The 2016-2021 Outlook for Lithium-Ion Batteries for Plug-In Hybrid and Pure Electric Vehicles in Greater China

Description: What is Latent Demand And The P.I.E.?

The concept of latent demand is rather subtle. The term latent typically refers to something that is dormant, not observable, or not yet realized. Demand is the notion of an economic quantity that a target population or market requires under different assumptions of P.I.E. quality, and distribution, among other factors. Latent demand, therefore, is commonly defined by economists as the industry earnings of a market when that market becomes accessible and attractive to serve by competing firms. It is a measure, therefore, of potential industry earnings (P.I.E.) or total revenues (not profit) if Greater China is served in an efficient manner. It is typically expressed as the total revenues potentially extracted by firms. The “market” is defined at a given level in the value chain. There can be latent demand at the retail level, at the wholesale level, the manufacturing level, and the raw materials level (the P.I.E. of higher levels of the value chain being always smaller than the P.I.E. of levels at lower levels of the same value chain, assuming all levels maintain minimum profitability).

The latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles in Greater China is not actual or historic sales. Nor is latent demand future sales. In fact, latent demand can be either lower or higher than actual sales if a market is inefficient (i.e., not representative of relatively competitive levels). Inefficiencies arise from a number of factors, including the lack of international openness, cultural barriers to consumption, regulations, and cartel-like behavior on the part of firms. In general, however, latent demand is typically larger than actual sales in a market.

For reasons discussed later, this report does not consider the notion of “unit quantities”, only total latent revenues (i.e., a calculation of P.I.E. times quantity is never made, though one is implied). The units used in this report are U.S. dollars not adjusted for inflation (i.e., the figures incorporate inflationary trends). If inflation rates vary in a substantial way compared to recent experience, actually sales can also exceed latent demand (not adjusted for inflation). On the other hand, latent demand can be typically higher than actual sales as there are often distribution inefficiencies that reduce actual sales below the level of latent demand.

As mentioned in the introduction, this study is strategic in nature, taking an aggregate and long-run view, irrespective of the players or products involved. In fact, all the current products or services on the market can cease to exist in their present form (i.e., at a brand-, R&D specification, or corporate-image level) and all the players can be replaced by other firms (i.e., via exits, entries, mergers, bankruptcies, etc.), and there will still be latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles at the aggregate level. Product and service offerings, and the actual identity of the players involved, while important for certain issues, are relatively unimportant for estimates of latent demand.

In order to estimate the latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles across the regions and cities of Greater China, I used a multi-stage approach. Before applying the approach, one needs a basic theory from which such estimates are created. In this case, I heavily rely on the use of certain basic economic assumptions. In particular, there is an assumption governing the shape and type of aggregate latent demand functions. Latent demand functions relate the income of a region, city, household, or individual to realized consumption. Latent demand (often realized as consumption when an industry is efficient), at any level of the value chain, takes place if an equilibrium is realized. For firms to serve a market, they must perceive a latent demand and be able to serve that demand at a minimal return. The single most important variable determining consumption, assuming latent demand exists, is income (or other financial resources at higher levels of the value chain). Other factors that can pivot or shape demand curves include external or exogenous shocks (i.e., business cycles), and or changes in utility for the product in question.

Ignoring, for the moment, exogenous shocks and variations in utility across geographies, the aggregate relation between income and consumption has been a central theme in economics. The figure below concisely summarizes one aspect of problem. In the 1930s, John Meynard Keynes conjectured that as incomes rise, the average propensity to consume would fall. The average propensity to consume is the level of consumption divided by the level of income, or the slope of the line from the origin to the consumption function. He estimated this relationship empirically and found it to be true in the short-run (mostly based on
cross-sectional data). The higher the income, the lower the average propensity to consume. This type of consumption function is labeled "A" in the figure below (note the rather flat slope of the curve). In the 1940s, another macroeconomist, Simon Kuznets, estimated long-run consumption functions which indicated that the marginal propensity to consume was rather constant (using time series data). This type of consumption function is shown as "B" in the figure below (note the higher slope and zero-zero intercept). The average propensity to consume is constant.

