

**Key Thoughtz:**

- Cyclical trends persist: 1H'10 saw a cycle peak and 2H'10 will see a sharp decline in AMLCD prices.
- Secular trends persist: the cash cost of AMLCD decreases more slowly than sales revenue does; scale returns diminish.
- Taiwanese AMLCD producers remain in trouble and in need of Chinese alliances.

## Q3'10 Preview: as Good as It Gets

Capacity remains the driving force in the AMLCD industry. Increases in area process capacity seem justified based on insatiable consumer demand for more displays in gadgets, computers and televisions. Increases in areal capacity come at a cost, however. Expansions require price reductions to clear more output through the market. If cash costs fall slower than prices do, producers experience diminishing returns to scale and increasing financial difficulties. In such event, the strong survive by reducing their cost of capital; the weak fail or retire to the sidelines and serve niche markets.

In this commentary, we examine cyclical and secular trends in the AMLCD industry then focus on troubles in Taiwan where producers seek access to Chinese capital. Analysis of their operating results over the past two business cycles (six years) provides the basis for predictions of coming quarters.

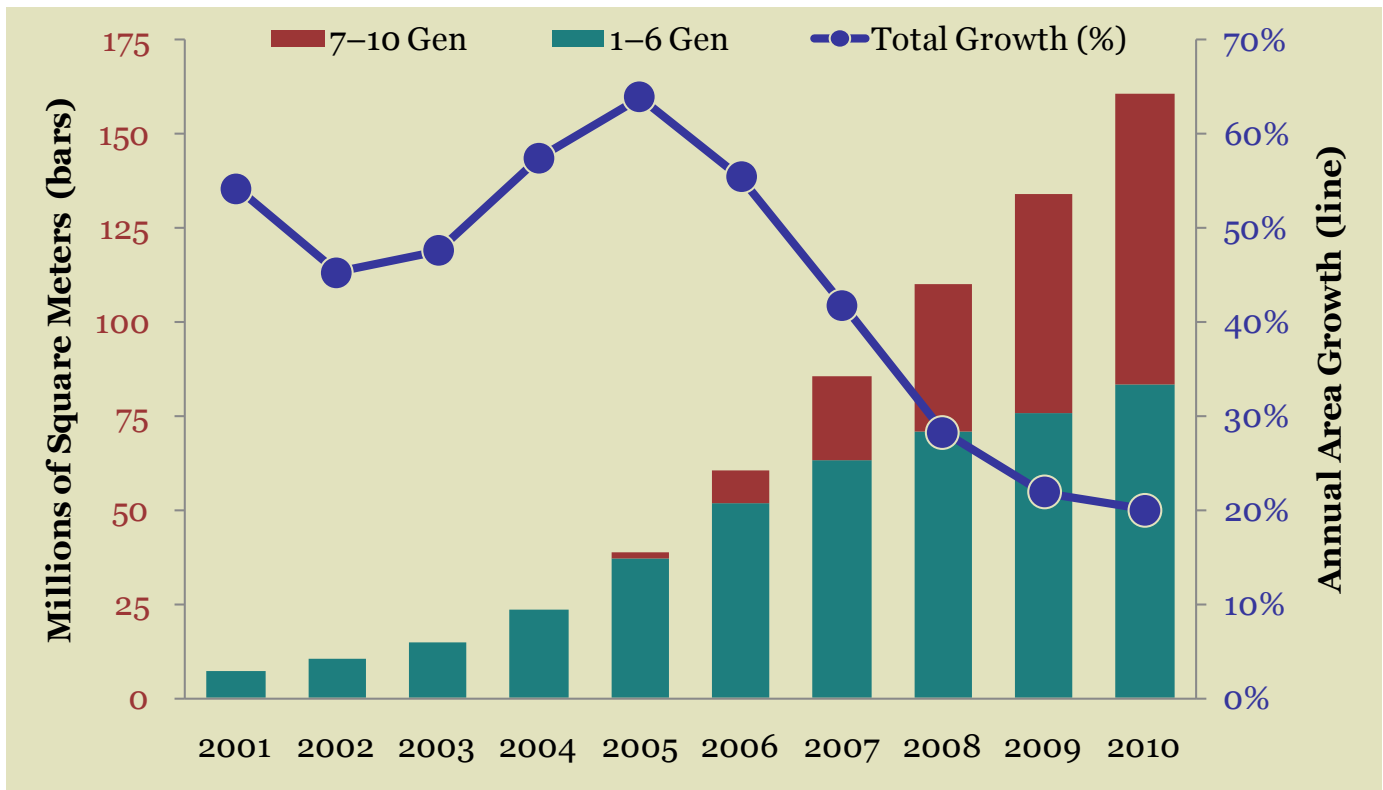
### Cyclical Trends

At first glance, the pace of AMLCD capacity expansion seems to be slowing. The average annual growth over ten years through 2006 was greater than 50% a year. Since then, annual growth has declined into the 20% regime.

Looked at another way, capacity expansion in larger substrate sizes intended to serve LCD TV markets remains strong. Replacement of CRT in PC markets was the main rationale for capacity expansion from the mid 1990s to the mid 2000s. As we will discuss later, the PC market matured by then, prompting producers to shift replacement efforts to the TV market. This led to a rapid expansion of Gen-7 and larger substrate capacity in expectations that demand for 52" or larger LCD TV sets would develop. AMLCD capacity in such fabs grew nearly 50% in 2009 and we estimate 33% growth this year.

