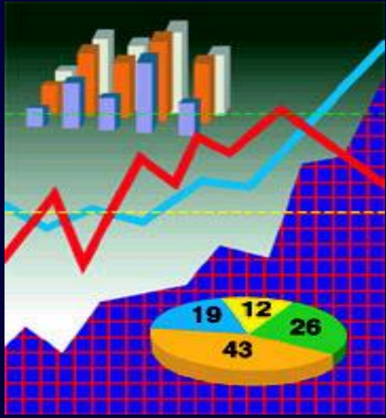


Business Outlook

Global Electronics Industry

(with emphasis on Europe)

Custer Consulting Group
www.custerconsulting.com
November 2019

Wish I could join you

Special thanks to Alun for presenting this information

Walt

Guest Speakers

2019 Situation

Global & European manufacturing growth has slowed or is contracting.

Tariffs, trade disputes and Brexit/EU are key issues

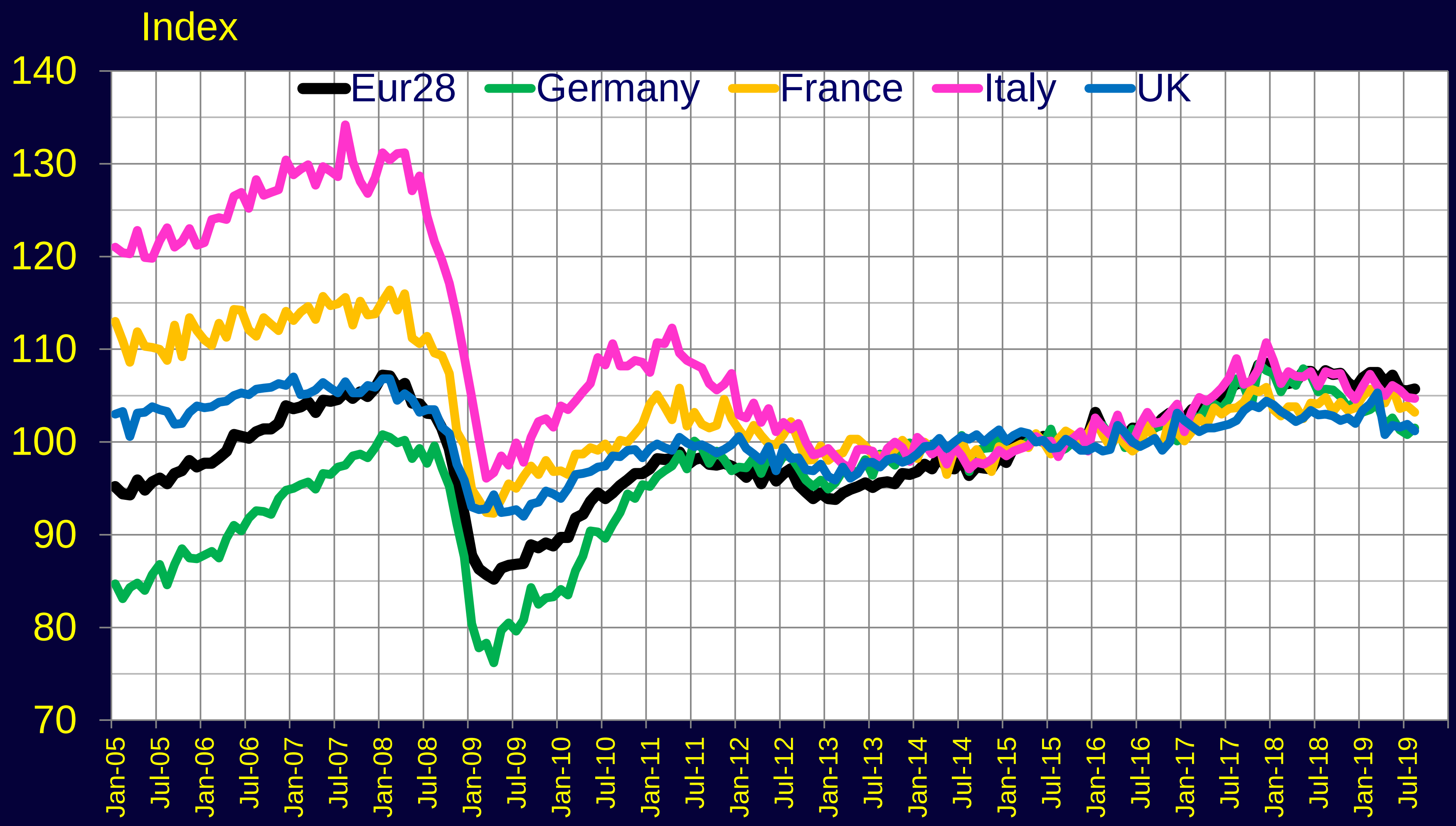
Geopolitical concerns remain very significant.

There are signs of a coming electronics rebound that are both product and region dependent.

