Forecast of Laser Refractive Surgery in China 2013 – 2023
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EXECUTIVE SUMMARY

Most of the growth of laser refractive surgery in China has occurred since 2005. The market size in 2012 was approximately 950,000 eyes (USD $713 Million) per year, a level that has overtaken the United States (U.S.) as the largest global laser refractive surgery market in terms of procedure volume.

This report analyzes the laser refractive surgery industry in China and forecasts likely market performance over the next ten years. Key findings are that:

1. Procedure volume will approximately triple in 10 years to an estimated 2.89 million eyes per year, representing a compound annual growth rate of (CAGR) 11.75%, for a 2023 market size of $2.16 Billion. This growth justifies investment at each level of the supply chain, including surgeon and personnel training, capital equipment providers, delivery centers, public awareness campaigns, etc.

2. Compared with the U.S. market, China’s market has a much larger range of variability of market penetration and much greater non-uniformity across many parameters, including procedure price, technology, surgeon training, marketing, and other factors. Standardization will significantly improve the industry.

3. The level of public awareness about refractive surgery in China is much lower than in the U.S., making it vulnerable to negative media reports, and providing an opportunity to increase market growth with improved awareness.

Several factors limit or threaten growth of the laser refractive surgery market. These include:

1. Lack of public awareness of the benefits of the procedure;
2. Regulatory concerns, particularly concerning the Private Centers, since nearly half, of all LASIK procedures are performed in private setting;
3. Dependency on growth in living standards and disposable income, to make laser refractive surgery affordable;
4. Conservative consumer attitudes regarding spending, and uncertain growth of the consumer credit markets;
5. Restrictions that limit advertising for medical procedures; and
6. The need for increased standardization in surgeon training, technology, and outcomes.

To our knowledge, this is the first long term industry forecast for the laser refractive surgery market in China to be published. It was conducted by industry experts, marketing experts and business analysts from Kellogg Northwestern School of Management, in close collaboration with the Aier Eye Hospital System (China’s largest Private Center system in eye care), Ming Wang, MD, PhD of Nashville, TN, and with the support of Alcon (China) Ophthalmic Product Co., Ltd., Zhai Qiying, President of Lumenis Ltd., China, and Professor Zhou Yuehua, MD of Beijing Tongren Hospital.

Our model considers the historical performance of the U.S. laser refractive surgery market, the performance of the China market in both Public Hospitals and Private Centers, China’s demographics, income growth, population statistics, the incidence of treatable refractive errors, and the expected market penetration levels at saturation. The analysis used to develop the model is described, and brackets for the forecast based on expected, worst-case and best-case scenarios are presented. A discussion of the factors limiting market growth, market risks, and potential business opportunities is provided.
LONGEVITY
INTRODUCTION

Laser Refractive Surgery is a highly developed, technically advanced procedure to reduce or eliminate dependence on glasses and contact lenses. It is performed as an outpatient procedure under topical anesthesia (drops) and takes only a few minutes to perform, lending itself to production-line style delivery models.

The development of laser refractive surgery in the United States provides useful comparisons to China. First introduced in the United States in 1996, the U.S. laser refractive surgery market has expanded and contracted with economic cycles. It is now at a relative steady state with little growth over the past 3 years. In 2012 U.S. procedure volumes were approximately 700,000 procedures per year\(^1\). The average price point of $1500 per eye in the United States factors to a total U.S. market size of $1.05 Billion / Year.

In contrast to the United States, where the market began to rapidly develop after the first FDA approvals for excimer lasers in 1996, most of the laser refractive surgery market development in China has occurred since 2005. Since 2005, procedure volumes in China have grown to reach approximately 950,000 eyes (USD $713 Million) per year\(^{ii}\) in 2012. Thus in terms of procedure volume, China has overtaken the United States and is now the largest global laser refractive surgery market. But because the procedures are priced at a lower level in China than the United States, China’s market stands at approximately USD $713 (compared with $1.05 Billion in the U.S.).

Except for timing, early growth patterns in the U.S. market and in China were similar despite differences in pricing, per capita income and regulations in China that prohibit the direct-to-consumer (DTC) marketing that is widely done in the United States. Over 90% of the laser refractive surgery performed in China is done using the procedure known as LASIK, which is slightly higher than the rate of 81% found in the U.S.\(^{iii}\).

Laser refractive surgery is typically performed once per patient, so market growth relies on increased numbers of patients opting for surgery from the available pool. Once the adoption rates stabilize and existing demand is exhausted, new procedures rely on new entrants into the field as young patients mature into the eligible range of at least 18 years of age. A forecast for growth therefore depends on estimates of the size of the pool of eligible candidates, expected adoption rates and population growth.

This report provides a forecast of the laser refractive surgery market in China over the next ten years. It considers the U.S. market performance and projects market growth based on the following market drivers: demographics, income statistics, prevalence of treatable refractive errors, technology considerations, delivery models and market acceptance. Assumptions underlying the model are evaluated using available data to bracket the forecast probability.

A forecast of China’s laser refractive surgery market has widespread implications. Stakeholders include government centers, private firms offering LASIK procedures, physicians, capital equipment manufacturers and distributors, pharmaceutical companies that provide related medications and disposables and, to a lesser extent, the glasses and contact lens industry that compete with LASIK in the vision correction space.
METHODS

Background

This report was prepared at Northwestern University Kellogg School of Management MBA Research team, as part of a Global Initiatives in Management course offered by Professor Mark Finn, PhD. The research team consists of the following members:

- **Guy Kezirian, MD, FACS, MBA (Cand.)** Dr. Kezirian is a board certified and sub-specialty trained ophthalmologist, who attended McGill University in Montreal, Canada and Brown Medical School in the United States. His company has run several FDA studies for excimer laser approvals. He is an industry consultant in ophthalmology through his company, SurgiVision® Consultants, Inc.

- **Laxmichand Fatnani, MBA.** Originally from India, he has worked in U.S., UK and the Middle East and is based in St Louis, U.S.. Mr Fatnani has 14 years of experience in leading technology practices, strategies, building operations and competency centers. His technology expertise includes Enterprise Resource Planning (ERP) – SAP, Cloud, Mobility and Open Source.

- **Eunice Opoku, MBA.** Ms Opoku is a seasoned Marketing & Sales Executive strong at developing new and existing markets that possess significant strategic challenges to deploying Consumer Package Goods. She is skilled at using integrated marketing initiatives to reshape conversations about the value propositions of brands to ensure that consumers realize optimal value and corporate achieve business targets. For the past 12 years, Ms. Opoku has traveled across 40+ states within the United States, 50+ countries and driven global initiatives to grow and strengthen international revenue to now constitute 65% of her company’s total revenue.

- **Michael K. Lyons, MBA.** Born and raised in New York City, Mr. Lyons is a pharmaceutical marketer in Eli Lilly and Company's Oncology Business Unit, with cross continental experience across, the United States, Europe, and Japan, and currently resides in Thailand.

