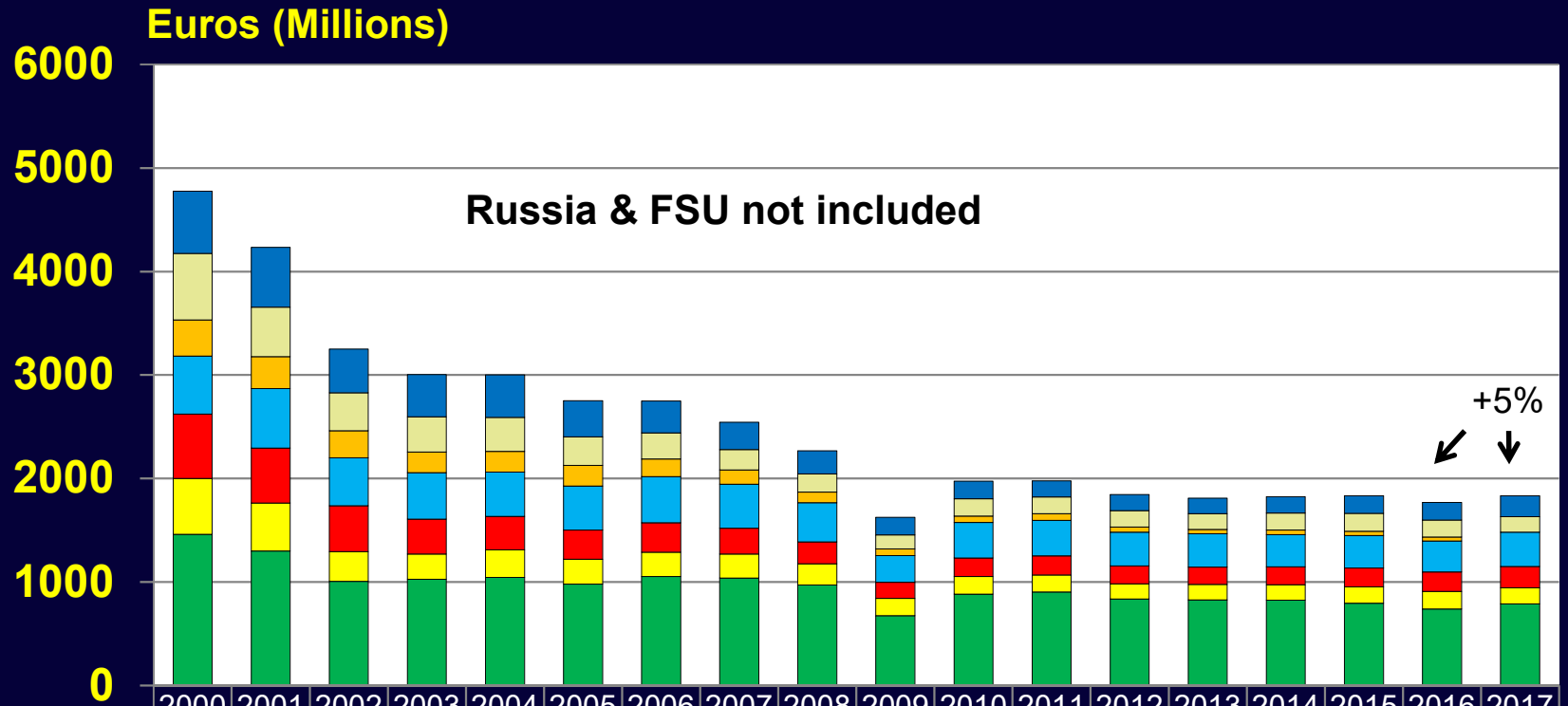
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
	2015				2016				2017				2018	
Total	1.980	1.890	2.035	2.000	1.937	1.844	1.972	1.961	1.939	1.965	2.206	2.634	2.043	1.977
■ IC Substrate	530	510	540	530	518	504	545	537	512	496	541	538	533	524
■ Flex	440	410	470	460	401	364	420	425	421	489	650	1138	529	476
■ Rigid	1010	970	1025	1010	1018	976	1007	999	1006	980	1015	958	981	977