We therefore interpret the data as evidence that incremental small panel demand is being met by rededicating older fabs for the most part and that new fabs are built to serve the LCD TV market, primarily.

AMLCD Capacity and Annual Growth, 2001–2010 (millions square meters, area growth Y/Y)



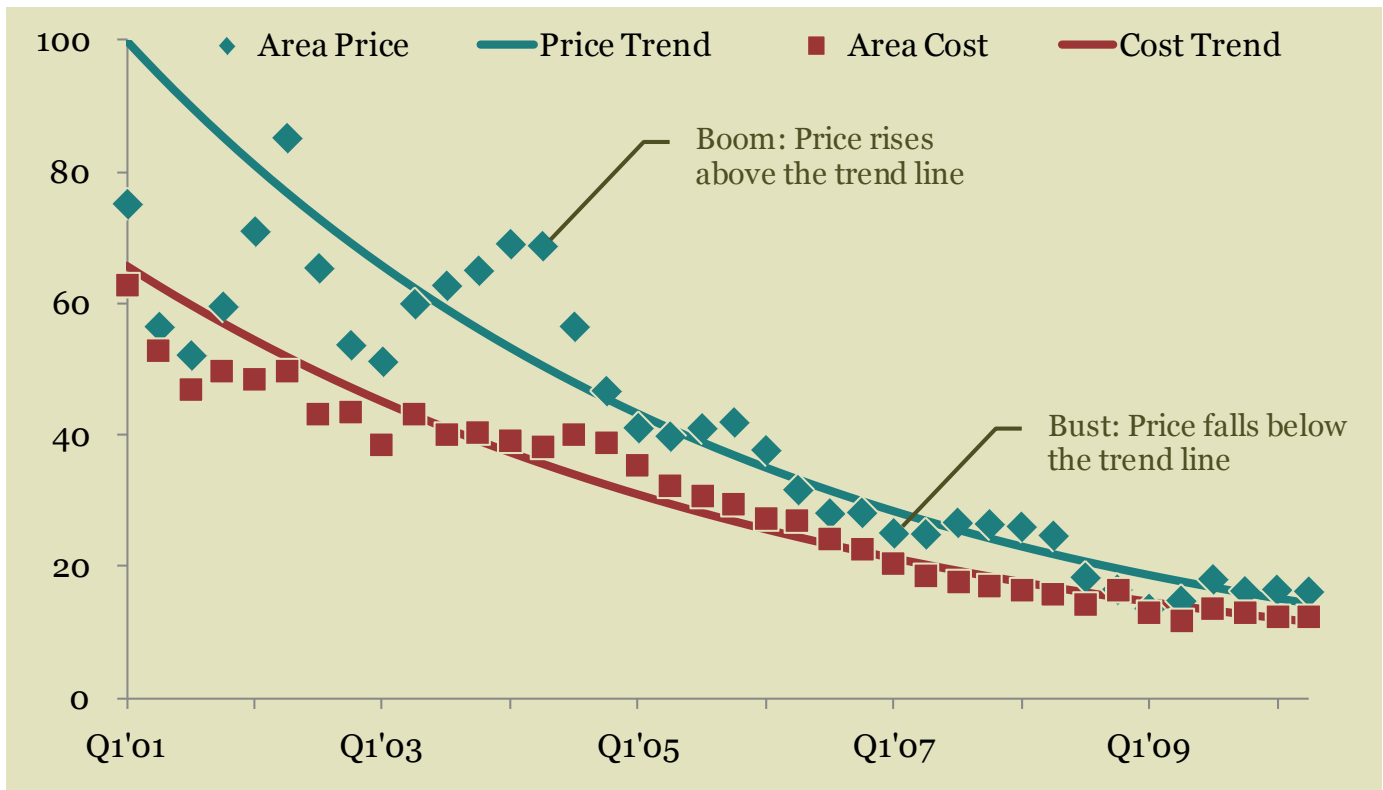
Source: DisplaySearch 2010 US FPD Conference with BizWitz estimates for 2010

Looking at capacity on an annual basis ignores short-term changes that affect market prices. If capacity increased or decreased at a constant rate, market prices for the display output would tend to decrease or increase at a constant rate. Capacity is built in bunches, however. In effect, there are “quantum increases” because balancing diverse types of equipment capacities leads to efficient production line groupings that can process 20,000 or 30,000 substrates per month. The cost of clean room infrastructure motivates producers to bring two or more such lines into full utilization as soon as possible during each project. As a result, capacity surges over a few quarters every three years or so for each producer because it takes about three years to build and stabilize a new fabrication plant.

Of course, different producers have different abilities to fund and build new fabs. In addition, key equipment suppliers cannot design and deliver new equipment to all producers at once. Producers therefore expand at different times, which smoothes growth over the long-term but makes growth choppy over the near term.

Just as one car’s acceleration can lead to a traffic jam, surges in capacity can lead to a price jam.

AUO + LGD Areal Price and Cost Development, Q1'01–Q2'10 (100 = trend price in Q1'01)



Source: company disclosures of consolidated results, BizWitz analysis

If we combine results from AU Optronics (AUO) and LG Display (LGD) we can see how their areal prices and costs fluctuate in reaction to capacity surges (cash cost = Sales minus EBITDA). For now, we focus on the green price line. We will consider the red cost line under Secular Trends. The chart scales areal prices to the trend-line value at Q1'01, which was \$5,173 per square meter of display area. Since then, prices have fluctuated on an exponential decay line falling 19% a year.