20191013

Industrial Production – Europe Manufacturing

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



Eurostat

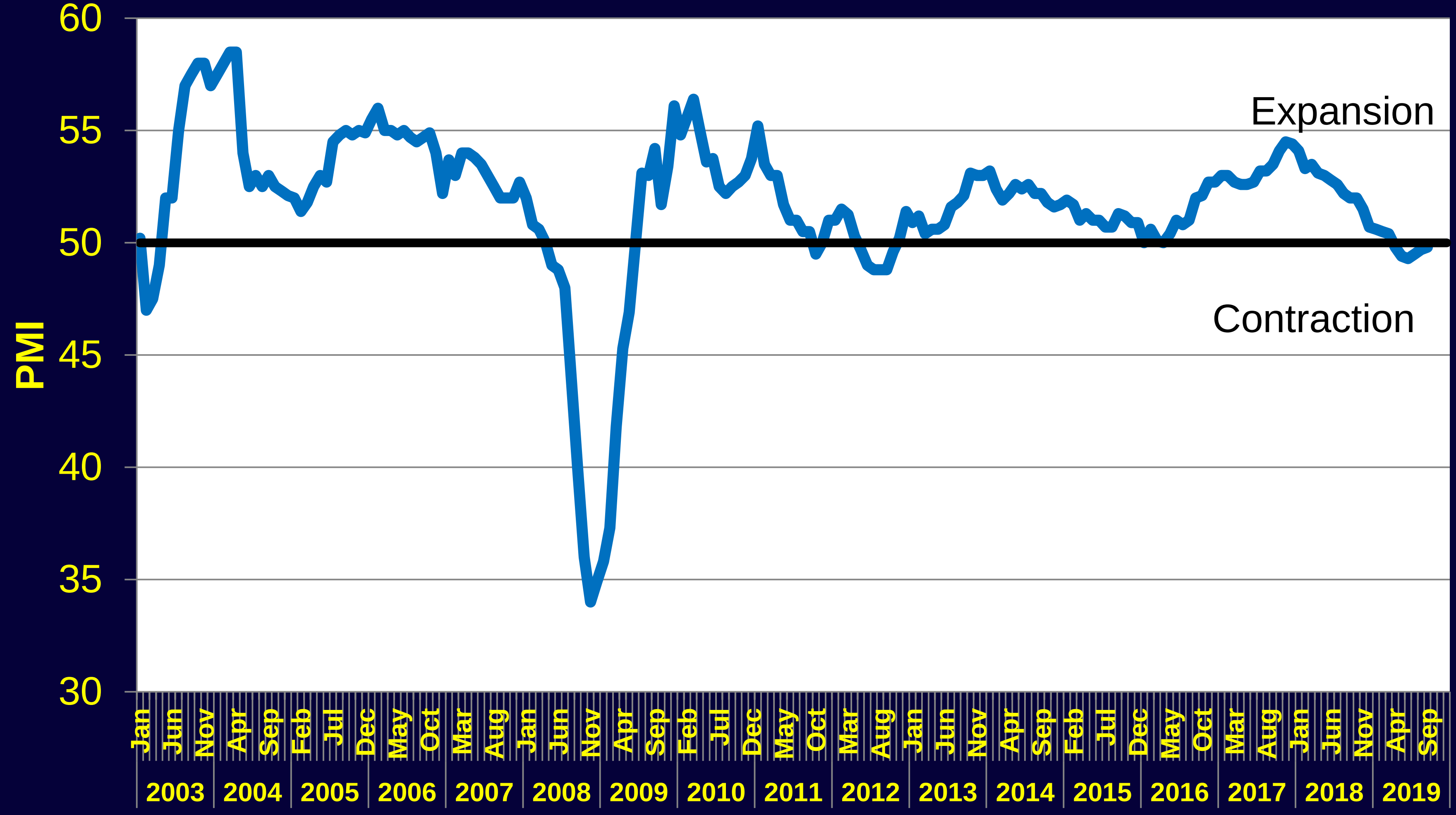
Purchasing Managers Indices

Useful but Sobering Leading Indicators

20191104

Global "Purchasing Managers" Index

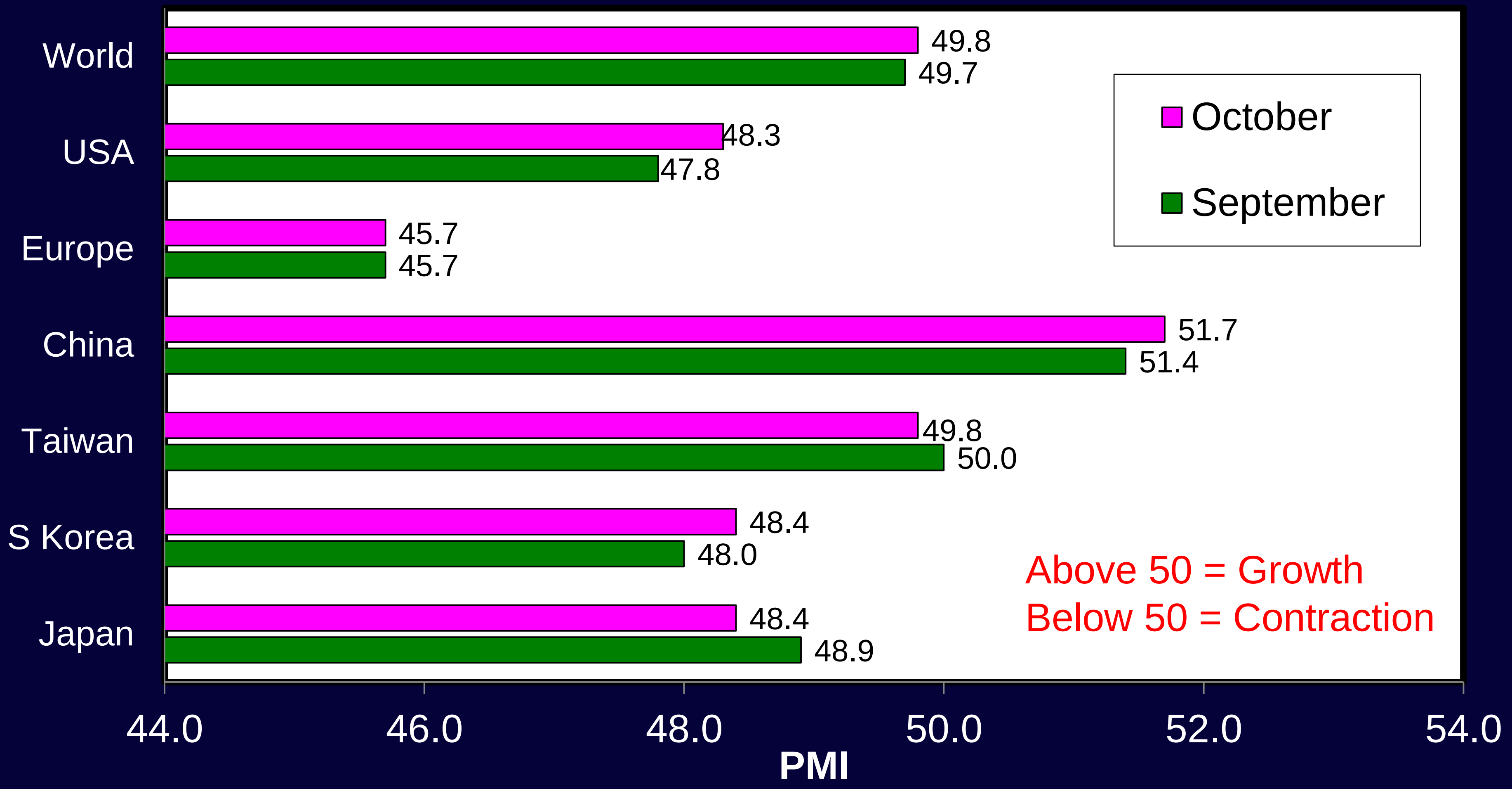
Diffusion Index, >50 = Growth



Markit Economics

20191109

Purchasing Managers' Indices October vs. September 2019

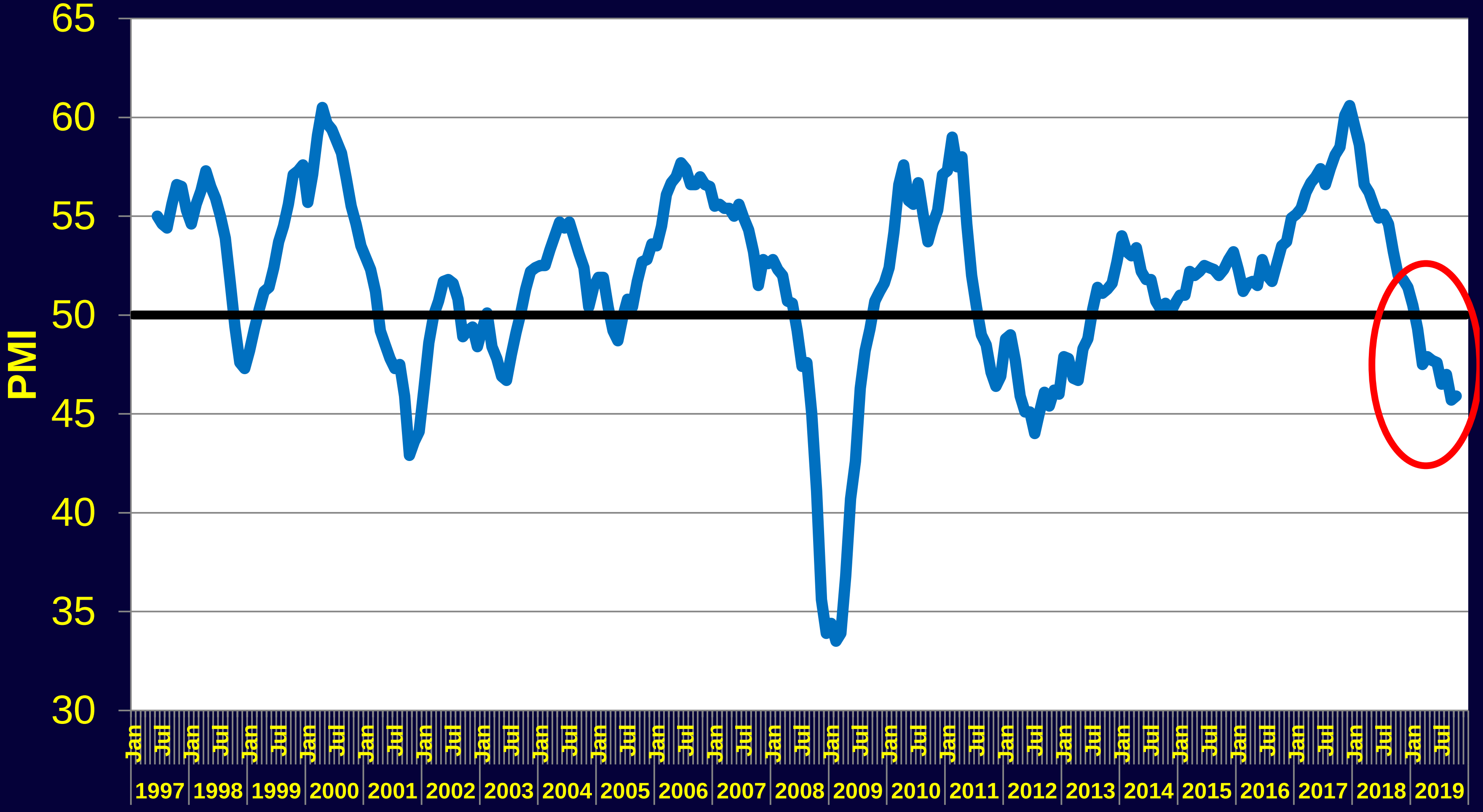


Markit Economics, ISM

20191104

Eurozone Manufacturing "Purchasing Managers" Index

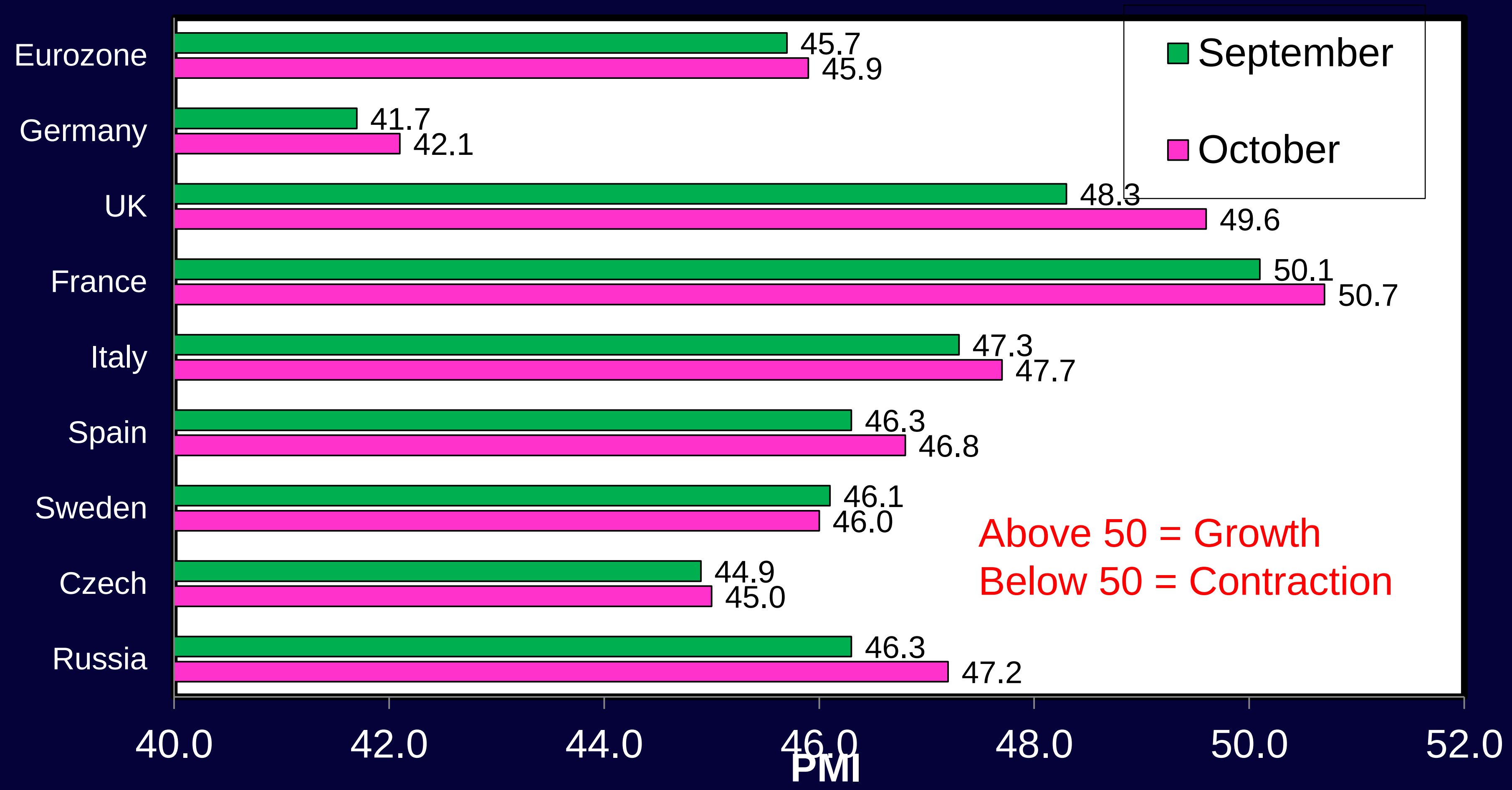
Diffusion Index, >50 = Growth



Markit Economics

European Purchasing Managers' Indices
October vs September 2019

20191104

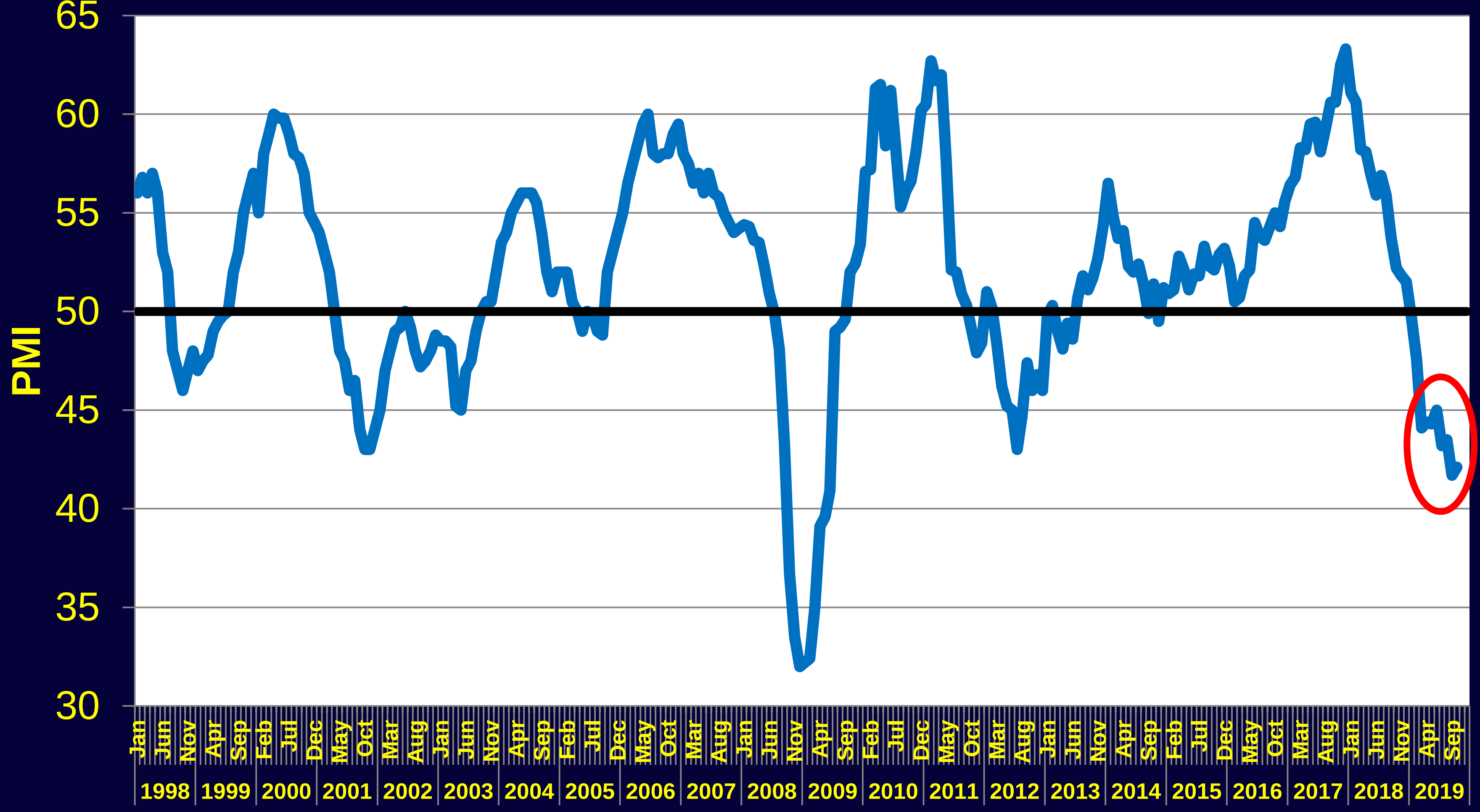


Markit Economics

20191104

Germany Manufacturing "Purchasing Managers" Index

Diffusion Index, >50 = Growth



Markit Economics

Electronic Equipment

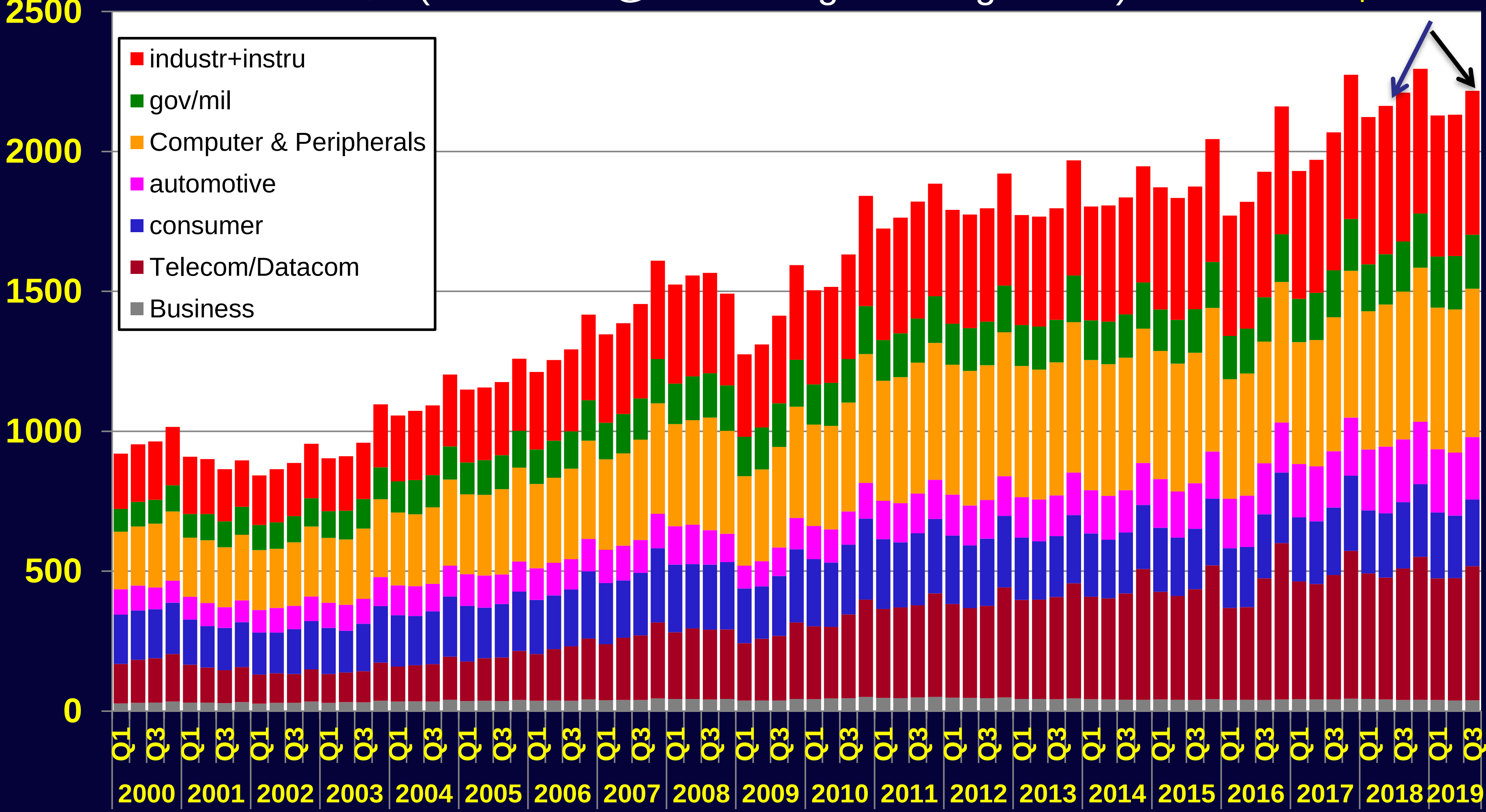
World

World Electronic Equipment Production By Type

20191108

Very Preliminary
3Q'19 est
Weighted avg
For total El Eq +0.3%

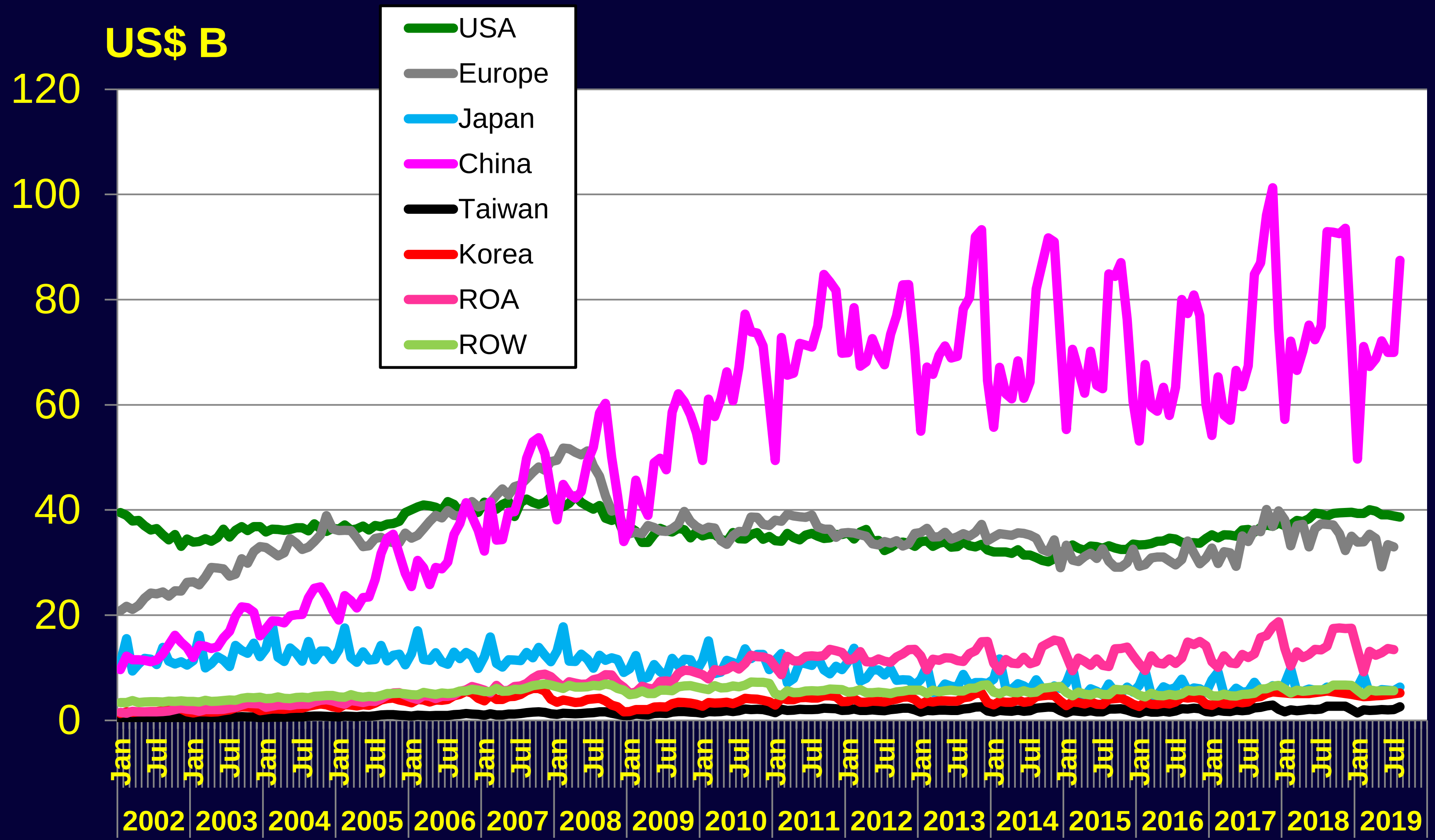
Annual Rate $B (converted @ fluctuating exchange rates)



World Electronic Equipment Monthly Shipments

20191104

Converted @ Fluctuating Exchange Rates

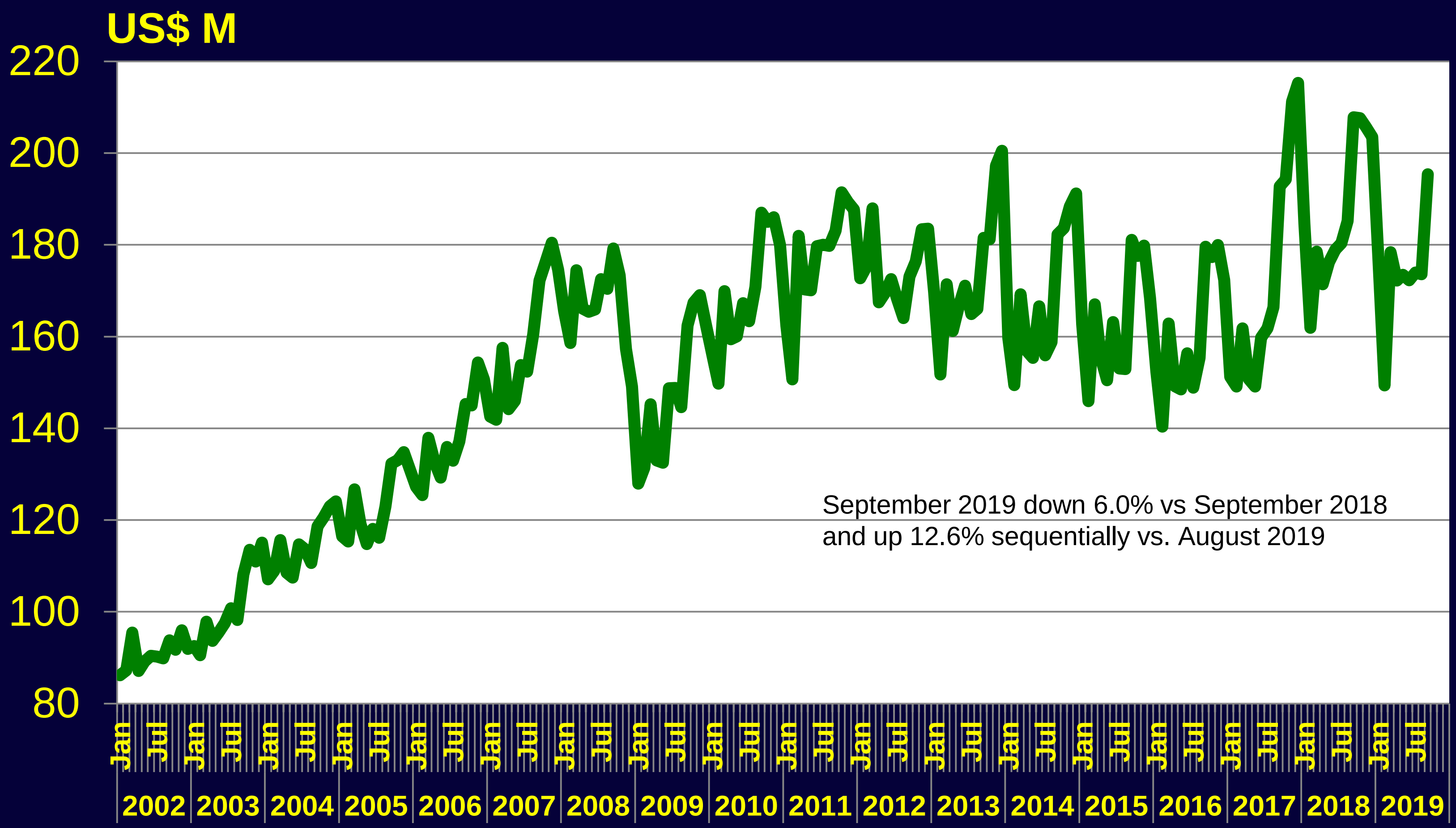


Source: Custer Consulting Group

20191104

World Electronic Equipment Monthly Shipments

Converted @ Fluctuating Exchange Rates



Source: Custer Consulting Group

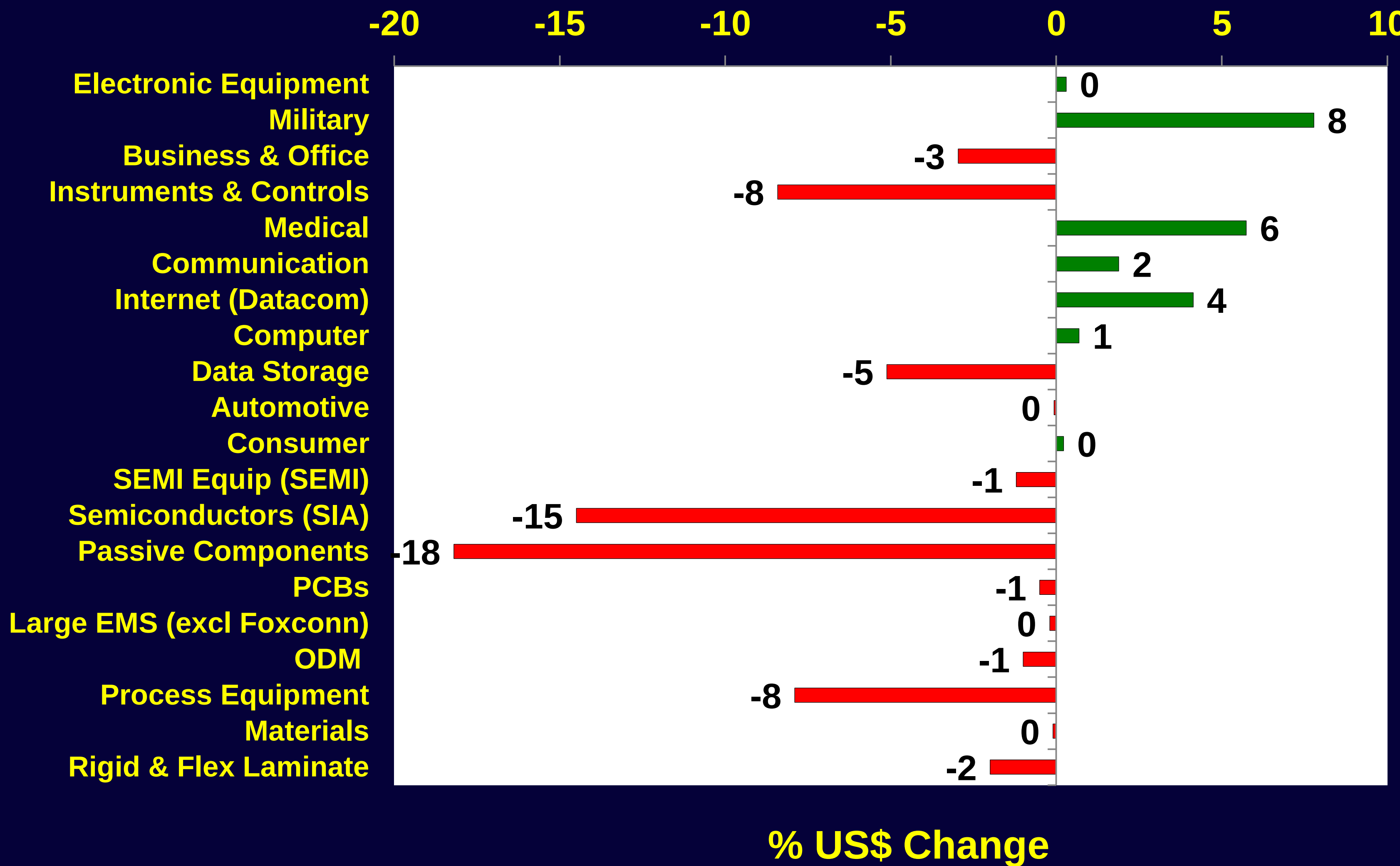
Electronic Supply Chain Growth

Europe & World

Global Electronic Supply Chain Growth

20191108

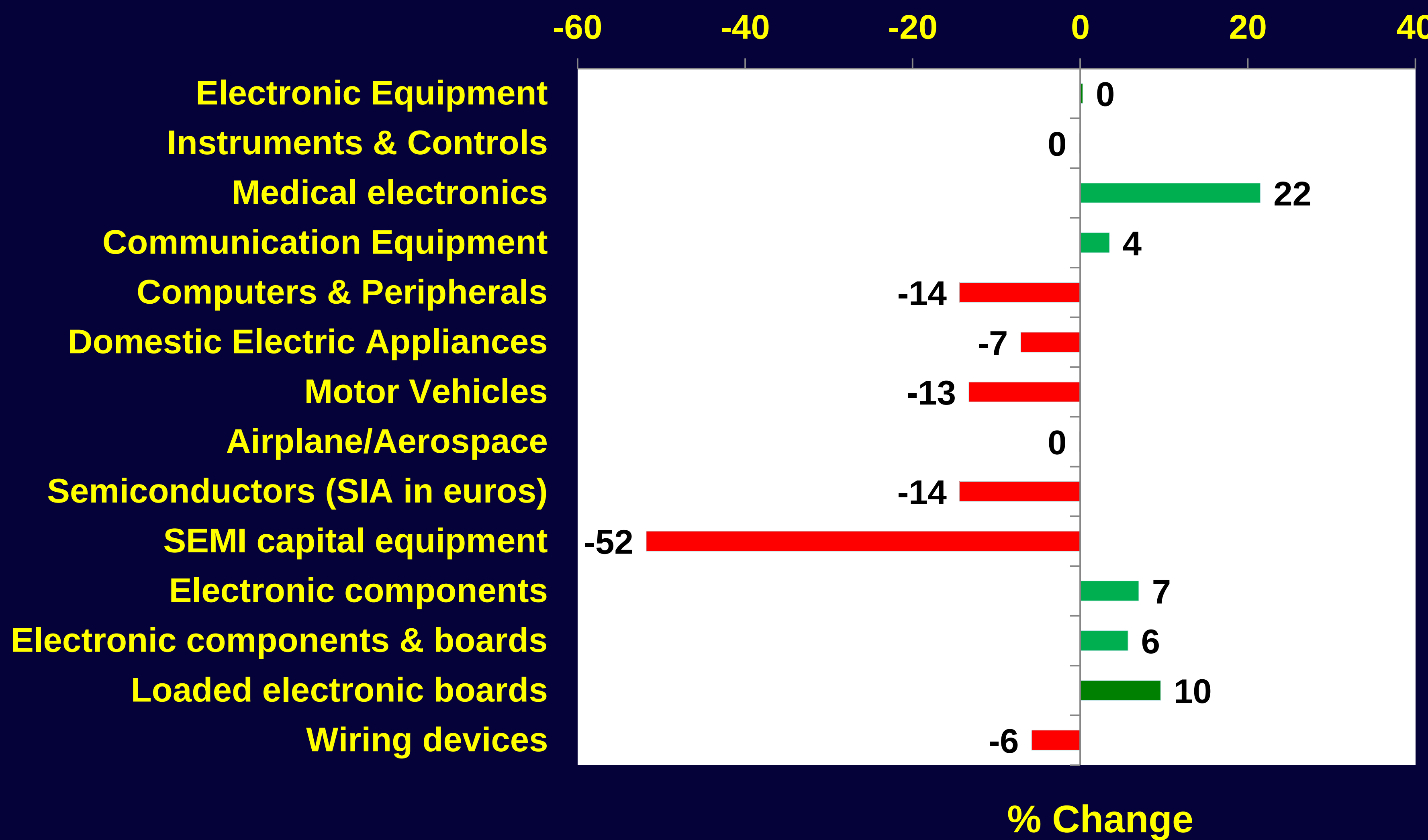
3Q'19 vs. 3Q'18 (Preliminary)



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

European Electronic Supply Chain Growth
2Q'19 vs 2Q'18

20190815



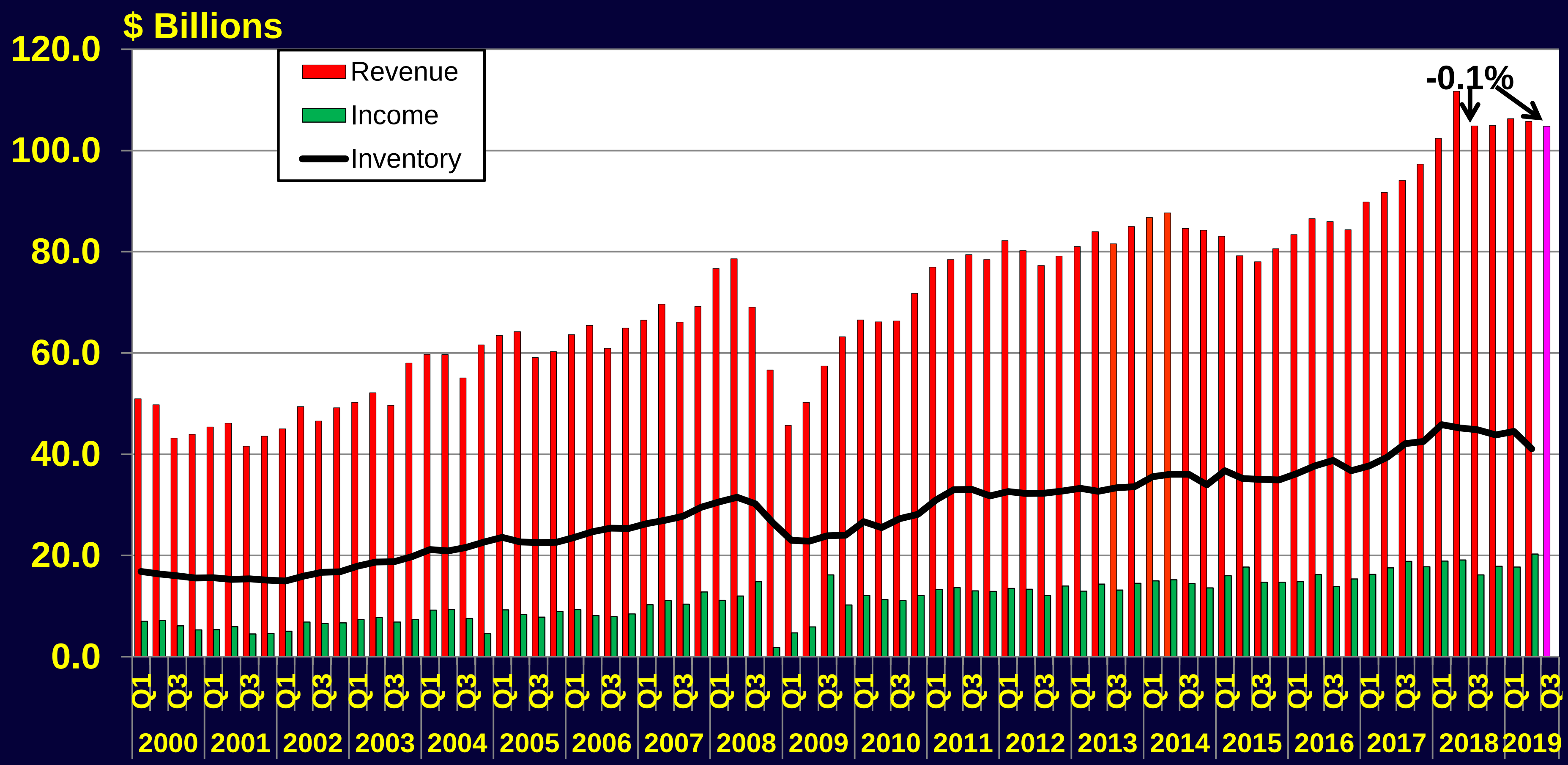
Euro denominated growth rates; Eurostat, SIA & Custer Consulting Group