Private communication from industry source

Europe

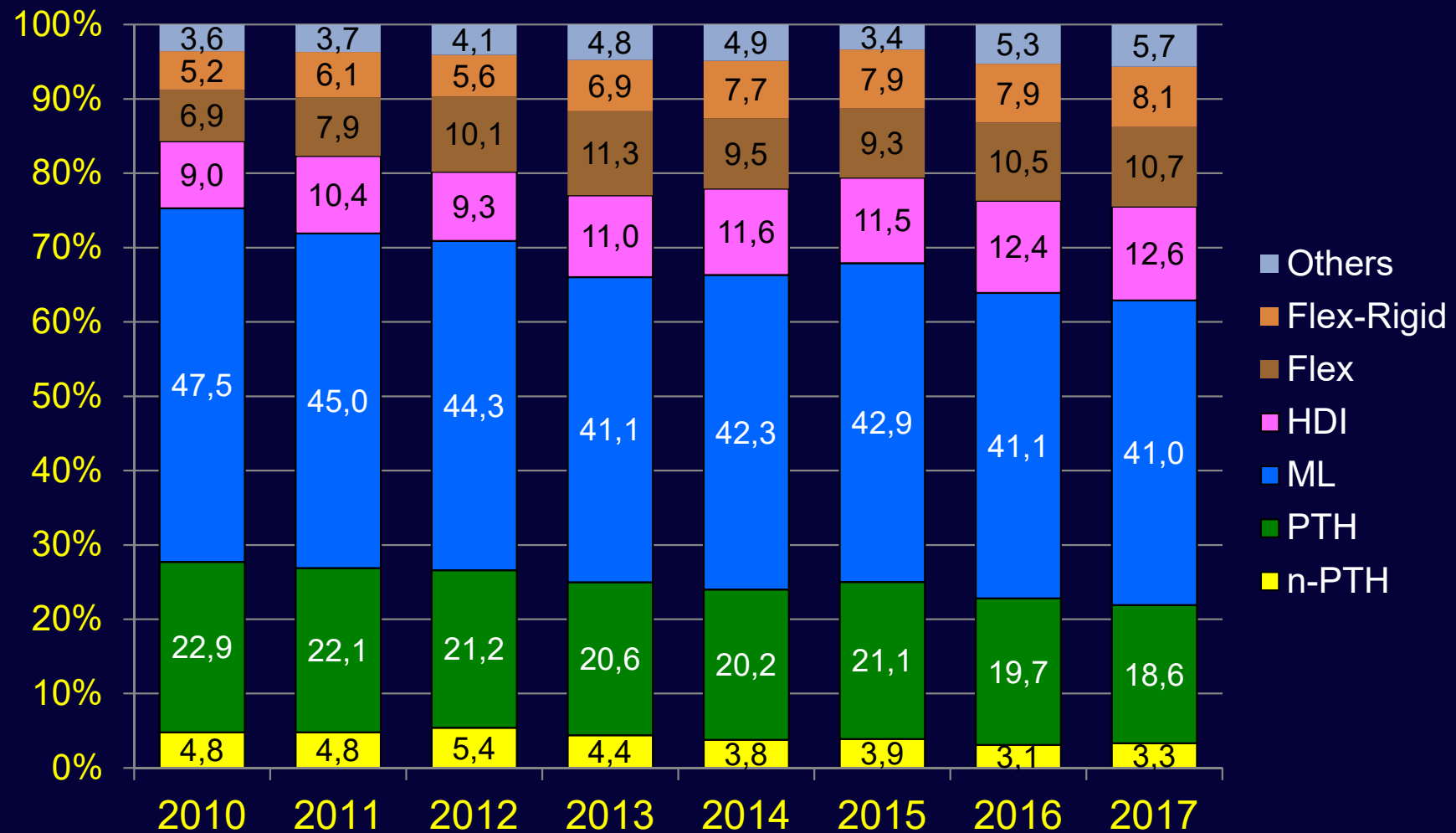
**Special thanks to
Michael Gasch**

European PCB Production

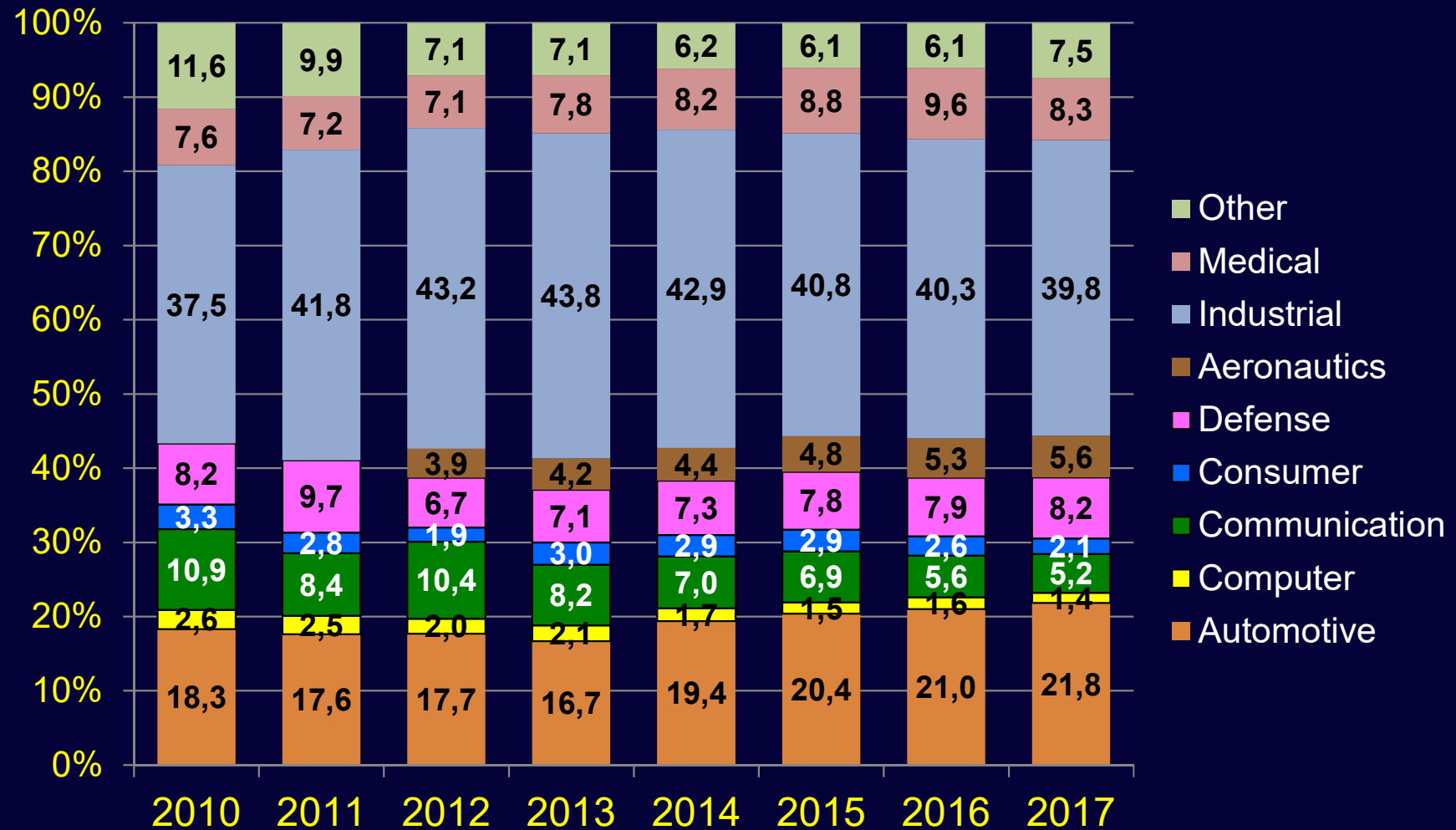


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other	601	577	422	408	410	346	309	264	221	169	170	155	157	151	158	170	172	202
UK	641	478	368	340	330	278	252	197	177	137	165	161	158	153	165	173	163	149
Scandinavia	351	309	260	201	200	198	169	137	103	64	64	64	50	40	42	40	40	
Austria/Switzerland	561	575	463	447	427	427	447	427	378	258	341	343	325	323	312	315	299	332
Italy	619	530	444	338	324	281	284	248	212	156	181	186	174	168	174	181	188	206
France	541	465	287	244	266	240	234	231	206	165	170	166	147	148	148	157	168	156
Germany	1461	1300	1006	1027	1044	981	1054	1039	970	676	883	902	835	828	825	796	740	788