Is it declining or is it constant? A number of other economists, notably Franco Modigliani and Milton Friedman, in the 1950s (and Irving Fisher earlier), explained why the two functions were different using various assumptions on intertemporal budget constraints, savings, and wealth. The shorter the time horizon, the more consumption can depend on wealth (earned in previous years) and business cycles. In the long-run, however, the propensity to consume is more constant. Similarly, in the long run, households with no income eventually have no consumption (wealth is depleted). While the debate surrounding beliefs about how income and consumption are related is interesting, in this study a very particular school of thought is adopted. In particular, we are considering the latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles across the regions and cities of Greater China. The smallest cities have few inhabitants. I assume that all of these cities fall along a "long-run" aggregate consumption function. This long-run function applies despite some of these states having wealth; current income dominates the latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles. So, latent demand in the long-run has a zero intercept. However, I allow different propensities to consume (including being on consumption functions with differing slopes, which can account for differences in industrial organization, and end-user preferences).

Methodology: used to create the latent demand estimates for lithium-ion batteries for plug-in hybrid and pure electric vehicles in Greater China. Since the author has asked me to apply this methodology to a large number of categories, the rather academic discussion below is general and can be applied to a wide variety of categories and geographic locations, not just lithium-ion batteries for plug-in hybrid and pure electric vehicles in Greater China.

Step 1. Product Definition and Data Collection

Any study of latent demand requires that some standard be established to define "efficiently served". Having implemented various alternatives and matched these with market outcomes, I have found that the optimal approach is to assume that certain key indicators are more likely to reflect efficiency than others. These indicators are given greater weight than others in the estimation of latent demand compared to others for which no known data are available. Of the many alternatives, I have found the assumption that the highest aggregate income and highest income-per-capita markets reflect the best standards for "efficiency". High aggregate income alone is not sufficient (i.e. some cities have high aggregate income, but low income per capita and can not assumed to be efficient). Aggregate income can be operationalized in a number of ways, including gross domestic product (for industrial categories), or total disposable income (for household categories; population times average income per capita, or number of households times average household income).

Latent demand is therefore estimated using data collected for relatively efficient markets from independent data sources (e.g. Official Chinese Agencies, the World Resources Institute, the Organization for Economic Cooperation and Development, various agencies from the United Nations, industry trade associations, the International Monetary Fund, Euromonitor, Mintel, Thomson Financial Services, the U.S. Industrial Outlook, and the World Bank). Depending on original data sources used, the definition of "lithium-ion batteries for plug-in hybrid and pure electric vehicles" is established. In the case of this report, the data were reported at the aggregate level, with no further breakdown or definition. In other words, any potential product or service that might be incorporated within lithium-ion batteries for plug-in hybrid and pure electric vehicles falls under this category. Public sources rarely report data at the disaggregated level in order to protect private information from individual firms that might dominate a specific product-market. These sources will therefore aggregate across components of a category and report only the aggregate to the public. While private data are certainly available, this report only relies on public data at the aggregate level without reliance on the summation of various category components. In other words, this report does not aggregate a number of components to arrive at the "whole". Rather, it starts with the "whole", and estimates the whole for all regions and cities in Greater China (without needing to know the specific parts that went into the whole in the first place).

Given this caveat, in this report we define the sales of lithium-ion batteries for plug-in hybrid and pure electric vehicles as including all commonly understood products falling within this broad category, irrespective of product packaging, formulation, size, or form. Companies participating in this industry
include Panasonic EV Energy, Toyota, Matsushita, Automotive Energy Supply, and Nissan. In addition to the sources indicated below, additional information available to the public via news and/or press releases published by players in the industry (including reports from AMR Research, Global Industry Analysts, Forrester Research, Frost & Sullivan, Gartner, IDC, and MarketResearch.com) was considered in defining and calibrating this category. All figures are in a common currency (U.S. dollars, millions) and are not adjusted for inflation (i.e., they are current values). Exchange rates used to convert to U.S. dollars are averages for the year in question. Future exchange rates are assumed to be constant in the future at the current level (the average of the year of this publication's release in 2015).