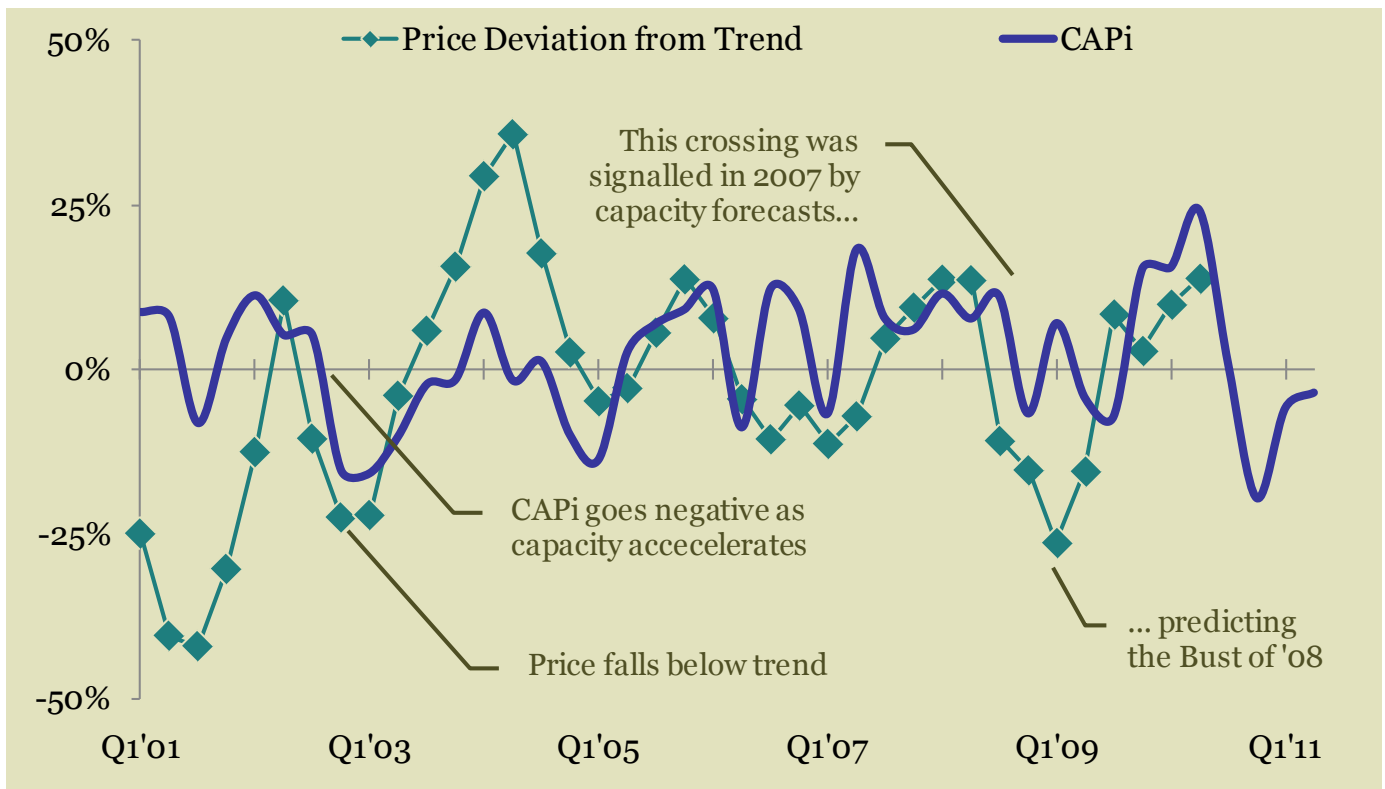
That trend line correlates to data obtained in the 1990s and to subsequent data published by DisplaySearch since 1996. Ten years ago, similar analysis by BizWitz principals generated 19% or 20% trend lines depending on start points, so the combined data from two leading producers seems in-line with data from all producers.

About ten years ago, BizWitz principals used such data to develop a model for price fluctuations that did not depend on market sentiment. We observed that most analysts assumed a demand, then adjusted price forecasts accordingly. They did this because of the mistaken assumption that there was some intrinsic Supply-Demand function affecting the industry. Many industry executives believed there was such a function and companies used Supply-Demand models to justify their business decisions. Such reasoning is erroneous, of course,

because price mediates between supply and demand in open markets. Thus, demand is an inherent function of Supply and Price. Price adjusts to match Supply and Demand. We can therefore estimate Price effects using Supply alone.

The new model looks at capacity acceleration, only. As a result, it is free of sentiment because sentiment has no affect on past capacity and little affect on capacity two years from now. Fab capacity is cast in concrete, literally. The model calculates acceleration as a percentage then multiplies it by minus one. That way, positive (rising) acceleration generates a negative-going signal for prices falling below the long-term trend line. The signal has called cycle busts correctly for nearly ten years by using capacity forecasts to identify negative crossings. We call this signal the Capacity Acceleration Price Indicator (CAPI).