European PCB Production by Technology

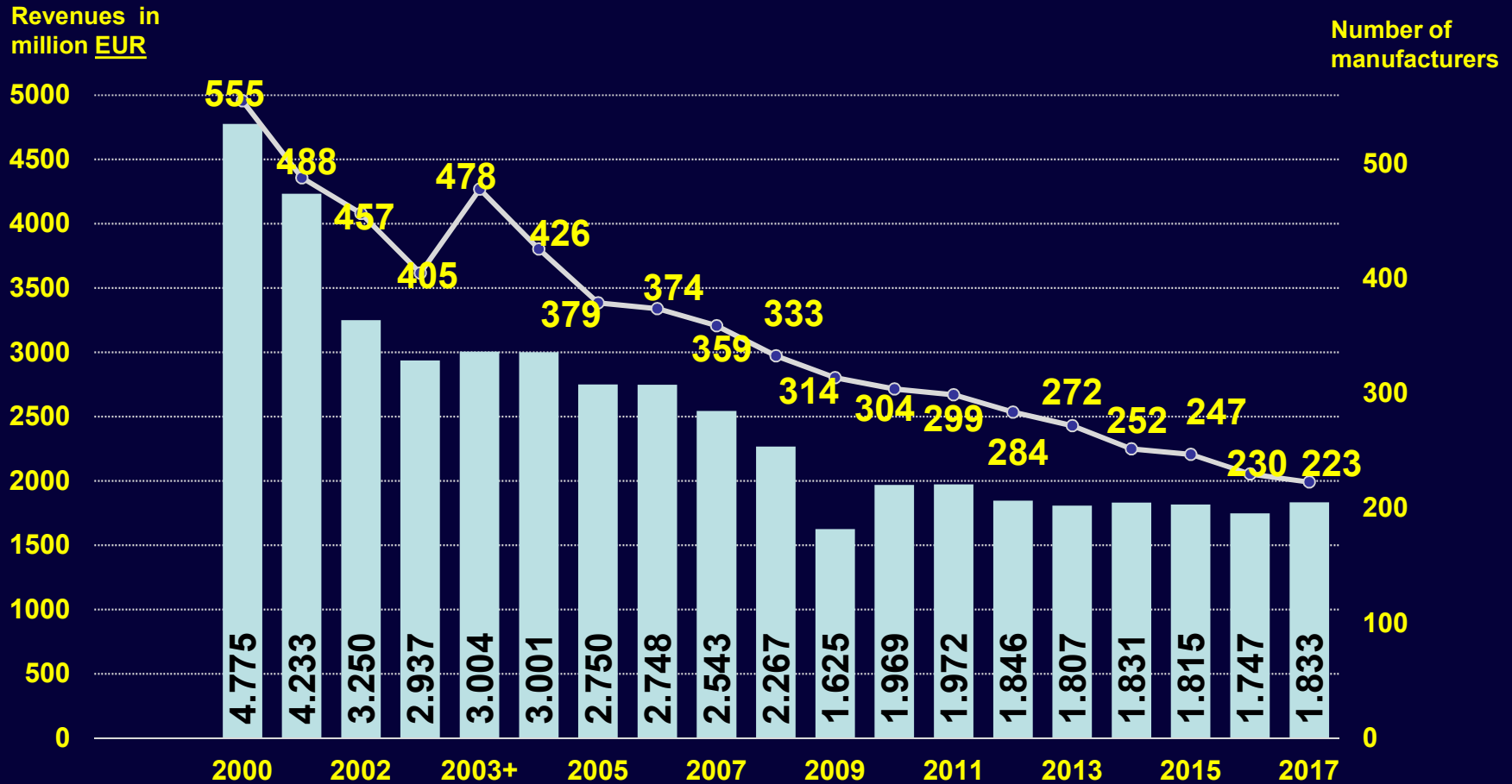


European PCB Production by End Market



PCB industry in Europe 2000 – 2017

revenues and number of manufacturers



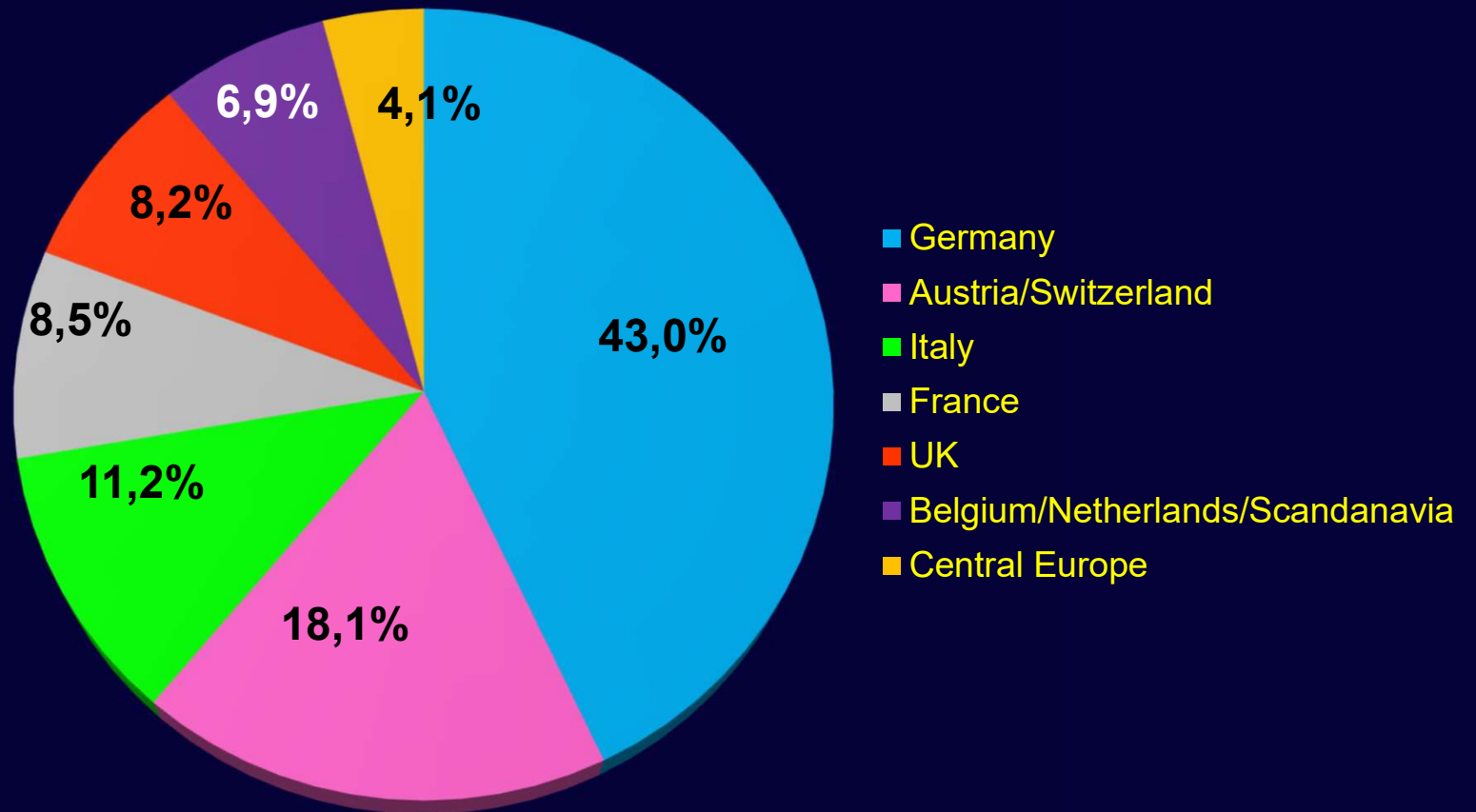
* 2003+ = incl. Central Europe

Europe's Top 41 PCB Companies Ranked by 2017 Revenues

Rank	Company	Rank	Company
1	AT&S / A	22	Cicor Group / CH
2	Würth Gruppe / D	23	Schaltungsdruck Storz / D
3	Schweizer Electronic / D	24	Aspocomp Oy –Gruppe / Fin
4	KSG GmbH + Co KG / D	25	ACB N.V. / B
5	Elvia Group / F	26	Eleprint srl / I
6	Mektec Europa / D	27	Europrint Eger Kft / B
7	Unimicron Germany / D	28	Tecnomaster SpA / I
8	SoMaCis / I	29	Graphic plc / GB
9	hmp Macroprint / D	30	Spirit Group / GB
10	Elco Group / I + NL	31	Silga SpA / I
11	European Electronic Systems / D	32	TW Elektronik Horst Muller / D
12	GS SwissPCB AG /CH	33	Ilfa / D
13	Dyconex AG / CH	34	Elekonta Marek GmbH / D
14	Varioprint AG Electronic / CH	35	OMR Italia SpA / I
15	Hausermann GmbH / A	36	Merlin (Falcon) Group / GB
16	Amphenol-Invotec /GB	37	Precoplat / D
17	Cimulec Group / F	38	Asetronic AG / CH
18	Optiprint AG / CH	39	Jenaer Leiterplatten / D
19	Cistelaier-Group / I	40	LAB Circuits S.A. / E
20	Polytron Print GmbH / D	41	Techno Service / PL
21	Rohde & Schwarz		

20160502

2017 European PCB Production



EUR 1832 million

Europe Comments

There has been a change in the reporting system, ZVEI will not release monthly numbers to the press, quarterly results only.

Quarterly revenues are still at their usual level but growth rates are slowing. Compared to the 3Q'17 sales rose by 1.9% and by 0.5% compared to the 2Q'18. However, last year already was a very good one and insofar the gauge was lying high.

Quarterly bookings were a catastrophe, especially September which suffered a severe cave-in. The 3Q'18 was 16% below last year's and 12% below the 2Q'18. The reshoring of orders last year (because of copper foil and laminate shortages in Asia) has provided a high base from which a certain decline was to be expected however, not to this extent.

Michael Gasch, Data4PCB 10/2018

Europe Comments

For the time being one can only speculate about the reasons (further data are needed) but some things are for sure already:

The shortage of key components caused cancellations or – in the lucky case – deferrals (without components no PCBs are needed)

The fraud of most of the companies in the German automotive industry (diesel-gate) provoked more severe type approval tests (WLTP) but most of the manufacturers reacted too late and many approvals are still missing. The consequence? They can't sell cars without approval; therefore, production shifts are cancelled = no PCBs needed.

Europe Comments

In addition to this the looming Brexit may create another wave of consumer refusal to buy new cars.

Insofar the old Chinese curse (“may you live in interesting times”) seems to become reality.

Let's hope to best and prepare for the worst.

