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The Impact of the Crisis on ICTs and their Role in the Recovery

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THE IMPACT OF THE CRISIS ON ICTs AND THEIR ROLE IN THE RECOVERY

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FOREWORD

This report was presented to the Committee for Information, Computer and Communications Policy (ICCP Committee) in March 2009 and the Working Party on the Information Economy (WPIE) in June 2009. The ICCP Committee in March 2009 agreed that the report could be declassified by a written procedure after it had been reviewed by the WPIE at its June 2009 meeting. The report was updated to take into account all comments and all available data through 17 July 2009.

The report was prepared by an OECD Secretariat team consisting of Arthur Mickoleit, Christian Reimsbach Kounatze, Cristina Serra-Vallejo, Graham Vickery and Sacha Wunsch-Vincent, under the direction of Graham Vickery, OECD Secretariat. The report aims to contribute to a better understanding of the evolution and impacts of the economic crisis on the ICT sector. It will also contribute to preparation of the biennial *OECD Information Technology Outlook* (www.oecd.org/sti/ito).

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Summary and conclusions

The ICT industry had a tough start to 2009, with almost all first quarter indicators declining, often very sharply. There are signs of recovery, with the rate of decline bottoming out and turning up in the most recent cyclical data (May/June 2009), with positive month-on-month growth for most countries, and inventories running down sharply. Performance in the first quarter of 2009 tested 2001-2002 declines in most ICT sectors, but relative year-on-year declines were not a great deal worse than in 2001-2002 and some sectors have performed better than in the earlier period. The ICT industry is also performing considerably better in this crisis than industries such as automobiles.

There have been clear regional differences in the effects of the crisis. Asian OECD countries were particularly hard hit by the down-turn, with slumping production and soaring inventories particularly in Japan. De-coupling of non-OCED countries also proved to be an illusion with non-OECD Asian economies (China; Chinese Taipei; Hong Kong, China; and Singapore) severely affected. Chinese Taipei's output was down by 40% in the early part of 2009 as was Japan's, and Asian ICT trade has been down by 25-40% year-on-year as the crisis took its toll in integrated Asian production networks. There are several reasons for this: currency fluctuations, especially handicapping export-dependent ICT industries in Japan, and plunging exports and slowing domestic demand for Chinese producers and their suppliers. However the recent month-on-month upturn has been very rapid, particularly in Japan, Korea and Chinese Taipei, and China has returned to positive growth after slipping below zero year-on-year at the start of 2009. Korean ICT manufacturing was one of the first to turn up in early 2009 helped by a weaker KRW.

The semiconductor industry is a bellwether for developments in the ICT industry. Semiconductor production fell particularly rapidly at the end of 2008 and in the first quarter of 2009, with world capacity use dropping towards 50% and semiconductor equipment manufacturers seeing very rapid falls in orders. However the crash has not yet reached the scale of 2001-2002 except in Asian OECD countries, and there has been a recent sharp upturn in total month-on-month semiconductor billings. Large semiconductor firms are generally in good financial shape, with net cash positions considerably higher than in 2001. R&D and innovation activities continue to be financed from internal sources as revenues contract, and so far semiconductor R&D has declined much less than revenues.

In terms of sectors, the revenues of global ICT hardware firms have been more affected early in the economic crisis than ICT services firms (IT services, software, Internet-related and telecommunications), as was the case in 2001-2002. Semiconductors, electronics, communications and IT equipment were hit by slumping business and consumer demand and growth dropped sharply. But ICT services have also slowed, and year-on-year growth of IT services and software both turned negative in the first quarter of 2009, with Internet business growth around zero. Internet and software firms saw steep falls in growth of over 20 percentage points in the last four quarters, in sharp contrast with their recent performance. Overall, hardware sectors such as semiconductors and communications equipment are declining less than in 2001-2002, and in comparison some ICT services are performing worse than in 2001-2002.

In general, despite a very difficult first quarter large firms in the ICT sector were stronger at the end of Q1 2009 than following the 2001 dot.com bust. Strong points include higher cash to debt ratios in company balance sheets, consolidated and stronger firms, and the greater importance of the Internet

economy. However some large hardware manufacturers, especially Japanese electronics producers, face difficulties as growth in new business areas does not compensate for declines in others.

ICT employment has trended downwards, but not as rapidly as in automobiles for example. Announcements of major lay-offs have been more pronounced in the semiconductor and electronics sectors and lower in IT services, software, and Internet-related activities. But layoffs are occurring in both goods and services, and some firms have reported that they will be releasing over 10% of their workforce in the near future. Company insolvencies also add to the pressure on ICT labour markets. In general, up-to-date employment data for the ICT sector are patchy and net employment changes difficult to quantify; announced layoffs are reported prominently and these reported data do not take into account new and continuing recruitments [see DSTI/ICCP/IE(2009)2, Secretariat Working document].

ICT R&D is declining, but it is performing somewhat better than employment and certainly better than production and revenues, as was the case in the last downturn. Where R&D is declining it is with a lag compared with turnover and employment, as investments in R&D and innovation are clearly seen as necessary for future competitiveness and the development of new growth areas (see *OECD Information Technology Outlook 2008*, Chapter 1). Despite generally good industry R&D performance in Q1 2009 and continuing support for R&D in Q2, some hard hit sectors such as electronics and semiconductors were however beginning to perform worse in R&D than in 2001. On the new firm side, venture capital slowed very markedly from mid-2008. Nevertheless around one-half continues to flow into the ICT sector and ICT-intensive clean technologies, and surveys suggest that software, new media and particularly clean technologies will continue to attract a major share of venture investments.

ICT policies need re-examination and refinement in the crisis and recovery. In recent years these policies have been increasingly integrated into broader strategies to use ICTs, the Internet and other networks to achieve growth, employment and wider socio-economic objectives. These objectives include addressing national challenges (*e.g.* social cohesion, ageing societies, national security) and global ones (*e.g.* climate change, energy-efficiency, global health), and using e-government to make the delivery of such services more efficient. The crisis and launching of economic recovery measures are a propitious time to re-evaluate these policies.

Economic stimulus packages to address the economic crisis affect the ICT sector directly and indirectly. The immediate aim of these packages has been to restore the health of the banking sector and stimulate demand in the short-term; re-financing banks, injecting cash into the economy and protecting jobs. These measures may help counteract downward pressures on the ICT sector and sustain the diffusion of ICTs. Most governments also plan to foster growth through long-term investments which have potentially providing an anti-cyclical stimulus on the supply-side. In many cases these long-term plans are directly related to the ICT sector or ICT applications, including "smart" applications in urban systems, transport systems, electricity distribution, etc. The question is how current ICT policies should be maintained or rethought in the context of the economic crisis and what is the appropriate balance between continuity in proven ICT policies and change in the form of *ad hoc* crisis measures.

Introduction

The 2008 edition of the *OECD Information Technology Outlook* (December 2008) showed that the downturn in the ICT sector was deepening rapidly and that official short-term indicators had not yet started to show the depth and rapidity of the decline. Tracking the rapid slump in the ICT sector has been particularly difficult.[1] Unlike the 2001-2002 recession which began with the bursting of the Internet bubble, the current recession began in the financial services sector due to deep-seated systemic weaknesses in OECD banks and insurance companies. The financial crisis rapidly worsened and spilled over from the United States to other countries and fed the subsequent crisis in the real economy. Despite massive government attempts to stabilise it, the financial system remains fragile, undermining global economic activity, and unemployment is rising rapidly.

The magnitude of the financial crisis and subsequent deep economic recession were difficult to foresee. OECD macroeconomic projections shifted down sharply in the 10 weeks from early September 2008 to mid-November 2008, from a rapid slowdown in growth and the onset of recession in *some* OECD countries to the *OECD area as a whole* entering recession and unemployment rising in many OECD countries.[2] The subsequent *OECD Interim Economic Outlook* in March 2009 and the *OECD Economic Outlook* in June 2009 have tracked the development of the deepest and most wide-spread global recession for more than 50 years, with real GDP declining in all OECD countries in 2009, non-OECD countries slowing sharply, real world growth turning negative, and trade declining rapidly in real terms.

Tight financial conditions and a generalised loss of confidence were projected to continue, but the June 2009 *Economic Outlook* was the first in two years to revise upwards the growth projections. Recovery appeared to be in motion in large non-OECD countries, particularly China, US activity could potentially bottom out in the second half of 2009, and Japan's trade-induced contraction looked to be close to the end, although the euro area was not displaying clearly visible signs of recovery.[3] Against this background, the outlook for the ICT sector has been particularly hazardous to position. A major challenge has been to develop an indicator base to better assess near-term trends.

There are three drivers of ICT production. First, longer-term prospects and trends for the ICT sector remain good, with cyclical and structural growth continuing across many segments, as ICTs become embedded in all economic, social and cultural activities (see OECD, *The Seoul Declaration on the future of the Internet economy*, 17-18 June 2008). Second, ICT investment is volatile. On the investment side this is due to the "acceleration principle". Investment is approximately proportional to the rate of change of output. This magnifies changes both upwards and downwards in periods of growth and slump. Third, consumer spending is under pressure and has dropped sharply. Consumer confidence has fallen very rapidly with the collapse of the house price bubble and stock markets. People feel less rich despite unchanged income (the "wealth effect"), there is rapidly rising unemployment (potentially reducing consumption expenditure) and increasing worries about job security (increasing household savings). Thus there are major downward pressures on ICT expenditures, particularly on goods expenditures.

To map the impacts of the crisis the next section analyses the performance of the ICT sector with data drawn from official statistical sources. The following section reports OECD analysis of quarterly reports of

1 OECD (2008a, b), "Tough year ahead for IT industry, warns OECD", Press release, 22 December, at www.oecd.org/sti/ito

2 OECD (2008d), *What is the economic outlook for OECD countries? An interim assessment*, 2 September; OECD, *OECD Economic Outlook, Number 84*, 25 November.

3 OECD (2009a), *OECD Interim Economic Outlook*, 31 March 2009; *OECD Economic Outlook, Number 85,* June 2009.

the largest ICT firms. The third section elaborates on the likely supply and demand factors re-shaping the sector in the economic crisis and the impacts on ICT diffusion and use. The paper closes with a discussion of ICT policy, a brief survey of relevant programmes in current government economic crisis packages, and interactions between current ICT policy and economic crisis packages.

The analysis in this report is designed to address the following questions:

- What is the depth and extent of the current downturn in the ICT sector?
- How does it compare with the 2000-2001 recession? Are some sectors and countries performing better than others?
- What are the likely near-term effects of the recession and recovery in the sector?
- Is there a changing role for ICT policy? What impacts will crisis packages have on the ICT sector and the use of ICTs across the economy?

Part 1. Recent aggregate ICT production trends

Short-term ICT production [4] [5]

By product area: ICT goods and services

Production of semiconductors has been leading the way down in this downturn, as it does habitually, and just as it leads the way up in upturns. Semiconductor production in current terms has been turning down in some countries since 2006, and the downturn accelerated in the second half of 2008. On the other hand communications equipment has tended to trend slowly down towards zero, and measuring and controlling instruments turned down later as industrial investment dried up (see Annex Figures).

ICT goods inventories built up rapidly in countries for which data are available. In Japan the build-up in the producer inventory ratio (inventory over shipments) rose rapidly to unprecedented levels at the end of 2008/early in 2009, particularly in electronic components and to a lesser extent in IT equipment, although inventory levels have now been pared back. Similarly in Korea producer inventories for computers rose to unprecedented levels in the last half of 2008 and semiconductor inventories to close to record highs. However they dropped sharply through the first quarter of 2009 as ICT manufacturers slashed production and as competitiveness improved with the declining KRW. The very rapid inventory build-up in Japan and Korea was due to the precipitous decline in exports as business and consumer confidence dropped in importing countries. On the other hand ICT inventories rose in the United States but to lower levels than in previous cycles.

Computer and IT services are slowing, but have still retained positive growth in most countries. In most countries for which data are presented, computer and IT services have recently been performing somewhat better than telecommunications services in monthly activity, output or turnover, and telecommunications services are even declining in China albeit from a high level.

Comparisons with the cyclical downturn of 2001-2002

Comparisons of production in the current period compared with the last cyclical downturn vary considerably across countries. In general, aggregate production of ICT goods in the United States and Europe is worse in terms of year-on-year changes than in 2001-2002. Historically very sharp falls in goods production in Japan, Korea and Chinese Taipei took year-on-year production indices down 30-40%, far below their 2001 cyclical lows. But all have shown equally sharp signs of upturns in Q1 2009, with Korea leading the way (see Figures 31, 34, 44 and 47).

In non-OECD Asia, Chinese Taipei was hit by a very sharp slump in flat-screen products and semiconductors, and Chinese ICT value-added data dropped below zero at the start of 2009, but they have now picked up to around 3% year-on-year, a far cry from close to 20% growth in June-July 2008. The producer inventory ratio for electronics and ICT equipment in Japan was very high compared with the previous cycle in 2001-2002. In Korea the inventory buildup in the second half of 2008 was higher and

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[4] All data is drawn from official national monthly statistics, most of which are released with an approximate 6 week lag. In this paper most national data are through May 2009, with some through June 2009. 3-month moving averages on seasonally adjusted data have generally been used to iron out short-term fluctuations, and to provide a better picture of recent movements than the 12-month moving averages in the *Information Technology Outlook.* A sample of the figures used to prepare analysis in this section is presented in Annex Figures 28-50.

[5] This section benefited from inputs and comments on Asian developments from Dieter Ernst, Economics Study Area, East-West Center, Honolulu.

sharper than the previous 2000-2001 cycle, although semiconductor inventories did not see the prolonged two-year buildup beginning late-1999. For the United States, inventory buildup was lower than previously and inventories are now dropping.

IT and computer-related services were generally performing better in most countries than during the last cyclical downturn in 2002, but have continued to trend down even as ICT goods pick themselves up from the bottom of the slump. Telecommunications services are often performing worse than IT and computer–related services in the current slump, after having performed better in the last one.

Performance compared with other product groups

In the previous slump in 2001-2002, ICT goods production was worse than the manufacturing aggregate and worse than both motor vehicles and chemicals in all countries for which detailed monthly data are available.

In the current slump, ICTs goods are generally performing better than aggregate manufacturing and in particular better than motor vehicles, which is the worst performing major sector across all countries surveyed except China. ICT goods are performing somewhat better than chemicals except in all Asian countries. In Japan and Korea ICT goods production is somewhat worse than total manufacturing and close to motor vehicles in its slump.

In Japan the producer inventory ratio in electronics and IT equipment rose much more rapidly than for total manufacturing, chemicals and motor vehicles, even though inventories in manufacturing, chemicals and motor vehicles reached historic highs in Q1 2009. Similarly in Korea, ICT manufacturing producer inventories rose to record highs in the second half of 2008. They peaked much sooner and more rapidly than chemicals and motor vehicles (which both remained relatively low) and were well above total manufacturing. In the United States ICT inventories started decreasing only very recently, later than for manufacturing as a whole and much later than for motor vehicles and parts. As a sign of relative resilience in US ICT goods production, the computer and professional equipment industries have had among the lowest year-on-year increases in their inventory to sales ratios amongst all US goods categories.[6]

IT and computer services remains positive in most countries and is performing much better than ICT goods. IT services performance is now generally better than aggregate services although continuing to trend down. In most countries IT services are now performing better than financial services, and better than communications services. In the previous slump in 2001-2002 IT services generally performed worse than total services, and considerably worse than both communications services and financial services.

Performance across countries

The ICT production slump has been about as deep as in 2001-2002 with the exception of Japan, Korea and Chinese Taipei where the slump has been particularly severe (see Figures 31, 34 and 47). This is in part due to the continuing restructuring of the ICT goods-producing industry away from many OECD countries towards Asia, particularly China, and to Eastern Europe, following the last slump, increasing synchronization with global demand. In Korea and Japan the deep slump in ICT goods production approximately equals that in motor vehicles, but the rapid run-down in ICT inventories suggests that ICT goods production is now likely to improve in the remainder of 2009.

Services performance has been consistently trending downwards in most of the sample set of countries, with no particularly major differences across them. This may be due to the domestic nature of

6 Data from *Econompic Data, 2009.*

most service transactions, so that they are not buffeted by the rapid collapse of export markets seen for ICT goods trade, but are now declining in 2009 along with the rest of the economy.

Semiconductors

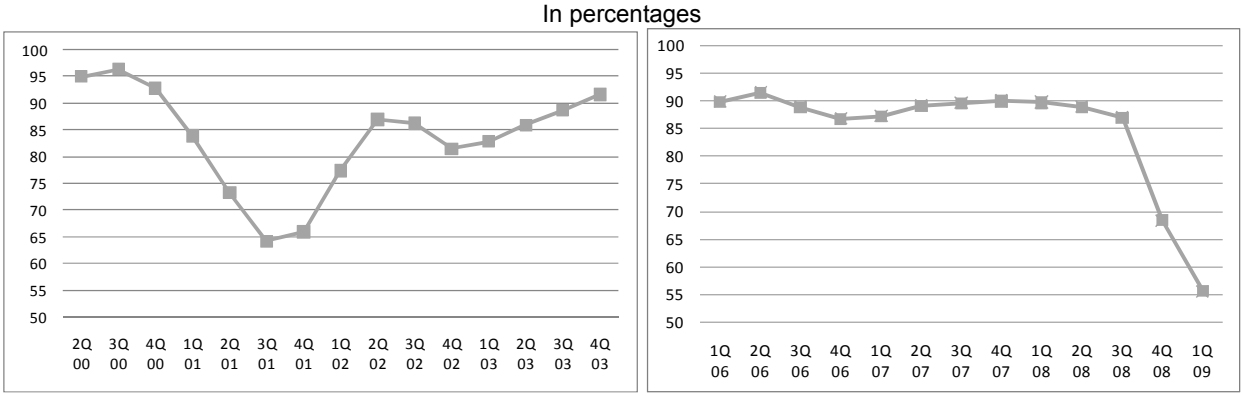
Semiconductors are always seen as the bellwether for the ICT goods industry. They are major intermediate inputs into production, leading the rest of the sector into slumps and pulling out first. Analysis of the performance of the semiconductor sector provides a good leading indication of what will later happen across the wider ICT goods industries.

The world-wide semiconductor market remained flat overall in the first three quarters of 2008, but with a sharp and continued drop since Q4 2008 with the onset of the global recession. The global market volume is expected to decline by at least 20% during 2009 and recovery is not expected before the end of 2009 or 2010 (see Annex Figure 25). Annex Figure 26 for semiconductor markets shows the rapid decline in billings in the last quarter of 2008 and the first one of 2009. The shape of the accelerating slump in Q4 2008 resembles that of the sharp down-turn from Q3 2001. A modest month-on-month upturn since March 2009 suggests that demand is beginning to stabilise, albeit at substantially lower levels than one year earlier and some commentators see a return to growth towards the end of 2009, following Q2/Q1 growth in the first half of 2009 (2009, IC Insights), as, for example, declines in PC sales level off.

Falling sales are exacerbating manufacturing over-capacity. Utilisation rates for semiconductor facilities in Q1 2009 have fallen to 55%, lower than the equivalent trough in 2001 (see Figure 1). These data suggest the current downturn is much sharper than in 2001. In the short term, continued price declines are leading to plant closures, delayed and reduced investments. In the medium to longer term, this might lead to product shortages and production under-capacities, especially in newer, more cost-efficient manufacturing facilities (*e.g.* for 300 mm wafers).

Figure 1. Utilisation rate of semiconductor manufacturing facilities

In percentages



Note: The two graphics indicate utilisation of state-of-the-art manufacturing facilities. There is a break in series in Q1 2006 due to changing technologies. These statistics are based on data supplied by merchant semiconductors manufacturers who together represent the great majority of world semiconductor production.
Source: Semiconductor Industry Association, May 2009.

Venture capital

Shifts in current flows of venture capital (VC) give an idea of where risk-taking investors see future innovations and the most promising areas for investment. The volume of these funds is currently very constrained by the availability of finance, and the potential for successful exit strategies through stock market listings or purchases of successful firms, *e.g.* by private funds. These data are often published very rapidly by VC industry associations, but are not readily comparable across countries. Detailed quarterly US

data is available with a lag of around one month and as the United States is by far the largest VC market, these data are indicative of global trends in funding ICT innovations.

The most recent US data (through Q1, 2009, see Annex Figure 27) show that ICT VC has held up moderately well, and the share of ICTs in total venture capital remains stable at around 50% even if it has declined from over 75% at its peak in the Internet bubble. However US ICT venture capital declined substantially in current terms to around USD 1.5 billion in the first quarter of 2009 from close to USD 3 billion in the last quarter 2008. The current level of ICTs in venture capital investments is almost as low as it was in 1996. These venture capital investments indicate the continuing importance of ICTs as promising sources of innovation and growth despite the US-led financial market crash, and this importance is expected to continue, although with some shifts, particularly towards ICT-intensive clean technologies.[7]

Part 2. Performance of top ICT firms in eight ICT sectors[8]

To analyse recent performance in more detail, this section looks at the ten largest firms in each of eight different ICT sectors. These firms are drawn from the top-250 ICT firms as identified in the *OECD Information Technology Outlook 2008*. The relative performance through to Q1 2009 (quarterly year-on-year growth) is compared with 2001 and Q1 2002. Year-on-year quarterly changes are calculated for each firm and then pooled to make up the Top-10 firm sector groupings.[9] These give an overview of the recent evolution of large ICT firms and the sector. Balance sheet net cash positions are analysed for the first time, with net cash defined as: cash plus short-term investments/marketable securities minus debt. These net cash data, although very variable across firms, give a forward indicator of their likely survival and their potential to self-finance R&D and innovation.

The results show considerable variation across sectors as would be expected in the recession and geographical and firm-specific factors also account for a large share of variability. Aggregate trends described in the first part of this report are largely confirmed by firm-level developments in the ICT sub-sectors analysed below. However, detailed data in this section of the report goes through the first quarter 2009. It does not capture the upturn in ICT goods which can be seen in the most recent cyclical data presented in this report and in the very preliminary analysis of firms reporting second quarter 2009 results.

Semiconductors

The semiconductor industry as usual was the earliest to be hit by the recession. Demand for semiconductors fell significantly throughout 2008 and severely during the final quarter, and continuing into Q1 2009. However there has been a modest recent uptake of demand and firms which have released results show that 2009 Q2 year-on-year results, although still negative, are better than for Q1, and that

7 A recent survey of 725 venture capitalists globally suggests that over the next 3 years investment interest will continue in telecommunications and semiconductors but it will be decreasing, that software and new media will attract increasing investment interest, and that clean technologies will attract the greatest increase in investments. Governments are expected to be most likely to increase venture capital investments compared to other actors, and governments should implement favourable tax policies for entrepreneurial development and develop policies to motivate institutional investors to invest in venture capital (2009, Deloitte Touche Tohmatsu, Global trends in venture capital: 2009 global report).

8 These data are drawn from quarterly and annual data provided by Yahoo! Finance (based on Capital IQ), MSN Money (based on EDGAR Online, SEC) and Google Finance (based on Thomson Reuters). Where audited Q4 2008 and Q1 2009 data were not available from these sources, they are taken from press releases on firms' websites.