- **Jesse Baker, MBA.** Mr. Baker is an information technology professional with experience in the Healthcare industry. He is based in Stamford, Ct and has worked on projects in Washington DC, Houston, TX and New York City.
Collaborations and Data Sources

Development of the report relied on close collaboration with several parties:

- Ming Wang, MD, PhD: Ophthalmic surgeon and medical director of the Wang Vision 3D Cataract and LASIK Center, Nashville, Tennessee, and International President of the Shanghai Aier Eye Hospital, China. Dr. Wang served as a key collaborator for this report.

- Aier Eye Hospitals Administrative Team: Aier is the largest Private Center system specializing in eye care in China with centers over a widespread geographical area. Aier currently performs approximately 10% of the laser refractive surgery in China in 43 centers. Aier provided market data, perspectives and on-site education at their Shanghai and Beijing centers.

- Professor Zhou Yuehua, MD, Beijing Tongren Hospital: This center is the largest single provider of laser eye surgery in China at over 15,000 procedure per year.

- Alcon (China) Ophthalmic Product Co., Ltd., Beijing, China.

- Zhai Qiying, President of Lumenis Ltd., China.

- U.S. Demographic data was obtained from the United States Census Bureau, using the 2010 census figures.

- China demographic data was obtained the CIA World Factbook, the U.S. Census Bureau, the National Bureau of Statistics of China, published information (esp. Starmass International, Singapore) and multiple published sources as cited in the References.

- Data regarding demographic trends for the United States laser refractive surgery market were taken from the SurgiVision® DataLink registry, a private registry operated and maintained by SurgiVision® Consultants, Inc. with data from the United States since 2005, and from published sources as cited in the References. These data were used to compare the U.S. market demographics to those in China.
**Model Development**

The forecast model for the China laser refractive surgery market was developed based on information obtained from background research as well as during onsite visits to the centers listed on page 10. The model considers the following elements:

1. Factors that affect market growth, including those that are common to both the U.S. and Chinese market, and those that are unique to the Chinese market;
2. The potential for growth of China’s laser refractive surgery market, with consideration of the U.S. market experience, based on demographic and economic data and with consideration of the incidence of treatable refractive errors in the Chinese population; and
3. Factors that may affect market saturation levels.

**Market Size Assessment**

Factors affecting the laser refractive surgery market in the U.S. have been widely studied. The laser refractive surgery market in China holds many parallels with the market in the United States, as well as important differences. Similarities include the impact of demographic features – age, income and refractive errors – on procedure volumes, and the fact that the vast majority of laser refractive surgery is patient-pay (not reimbursed by insurance) in both markets.

Three key factors determine the potential pool of candidates for laser refractive surgery and apply similarly across markets:

- Population size;
- The demographic characteristics of the available patient population, including age and income; and
- The prevalence of treatable refractive errors in the population.

The factors above limit the market potential but are not sufficient to predict market growth.

For example, economic factors impact refractive surgery volumes. The U.S. experience has shown that refractive surgery volume parallels macroeconomic cycles. This is evidenced in declining procedure volumes after 2001 and 2008, as shown in Figure 1. Although economic forecasts for China predict slower growth in the coming years than in the prior decade, a key assumption of our model is that China will have relatively stable economic growth over the next 10 years without major downturns.
In addition, widely publicized reports of complications have, at various points, negatively impacted surgical volumes in the U.S.\textsuperscript{v} Negative media reports of refractive surgery have had a similar effect in China. For example, the publication of a negative report by a prominent Taiwanese ophthalmologist in 2012,\textsuperscript{vi} led to a drop in laser refractive surgery volume throughout China.

However, one important difference between the U.S. and China refractive surgery markets is that the Chinese market expanded at a later point in technology development than it did in the United States. This has allowed China to avoid most of the early technology-related complications that were experienced in the United States. The advanced state of current technology should allow laser refractive surgery development in China to avoid similar challenges going forward.

Nevertheless, significant limitations in the Chinese market present barriers to growth of the laser refractive surgery market. These include:

- Low patient awareness of the procedure’s benefits and safety record;
- Susceptibility to authoritarian pressures;
- A limited pool of qualified refractive surgeons among Chinese ophthalmologists;
- Unpredictable government regulations;
- Strategic misalignments among stakeholders;
- Challenging capital equipment acquisition models;

KEY TERMS AND DEFINITIONS

- **Refractive Surgery**: Ophthalmic surgical procedures performed to reduce or eliminate dependence on glasses and contact lenses.

- **Laser Refractive Surgery**: Refractive surgery performed using lasers.

- **Excimer laser**: The most common laser technology used to perform the refractive component of laser refractive surgery.

- **Photorefractive Keratectomy (PRK)**: A laser refractive procedure that reshapes the cornea on the surface, which requires the corneal surface to heal over several days.

- **LASIK**: A laser refractive procedure that reshapes the cornea of the eye under a thin layer of tissue (the “flap”) that is replaced after surgery, greatly speeding visual recovery.

- **Femtosecond Laser**: A laser used to create the corneal flap used in LASIK.

- **Microkeratome**: A mechanical device used to create the flap used in LASIK.

- **Myopia**: Nearsightedness, which is the most common refractive error in the Chinese population with an incidence of approximately 50%.

- **Hyperopia**: Farsightedness, which is much less common in the Chinese population than myopia.

- **Astigmatism**: A refractive error resulting from the cornea having two radii of curvature, like the back of a spoon.
• Financial challenges to providing surgeons with new capital equipment as technology improvements are released (technology cycle management);
• Reliance on continued improvement in the overall living standards and the educational levels;
• The need for loosening of government restrictions on advertising of medical procedures;
• Inadequate government support of Private Centers offering laser refractive surgery; and
• Reliance on the growth and increased acceptance of consumer credit markets.

Any reasonable forecast of China’s LASIK market must consider these factors, as is described next.

**Determination of Market Baseline and Saturation Levels**

The model for potential market growth is based on the observation that the laser refractive surgery market in the United States demonstrated saturation at approximately 2.7% penetration, and showed a baseline volume at approximately 1.2% penetration, as detailed below.

In this context, market penetration is defined as annual procedure volume compared to the potential candidate pool. The potential candidate pool is calculated as:

\[
\text{Potential U.S. Candidate Pool} = \text{Overall Population (310 Million People)} \times \text{Patients in Treatable Age Group of 18 to 45 Years (36.5%)} \times \text{Patients with Treatable Refractive Errors (50%)} \times \text{Patients with Adequate Disposable Income (50%)}
\]

**EQUATION 1:** General estimate of United States candidate pool for laser refractive surgery.

The result calculates to 28.3 million people.
Eyes with treatable refractive errors in Equation 1 includes all refractive ranges (myopia, hyperopia and mixed astigmatism). The U.S. patient pool calculates to 28.3 million people, or 56.6 million eyes. Notably, approximately 9.0% (28.3/310) of the current U.S. population of 310 million comprises the potential candidate pool. Accordingly, to date approximately 10 million U.S. citizens or 1/3 of the potential U.S. candidate pool has had laser refractive surgery.

Historically, LASIK started in the U.S. in 1996 and quickly grew to reach a peak market penetration of 2.7% in 2000, declining to a current market penetration of 1.2%. The current rate is likely influenced by the economic downturn of 2008, as Figure 1 suggests.