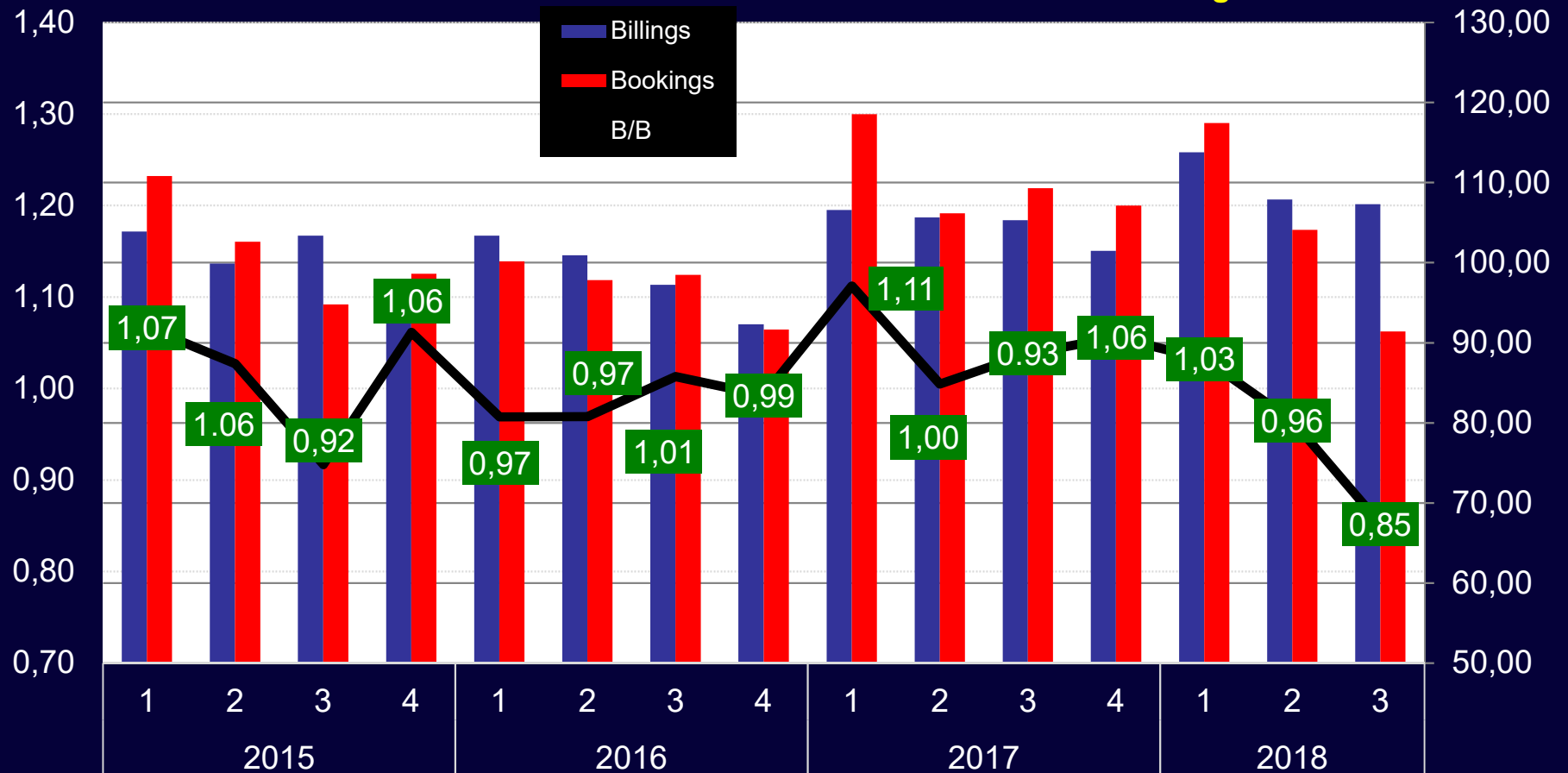
20181111

DACH PCB

Bookings, Billings & Book/Bill

Book/Bill

Booking & Billing Indices
Base = Average of Sales in 2015

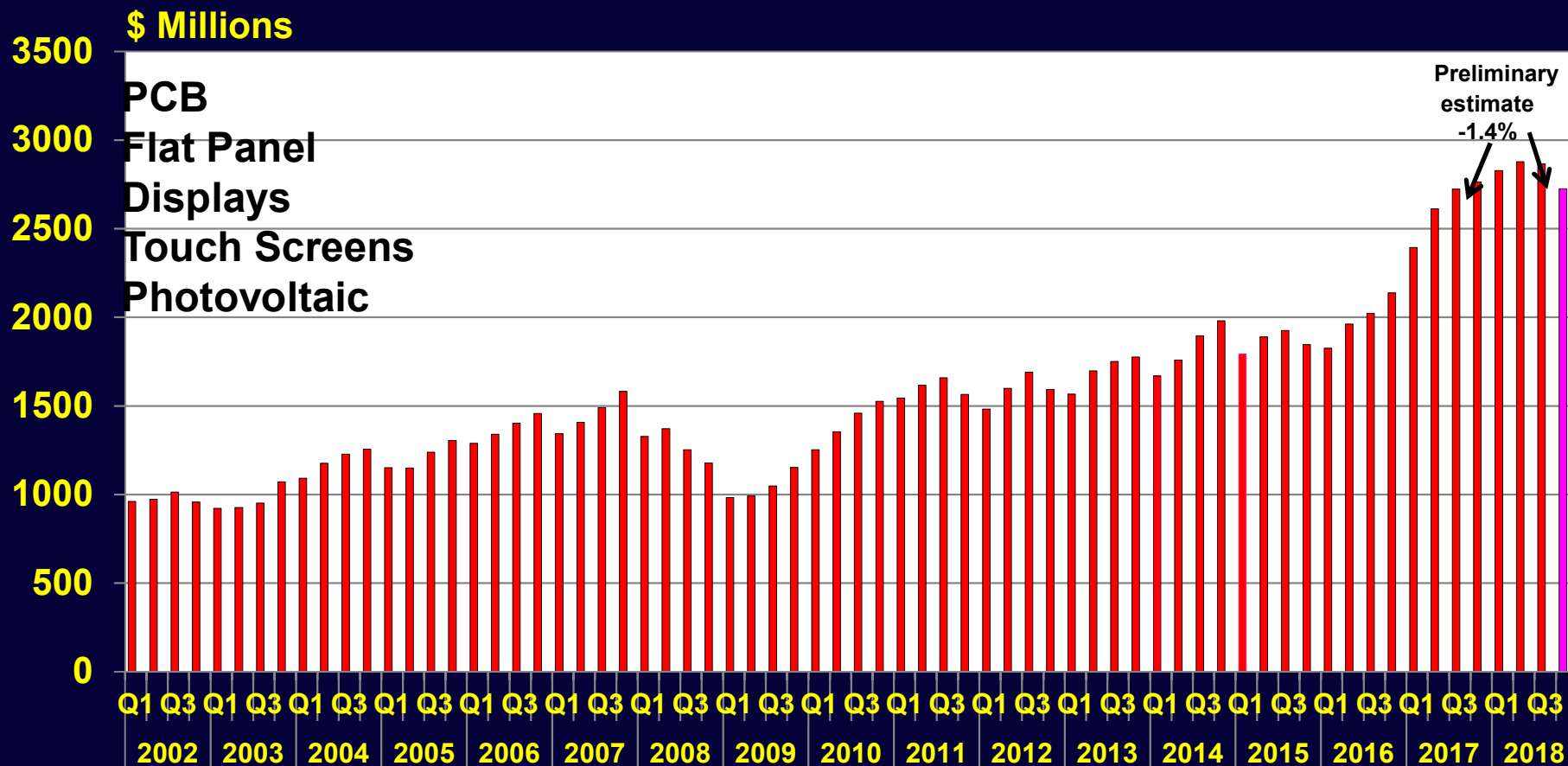


M Gasch based on ZVEI data 10/18

**Process Equipment,
Laminate &
Materials Suppliers**

20190208

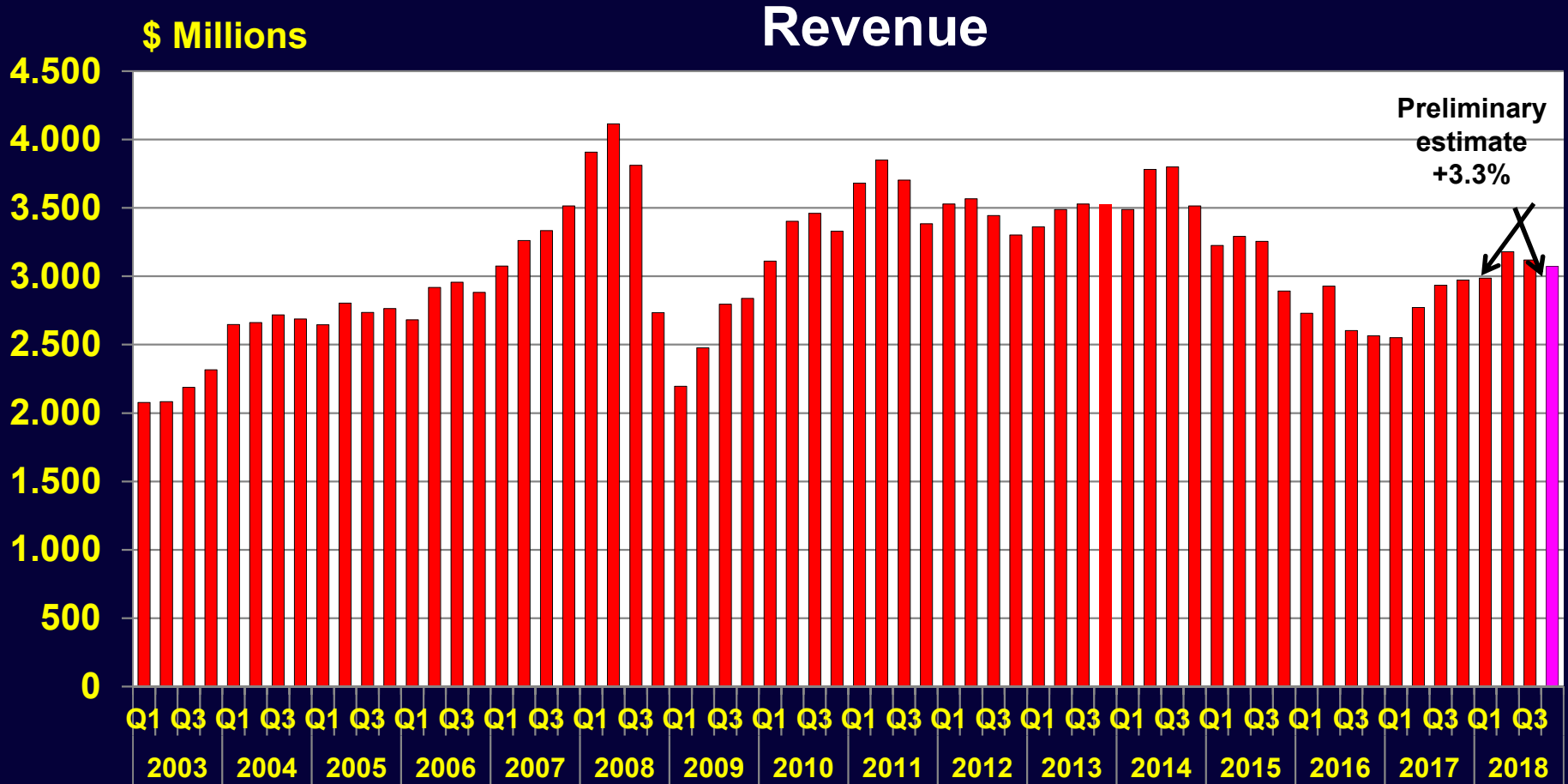
Process Equipment Related Suppliers Composite of 12 Companies Revenue



C-Sun, Tailing Technology, Camtek, Cadence, ESI, GSI Group, Mentor Graphics, Nordson, Rofin-Sinar, Coherent, Orbotech, Data I/O

Material Suppliers (excluding laminate) Composite of 14 Companies

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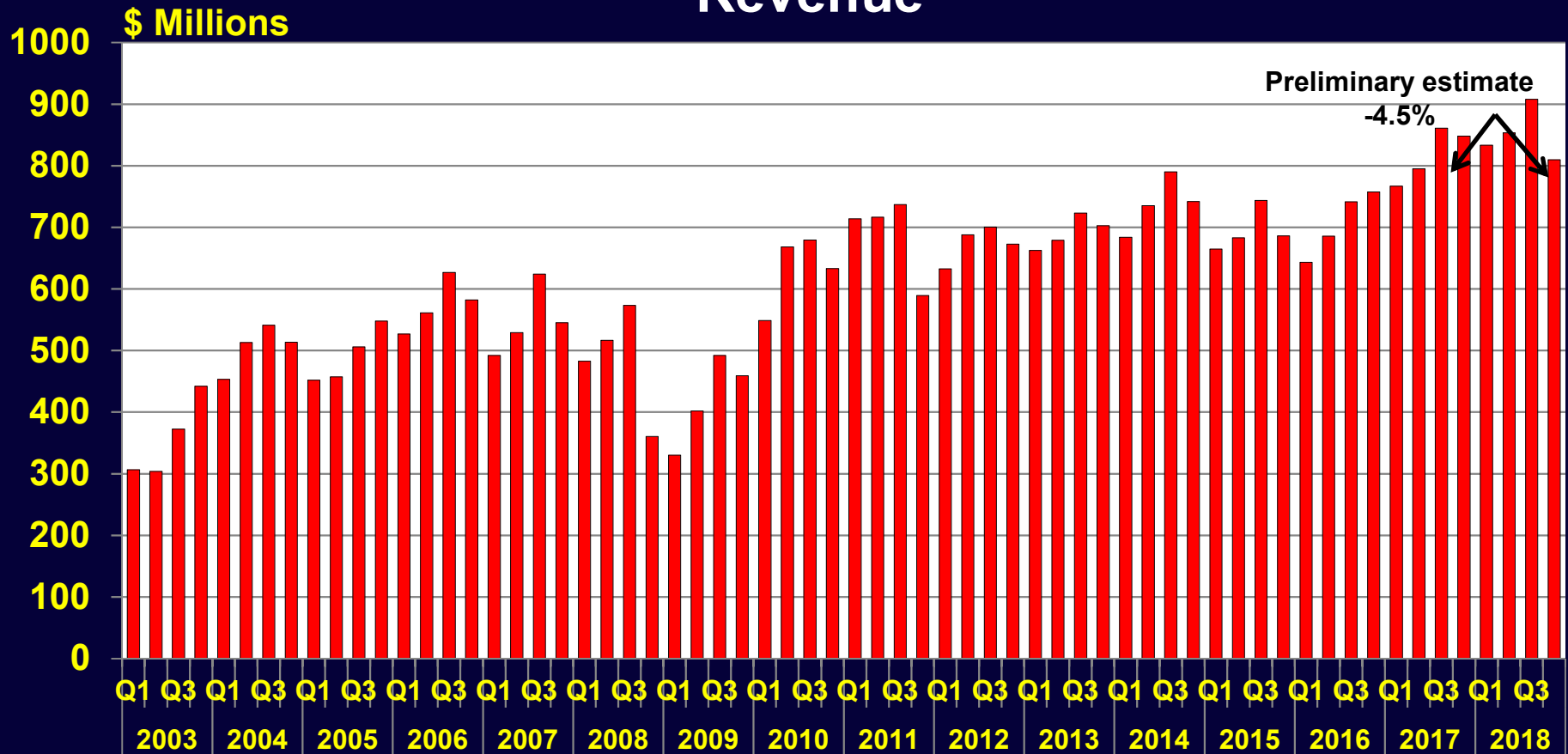


Momentive, OM Group, Taiwan Glass, Baotech, Glotech, Shenmao, Wahlee, Topoint, Cabot Micro, Cookson Elec, Eternal Chemical, Hexcel, Chang Wah, Platform Specialty Products