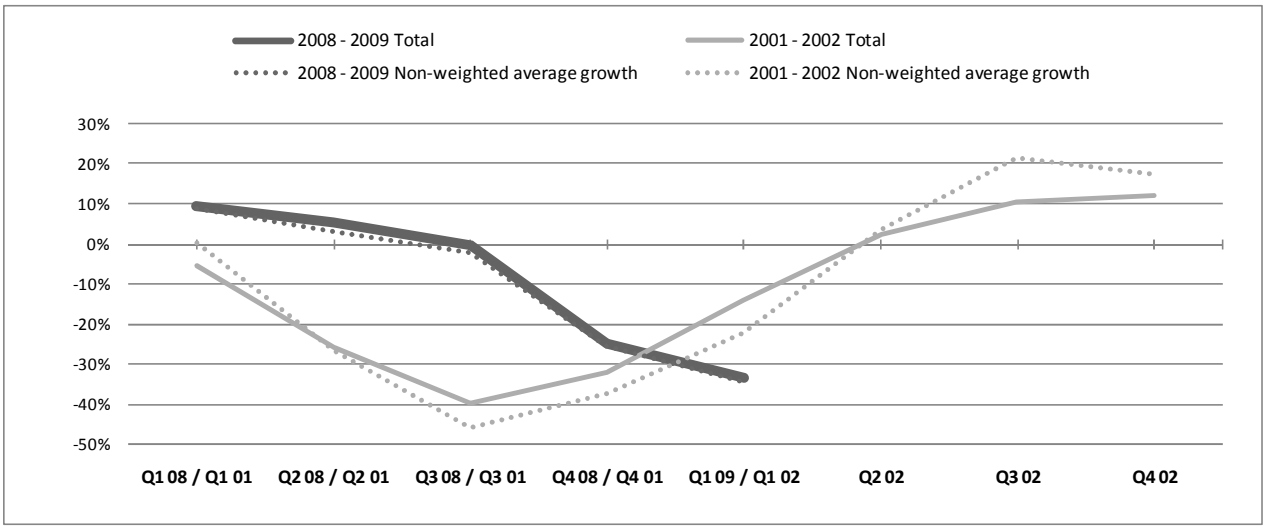
9 To reduce the effect of exchange rate fluctuations, March 2008 OECD exchange rates were applied to all of the quarterly results for 2009, 2008, 2007 and 2002, 2001, 2000.

there is quarter-on-quarter growth.[10] However the rapid fall has affected the entire sector, including semiconductor equipment suppliers (*e.g.* ASML, Applied Materials, Kla-Tencor, Tokyo Electron) and subcontractors. Utilisation rates dropped rapidly through Q1 2009 (see Figure 1 above). Despite positive headlines (*e.g.* Intel investing USD 7 billion in manufacturing facilities over the next two years, and positive quarter-on-quarter results and improving year-on-year results) 2009 is expected to see a year-on-year revenue decline for the sector of at least 20% (Annex Figure 25).

Memory semiconductors have been particularly affected with rapidly falling demand and large overcapacities. Gartner reported that the total market for DRAM memories contracted by over one-third in the final quarter, both on the previous quarter and year-on-year (Fabtech, 2009). Memory prices continue to fall and companies affected go beyond Asian manufacturers as German Qimonda's insolvency case shows. Some growth for the semiconductor industry in 2009 is expected from increasing demand for "netbooks", smartphones, GPS systems, energy-efficient semiconductors and photovoltaic technologies.

Year on year revenue growth for the top-10 companies throughout 2008 was on average higher than in 2001.[11] However, combined quarterly revenues then dropped by 34% in the first quarter of 2009 compared to the first quarter in 2008. This drop was stronger than revenue declines witnessed for these companies in the beginning of 2002, but still above the lowest growth rate of 2001-2002 (Figure 2).

Figure 2. Quarterly revenue growth (year-on-year), Top-10 "Semiconductors"



Note: Average growth refers to non-weighted average of firms' annual growth rates. Quarterly revenues of ASM International for Q1 to Q4 2000 and 2001 has been estimated using annual revenues.

Semiconductor companies seem better placed in terms of cash availability than seven years ago. Semiconductor companies have more net cash at the end of 2007, 2008 and the first quarter of 2009 than seven years ago (Figure 3).[12] Intel, Texas Instruments and Taiwan Semiconductor had several USD billions net cash in their balance sheets in the beginning of 2009. However, only Taiwan Semiconductor (together

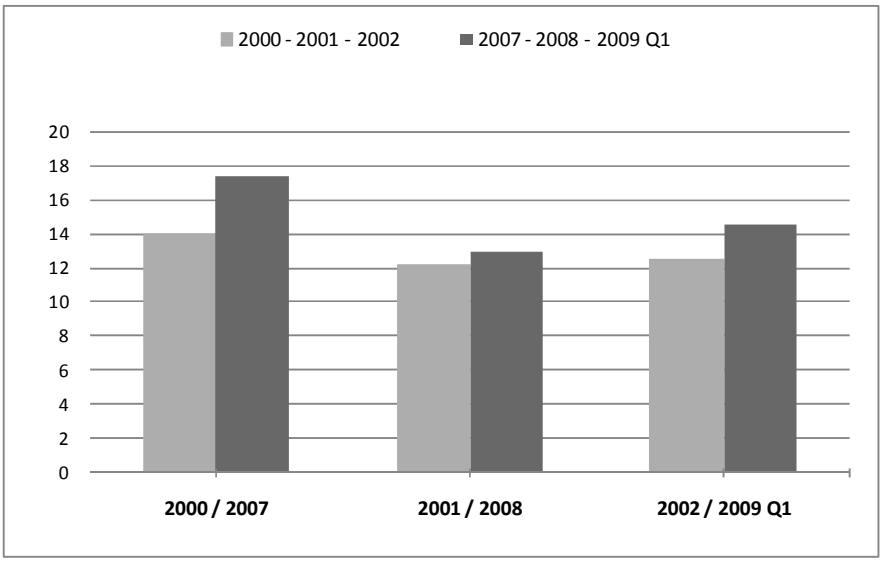
10 Quarter 2 results for Intel, Micron Technology and Texas Instruments. Their improving results compare favourably with *e.g.* IT services and software, where early reporting firms had worse year-on-year results in Q2 2009.

11 Annual data are from annual reports (*i.e.* they are not the sum of four quarters).

12 This does not include the net cash of Freescale and NXP, as their long-term debt has increased dramatically after buyouts by private equity firms in 2006. In 2008, for example, Freescale had net cash of USD -8.3 billion and NXP USD -4.5 billion.

with three other firms) has increased its net cash since 2007. Increasing net cash together with falling quarterly revenues indicate successful cost reduction measures in the industry.

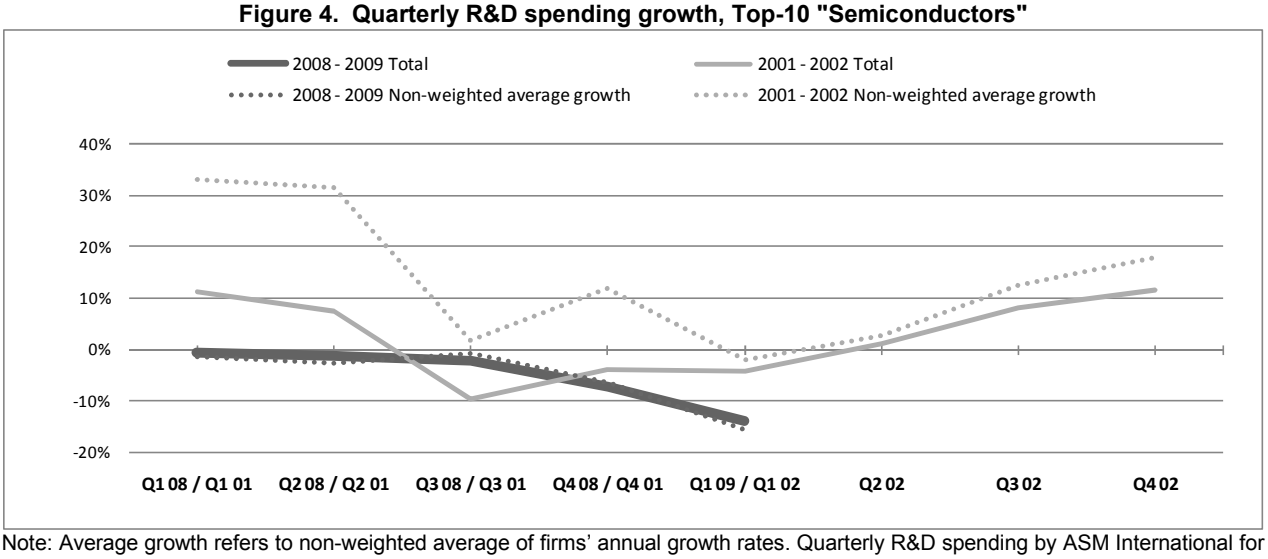
Figure 3. Net cash by year, Top-10 "Semiconductors"
In billion current USD



Note: Based on March 2008 USD exchange rates. Values do not include net cash of Freescale and NXP.

R&D did not show dramatic decreases until the last quarter of 2008, where R&D spending fell at 7%, followed by a drop of 14% in the first quarter of 2009 (Figure 4). Overall, semiconductor firms rank at the bottom regarding their quarterly R&D spending growth in the first quarter of 2009 when compared with the top-10 firms of other sectors (NXP: -48%; Taiwan Semiconductor Manufacturing: -29%; Infineon: -28%; and Texas Instruments: -25%). Only one semiconductor firm (STMicroelectronics NV) increased its R&D expenditures in the first quarter of 2009. Intel, which spent 35% of total annual R&D expenditures of the top-10 semiconductors in 2008, reduced its quarterly R&D spending by 10% in the first quarter of 2009 and cut by the same amount year-on-year in the second quarter, although year-on-year revenues were well below both. Spending cuts on R&D typically lag behind revenue declines. This cyclical lag in R&D cuts was also the case in the previous business cycle in the early 2000s (see *OECD Information Technology Outlook 2008)*.

Figure 4. Quarterly R&D spending growth, Top-10 "Semiconductors"



Note: Average growth refers to non-weighted average of firms' annual growth rates. Quarterly R&D spending by ASM International for Q1 to Q4 2000 and 2001 has been estimated through annual R&D expenditures.

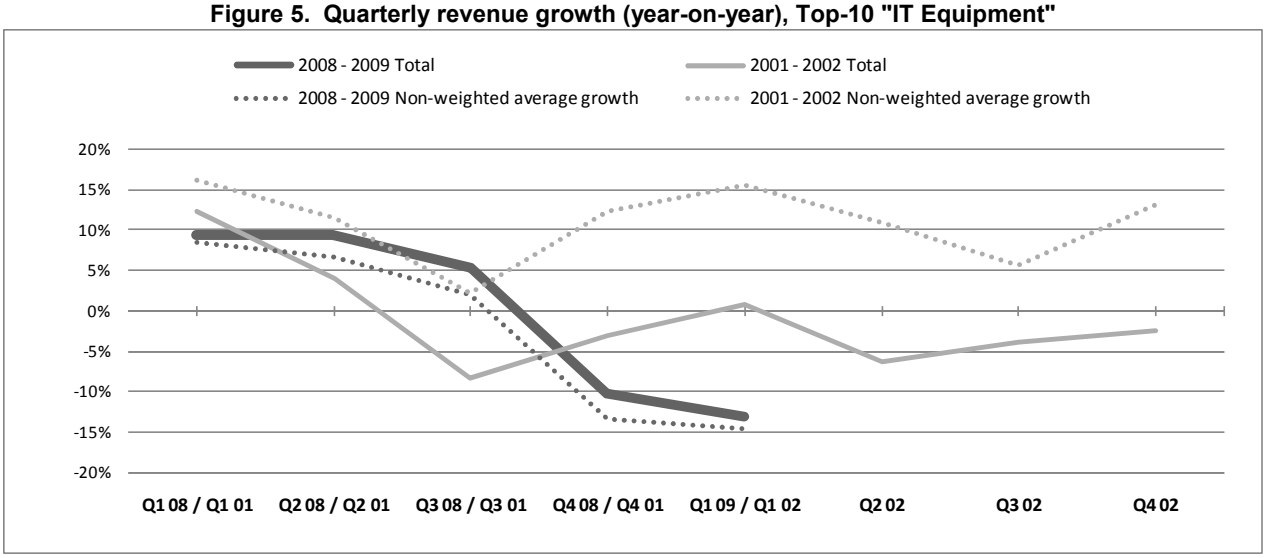
IT equipment

Slowing demand for computers, consumer electronics devices and semiconductors and decreased spending on enterprise servers hit IT equipment manufacturers hard. During the final quarter of 2008, year-on-year global PC shipments declined for the first time since 2002; the decline accelerated during the first quarter of 2009 (IDC, 2009a; iSuppli, 2009). New growth areas are expanding, *e.g.* "netbooks", but they were not expected to compensate for the overall weakening market in 2009. As consumers generally see cheaper "netbooks" as a substitute for higher-priced traditional notebooks, total revenues from PC sales will in the short term decline despite the increasing number of units being shipped.

During 2008, major IT equipment companies followed a similar trajectory to that of semiconductor manufacturers. Whereas revenues grew strongly most of the year, the decline in the final quarter was much stronger than revenue declines witnessed in 2001 and 2002 for the same companies (Figure 5). The downwards trend of revenues continued into 2009.

Major US companies in this category HP and IBM were in total not as strongly hit by the downturn over the whole year as Asian firms because of stronger growth rates in first half of 2008 and a strong focus on software and services provision. In contrast, Dell suffered higher revenues declines because of its greater focus on hardware sales. Manufacturers from Chinese Taipei (ASUSTeK, Quanta Computer) and Japan were severely affected, the latter also due to a strong JPY slowing exports. Apple is the only top-10 company to have positive revenue growth since the last quarter of 2008, mainly due to continuing high sales of iPhones and PCs, underpinned by the availability of Internet downloads of entertainment and applications (see Internet section).

Figure 5. Quarterly revenue growth (year-on-year), Top-10 "IT Equipment"

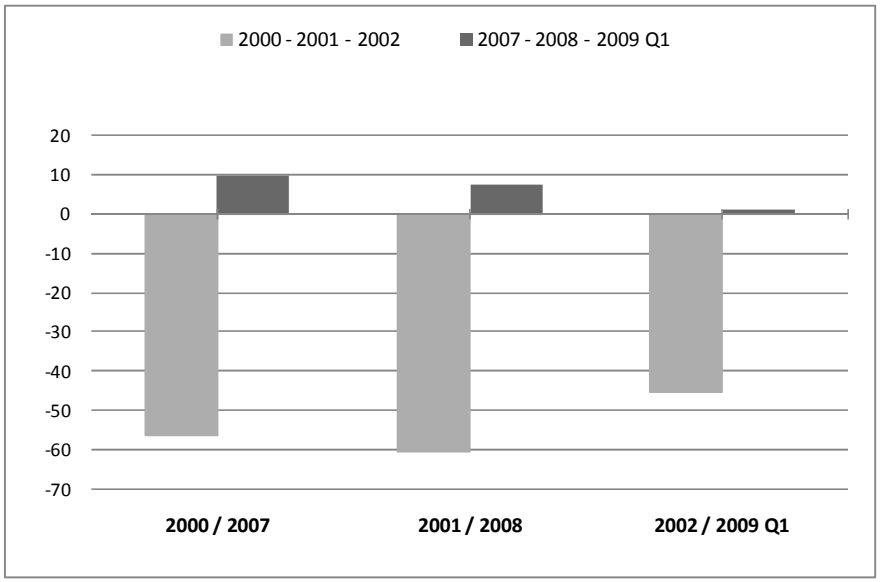


Note: Average growth refers to non-weighted average of firms' annual growth rates. Quarterly revenues of NEC and ASUSTeK for Q1 09 have been estimated using Q4 08 revenues as proxies. All quarterly revenues of HonHai and all quarterly revenues of ASUSTeK and Quanta for 2002 to 2000 have been estimated through annual revenues.

Major IT equipment firms had more net cash at the outset of the recent economic downturn than before the dot.com bust. However, a decline of total net cash can be observed (Figure 6). At the end of 2008, only Apple, Dell, ASUSTeK and Quanta had positive net cash in their balance sheets (USD 24 billion, USD 7 billion, USD 5 billion and USD 5 billion respectively). Toshiba, IBM and HP had the lowest net cash positions with USD -16 billion, USD -12 billion and USD -8 billion respectively (in the case of HP, debts "inherited" through the acquisition of EDS).

Figure 6. Net cash at end of year, Top-10 "IT Equipment"

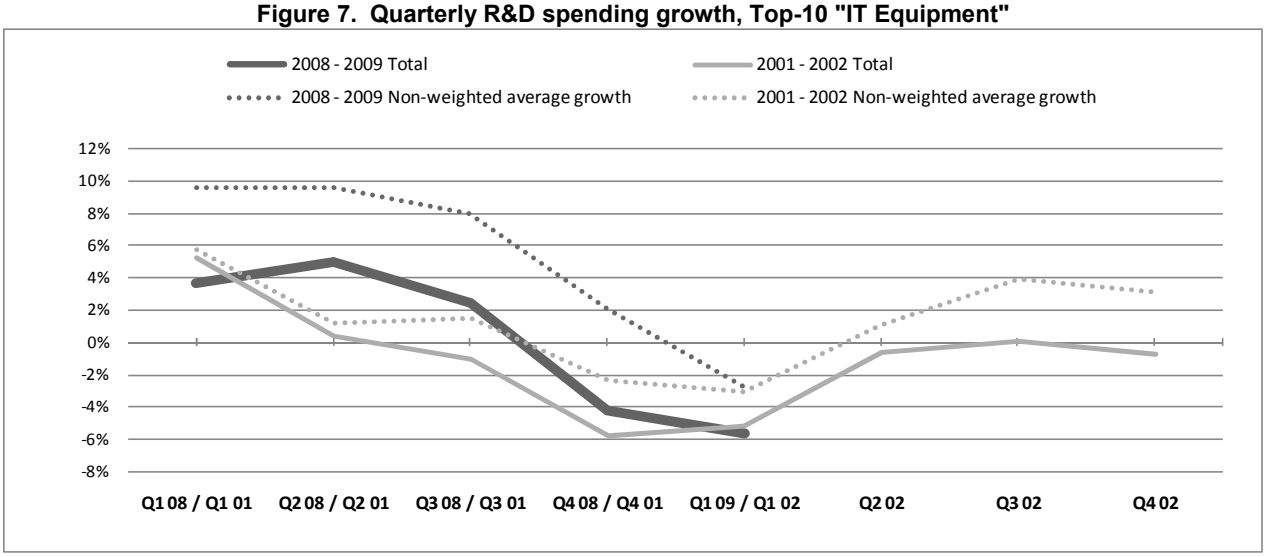
In billion USD



Note: Based on March 2008 USD exchange rates. Net cash of NEC, ASUSTeK and Quanta for Q1 2009 has been estimated using 2008 values.

Quarterly R&D spending of top-10 IT equipment firms followed the same trajectory as their quarterly revenues (Figure 7). HP, IBM and NEC, which spent together more than 75% of total annual R&D spending among the top-10 firms in 2008 (with IBM accounting for 35% of the total), have all reduced their R&D expenditures in the first quarter of 2009 (HP: -21%, IBM: -6%, and NEC: -2%). However, two IT equipment firms have increased R&D expenditure in the beginning of 2009: Apple (17%) and Fujitsu (2%).

Figure 7. Quarterly R&D spending growth, Top-10 "IT Equipment"



Note: Average growth refers to non-weighted average of firms' annual growth rates. Quarterly R&D spending by NEC and ASUSTeK for Q1 09 have been estimated using Q4 08 R&D spending as proxies. All quarterly R&D spending by HonHai and all quarterly R&D spending by ASUSTeK and Quanta for 2002 to 2000 have been estimated through annual R&D spending.

Communications equipment

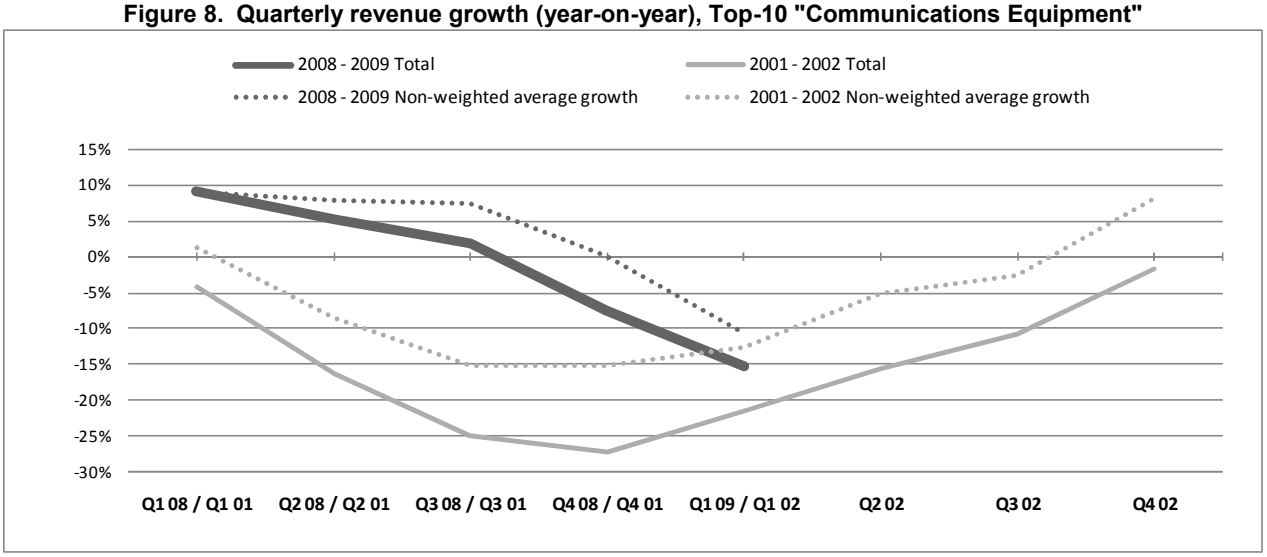
Different developments in markets for handsets and ICT infrastructures have led to heterogenous trends in the sector's top-10 companies. In 2008, global growth of handset sales slowed down to 3.5% and

was especially weak during the holiday season (-13% in the final quarter, compared to one year earlier; IDC, 2009b). The trend continued into 2009, although smartphones have become a major area of growth globally. Samsung, LG, Apple, RIM and to some degree Nokia were able to benefit from these developments. Motorola and SonyEricsson lost significant market shares, partly due to weaker positions in smartphones and touch-screen mobile phones.

Investments in infrastructure networks are expected to slow in 2009, but demand for advanced wireless broadband networks persists. Economic stimulus packages in OECD countries include expanding broadband networks and smart electricity grids, which depend on broadband (see Part 3 of this paper). China's government has announced it will invest over USD 40 billion in 3G infrastructures over the next two years. Companies such as Cisco Systems, Ericsson, Nokia Siemens Networks and Huawei are likely to benefit most from these public initiatives when implemented in response to the crisis.

Revenues of communications equipment firms grew more slowly during the course of 2008 and declined strongly from the final quarter of 2008, both in total and as an unweighted average. Ericsson and L-3 were the only top-10 firms with positive growth in the beginning of 2009 (Ericsson 12% and L-3 4%). Strikingly, Nokia, Motorola and Cisco (the top-3), which generated more than 50% of the total annual revenues of the top-10 communications equipment firms in 2008, all suffered the highest decline in quarterly revenues in the first quarter of 2009 among top-10 firms (Nokia -27%, Motorola -28%, and Cisco -17%). Overall, however, communications equipment companies fared better in 2008 and in the beginning of 2009 than they did in 2001-2002 (Figure 8).

Figure 8. Quarterly revenue growth (year-on-year), Top-10 "Communications Equipment"

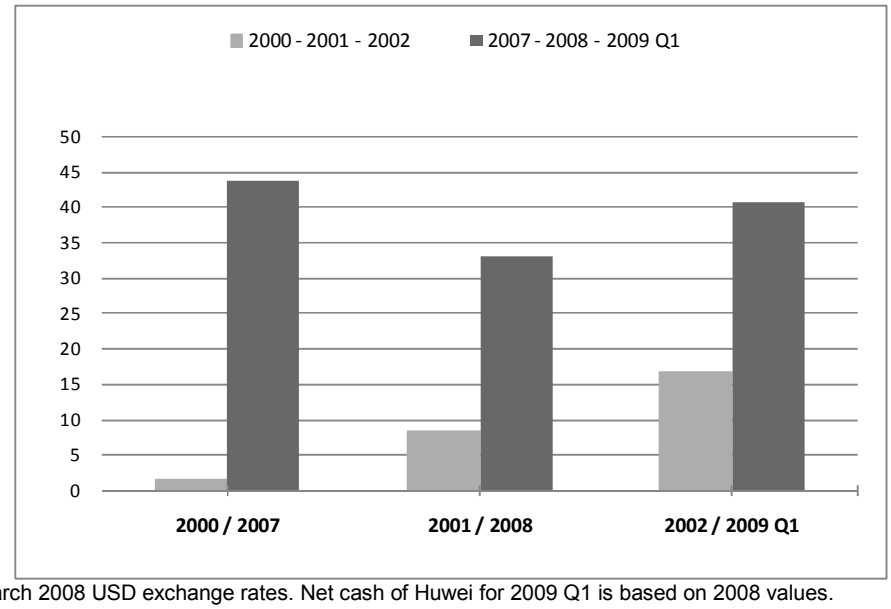


Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly revenues of Huawei and all quarterly revenues of Avaya for 2008 have been calculated from annual revenues. Quarterly revenues of Alcatel-Lucent for 2002 and earlier are based on combined annual revenues of Alcatel and Lucent Technologies.