In 2012 approximately 700,000 eyes were treated in the United States, or 1.2% of the potential candidate pool. In 2008, approximately 1.5 million eyes were treated — 2.7% of the potential candidate pool. The former rate (1.2%) is interpreted as the baseline market, and the latter (2.7%) as the likely penetration level at market maturity.

Laser refractive surgery volumes in the United States have fluctuated based on several factors. Several authors have observed that laser refractive surgery procedure volume correlates with consumer confidence. Other factors impacting surgical volume include reports of surgical complications, market fragmentation, price variation and the introduction of the Warfighter Act which declared glasses-free vision as a condition of combat readiness for the U.S. Armed forces, and led to laser refractive surgery being performed in military centers and led to an overall increase in volume of approximately 150,000 procedures per year.
For this model, a market penetration rate at maturity of 1.95% was used, representing the midpoint between baseline level of 1.2% and 2.7% and estimates were bracketed using the 1.2% and 2.7% rates. These figures were applied against the corresponding demographic, refractive and income data for the Chinese population to determine the potential size of the laser refractive surgery market, presented next.
TRUST
**RESULTS**

Input data for the saturation model were obtained from the sources listed under *Collaborations and Data Sources* and are detailed in Table 1. All data are subject to estimation. The low and high values provide the range suggested by the various collaborators for this project. The calculations behind the cells in Table 1 are provided in Appendix 1.

**Current Market Size**

Estimates of the 2012 laser refractive surgery procedure volumes in China obtained from Aier, Tongren and Alcon ranged between 850,000 and 1 million eyes, with an average estimate of the three sources at approximately 950,000 eyes. Note that this value approaches the low estimate in the model in Table 1 and supports the model’s assumptions. Based on this procedure volume and an average $750 ASP per eye, the value of China’s laser refractive surgery market in 2012 factors to 950,000 eyes, generating USD $713 Million / Year.

**Projected Market Maturity and Saturation Levels**

Taking current procedure volume and market size baseline figures, and assuming linear growth to maturity over time using the Expected-Low-High estimates shown in Table 1, it is possible to estimate the expected compounded annual growth rate based on estimates for the time to market saturation. This approach is supported by considering two additional factors: the depletion of the potential candidate pool to date, and the ratio of the current procedure volumes to the expected volumes at market maturity.

In China, the number of people who have had laser refractive surgery to date is approximately 6 million. As was done for the U.S. market using Equation 1, the Estimated Total Candidate Pool for China can be calculated using Equation 2 to be approximately 74 million people.

Since approximately 6 million people in China have had laser refractive surgery to date, approximately 8.1% of the candidate pool (compared with approximately 1/3 in the U.S.) has already had laser refractive surgery. In other words, controlling for income, population, and the distribution of refractive errors, the Chinese laser refractive surgery market is 25% as developed as the U.S. market.
### Forecast of Laser Refractive Surgery in China: 2013-2023

#### Table 1: Population Input Data and Estimated Patient Pool

<table>
<thead>
<tr>
<th>Input Metric</th>
<th>Estimated</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>China population</td>
<td>1.36 Billion</td>
<td>1.34 Billion</td>
<td>1.39 Billion</td>
</tr>
<tr>
<td>Percentage in the treatable age group of 18 to 45</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
</tr>
<tr>
<td>Percentage with treatable refractive errors</td>
<td>35%</td>
<td>26.7%</td>
<td>58.9%</td>
</tr>
<tr>
<td>Percentage with the required income</td>
<td>33%</td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td>Estimated Total Candidate Pool</td>
<td>73,984,680</td>
<td>42,128,595</td>
<td>154,244,964</td>
</tr>
<tr>
<td>Market Penetration at Saturation</td>
<td>1.95%</td>
<td>1.2%</td>
<td>2.7%</td>
</tr>
<tr>
<td><strong>Procedure Volumes</strong></td>
<td><strong>Estimated</strong></td>
<td><strong>Low</strong></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Estimated Volume at Maturity (People)</td>
<td>1,442,701</td>
<td>505,543</td>
<td>4,164,614</td>
</tr>
<tr>
<td>Estimated Volume at Maturity (Eyes)</td>
<td>2,885,403</td>
<td>1,011,086</td>
<td>8,329,228</td>
</tr>
<tr>
<td><strong>Market Estimates</strong></td>
<td><strong>Estimated</strong></td>
<td><strong>Low</strong></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Average Selling Price ASP (Cost to Patient) Per Eye</td>
<td>USD $750</td>
<td>USD $505</td>
<td>USD $1,250</td>
</tr>
<tr>
<td>Market Size</td>
<td>USD $2.16 Billion</td>
<td>USD $505.5 Million</td>
<td>USD $10.4 Billion</td>
</tr>
</tbody>
</table>

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**ESTIMATED PATIENT POOL**

Table 1: Population Input Data and Estimated Patient Pool
Forecast of Laser Refractive Surgery in China: 2013-2023

Regarding the ratio of the current procedure volumes to the expected volumes at market maturity, the 2012 volume level of 950,000 eyes / year compares to the expected procedure volume of 2.89 million eyes / year, for a ratio of 32.9%.

The length of time needed for the market to reach maturity therefore becomes a critical factor in estimating the rate (but not the final level) of market growth. Given that the Chinese market for laser refractive surgery is 1/3 developed, the question becomes: How long will it take to reach maturity?

Unfortunately, reliable statistics about recent growth rates are incomplete. Figures from the Aier Eye Hospital System show significant regional variation. Estimates obtained from the Beijing Tongren Eye Hospital suggest significant year-over-year volatility, which was ascribed to recent negative reports in the media regarding LASIK and a public that is susceptible to such reports (further discussed below). Alcon, China and Lumenis China, both expect a 10% CAGR in LASIK procedure volume, based mostly on heuristics and recent data.

Figure 2 shows the compounded annual growth rates (CAGR) in procedure volume required to achieve the expected annual procedure volumes of 2.9 million procedures per year, based on different times to maturity. Based on reports of market growth over the past 5 years, prior performance suggests that it may take up to 10 years for China’s laser refractive surgery market to reach maturity.

\[
\text{Potential China Candidate Pool} = \text{Overall Population (1.36 Billion People)} \times \text{Patients in Treatable Age Group of 18 to 45 Years (47.1%)} \times \text{Patients with Treatable Refractive Errors (35%)} \times \text{Patients with Adequate Disposable Income (33%)}
\]

EQUATION 2: General estimate of China candidate pool for laser refractive surgery. The result calculates to 74 million people.
Financial Growth

The model in Table 1 shows an Expected, Low and High estimates in order to bracket the limits on probable performance. This approach provides valuable information, but by combining all the best and worst case extremes in the Low and High columns, the Low and High columns likely exaggerate real events.