NT\$ & GBP converted to US\$ at fluctuating exchange

Rigid & Flex Laminate Suppliers Composite of 13 Companies

Revenue



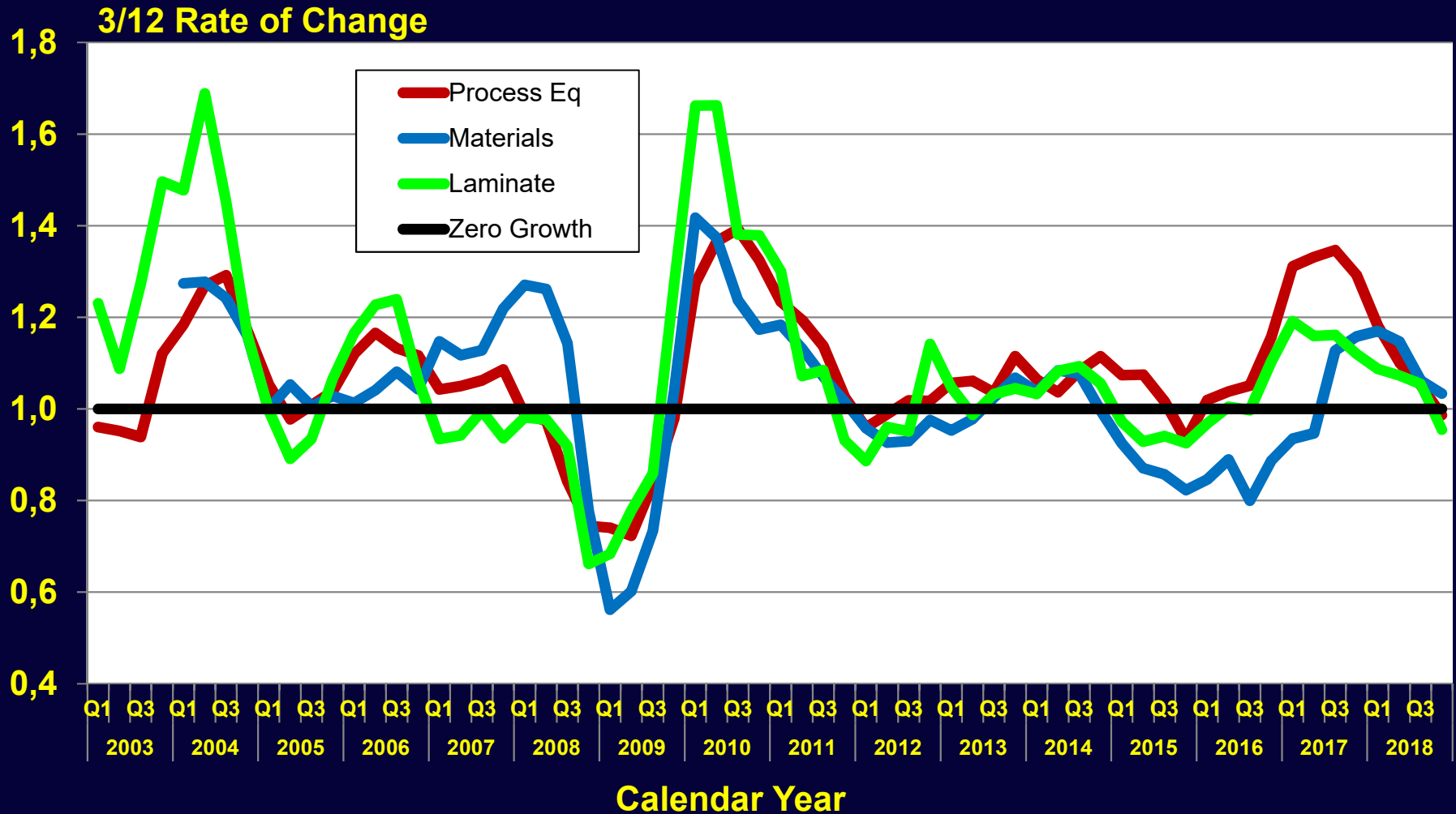
Arisawa, Arlon Electronic Materials, Elite Materials, Hwa Woei, Iteq, Microcosm, Park Electrochemical, Rogers, Shinemore, Taiflex, Thinflex, Top Union, Uniplus

NT\$ converted at fluctuating exchange

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Global Growth Rates

Process Equipment, Materials & Laminate

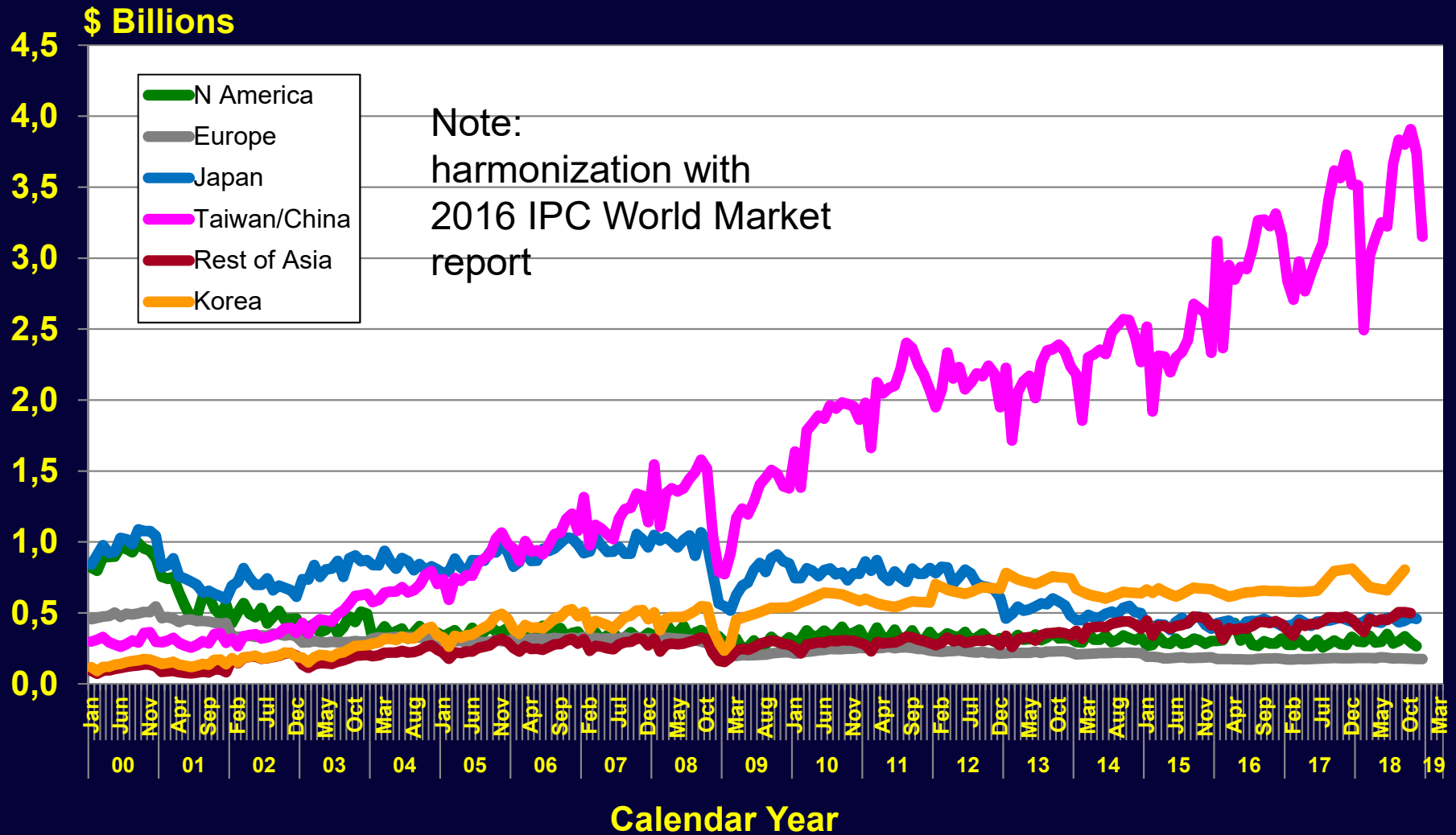


Company Financials of 12 Laminate suppliers, 13 material suppliers & 8 Process Equipment Suppliers