Another indicator of the better state of communications equipment companies is higher net cash than in 2000-2001 (Figure 9). At the beginning of 2009, major firms had on average USD 7.8 billion in net cash on their balance sheets. Whereas Nokia's net cash declined during 2008, companies such as Cisco Systems, Ericsson and Qualcomm were all able to increase their net cash. Nortel Networks' bankruptcy filing, however, points to more severe competition in the current downturn.

Figure 9. Net cash at end of year, Top-10 "Communications Equipment"

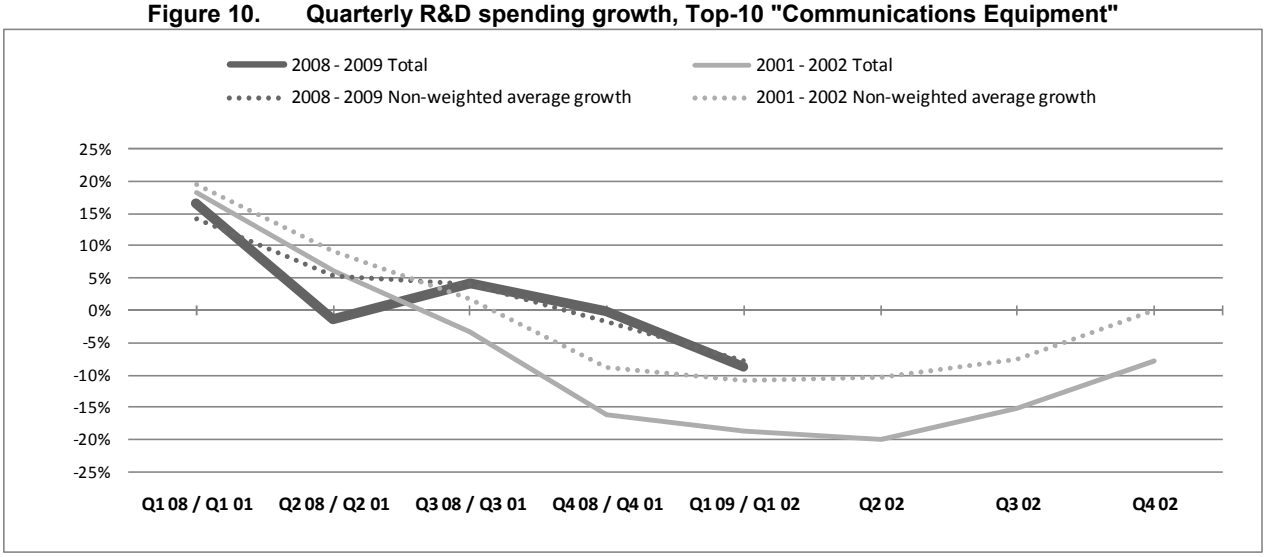
In billion USD



Note: Based on March 2008 USD exchange rates. Net cash of Huwei for 2009 Q1 is based on 2008 values.

Quarterly R&D spending of communications equipment firms almost follows the same trajectory as quarterly revenues (Figure 10). Among the top-3 communications equipment firms (Nokia, Motorola and Cisco), which together accounted for more than 50% of total annual R&D expenditure in 2008,[13] only Nokia has increased quarterly R&D spending in the beginning of 2009 (+2% in the first quarter of 2009 compared to +7% in the last quarter of 2008 and +6% in the third quarter of 2008). The other two firms have significantly dropped their quarterly R&D spending in the beginning of 2009 (Motorola -20% and Cisco -16%). The highest increase in R&D spending in the beginning of 2009 has been realised by Qualcomm (9%), and this is in line with the company's announcement to recruit additional engineers.

Figure 10. Quarterly R&D spending growth, Top-10 "Communications Equipment"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly R&D spending by Huawei and L3 Communications Holding, and all quarterly R&D spending by Avaya for 2008 have been calculated from annual R&D spending. Quarterly R&D spending by Alcatel-Lucent for 2002 and earlier are based on combined annual R&D spending by Alcatel and Lucent Technologies.

13 Nokia accounts for 27% of total R&D spending in 2008, followed by Cisco (16%) and Motorola (12%).

Electronics

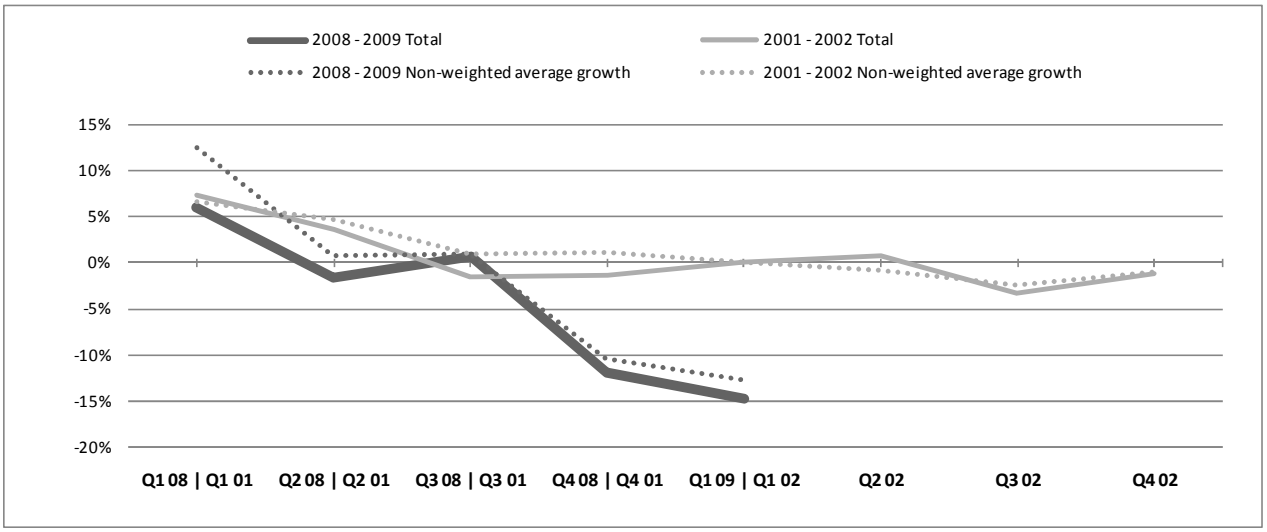
The electronics sector was hit by declining global sales, as was IT equipment. Demand plunged for a wide range of consumer electronics and related components, *e.g.* LCD panel displays for notebooks and other screens, and Japanese firms were hit particularly hard. Growth is expected from emerging clean technologies and related electronics, *e.g.* efficient battery technologies and development of "smart" electricity grids. Solar cells are another example: the Japanese firm Sharp saw overall revenues decline by 20% in the final quarter of 2008, but its solar cells division increased revenues by 18%.

Many major electronics firms are highly diversified, which also brings challenges. Japanese firms particularly seem to suffer from "over-diversification" in the current downturn, *e.g.* producing "white goods" such as freezers and air conditioners (*The Economist*, 2009). On the other hand, Korean firms Samsung and LG have focused their operations around high-growth mobile phones and home entertainment devices. The share of revenues of these business divisions at Samsung, for example, has grown from under 50% to over 60% in the most recent year.

Overall, revenues of top-10 electronic firms continued to decline in 2009 from the rapid fall at the end of 2008 (see Figure 11). The largest drops in the first quarter of 2009 were at Japanese electronics firms, representing more than half of top-10 electronics companies (Canon -32%, Panasonic -30%, Hitachi -25%, and Sony -22%). This is partly due to a strong JPY and consequently slowing exports. Korean firms Samsung and LG displayed positive quarterly growth rates throughout 2009, in part due to a weak KRW. German company Siemens saw positive revenues growth in Q1 2009.

Electronics revenue declines have accelerated more strongly during the current economic crisis than was the case during the dot.com bust (see Figure 11). This is partly due to slumping demand, but a strong Japanese Yen is throttling growth of export-oriented Japanese manufacturers which are the majority of top-10 electronics companies. Official statistics confirm the steep decline of electronics production in Japan, in the early part of 2009, but they also show the equally rapid turn-up apparent by May 2009 (Annex Figures 31 and 32; summarised in Part 1).

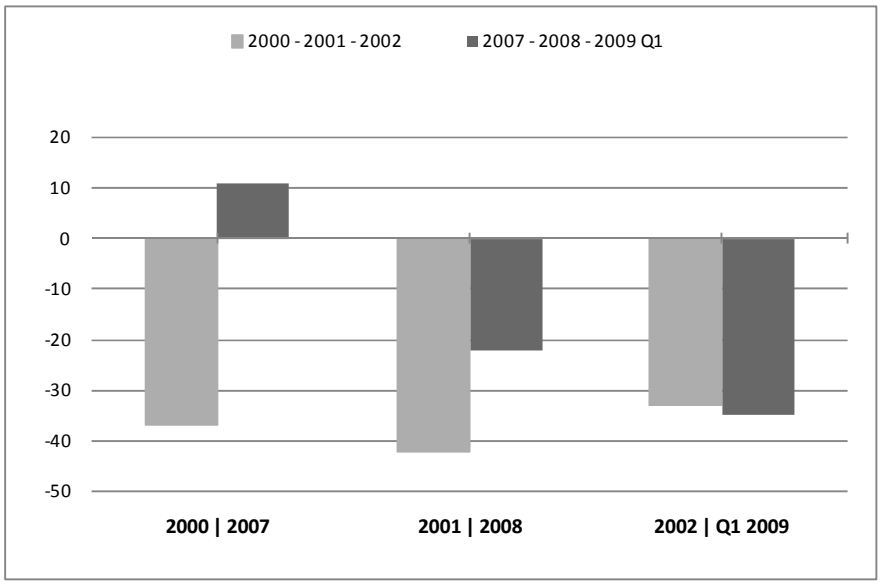
Figure 11. Quarterly revenue growth (year-on-year), Top-10 "Electronics"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly revenues for Mitsubishi, quarterly revenues for Hitachi for 2007 and earlier, and quarterly revenues for Samsung for 2002 and earlier have been estimated through annual revenues. For Sharp half-yearly revenue data have been used to estimate quarterly revenues.

Net cash of top-10 electronics firms has decreased since 2008, partly due to falling revenues (Figure 12). Over half of the companies had negative net cash (*i.e.* were indebted) at the end of first quarter 2009. The average net cash position was USD -3.5 billion. Canon had the highest net cash among electronic firms with USD 6 billion. Hitachi and Siemens had the lowest net cash with USD -21 billion and USD -15 billion respectively.

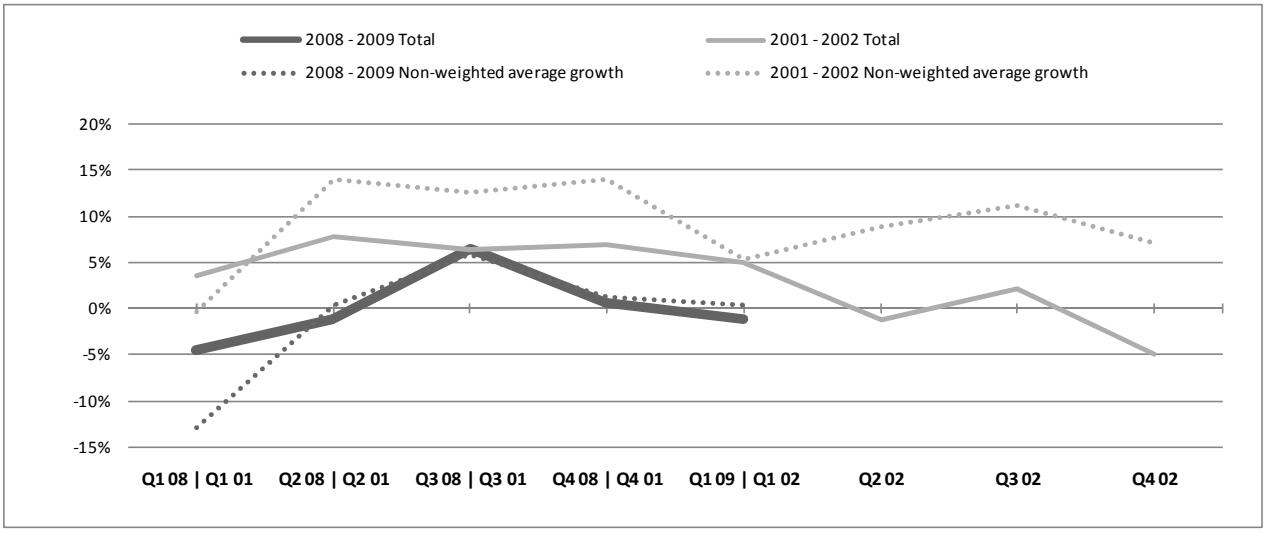
Figure 12. Net cash at end of year, Top-10 "Electronics"
In billion USD



Note: Based on March 2008 USD exchange rates. Net cash of Samsung, Mitsubishi and LG for 2009 Q1 has been estimated using 2008 annual balance sheet values.

Where available, quarterly R&D expenditures in the electronics industry increased slightly until the last quarter of 2008 and have since decreased (Figure 13). Falling revenues in combination with negative net cash have increased the pressure on R&D budgets in this sector. This is especially true for Japanese electronics firms, which had the strongest fall in R&D expenditures in the beginning of 2009 (*e.g.* Sony -10%, and Canon -9%). On the other side, Siemens and Philips Electronics were leading the sector in terms of quarterly R&D spending growth in the first quarter of 2009 with 6% and 5% growth respectively. These two firms account for 25% of total annual R&D spending among top-10 electronics firms in 2008.

Figure 13. Quarterly R&D spending growth, Top-10 "Electronics"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly R&D spending by Samsung, Panasonic, and Mitsubishi, and quarterly R&D spending by Hitachi in 2007 and earlier has been estimated using annual R&D spending. For all firms besides Sony and Philips Electronics quarterly R&D spending in 2002 and earlier has been estimated through annual R&D spending.

IT services

IT services providers were able to maintain growth throughout most of 2008, slowing during the final quarter. Demand for IT and Business Process Outsourcing (ITO/BPO) persists as IT executives continue to focus on reducing costs via (offshore) outsourcing (see Box 1). However, outsourcing revenue growth was expected to decline in 2009 with small and short-term IT projects (with short amortisation periods) being favoured over high-value and long-term IT investments. Banking and financial services firms account for around one–fifth of global outsourcing deals (Everest Research, 2009) and the severe crisis in these sectors has had a pronounced effect on demand for ITO/BPO services. In 2008, the total value of deals in the sector dropped by 28% to USD 18 billion, the lowest since 2001 (TPI, 2009). On the other hand, pressures to cut internal costs is favouring IT services outsourcing, network services have increased particularly in Asia, and Indian IT services firms are optimistic about the future of their business.

The top-10 services firms had almost constant revenue growth rates of around 9% during the first three–quarters of 2008, but quarterly revenues slipped by 6% in the first quarter of 2009 (Figure 14). SAIC, Affiliated Computer Services and Cap Gemini had the highest revenue growth in the beginning of 2009 (12%, 4% and 1%). In contrast, Tech Data, Unisys and Computer Sciences Corporation suffered the strongest decline with -18%, -15% and -12% respectively. Some IT service providers from other sectors also saw flat or slightly declining revenues in their IT services divisions in the first quarter of 2009, *e.g.* -4% at IBM's services division.

Box 1. Trends in IT outsourcing for 2009

The economic crisis has put IT services costs, as is the case for all costs, under pressure. This may benefit outsourcing due to increased internal cost-cutting and perceived benefits from more flexible external sourcing of IT services. In terms of total IT budgets, forward surveys undertaken in 2008 for the 2009 year showed that many IT executives planned to increase their IT budget in 2009 but some were already planning to cut budgets as they had done in 2008. For example, a survey conducted by the *Society for Information Management* (SIM) of 230 firms in the United States revealed that "44% of IT leaders plan to increase their IT budgets in 2009, 37% plan to leave their budgets at the same level as in 2008 and 19% of respondents admitted planning to cut their IT budgets". For comparison: in 2008, IT spending significantly increased in 46% of IT companies over 2007, 28% kept their budget at 2007 levels, and 28% reduced their IT budgets (TEAM International, 2008).

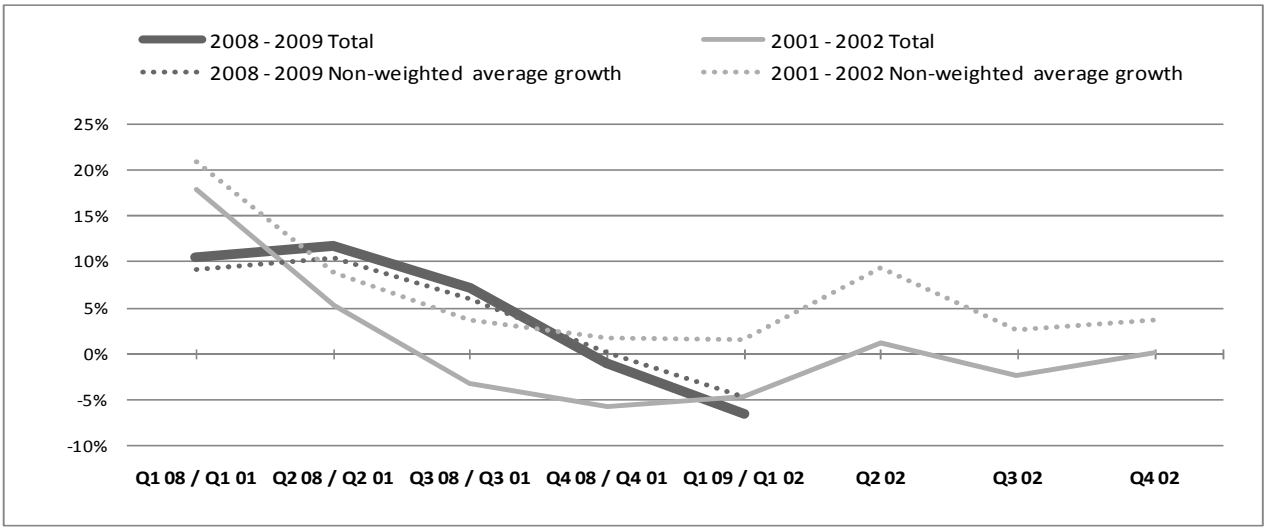
Other surveys conducted in the United States showed that IT (offshore) outsourcing is seen by IT executives as a mean to reduce costs and to improve cash-flow. *Info-Tech Research*, for instance, surveyed more than 150 IT companies, and showed that more than 60% of the IT departments are "focusing on reducing costs via offshore outsourcing". According to the survey of *Robert Half Technology*, 43% of 1 400 CIOs were planning to increase offshore transactions in 2009 (TEAM International, 2008).

The European Information Technology Observatory (EITO) has also projected an increase in revenues for IT and BP *outsourcing* in 2009 in Europe. In Germany, for instance, annual revenues generated by IT and BP outsourcing are expected to increase by 7.2% in 2009 compared to 7.4% in 2008 (BITKOM, 2009).

Recent quarterly data of the outsourcing market indicates that revenue growth through IT and BP outsourcing will probably decline in 2009, due to the current highly uncertain economic outlook. This is reflected by an increasing number of contracts, but with a decreasing Total Contract Value (TCV). According to Technology Partners International (TPI), the TCV of outsourcing deals fell by 22% in H1 2009 compared with H1 2008, and annual TCV in 2009 could "easily fall below USD 80 billion" (TPI, 2009). The last time TCV was below USD 80 billion was during the 2001 recession. However, quarter-by-quarter comparison shows signs of stabilisation. TCV in Q2 2009 increased by 5% compared to Q1 2009. In the Asia Pacific region TCV even increased by more than 150% in H1 2009 over H1 2008, but from a low base, and Indian firms providing outsourcing services have remained relatively optimistic as they change their service product mix to adapt to changing market demands.

Figure 14. Quarterly revenue growth (year-on-year), Top-10 "IT services"

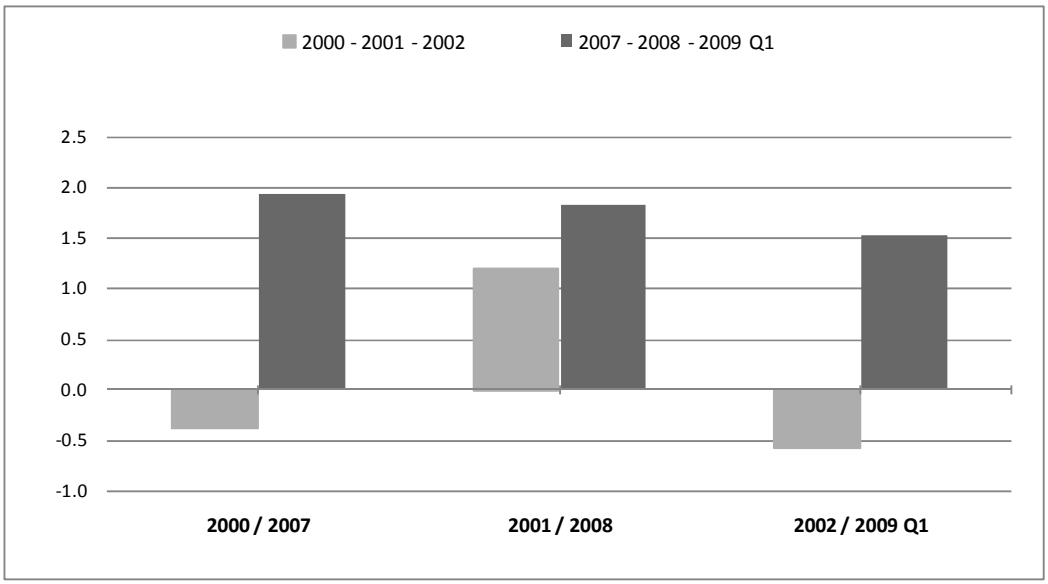
In billion USD



Note: Average growth refers to non-weighted average of firms' annual growth rates. The quarterly revenue of SAIC for Q1 09 has been estimated using its Q4 08 revenue.

The better overall performance of IT services firms in 2008 and the beginning of 2009 is also reflected by improved net cash compared to 2001-2002 (Figure 15).[14] In the first quarter of 2009, the top IT services firms had positive net cash of USD 1.5 billion, compared to a negative net cash of USD -577 million in 2002. Accenture had almost USD 3 billion in net cash, and Cap Gemini and Automatic Data Processing around USD 1 billion.

Figure 15. Net cash at end of year, Top-10 "IT services"
In billion USD



Note: Based on March 2008 USD exchange rates. Values do not include net cash of First Data. The net cash of SAIC has been estimated using 2008 balance sheet values.

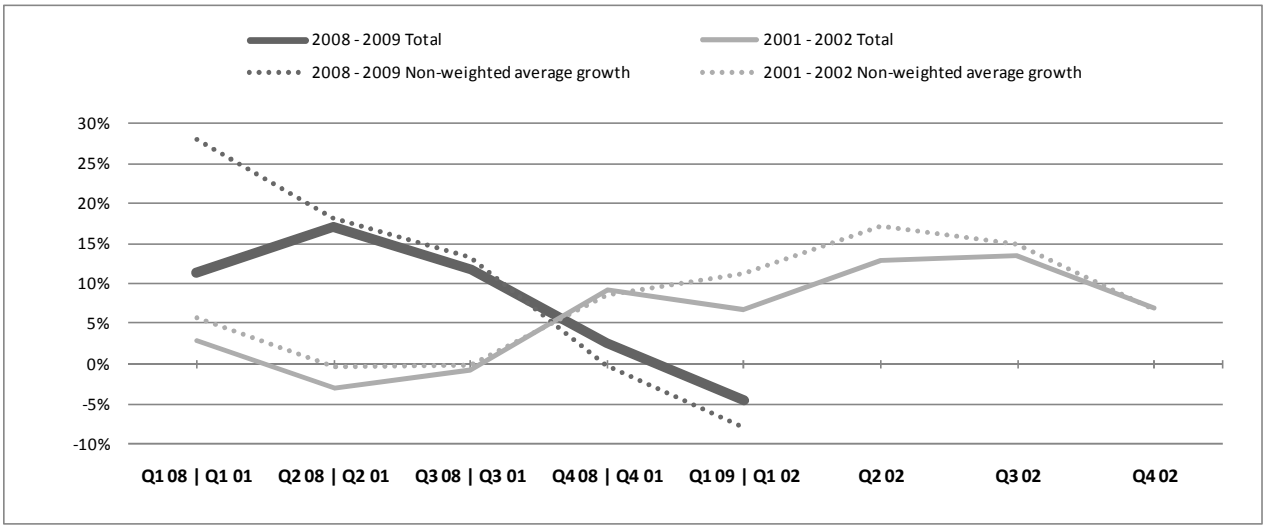
Software

Major software firms maintained positive growth in their quarterly revenues throughout 2008, but with a steep fall in growth rates since the second quarter and negative overall growth in the first quarter of 2009. Declining business confidence in the current economic downturn is likely to continue to slow investments in long-term and high-valued software projects.