**AUO + LGD Areal Price Deviation and the Capacity Acceleration Price Indicator, Q1'01–Q2'10**



Source: company disclosures. BizWitz analysis

When we plot CAPI (in purple above) with the percentage areal price deviation (in green) from the 19% decay line, we see that CAPI predicts cyclical price declines when it falls below zero. Capacity forecast data in 2006 and 2007 signaled a cycle bust would occur in 2H'08. That signal was not received well. Industry sentiment was bullish in 2007–2008. Thus, clients who acted on CAPI were spared the worst effects of the bust in 2008. From our pre-crisis perspective, the industry was headed

toward a cyclical bust even if macroeconomic conditions remained positive in 2008. The bust was cast in concrete years earlier as a result of reinvestment decisions AMLCD producers made during a cycle boom. As has been the case since the AMLCD business began, rising expectations on rising prices lead to a new round of investment that precipitates a bust about 2½ to 3 years later. Such delay is a natural result of the time for building, equipping and stabilizing a new plant.

The main effect of the credit crisis (aka Great Recession) was capacity utilization reduction. In prior business cycles, some AMLCD producers reduced utilization towards 75% but most producers responded to the supply surge by reducing prices and seeking share growth. Such behavior changed in 2008 when some producers stopped entire plants, thereby reducing their asset utilization below 50%. Other producers reduced utilization to a greater degree in 2008 than in prior cycles as means of supporting their prices. A number of producers refused to book orders at loss-making prices.

Returning to the traffic analogy, when producers tapped their breaks, suppliers in cars behind them came to panic stops. Key suppliers with continuous processes (e.g. glass foundries) shut plants down. Time lags resulting from need to rehire and restart exacerbated demand shortfalls as downstream inventories were depleted in early 2009. Producers could raise prices under such short supply conditions.

And raise them they did. Plant closures and construction stoppages reduced panel supply and planned expansion. As in prior cycles, flat capacity led to rising prices as brands bid higher to obtain panels. Also, as in prior cycles, rising prices encouraged producers to reinvest in more capacity. So, while the percentage increase in total capacity this year is moderate, the acceleration of capacity sends the CAPI down sharply in 2H'10.

Reading the Asian business press affirms the CAPI signal. Chinese PC and TV inventories are higher than normal for the third calendar quarter. Prices for LED backlit TV sets have been cut 30% or more. Taiwanese AMLCD producers plan utilization cuts again. Samsung warns of a DRAM glut. Consumer sentiment in the West remains gloomy. We think Q3'10 will prove to be a turning point for another business cycle.

Readers with access to good capacity forecasts, such as those published by DisplaySearch, can estimate future acceleration in 2011–2012. Based in data presented at the USFPD Conference earlier this year, BizWitz can estimate future acceleration only as far as Q1'11. That looks favorable. We may see prices rise above the trend line later next year. Meanwhile, producers must cope with more tough times.

## Secular Trends

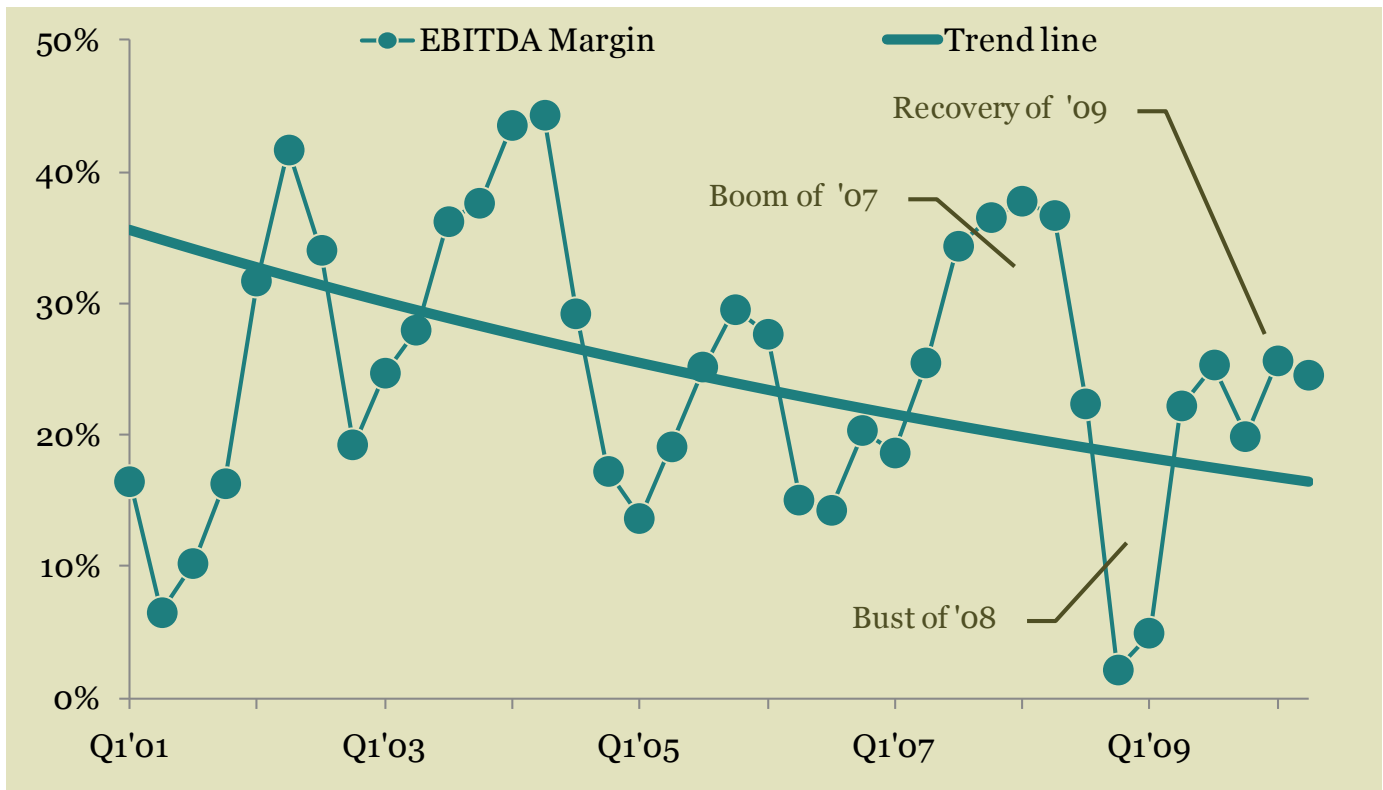
Returning to the chart of areal price and cost, we note two easy observations. Areal price fluctuates more than cost does and it falls faster. The first observation is unsurprising. It is easier to cut prices than costs. Key suppliers of glass (e.g. Corning), optical films (e.g. Fujifilm) and liquid crystals (e.g. Merck) have more pricing power than other suppliers in general, so costs for such materials fall more slowly. In addition, operation of newer, larger substrate lines has the perverse effect of increasing the area cost of some materials (e.g. glass) because of supplier yield risk. AMLCD producers therefore rely on redesigns to reduce costs by using common parts or reducing parts. Reducing the number of LED sidelights in LCD TV panels or using multi-function optical films are recent examples. Unfortunately, realizing such savings takes time. Inventories of higher-cost panels must be sold and older designs remain in production until new models ramp-up. Such factors have a smoothing effect on cost reduction rates.