Markets of European Focus

20191109

Automotive Equipment Suppliers Composite of 15 Public Companies

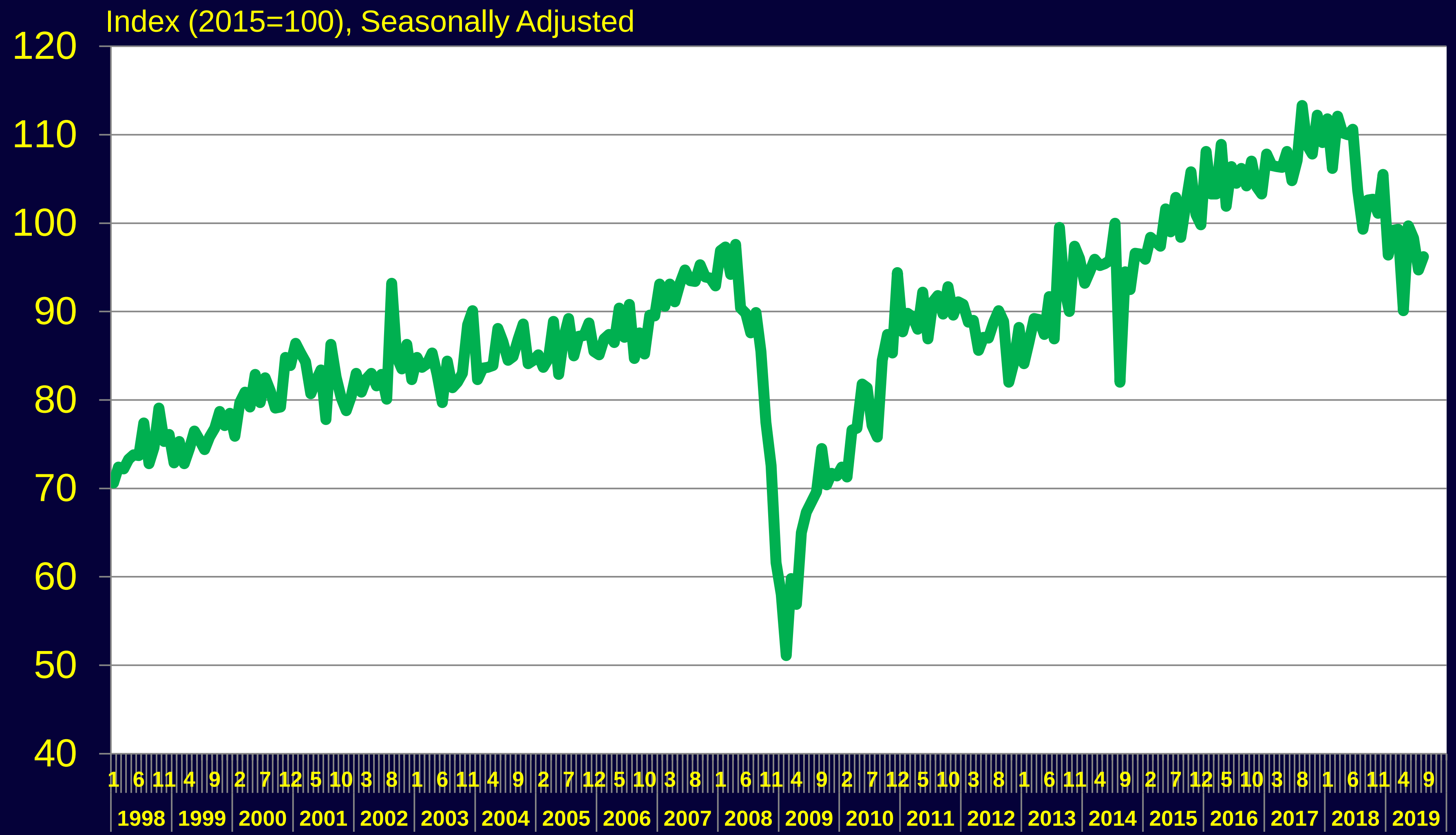
Revenue, Net Income & Inventory



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

20191014

European Motor Vehicle Production

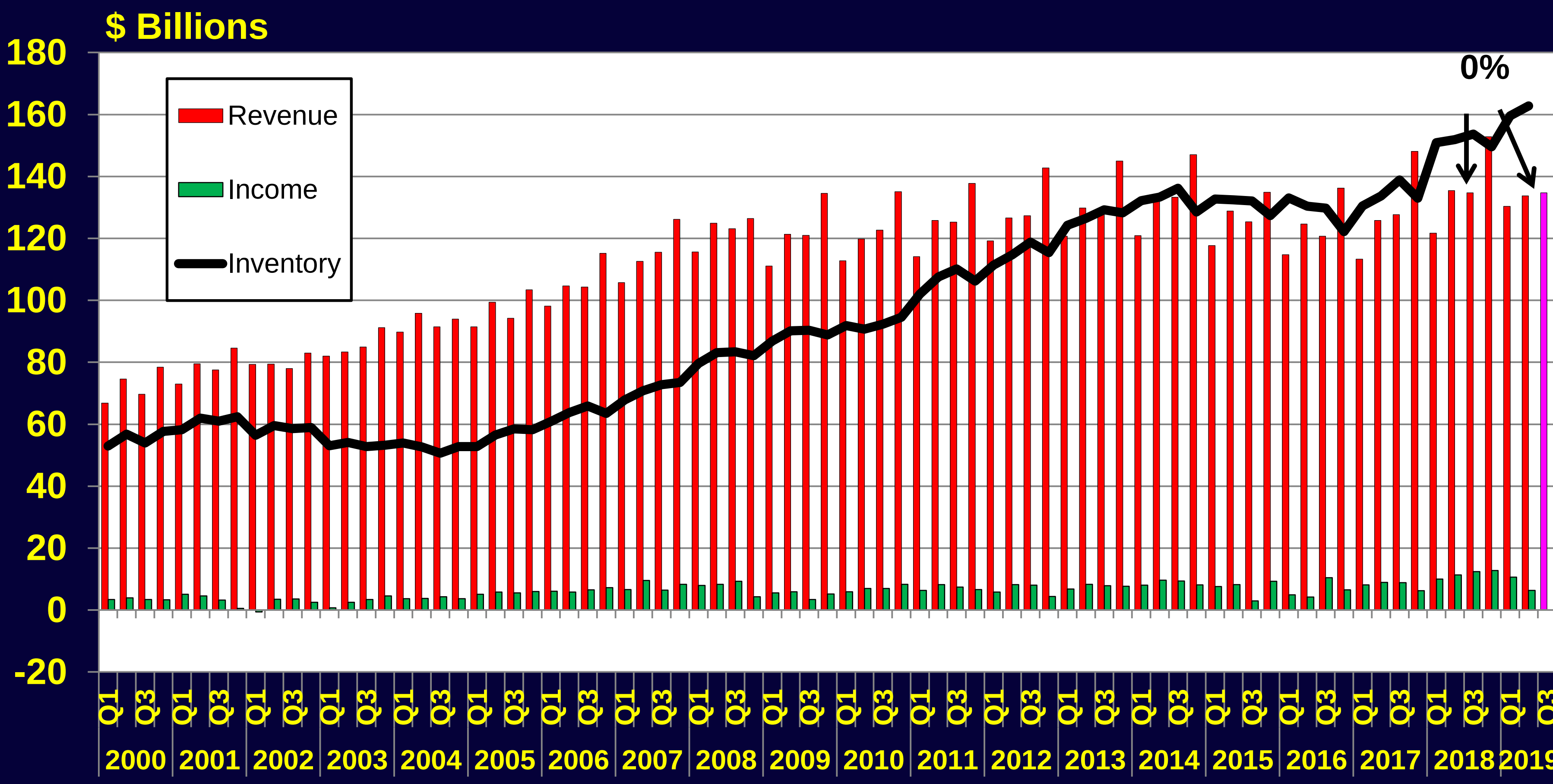


Eurostat, C291 category, EU 27 countries

20191109

Military & Aerospace Composite of 22 Public Companies

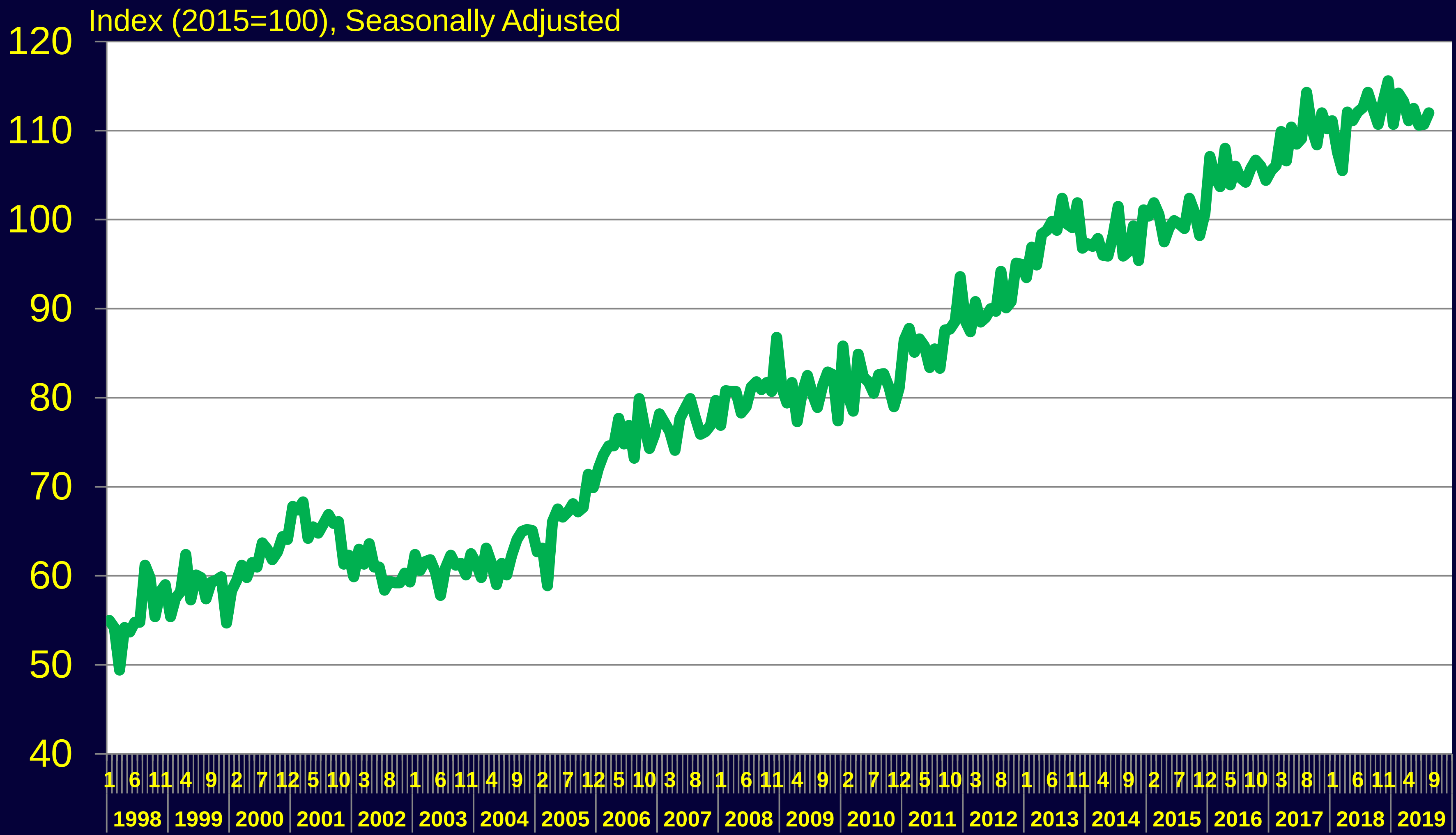
Revenue, Net Income & Inventory



Boeing, Bombadier, 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

20190913

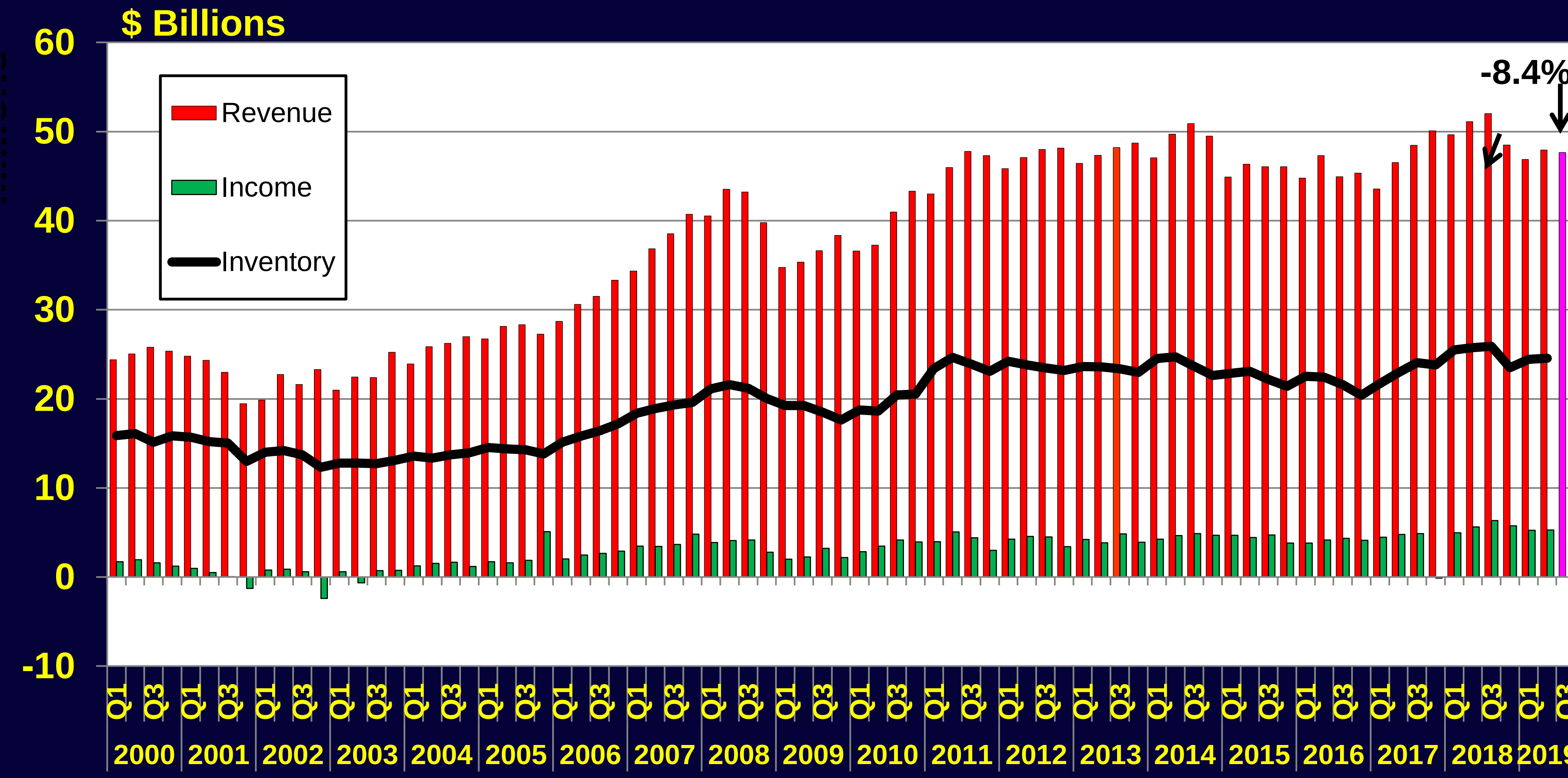


Eurostat, C303 category, EU 27 countries

2010-1109

Instruments & Control Equipment Composite of 16 Public Companies

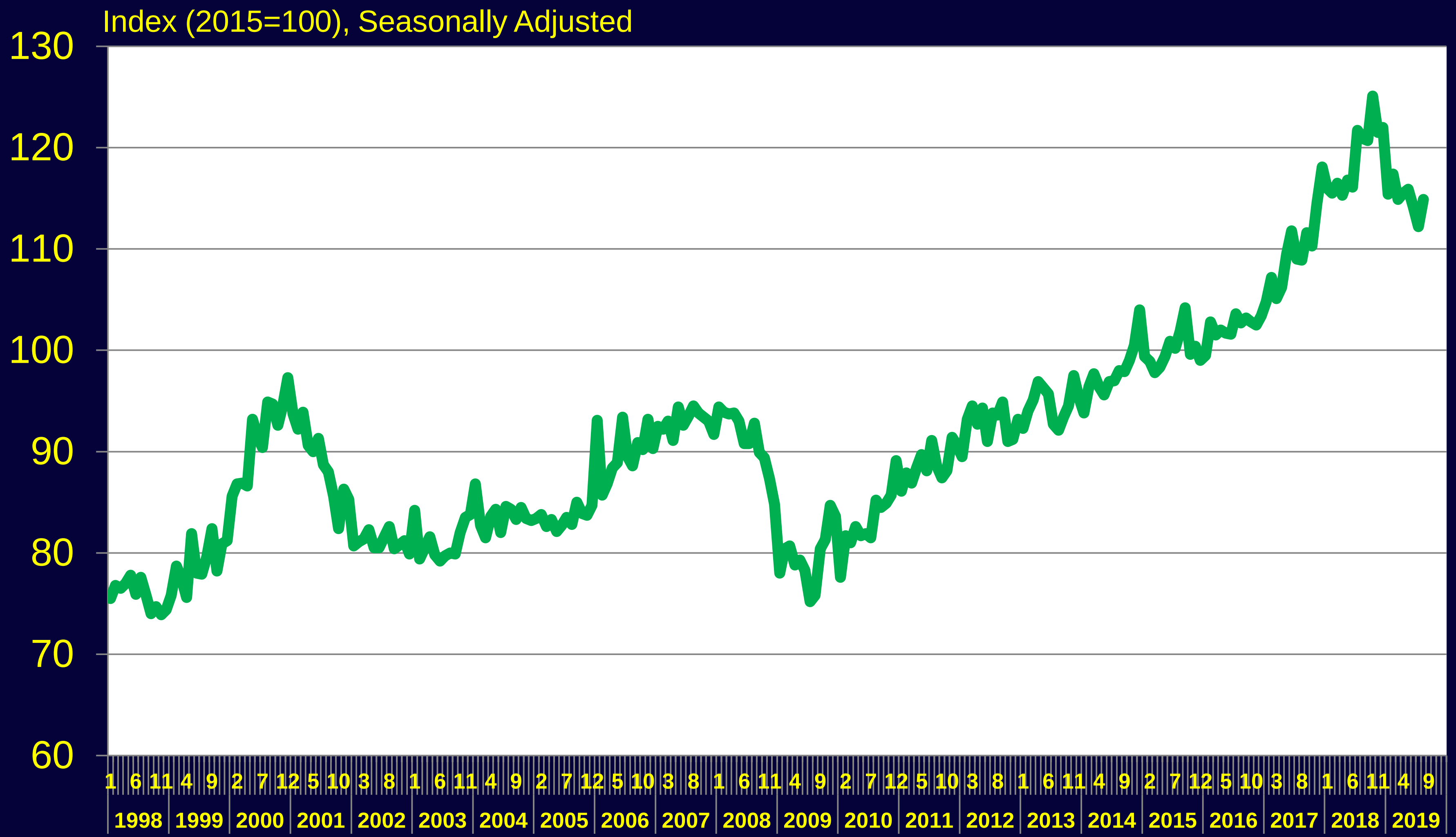
Revenue, Net Income & Inventory



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

20191013

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

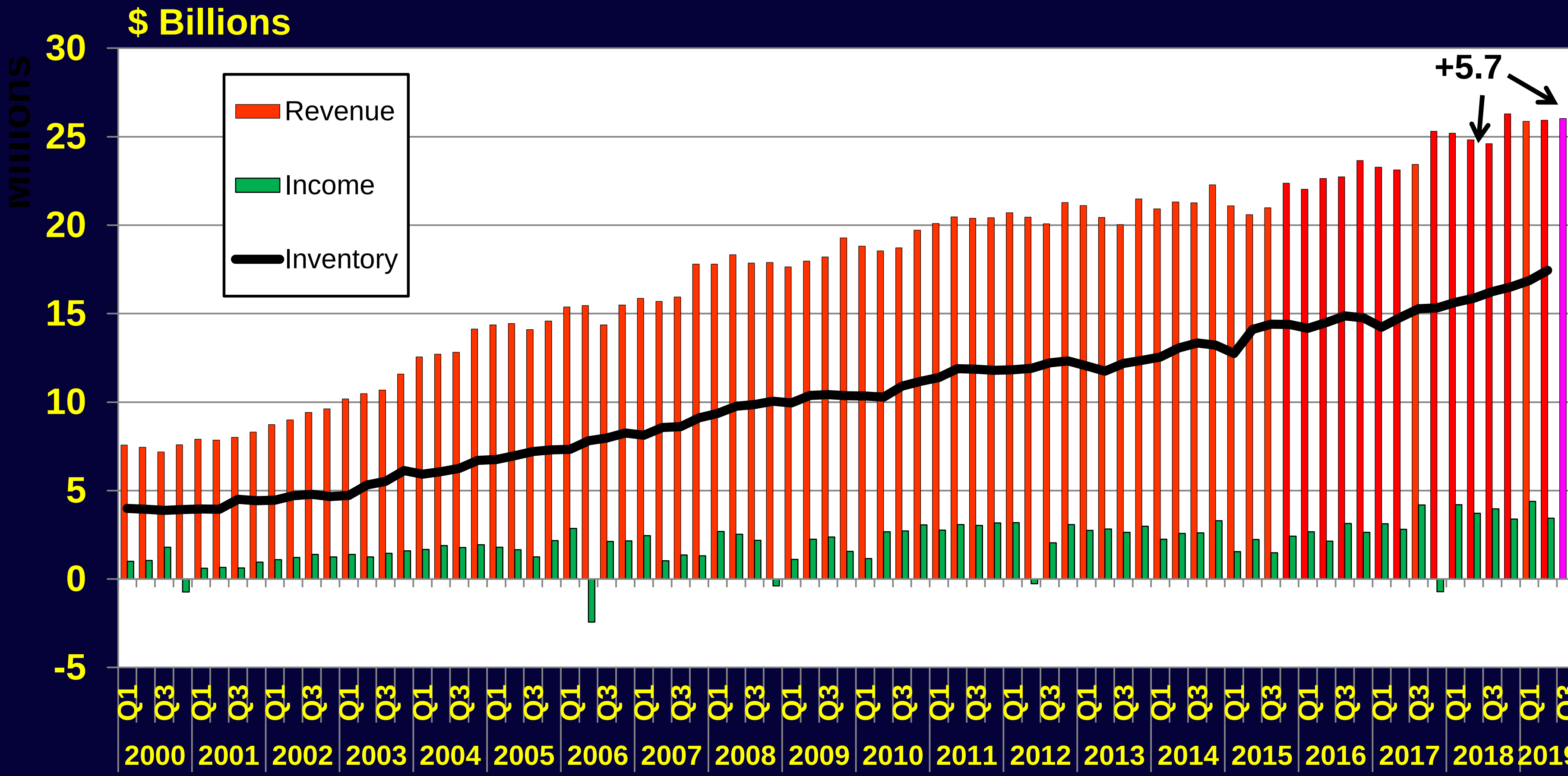


Eurostat, C2651 category, EU 27 countries

20191109

Medical Equipment
Composite of 21 Public Companies

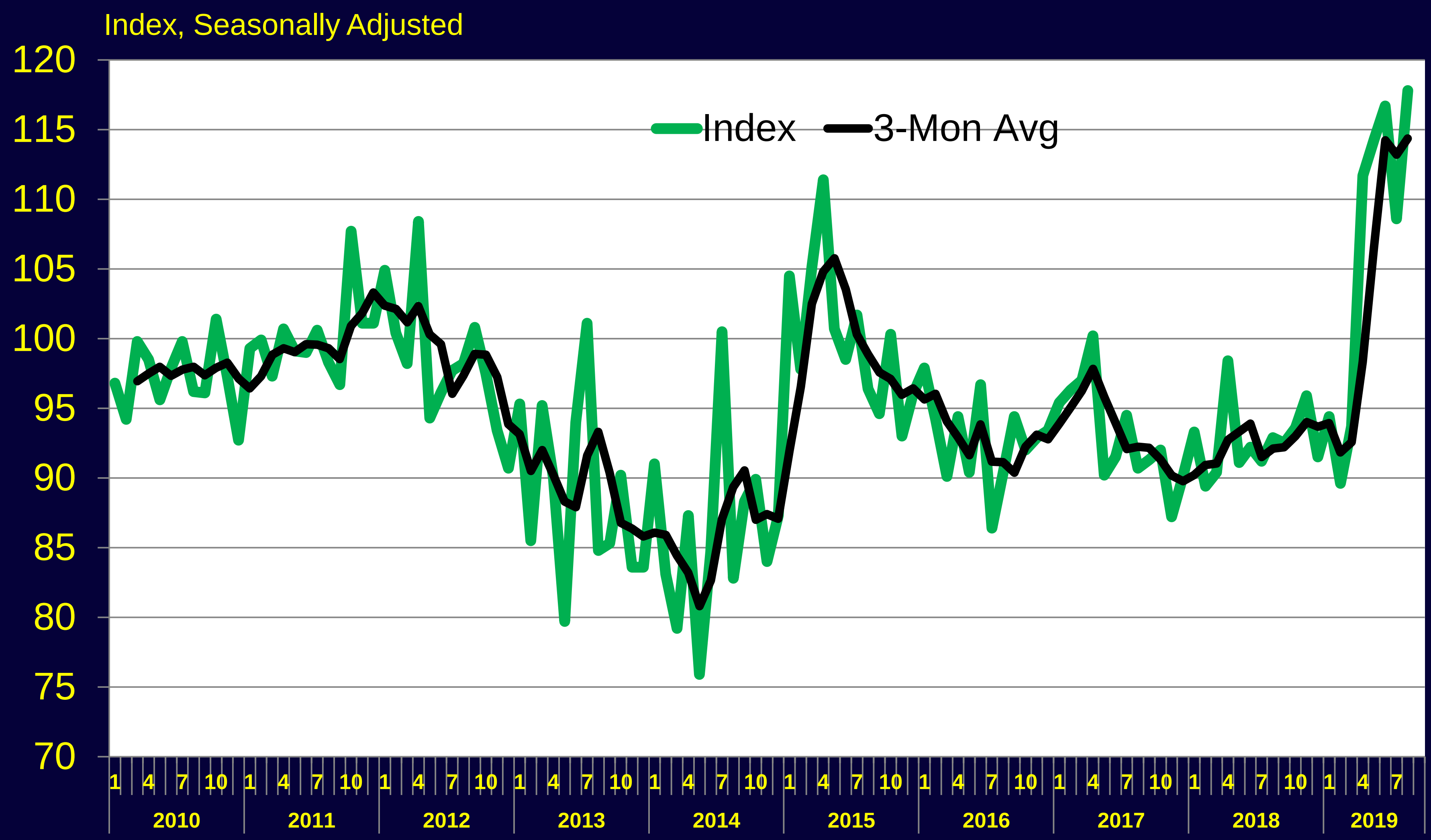
Revenue, Net Income & Inventory



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

20191013

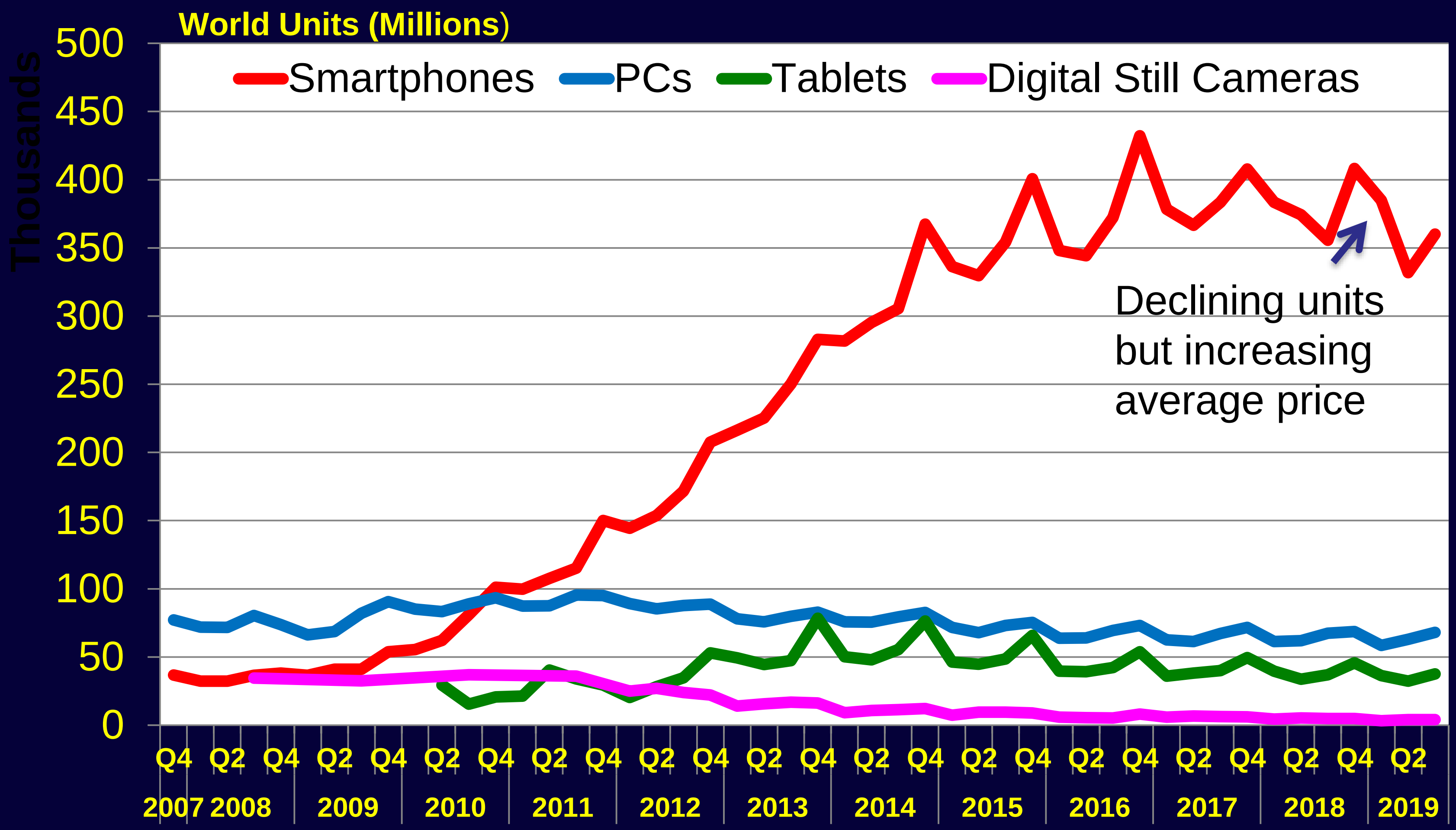
European Production - Irradiation, Electromedical & Electrotherapeutic Equipment



Eurostat, C266 category, EU 27 countries

“Volume” Markets are Flat

Smartphones Cannibalize PCs, Tablets & Digital Cameras



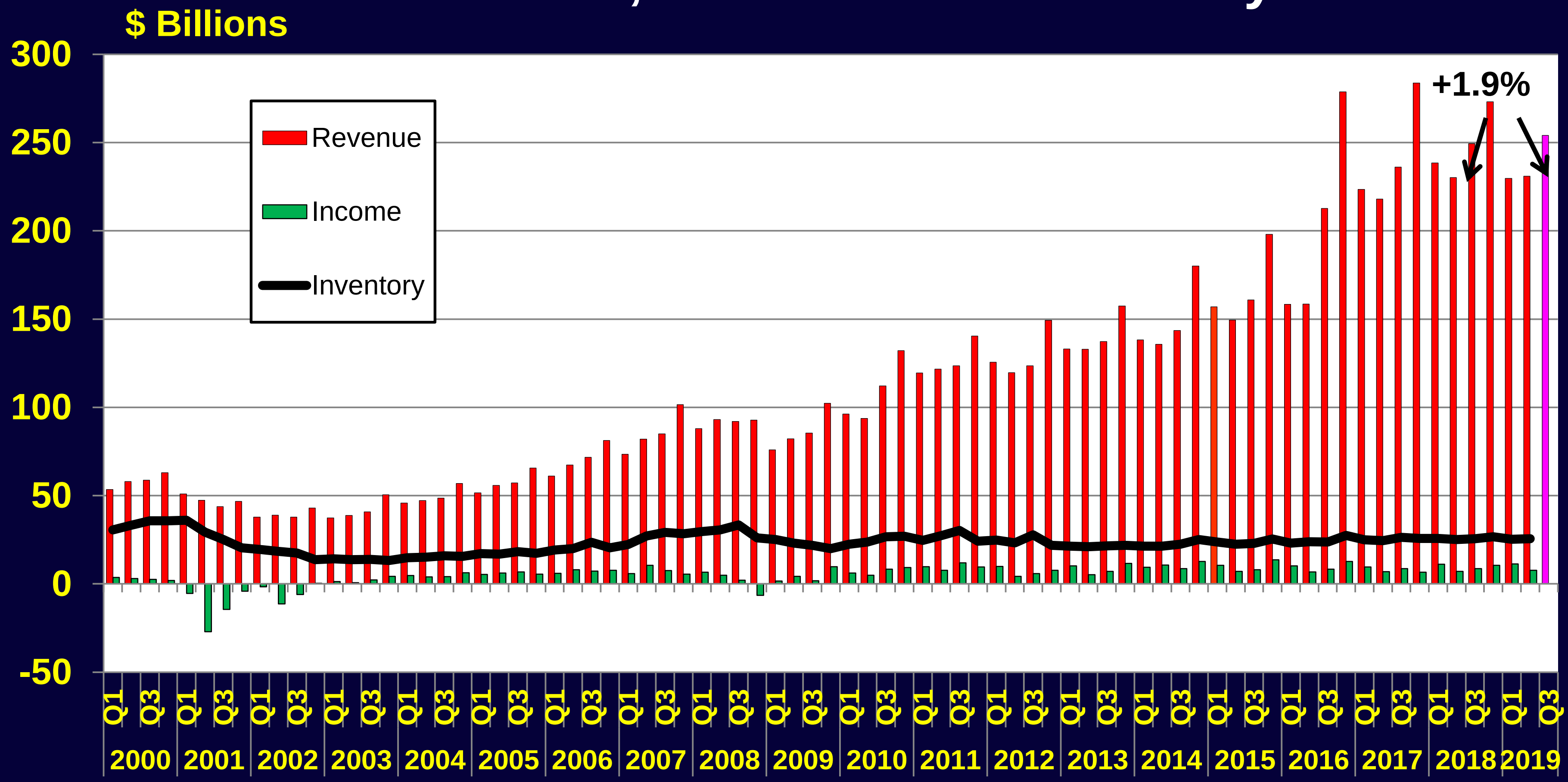
www.gartner.com; www.cipa.jp/; www.icinsights.com; www.idc.com; www.digitimes.com