Table 2 shows the Low and High CAGR for the model holding the ASP at $750 per eye and estimating time to market maturity at 10 years. Given the constraints on ASP mentioned in Appendix 1, and the procedure growth rates shown in Figure 2, this seems like a plausible scenario. Using this approach, the Low forecast shows a CAGR of only 0.63% and the High model is pared to a 10 year CAGR of 24.25%, which is in line with the growth seen in the pharmaceutical sector in China.\textsuperscript{xvii}

Figure 3 (see page 22) graphs the expected growth of the population and market size for laser refractive surgery, and of the market penetration, over time.

Figure 4 applies the model to project the potential market for selected cities.

\[\text{FIGURE 2: Compounded annual growth rates (CAGR) required to achieve the expected annual procedure volumes of 2.9 million procedures per year, based on different times to maturity. The 10-year, 11.75\% CAGR is used to create the Expected financial model.}\]
Forecast of Laser Refractive Surgery in China: 2013-2023

<table>
<thead>
<tr>
<th>Model</th>
<th>Current Market Procedure Volume</th>
<th>Projected Volume at Maturity</th>
<th>Projected Market (Billions USD)</th>
<th>CAGR over 10 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>950,000</td>
<td>2,885,403</td>
<td>$2.16</td>
<td>11.75%</td>
</tr>
<tr>
<td>Low</td>
<td>950,000</td>
<td>1,011,086</td>
<td>$0.76</td>
<td>0.63%</td>
</tr>
<tr>
<td>High</td>
<td>950,000</td>
<td>8,329,228</td>
<td>$6.25</td>
<td>24.25%</td>
</tr>
</tbody>
</table>

**COMPOUNDED FINANCIAL ANNUAL GROWTH RATES**

Table 2: Compounded Annual Growth Rates (CAGR) projected by the model in Table 1, over 10 year growth curves. In this table, the ASP is held at $750 per eye rather than varying for each model as it does in Table 1.

**Expected Market Size and Expected Penetration for Selected Markets**

*Figure 4: Application of the model projection to selected markets.*
Figure 3 (Top): Expected growth of the overall population, the 18—45 year old age group that comprises the bulk of the patients in the laser refractive surgery market, and the expected market size based on the model shown in Table 1.  (Bottom): Expected market penetration vs. the potential market size, based on the model.
WISDOM
DISCUSSION


The model predicts and estimated CAGR of 11.75% over 10 years for the laser refractive surgery market in China, to reach an annual market size of USD $2.16 Billion. This estimate factors for population size, demographic distribution of the potential candidate pool, affordability based on income levels, anticipated average selling price to the consumer and the prevalence of refractive errors in the Chinese population. Market saturation was modeled after the experience in the United States, which has a more mature market for laser refractive surgery. Assumptions for the model are listed in Table 1 and the model outputs are listed in Table 2 and Figures 2-4.

The model can be used to bracket the influence of the input parameters to generate the upper and lower limits for the market prediction. While each parameter may vary within the range described, it is doubtful that all the parameters will vary in the same direction at once. Therefore, neither the Low nor the High estimates are seen as probable occurrences, but they do provide a good sense of the lower and upper limits of the market potential.

The lower limits predict minimal growth of the market and suggest that the current market has matured. This conclusion is not supported by the comments received during the on-site interviews conducted in China for the preparation of this report. Rather, the sources interviewed all predicted growth rates between 8 and 12%. While none had created a model such as the one presented here, their predictions were all based on significant experience with China’s laser refractive surgery market. The agreement of these predictions with this model — which forecasts growth at 11.75% over 10 years — provides good support for the model’s acceptance.

As detailed in the Appendix 2, the expected annual growth rate of an established center is 11.9% ± 13.5% (-1.6% to 25.4%). This number is derived from the composite figures provided by the Aier Eye Hospital system over a five year history and agrees very well with the findings of this study.

This model is based on several assumptions, among which two stand out as critical. First, the model assumes stable economic growth. Should economic growth slow and consumer confidence decrease, growth of the refractive surgery industry can be expected to slow, as it has in the United States during down economic cycles.
The second critical assumption is that market saturation will take 10 years to achieve. We have modeled the 10 year growth curve. The challenges faced by China’s refractive surgery market are described in the next section and are felt to justify this assumption. However, China’s economy has surpassed expectations in many other industries, so the possibility exists that growth in the laser refractive surgery market may occur faster than anticipated by this model.

The China-based collaborators for this report (Aier, Tongren, Alcon (China) Ophthalmic Product Co., Ltd., and Zhai Qiying, President of Lumenis Ltd., China) provided many insights as to the potential opportunities and risks facing China’s laser refractive surgery market. Their insights are summarized in the next sections. The actual performance of the laser refractive surgery market in China may depend on how those considerations develop.

**General Characteristics of China’s Laser Refractive Surgery Market**

Several characteristics of the laser refractive surgery market in China will influence its growth.

**Limited Public Awareness and Lack of Public Trust**

It is our impression that a lack of public awareness and limited public trust is the single most important factor limiting the growth of the laser refractive surgery market in China.

Elective surgery is relatively new in China. People seem to be aware that laser refractive surgery exists but their knowledge of the risks and benefits is poor. To many, the thought of refractive surgery can be alarming. During our visit to China we conducted a non-scientific poll of people wearing glasses, and asked about whether they had heard of laser refractive surgery (LASIK) and whether would consider having it. The responses were nearly 100% that they had heard of it but had not considered having it, with the most commonly cited reason being “I can’t stand the thought of having my eyes operated on.”

This perception is not unique to China, but it has been largely overcome in the United States through marketing and time. A compelling argument can be made that laser refractive surgery, particularly LASIK, is a) safer than contact lenses and provides personal safety through full time vision without spectacles; b) provides better quality vision than glasses and c) is less expensive than either glasses or contact lenses, over a lifetime. This perception is not widely shared in China, and this message must be conveyed for the laser refractive surgery market to grow.
Clearly, major impediments to growth of the laser refractive surgery market in China are patient awareness and public acceptance. The most active stage of growth of refractive surgery in the U.S. market occurred between 1996 and the first half of 2001, when the laser manufacturers sponsored a nationwide direct-to-consumer (DTC) campaign promoting the procedure. Restrictions on DTC marketing in China prevent use of this approach. However, tools that are not considered DTC marketing could be used to improve public awareness and help build patient acceptance of the procedures. These include television or web documentaries and magazine articles, social media, educational patient seminars and other outlets. Information about LASIK should be made easily and readily accessible in the waiting rooms of Private Centers and Public Hospitals.

Although China bans advertising medical procedures to patients, programs could be crafted to emphasize the benefits of having “20/20 vision”. Such campaigns could be tied to social causes or interests, such as military service and athletic performance. Campaigns should target specific market segments. For instance, education to the late teen demographic could emphasize the limitations of glasses and contact lenses on occupational opportunities, and campaigns directed at adults could emphasize the status appeal and lifestyle improvement that comes with laser refractive surgery.

**Delivery Models**

Laser refractive surgery is provided through two delivery models in China: Public hospitals (including both hospitals and clinics) and privately operated centers. For this report, public hospitals and clinics are referred to collectively as “Public Hospitals” and privately owned centers will be referred to as “Private Centers”. Some Private Centers co-exists on site within the Public Hospitals. These are sometimes referred to as “islands” and are grouped together with Private Centers for the purposes of this report, except as noted.

