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An Economic Model of the Evolution of Food Retail and Supply Chains from Traditional Shops to Supermarkets to e-Commerce¹

Liang Lu¹ and Thomas Reardon²

¹Department of Agricultural Economics and Rural Sociology, University of Idaho

²Department of Agricultural, Food, and Resource Economics, Michigan State University

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¹ Liang Lu is Assistant Professor in the Department of Agricultural Economics and Rural Sociology, University of Idaho. Thomas Reardon is Professor in the Department of Agricultural, Food, and Resource Economics, Michigan State University. Lu thanks Idaho Agricultural Experiment Station for funding. Reardon thanks USAID via the Food Security Policy Innovation Laboratory at Michigan State University for funding. Correspondence should be sent to Liang Lu at llu@uidaho.edu.

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Abstract

Food retail has been in continuous evolution for the past century, both in developing and developed countries: from local traditional stores to supermarkets to e-commerce. In this paper we analyze the evolution of food retail by building a store choice equilibrium model and provide an illustrated discussion. The patterns in retail in any given time and place of different types of stores (such as traditional shops, supermarkets, and online e-commerce) depend on two main factors. The first are consumers' characteristics such as income, tastes, and travel costs of going to different stores and/or shipping costs if purchasing online. The second are the stores' cost structures, which include item costs from upstream producers, the costs of procurement supply chains (beyond the cost of the item) for perishable items, and the costs of in-store storage. We show under what conditions in equilibrium the different retail types exist and which can become dominant, and what types of goods (dry packaged foods versus perishables) are distributed by what type of retailers.

Keywords: Traditional retail, Supermarkets, e-Commerce, Supply Chains

JEL Classification Numbers: Q12, Q18.

Introduction

Retail has been evolving rapidly for the past century, first in the developed regions (such as the US and Western Europe), and then recently in the developing regions (of Asia, Africa, and Latin America). The evolution in each region has typically occurred in two transitions, from traditional shops/wet markets to supermarkets, and from supermarkets to the emergence of e-commerce. In each of these two transitions there has been concern among retail analysts and policymakers that one type of retail would fully dominate as a “corner solution” and push out the other retail types, or one would dominate and block the emergence of the next stage. Examples of expressions of and research on these concerns include: (1) supermarkets out-competing and eliminating traditional dry, packaged foods shops (as in Chile, Faiguenbaum, Berdegué, and Reardon 2002); (2) wet markets out-competing supermarkets forestalling the development of the latter (as in Thailand, Gorton, Sauer, and Supatpongkul 2011); (3) large supermarket chains pushing out independent supermarkets and traditional shops as in Brazil, Farina, Nunes, and Monteiro (2005); or (4) e-commerce capturing increasing share from “brick and mortar” supermarket chains, such as in non-food durables in the US (Bakos 2001). While the hypothesis, even concern, underlying these strands of research was that a single retail type would dominate, the actual situation has continuously showed a mix of retail types, albeit with “moving averages” of retail type composition. For example, in the Chile case, small general food shops did indeed disappear rapidly over the 1990s as they had in most of the US earlier in the century. In Thailand, against predictions, supermarkets have rapidly gained share against traditional wet markets. In developing countries in general, supermarkets gained rapidly against small traditional shops, contrary to earlier predictions (Reardon et al. 2003). In the US, while e-commerce has rapidly grown to reach 11.7% of total US retail (Zaroban 2017), it appears that there will be a long period in which supermarkets survive, and even emerging signs that e-commerce will develop a link to supermarkets as in the recent case of the acquisition of Whole Foods by Amazon.

The rapid evolution of retail types, combined with the dynamic and mixed composition of retail types over time, has been the grist of a continuous retail empirical literature, especially for

traditional retail and supermarkets, and now emerging for e-commerce. However, while a *priori* economists would expect that with heterogeneity in the characteristics of retail types as well as consumers, and in the transaction costs that consumers must face to shop at retailers, there has been no systematic formal model in the agricultural economics literature analyzing the conditions determining the evolution of the three types of retail, nor the empirical outcome at any given time and in any given place, of the pattern of composition of retail types and consumer choices. Therefore, the aim of this paper is to create and present such a general model that would account for the observed retail patterns, and generate propositions with illustrations of them. Further, we contribute by laying out the path of evolution of the three retail types.