Communication Equipment Suppliers Composite of 30 Companies

20191109

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

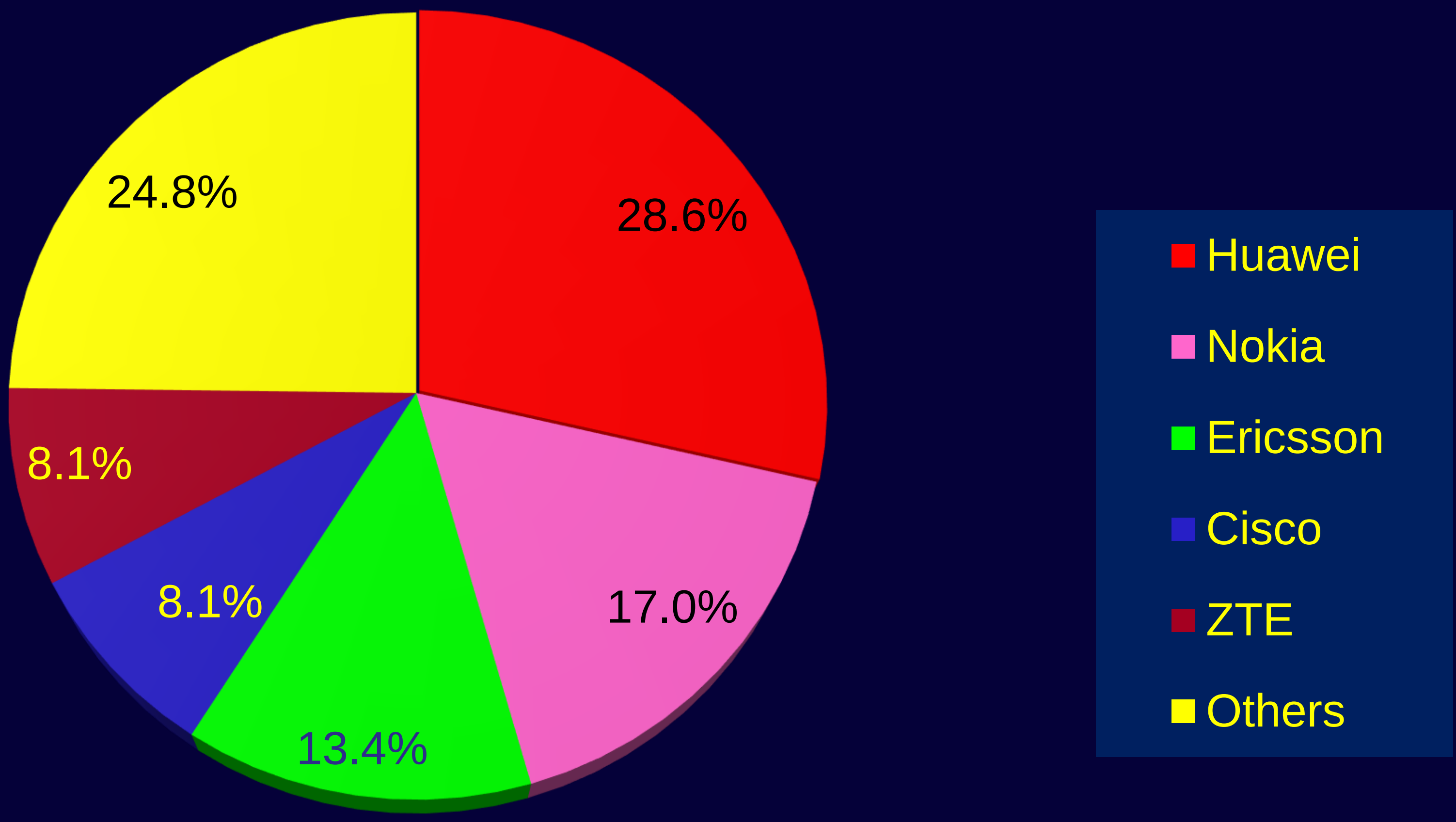
Revenue, Net Income & Inventory



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

Telecom Market Share 2018

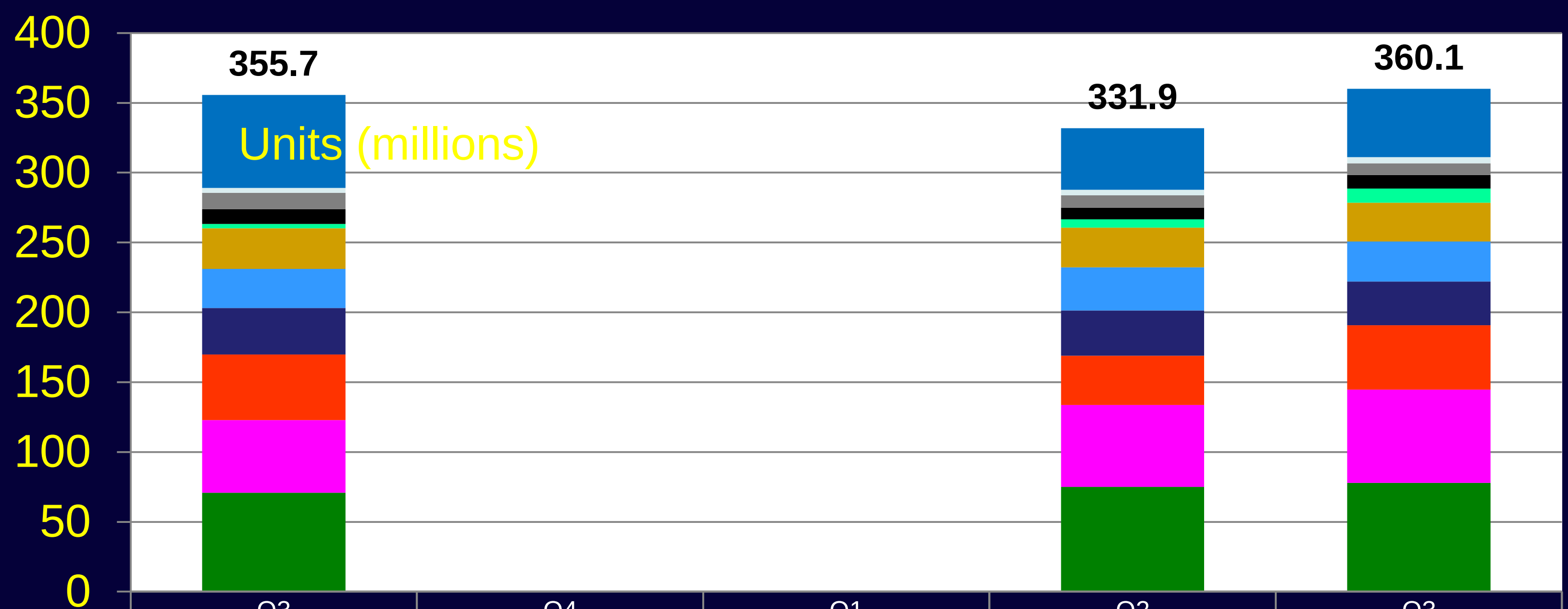
20190203



Dell’Oro 3/19

20191101

World Smartphones Shipments

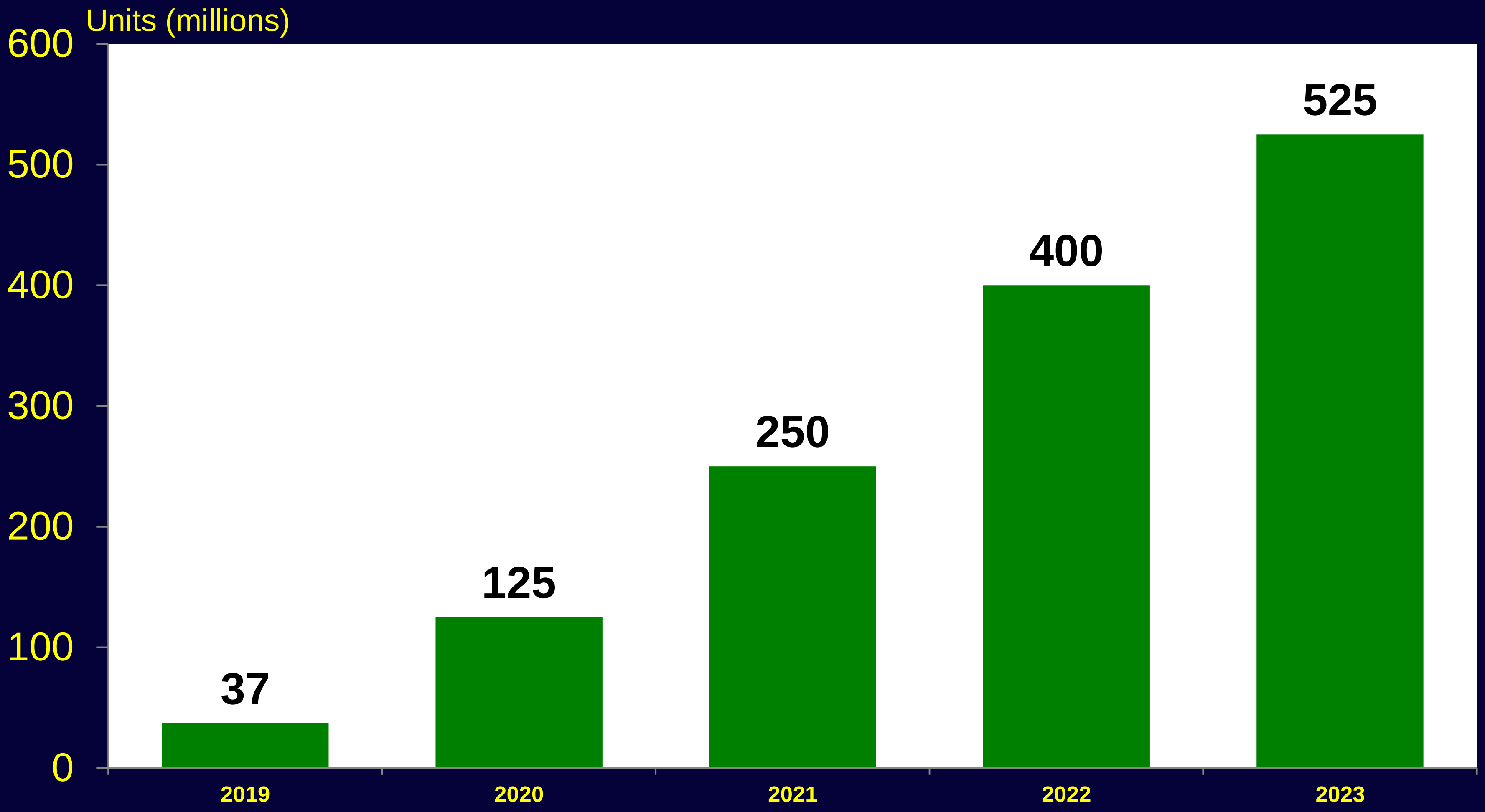


	Q3 2018	Q4 2018	Q1 2019	Q2 2019	Q3 2019
Total	355.7			331.9	360.1
Others	66.7			44.2	49.0
Techno	3.5			3.9	4.4
LG	11.6			8.9	8.3
Motorola	10.7			8.3	9.7
Realme	3.1			6.0	10.1
vivo	28.9			28.4	27.9
Oppo	28.1			30.8	28.6
Xiaomi	33.3			32.4	31.4
Apple	46.9			35.3	45.9
Huawei	52.0			58.7	66.8
Samsung	70.9			75.0	78.0

IHS 10/19

20160717

5G Handset Shipments



IHS Markit 4/19

Emerging Volume Markets

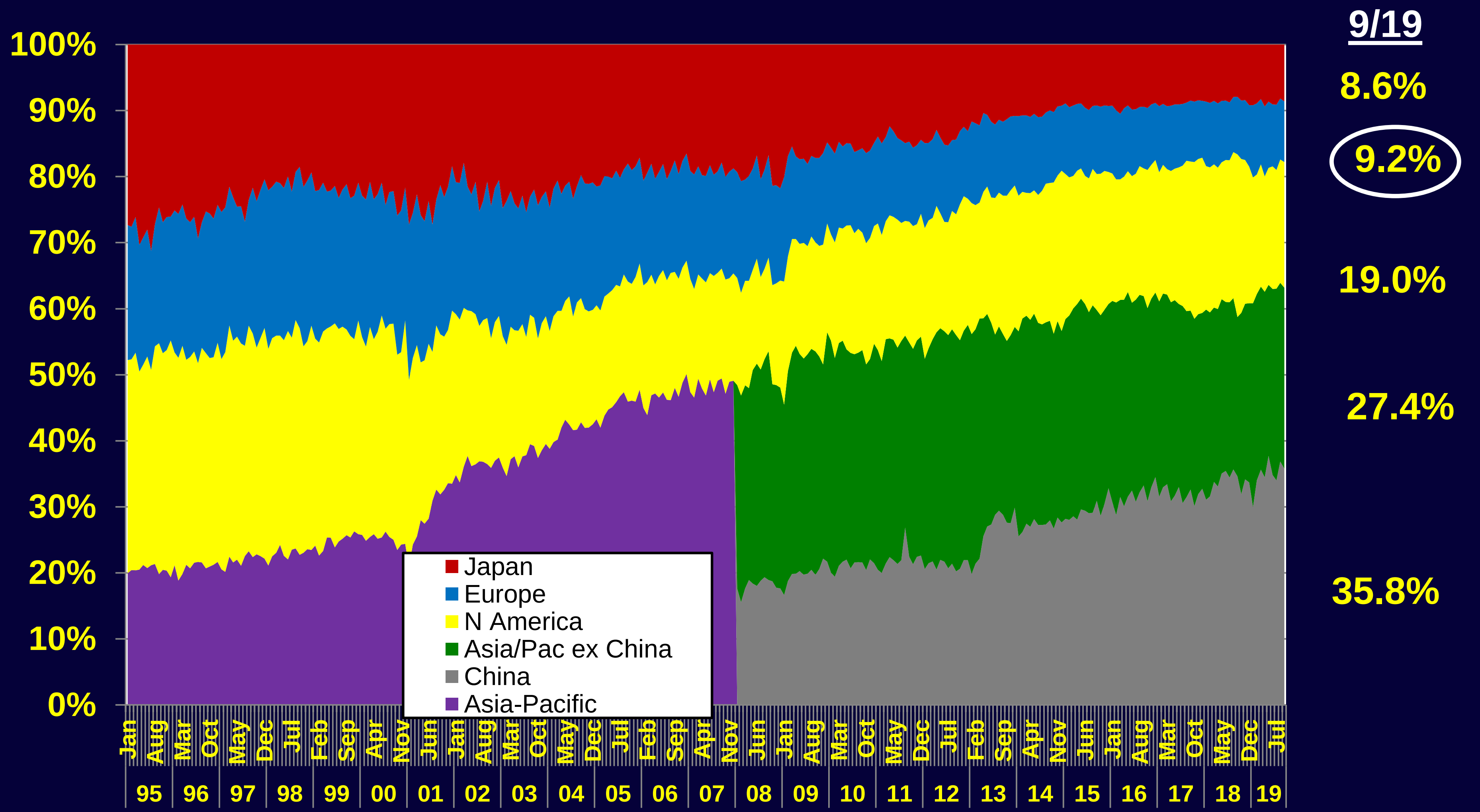
Autonomous cars
Internet of Things (IoT)
Industrial Internet of Things (IIoT)
Cloud storage
$\boxed{\text{5G Handsets \& Infrastructure}}$
Virtual & Augmented Reality
AI/Machine Learning
Smart Cities, Smart Agriculture
Drones
Robots
Wearables
3D Printing
Health Care

Semiconductors

20101103

Total Semiconductor Shipments to an Area

Monthly Shipments - Reporting Firms (showing China)

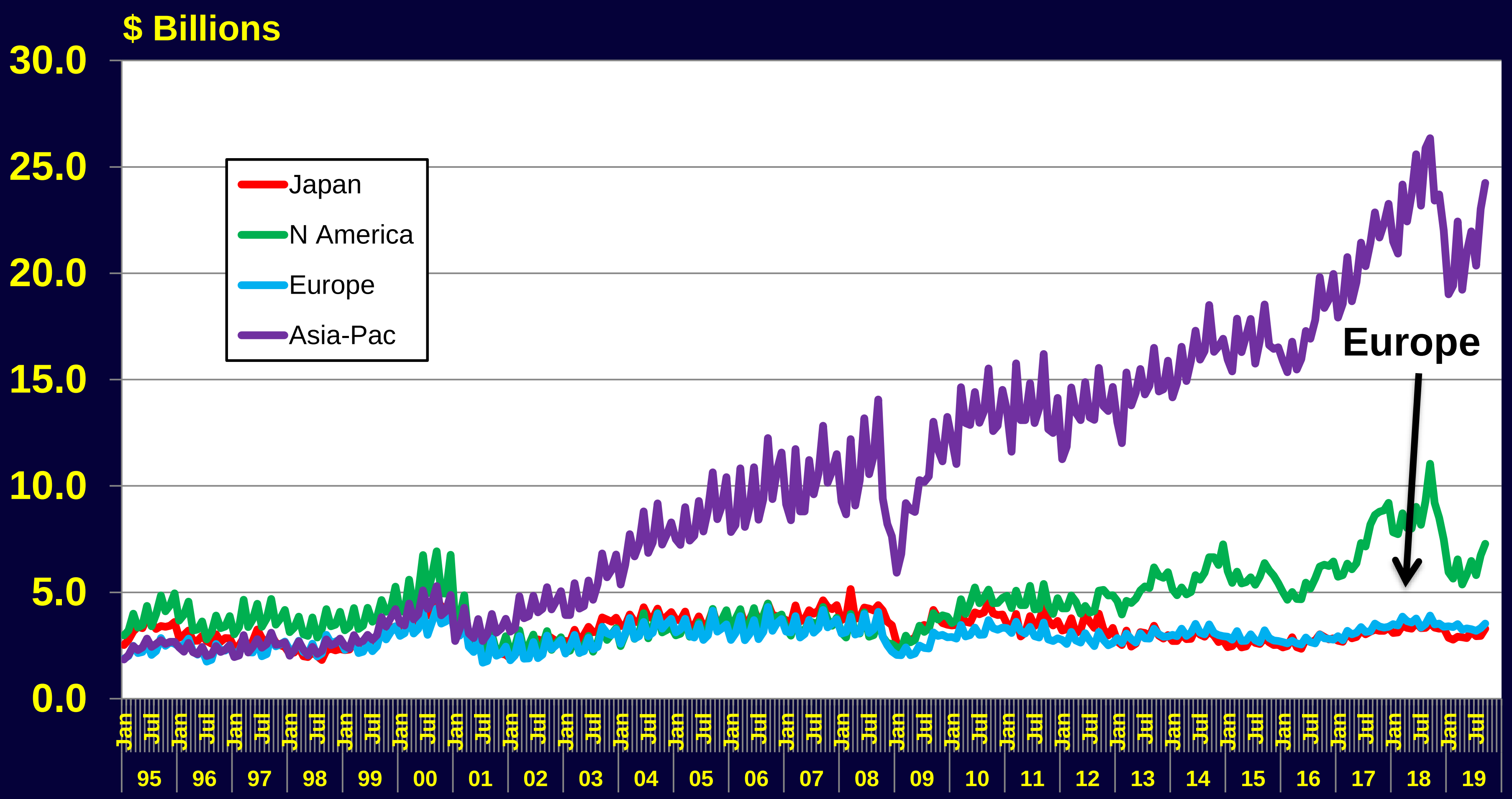


SIA website: www.semiconductors.org/

20191103

Total Semiconductor Shipments to an Area

Monthly Shipments - Reporting Firms

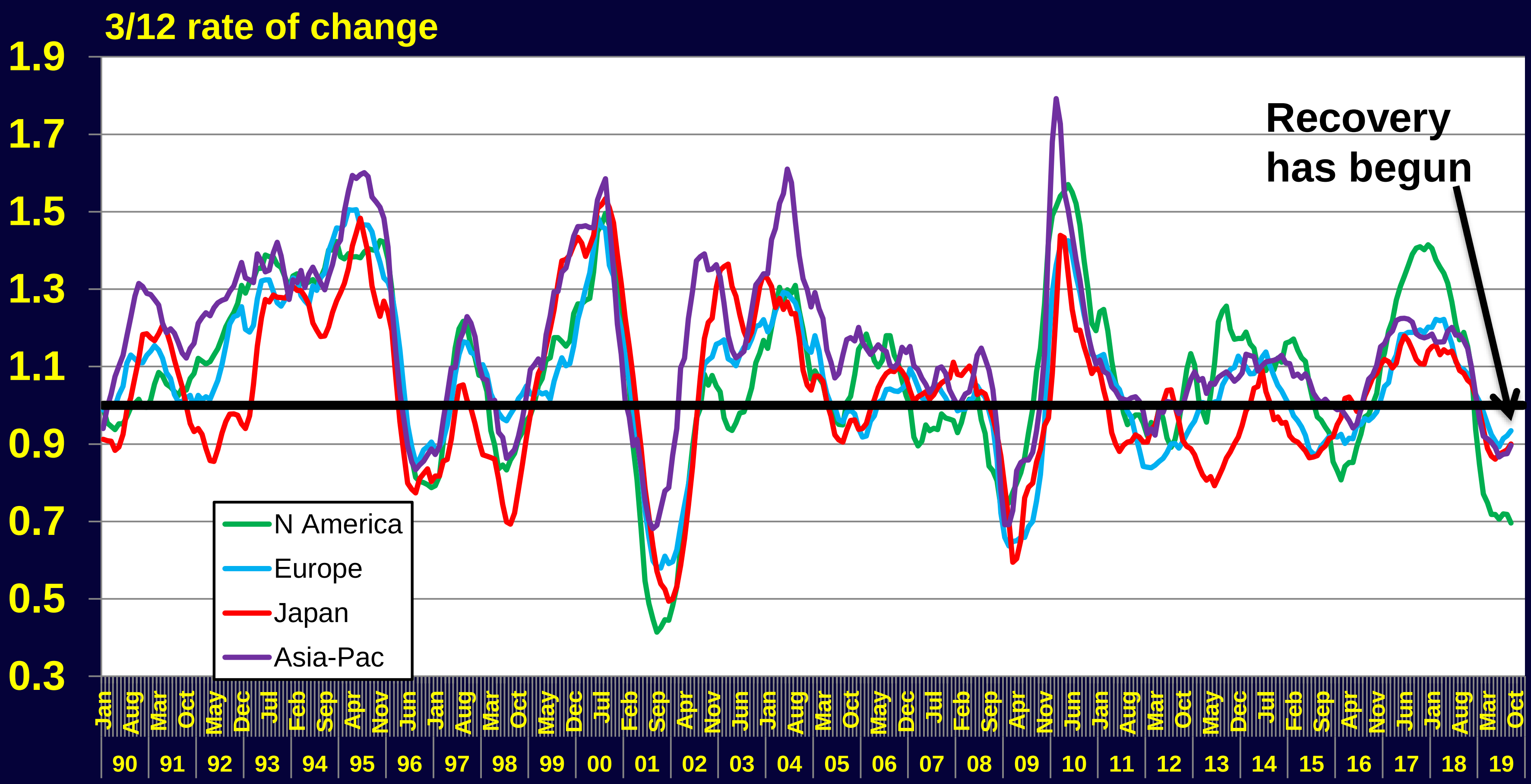


www.wsts.org,
www.semiconductors.org

Semiconductor Growth Rates

20191103

Total $ Shipments to an Area



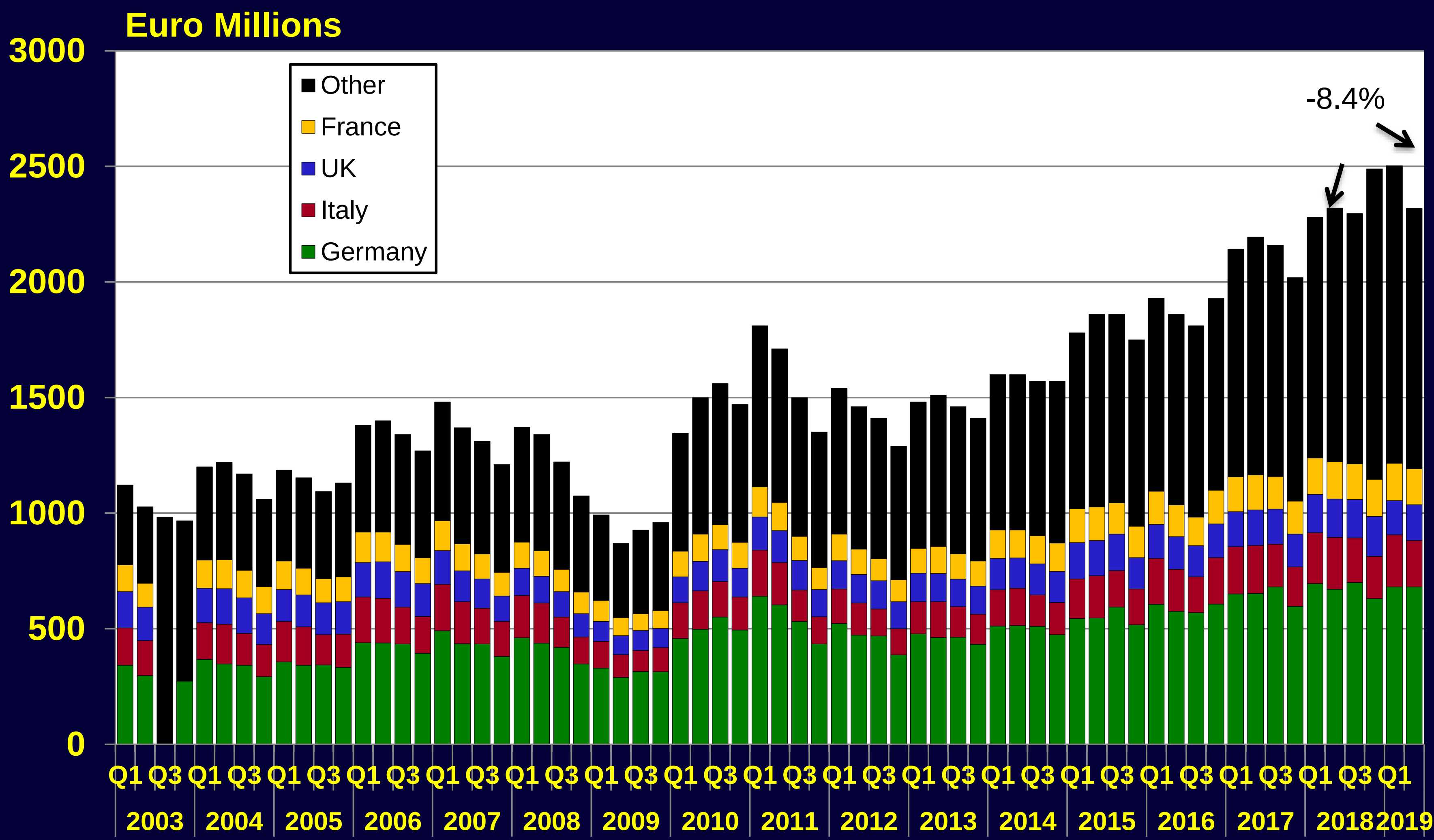
Total $ Shipments from All Countries to an Area