There are approximately 20,000 health care facilities in China (Public Hospitals and Private Centers combined) and about 2,000 (10%) are Private Centers. In 2012, an estimated 39% of the laser refractive surgery procedures in China were performed in Private Centers, the remainder were performed in Public Hospitals. Hence, Private Centers performed 6 times more LASIK procedures per site than the Public Hospitals. This may be due to the increased level of specialization, and a more
consumer-oriented patient experience at the Private Centers. Whatever the cause, Private Centers have achieved significantly greater efficiencies for delivering laser refractive surgery than Public Hospitals.

As such, government support (or conversely, regulatory limits) of Private Centers will significantly impact the growth of the laser refractive surgery industry. If the government is supportive of the Private Centers and they are allowed to grow in number and market share, then the laser refractive surgery market can be expected to grow. If the government instills policies and regulations that impede Private Centers, then market growth will suffer.

This observation is not without a historical basis. In 2005, the Chinese government declared Private Center “islands” – Private Centers that exist within or near the grounds of a Public Hospital – to be illegal. Prior to 2005, government encouraged the development of Private Center islands because they attracted external investors, brought technology into China and answered an unmet need for elective surgery. Private Center islands were often the only part of the hospital that were profitable. However, over time these Private Center islands became an embarrassment to the Public Hospitals, as they drew contrasts in efficiency, cleanliness, waiting times, etc., and began to attract doctors away from the Public Hospitals. This contrast was not welcome, and without warning the government declared the Private Center islands illegal.

The co-location of the Private Center island facilities in the Public Hospitals helped foster growth of the private health care system. Trust in Public Hospitals is high among the general Chinese population, who do not expect the Public Hospitals would “cheat” them, where trust did not exist to the same extent in the Private Centers. By locating Private Center islands in Public Hospitals, Private Center islands were able to share in the trust extended to the Public Hospitals.

The Public Hospital system in China is divided into three tiers based on size and degree of specialization. Laser refractive surgery is generally offered in Tier 3 (or tertiary) hospitals which are larger facilities that are located in cities. Tier 3 hospitals generally offer many services, with laser refractive surgery being one of many provided. Tier 3 hospitals have the advantage of being well-known and generally trusted among the public. They are staffed by experienced doctors, but are
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often crowded and provide inconvenient service.

Our visit to the Beijing Tongren Eye Hospital exemplified the Tier 3 hospital experience. This hospital is one of the busiest centers performing laser refractive surgery in China. It provided a startling glimpse into the Chinese healthcare delivery system. The waiting rooms were overcrowded, the facilities were aging and patient wait times were long. Patient privacy was non-existent. The refractive surgery lasers being used ranged from equipment considered obsolete in most countries to state-of-the-art technologies. Quality control is not emphasized and the atmosphere is anything but patient or consumer-friendly. Nevertheless, the ASP for the procedure was among the highest we encountered in China, at ¥ 15,000 (USD $2,400) for both eyes.

Nevertheless, the Beijing Tongren Eye Hospital performed laser refractive surgery on approximately 14,000 eyes (7,000 patients) in 2012, a very high volume. The surgeon explained that “patients in China follow the famous surgeons” rather than the center or advertising. This insight is important and may significantly limit the growth of the laser refractive surgery market, as the number of famous surgeons is very limited.

While this delivery model may currently appeal to the Chinese Public Hospital patient, its growth is limited by the lack of a financial incentive system for the doctors and staff. Public Hospital surgeons are government employees and are paid a government salary. They are not financially rewarded for increasing production. As one surgeon stated openly to us, “I’m paid the same whether I do 10 cases or 100 cases a day. Why should I do more cases?”

The Private Centers provide a stark contrast to the Public Hospital model. Aier Private Eye Hospital Group (Aier Ophthalmology) closely collaborated with the research and development of this report. Aier offers laser refractive surgery in 43 centers throughout China and has grown through acquisition and the development of new centers. Aier claims to be the largest single provider of laser refractive surgery in China with approximately 10% market share. Aier stock is publicly traded on the Shenzhen stock exchange (300015:CH) and they use high-quality digital marketing tools, web-based marketing and patient education materials within the confines of the system, which prohibits direct advertising.
of medical procedures to the public. Aier provides a full range of ophthalmic services. The emphasis on laser refractive surgery at Aier centers varies by location.

Growth of the Private Centers in general is limited by several factors. Capital equipment is expensive. Surgeons trained and qualified to do refractive surgery are not readily available. However, demand is strong and the need for more centers in China is real, as many regional markets are underserved and some are not served at all.

For the laser refractive surgery market in China to grow to its potential relies on the proliferation of Private Centers. The case can be made that on average, Private Centers have demonstrated increased efficiencies in delivering laser refractive surgery to the population over Public Hospitals.

**Regional Variation based on the Prevalence of Refractive Errors and Market Size**

Many reports in the ophthalmic literature describe regional differences in the prevalence and nature of refractive errors in China. Various correlations are described in an effort to explain these differences, including education level, city vs. rural environment, population density, ethnicity and other factors. The model presented in this report considers China as a whole and does not attempt to predict regional differences in market growth. While regional difference in the prevalence of refractive errors may reflect the potential of specific markets, we could not locate reliable data to support region-based projections.

As of 2009 there were 655 cities in China. China’s cities are often characterized by Tiers, based on the city’s economy and population size. Tier 1 cities are the largest cities in China. Exact definitions of the Tier system vary. Examples of tier 1 cities are Shanghai with GDP of USD 228 billion (1USD=6.6RMB) and population of 14 million; Beijing with GDP of USD 184 billion and population of 12.46 million; and Guangzhou with GDP USD 138 billion and population of 10.26 million in 2009. Shenzhen is also characterized as a Tier 1 city with 15 million people. These very large Tier 1 cities
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seem to be where the bulk of China’s high-end consumers live. Most of the tier 2 cities are provincial capitals and generally have a population of at least 4 million and include more than 20 cities in this category. Tier 3 cities generally have populations of less than 2 million people.

Aier divides their market into 3 segments based on tier characteristics. Interestingly, despite purported regional variation in the prevalence of refractive errors, Aier Eye Hospital data suggest that there is little regional variation in the market acceptance of laser refractive surgery around China. Their presence in 43 distinct markets provides a good sampling and our analysis of their data substantiates this claim. However, Aier did report difference in market performance based on city size. This is probably not related to the prevalence of refractive errors, but rather to disposable income levels. According to Aier data, Tier 2 and 3 cities seem to outperform larger or smaller cities, particularly in terms of new center growth.

Based on patterns to date, one can speculate that most of the refractive surgery market growth will occur in China’s 160 cities with populations of 1 million or more, particularly in the Tier 1 and 2 cities, where most of the wealth is concentrated.

**Media Reports**

As with the United States market for laser refractive surgery, negative media reports can significantly impact laser refractive surgery volumes. For example, the media report from Taiwan in 2012, where a prominent LASIK surgeon declared he would no longer perform LASIK due to safety concerns, led to a country-wide drop in LASIK volume of 18%. This figure was provided by Aier and confirmed by Alcon, but interestingly, not all centers were equally affected, implying that local factors, such as marketing, public awareness, and economic factors, can mitigate this effect.