The top-10 software firms had a total annual revenue growth of 12% in 2008 compared to 6% in 2001. During the first two quarters of 2008, they had high revenue growth rates with a peak in Q2 of 20%. However, in the second half of 2008 there was a dramatic drop in their combined revenue growth to 12% and 3% year-on-year (*e.g.* Oracle: 24% in Q2, 18% in Q3, and 6% in Q4 2008; SAP: 18% in Q2, 14% in Q3, and 8% in Q4 2008). In the beginning of 2009, quarterly revenues then started to fall (-5%), these were below the lowest growth rates of 2001-2002 (Figure 16). In the beginning of 2009, only Intuit and Oracle were able to maintain positive growth rates (9% and 2% respectively).

[14] This does not include the net cash of First Data, as its long–term debt has increased dramatically after a buyout by a private equity firm in 2007. In 2008, for example, First Data had net cash of USD -22 billion.

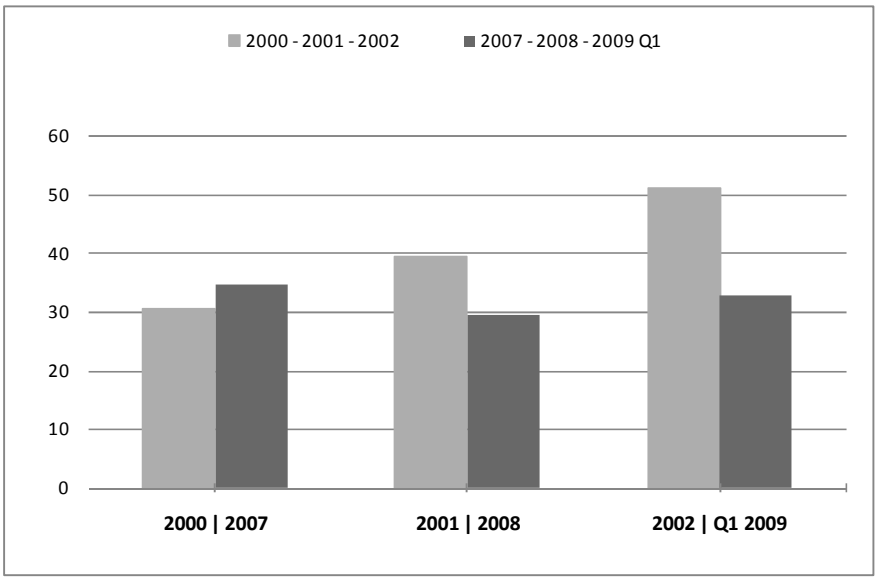
Figure 16. Quarterly revenue growth (year-on-year), Top-10 "Software"



Note: Average growth refers to non-weighted average of firms' annual growth rates..

Top-10 software firms in the beginning of 2009 had USD 2 billion less net cash than in 2007. This is an opposite trend that observed in 2000-2002, where total net cash increased by more than USD 20 billion (Figure 17). In both timeframes, Microsoft alone accounts for more than 70% of the total net cash with USD 23 billion in the first quarter of 2009 compared with USD 39 billion in 2002.

Figure 17. Net cash at end of year, Top-10 "Sotfware"
In billion USD

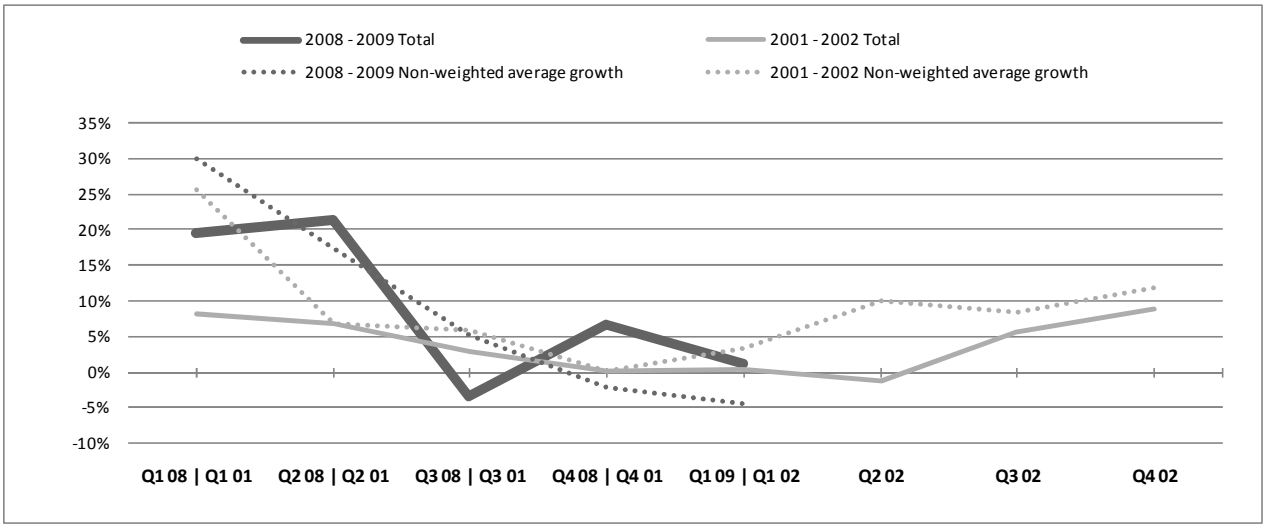


Note: Based on March 2008 USD exchange rates.

Top-10 software firms increased their annual R&D spending in 2008 by 10% compared to 2007, with Microsoft accounting for more than 46% of total annual R&D expenditure in 2008 (USD 8 billion) and Intuit having the highest increase in quarterly R&D spending compared to 2007 (28%). Quarterly year-on-year comparisons, however, reveal decreasing growth rates in R&D expenditures, falling below zero for most of the top-10 firms in the final quarter of 2008 (see non-weighted average growth in Figure 18). In the first quarter of 2009, total R&D expenditure increased by 1%, mainly because Microsoft increased its

quarterly R&D spending to USD 2.2 billion in the first quarter of 2009 from USD 2 billion in the first quarter of 2008.

Figure 18. Quarterly R&D spending growth, Top-10 "Software"



Note: Average growth refers to non-weighted average of firms' annual growth rates.

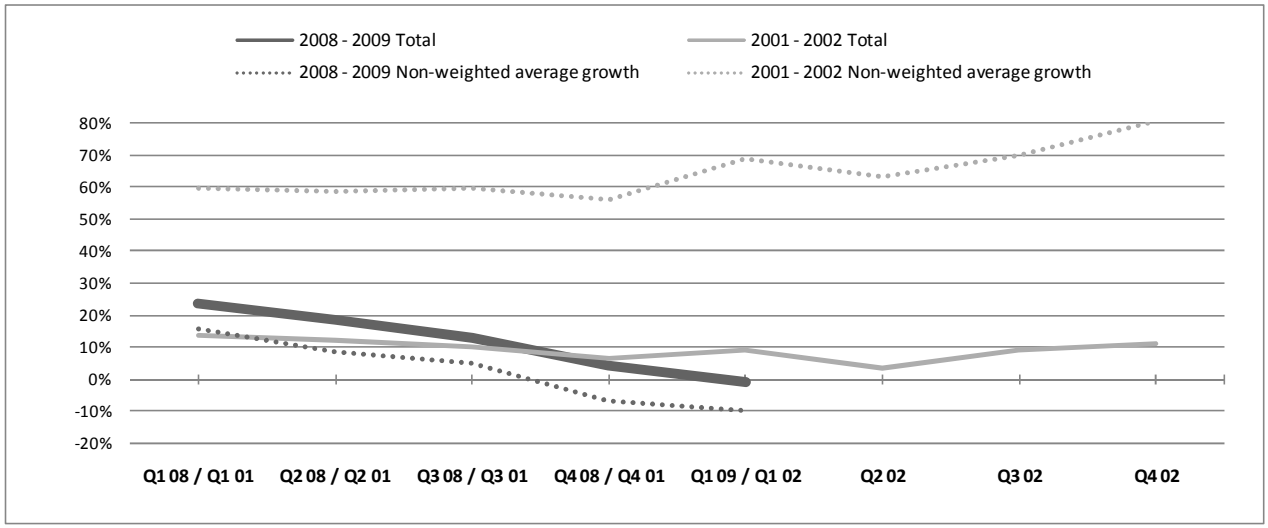
Internet

The fate of top-10 Internet companies depends on factors different from other sectors: a mix of developments in consumer demand as online transactions continue to grow as a share of total retail purchases (Amazon, eBay, Expedia), advertising spending (Google, AOL, Yahoo!, IAC), financial markets (E*Trade, TD Ameritrade), as well as growth in broadband subscriber numbers. Slower overall growth in some of these sectors can benefit Internet companies as consumers look for better deals online and advertisers focus on online advertising (see ZenithOptimedia, 2008). This is likely to benefit the most successful firms and encourage further consolidation, *e.g.* Amazon for online retailing, Google for online advertising, Apple for digital content. Apple's iTunes Store, for example, makes up over 12% of Apple's revenues, driven by downloads of music, films and iPhone applications.

Total top-10 quarterly revenues increased throughout 2008, but at falling growth rates (Figure 19). Total growth dropped to just below zero in the first quarter of 2009, indicating that Internet businesses are not crisis-proof. Whereas Amazon continued double-digit growth, Google had a one-digit growth rate for the first time since its IPO in 2004. The remaining firms had year-on-year quarterly revenue declines, mostly over 10% (TD Ameritrade: -24%; AOL and E*Trade: -23%; Yahoo Inc: -13%; IAC: -11%). eBay, one of the firms with the highest growth rates in 2001 and 2002, suffered a decline of quarterly revenues from the end of 2008 (-7% in Q4 2008 and -8% in Q1 2009).

Combined revenue growth during 2008 is considerably higher than the average growth because revenue growth at Google and Amazon strongly influences the sector's total performance. In 2001-2002, on the other hand, average growth was much higher than the combined growth of revenues because of Google's three-digit growth.

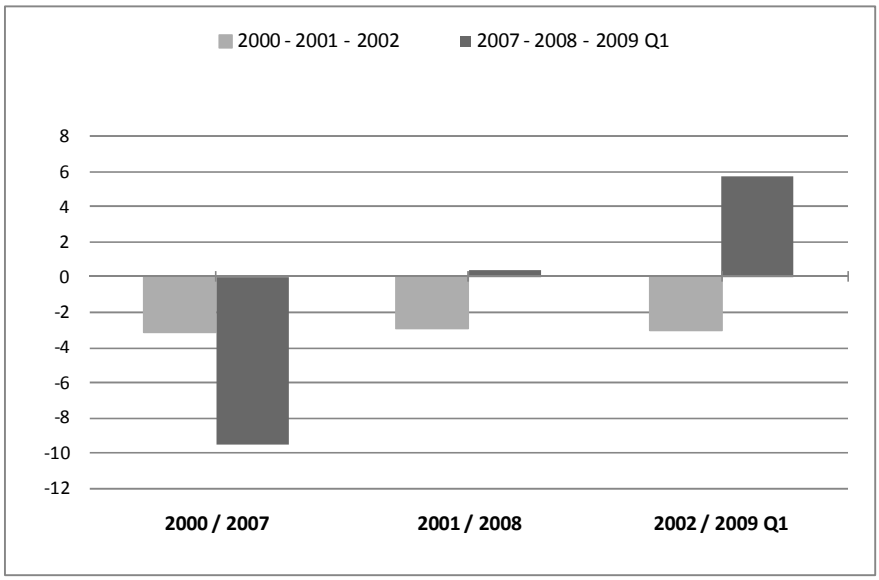
Figure 19. Quarterly revenue growth (year-on-year), Top-10 "Internet"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly revenues of Google and AOL for 2002 and earlier have been calculated from annual revenues.

The top-10 Internet firms are better placed financially than in 2001-2002. In the first quarter of 2009, they had an aggregated net cash of around USD 6 billion compared to USD -3 billion in 2002 (Figure 20). Those data, however, do not include Google, which was not yet public in 2002 – the company has almost USD 18 billion in net cash, making it one of the most cash-rich ICT firms.

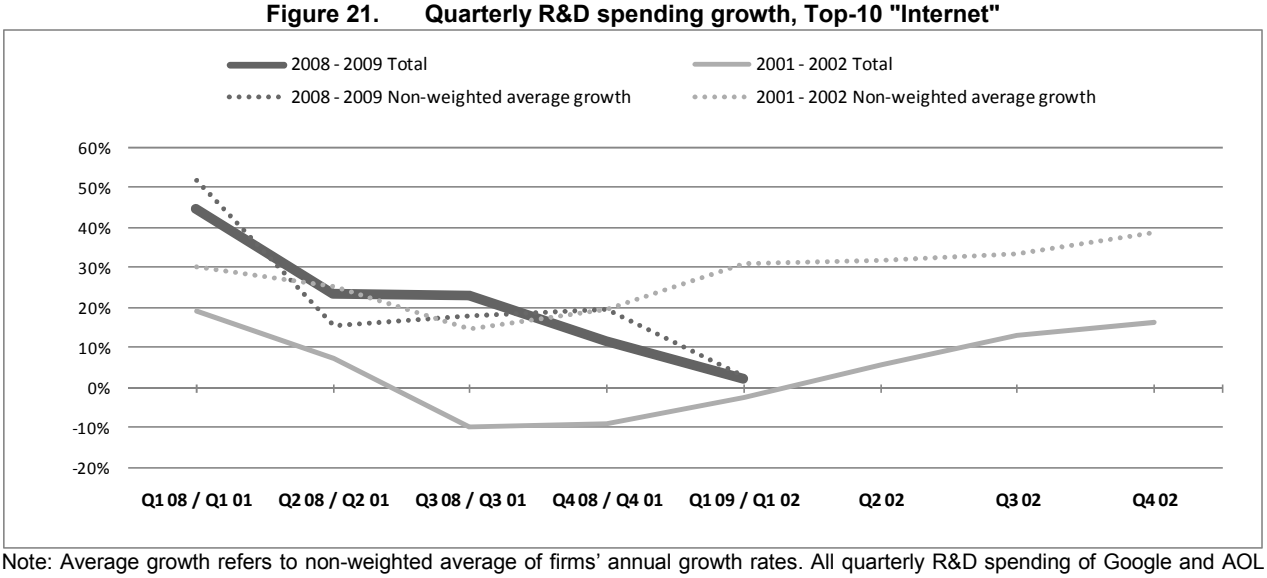
Figure 20. Net cash at end of year, Top-10 "Internet"
In billion USD



Note: Based on March 2008 USD exchange rates. Does not include the net cash of Google.

Where available, annual R&D expenditures increased in 2008 compared to 2007 (*e.g.* Google: 32%, eBay: 17%, and Expedia: 15%). However, quarterly R&D expenditures had falling growth rates (Figure 21). For example, Google, the Internet firm with the highest annual R&D spending in 2008, increased its quarterly R&D expenditures by 65% in the beginning of 2008 compared with 2007. In the middle of 2008, Google then increased R&D expenditures by 28%, then by 16%, and in the first quarter of 2009 R&D spending fell by 5% year-on-year. Nevertheless, most Internet firms still increased their R&D spending in the first quarter of 2009 (*e.g.* Amazon 18%, eBay 14% and Expedia 8%).

Figure 21. Quarterly R&D spending growth, Top-10 "Internet"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly R&D spending of Google and AOL for 2002 and earlier have been calculated from annual R&D spending.

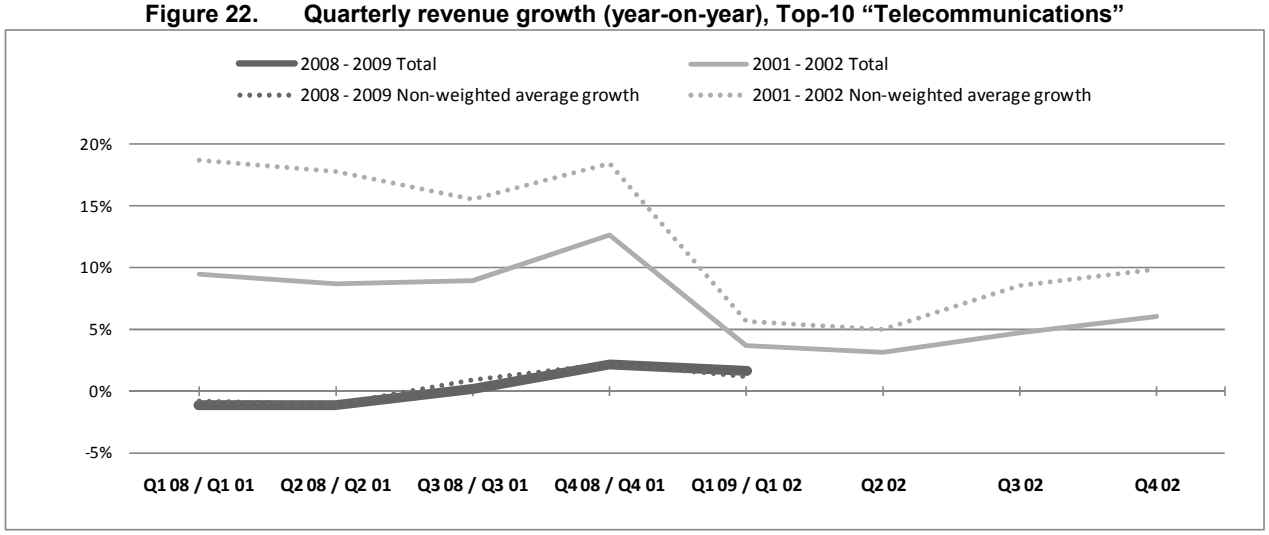
Telecommunications

Diversification in telecommunication services has led to heterogeneous trends in the industry. While the fixed-line usage and subscriber base continue to decline – partly due to the increasing use of cheap or entirely free Voice over Internet Protocol (VoIP) services – the number of mobile subscribers is increasing worldwide. Estimations suggest that global mobile subscribers were over 4 billion by the end of 2008 (an 18% increase compared to 2007) with China, India, Russia and Brazil the fastest growing mobile markets and China also the largest market (over 600 million subscribers in 2008) (ITU, 2008). Mobile data services rather than mobile voice telephony are expected to be the major source of revenue growth in major EU countries (IDATE, 2009).

Another increasing segment is Internet access and services. In some cases they also include VoIP access, which has become a widely accepted substitute for fixed-line voice telephony. In OECD countries, broadband penetration (*i.e.* broadband subscribers per 100 inhabitants) increased by 13% during 2008 (OECD, 2009b). Although growth is losing momentum, Internet access and services can be expected to profit from investments in broadband networks stimulated by economic recovery packages in OECD countries (see Part 3).

Top-10 telecommunications firms maintained their positive quarterly revenue growth rates in the beginning of 2009. However, revenue growth rates were lower than during the dot.com bust (Figure 22). Companies with strong mobile segments had growing revenues throughout 2008 and the beginning of 2009 (*e.g.* Vodafone: 17% in the last quarter of 2008, and 8% in the first quarter of 2009). The strong Chinese mobile market is especially favourable for China Mobile, which still had double digit growth rates in the first quarter of 2009 (14% in the second half of 2008, and 10% in the first quarter of 2009). Companies with a focus on broadband services also maintained positive growth rates (*e.g.* Verizon: 3% in the last quarter of 2008, and 12% in the first quarter of 2009). Companies with the strongest fall in quarterly revenues in the first quarter of 2009 are Spring Nextel (-12%), Telecom Italia (-7%), and NTT (-5%).

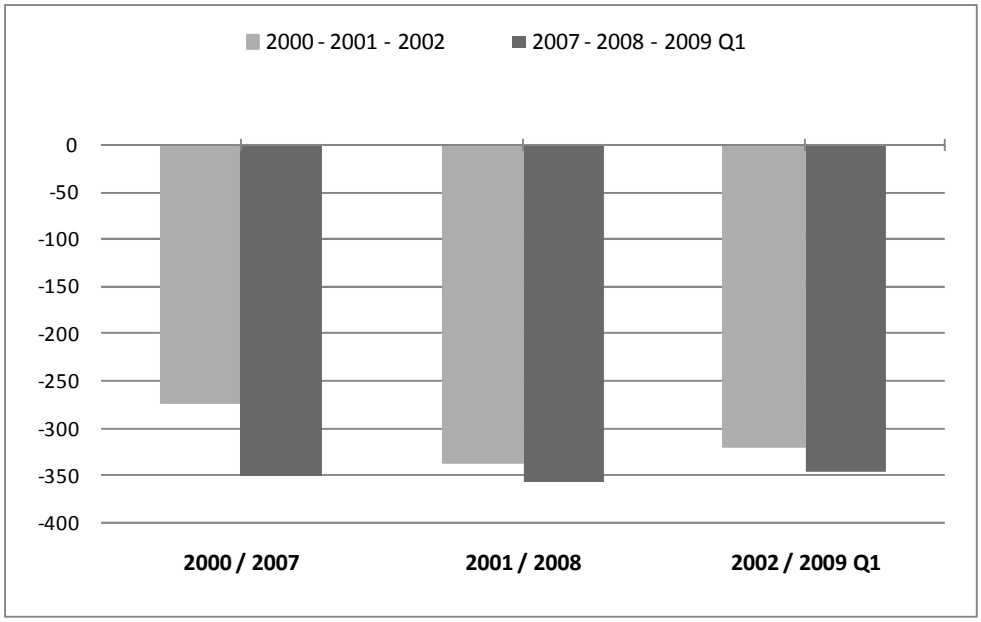
Figure 22. Quarterly revenue growth (year-on-year), Top-10 "Telecommunications"



Note: Average growth refers to non-weighted average of firms' annual growth rates. All quarterly revenues of France Telecom, Vodafone and China Mobile are based on half-yearly data. Quarterly revenues before 2002 of Nippon Telegraph, Deutsche Telekom, France Telecom, and Vodafone are based on annual revenues.

Top-10 telecommunications firms are deeply in debt with around USD -350 billion net cash throughout 2008 and the first quarter of 2009 (Figure 23). All but one telecommunications firms (China Mobile) had negative net cash in the beginning of 2009. With more than USD 18 billion China Mobile is one of the richest firms in the ICT sector (after Microsoft with USD 23 billion). In contrast, NTT had the lowest net cash with USD -31 billion among telecommunication firms.

Figure 23. Net cash at end of year, Top-10 "Telecommunications"
In billion USD



Note: Based on March 2008 USD exchange rates. Net cash for Q1 2009 of France Telecom, Vodafone and China Mobile are based on 2008 balance sheet data.

Summary of sectoral performance of large ICT firms

Overall, different ICT segments are performing differently through Q1 2009, but with some common features. Revenues are generally declining, and hardware has been hardest hit in absolute terms,

but some hardware segments (semiconductors and communications equipment) are still out-performing compared with the slump of the early 2000s. On the other hand, although services are slowing rather than contracting, they are generally performing worse than in the previous slump. Furthermore, hardware firms appear to be rebounding somewhat in Q2 with positive quarter-on-quarter growth while services firms still appear to be declining.

Net cash is higher across almost all segments than in the early 2000s, suggesting that large ICT firms learned important lessons from the previous slump and are in a much stronger position to survive and maintain R&D and innovation. R&D is declining but with a lag or at a considerably slower pace than revenue declines, and some firms are increasing R&D during the slump. Finally, employment is also holding up better than revenues but is starting to decline (see DSTI/ICCP/IE(2009)2).

Part 3. ICT sector challenges and opportunities

Information and communication technologies (ICTs) have been a major source of innovation, growth, and employment. The ICT sector itself contributes a considerable share of business sector value-added (around 8% in 2006 for the OECD) and employment (5.5% of business sector employment in the OECD). The ICT sector is also highly R&D-intensive and a source of innovation. Furthermore, ICTs and the Internet are a fundamental economic infrastructure, driving productivity and innovation.

Given the central nature of ICTs in the economy the impact of the economic crisis on ICTs is two-fold, *i.e.* direct and indirect impacts on the ICT sector itself, but also on the productive and innovative use of ICTs across the economy and society. The two impacts are mutually reinforcing. A slowing ICT sector will generate lower productivity increases and potentially fewer ICT innovations. Slower uptake of ICTs slows the productivity- and innovation-enhancing features of ICTs from diffusing throughout the economy. Network effects induced by a broadly installed ICT infrastructure do not materialise.