Background

Urban food retail has been in continuous evolution for the past century, first in the US and Western Europe, and recently in today's developing regions in Africa, Asia, and Latin America. This evolution has come in four waves.

First, retail traditionally in all these regions has been composed of small local shops and market stalls selling dry goods and perishable products. Consumers shopped at these outlets near their residences and did so frequently, facing low transaction costs, storing little, buying the limited set of products on offer, meeting their needs for several days at a time.

Second, in the 1920s to 1940s in the US and Western Europe, and in the 1980s/1990s in developing areas, supermarkets emerged and in each region after several decades diffused rapidly. Supermarkets initially offered dry goods, food and non-food, procured with economies of scale in order to sell cheaply. In both sets of regions, supermarkets out-competed small dry goods stores, "mom & pop shops", general stores, and in large numbers these exited. Those in the densest areas survived by dint of convenience until modern convenience store chains, also depending on economies of scale of procurement, undercut those. Gradually supermarket chains overcame procurement and storage hurdles and penetrated perishable foods markets. Late in the supermarket diffusion path they drove a reduction in the market share of produce shops and butchers, wet mar-

kets and dairy stores. By having great diversity of products, economies of scope, supermarkets and hypermarkets became one-stop-shops for consumers to buy dry packaged foods, and buy and store in their new refrigerators perishable foods. By the mid-2000s, supermarkets nearly fully ruled food retail in developed countries, and had a large and rapidly growing share in developing countries, and there appeared no glint of challenge on the horizon.

Third, however, a challenge to supermarkets and the remaining traditional shops did indeed arise, in the form of the rapid rise of e-commerce in the late 2000s and 2010s. Giants like Amazon, and emerging giants such as Alibaba, combined and even extended the advantages of economies of scale and scope that the supermarkets had successfully brought to bear in their combat with the traditional shops, and e-commerce immediately bested supermarkets by reducing transaction costs to consumers – allowing ordering on-line and delivering the products to their home, at the time gaps in supermarket services. But e-commerce firms soon discovered they too had a weakness, the lack of “brick and mortar” sites for tangible observation of products.

Fourth, with the two sets of competitors recently aware of each other’s Achilles Heel, supermarket chains have been moving quickly to add e-commerce, and e-commerce firms, to acquire brick and mortar outlets, such as Amazon’s acquisition of Whole Foods, and Alibaba’s of part of the Auchan and RT Mart chains in China.

There is a substantial literature (Reardon, Timmer, and Minten 2012, Reardon et al. 2003 for example) documenting the evolution of retail innovations from small shops to supermarkets, and an emerging discussion on the transition to yet another retail innovation, e-commerce. The literature has analyzed the retail evolution, and the underlying economics of the choices by consumers and firms, only partially, emphasizing one or other aspect but not conceiving of the evolution as a moving general equilibrium. The retail and supply chain management literature has focused on management system and product composition choices to supply particular consumer segments, such as procurement system efficiency to retail “everyday low price” food to poor and lower middle class consumers, or quality assurance to retail differentiated quality products to the middle and upper income consumers. The economic geography and consumer behavior literature (Ellickson

and Grieco 2013 for instance) have analyzed supermarket diffusion and location dynamics, and consumers' shopping location cum channel decisions. The trade press has breathlessly followed the sudden emergence of e-commerce and speculated as to the exact nature of its challenge to supermarkets.