The ability of media reports to cast a chill on the refractive surgery market is a reflection of the lack of public awareness and public trust mentioned above. As China’s market matures and more people have direct experience with refractive surgery, either personally or through friends, family and co-workers, the impact of negative media reports can be expected to diminish.
**Government Policies**

Like all business in China, refractive surgery is closely regulated by the government. Refractive surgery, particularly in private centers, only exists in China because the government allows it. As such the future of refractive surgery in China may be impacted by changes in government regulations and policies.

Refractive errors are considered a barrier to certain military occupations. Refractive surgery increases the available pool of candidates for military and police service. One of the factors driving the growth of refractive surgery in China is the attraction of rural populations to military service and to work in the police force. One hopes that this consideration will discourage any government actions to restrict refractive surgery, making it difficult to envision the Chinese government prohibiting refractive surgery altogether.

China is a non-democratic system. One of the goals of non-democratic governments is to maintain stability and to provide essential services at an acceptable level. China’s public hospital system provides the vast majority of medical services to the population and it is often crowded beyond capacity. To help address growing demand, the Chinese government has allowed private centers to proliferate to help address the growing need for certain medical services, including refractive surgery. It seems unlikely that the government will disallow private centers from providing these services, especially since refractive surgery is paid for by patients and does not impose a significant financial burden on the government. Should the government perceive that private centers are creating the impression that the public hospitals provide inefficient or poor quality care, it may result in the government “losing face”. If this occurs, government intervention to limit support of private centers may occur.

**Regulatory Considerations**

There are no significant medical device-related regulatory barriers to the growth of refractive surgery in China. All modern laser platforms are already approved by the government for sale in China and the refractive surgery industry is well poised for growth from a technology perspective.
The Growth of Consumer Credit

One area for potential growth in the LASIK market is supported by a trend amongst Chinese consumers around consumer credit. Consumer credit dependence is growing at impressive rates, and is increasing in spite of traditional Confucian beliefs which look negatively on borrowing money – especially borrowing beyond one’s means.

Credit cards were introduced in China in 1985, and while they had slow growth at first, the behavior has changed in recent years. In 2011, purchases combined to over one trillion U.S. dollars in China, in a country that historically used cash for transactions. According to RNCOS, an industry researcher, credit card purchases in China will continue to grow at a rate of over 30% per year for the next five years. In addition, MasterCard projects that by the year 2020, China will be the largest credit card market in the world. The United States is expected to be second.

The growth of consumer credit use represents a cultural adjustment in Chinese traditional values and is particularly seen in urban young adults and professionals under 35 who live in first and second tier cities. The change can be attributed to aggressive marketing by financial institutions and a status-driven culture. Growth of consumer credit facilities could create a market where laser refractive surgery can be financed with the swipe of a credit card.

Capital Equipment Acquisition and Technology Cycles

Laser refractive surgery is capital equipment intensive. A laser suite costs approximately USD $1 million and equipment prices are similar in China to the rest of the world. Equipment leasing is uncommon in China and the high cost to purchase the capital equipment needed to equip a laser suite presents a significant barrier to the development of new centers.

One laser suite can accommodate a high capacity of patients. Run efficiently, one suite using modern technology could handle over 100 patients per day. In general it is patient demand, not capacity, that limits center operations.
One key piece of equipment in a refractive surgery laser suite is the excimer laser. The capital equipment model for excimer lasers in the United States has three components: laser sale, service fees and a per-use fee charged for each procedure. Service fees are based on utilization and vary widely, but costs average about $35,000 per year. Per-procedure excimer laser costs vary with volume but can commonly exceed $500 USD per eye.

The capital equipment model for excimer lasers in China shares two of the three components with the US model: laser sale and service. The China laser market does not have a per-use fee built into the model. Laser manufacturers and/or distributors appreciate revenues from laser sells and service contracts. Service fees run about USD $60,000 per year in China for excimer lasers.

Capital equipment to outfit a refractive laser suite also includes a femtosecond laser, which is used to create the LASIK flap. Both purchasing and service costs for femtosecond lasers are comparable to those for excimer lasers. In addition, femtosecond lasers require a disposable “patient interface” that costs approximately USD $160 on a per-eye basis. Fees for the patient interface are similar in China and the U.S.

There are strategic misalignments in the current capital equipment model that create conflicts between manufacturers, distributors and refractive surgery centers. These misalignments exist in both the United States and China. Steep acquisition costs present a high barrier to entry. A model based on equipment purchase makes it challenging for refractive centers to stay current with new technology. The lack of an annuity model for excimer lasers (per-use fee) in China blunts the interest of manufacturers and distributors to spend money on public awareness campaigns.

One solution would be to revise the capital equipment model to a lease model in place of the current purchase model. This would decrease the barrier to entry to purchase new equipment and open new centers. A leasing model would also allow the manufacturers and distributors to replace lasers in the field more frequently. This would improve access to newer technologies.
Unless the capital equipment model is improved to lower the barrier to entry for new centers and to make it less costly to upgrade when new technologies become available, capital equipment concerns will continue to negatively impact market growth.

**Surgeon Training**

Surgeon training in China is very different than in the United States, where ophthalmic residency programs are well established, conform to published standards and turn out trained surgeons according to a schedule. In China, training programs vary considerably in their structure and organization. Training may go for several years longer than in the United States and the surgical skills of doctors who graduate from ophthalmic training programs vary widely.

Surgeon training for laser refractive surgery is not trivial. A key element of effective surgeon training is a focus on clinical outcomes, which occurs through proliferation of best-practices among centers. The current system in China varies by region, is non-standardized, and does not support adherence to best-practice guidelines. Many centers in China are using equipment considered outdated by modern standards, and systematic clinical outcomes analysis is rare if it exists at all. Growth of the refractive surgery industry in China requires improvement in surgeon training, standardization of best-practices and greater focus on clinical outcomes.

China does not currently have enough refractive surgeons to meet the potential demand forecasted by this model. Laser manufacturers and/or distributors could—and arguably should—take a more active role in surgeon training. This has been successfully implemented in U.S. and European markets, and this western model for surgeon training could be replicated in China.
GOOD FORTUNE
BUSINESS OPPORTUNITIES IN THE CHINA REFRACTIVE SURGERY MARKET

This forecast suggests many significant business opportunities for the refractive surgery industry in China, including center development, capital equipment provision, surgeon training, marketing, and the provision of medications and disposable goods used in refractive surgery.

The refractive surgery industry can be divided into two unique but overlapping segments: business to business (B2B) and business to consumer (B2C). The B2B market consists of the wholesalers and distributors who sell equipment to the centers. Capital equipment manufacturers and distributors are well positioned to positively impact the growth of refractive surgery in China. There is a need to revise the current capital equipment so that the interests of the manufacturers, centers and patients are aligned. A key step is to lower up-front capital equipment costs, in order to make it easier to open new centers and to accommodate new technology upgrades as they occur. Where possible, manufacturers should work with private centers to take advantage of the ability to establish private refractive surgery centers within public hospitals (so called “islands”). Co-location of private center islands in public hospitals provides an inherent endorsement of refractive surgery and will greatly facilitate public acceptance of the procedures.