When assessing the economic crisis and its interactions with ICT production, diffusion and use, the special nature of ICTs has to be considered. The next section deals with the direct and indirect impact on the ICT sector before shifting to impacts on the side of diffusion.

Impacts on the ICT sector

Short- to medium-term impacts

The economic crisis is having a direct impact on the ICT sector itself. Table 1 shows potential opportunities and challenges over the short and longer terms.

The first block looks at short- to medium-term impacts on the ICT sector. On the side of opportunities, it shows the factors that may benefit the ICT sector relative to other industries. In a period of economic contraction, the greater centrality of ICTs in business, government and society may make it harder to radically compress IT budgets, or at least any faster than the declines in economic activity. Moreover, ICTs are essential in times of restructuring, value chain reconfigurations and new regulations, potentially leading to increased demand for certain types of ICT services (*e.g.* software).

On the side of challenges, the ICT sector is not isolated from the economic crisis. As shown in Parts 2 and 3, despite potential resilience ICT production and sales are falling under the twin impacts of pressures on business IT budgets and significant falls in business and consumer confidence and demand. The impacts are being felt most immediately by suppliers to the top ICT firms and low-cost production locations which have seen their activity plummet, for example in semiconductors. Although the ICT sector maintained R&D and innovation expenditures in the last cyclical down-turn and these only showed a lagged decline,

decreased revenues, faltering growth and a lack of capital may influence longer-term capacities to invest in R&D, innovation and ICT-related human capital in this economic downturn.

Table 1. ICT sector challenges and opportunities

	Opportunities	Challenges
Short- to medium-term	Downturn leads to ICT sector restructuring and greater efficiencies Despite pressures to reduce capital investments, ICT budgets are harder to compress with greater reliance on ICTs and the Internet Restructuring and cost-cutting in other sectors leads to more use of ICTs (information management and productivity tools, CRM) ICT cost cutting measures could lead to more outsourcing of services (hosting etc.), software-as-a service, open source software, more sustainable energy efficient ICTs Public sector and emerging economies continue to invest in ICTs Stimulus coming from economic recovery packages	Declines in R&D and innovation activities Decreasing access to capital (including venture capital) for the ICT sector, financial difficulties of ICT suppliers and SMEs / falling investments in the ICT sector Pressures on IT budgets in all sectors / regions leading firms to operate with current ICT infrastructure Potential reduction in outsourced services Countries specialised in ICT manufacturing see operations rapidly reduced (China, E.Europe) with declines in ICT trade Fall in consumer ICT spending as confidence drops and unemployment rises Fall in demand from emerging economies
Longer-term	ICT sector continues as a leading source of value-added, employment and innovations New ICT R&D and innovation priorities as growth driver (IT, nano- and bio-tech) Growth in digital content applications Low-carbon economy and green IT as growth drivers: remote working, sensors, smart grid Socio-economic challenges as driver: climate change, energy efficiency, health & aging Consolidation and globalisation of value chains and back-office operations, resulting in greater use of information management, *e.g.* to improve transparency of financial markets and public sector Spending on ICT security up Longer-term stimulus from economic recovery packages	Dropping ICT R&D priorities and pre-recession innovation opportunities lowering future growth / weakening ICT innovation and value chain networks Prolonged ICT sector financing problems Slow or no development of ICT and digital content business models and products (*e.g.* advanced broadband services) to drive industry growth Slowdown in supply of ICT professionals and ICT skills Resistance to change and decreasing trust slows ICT-enabled innovation (*e.g.* organisational change) Continued fall in business / consumer ICT spending Prolonged underinvestment in ICT infrastructure (supply and demand) lowering future growth Backlash to globalisation putting pressure on efficient globalised ICT value chains / permanent effects on production ability of low-cost production locations Slower ICT uptake and diffusion through economy and society slows growth of ICT sector

Longer–term impacts on the ICT sector

The second block looks at longer-term impacts on the ICT sector. On the side of opportunities, a range of factors will foster the central role of ICTs in our economy and society. In the business sector, it can be argued that enterprise models will continue to evolve around ICT-enabled networks and the rationalisation of production. Different forms of business and social innovations will add to the growth

potential of the ICT sector. New trends such as the further dematerialisation of production, and the shift to a low–carbon economy will provide further boosts. Finally, solutions to ever-central socio-economic challenges in fields such as climate change, health and aging, and mobility will be ICT-based.

The economic stimulus packages of OECD countries may provide further growth and diffusion of ICTs. Most governments plan to foster growth through smart investments which have repercussions on the supply-side, helping to restore favourable conditions for innovation and long–term growth. In many cases these plans will be directly relevant to the ICT sector and technology diffusion. The way these ICT investments could feed into the economy and society also illustrates the broader interactions between the ICT supply and the use side. Figure 24 sketches out some of these interactions.

Potential longer-term down-side risks to the ICT sector are shown in Table 1. Some of these are a direct prolongation or outcome of short-term challenges. Depending on the overall business cycle and the evolution of the crisis, a continued fall in ICT spending and uptake and a prolonged period of under–investment in the ICT infrastructure is a possibility. The inability of the ICT sector to generate finance in the longer-term and potential under-investment in R&D and innovation might also be felt or become more chronic. A neglect of key R&D priorities would also mean that the ICT sector will be less able to deliver solutions to societal challenges. A slowdown in the supply of ICT professionals and ICT skills could also have important long-term effects. Given the international nature of ICT production and sales, a backlash to globalisation and protectionism will also have a direct impact on ICT sector production.

Impacts on ICT diffusion and use

ICTs and the Internet are a fundamental economic infrastructure (OECD, 2008c). The benefits of ICTs are amplified by their use throughout the economy and society, and the innovations that they drive. ICT investments spur competitiveness and productivity at the firm and aggregate level, in particular when combined with investment in skills, organisational change (and industry restructuring), innovation and new firm creation (OECD, 2003; *OECD Information Technology Outlook,* various years). Investment in ICT contributes to overall capital deepening helping to raise labour productivity. Technological progress in the production of ICTs may contribute to more rapid multifactor productivity growth in the ICT-producing sector. Finally and most importantly, greater use of ICT outside the ICT sector throughout the economy helps firms, public and social institutions to increase efficiency and enhance innovation, develop new products and services and raise multifactor productivity growth. The Internet is an increasingly important platform for much of this creativity and innovation.[15]

Figure 24 provides a snapshot of the interactions between the ICT supply and demand side, by highlighting how certain policy measures promoting the ICT infrastructure or the ICT demand side 'ripple' through the economy and foster growth, employment and innovation. Initially ICT spending yields first order effects in terms of wages and jobs. Second- and third-order effects are however also engendered which increase the stimulus impact.

As partly shown in Table 1 a fall in sales and shipments from the ICT sector is the mirror of falling demand and declining ICT uptake by businesses, the public sector and households. At a minimum new investments and upgrades of the existing ICT infrastructure are delayed. The result could be a slowdown in ICT diffusion and uptake (potentially to firms and sectors which had been special policy targets) and slowdowns in the development of ICT skills, potentially leading to longer-term skill mis-matches and shortages. ICT uptake and use still have an important role to play if countries are to return to the productivity growth path of the late 1990s and early 2000s and the crisis will probably slow this return. In

[15] Chairman's summary, Ministerial on the Future of the Internet Economy, Seoul, June 2008, www.oecd.org/dataoecd/53/49/40989438.pdf.

this case expected productivity-enhancing impacts and ICT-enabled innovations will be less frequent and overall ICT-induced job and growth will remain below potential.

Figure 24. ICTs in the economy

	ICT industry and supply side	Non-ICT industry and demand-side
Measures fostering demand for ICTs	Supporting infrastructure investment, either in unserved or underserved areas or fostering next-generation networks	Upgrading ICT infrastructure in schools, public sector, healthcare, research, education, etc. Introducing "smart" and "green" ICT-related infrastructure (e.g. health IT, smart grid)
First-order effects	Immediate positive revenue impact for communication companies and equipment vendors and others involved in the deployment of infrastructure Preservation and creation of jobs for infrastructure deployment. Workers continue to spend money in other sectors	Creates demand for ICT industry products and services feeding into ICT sector revenues and employment Rise of new specialised hardware, service and consultancy providers (smart grid, health IT, etc.) Preservation & creation of ICT technical and related jobs in other sectors
Second- and third-order effects	Increase of business and consumer spending (including from newly connected areas and ICT sector wages) Preservation of revenues and jobs related to infrastructure Stimulus for ICT hardware demand Multifactor productivity growth in the ICT-producing sector Demand for broadband content & applications and creation/preservation of related jobs	Investment in ICT contributes to overall capital deepening and raises labour productivity Re–organisation of these sectors and productivity impacts (efficiency and MFP) New products and services (distance education, telework, online medicine, etc.) Demand for more infrastructure or servicing that infrastructure New skills
	New business opportunities and generation of new revenue flows through new products and services (e-commerce, healthcare, online education, knowledge-intensive professional services, digital content, entertainment) ICTs enable other innovation at firm, sector and country level and drive productivity & growth The use of ICTs can also contribute to better education, health care and solving societal problems.	

Finally, lack of ICT infrastructure and broader ICT uptake throughout the economy in areas of smart applications in *e.g.* transport, development of energy-efficient buildings, and the health sector, will have long-term negative consequences and slow the ability to address key social challenges.

Part 4. ICT policy and the economic crisis

This section focuses on potential implications for ICT policy. The questions are whether and how ICT policies may need to be adjusted or reinforced in the economic crisis and whether current economic stimulus packages to foster short-term demand and provide foundations for long-term sustainable growth coherently address ICT policy goals. The section first sets out OECD ICT policy themes and approaches

before the crisis and asks questions about their new directions. Then it discusses how economic stimulus packages and associated policies are directly or indirectly related to ICT policies.

The 'pre-crisis' OECD ICT policy framework

ICT policies have been increasingly integrated into overall strategies for enhancing economic growth, employment and welfare in OECD countries (*OECD Information Technology Outlook 2008*, Chapter 7). They have shifted in the last decade from dealing with sector-specific infrastructure issues towards long-term strategies on how ICTs, the Internet and other types of networks can achieve wider socio-economic objectives. E-government activities are a part of strategies to boost public-sector efficiencies, and ICTs are increasingly used to address wider issues at national level (*e.g.* social cohesion, aging, national security) and globally (*e.g.* climate change, energy efficiency, global health issues).

ICT policies of OECD countries range from "Fostering ICT innovation" to "Promoting trust online". Table 2 lists the top ten ICT policy priorities in OECD countries as summarised in the *OECD Information Technology Outlook 2008*. At the top of the ranking are government online activities and policies to promote broadband uptake and use. Specific policies to foster innovation in the top ten are ICT R&D programmes and ICT innovation support. Policies to promote IT education and to encourage industry-based/on-the-job IT training also feature prominently.

These policy areas need reviewing in the context of the economic crisis and their adjustment / reinforcement. The recession will, for example, create pressures for government-supported build-out of the infrastructure (due to lack of finance or hesitance of companies to invest), for ICT innovation (*e.g.* R&D expenditures, venture finance, support for small firms), for the diffusion of ICTs to businesses, etc. In times of a crisis, trust online or the security of ICT networks might decrease as evidenced by the increase in viruses or malware and governments cannot walk away from this policy priority. At macroeconomic level, trade and foreign direct investment are down and protectionism may increase.

ICT policy can be affected in two ways. With pressures on government budgets attention may shift away from current ICT policy approaches. On the other hand, expansionary fiscal policies and the desire to craft new 'anti-crisis' stimulus packages may provide additional resources and political will to reinforce or modify existing ICT policies.

Table 2. Top ten ICT policy priorities, 2008

1	Government online, government as model users
2	Broadband
3	ICT R&D programmes
4	Promoting IT education
5	Technology diffusion to businesses
6	Technology diffusion to individuals and households
7	Industry-based and on-the-job training
8	General digital content development
9	Public sector information and content
10	ICT innovation support

Source: OECD Information Technology Outlook 2008.

OECD governments have been updating ICT policies with the announcement of new broadband strategies (*e.g.* Australian Broadband Plan, Ireland national broadband scheme, Korean broadband plan[16])

16 Korea has initiated plans to bring 1 GB/s broadband connections to homes by 2012.

or new ICT policies (France numérique 2012, Spain Avanza, United Kingdom Digital Britain). Beyond broadband, themes include the improved use of wireless spectrum, new UMTS licenses, mobile and digital TV, developing digital content services and advanced broadband uses (*e.g.* telework, distance education, e-government and health applications). The United Kingdom's Digital Britain plan aims to modernise digital networks, create an investment climate for digital content, applications and services, foster universal availability coupled with the skills and digital literacy, and enable the widespread online delivery of public services. Spain's Plan Avanza 2 is designed to contribute to the economic recovery through the widespread and intensive use of ICTs (with a focus on the future Internet and digital content). Korea has re-launched its New Growth Engines Initiative focused on new ICT goods, ICT services and software.

Some OECD governments have identified ICTs as an important direct or indirect component of economic stimulus plans. This is based on the rationale that ICTs are a fundamental economic infrastructure and a precondition for competitiveness. The idea is that ICT infrastructure and applications throughout the economy and society induce large benefits through their productivity- and innovation-enhancing features (see above). Figure 24 sets out some of the direct and indirect impacts of ICT-specific and ICT-related economic stimulus measures including adoption and use throughout the economy.

ICTs in economic stimulus packages

Governments in OECD and major non-OECD countries are setting up economic stimulus packages to address the economic crisis.[17] The aim of these packages is to stimulate demand in the short term, *i.e.* re-financing banks, injecting cash into the economy and protecting existing jobs. However, most governments also plan to foster growth through smart investments which have repercussions on the supply-side, helping to restore favourable conditions for innovation and long term growth. In most cases these plans are directly relevant to the ICT sector and technology diffusion, and many include ICT-related elements which should prove a positive stimulus to the ICT sector.

Measures aimed at the ICT infrastructure

Many of the stimulus packages recognise the importance of modern fixed and wireless communication infrastructure to support innovative products and services and the need to devote some public resources to improve or accelerate deployment (see Table 3).

These cover two key areas: extending broadband to areas without connectivity and upgrading existing networks to support very-high speed communications. Many plans focus on closing the broadband gap by providing universal broadband coverage. These investments will be largely devoted to rural and remote areas. Depending on the country, plans also devote resources to building out new, very-high-speed networks (next-generation networks). In most cases, the exact meaning of 'broadband' and 'unserved' or 'underserved' are not defined in terms of geography, speeds or technology. Some plans make explicit reference to the fostering of wireless services or fibre deployment.

In all cases, the deployment of broadband is to ensure more widespread connectivity and lay the foundation for broadband applications and content development (for details see OECD, 2009c, and for principles to guide any government investment, see OECD, 2009d). Most plans do or will entail non-budgetary, regulatory measures to sustain policy targets (*e.g.* facilitating fibre roll-out) largely pursuing policy targets and regulation analysed in previous OECD work (see OECD, 2008c and OECD Council

[17] See OECD, 2009c. Within "Measures relating to innovation and long term growth", these include: (i) Improving the infrastructure, (ii) Support for R&D and innovation, (iii) Investment in human capital, education/training, (iv) Green technologies and innovation to foster energy-efficiency and sustainable economic growth, and (v) Support for innovation and entrepreneurship.

Recommendation on Broadband Development). Governments are also planning to foster convergence and drive demand for the ICT infrastructure and services. As part of their stimulus packages, the United States, Korea and Japan for example, are using regulatory measures to foster the transition to digital broadcasting.

Table 3. "Networked recovery": Investing in ICT infrastructure

	Planned investment	Goals	Penetration targets	Speed targets
Australia	AUS 43 billion (USD 34.4 billion) (public-private)	Combination of fibre to the premises (FTTP) and next generation wireless and satellite technology	90% for FTTP and 10% for wireless/satellite	100 Mbit/s for fibre
Austria	EUR 25 million (government) – EUR 100 million (public-private)	Extending high speed broadband and usage of broadband	n.a.	over 25 Mbit/s
Canada	CAD 225 million (USD 211 million)	Extending broadband coverage to un-served rural and remote communities	as many households as possible by 2012	n.a.
Finland	EUR 66 million (USD 96 million) of EUR 200 million (public-private)	Extending high-speed broadband	all permanent residences, business, public administration establishments	1 Mbit/s by end of 2010 100 Mbit/s by end of 2015
France	n.a. EUR 750 million for three years (government share n.a.)	Development of broadband network in small or medium-sized cities, extending (fixed / mobile) broadband. Internet on TGV Est lines (EUR 15 million), and development of networks for education and research Funds provided by a French public bank and the private sector to develop next-generation networks in less connected areas	access to broadband by 2010 and mobile broadband by 2012 for everyone n.a.	n.a. n.a.
EU	EUR 1 billion (USD 1.46 billion)	Extending and upgrading high-speed Internet (focus on rural communities)	100% coverage of high speed Internet by 2010	n.a.
Germany	an estimated EUR 150 million (USD 219 million)	Accelerating the spread of broadband networks. By 2010 all unserved areas connected. Nationwide capable broadband access by no later than the end of 2010	by 2014, ¾ of households should have access to high-speed Internet (all by 2018)	target is 50 Mbit/s
Japan	Yen 185 billion (USD1.9 billion)	Eliminating the digital divide, promoting the development of wireless broadband and fostering digital terrestrial broadcasting	broadband: 100% by 2010 ultra-high speed: 90% by 2010	n.a.
Luxembourg	EUR 195 million (USD 285 million)	Accelerating the build-out of Luxconnect information highway, including through boosting public telecommunications works	n.a.	n.a.
Portugal	EUR 50 million – fiscal incentives[1] (USD 73 million)	Subsidised investments in new generation broadband networks	optic fibre that will allow 1,5 million users to connect	n.a.
Spain	n.a.	Measures for overseeing the installation of new generation fibre and regulating broadband	n.a.	up to 30 Mbit/s, "at cost-oriented prices"
United Kingdom[2]	GBP 200 million (USD 328 million) GBP 150-175 million a year raised by levy on fixed copper lines	Universal service commitment for broadband Next Generation Final Third project which is aimed at developing next generation networks	virtually every community 90% coverage by 2017	2 Mbit/s per second by 2012
United States	USD 7.2 billion (EUR 4.9 billion)	To foster broadband service to unserved / underserved areas, promote broadband in schools, libraries, health-care providers, and other entities.	n.a.	no set minimum data speeds

Note: n.a. stands for not available.

[1] In parallel to its stimulus package, Portugal is planning to increase broadband Internet and local area network access in schools (EUR 61 million).
[2] The UK also pursues the 'Digital Region' project, a GBP 100 million (USD 145.7 million) project for next-generation broadband in South Yorkshire.

Other OECD countries are developing their broadband stimulus plans in parallel to their recovery package. Italy is aiming to foster broadband networks in unserved areas (99% coverage by 2011) and upgrading the network for an approximate EUR 1.25 billion. Ireland is planning to deliver broadband to targeted areas in which it is not available by October 2012 (download speeds of 1.2 Mbit/s and a minimum upload speed of 200 KP/s). Korea is planning to boost broadband by USD 27 billion (KRW 34.1 billion) until 2012 to achieve speeds between 50 Mbit/s and 1 Gbit/s by 2012 (with the government paying a little more than USD 1 billion) while New Zealand has plans to spend USD 1.7 billion (government paying half) to develop fibre optic networks covering three-quarters of the nation at speeds of 100 Mbit/s.

Other targets involving ICTs

Besides direct investment in broadband, stimulus packages often have a more indirect but larger impact on ICT deployment and use, for example investment in "intelligent" transport systems, greener cars with more electronics and embedded software, smart buildings and electricity grids (see Box 2), health, the environment, and modernising public services. Planned investments in these areas are much bigger in monetary terms than those for broadband (*e.g.* in the US, USD 19 billion for health care ICTs and USD 100 billion for modern infrastructure, compared with USD 7 billion for broadband).

The fostering of ICT infrastructure and services in for example health care or research networks will also provide the technological basis for ICT innovation, new infrastructure and services in other fields, and there are for example synergies between broadband deployment and smart electricity grids and transport systems. Most new infrastructure investments in areas such as modernising schools, health care, and transport systems will have an impact on deployment of ICTs and fostering ICT applications, and projects in the fields of education, R&D and green technologies also feature ICT components.

A list of specific ICT examples includes:

Modernising research institutions and facilities (including advanced ICT research networks). Some of the proposed public R&D expenditures will positively impact ICT research. This also applies to R&D support aimed at green technologies.

- Modernising educational and training institutions (including ICT infrastructure and hardware, software and digital content applications).
- Modernising public services (including e-government).
- Modernising the healthcare sector.
- Modernising the transport infrastructure (intelligent transport systems).
- Modernising and developing the energy infrastructure (*e.g.* smart electrical grids, Box 2).

Box 2. Smart grids for a greener economic recovery

A few governments have announced programmes to develop and deploy "smart grids" as part of "green" economic stimulus packages. This includes the United States with around USD 11 billion for the smart electricity grid and Korea with specific measures as part of its "Green New Deal". The central idea behind smart grids is to use two-way communication and electricity flows, sensors and advanced ICTs to create a connected, secure and reliable power grid to optimise energy distribution, consumption and conservation.

Smart grids can help reduce greenhouse gas emissions through technology-based efficiency gains as well as wide-scale systemic changes. A smart electricity grid includes smart meters to optimise household energy consumption, but it also facilitates plug-in electric and hybrid vehicles infrastructures, distributed electricity generation, improved energy storage and peak demand management. Smart grids can also help identify locations and reasons for electricity losses along the distribution chain. Projections of overall emissions reductions depend on the scenarios applied, but can be as high as 2 gigatonnes of CO_2e emissions reductions worldwide in 2020 (GeSI, 2008).

Widespread modernisation of electricity grids has economic implications for the ICT and energy sectors. For the ICT sector this will be most obvious in the areas of communications equipment, electronics, software and services to develop and implement complex grid management systems. The energy sector will increasingly rely on computer engineers and ICT-skilled workers to develop and maintain the new infrastructures. Impacts will also be felt by suppliers (*e.g.* steel) and adjacent sectors (*e.g.* renewable energy technologies).

Challenges persist in the deployment of a smart grid: the roll-out of smart grids requires high initial investments that the private sector cannot always carry alone; further R&D and better technologies are needed; open international standards for communication between the components within a smart grid and between national grids are necessary; business models in the energy sector will need to be adapted; demand for skilled labour might not be met immediately; privacy and security issues need to be addressed. Finally, existing grid infrastructures are different across countries and especially so in developing economies.

Sources: OECD (2009c) and GeSI (2008), "SMART 2020: Enabling the Low Carbon Economy in the Information Age".

For example, the United States healthcare sector has a major computerisation initiative aimed at reducing healthcare costs (*e.g*, digitisation of health records of every American over the next five years) and fostering health IT systems. Canada plans to invest CAD 500 million to develop electronic health records and to further existing ICT health plans. Japan is drawing up a three-year IT strategy, increasing total public- and private-sector investment by JPY 3 trillion, mainly focussed on IT infrastructure in the medical sector, the promotion of e-government and green IT (*e.g.* intelligent transport systems). France is fostering web 2.0 platforms and the video and computer game industry (serious games).

The objective to develop energy-efficient and green infrastructure will also have major ICT dimensions, *e.g.* more energy-efficient smart homes, smart transport systems and the smart grid. Korea, for instance, has "Green IT" as a specific component of its stimulus plan. Spain will also foster the widespread use of ICTs, in particular for projects leading to sustainability and energy-saving. Hungary and Japan will promote the use of teleworking. Second order effects include the developments enabled by that same infrastructure, *i.e.* new products, services, business opportunities and productivity-enhancing features resulting from the availability of ICT infrastructure.