SIA website: www.semiconductors.org/

European Component Shipments by Country

20190816

DMASS - European Semiconductor Distribution Industry

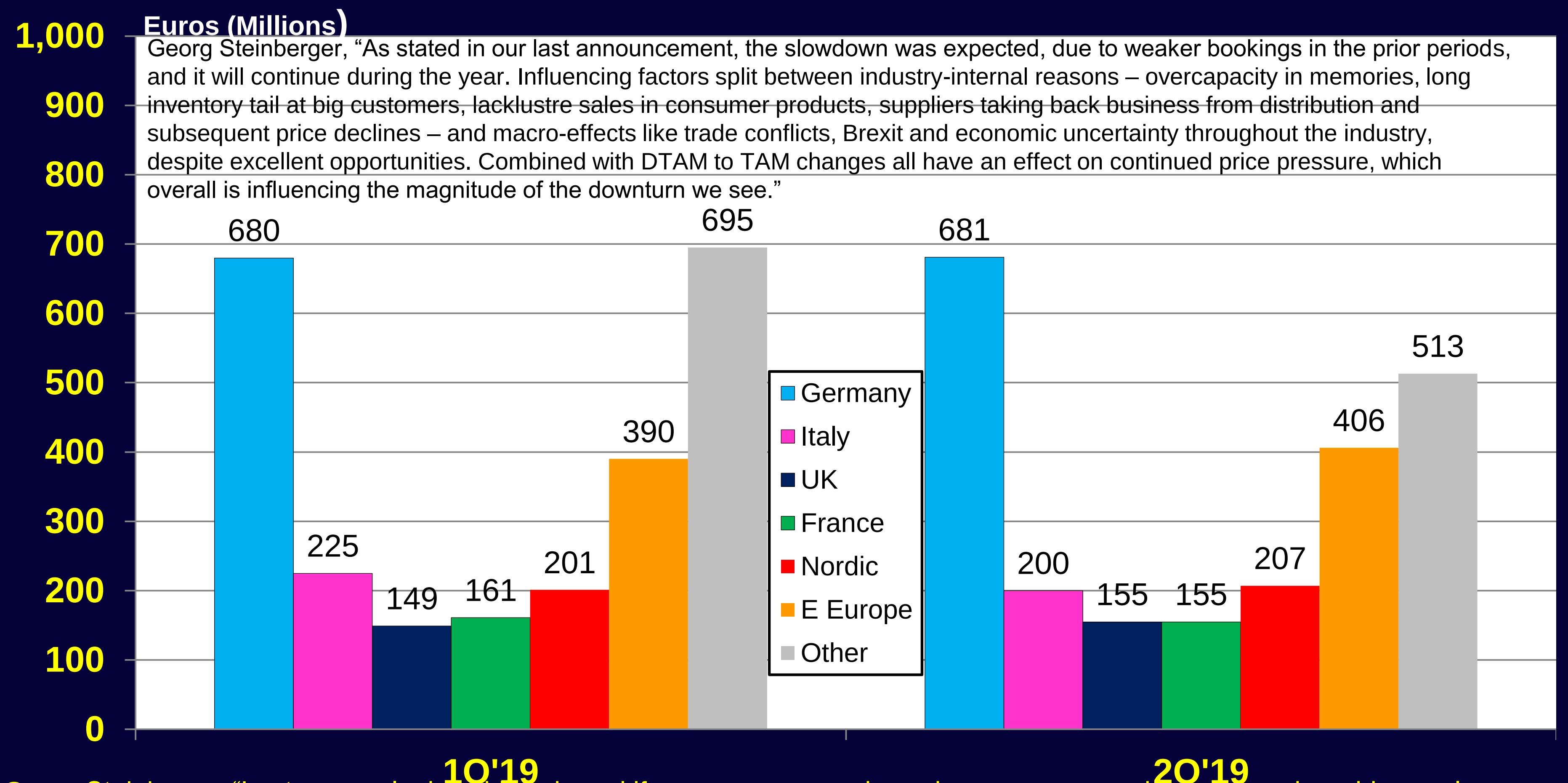


http://dmass.com/ 8/19

20190608

DMASS

European Semiconductor Distribution Industry



Georg Steinberger:"Last quarter looks a bit awkward if you compare products that are connected through project-driven sales – Analog grows while MOS Micro declines, Programmable Logic drops while ASSPs clearly explode, Opto and LEDs decline, Sensors grow. If you would pick a real setback, it would probably be the disappointing LED business. To be noted positively are Power-MOS which have grown to the second-biggest product category in distribution, only outperformed by Power Management. And Digital Logic is slowly starting to overtake Programmable Logic. Comrade Trend says hello…"

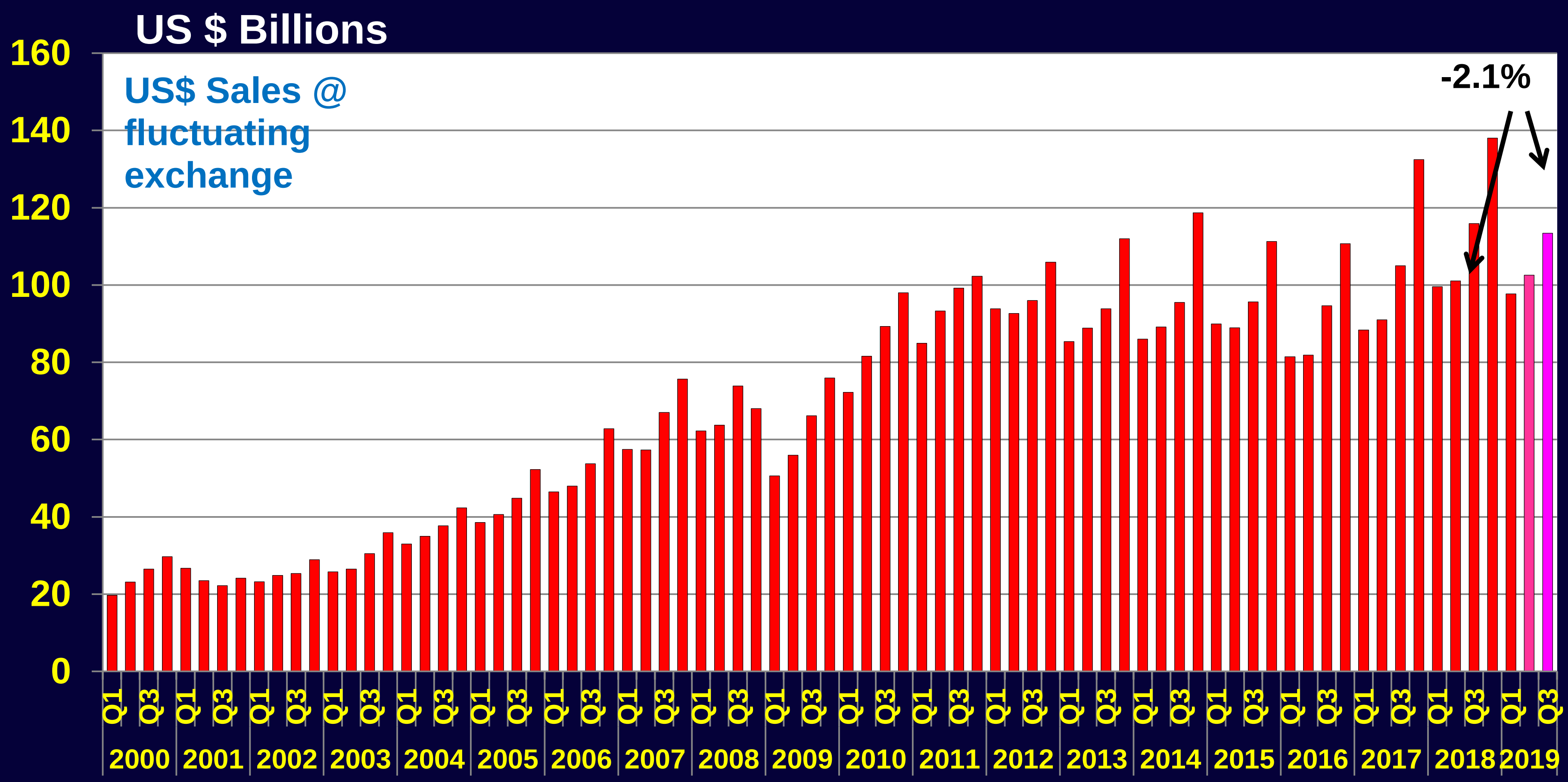
DMASS 8/19; http://dmass.com/

EMS & ODM Companies

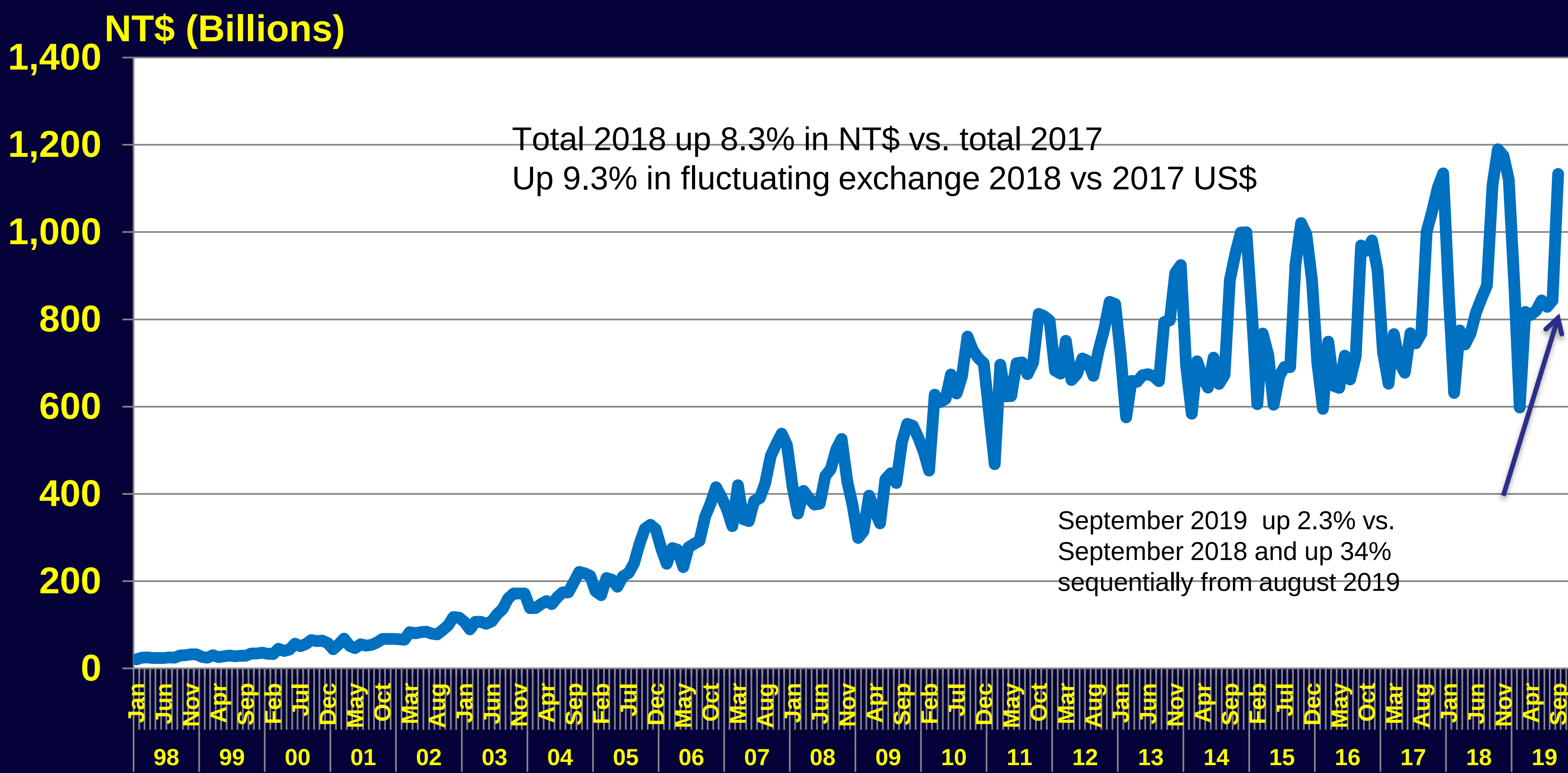
20191108

Global EMS & ODM Companies
Composite of 52 Public Companies

Revenue



Taiwan ODM Companies
Composite Sales of 11 Large Manufacturers



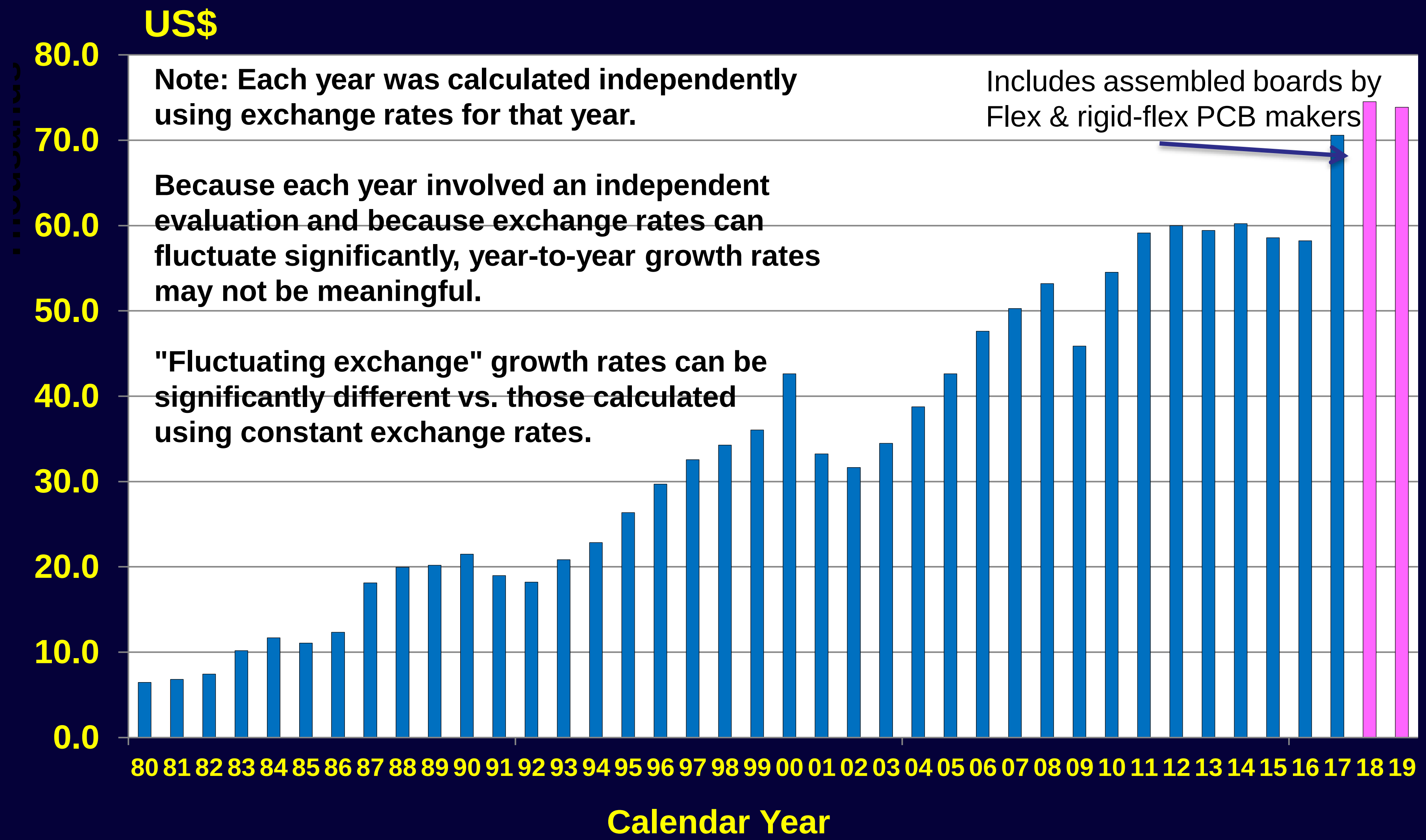
Company Financial Releases

Calendar Year

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

PCB
Market

World PCB Production 1980-2019



IPC: World PCB Production Report 2016 + Nakahara estimates for 2018 & 2019

World's Top 20 PCB Companies – 2018 Revenues US$M (converted at 2018 exchange rates)

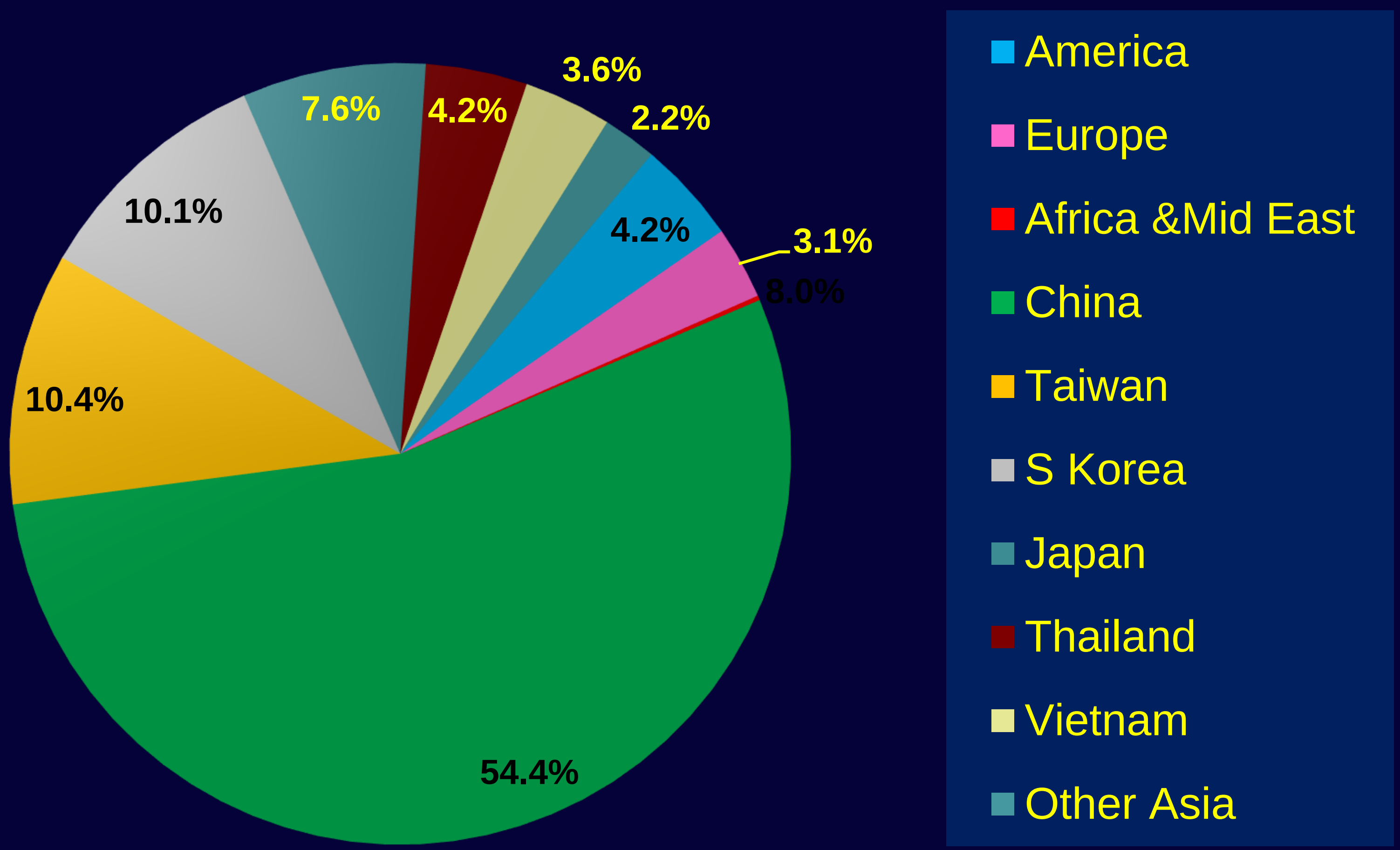
Rank	Maker	Nationality	2017	2018	Growth
1	ZD Tech*	Taiwan	3,608	3,929	8.9%
2	TTM Technologies	U.S.A.	2,659	2,847	7.1%
3	Nippon Mektron*	Japan	3,283	2,704	-17.6%
4	Unimicron	Taiwan	2,155	2,513	16.6%
5	Tripod	Taiwan	1,519	1,728	13.8%
6	Mflex (DSBJ)*	China	966	1,725	78.6%
7	Compeq	Taiwan	1,789	1,685	-5.8%
8	HannStar	Taiwan	1,314	1,435	9.2%
9	Samsung E-M	S. Korea	1,279	1,348	5.4%
10	KB Chem PCB Group	China	1,040	1,237	18.9%
11	AT&S	Austria	1,175	1,218	3.6%
12	Young Poong Group*	S. Korea	1,746	1,217	-30.3%
13	Fujikura*	Japan	1,138	1,155	1.5%
14	Shennan Circuit	China	860	1,152	40.0%
15	Meiko	Japan	986	1,081	9.6%
16	Ibiden	Japan	1,051	1,054	0.3%
17	Wus Group	Taiwan	880	1,016	15.4%
18	Nanya PCB	Taiwan	883	956	8.3%
19	Simmtech	S. Korea	738	916	24.1%
20	Flexium*	Taiwan	857	888	3.6%
	* Primarily Flex Circuits				

* Primarily flex circuits

Dr Hayao Nakahara, N.T. Information Ltd 7/2019

20190611

2018 World Total PCB Production by Geographical Area



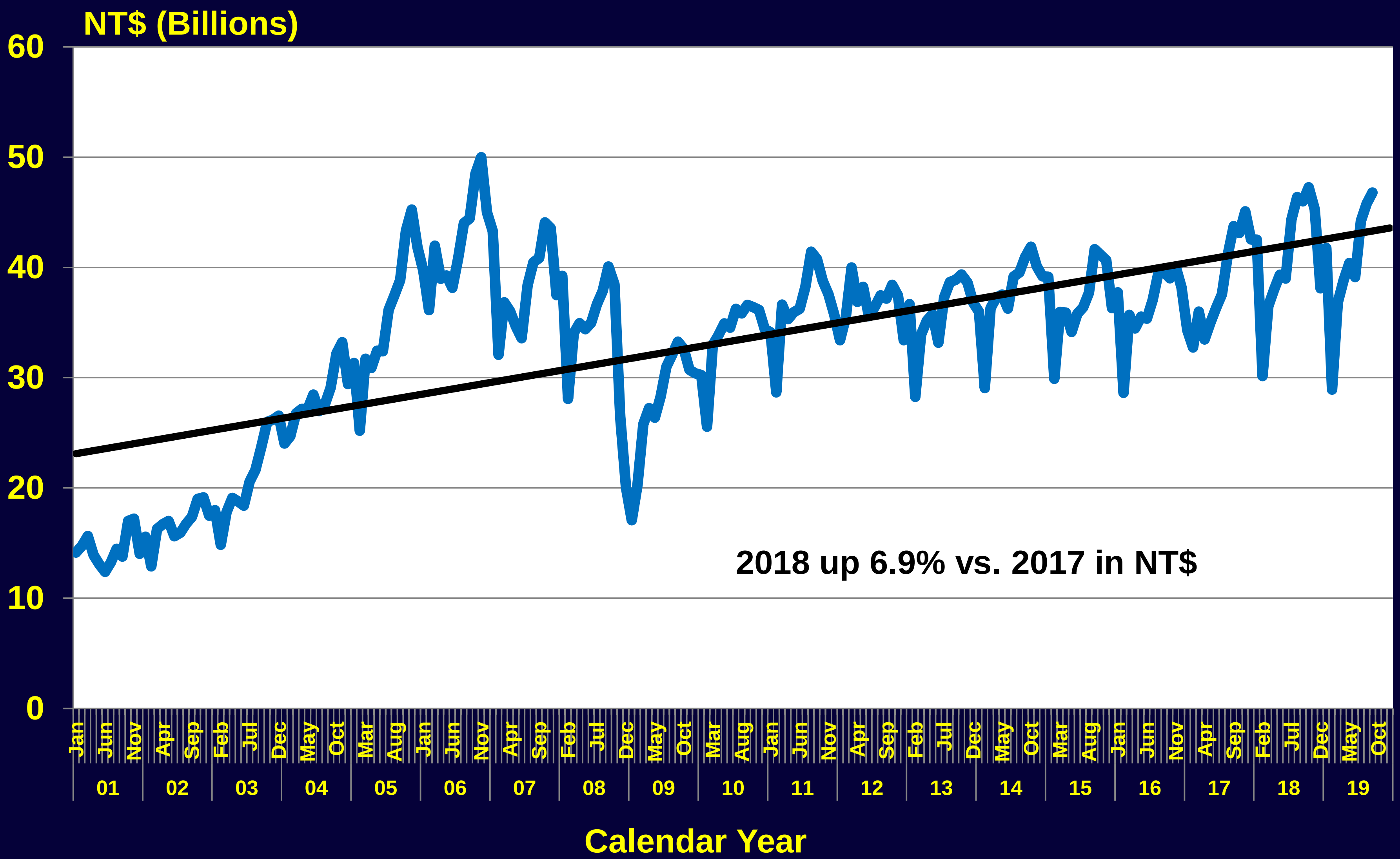
Total: $74.5 Billion (includes assembly by PC makers, particularly FPC)