China’s consumer market is notable for embracing products that have western brands, particularly those from the United States. Direct foreign investment opportunities in China are limited, but special economic zones (SEZs) provide opportunities for wholly owned foreign enterprises and joint ventures. Both of these structures may allow established U.S. firms to access China’s growing refractive surgery market. Similarly, joint ventures between U.S. refractive surgery firms and Chinese private centers such as Aier may provide mutually beneficial business opportunities.

The B2C market is comprised of the surgeons/centers and patients. Increased patient awareness must occur through creating marketing programs that work within the regulatory limits that prevent direct to consumer advertising for medical procedures. Improved surgeon training programs are needed and should be developed. Private centers that offer refractive surgery procedures provide a significant opportunity to create high returns on investment, but are potentially at risk for changes in government regulations that could limit their ability to do business. Because of this, private centers that offer other services might diversify the risk should regulations occur that are directed at refractive surgery, specifically.

The development of refractive surgery in China is remarkable in that it represents a cash-pay, consumer-focused industry amidst a medical system that is mostly government run. Delivery models for cash-pay services are necessarily different than those for government reimbursed care. The refractive surgery industry’s development must align both B2B and B2C elements to serve to ultimate customer, i.e., the patient. This may present challenges in the context of a government run medical system. With refractive surgery, business practices should be developed to best serve the patient.
THINKING OUTSIDE THE BOX
DISCLOSURES

Guy M. Kezirian, MD, FACS is the President of SurgiVision® Consultants, Inc. of Scottsdale, Arizona. Dr. Kezirian has a long history of involvement with refractive surgery in the United States starting in 1991, when he established the first ophthalmic practice limited to refractive surgery in the United States, SurgiVision® PC. Between 1996 and 2008, Dr. Kezirian administered several of the U.S. FDA trials that led to the approval of LASIK for several laser platforms. Today his company, SurgiVision Consultants, Inc., manufactures the SurgiVision® DataLink software products, which track clinical outcomes and provide surgery planning for refractive surgery and cataract surgery, and comprises one of the largest data registry of ophthalmic data in the world.

Dr. Kezirian has no affiliation with the collaborators of this report (Aier Eye Hospital system, Alcon China, Ltd., Lumenis Ltd, China or the Tongren Hospitals), he has no direct financial interest in the products mentioned in this report and has no financial investments related to the growth of the laser refractive surgery market in China.

None of the other authors of the report have any financial interests in the products mentioned in this report or in the growth of the laser refractive surgery market in China.

APPENDIX 1: DEVELOPMENT OF DATA POINTS FOR TABLE 1

Population Statistics and Calculation of the Treatable Age Group

The population estimates used in this report were obtained from the US Census models and the CIA World Factbook.

There was good agreement among the project collaborators that the vast majority of laser refractive surgery in China occurs in the age range between 18 and 45 years of age. Today, approximately 45.1% of the Chinese population is in this range. Approximately 10% of patients are less than 18 or over 45 years old, and were estimated to contribute an additional 2% of the population.

This sum (47.1%) is used for the model as the percentage of the population that is in the potential candidate pool for refractive surgery. While the exact distribution of ages will vary slightly over time, the impact of the changes on the size of the potential patient pool will be minimal and are not considered here.

* This differs from the US where the median age for laser refractive surgery has drifted down from the low 40’s in 2001 to the mid-thirties today, an observation related to demographic shifts of the population.

† The overall age distribution has been affected by the one-child policy, but the forecasted impact of this policy on the 18-45 year old demographic over the next ten years is relatively minor. A person born in 1970 would be over 40 years old today, so those born under the one-child policy have already aged into the 18 to 45 year range that is most likely to have refractive surgery.
**Percentage with Treatable Refractive Errors**

Estimation of the patient pool provided in Table 1 was based on the determination that 35% of China’s population has treatable refractive errors.

The distribution of refractive errors in the Chinese population has been the focus of a great deal of research in the ophthalmic and optometric literature over the past 20 years. Several issues have been considered: genetic variation between the majority Han and minority populations, regional differences, urban vs. rural location, population density, sex, age and occupation and education levels.

No reliable overall statistic for the incidence of myopia across China was found, and estimates vary widely. On the high side of the estimate range is a study of 5060 Chinese university students in Shanghai found the prevalence of myopic refractive errors to be 95.5%. This supports the commonly cited observation that the incidence of myopia increases with academic achievement. Other reports refute the association. Nevertheless, many references correlated academic achievement with nearsightedness (myopia). One result of the one-child policy has been an increased emphasis on educational achievement in many regions. Whether this will affect the incidence of myopia in the population is uncertain, but what can be inferred is that the laser refractive surgery candidate pool will draw from the more educated segments of the population—a finding consistent with the observations from Aier and Tongren.

In contrast, other studies showed distributions of refractive errors that are more in line with studies published in the western literature from Europe and the United States, with a prevalence of myopia of approximately 35%.

The contribution of age to the development of myopia is well understood. Myopic refractive errors typically manifest prior to puberty and are evident by the age of 21 if they are going to develop. This is one reason why laser refractive surgery is not commonly performed on adolescents and helps explain the 18-45 age range of patients undergoing the procedures.

Both Aier Eye Hospitals report that over 95% of the laser refractive surgery cases performed were for myopic refractive errors, while Tongren reports that the treatment of non-myopic (e.g., hyperopic) refractive errors may be as high as 20%. The figures cited in Table 1 for the percentage of patients with treatable refractive errors was derived from a search of the peer-reviewed literature that yielded over 300 references related to the topic “prevalence of refractive errors in China”. The most relevant citations are included in the References.

* Author’s Note (Guy M. Kezirian, MD, FACS): Whether reading causes myopia is a longstanding controversy in ophthalmology. The observations made in this study are correlations and do not imply causation.
**Average Selling Price (Cost to the Patient) per Eye**

The price of laser refractive surgery varies widely, even within centers, based on the center location, laser technology used, and delivery model (public hospital vs. private center or hospital). Across the Aier centers, prices for both eyes range from ¥2000 to ¥19800 (USD $320 to $3168) based primarily on the regional location of the center and the technology used. The mean price for the basic laser technology procedure averages ¥4263 ± ¥1503 (USD $682 ± $241) and the mean price for the advanced technology procedure is ¥14,993 ± ¥2,764 (USD $2,399 ± $423).‡

Priced in the public Beijing Tongren Eye Hospital were similar, at ¥15,000 (USD $2,400) for both eyes.

For the purposes of this report, an expected price of $750 per eye was used, with a low estimate of $505 and high estimate of $1,250 per eye. The US market has seen price erosion in some areas with price stability occurring at about $1,500 per eye. Further erosion is unlikely due to the level of the fixed and variable costs associated with providing the service. The China laser refractive surgery market has matured to the point where prices seem to have stabilized, but with considerable regional variability. The price point of $1,200 per eye in the public hospital in Beijing is at the high end of the price range.