World PCB Model

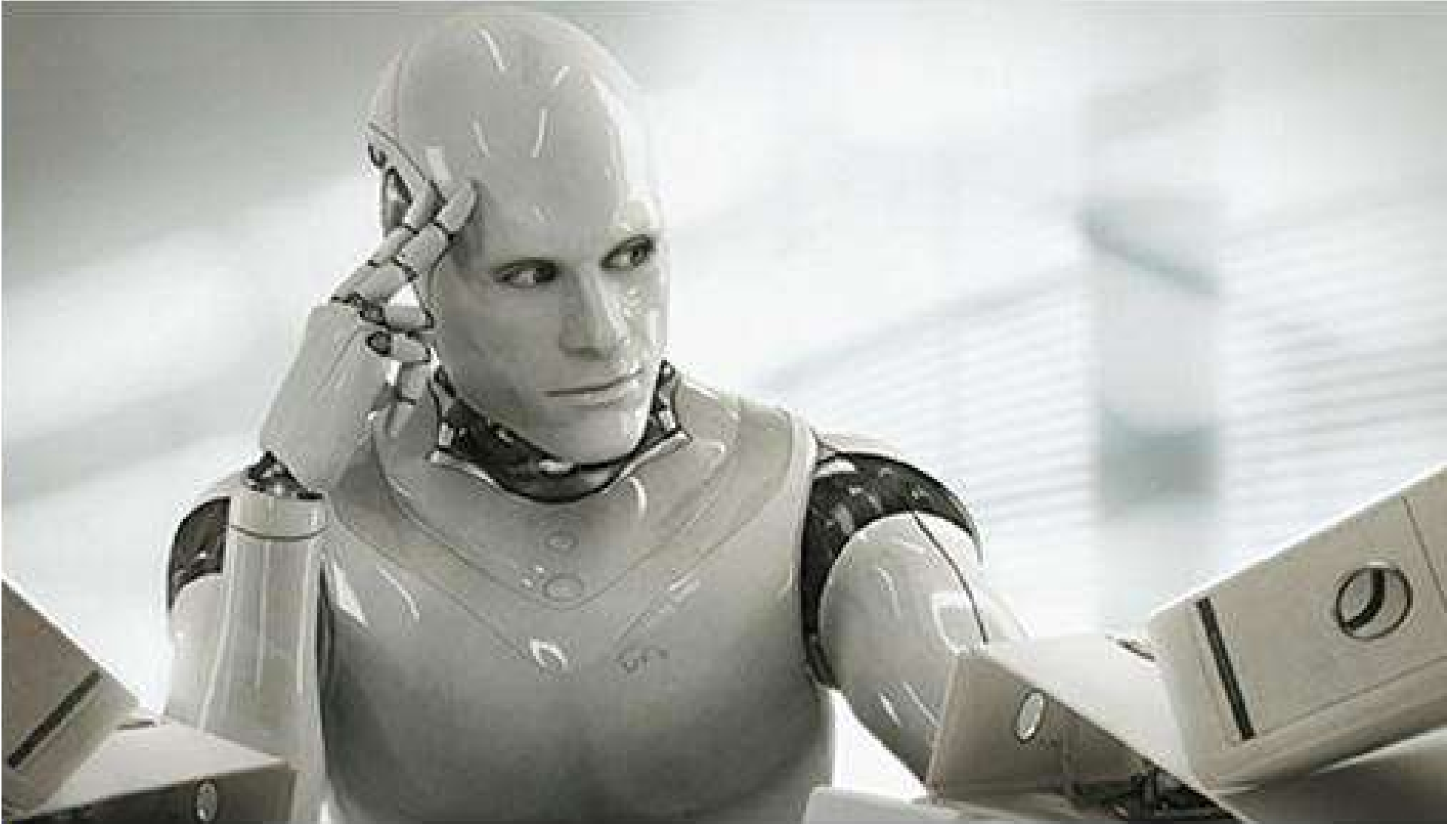
World PCB Monthly Shipments

Converted @ Fluctuating Exchange Rates



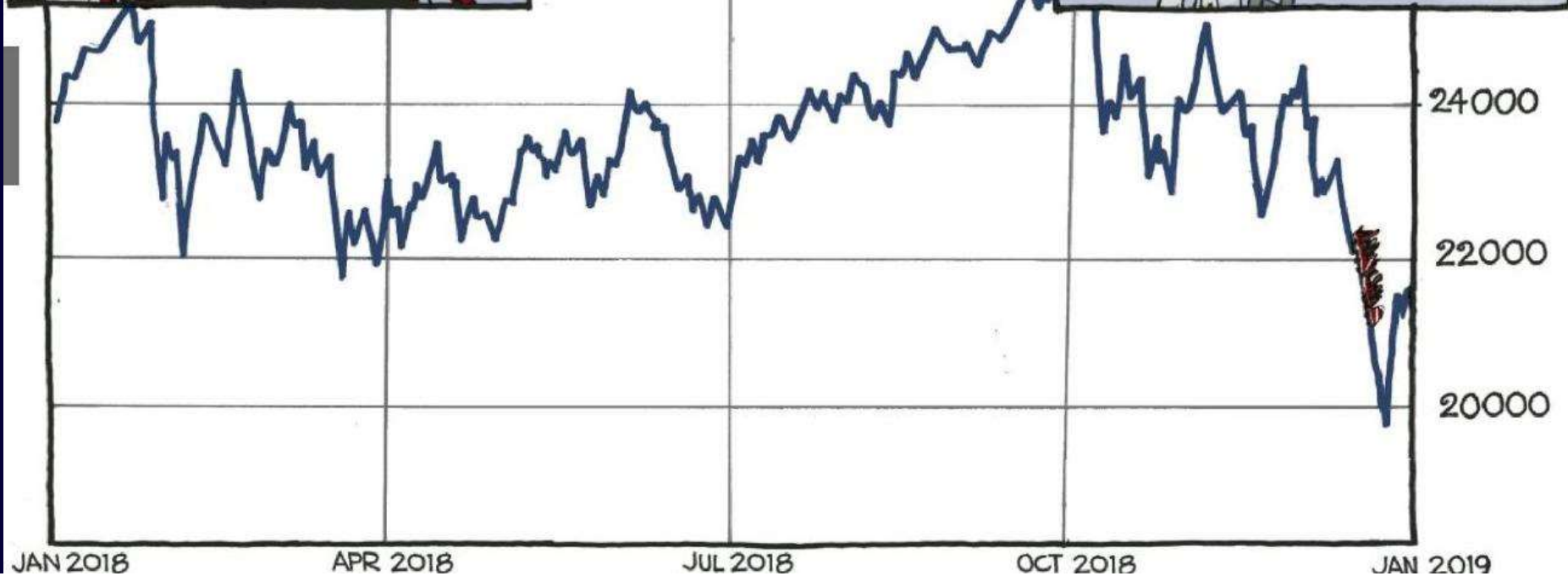
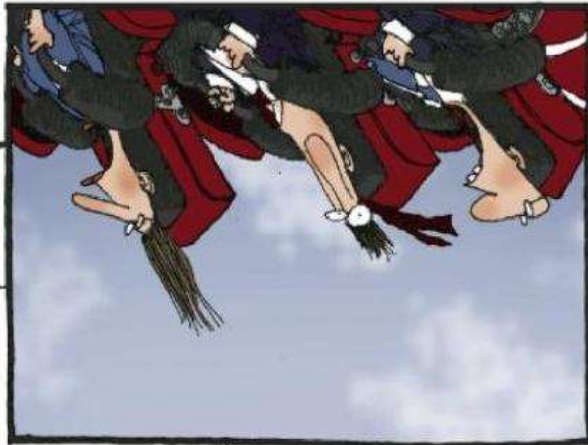
Source: Custer Consulting Group