The observation that cost (meaning Sales less EBITDA over area) declines slower than price does may surprise some, but this trend has been consistent. As shown for the combination of AUO and LGD, their price followed a 19% annual decay line while their cost followed a 17% decay line. The chart uses US dollar values to plot their combined results but we find similar data using native currency results. There is persistent evidence of a nominal two-point difference between the rate of price reduction and the rate of cost reduction.

The expansion of capacity for both companies resembled exponential curves until 2006–2007 when they slowed the pace of expansion to better match demand. Their expansion now resembles S-curves but the linear pace of expansion from 2000 through 2010 remains heroic. The ten-year CAGR for AUO is 65% (with acquisitions) and the figure for LGD (organic growth) is 49%. Such figures are pertinent to the discussion because they support the contention that AMLCD producers are obtaining diminishing returns to scale.

Considering the rise of capacity while prices fall faster than cost, declining EBITDA margin is no surprise. Here we plot margin over 38 quarters to show how it trends down about 2 points a year. Not shown in the chart is the general market condition of 1999–2000 when prices rose and fell dramatically as millennium fears came to an end. The fluctuation then resembled the curve plotted for 2007–2008. The trend line reflects the severe boom-bust that occurred before we collected consolidated financials from Taiwanese producers.

AUO + LGD EBITDA Margin in USD terms, Q1'01–Q2'10



Source: company disclosures; US Federal Reserve

Diminishing returns to scale is a secular trend underlying our scenario of Legacy Transfers (download [here](#)). We expect AMLCD producers will continue seeking permission to form ventures in China where bankers are accommodating if politicians are. We believe BizWitz Scenarioz are supported by two other long-term trends.

- Emerging markets sustain the trend of flat to falling panel sizes.
- Maturing PC markets alter the purpose of older AMLCD fabs.

## Emerging Markets

Suburban homes are similar the world around: they have room for big screen TV sets, perhaps several. Visions of 46", 52" and larger screens in homes drove AMLCD producers to invest in seventh, eighth, even tenth generation lines. Such visions were rational to a degree. Consumers in Europe and North America will buy larger TV sets as they recover from the Great Recession. Meanwhile, consumers in emerging markets prefer smaller sets for smaller homes and much smaller budgets. Recent reports from China reveal that more than one-half the LCD TV sets sold in 1H'10 were 26" or 32" models.

Consider India, also. Consumers in this emerging market are aural, not visual. The PC did not catch-on there but small TV sets with big speakers and small phones with long talk times did. More recently, Indians began purchasing smart phones as mobile terminals. Markets like this may demand a lot of screens but not a lot of screen area.

As a result, we note a trend toward flat or declining average panel size. We therefore caution readers against reading too much into reports of rising unit shipments. In the past, rising shipments combined with rising display sizes to boost real demand for AMLCD producers. Today, producers may ship more units but no more area.

## Maturing Markets

While planning the world's first sixth-generation fab for LG Display in 2002, it seemed clear to BizWitz analysts that the PC market would be growing at single-digit rates when the investment reached breakeven in the latter half of the decade. The investment made sense if the assets could make a wider variety of products.

The good news is that the LG Display fab was flexible and able to adapt. The PC market did mature: IBM sold its PC business and HP offered services. A decline in desktop PC demand meant fewer large monitor panels. A decline in desktop replacement PC demand by companies and an increase in netbook demand by consumers meant smaller average notebook panels. Such non-cyclical trends contributed to the general slowing of display area growth noted above.

There is some countervailing move towards larger displays in smart phones and other gadgets. The impact of such moves is constrained by the human hand, however. Few mobile phones will feature panels larger than four diagonal inches. Indeed, smarter phones made for emerging markets like China or India may feature smaller displays.