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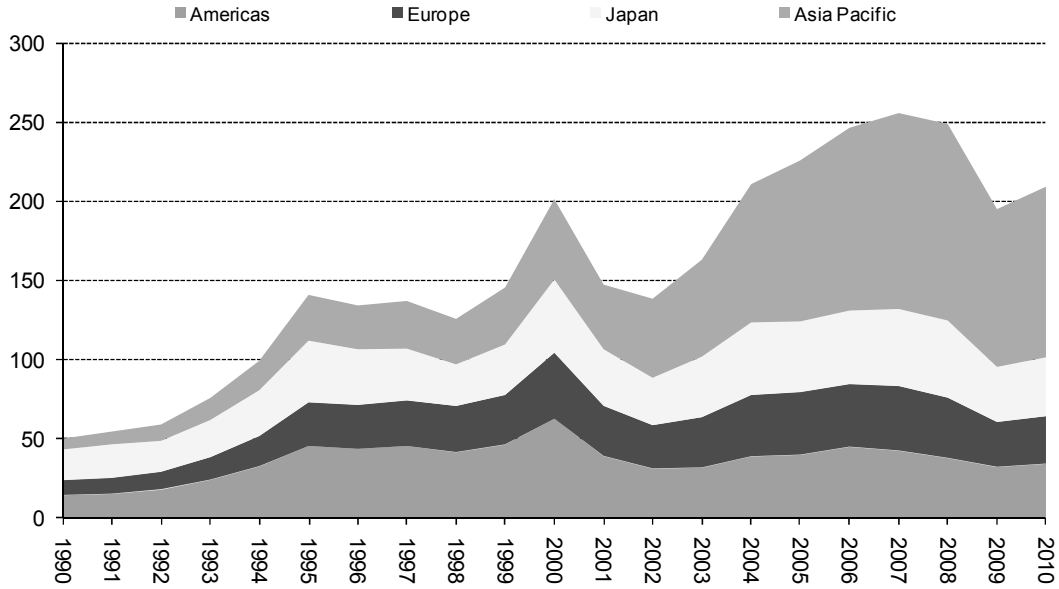
ANNEX FIGURES

Figure 25. Worldwide semiconductor market by region, 1990–2010

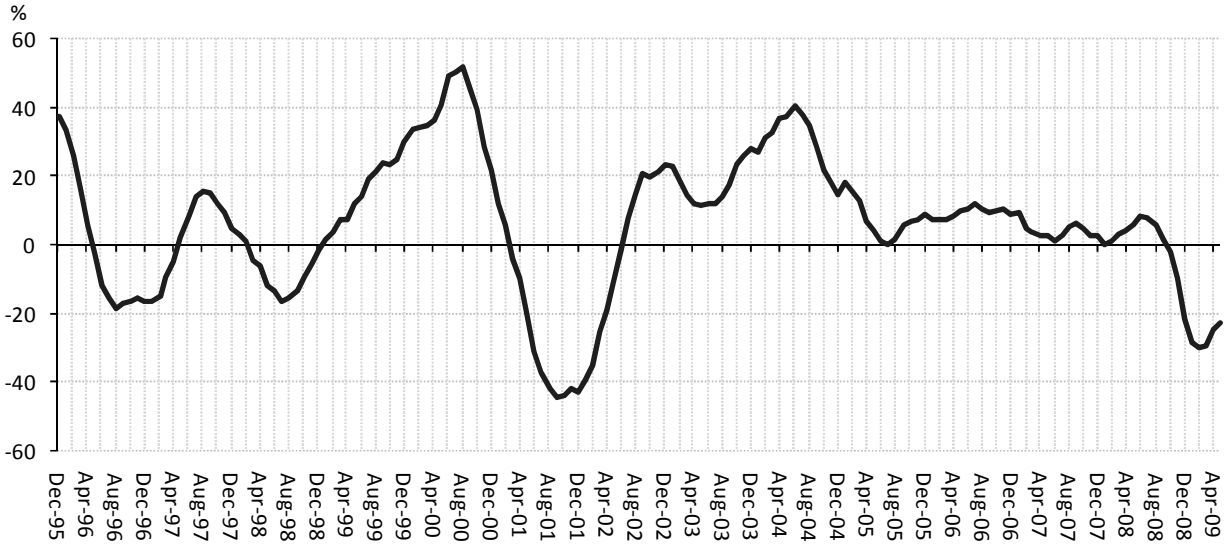
USD billions, current prices



Note: 2009 and 2010 are forecast.
Source: OECD based on World Semiconductor Trade Statistics, July 2009.

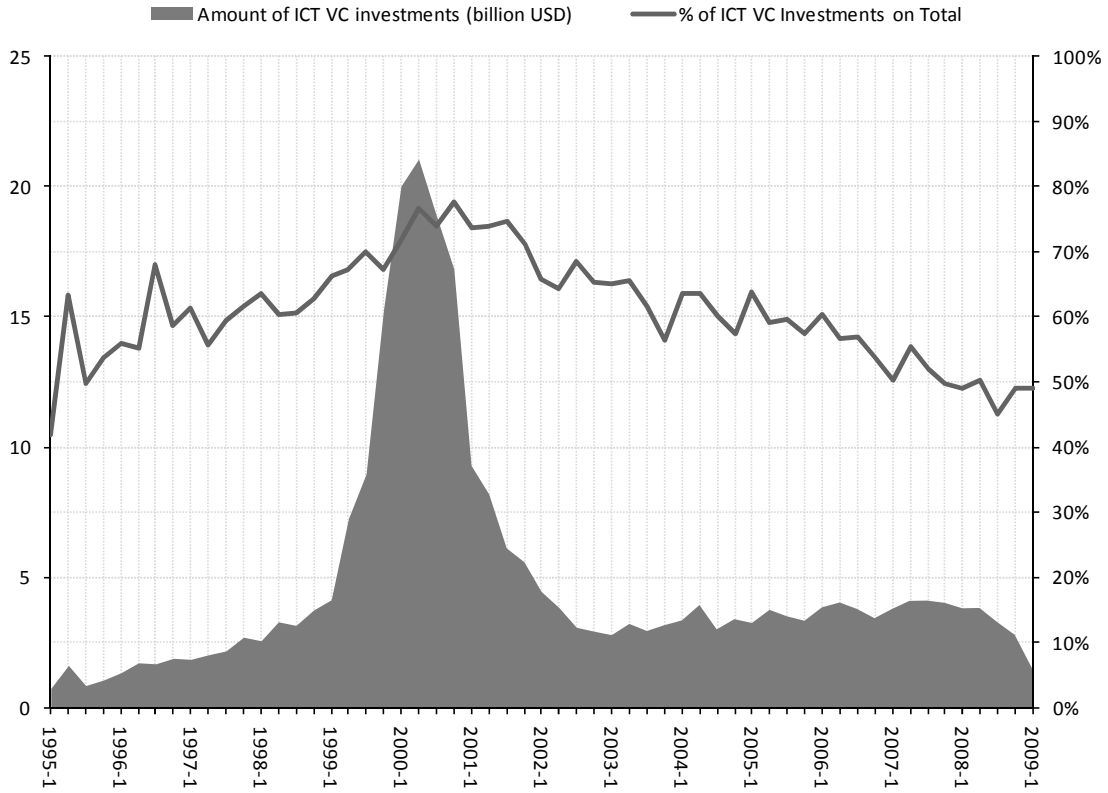
Figure 26. Growth in the monthly semiconductors worldwide market billings, December 1995 – May 2009

Year-on-year percentage, 3-month moving average



Source: World Semiconductor Trade Statistics (WSTS), July 2009.

Figure 27. Quarterly venture capital investments in the ICT sector in the United States, Q1 1995 - Q1 2009

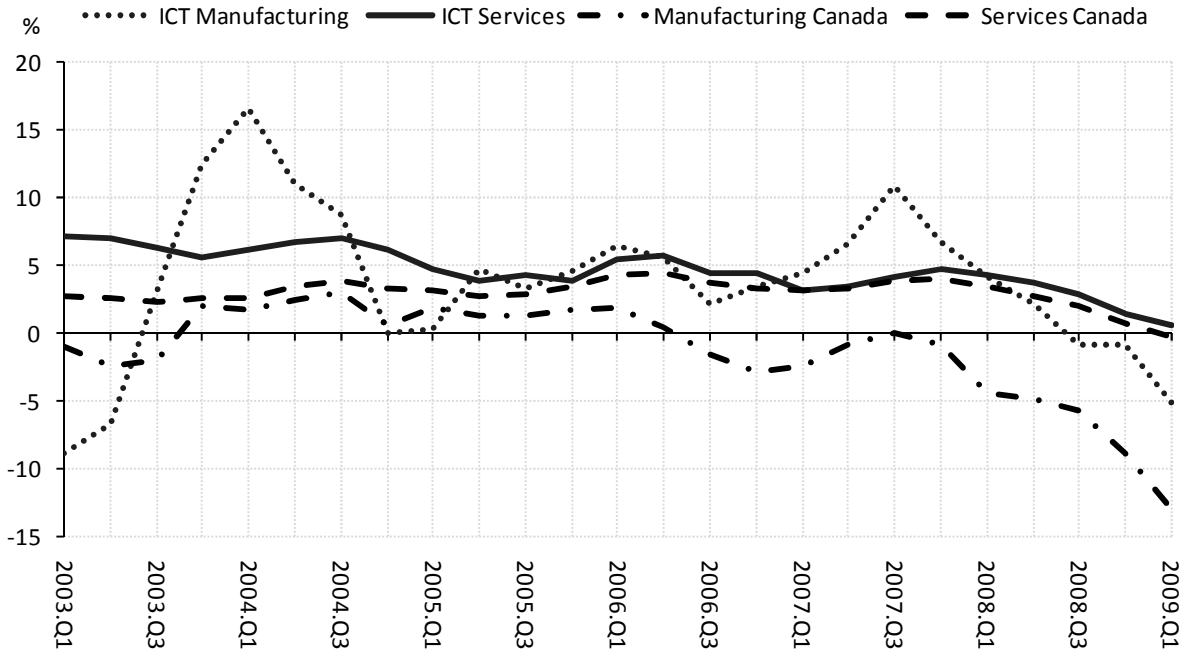


Source: MoneyTree survey report, PricewaterhouseCoopers, May 2009.

CANADA

Figure 28. Growth in the real output (GDP), Q1 2003 – Q1 2009

Year-on-year percentage change

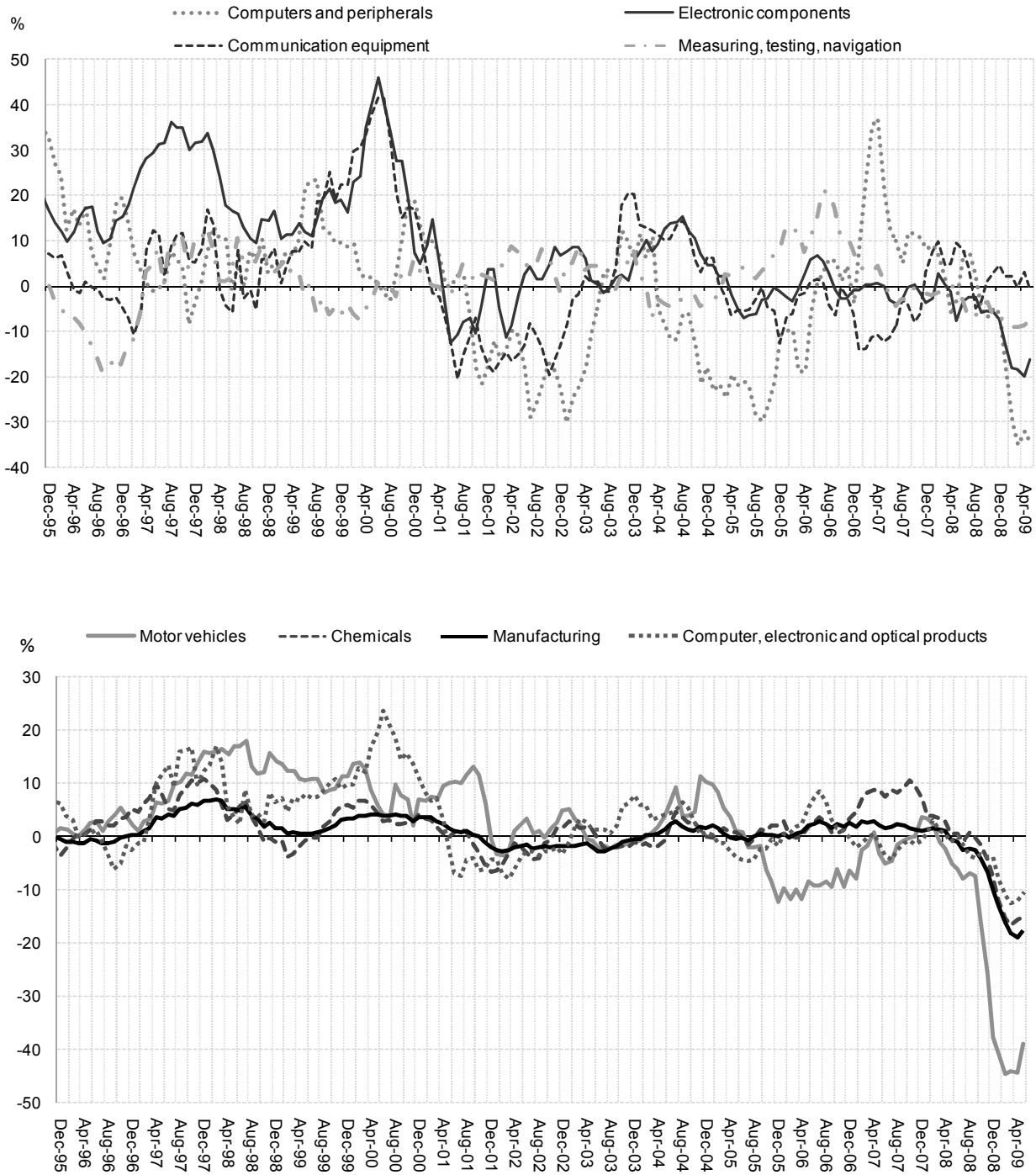


Source: Industry Canada, Quarterly Monitor of the Canadian ICT Sector, First Quarter 2009, June 2009.

FRANCE

Figure 29. Growth in monthly production in ICT and selected goods sectors, December 1995 – May 2009

Year-on-year percentage change, monthly volume index, seasonally adjusted, 3-month moving average

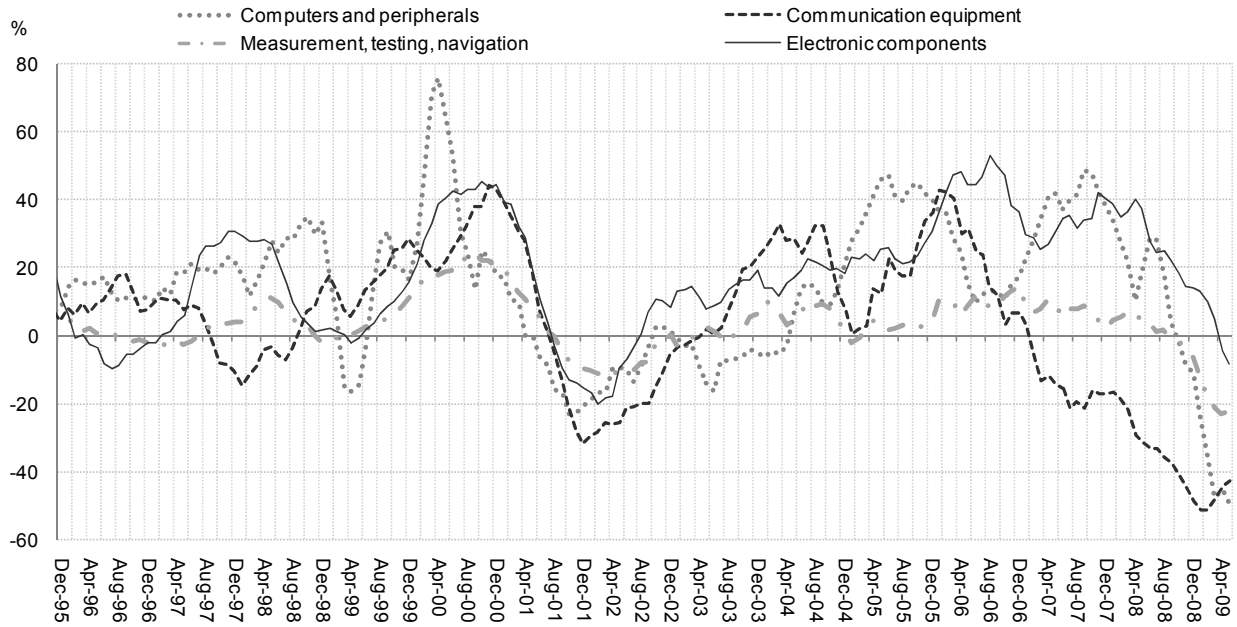


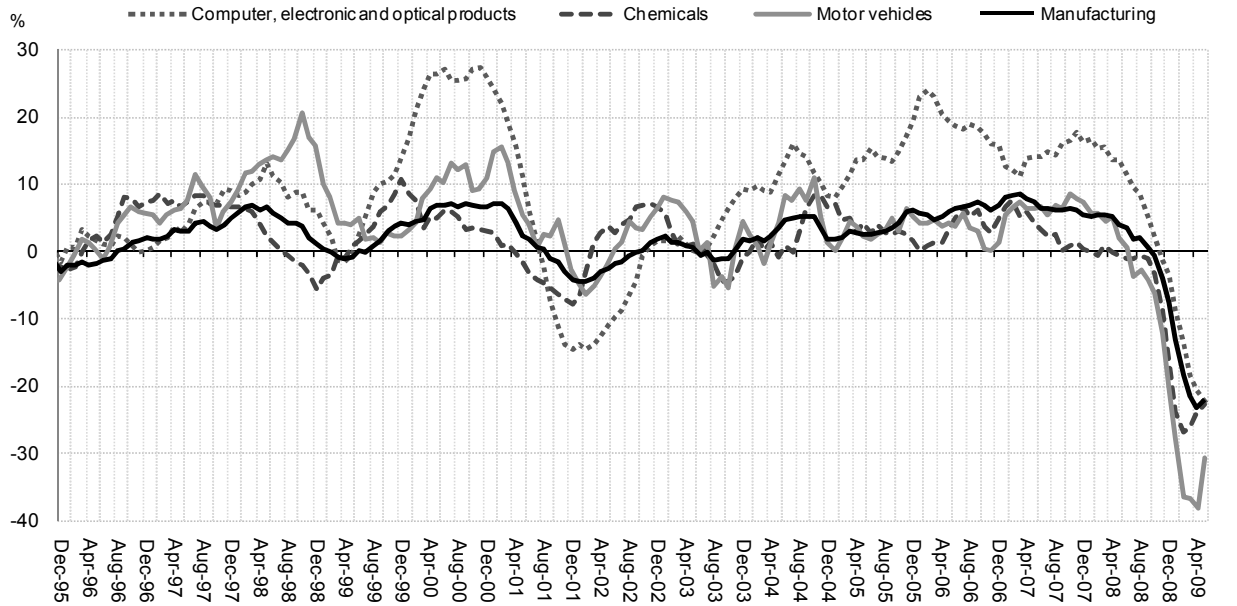
Note: ISIC REV4 sector classification.
Source: INSEE, *Indice et séries statistiques*, July 2009.

GERMANY

Figure 30. Growth in monthly production in ICT and selected goods sectors, December 1995 – May 2009

Year-on-year percentage change, volume index, seasonally adjusted, 3-month moving average



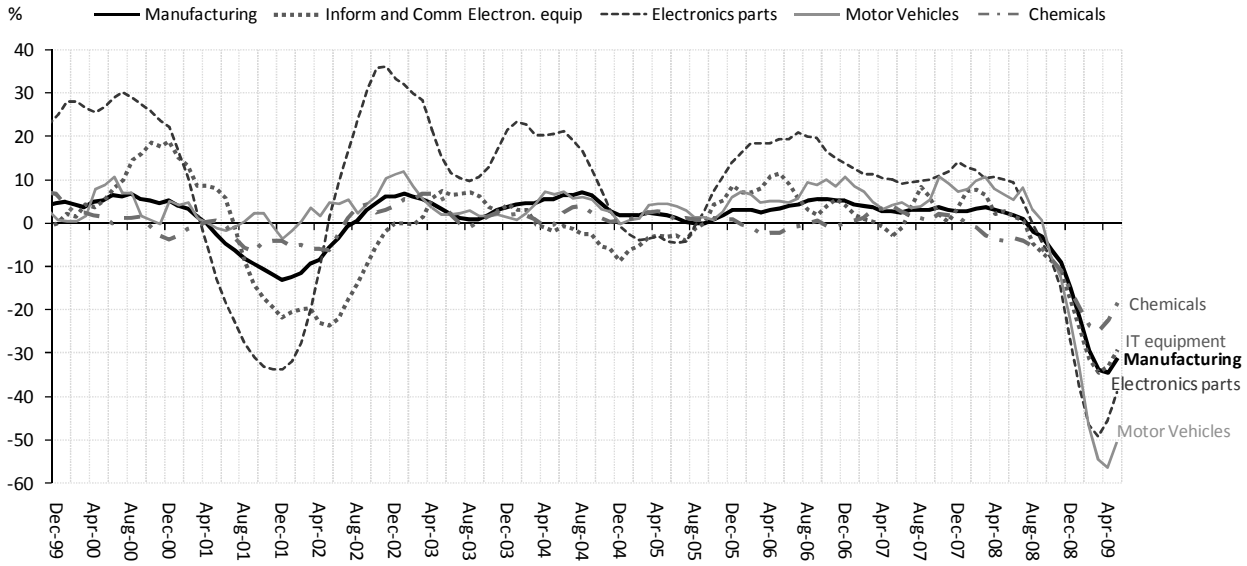


Note: ISIC REV4 sector classification.
Source: *Statistisches Bundesamt, Produktionsindex*, July 2009.

JAPAN

Figure 31. Growth in monthly production in ICT and selected goods sectors, December 1999 – May 2009

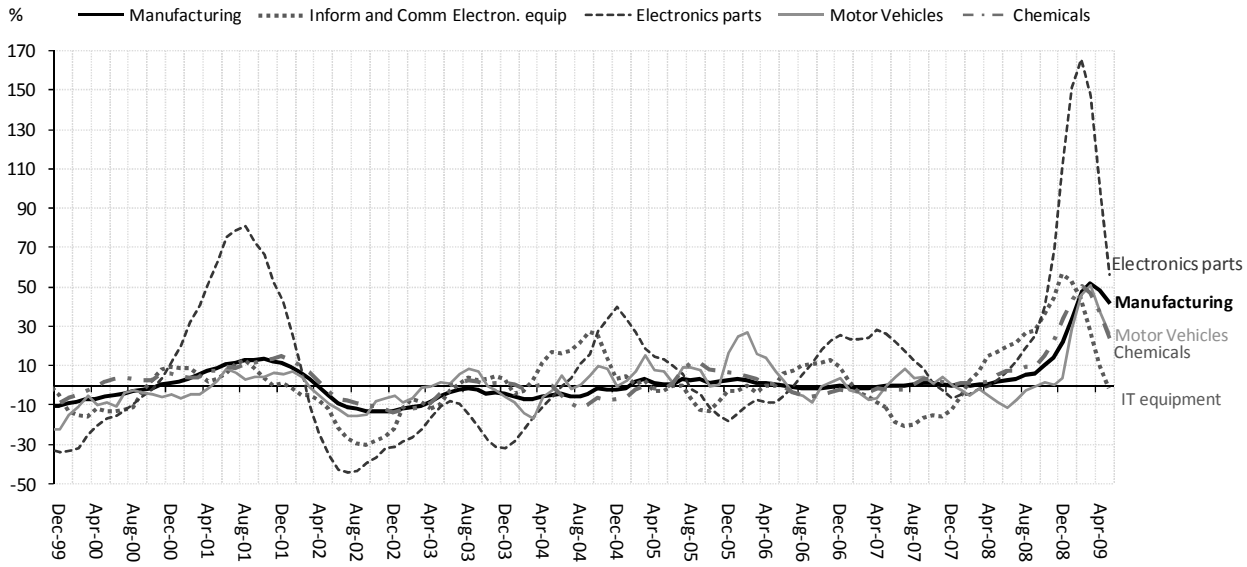
Year-on-year percentage change, volume index, seasonally adjusted, 3-month moving average



Source: Japanese Ministry of Economy, Trade and Industry, June 2009.