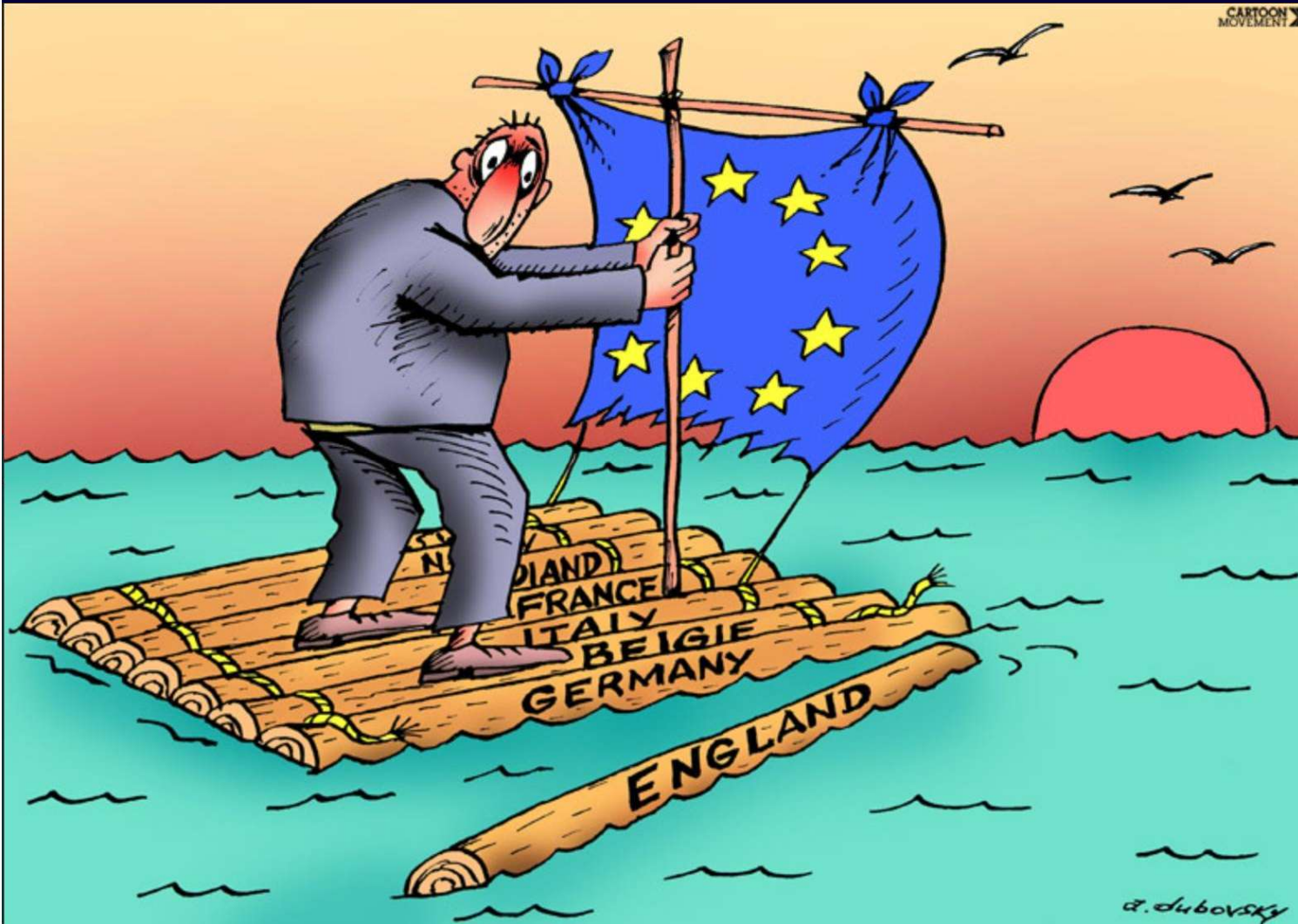
Forecasts



Business Conditions

RAMIREZ LAS VEGAS REVIEW-JOURNAL
2018 © CREATORS.COM



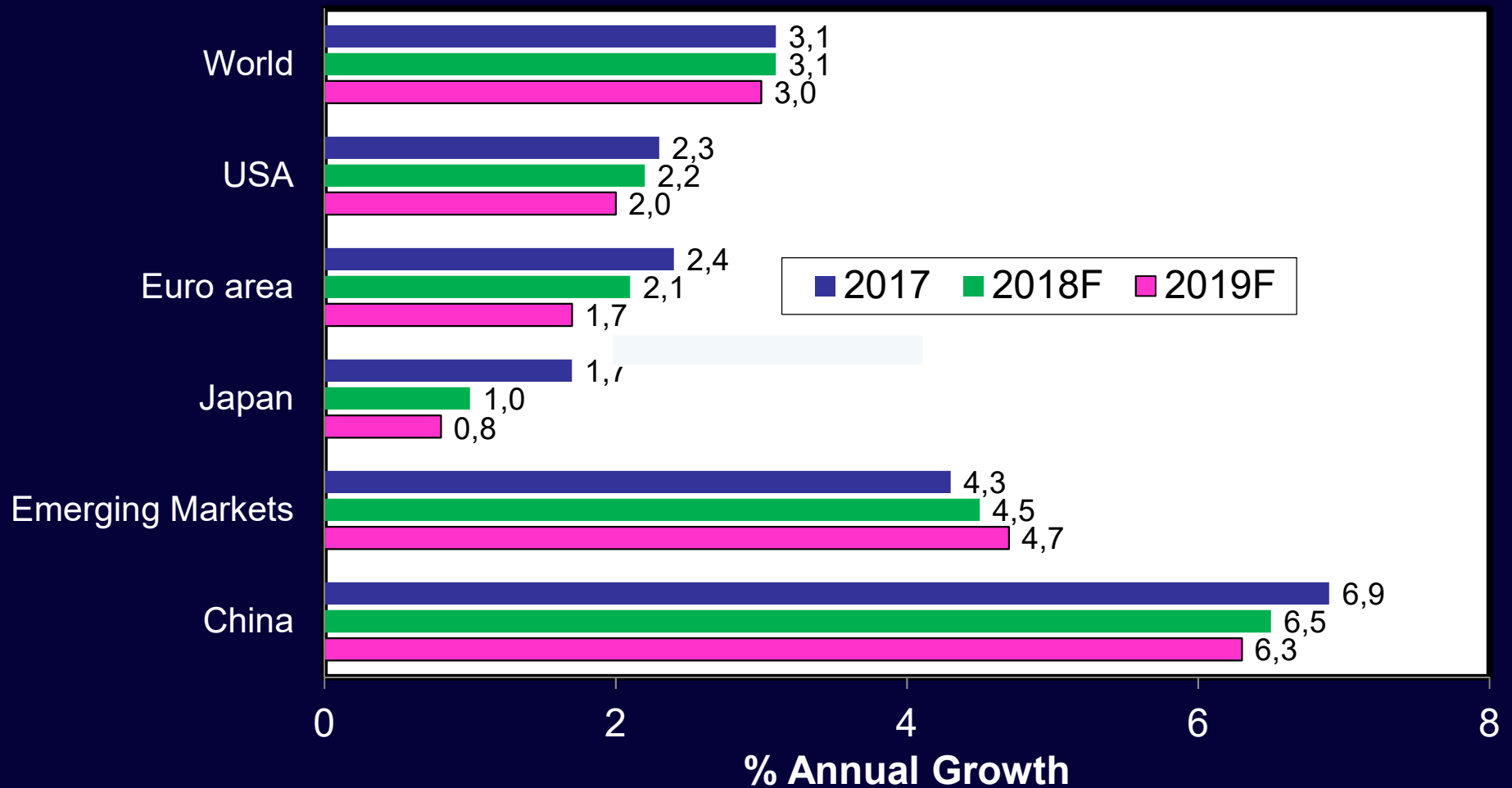


CARTOON
MOVEMENT

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Real GDP Growth

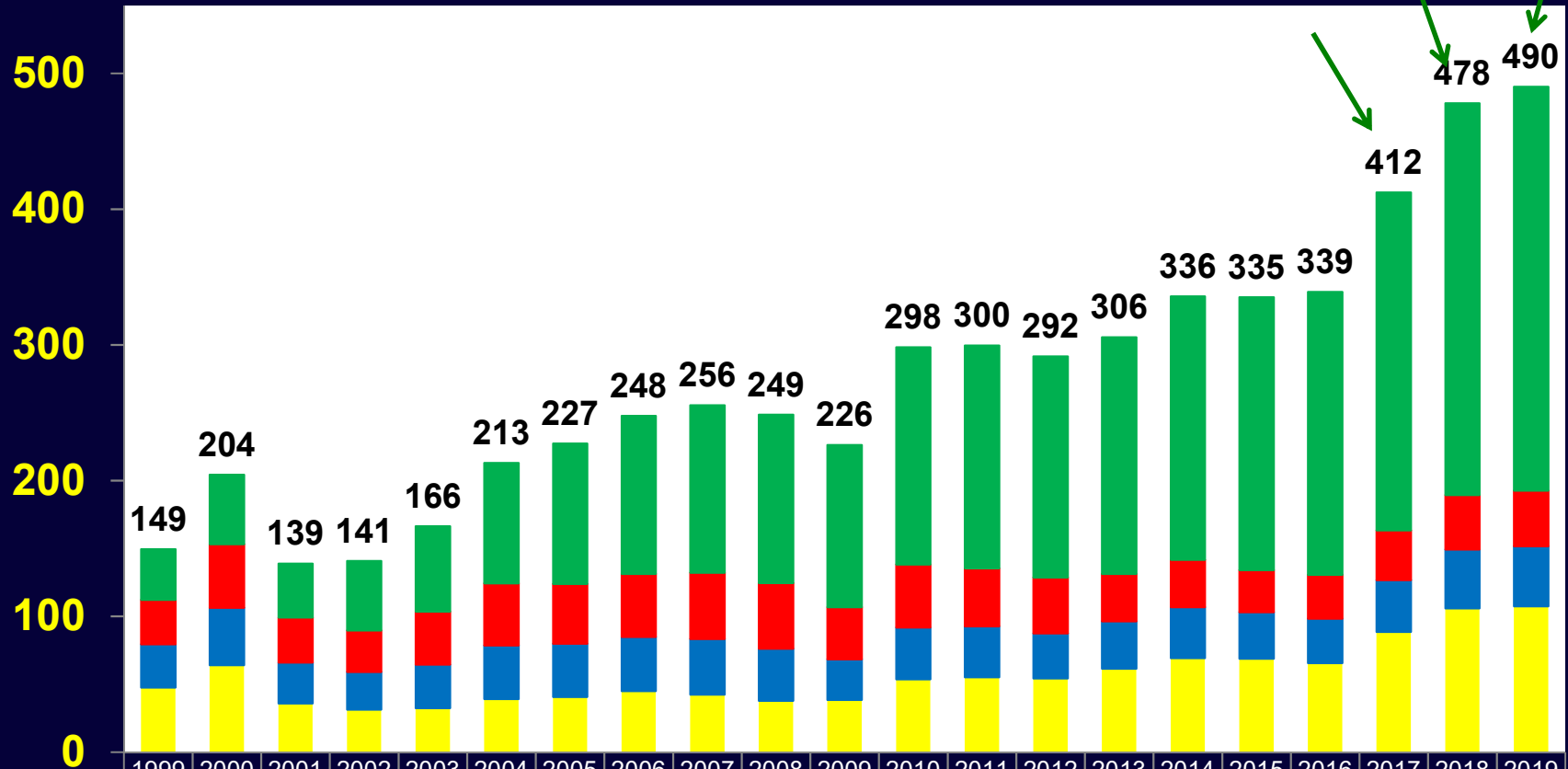
Growth rates calculated using constant 2010 US\$ weights



Worldwide Semiconductor Market by Geography WSTS Forecast

\$ B

+21.6% +15.9% +2.6%

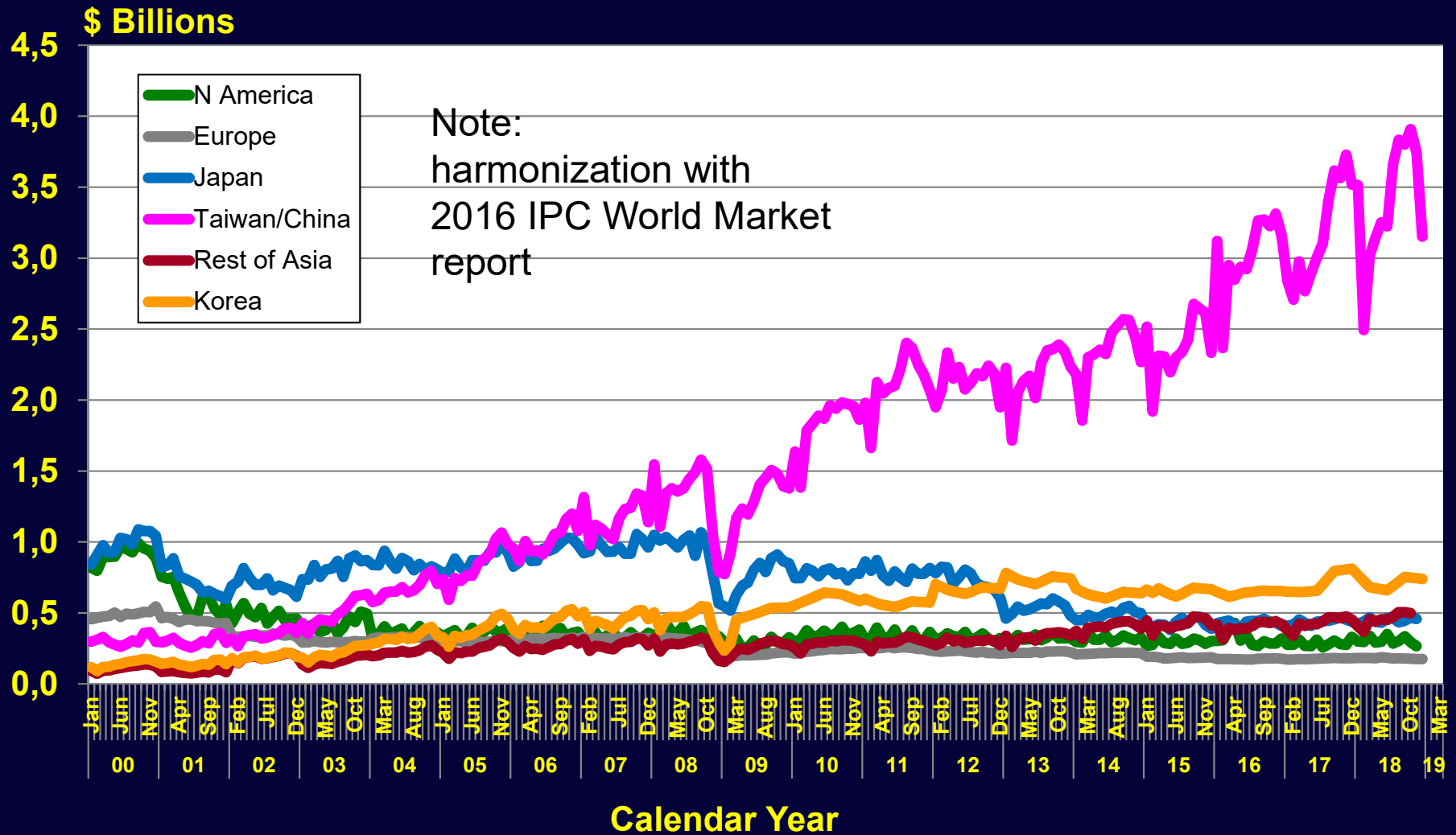


	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total	149,4	204,4	138,9	140,8	166,3	213,1	227,4	247,7	255,6	248,6	226,3	298,3	299,5	291,6	305,6	335,8	335,2	338,9	412,2	477,9	490,1
Asia Pacific	37,2	51,3	39,8	51,2	62,8	88,8	103,5	116,5	123,5	124,0	119,6	160,0	164,0	163,0	174,4	194,2	201,1	208,4	248,8	288,6	297,5
Japan	32,8	46,7	33,1	30,5	38,9	45,8	44,1	46,4	48,8	48,5	38,3	46,6	42,9	41,1	34,8	34,8	31,1	32,3	36,6	40,1	41,1
Europe	31,9	42,3	30,2	27,8	32,3	39,4	39,1	39,9	41,0	38,2	29,9	38,1	37,4	33,2	34,9	37,5	34,3	32,7	38,3	43,4	44,2
Americas	47,5	64,1	35,8	31,3	32,3	39,1	40,7	44,9	42,3	37,9	38,5	53,7	55,2	54,4	61,5	69,3	68,7	65,5	88,5	105,8	107,3