H Nakahara

20191012

Taiwan Rigid & Flex PCB Shipments

Broad Composite of 46 Taiwan-listed Manufacturers

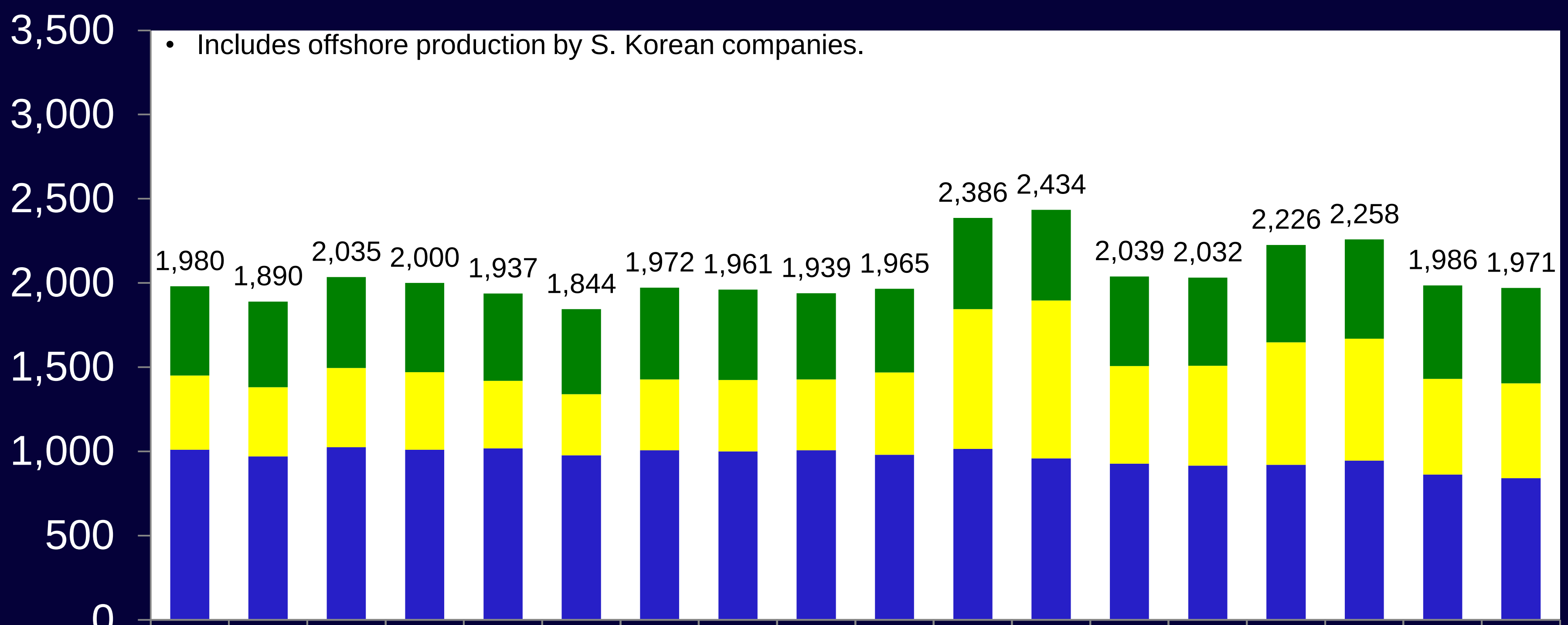


Company Financial Releases

S Korean Companies' Global PCB Production

20190825

US$ millions (converted at 1150 won/$)

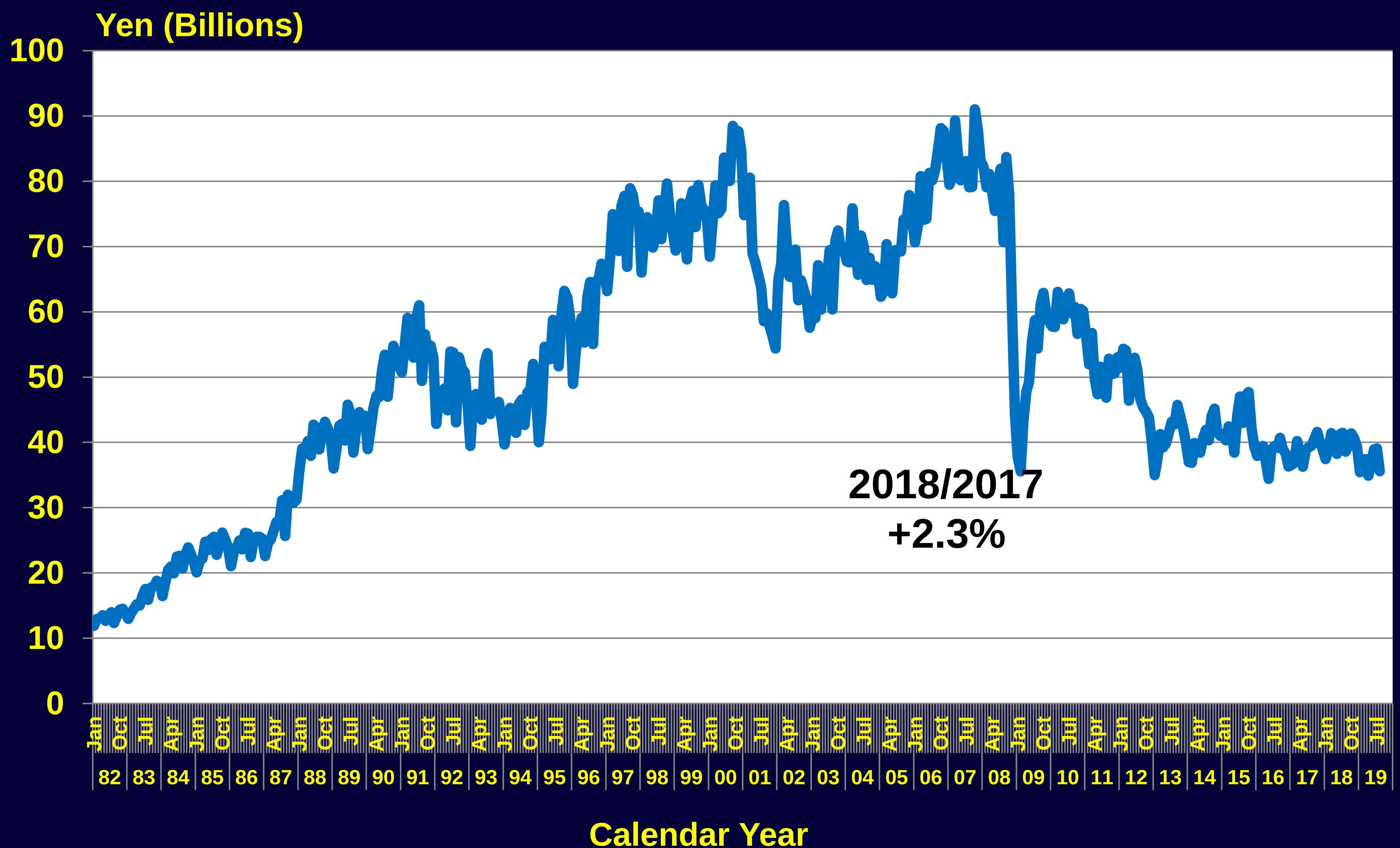


	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
	2015				2016				2017				2018				2019	
Total	1,980	1,890	2,035	2,000	1,937	1,844	1,972	1,961	1,939	1,965	2,386	2,434	2,039	2,032	2,226	2,258	1,986	1,971
IC Substrate	530	510	540	530	518	504	545	537	512	496	541	538	533	524	579	589	556	566
Flex	440	410	470	460	401	364	420	425	421	489	830	938	579	592	726	724	567	563
Rigid	1010	970	1025	1010	1018	976	1007	999	1006	980	1015	958	927	916	921	945	863	841

Private communication from industry source

20191023

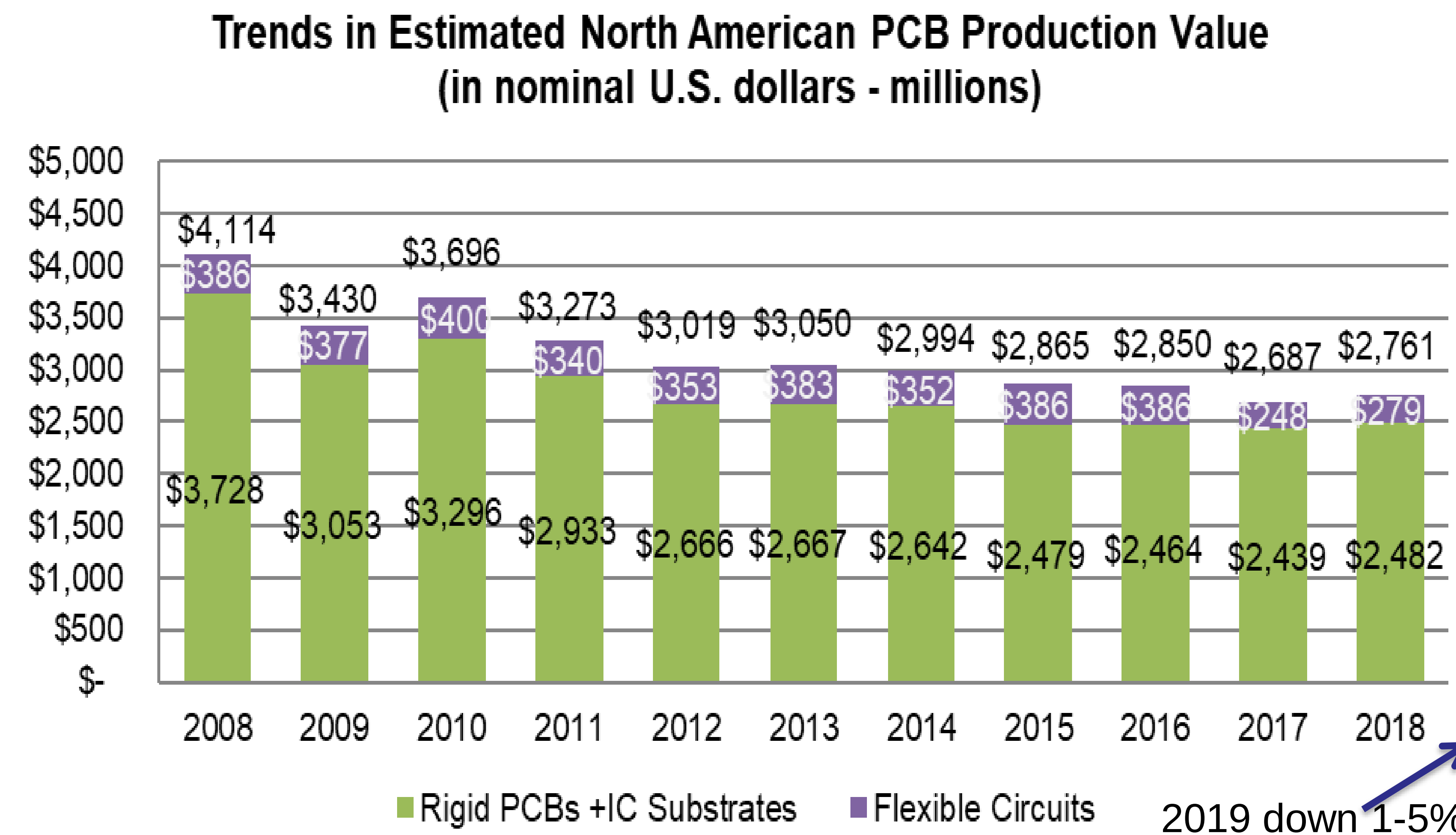
Japan PCB Production



JEITA

N American Rigid & Flexible PCB Shipments

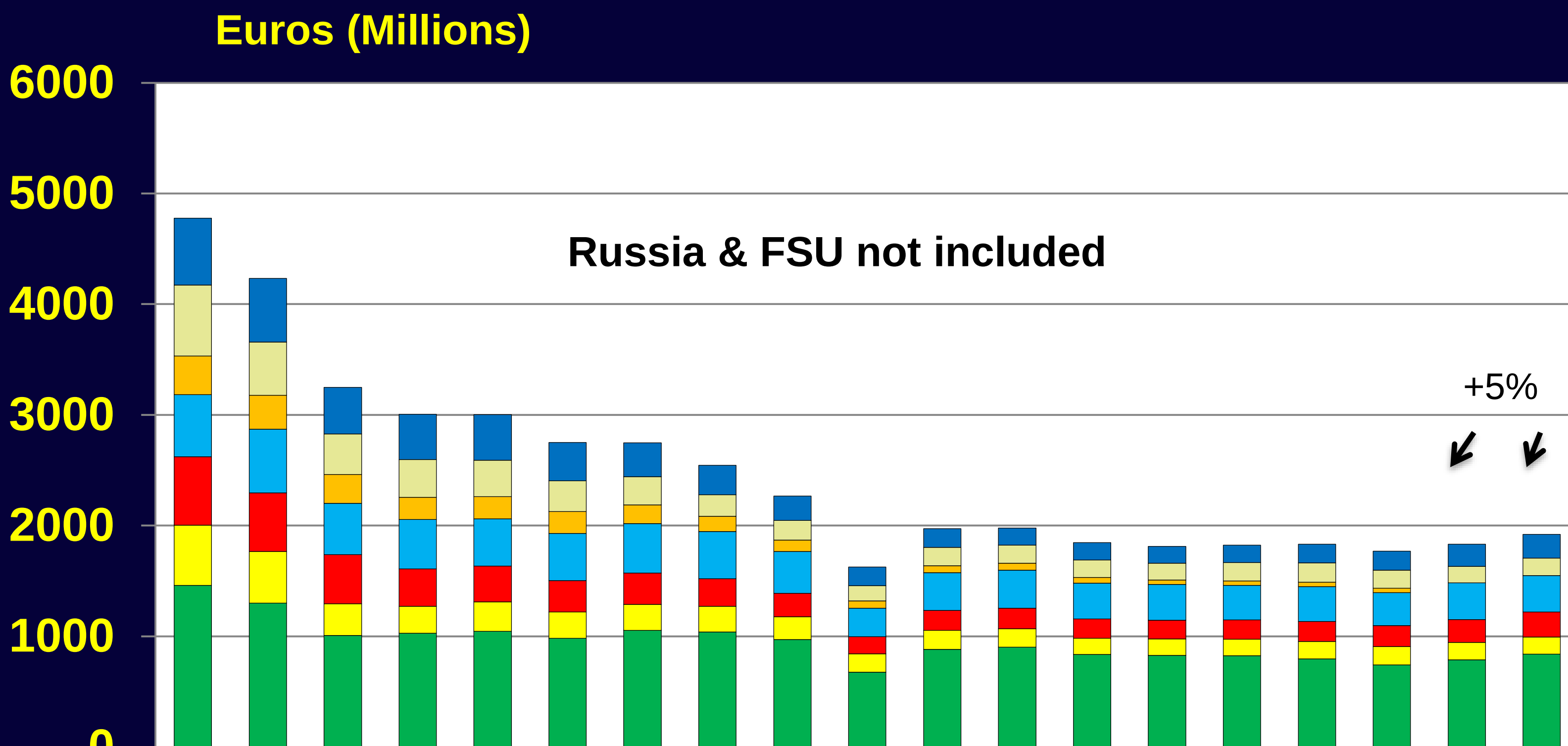
$M



2019 down 1-5%

20190609

European PCB Production

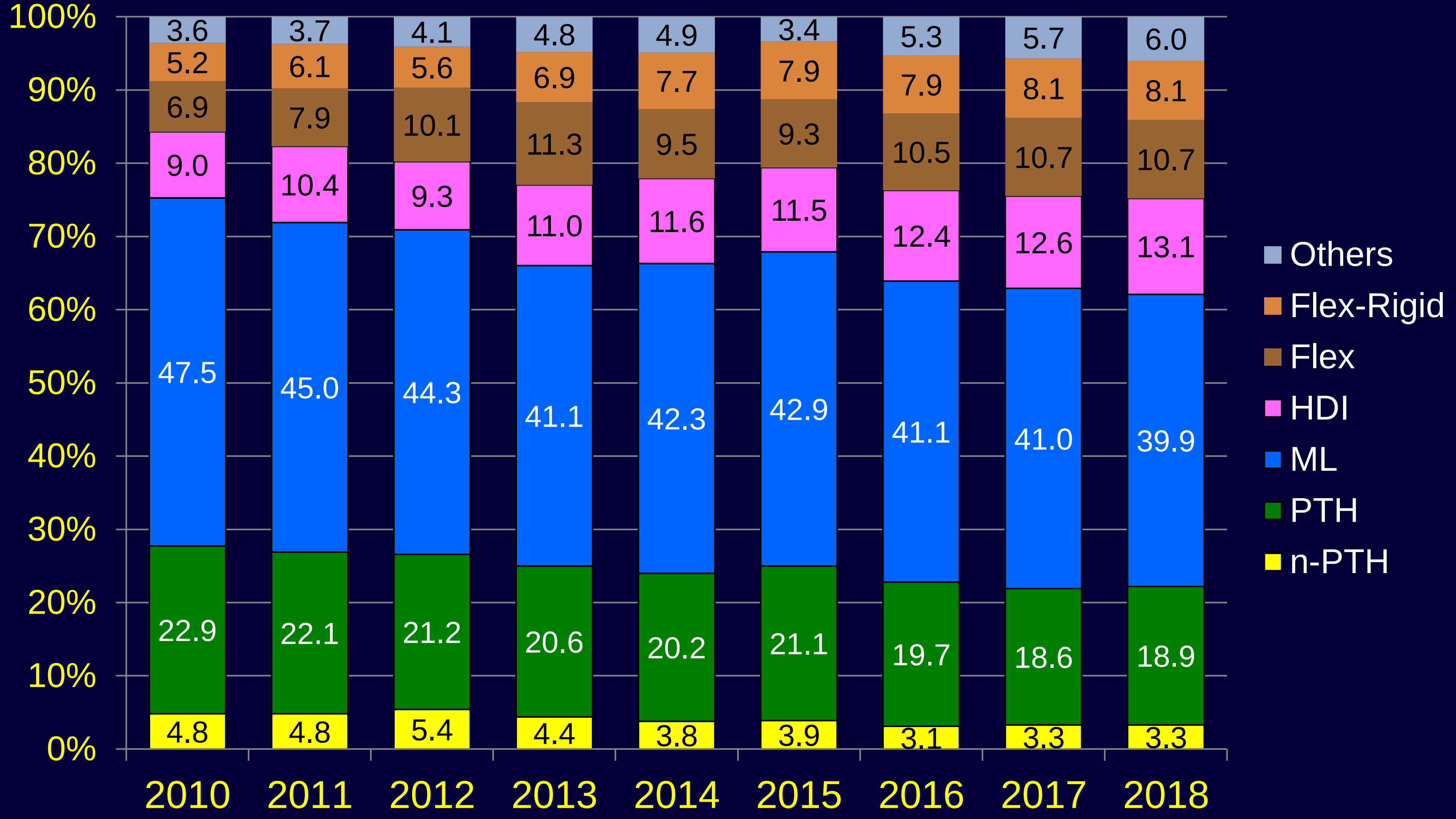


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Other	601	577	422	408	410	346	309	264	221	169	170	155	157	151	158	170	172	202	216
UK	641	478	368	340	330	278	252	197	177	137	165	161	158	153	165	173	163	149	158
Scandanavia	351	309	260	201	200	198	169	137	103	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	329
Italy	619	530	444	338	324	281	284	248	212	156	181	186	174	168	174	181	188	206	226
France	541	465	287	244	266	240	234	231	206	165	170	166	147	148	148	157	168	156	154
Germany	1461	1300	1006	1027	1044	981	1054	1039	970	676	883	902	835	828	825	796	740	788	839