Display area demand by iPad-like tablets is constrained to some degree, also. Portable devices can be only so big and several recent tablet designs use smaller displays than the original iPad screen. More important, such gadgets are substitutes for netbooks or other PC products. We do mean that all consumers will perceive an either-or decision but that such gadgets will take some portion of consumer spending out of the conventional PC market.

With gadget demand rising in units but not so much in area while PC display area demand falls overall, AMLCD producers face new choices for capacity allocations. They learned how to cut tens or hundreds of panels from a substrate several years ago, so now they can shift remaining demand from older to newer fabs. Plants built five or more years ago may not operate profitably during downturns, so producers

are shifting a broader range of small panels to newer fabs. Older lines are the first ones stopped during cyclic busts.

This helps explain why display makers (and color filter suppliers) are so eager to serve smart phone or touch-screen applications. Given the cost of market exit, producers are rational accepting near-zero marginal return if they can use nearly all their assets. They are also rational if they form joint ventures to assemble products overseas in BRIC countries as long as these absorb domestic fabrication capacity.

## Trouble in Taiwan

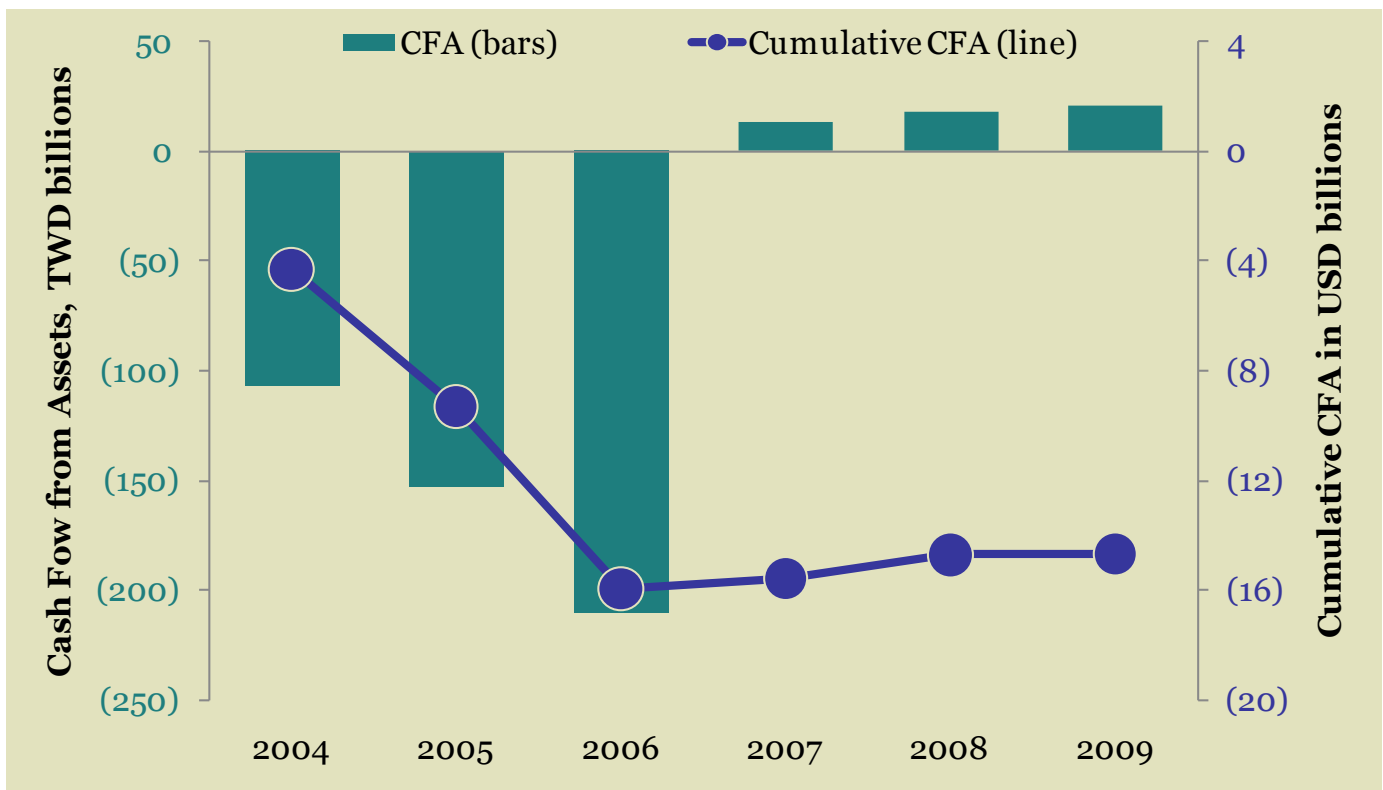
Secular trends have affected Taiwanese producers more than others for two reasons. Government ministers fostered too many producers in Taiwan and the producers served PC assemblers as merchant component suppliers for the most part. Taiwanese ministers admitted overstimulation of the industry last decade so that is not news. The newsworthy result is that we are still waiting for consolidation. Earlier this month, Taiwanese newspapers speculated about Chunghwa Picture Tubes (CPT): would it be acquired by a Korean or Taiwanese firm? Familial and national bloodlines run deep in Asia. They influence consolidation as much as financial considerations do. For example, we note that AUO grew by acquiring domestic competitors run by professional managers (Unipac Optoelectronics and Quanta Display). Consolidating firms run by leading family empires such as CPT (Tatung) or HannStar Display (Walsin Lihwa) has proved more difficult.