Figure 32. Growth in monthly inventories in ICT selected goods sectors, December 1999 – May 2009

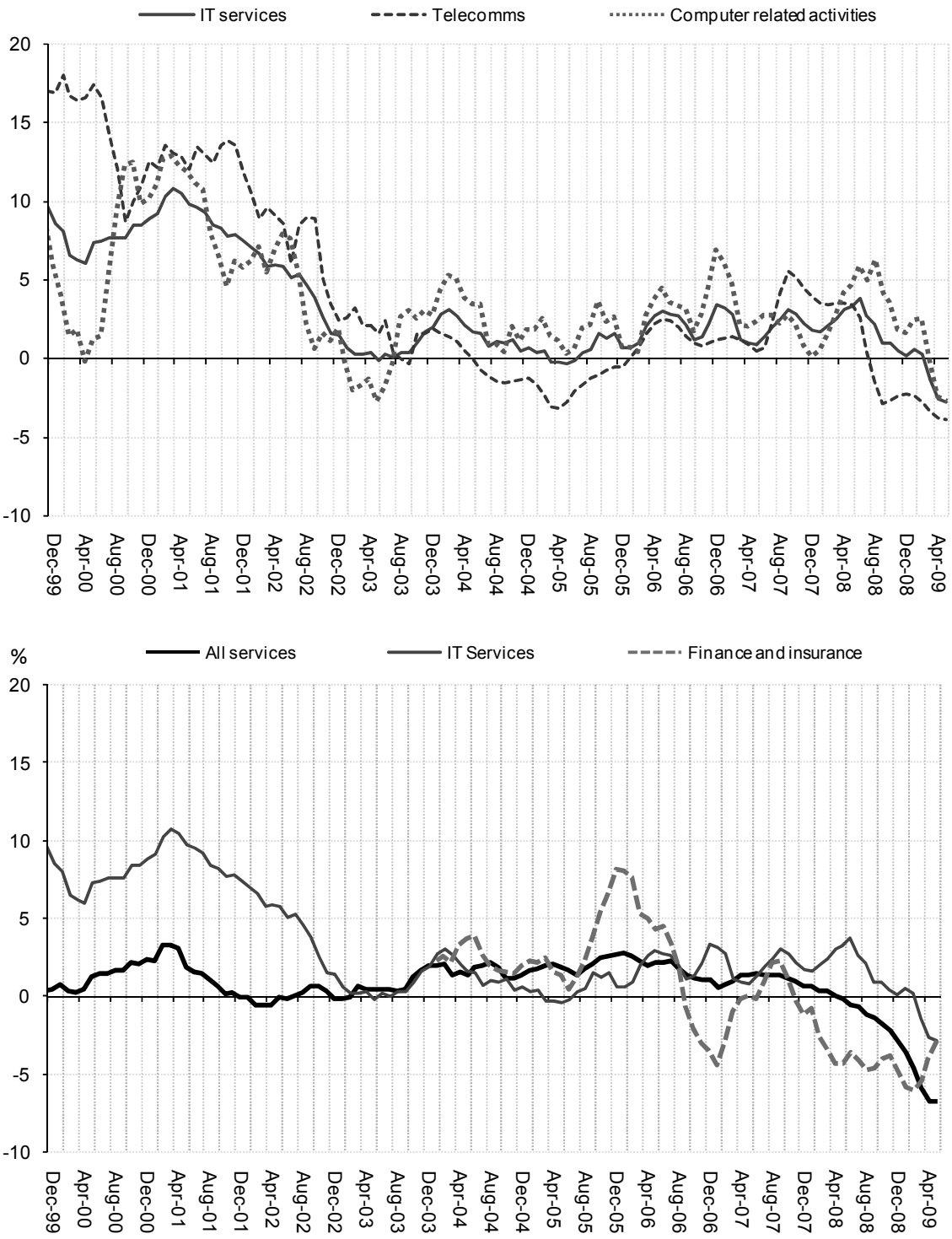
Year-on-year percentage change, producer inventory ratio index, seasonally adjusted, 3-month moving average



Source: Japanese Ministry of Economy, Trade and Industry, June 2009.

Figure 33. Growth in monthly industrial activity in IT and selected services, December 1999 – May 2009

Year-on-year percentage change, production indices, seasonally adjusted, 3-month moving average

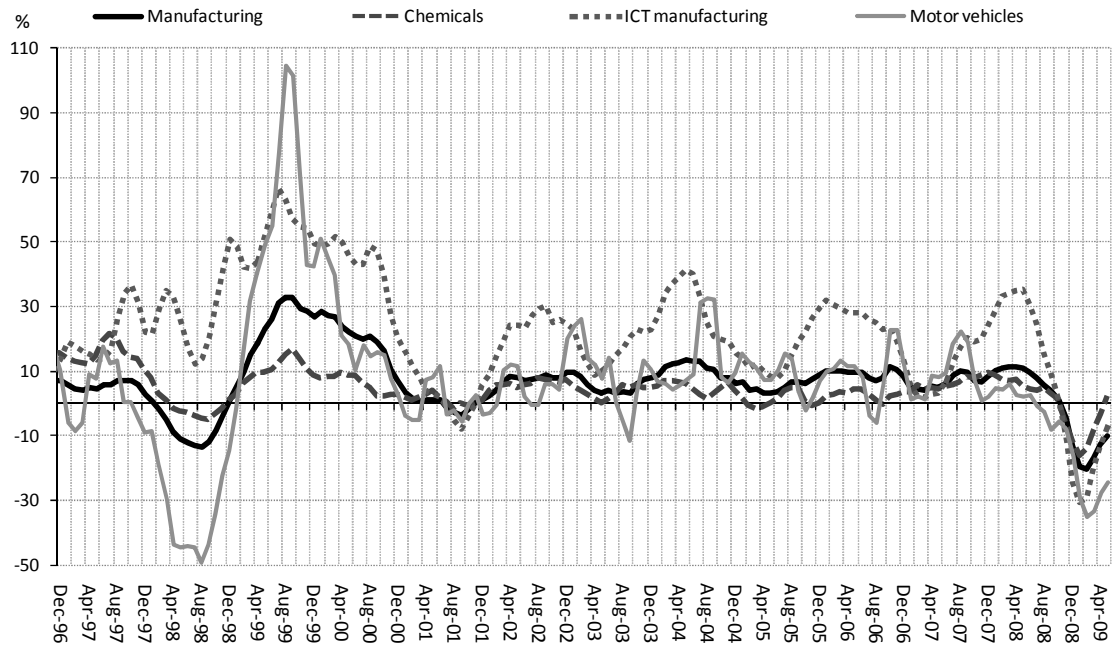


Note: The indices have been rebased 100 = 2005. No data available for Finance and insurance services prior to 2003. See www.stat.go.jp/english/index/official/208.htm for details.
Source: Japanese Ministry of Economy, Trade and Industry, July 2009.

KOREA

Figure 34. Growth in monthly production in ICT and selected goods sectors, December 1996 - May 2009

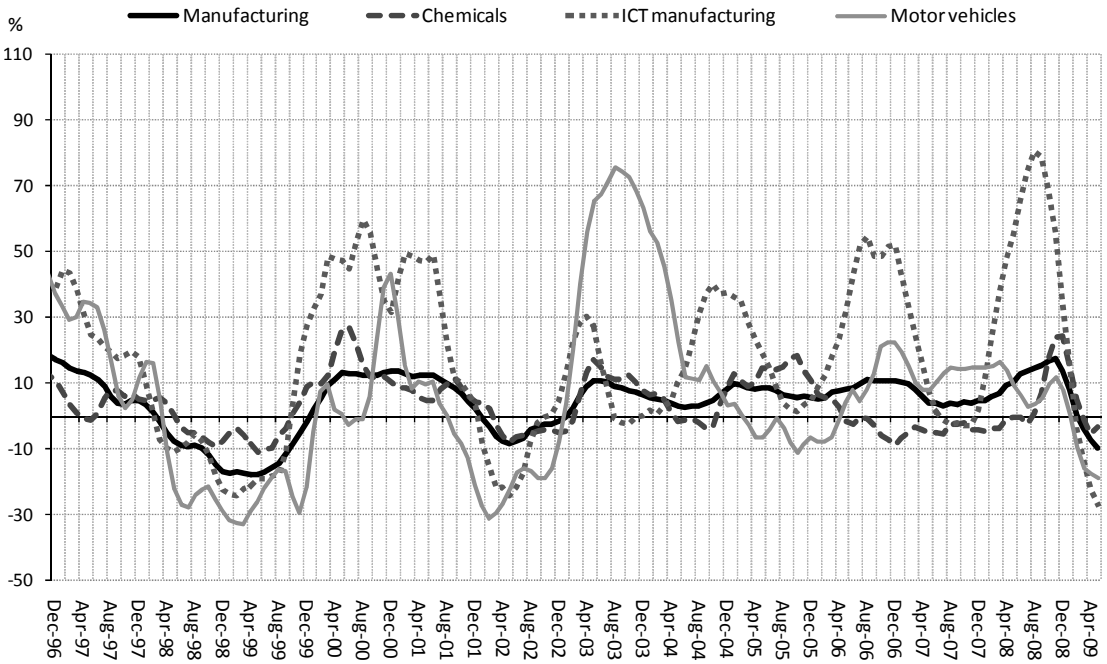
Year-on-year percentage change, monthly volume index, seasonally adjusted, 3-month moving average



Source: Korea National Statistics Office, July 2009.

Figure 35. Growth in monthly inventories in ICT and selected goods sectors, December 1996 - May 2009

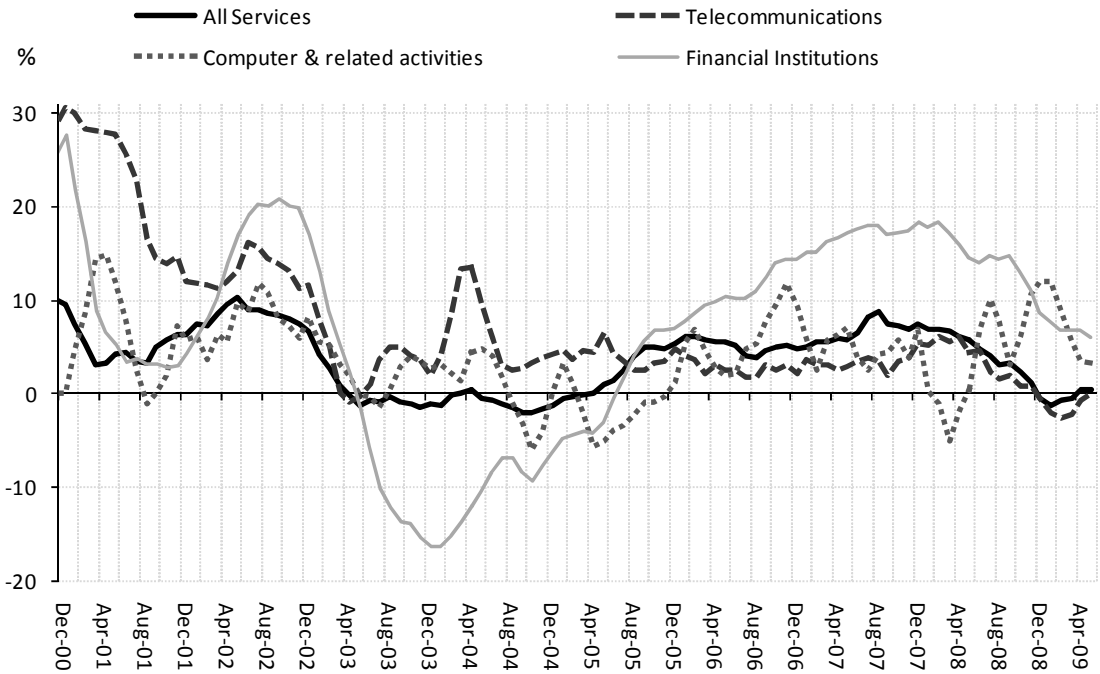
Year-on-year percentage change, monthly volume index, seasonally adjusted, 3-month moving average



Source: Korea National Statistics Office, July 2009.

Figure 36. Growth in monthly activity of ICT and selected services, December 2000 - May 2009

Year-on-year percentage change, volume index, 3-month moving average

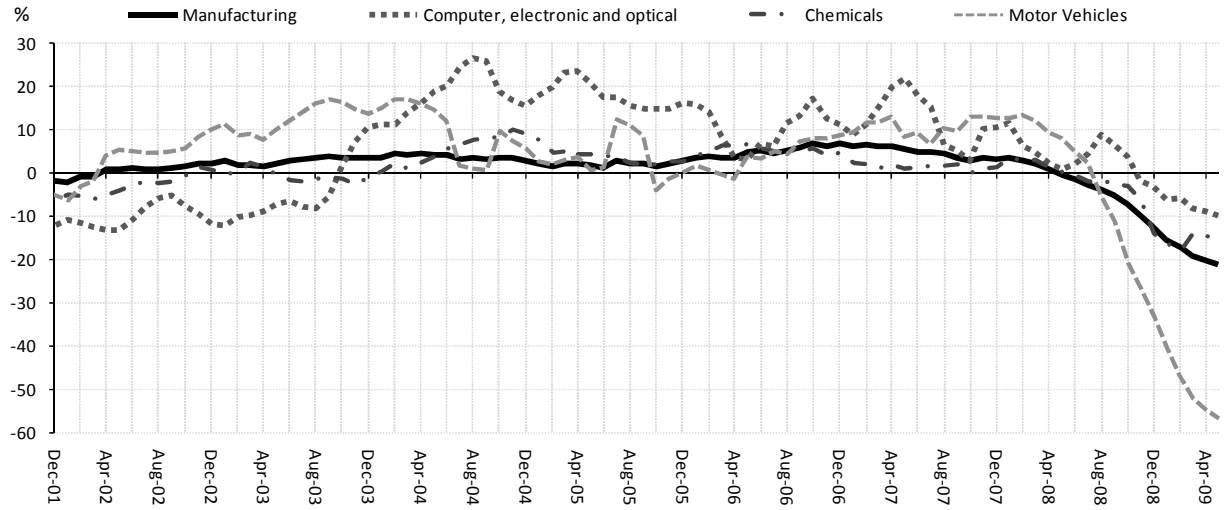


Source: Korea National Statistics Office, July 2009.

SWEDEN

Figure 37. Growth in monthly production in ICT and selected goods sectors, December 2001 – May 2009

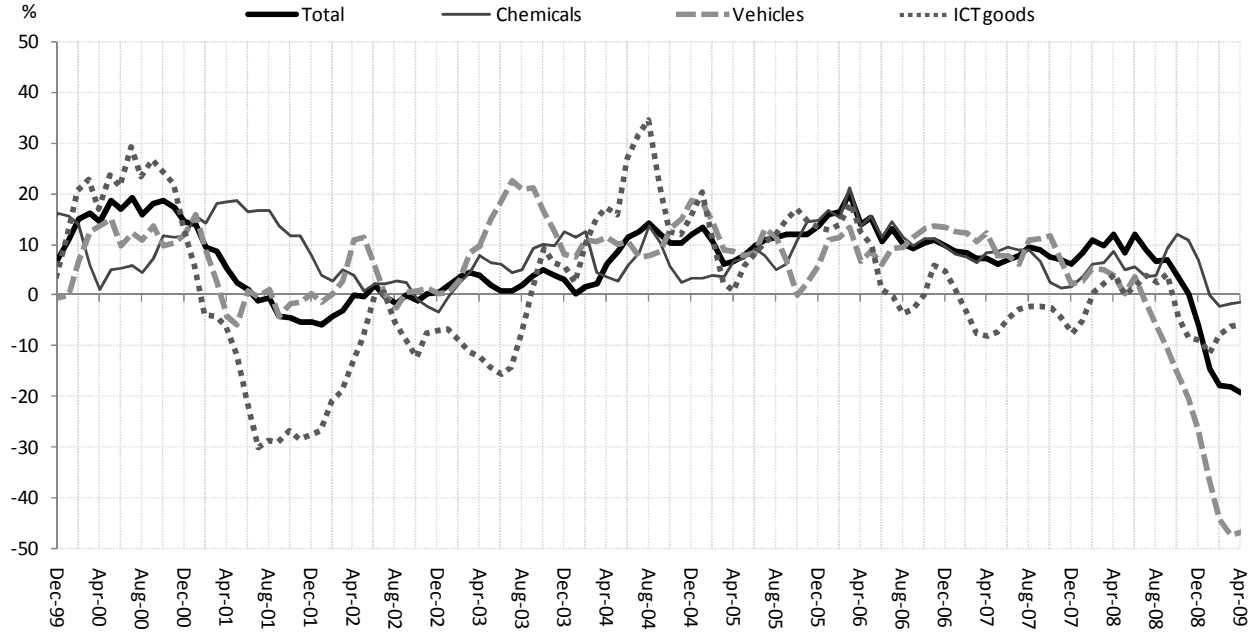
Year-on-year percentage change, volume index, seasonally adjusted, 3-month moving average



Note: ISIC REV4 sector classification.
Source: Statistics Sweden, July 2009.

Figure 38. Growth in monthly trade in selected goods, December 1999 – April 2009

Year-on-year percentage change, 3-month moving average

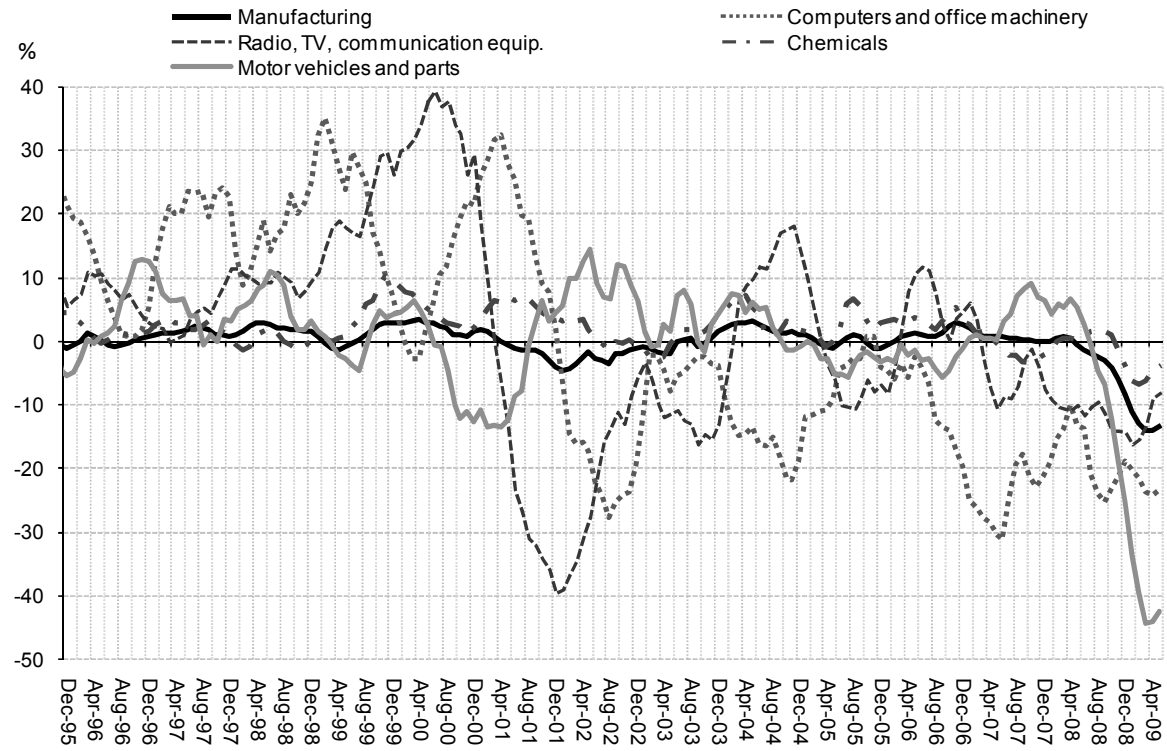


Note: Classified by SITC commodity group.
Source: Statistics Sweden, June 2009.

UNITED KINGDOM

Figure 39. Growth in monthly production in ICT and selected goods sectors, December 1995 – May 2009

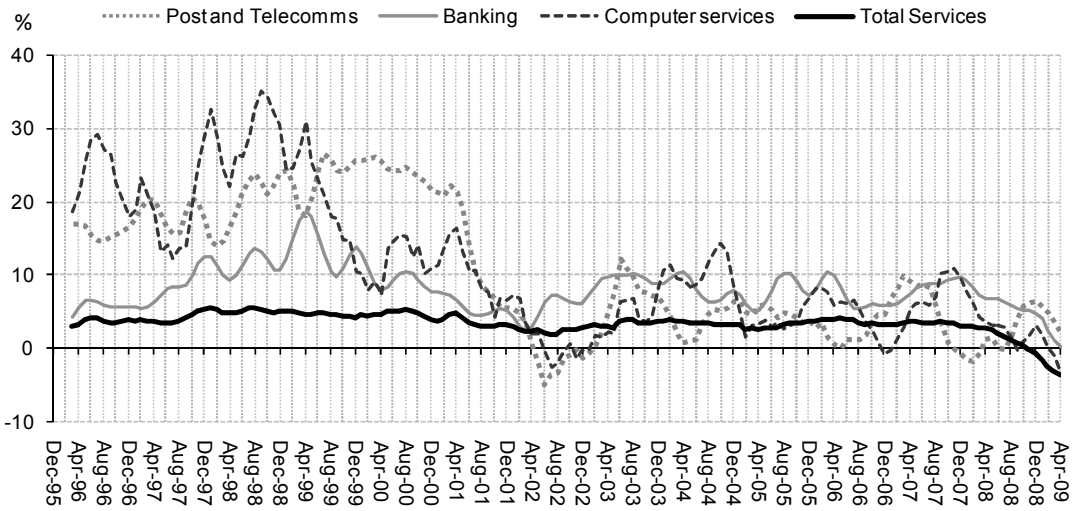
Year-on year percentage change, volume index, seasonally adjusted, 3-month moving average



Note: Sectors according to ISIC rev. 3.1
Source: National Statistics Office, July 2009.

Figure 40. Growth of monthly output in ICT and selected services, December 1995 – April 2009

Year-on-year percentage change, volume index, seasonally adjusted, 3-month moving average

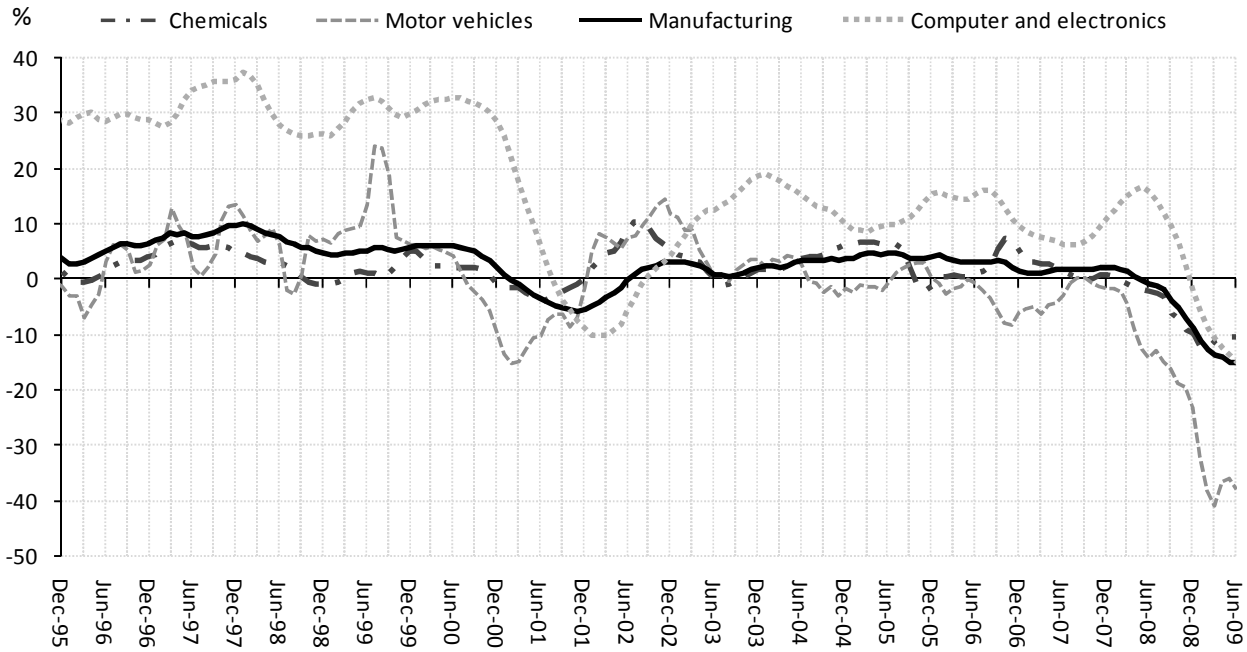


Note: Division 64 used as proxy for 64.2 Telecommunications.
Source: National Statistics Office, June 2009.