Data4PCB 4/19 & prior

20190609

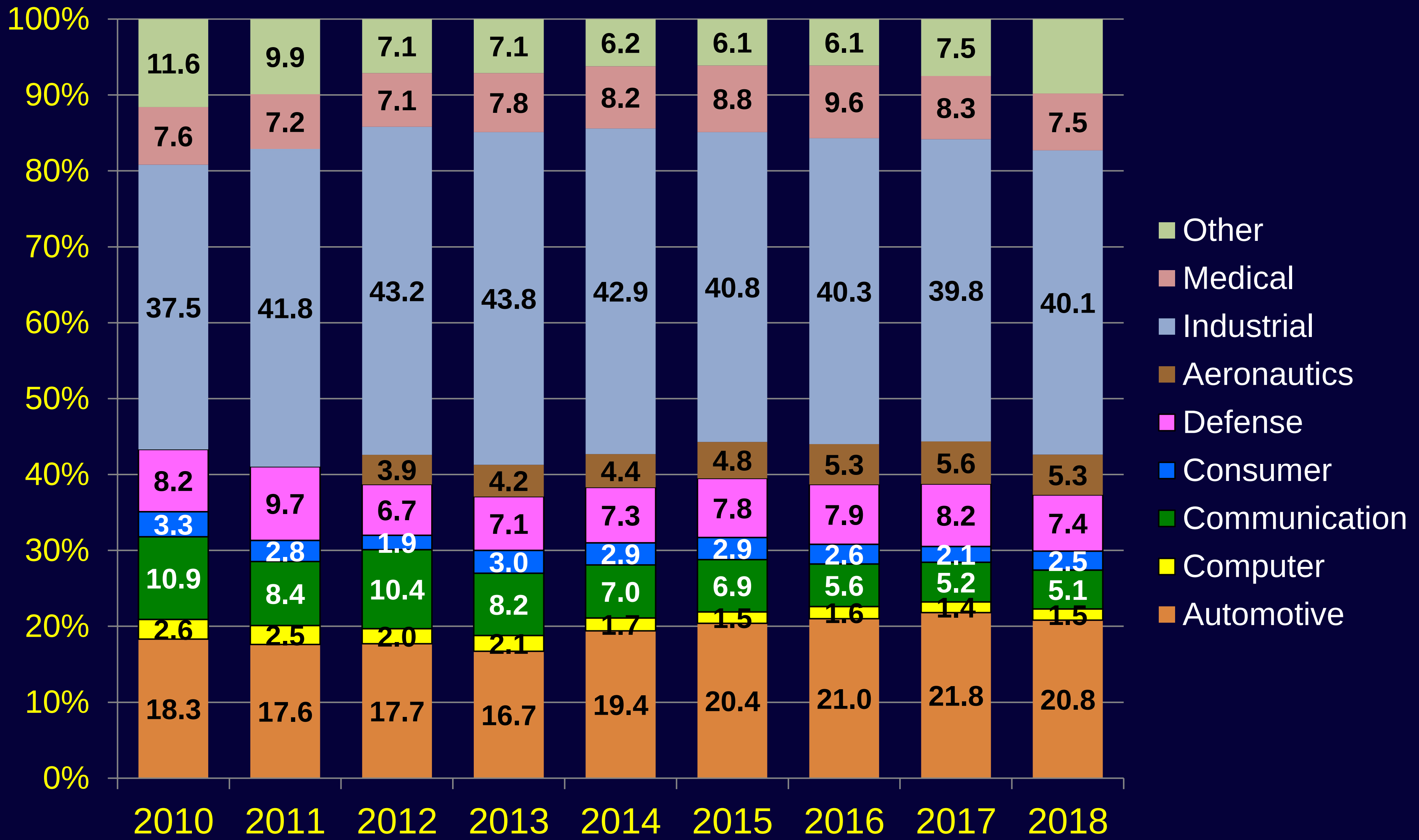
European PCB Production by Technology



Data4PCB 4/19

20190609

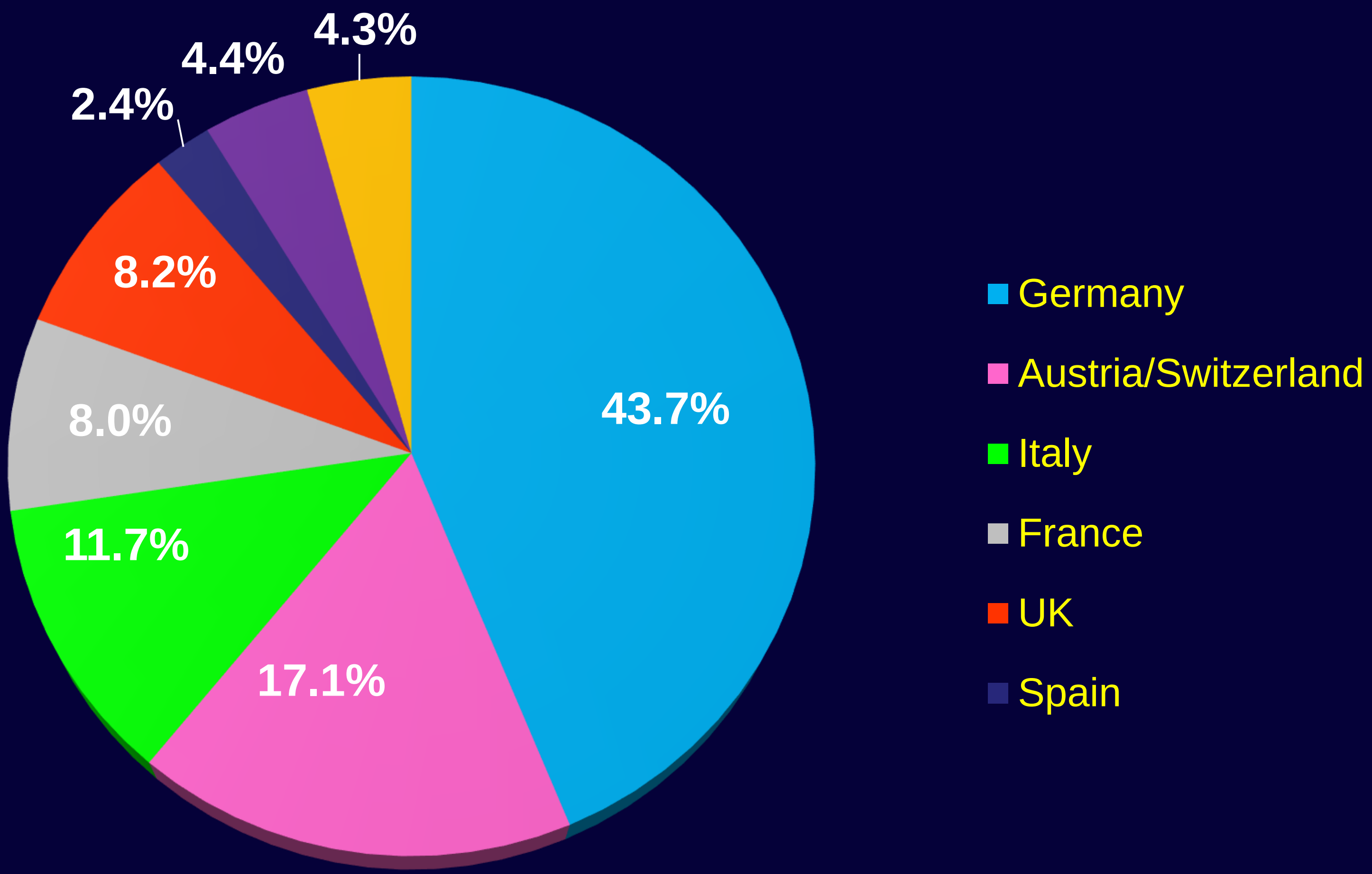
European PCB Production by End Market



Data4PCB 4/19

20190609

2018 European PCB Production



EUR 1921 million

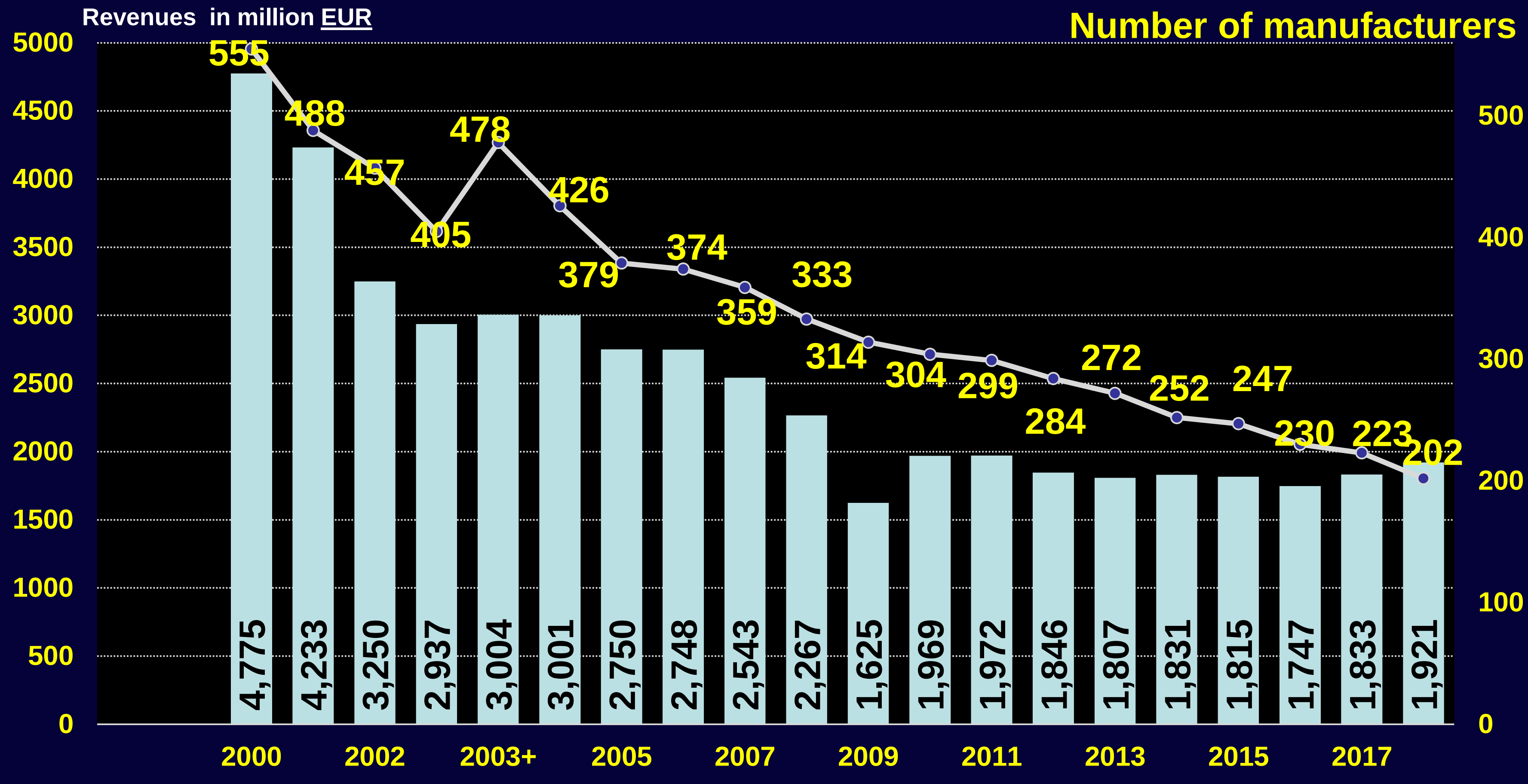
Data4PCB 4/19

PCB-Production in Europe 2018

summary	2012	2013	2014	2015	2016	2017	2018
revenues (million €)	1.846	1.807	1.831	1.815	1.747	1.833	1.921
staff	16.935	16.546	16.432	16.641	15.902	16.015	16.587
number of manufacturers per company size							
< 2 million €	125	125	113	109	94	87	66
2 – 10 million €	116	104	99	98	98	92	84
10 – 50 million €	38	37	34	34	32	38	46
> 50 million €	5	6	6	6	6	6	6
Total	284	272	252	247	230	223	202

Data4PCB 4/19

PCB industry in Europe 2000 – 2018
Revenues & Number of Manufacturers



* 2003+ = incl. Central Europe

Data4PCB 4/19 & earlier

20190609

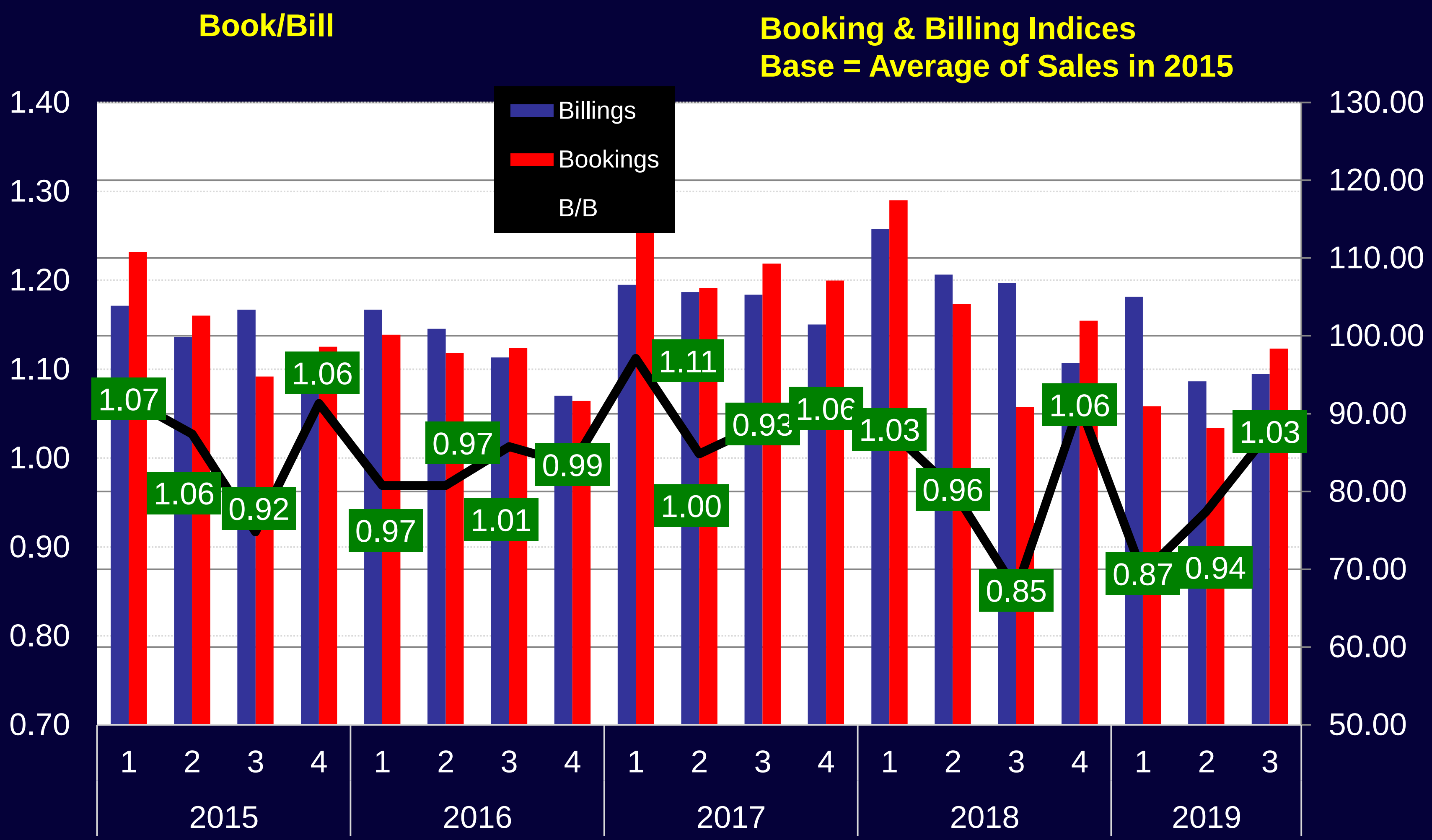
Europe's Top 41 PCB Companies
Ranked by 2018 Revenues

Rank	Company	Rank	Company
1	AT&S AG	22	Cicor group
2	Würth-group	23	Polytron Print GmbH
3	KSG group	24	Rohde & Schwarz
4	Schweizer Electronic AG	25	Tecnomaster group
5	Elvia PCB	26	Schaltungsdruck Storz
6	Mektec Europa	27	Spirit group
7	Unimicron	28	Graphic plc
8	SoMaCis SpA	29	Eleprint srl
9	hmp Microprint	30	Ilfa
10	EES-group	31	Cipsa
11	Elco group	32	Eltos
12	GS SwissPCB AG	33	TW Elektronik Horst Müller
13	Optiprint AG	34	Elekonta Marek GmbH
14	Invotec	35	OMR Italia SpA
15	Varioprint AG	36	Piciesse elettonica s.r.l.
16	Dyconex AG	37	LAB Circuits S.A.
17	Cistelaier-group	38	Asetronic AG
18	groupe Cimulec	39	Jenaer Leiterplatten
19	ACB-group	40	Merlin (Falcon) group
20	Eurocircuits group	41	Precoplat
21	Aspocomp Oy		

Data4PCB 4/19

201811
11

DACH PCB
Bookings, Billings & Book/Bill



M Gasch based on ZVEI data 10/19

Europe Comments –Michael Gasch

Revenues are slightly above 2Q’19 but 11% below 3Q’18. PCB shops are feeling the consequences of "diesel gate" and machine building is suffering because of the trade wars. Both have negative effects on the PCB industry.

Order intake in the 3rd quarter was surprisingly high for diverging reasons:
- 3Q’18 was exceptionally low (as orders were pushed into 4Q’18)
- certain groups of orders traditionally have been placed in September .

In general, there is a hesitant sentiment to place new orders. The continuing insecurity due to Brexit (the drama got a new extension) and the ongoing wars picked by an immature and erratic U.S. president with China & Iran, so far doesn't give room for hope. American military policy has opened hot wars (in Afghanistan, Iraq, Syria etc.) leaving their refugees to Europe.

The 3rd quarter has a B2B factor of 1.03 the first 9 month of 0.94.

Europe most likely will close with a loss of 10% against 2018.

M Gasch, data4PCB 11/2019

Europe Comments – Hans Friedrichkeit

Economic turnaround reached?

- At 45.7 points, the European PMI will not fall further in the third quarter. The German PMI rose slightly in October vs. November from 45.5 to 45.7 points, although below 50 points still means a downturn.

- A first glimmer of hope has formed in German industry. The downturn in incoming orders has slowed. At the same time, however, production is likely to fall somewhat further in the coming three months due to the decline in orders from the past.

- The automotive industry is likely to stabilize. In the course of the year to date, new car registrations in Germany have risen to 3.0 million units (+3 percent). Order intake for Germany rose by +5% YTD while order intake for exports fell by 4% YTD.

Hans Friedrichkeit, PCB-Network 11/19

Europe Comments – Hans Friedrichkeit

- PCB Companies such as Schweizer Electronic with a high share in the automotive industry were able to stabilize the 3rd quarter versus the 2nd quarter. The situation with regard to turnover, incoming orders and earnings has stabilized in recent months and is showing the first signs of improvement. The management board expects sales of -4% to 0% in 2019 compared to 2018.

- Even globally positioned and technologically highly differentiated printed circuit board manufacturers such as AT+S had to accept sales of -5.1% in the 2nd +3rd quarter with an EBIT margin more than halved versus the previous year.

- For 2019 as a whole, however, sales are expected to remain at the previous year's level, with a positive outlook.

- Unimicron Germany (former Ruwel) announced the dismissal of 60 temporary employees in November.

- <u>It looks as if the bottom of the economic valley of tears has been passed.</u>

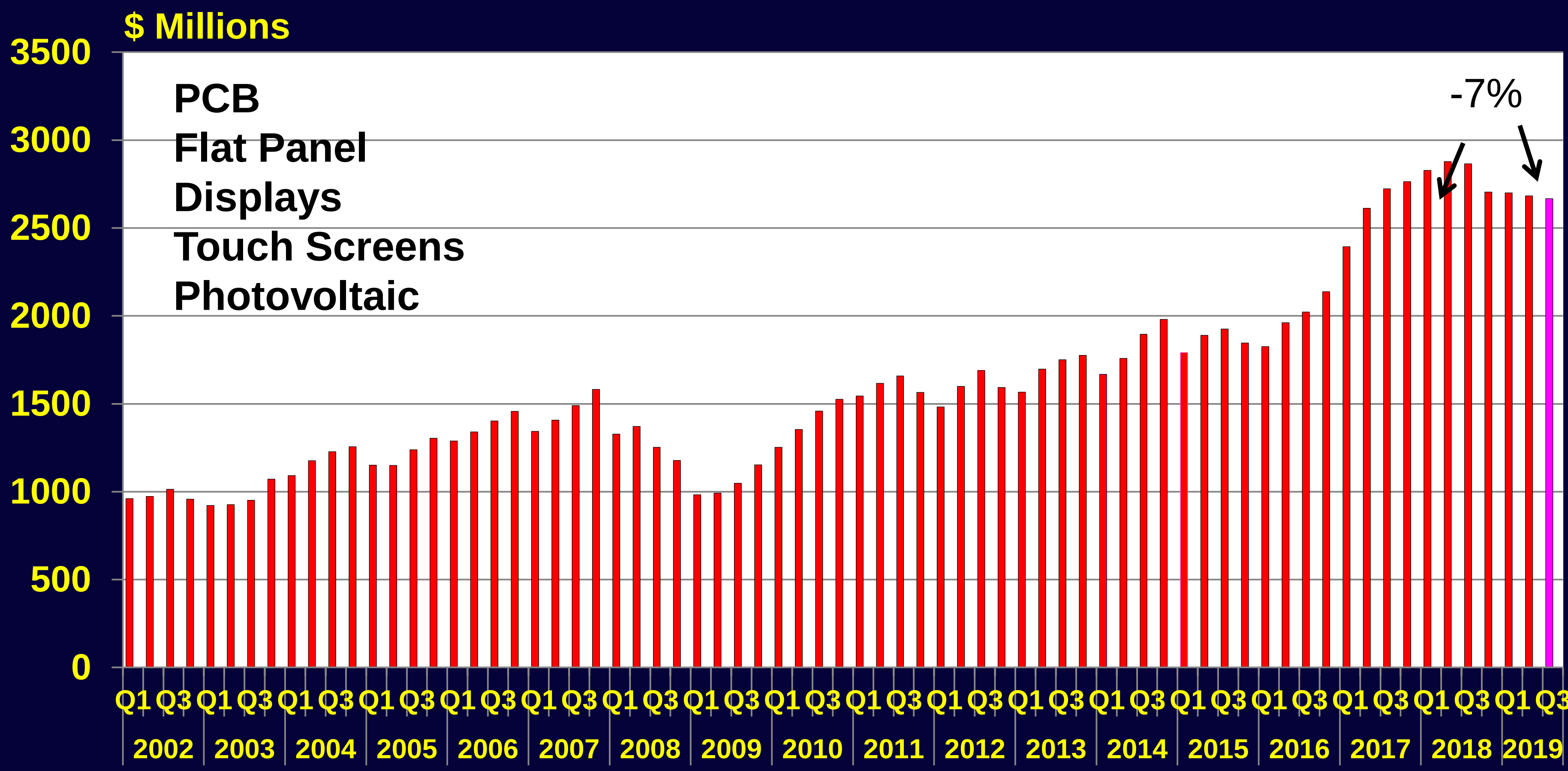
Hans Friedrichkeit, PCB-Network 11/19

Process Equipment, Laminate & Materials Suppliers

20191105

Process Equipment Related Suppliers Composite of 12 Companies

Revenue

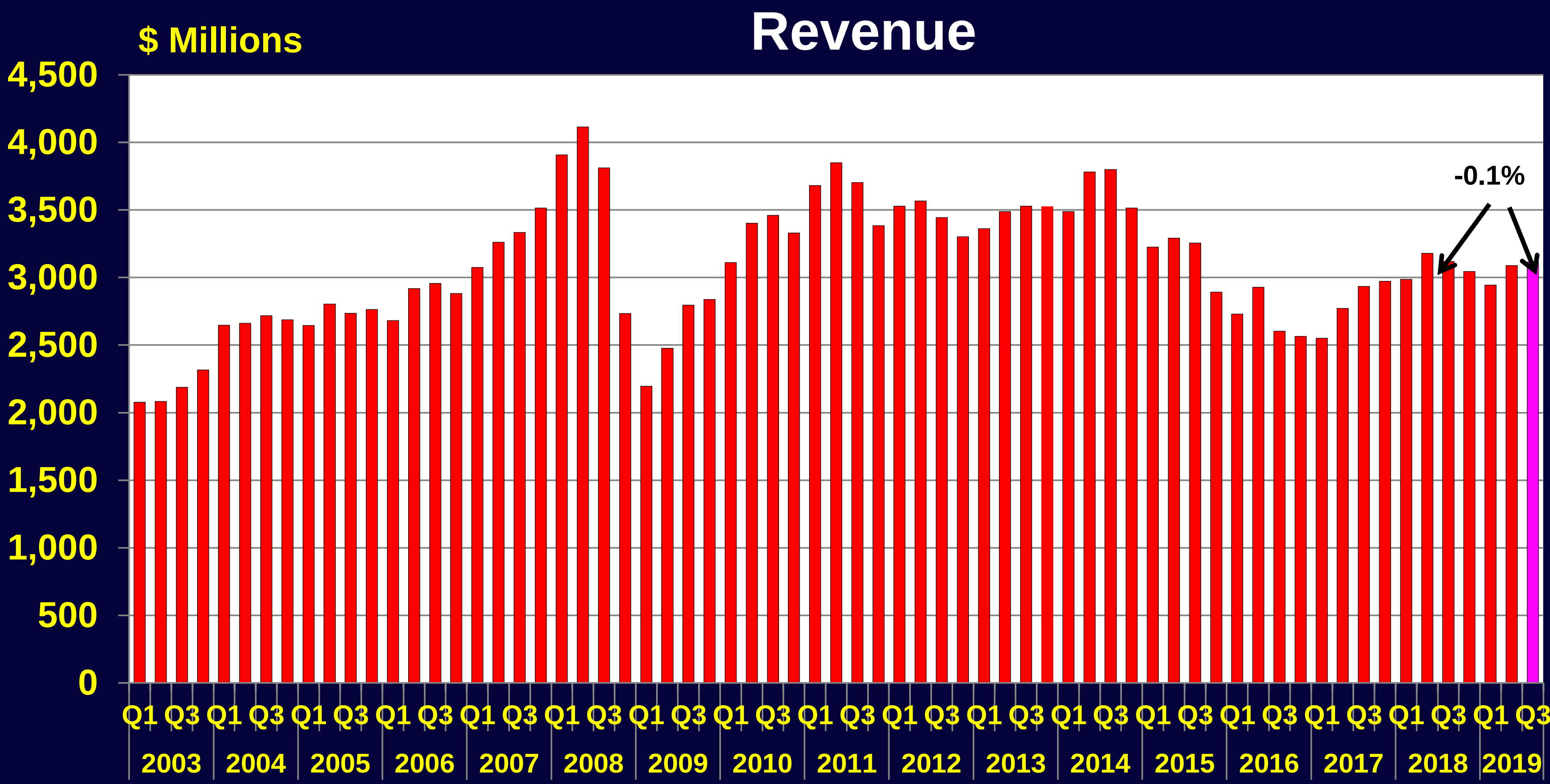


C-Sun,Tailing Technology, Camtek, Cadence, ESI, GSI Group, Mentor Graphics, Nordson, Rofin-Sinar, Coherent, Orbotech, Data I/O

Material Suppliers (excluding laminate)

20191105

Composite of 14 Companies

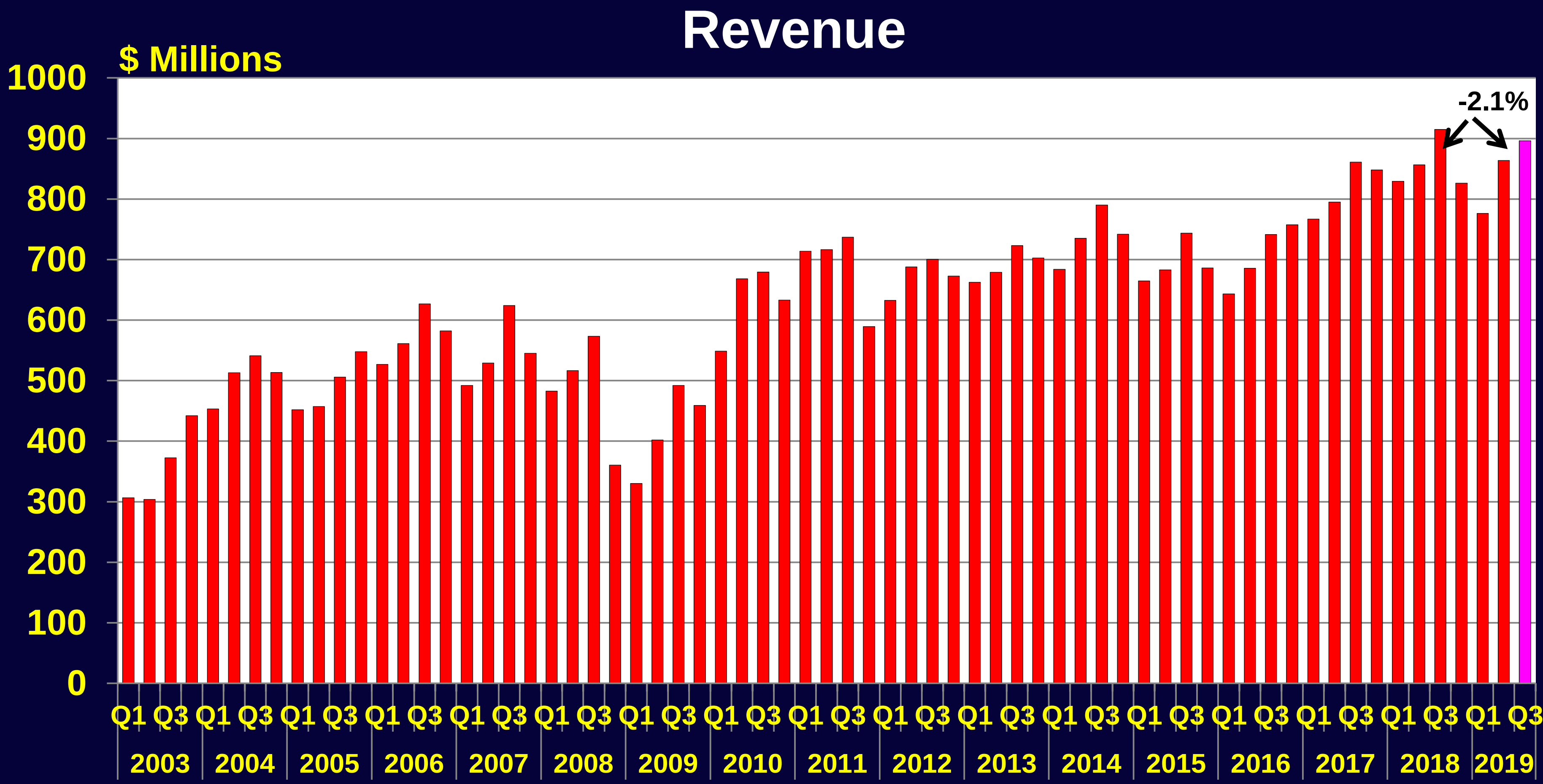


Momentive, OM Group, Taiwan Glass, Baotech, Glotech, Shenmao, Wahlee,Topoint, Cabot Micro, Cookson Elec, Eternal Chemical, Hexcel, Chang Wah, Platform Specialty Products

NT$ & GBP converted to US$ at fluctuating exchange

20191105

Rigid & Flex Laminate Suppliers Composite of 13 Companies

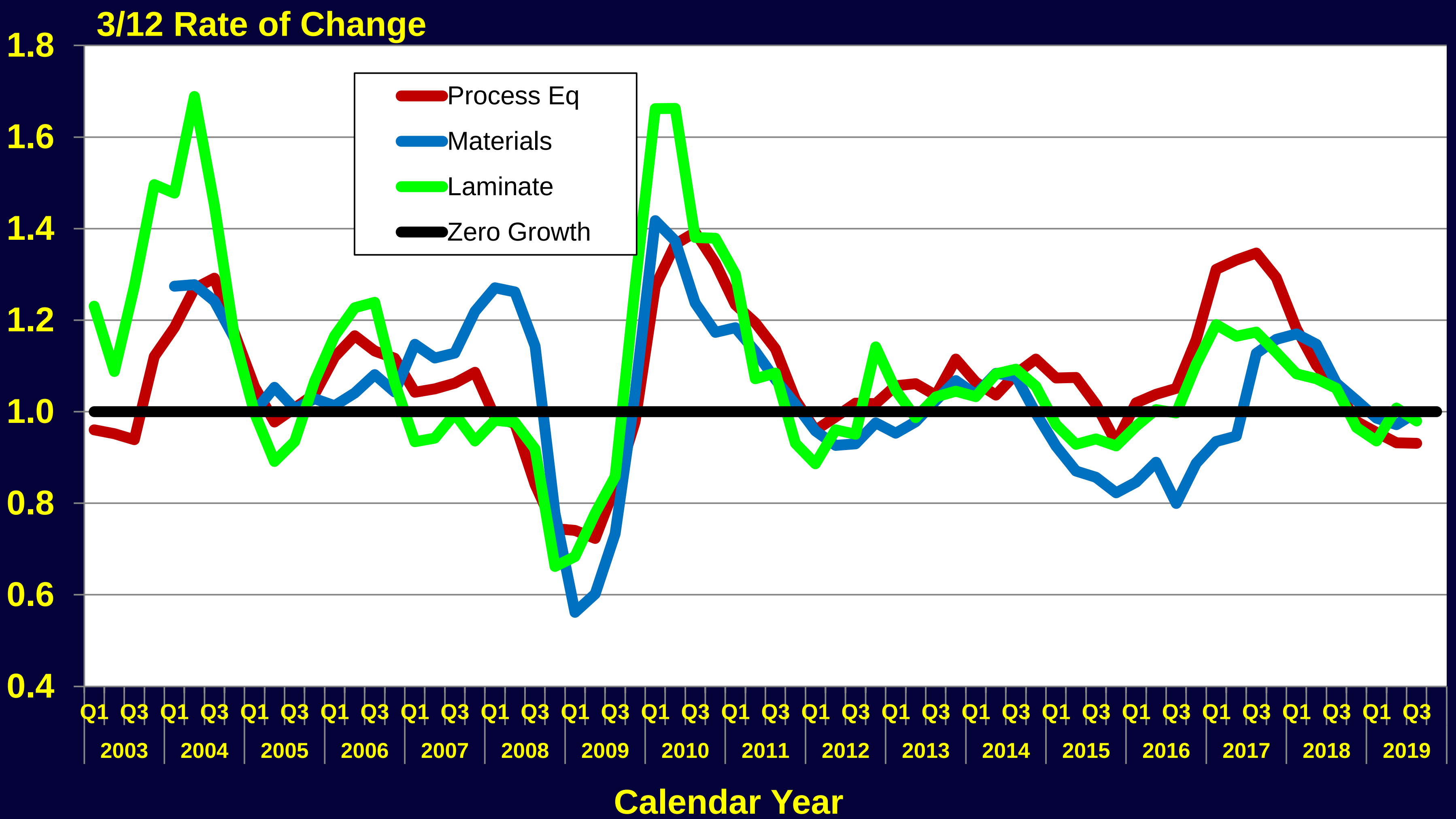


Arisawa, Arlon Electronic Materials, Elite Materials, Hwa Woei, Iteq, Microcosm, Park Electrochemical, Rogers, Shinemore, Taiflex, Thinflex, Top Union, Uniplus