**Percentage with the required income**

For purposes of this report, 33% of the population was estimated to be able to “afford” laser refractive surgery, with a low and high estimate assigned at 25% and 40%, respectively. These figures were provided by the marketing director from Aier Eye Hospitals.

There are several potential approaches that might be used to determine the affordability of laser refractive surgery to the patient. In the United States, affordability can be estimated as a function of income levels and access to consumer credit, as reliance on consumer credit to pay for laser refractive surgery is common in the United States. In China, at least at present, consumer credit is seldom used to finance laser refractive procedures, as reported by both the Aier Private Eye Hospitals and Tongren Public Eye Hospital. Aier reports that most patients pay for their procedures in cash. However, the one-child policy tends to afford younger people with access to family funds that significantly increase their ability to afford procedures.

The cash-pay basis of the laser refractive surgery market in China is an important difference from the US market. For example, Lasik Plus, the largest US corporate provider of laser refractive services, reports that a “significant number” of patients pay for procedures using external financing and that they

‡ Conversion rate of ¥1 to USD $0.16 was used.
internally finance many patients who are unable to obtain external financing, accounting for 6% of their booked revenues. As mentioned above, both Aier and Tongren report that “nearly all” of their patients pay with cash.

Reliable data about the current income levels of patients undergoing laser refractive surgery was not readily available. Furthermore, direct comparisons of the ratio of the ASP (average selling price) of laser refractive surgery to median income is not helpful, because of the differing cultural norms for use of credit, and the influence of the one-child policy on increasing the disposable income for persons in their twenties.

Nevertheless, the ratio of median household income in the United States in 2009 (approximately $49,000) to laser refractive surgery (ASP of $1,500 per eye) is 32.6 to 1. The ratio of median household income in China in 2009 ($10,220) to laser refractive surgery (ASP of $1000 per eye based on Aier data) is 10.21. By this metric, laser refractive surgery is three times more affordable in the United States than in China.

There is significant regional variation in income levels in China. Figure 5 displays the mean and median personal incomes in urban and rural populations in China in 2011 as reported by the National Bureau of Statistics of China. USD equivalents are overlaid below the Yuan figures. The per-capita figures do not stratify by age and so do not allow the income figures to be compared to the candidate pool for laser refractive surgery. For the urban population, the ratio of personal median income to ASP of laser refractive surgery per patient (two eyes) is 3:1 in China. The comparable number in the United States in 2009 was $21,000 to $1,500, or 14 to 1. By this metric, laser refractive surgery is 4.7 times more affordable in the United States than in China.
In summary, the affordability of laser refractive surgery is very subjective and difficult to assess using objective measures, particularly since no data was forthcoming regarding the income levels of patients currently having the procedures.

**Market Penetration at Saturation**

Refractive surgery markets in the United States appear to grow to a steady state level of penetration within each market area. We use the term “market saturation” to describe this effect.

Market penetration is defined as the annual number of patients having laser refractive surgery compared to the potential candidate pool (patients in the appropriate age range with treatable refractive errors and required disposable income). Market saturation levels in the United States have been observed to vary with consumer confidence as discussed earlier in this report. Saturation occurs at 2.7% in good economic times. Market penetration falls to 1.2% in difficult economic times. The midpoint of these two values (1.95%) was used as the expected saturation penetration for the predication model, as shown in Table 1.

**Years to Market Saturation**

The US market initially achieved saturation within 5 years of LASIK approval by the FDA, which occurred in 1999. The growth of laser refractive surgery in China to date suggests that saturation will take much longer to achieve. Factors mitigating market growth are discussed below.

This projection in Table 1 models growth to saturation. Figure 2 and Table 2 show the CAGR needed to achieve market maturity at different intervals.
APPENDIX 2: SAME CENTER GROWTH RATE ANALYSIS

Data regarding procedure volumes between 2008 and 2012 were provided for 43 of 44 (97.7%) of the Aier Eye Hospital centers. Of these, 28/43 (65.1%) centers had data going back to 2010 to allow for three year analysis, and 16/43 (37.2%) centers had data for all five years. There were 8/43 (18.6%) centers with 2012 data, only.

An analysis was performed regarding year-to-year growth rates on the 35 centers with multi-year data. The following observations were made:

1. All but 4 (31/35, 88.6%) centers showed same-center growth from the first to second years of existence. The mean growth in year 2 over year 1 was 79% ± 108% (range -22% to 467%). Since first-partial year data are not provided, first to second year growth rates probably overestimate the true rates.

2. Of the 28 centers with 3 or more year data through 2012, the year 2012 showed decrease in volume compared with 2011 for 22/28 (78.5%) centers, which may relate to a negative announcement in the media about LASIK by a prominent Taiwanese LASIK surgeon. The 6/28 (21.5%) centers that showed increase in growth for 2012 were located in Haerbin, Tianjin, Shijiazhuang, Nanchong, Chongqing and Shanghai. Four of 6 of these centers (Tianjin, Shijiazhuang, Nanchong and Chongqing) were acquired by Aier and underwent a name change, and this may account for the growth in procedure volumes in 2012 at these sites.

3. The year 2012 is seen as an anomalous year that was affected by the negative Taiwan report about LASIK. Of the 16 centers with data from 2008 – 2011, 10 (62.5%) showed at least one year of flat or negative growth and 6 (37.5%) showed positive growth each year. Overall growth in 2011 in all 16 of these “mature” centers (in existence at least 3 years) over 2010 was 11.9% ± 13.5% (range -3% to 37.8%).

The 11.9% ± 13.5% (-1.6% to 25.4%) figure is taken as the expected annual growth in a mature center for the model, and agrees very well with the 11.75% expected CAGR forecast for the overall market that is put forward by this model.
**REFERENCES**

i. Source: SurgiVision® Consultants, Inc., in collaboration with Alcon Laboratories, Inc.

ii. Procedure volume estimates are based on data collected for this report and were collaborated from among three sources: Alcon (China) Ophthalmic Product Co., Ltd., Aier Eye Hospitals and Lumenis Ltd., China.

iii. The rate of LASIK vs. PRK in China was based on data obtained from the Aier Eye Hospital system in China. The 81% for the US market is based on the SurgiVision® DataLink registry data in an analysis of 650,000 eyes operated over the past 5 years (SurgiVision® Consultants, Inc., private communication).


ix. US Census Bureau International Data. [http://www.census.gov/population/international/data/db/region.php?N=%20Results%20&T=13&A=separate&RT=0&Y=2022&R=-1&C=CH](http://www.census.gov/population/international/data/db/region.php?N=%20Results%20&T=13&A=separate&RT=0&Y=2022&R=-1&C=CH)


xvii. Novartis, China. Personal correspondence.

xviii. Based on data provided by Alcon (China) Ophthalmic Product Co., Ltd.


xxv. Robert O. Weagley, Ph.D., CFP(r) Chair, Personal Financial Planning University of Missouri Columbia, MO 65211, citing the Survey of Chinese Consumer Finances, collected by Tsinghua University and funded by Citibank (China) Co., Ltd.