Step 2. Filtering and Smoothing

Based on the aggregate view of lithium-ion batteries for plug-in hybrid and pure electric vehicles as defined above, data were then collected for as many geographic locations as possible for that same definition, at the same level of the value chain. This generates a convenience sample of indicators from which comparable figures are available. If the series in question do not reflect the same accounting period, then adjustments are made. In order to eliminate short-term effects of business cycles, the series are smoothed using a 2 year moving average weighting scheme (longer weighting schemes do not substantially change the results). If data are available for a geographic region, but these reflect short-run aberrations due to exogenous shocks (such as would be the case of beef sales in a region or city stricken with foot and mouth disease), these observations were dropped or "filtered" from the analysis.

Step 3. Filling in Missing Values

In some cases, data are available on a sporadic basis. In other cases, data may be available for only one year. From a Bayesian perspective, these observations should be given greatest weight in estimating missing years. Assuming that other factors are held constant, the missing years are extrapolated using changes and growth in aggregate national, regional and city-level income. Based on the overriding philosophy of a long-run consumption function (defined earlier), regions and cities which have missing data for any given year, are estimated based on historical dynamics of aggregate income for that geographic entity.

Step 4. Varying Parameter, Non-linear Estimation

Given the data available from the first three steps, the latent demand is estimated using a "varying-parameter cross-sectionally pooled time series model". Simply stated, the effect of income on latent demand is assumed to be constant unless there is empirical evidence to suggest that this effect varies (i.e., the slope of the income effect is not necessarily same for all regions or cities). This assumption applies along the aggregate consumption function, but also over time (i.e., not all regions or cities in Greater China are perceived to have the same income growth prospects over time). Another way of looking at this is to say that latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles is more likely to be similar across regions or cities that have similar characteristics in terms of economic development.

This approach is useful across geographic regions for which some notion of non-linearity exists in the aggregate cross-region consumption function. For some categories, however, the reader must realize that the numbers will reflect a region's or city's contribution to latent demand in Greater China and may never be realized in the form of local sales.

Step 5. Fixed-Parameter Linear Estimation

Nonlinearities are assumed in cases where filtered data exist along the aggregate consumption function. Because Greater China consists of more than 1000 cities, there will always be those cities, especially toward the bottom of the consumption function, where non-linear estimation is simply not possible. For these cities, equilibrium latent demand is assumed to be perfectly parametric and not a function of wealth (i.e., a city's stock of income), but a function of current income (a city's flow of income). In the long run, if a state has no current income, the latent demand for lithium-ion batteries for plug-in hybrid and pure electric vehicles is assumed to approach zero. The assumption is that wealth stocks fall rapidly to zero if flow income falls to zero (i.e., cities which earn low levels of income will not use their savings, in the long run, to demand lithium-ion batteries for plug-in hybrid and pure electric vehicles). In a graphical sense, for low income cities, latent demand approaches zero in a parametric linear fashion with a zero-zero intercept. In this stage of the estimation procedure, a low-income city is assumed to have a latent demand proportional to its income, based on the cities closest to it on the aggregate consumption function.

Step 6. Aggregation and Benchmarking
Based on the models described above, latent demand figures are estimated for all cities in Greater China. These are then aggregated to get regional totals. This report considers a city as a part of the regional and national market. The purpose is to understand the density of demand within a region and the extent to which a city might be used as a point of distribution within its region. From an economic perspective, however, a city does not represent a population within rigid geographical boundaries. To an economist or strategic planner, a city represents an area of dominant influence over markets in adjacent areas. This influence varies from one industry to another, but also from one period of time to another. I allocate latent demand across areas of dominant influence based on the relative economic importance of cities within its region. Not all cities (e.g. the smaller villages) are estimated within each region as demand may be allocated to adjacent areas of influence. Since some cities have higher economic wealth than others within the same state, a city's population is not generally used to allocate latent demand. Rather, the level of economic activity of the city vis-à-vis others is used. Figures are rounded, so minor inconsistencies may exist across tables.

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