WSTS 12/18

World PCB Monthly Shipments

Converted @ Fluctuating Exchange Rates



Source: Custer Consulting Group

World PCB Shipments (with forecast)

Converted @ Fluctuating Exchange Rates

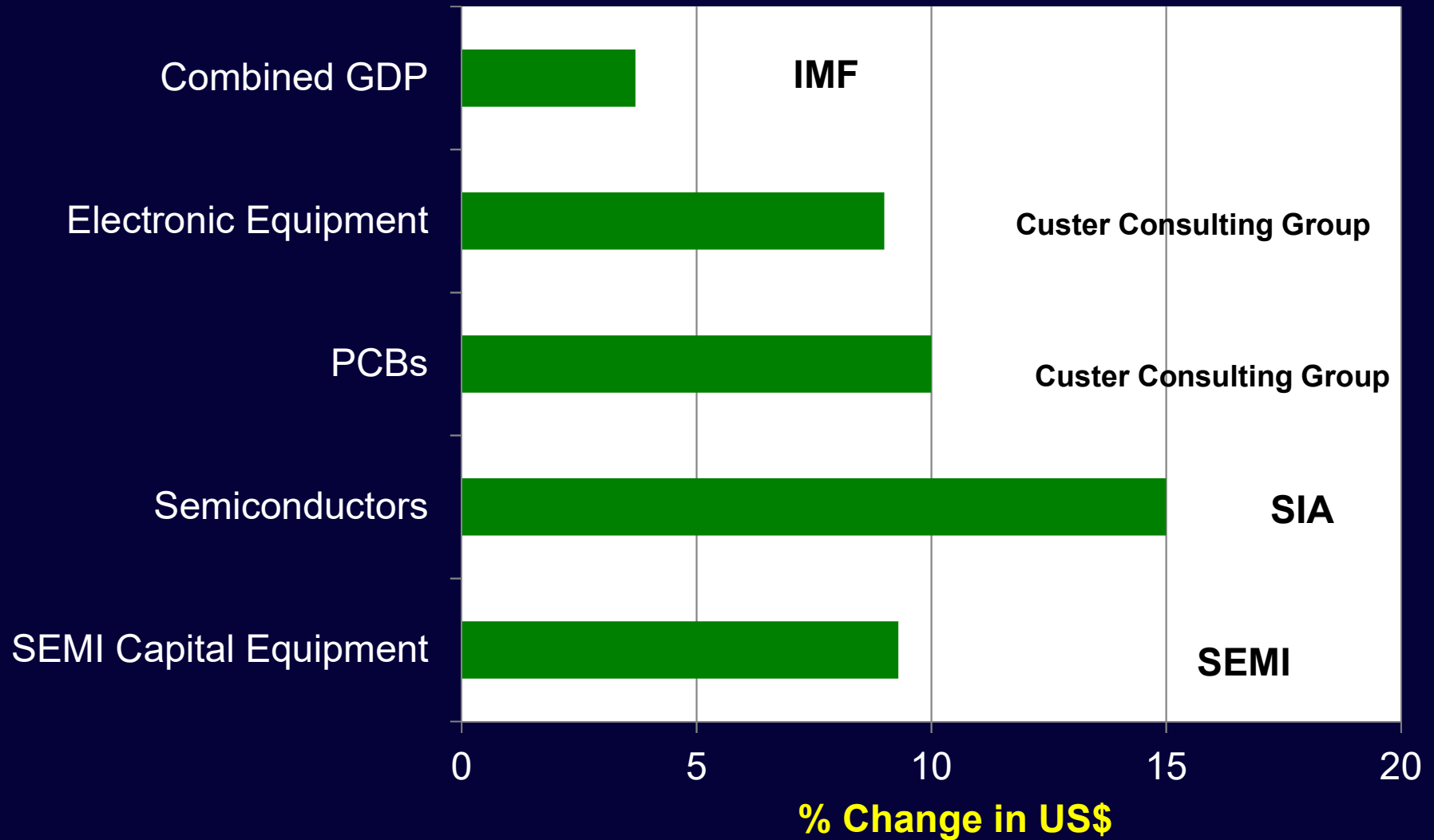


Source: Custer Consulting Group - 2010 base year expanded by monthly growth of N. American, European, Japanese, Korean & Taiwan/China monthly PCB shipments

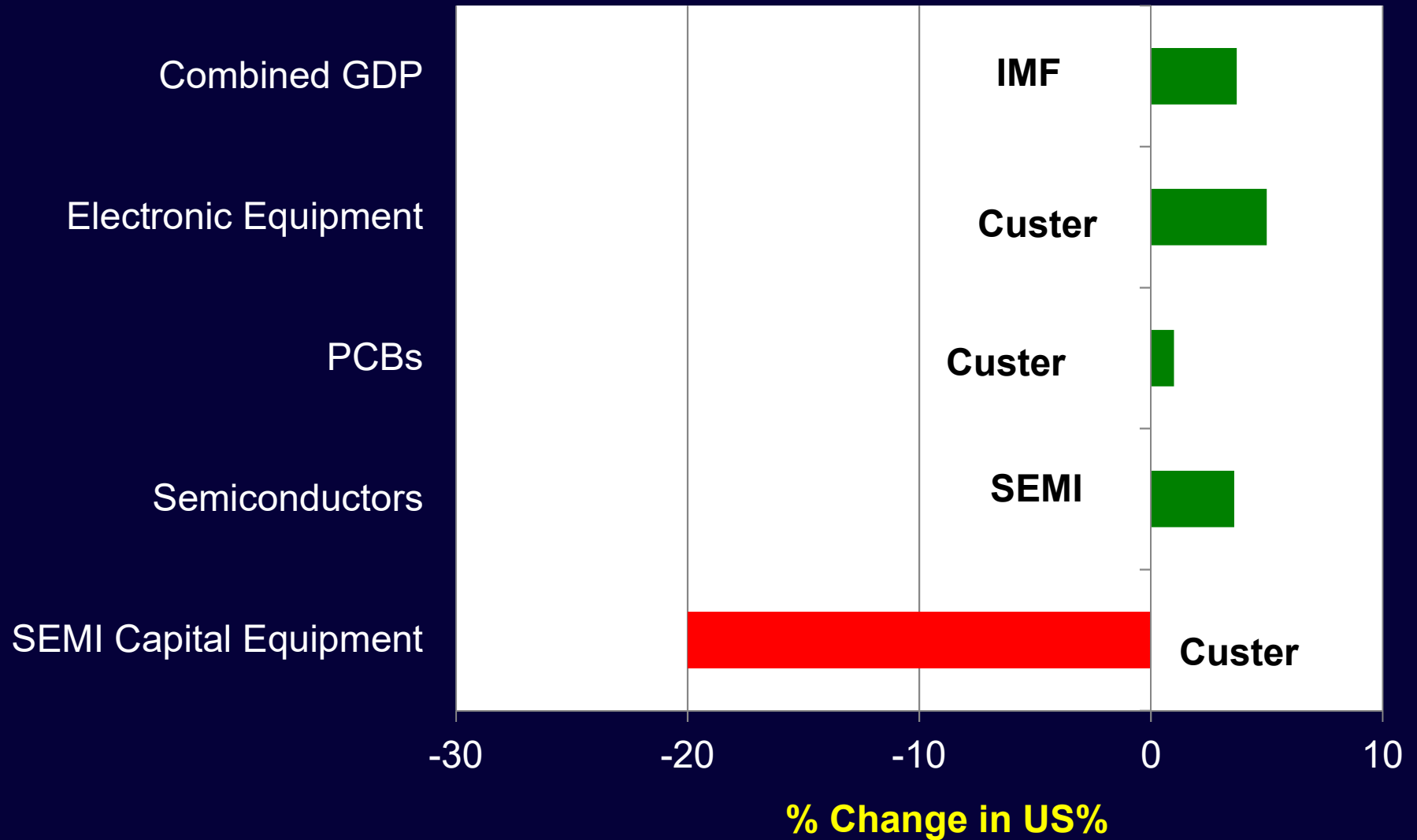
20180211

Global Electronic Supply Chain Forecast

2018 vs. 2017



Global Electronic Supply Chain Forecast 2019 vs. 2018 (Very preliminary)



Summary

Slowing growth especially in Europe

Trade disputes impact long standing regional alliances

Electronic assembly may shift globally to countries less affected by tariffs

Many exciting new electronic products are on the horizon but no large ones are imminent

5G offers exciting opportunities for next decade

Cluster Consulting Group Products

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- **Solar/Photovoltaic supply chain**
- **Automotive supply chain**

Business Outlook

- **Market charts & data**

Global market

OEMs

Components, EMS, ODM, materials & process equip

Solar/Photovoltaic

- **Weekly Market Comments with latest charts**