In addition to having many competitors and banks to fund them on island, Taiwanese producers became merchants, not brands. While we note efforts such as Chi Mei brand monitors or Hannspree brand TV sets, these are exceptions that prove the rule. Unlike LG or Samsung affiliates in Korea, Taiwanese producers depend almost entirely on orders from contract PC or TV assemblers. Lack of vertical integration decreases potential for product coordination and increases their potential business risk. In addition, their role as merchants leads to second-sourcing LG or Samsung affiliates at best or serving commodity markets at worst. For that reason, we view the formation of Chimei Innolux favorably. Those formerly independent Taiwanese producers have better prospects as part of Hon Hai's vertically-integrated system.

Unfortunate secular trends and industrial structures combined to destroy value in Taiwan. That becomes visible when evaluating cash flow from assets (CFA). The measurement is EBIT less Tax less changes in working capital and fixed assets. It gets at the heart of the matter: what value derives from large capital investments?

We calculate that seven AMLCD producers in Taiwan generated TWD418 billion of negative cash flow from 2004 to 2009. That translates to about \$14.7 billion. As charted below, the consolidated results became positive after 2006 as several producers reduced their pace of expansion but not enough to forestall the need for restructure.

Taiwanese Cash Flow from Assets 2004–2009 (billions TWD and USD)



Source: consolidated company disclosures; US Federal Reserve and BizWitz analysis; Taiwanese include AU Optronics, Chimei Innolux acquisitions, Chunghwa Picture Tubes, HannStar Display and Wintek

The shift to positive flows in 2007 seems too little, too late. If the industry had started in 2004, then positive flows in 2007 would appear to be normal evolution: risk investment for several years followed by positive returns as scale economies improved and the pace of expansion slowed. In reality, the industry started in the mid 1990s, more than ten years earlier. By the late 2000's it seemed clear that Taiwanese producers would not recover their investments in the foreseeable future.

Summing their expenditures on property, plant and equipment (CapEx) in dollar terms from 2003 through 2009, Taiwanese AMLCD producers put 46.3 billion USD into the ground to generate negative pre-finance cash flow of 12.9 billion USD. Cash flow from operations exceeded cash flow from investments in 2007 and 2008 only. Most of the time, producers lived on credit.

In aggregate and individually, they kept going through debt and cash management. Taiwan is known for being over-banked, so producers could raise cash with convertible bonds or debt facilities. In addition, they were able to stretch-out payments to their suppliers. Their cash cycle was shorter than 20 days in most years and some producers (e.g. AUO) achieved negative cash cycles during which customer receipts financed working capital. This did not help profit margins nor shareholder returns however.

## Past Performance

Keeping one step ahead of creditors may not be enough to please shareholders seeking earnings growth as some indication of future dividends. Sadly, the aggregate net profit margin from 2003 through 2009 was 1%. Smaller producers such as CPT and HannStar had total loss margins of 5% or more over those years. The aggregate profit margin, such as it was, came from leaders such as AUO, which generated earnings every year but 2009. The aggregate results from 2004 through 2009 are presented below (2003 data was used for year-on-year calculations in 2004). For reference, aggregate sales of 983,320 million TWD in 2009 translate to \$30,777 million using the US Federal Reserve exchange rate for December 31 that year.

**Taiwanese Income 2004–2009 (TWD billions; approximately 310 million USD per billion TWD)**

Income	2004	2005	2006	2007	2008	2009
<b>Sales</b>	462	672	836	1,246	1,147	983
<b>EBITDA</b>	122	113	151	334	240	138
<b>EBIT (IFO)</b>	56	17	13	144	30	(87)
<b>EBT (pre-tax profit)</b>	54	9	(3)	127	3	(124)
<b>Net Profit after Tax</b>	54	9	(7)	127	(6)	(122)

The aggregate gross profit from 2003 through 2009 was about 18 billion USD for a gross margin of 10%. We estimate that the cost of material ranged from 60% to 70% of Sales, which is in line with disclosures by LG Display of Korea. All AMLCD producers face the paradox of making large capital bets on businesses dependent on material contribution margins. The paradox is greater when we consider that about two-thirds of their material costs arise from post-fabrication assembly outside the fab. In other words, risking capital on a next-generation fab creates potential scale benefits but most of these will be realized in material purchases independent of fab activity. This paradox makes line stoppages rational in times of falling prices. The fab may be expensive but material contribution is essential.

Dividing income by Sales yields the following common-sized figures. Prior to 2009, ROC-GAAP made EBIT (income from operations) greater than it would be under US-GAAP or IFRS accounting. There is little difference between pre-tax and after-tax profit because producers often earned tax credits for R&D expenditures or for past losses.

**Taiwanese Sales Ratios 2004–2009**

Sales Ratio	2004	2005	2006	2007	2008	2009
<b>Sales</b>	100%	100%	100%	100%	100%	100%
<b>EBITDA</b>	26%	17%	18%	27%	21%	14%
<b>EBIT (IFO)</b>	12%	3%	2%	12%	3%	(9%)
<b>EBT (pre-tax profit)</b>	12%	1%	(0%)	10%	0%	(13%)
<b>Net Profit after Tax</b>	12%	1%	(1%)	10%	(0%)	(12%)

Using data from 2003 allows us to calculate financial ratios from 2004 through 2009 in Taiwan currency terms. The DuPont ratios (Asset Turnover \* Net Profit Margin \* Equity Multiple = Return on Equity) seem unsurprising given the foregoing, so we place more attention on Return on Capital Employed (RoCE). Those results seem inadequate given the capital invested and the risks taken.