NT$ converted at fluctuating exchange

20191105

Global Growth Rates
Process Equipment, Materials & Laminate



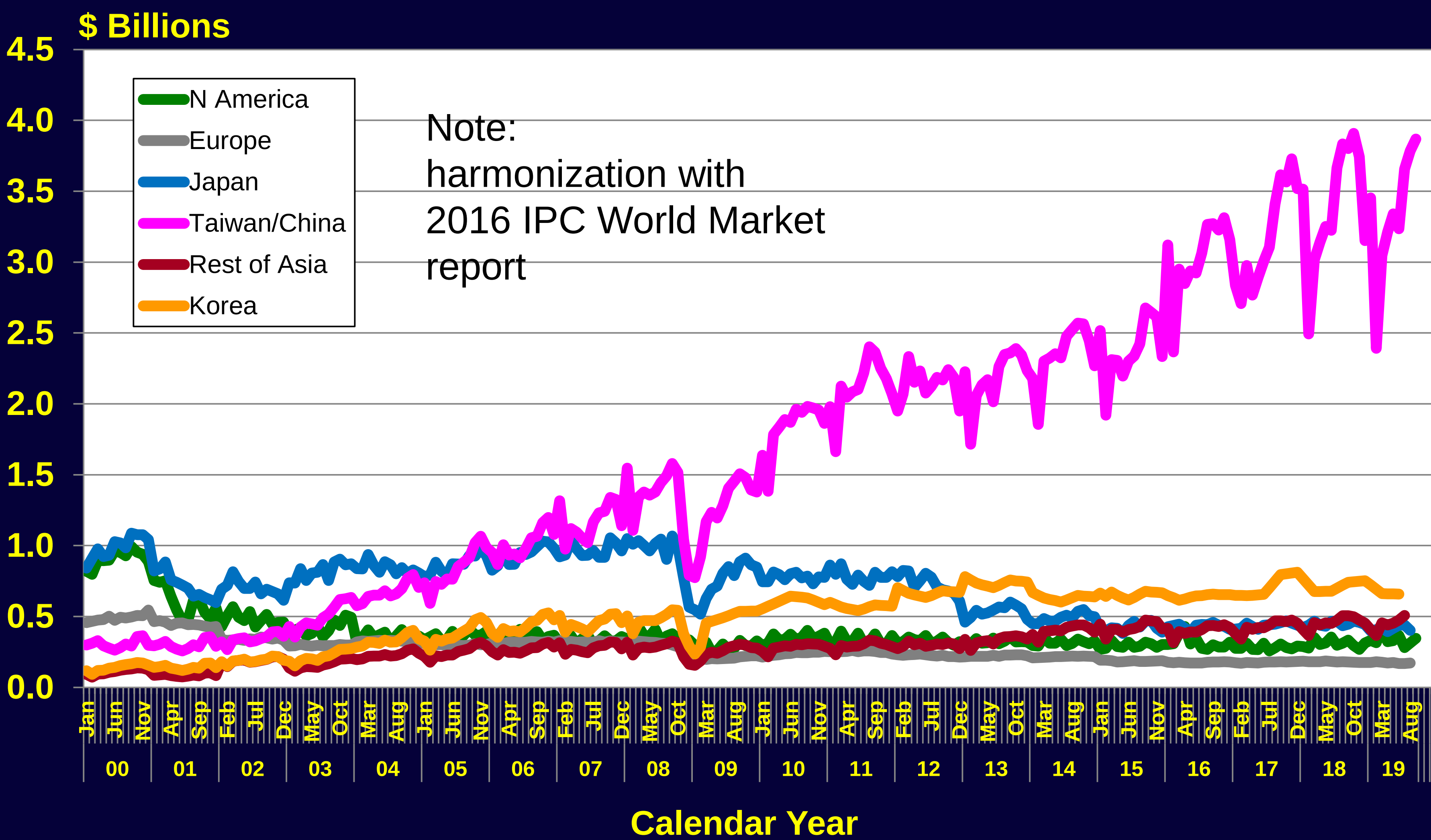
Company Financials of 12 Laminate suppliers, 13 material suppliers & 8 Process Equipment Suppliers

World PCB Model

20191024

World PCB Monthly Shipments

Converted @ Fluctuating Exchange Rates



Source: Custer Consulting Group

20191024

World PCB Shipments

Converted @ Fluctuating Exchange Rates

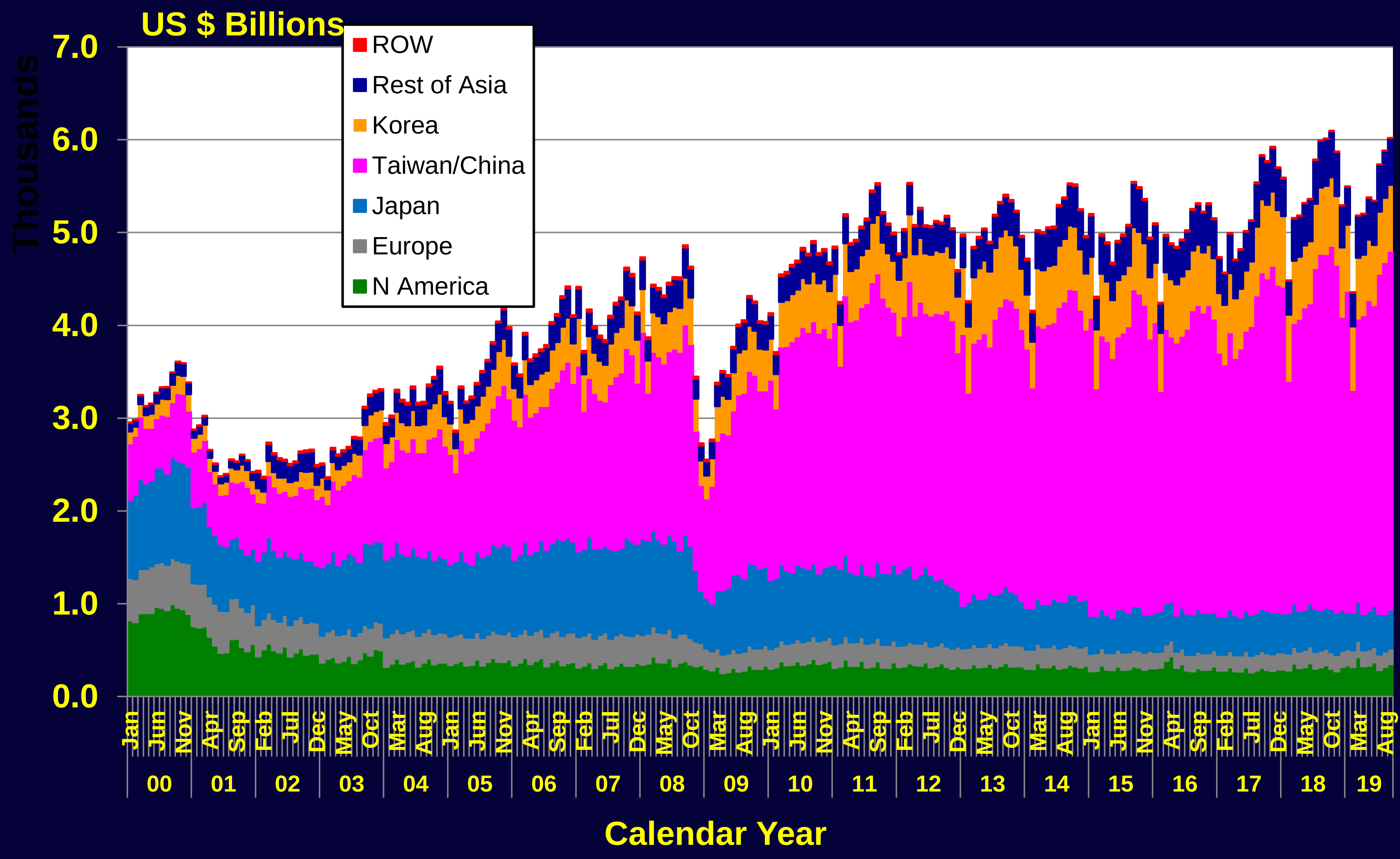
Calendar Year

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

20191024

World PCB Monthly Shipments

Converted @ Fluctuating Exchange Rates

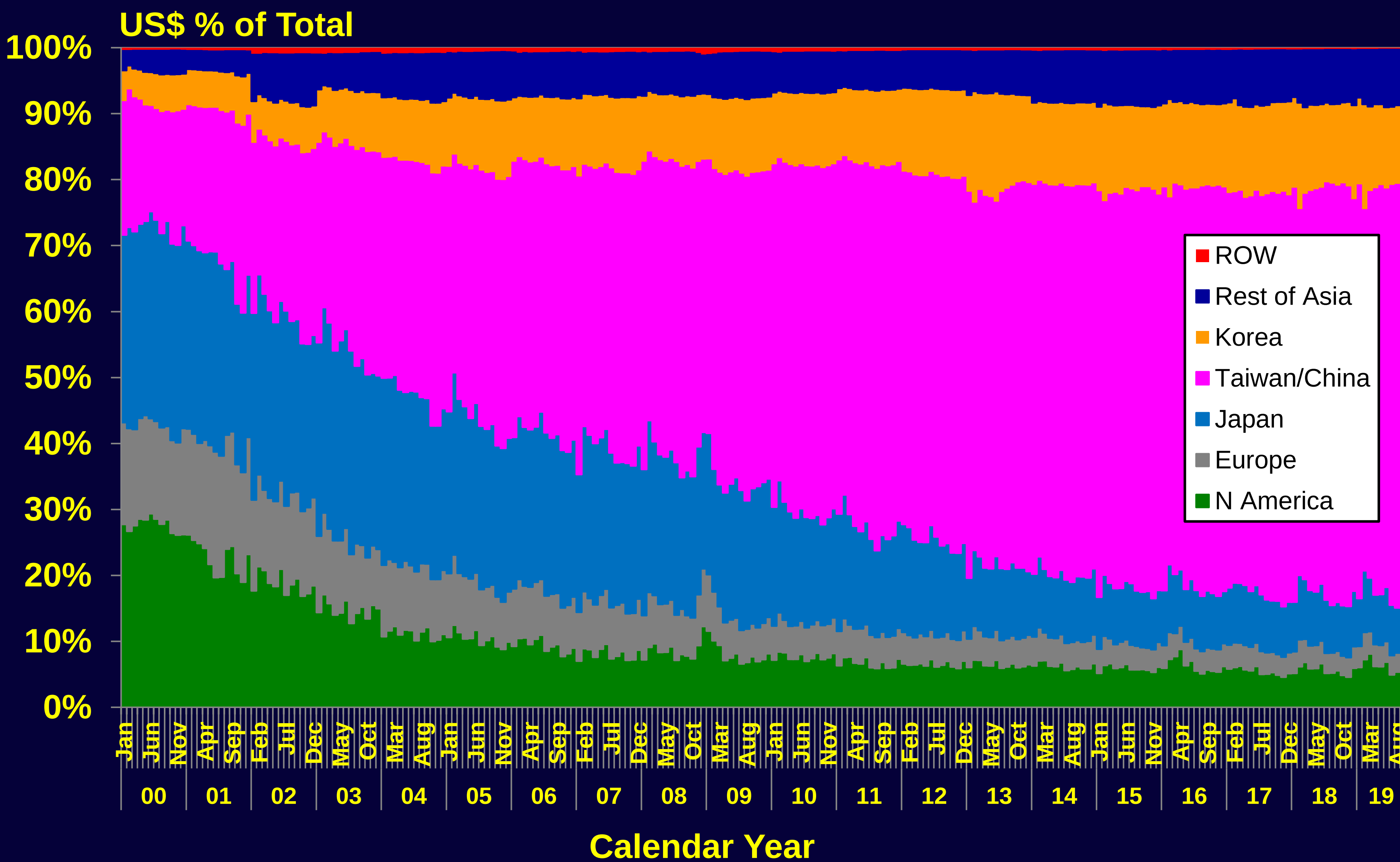


Source: Custer Consulting Group

20191024

World PCB Monthly Shipments

Converted @ Fluctuating Exchange Rates



Source: Custer Consulting Group

Forecasts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SEAL OF THE PRESIDENT OF THE UNITED STATES

20190608

Real GDP Growth

Real Rates of Economic Growth

	2018	2019f	2020 f	2021f
World	3.0	2.6	2.7	2.8
USA	2.9	2.5	1.7	1.6
Euro Area	1.8	1.2	1.4	1.3
Japan	0.8	0.8	0.7	0.6
China	6.6	6.2	6.1	6.0
Emerging/Developing	4.3	4.0	4.6	4.6

Global Economic Prospects, World Bank 6/19
https://openknowledge.worldbank.org/bitstream/handle/10986/31655/9781464813986.pdf

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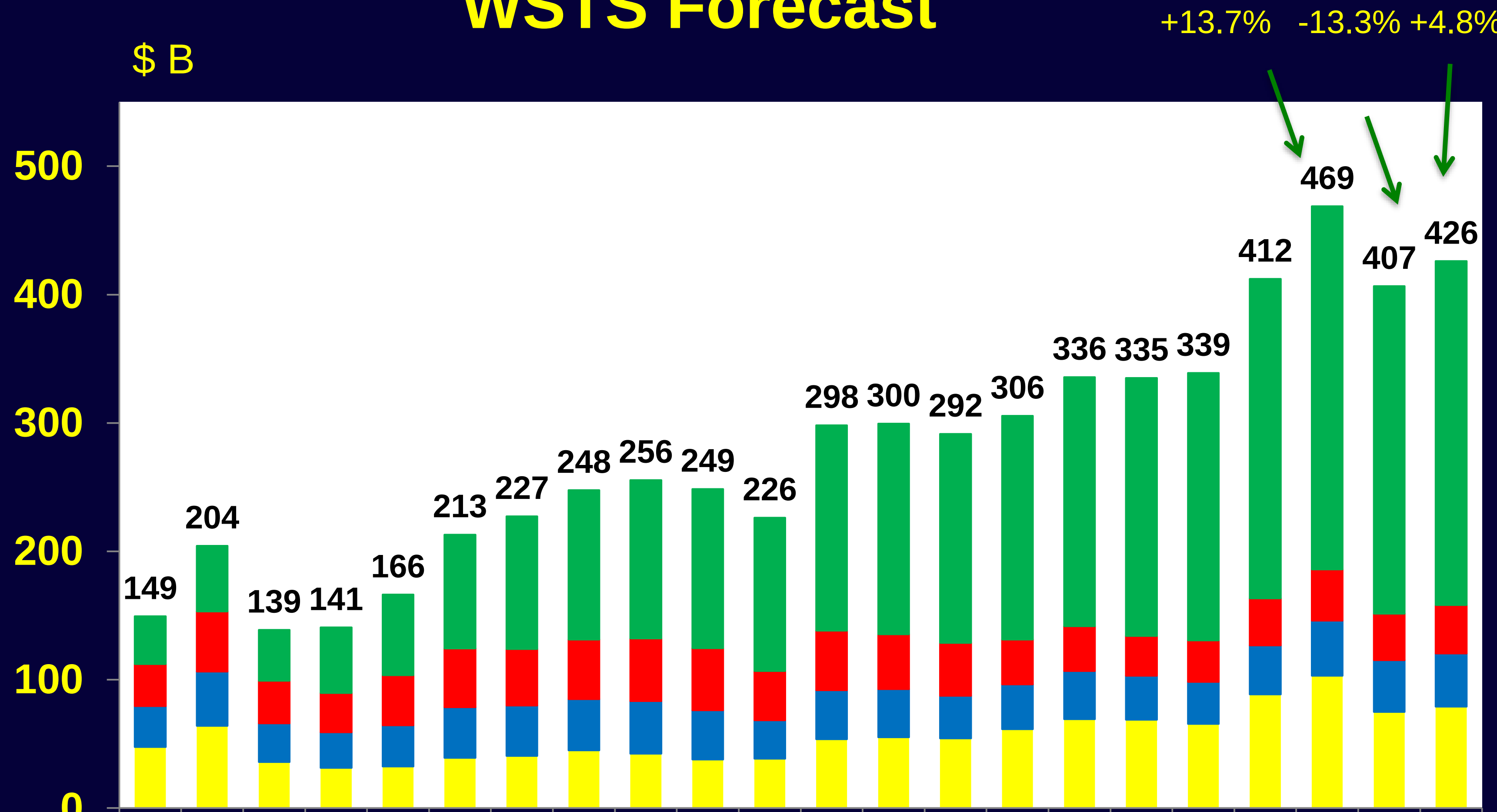
Worldwide Semiconductor Market by Geography
WSTS Forecast



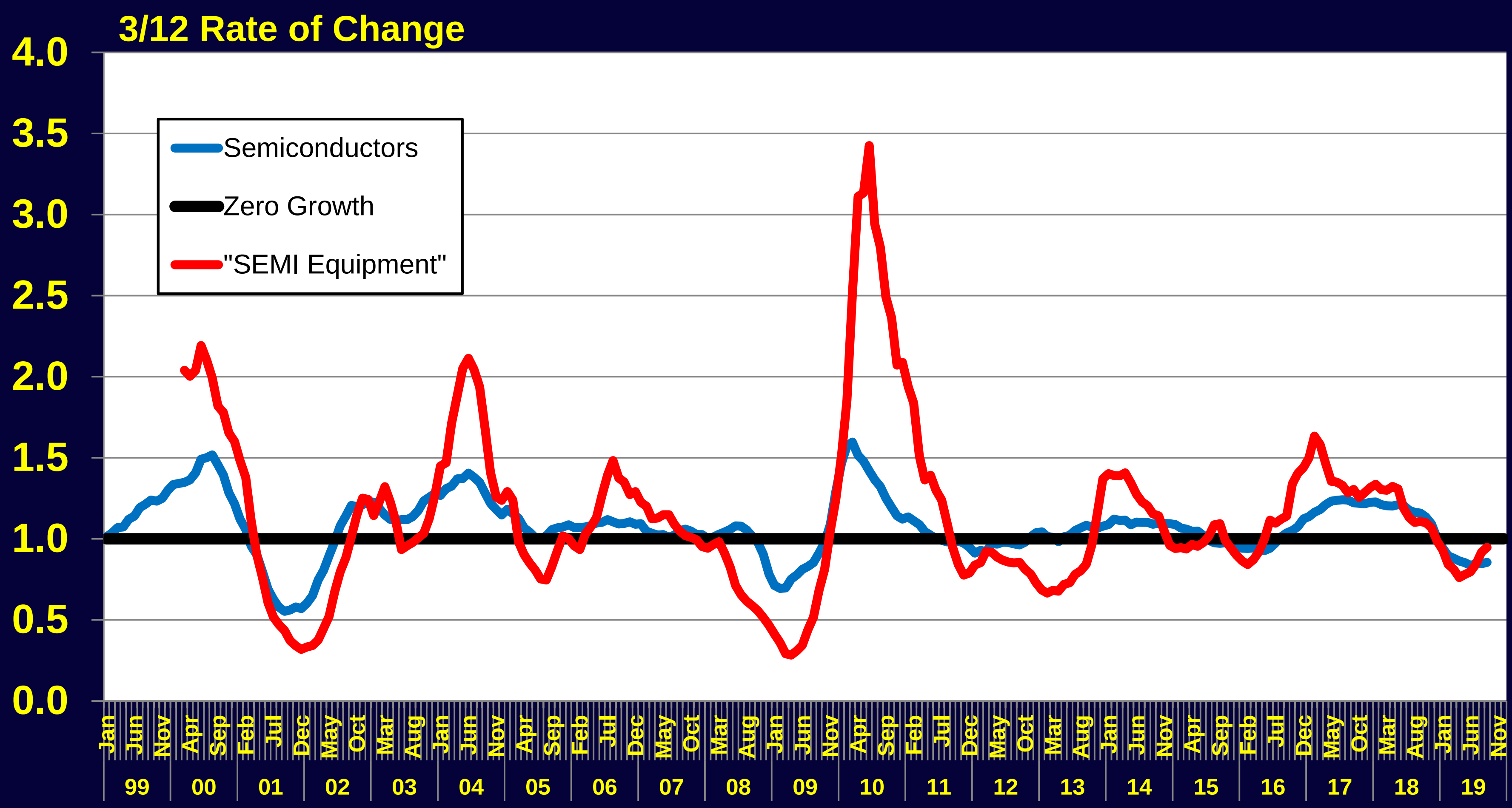
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total	149.4	204.4	138.9	140.8	166.3	213.1	227.4	247.7	255.6	248.6	226.3	298.3	299.5	291.6	305.6	335.8	335.2	338.9	412.2	468.8	406.6	426.1
Asia Pacific	37.2	51.3	39.8	51.2	62.8	88.8	103.5	116.5	123.5	124.0	119.6	160.0	164.0	163.0	174.4	194.2	201.1	208.4	248.8	282.9	255.3	268.0
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	40.0	36.1	37.6
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	43.0	40.3	41.6
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	103.0	74.9	78.9

WSTS 8/19

Global Semiconductor & Semiconductor Capital Equipment

20191105

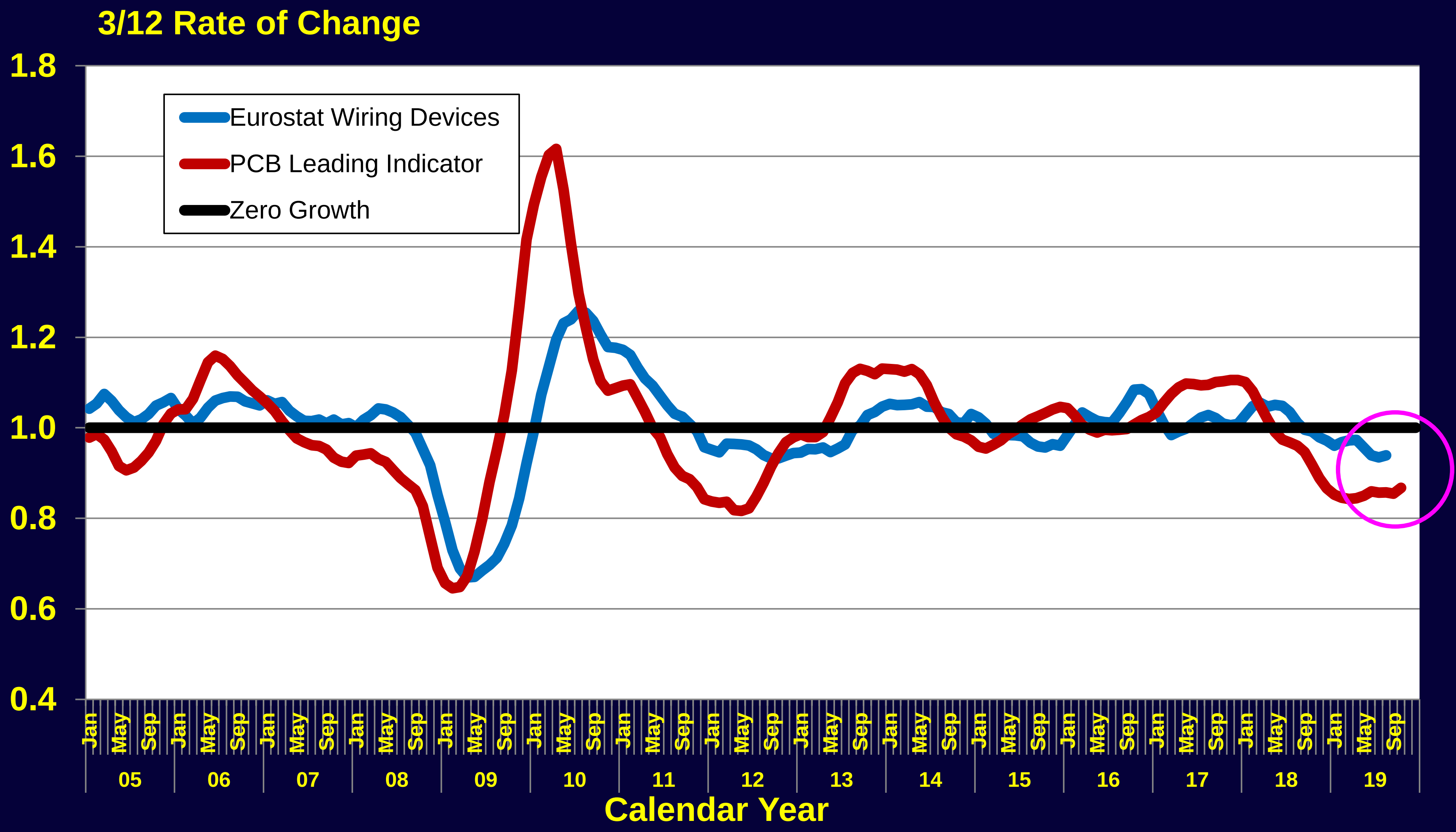
3-Month Shipment Growth Rates on $ Basis



Sources: www.semiconductors.org; www.semi.org

Europe PMI Leading Indicator vs. Europe Wiring Devices

20191104



Source: Custer Consulting Group

World PCB Production 2017-2019F

20170311

World PCB Production* by Region (US$ Million)					
Region	2017	2018	YoY	2019F	YoY
America	3,037	3,158	4.0%	3,174	0.5%
Germany	960	994	3.5%	939	-6.0%
Other Europe	1,385	1,257	1.2%	1,270	1.0%
Africa & Middle East	142	143	0.0%	145	1.4%
West Total	5,524	5,552	3.1%	5,528	0.4%
China	37,200	40,510	8.9%	39,880	-1.5%
Taiwan	7,685	7,780	1.2%	7,690	-1.2%
S. Korea	7,215	7,515	4.1%	7,214	-4.0%
Japan	5,625	5,654	0.5%	5,796	-1.2%
Thailand	2,980	3,132	5.1%	3,160	0.9%
Vietnam	2,620	2,704	3.2%	2,905	3.7%
Other Asia	1,738	1,668	-4.0%	1,700	1.9%
Asia Total	65,063	68,963	6.0%	68,345	-0.9%
World Total	70,587	74,515	5.6%	73,873	-0.9%
					(N.T. Information Ltd)

* Note; Production includes assembly by PCB makers, particuarly FPC

Summary

Slower current European growth especially in automotive

Trade disputes impact long standing regional alliances

Electronic assembly may shift globally to countries less affected by tariffs

Many good new electronic products are on the horizon.

5G offers exciting opportunities for next decade

Special Thanks for their invaluable contributions

Michael Gasch
Data4PCB

Hans Friedrichkeit
PCBNetwork