Summary

Traditional Retail Distribution in Megacities

This dissertation analytically explores traditional retail distribution, entailing a special retail format – nanostores – existing in large numbers in emerging-market megacities. As the dominant retail format in many emerging-market megacities, nanostores contribute substantial profits to CPG suppliers. Under CPG suppliers' direct channel distribution, we study the sales effort policy in Chapter 2 and study the pricing and sales visit strategies in Chapter 3. In Chapter 4, we address the trade-off between the direct and wholesale channel distribution and study the channel distribution policy in a demand growth setting. In Chapter 5, we study the network capacity strategy of on-demand retail platforms to trade off the late order delivery refund cost and network maintenance cost. Finally, we predict the fate of nanostores in the coming decades and also pose relevant potential research topics in Chapter 6.

Selling to Nanostores

Chapter 2 investigates the sales effort strategy for a CPG supplier selling a perishable product to a nanostore over a finite time horizon. Nanostores have a sales chasing ordering tendency to under (over)-order when the previous period's sales are low (high), which leads to undesired lost sales (excessive outdated inventory disposal cost). To combat these negative consequences, in practice, CPG suppliers dispatch sales representatives to convince nanostores to order more (less) than nanostores' base order level, which incurs a fixed and a variable convincing-up (down) costs where the variable component is convexly increasing in the convincing effort.

We model the sales effort problem as a Markov Decision Process to trade-off the benefits and costs of exerting sales effort. We show a variety of optimal sales effort policies under different conditions. When the gross marginal return of exerting convincing-up effort is always nonnegative, with zero fixed costs, a Generalized Base Stock Policy is optimal. With positive fixed costs, a Generalized (s_t, S_t) Policy is optimal under a convex variable cost, subject to some technical conditions. When the gross marginal return of exerting convincing-up effort is only positive for small base order levels, with zero fixed costs, a Generalized Target Interval Policy

is optimal. With two-sided fixed costs, we define and develop the new notions of Backward-K^D-Concavity and Bidirectional-(K^U, K^D)-Concavity and characterize the $(s_t^U, S_t^U, S_t^D, s_t^D)$ Policy under some technical conditions.

Competing for Nanostores

Chapter 3 investigates the pricing and sales visit strategies of two CPG suppliers who each sell a non-perishable product to a nanostore over an infinite time horizon. These two CPG suppliers are in competition for cash and/or shelf space of the nanostore who is known to be limited in both assets. Nanostore owners use the revenue of selling CPG products to pay for their family's subsistence needs and use the rest to replenish inventories. They are able to survive as long as the profits they earn can finance their family's subsistence needs. We show that the suppliers should price their products and schedule their sales visits such that the profit rate the nanostore earns covers exactly his family's subsistence needs. This implies a co-prosperity relationship between CPG suppliers and nanostores such that suppliers' profitability to sell to nanostores bundles with nanostores' long-run survival.

Interestingly, when the two suppliers compete only for cash, they can mutually benefit from each other in that they contribute two sources of revenue to render the nanostore more likely to earn a sufficient profit rate to finance his family's subsistence needs. This also applies to the case when the two suppliers compete for both cash and shelf space as long as the benefit of forming a duopoly dominates the gain of monopolizing the market. However, when the reverse happens, one supplier can choose to drive his counterpart out of the market and acquire his counterpart's demand through product substitution.

Supplying to Nanostores

Chapter 4 investigates the distribution channel selection of a CPG supplier selling a nonperishable product to a cluster of nanostores located in a rectangular region over a finite time horizon. We model that the CPG supplier can switch between the wholesale and the direct channel over the time horizon. Using the direct channel grows the market demand at a faster rate, however, incurs higher logistics costs than using the wholesale channel. Therefore, the supplier needs to trade-off the logistics costs and the demand growth potential when selecting the distribution channel policy over the time horizon.

With the assumption of deterministic demand growth, we show that there is at most one channel switch over the entire time horizon. The supplier uses the wholesale channel over the entire horizon to save on the logistics costs and uses the direct channel over the entire horizon to take use of its high demand growth potential. In case of channel switch, the supplier begins to use the direct channel to grow the market in order to switch to a more profitable wholesale channel; the supplier begins to resort to wholesale in order to build up a decent market size so that an excessive profit loss can be avoided when using the direct channel from the beginning. We also show that the supplier should devote more time to use the direct channel when the time horizon is longer since a longer horizon gives the direct channel more opportunity to realize its demand growth potential.

Connecting through Nanostores

Chapter 5 investigates the network capacity strategy of an on-demand retail platform which sells a product to consumers through nanostores over an infinite time horizon. In recent years, tens of thousands of nanostores have been recruited by on-demand retail platforms including Beequick in Beijing as inventory stocking locations and online consumer order delivery force. These platforms promise to deliver each consumer order within a certain amount of time and incur a refund cost if they fail to do so. When the platforms operate a network with a higher nanostore density(i.e., network capacity), each consumer order is more likely to be delivered on time and, as a result, the late delivery refund cost is lower. However, as a negative side, the platforms need to incur a higher cost to maintain a network with a higher nanostore density.

In Chapter 5, we model a location based demand-supply match policy where each consumer's order is assigned to the consumer's nearest nanostore whose delivery staff is available. We model the locations of consumers and nanostores according to two independent Poisson point processes, based on which, we approximate the consumer order late fulfillment probability. We show that there exists a unique optimal nanostore density, which is first nondecreasing then nonincreasing in the order fulfillment time guarantee. We also show that it is optimal not to sell to the consumers when the consumer density does not reach a sufficient size or gets beyond a threshold such that the delivery system becomes unstable.

The future of nanostores and the future research

In Chapter 6, we argue that nanostores target a distinct type of consumer or consumer demand of all other retail formats. We claim that nanostores are very adaptive and CPG suppliers are in a co-prosperity relationship with nanostores. We also opine that traditional retail operations is very likely to overcome the increasing logistics and real estate costs while the emergence omnichannel operations brings a new source of income to nanostores. Based on these, we predict that nanostores have great potential to adapt to new retail environment in the coming decades and they may even prosper in future omnichannel operations.

As an extension of this dissertation, relevant research directions with great potential include *traditional and modern retail competition* which addresses the interaction between nanostores, supermarkets and CPG suppliers, *nanostores in omnichannel operations* which addresses the collaboration of nanostores with conventional e-commerce companies and omnichannel operators and *traditional retail operations strategies and nanostore welfare* which are not covered in this dissertation.