UNITED STATES

Figure 41. Growth in monthly production in ICT and selected goods sectors, December 1995 – June 2009

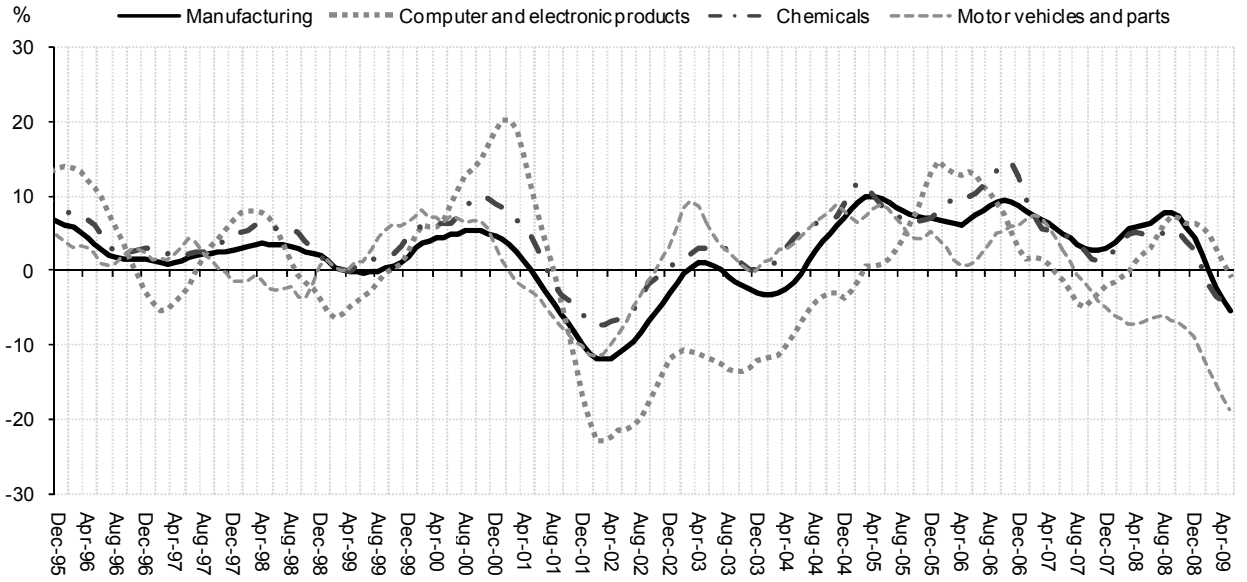
Year-on-year percentage change, index, seasonally adjusted, 3-month moving average



Source: The Federal Reserve Board, July 2009.

Figure 42. Growth in monthly inventories in ICT and selected goods sectors, December 1995 – May 2009

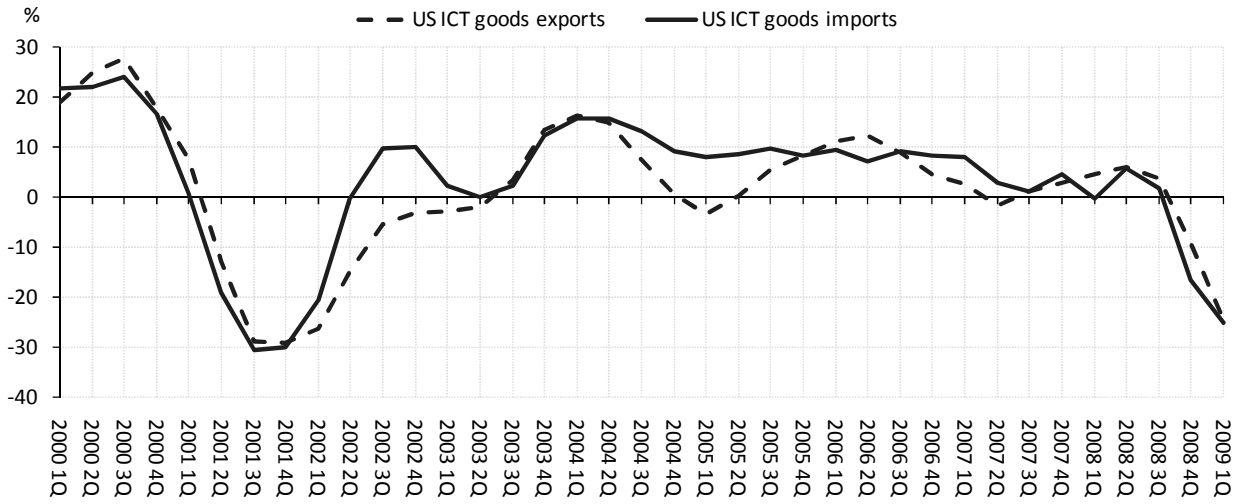
Year-on-year percentage change, current cost or pre-LIFO, seasonally adjusted, 3-month moving average



Source: OECD, based on US Bureau of the Census, Manufacturer's Shipments, Inventories and Orders (M3) survey, July 2009.

Figure 43. Growth in quarterly ICT goods trade, Q1 2000 – Q1 2009

Year-on-year percentage change, trade values, seasonally adjusted

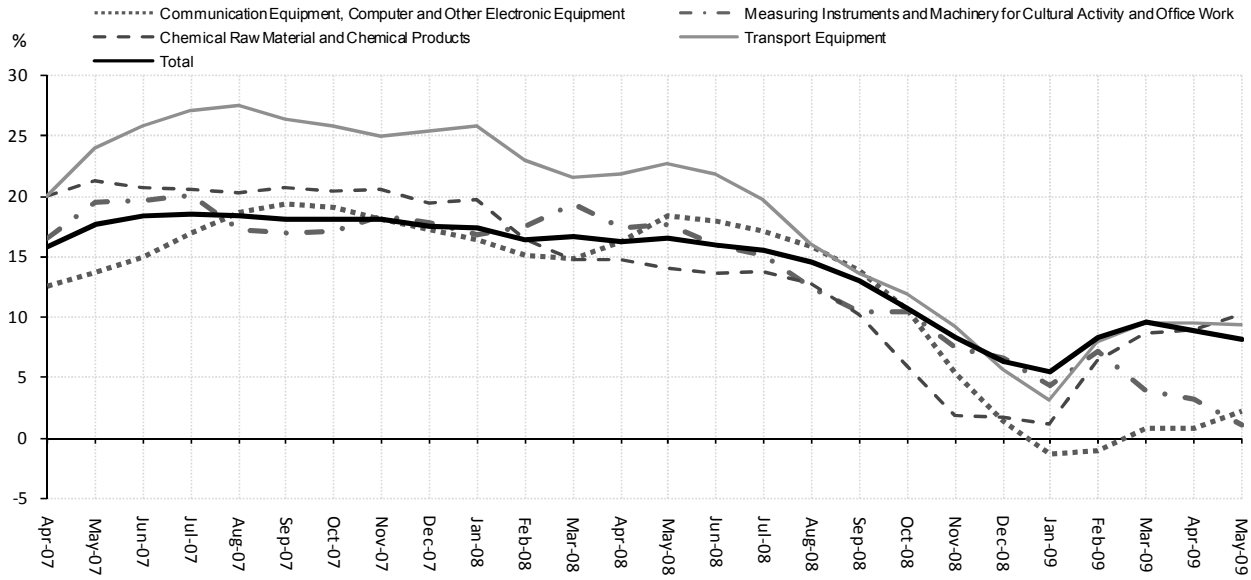


Source: OECD, based on Bureau of Economic Analysis and US Bureau of the Census Foreign Trade, June 2009.

CHINA

Figure 44. Growth in monthly value added of ICT and selected goods sectors, April 2007 – May 2009

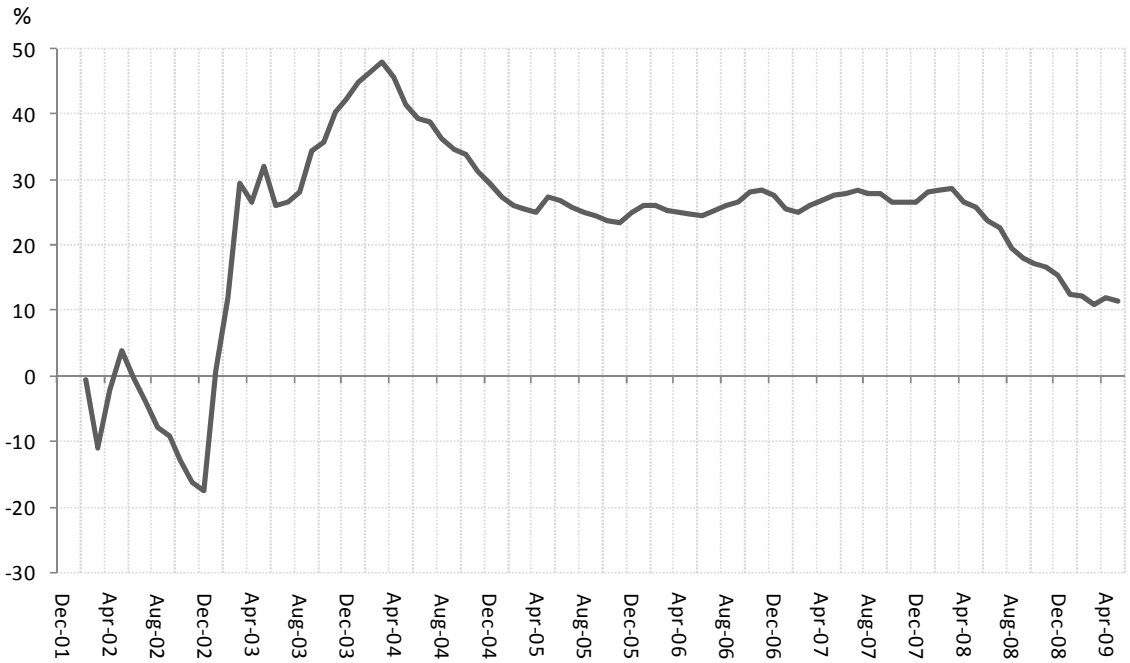
Year-on-year percentage change, 3-month moving average



Source: National Bureau of Statistics of China, June 2009.

Figure 45. Growth in monthly output of telecommunication services, December 2001 – May 2009

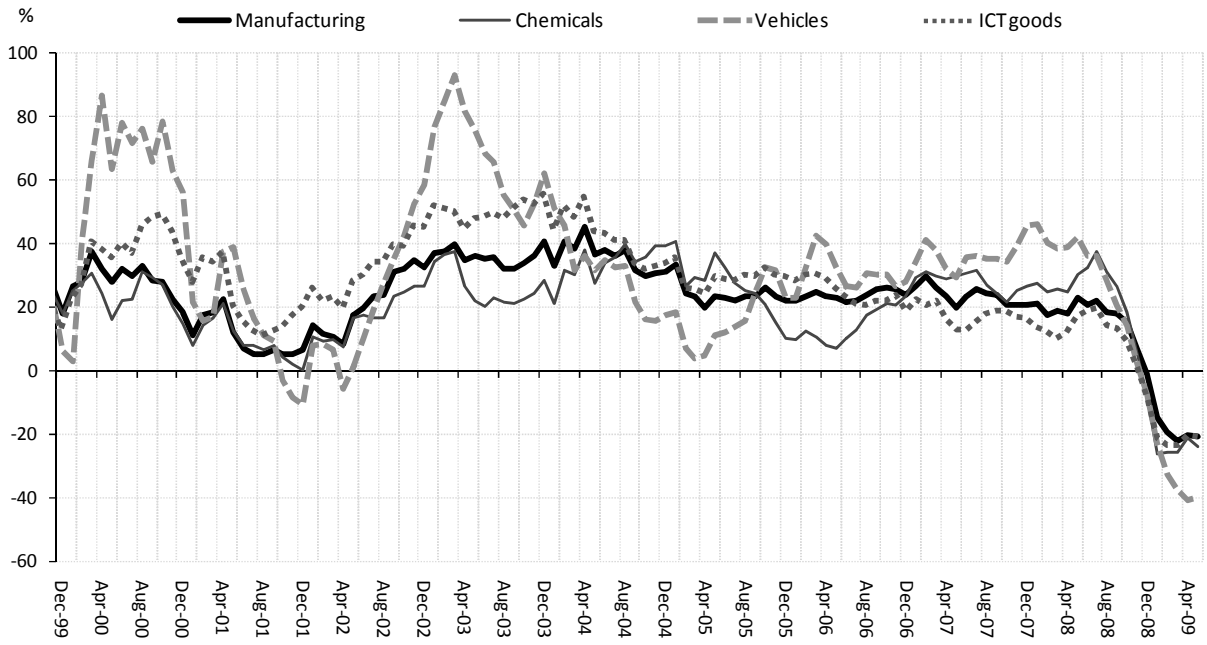
Year-on-year percentage change, values, 3-month moving average

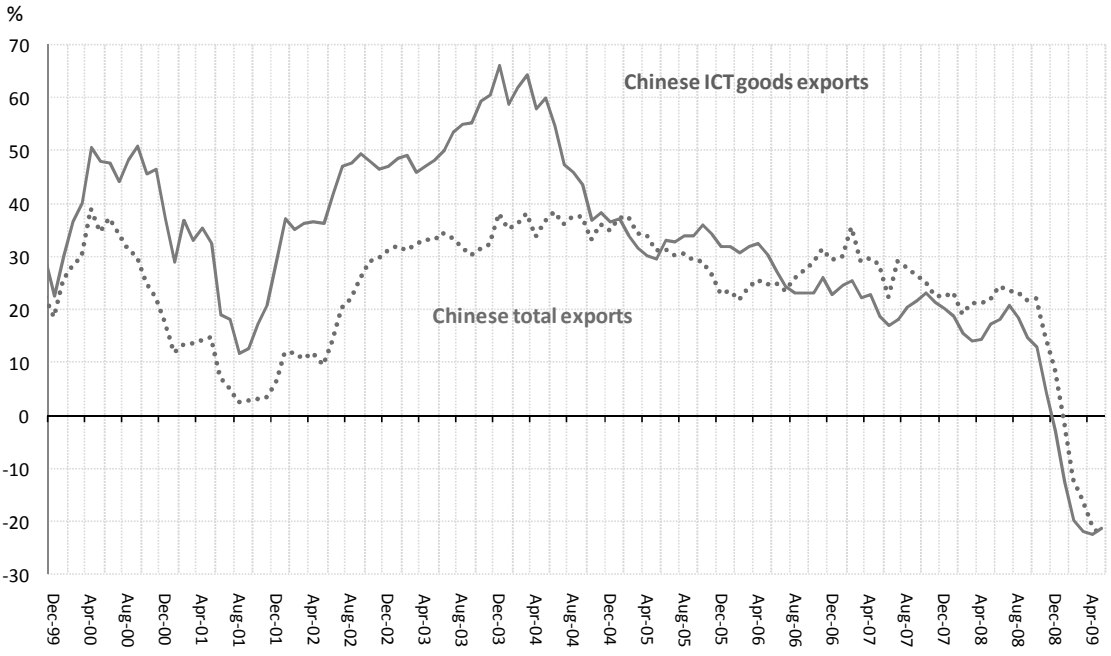


Source: Ministry of Industry and Information Technology, July 2009.

Figure 46. Growth in monthly trade of selected goods, December 1999 – May 2009

Year-on-year percentage change, trade values, 3-month moving average



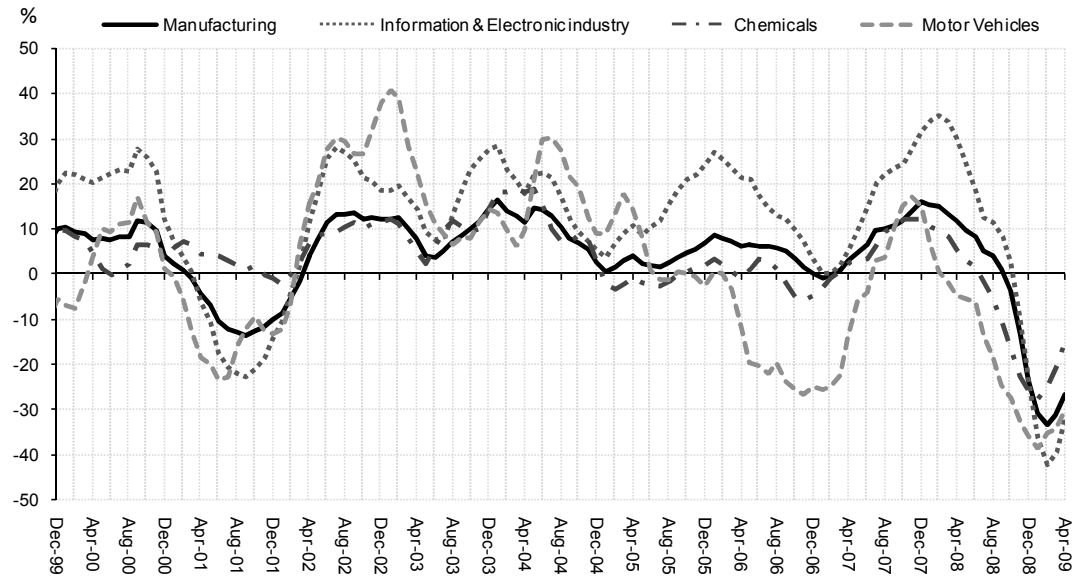


Note: Classified by SITC commodity group.
Source: General Administration of Customs of China, July 2009.

CHINESE TAIPEI

Figure 47. Growth of monthly production in selected manufacturing industries in Chinese Taipei, December 1999 - April 2009

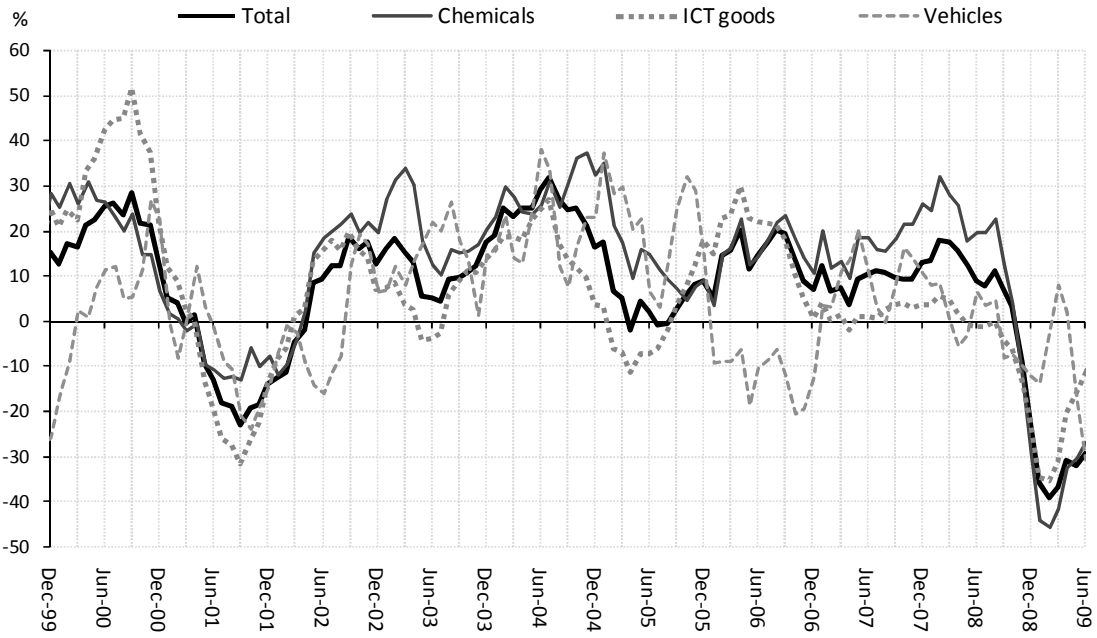
Year-on-year percentage change, seasonally adjusted, 3-month moving average



Source: Ministry of Economic Affairs of Taiwan, July 2009.

Figure 48. Growth in monthly trade of selected goods, December 1999 - June 2009

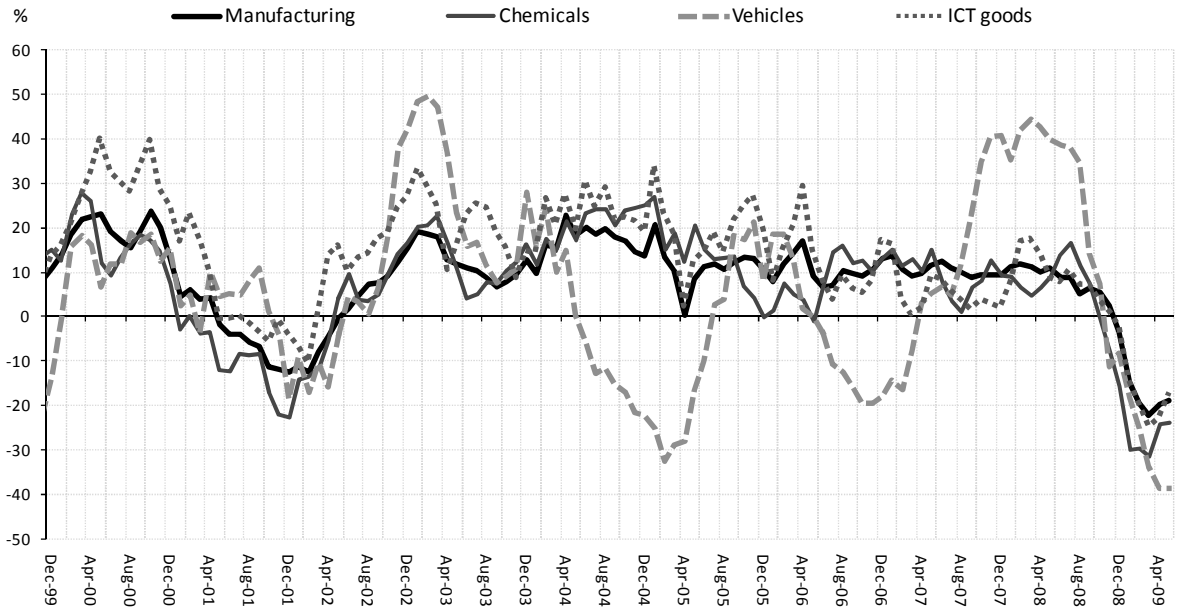
Year-on-year percentage change, values, 3-month moving average



Source: Ministry of Finance, R.O.C., July 2009.

HONG KONG, CHINA

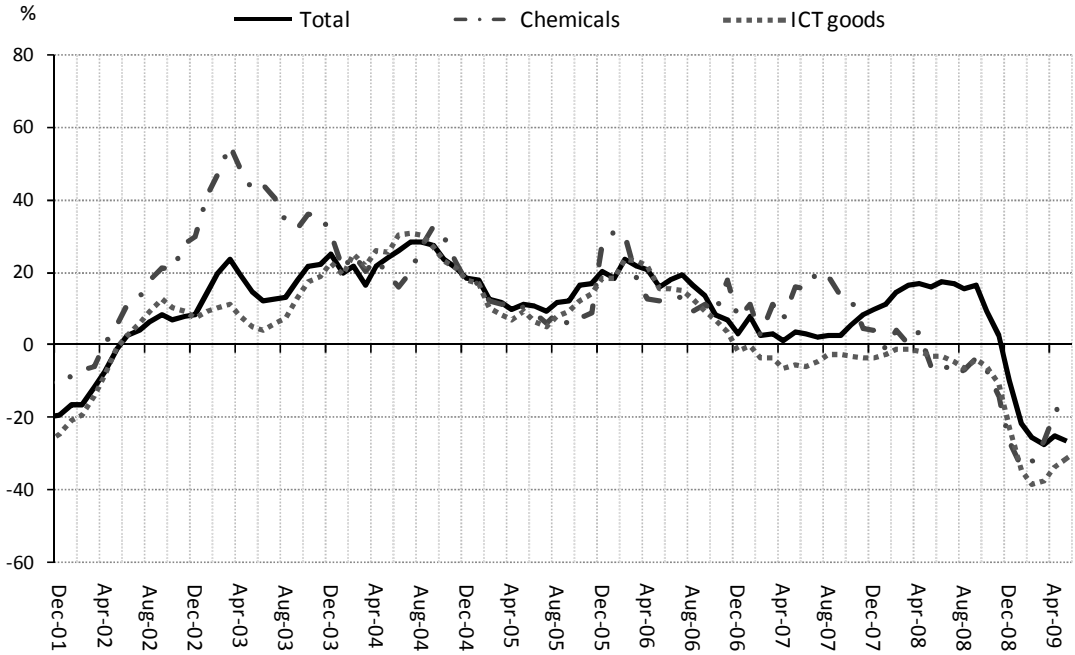
Figure 49. Growth in monthly trade of selected goods, December 1999 - May 2009
Year-on-year percentage change, values, 3-month moving average



Source: Census & Statistic Department, July 2009.

SINGAPORE

Figure 50. Growth of monthly trade of selected goods in Singapore, December 2001 - May 2009
Year-on-year percentage change, values, 3-month moving average



Source: International Entreprise Singapore, July 2009.