Consideration of the weighted cost of capital for Taiwanese firms is beyond the scope of this discussion. Still, we assume that RoCE has seldom jumped a prudent hurdle rate. Even looking at results for AU Optronics dating back to 2001, we see its RoCE average 9%. That is best in class for Taiwanese producers.

**Taiwanese Financial Ratios 2004–2009**

Finance Ratio	2004	2005	2006	2007	2008	2009
<b>Net Debt/Equity</b>	42%	50%	65%	32%	39%	43%
<b>Capital Turnover</b>	101%	104%	98%	123%	110%	100%
<b>Asset Turnover</b>	70%	73%	67%	82%	72%	63%
<b>Net Profit Margin</b>	12%	1%	(1%)	10%	(0%)	(12%)
<b>Equity Multiple</b>	194%	208%	231%	219%	208%	223%
<b>Return on Equity</b>	16%	2%	(1%)	18%	(1%)	(18%)
<b>Return on Cap. Emp.</b>	11%	3%	1%	13%	3%	(8%)

Capital Turnover = Sales / (Average Debt + Average Equity – Average Cash)

Asset Turnover = Sales / Average Assets

Equity Multiple = Average Assets / Average Equity

Return on Capital Employed = EBIT / (Average Assets – Average Current Liabilities)

## Future Performance

The CAPI shows Q2'10 as the peak of a business cycle. We therefore think Q3'10 results will resemble Q1'10 results and that Q4'10 results will resemble Q4'09 results.

### Recent Taiwanese Operating Profits (TWD millions)

Operating Profit	Q2'09	Q3'09	Q4'09	Q1'10	Q2'10
<b>AU Optronics</b>	(4,467)	7,551	1,900	8,129	13,215
<b>Chimei Innolux*</b>	(1,450)	1,043	(366)	4,216	12,004
<b>Chunghwa Picture Tubes</b>	(8,156)	(4,854)	(7,407)	(2,649)	(1,238)
<b>HannStar Display</b>	(2,629)	31	(3,277)	(1,083)	1,083
<b>Wintek</b>	(646)	(21)	(303)	(958)	277
<b>**E Ink Holdings</b>	(651)	(30)	133	644	1,046

\*Pre-acquisition results for Innolux Display in 2009; \*\* E Ink not included in aggregate Taiwanese results.

AU Optronics remains exposed to the cycle in its core business but the producer is proactive in extending activity beyond AMLCD. Chimei Innolux faces merger integration challenges near term but forward integration opportunities long term. Other AMLCD producers are candidates for acquisition or restructure. Note that E Ink Holdings acquired Korean assets (the former Hyundai LCD operations) and entered electrophoretic display material markets, so it has altered its business strategy more than any other Taiwanese firm. As a result, we did not include it in the aggregate amounts.

### Recent Taiwanese Operating Profit Margins (percent of Sales)

Operating Profit	Q2'09	Q3'09	Q4'09	Q1'10	Q2'10
<b>AU Optronics</b>	(5%)	7%	2%	7%	10%
<b>Chimei Innolux*</b>	(4%)	2%	(1%)	6%	8%
<b>Chunghwa Picture Tubes</b>	(69%)	(26%)	(44%)	(12%)	(5%)
<b>HannStar Display</b>	(20%)	0%	(23%)	(7%)	6%
<b>Wintek</b>	(10%)	(0%)	(4%)	(13%)	2%
<b>**E Ink Holdings</b>	(15%)	(1%)	3%	13%	20%

In conclusion, we interpret the data to mean all Taiwanese producers should seek opportunities for joint ventures in BRIC countries. As was the case in Taiwan (and in Korea or Japan before 1999), BRIC nations are eager for high-tech industry and their governments are willing to stimulate technology transfer through state-sponsored research programs, tax incentives and FDI policies. Such environments contrast

with domestic ones where home countries have come to see so-called clean industries as potential polluters and once promising industries as disappointing ones. Thus, while Taiwan prefers to keep its latest technologies at home, it has little choice but to let its panel makers trade technology for capital overseas. Perhaps Taiwan's AMLCD producers will succeed by using other people's money.

We should note here that Taiwan grants its producers permission to venture into China on the condition that they invest domestically in next-generation fabs first. For this reason, we expect AU Optronics to build advanced technology plants in Taiwan this decade. We suspect that these will not generate substantial returns, though they will enable the producer to take advantages of less costly operations in China.

If such observations seem too dire, we should note that conditions for Korean panel makers are better but only slightly so. They benefit from vertical integration with global brands: LGE and Samsung. Korean producers face the same market dynamics Taiwanese makers do, however. In addition to adverse, long-term trends, Korea is not as important as Taiwan is to China. China hopes to re-unite its former province and re-integrating Taiwan's high-tech industry with China's is one step forward. As a result, political approval of potential China-Korea joint ventures is not coming as fast as are approvals for China-Taiwan fab proposals. Thus, while Korea granted permission for its AMLCD producers to transfer fab technology to China first, Taiwanese makers may get there first.



—David Barnes for BizWitz LLC, a consultancy specializing in electronic display and imaging business decisions through the supply chain from raw materials through retail, worldwide