As we note above, the existing literature has mainly analyzed descriptively the retail evolution, but has not yet conceptualized in an integrated way the evolution from the viewpoint of economic theory. The literature is lacking a coherent framework that analyzes how economic forces, which include changes in technology of production as well as the technology and organization of retail, and income growth and consumer preferences led to the retail evolution and its outcome of fundamental transformations of supply chains and consumer shopping patterns. Such a framework is important as we try to assess and predict further changes in the structure of food retailing, such as how the emerging e-commerce will cause changes in food supply chains. The purpose of this paper is to provide such a framework. It relies on the idea that radical innovations result in new supply chains and marketing arrangements (Zilberman, Lu, and Reardon 2017), and we develop a model that relies on basic ideas of comparative advantage, urban economics, and supply chain and production economics.

Our framework utilizes the well established "continuum of goods" model to build the conceptual framework of market equilibrium of store type existence and types of products carried at different stores. The continuum of goods model was first developed by Dornbusch, Fischer, and Samuelson (1977) and further expanded in Melitz (2003) as well as others. We adopt this framework with several considerations: first, the main feature of Dornbusch, Fischer, and Samuelson (1977) and Melitz (2003), in the context of international trade, is to predict which country should be specialized in producing what. In our context, the essential question is no different: which store type will serve what consumer segments and which retail type should be carrying what items. The main conclusion of our paper is thus similar to those papers: stores will be specialized in carrying items according to their comparative advantage where the source of advantage may be coming from lower perishables procurement costs, lower costs of storage, and/or higher bargaining power

over the upstream. Second, the reason that [Melitz \(2003\)](#) is widely used in trade literature is that it provides a general yet very flexible model so that it is convenient to expand the model in many ways. In our main model, we expand the [Melitz \(2003\)](#) model by introducing the discrete choice of consumers- at which store types to purchase the commodities. This can be viewed as a combination of the [Melitz \(2003\)](#) and the [Just and Zilberman \(1983\)](#) model. Moreover, in our discussion, we outline a few ways to expand our main model to address several new trends.

Store Choice Equilibrium

Demand

Consider a representative consumer's problem. The consumer faces a discrete and a continuous choice problem: the discrete choice is at which store (type) to shop to and the continuous choice is how much of each good to purchase at each store type. To characterize the first choice, we assume that there are two types of stores. We use superscript j ($j = 1, 2$) to denote the two stores types, which for simplicity we will call stores. If the consumer chooses to shop at store j , he/she incurs a fixed travel time cost t^j . The consumer could also shop at both stores and incur a travel cost of $t^1 + t^2$. Without loss of generality, we assume that $t^1 < t^2$. That is, store 2 is further away from the consumer than store 1. For example, store 1 can be a small traditional shop that is close to the consumer's residence and store 2 is a supermarket that is far away from the consumer.

To capture the general properties of the consumer's problem, yet keep the solution tractable, we adopt the continuum of goods framework as noted above. Following [Melitz \(2003\)](#), we assume that there is a continuum of goods and we index the commodities on an interval $[0, N]$. Each $\omega \in [0, N]$ represents a type of commodity. We use $x(\omega)$ to denote the consumer's consumption of commodity ω . Since the consumer may purchase this good from store 1 ($x^1(\omega)$) or from store 2 ($x^2(\omega)$), we must have $x(\omega) = x^1(\omega) + x^2(\omega)$. Again, following [Melitz \(2003\)](#), the preferences of the consumer are given by a C.E.S utility function:

$$(1) \quad U = \left[\int_0^N (x^1(\omega) + x^2(\omega))^{\rho} d\omega \right]^{1/\rho},$$

where the elasticity of substitution between two goods is given by $\sigma = \frac{1}{1-\rho}$. The price of each commodity ω at store j is $p^j(\omega)$. Note that, due to travel cost, the law of one price may not necessarily hold in this model: a consumer may choose to buy the goods at a higher price at the local store to avoid travel cost. We use the price ratio, $r(\omega) = \frac{p^1(\omega)}{p^2(\omega)}$, at the two stores to rank the commodities. For any two commodities $\omega_1, \omega_2 \in [0, N]$, a higher index of ω ($\omega_1 < \omega_2$) indicates higher relative price at store 1. That is $r(\omega_1) \leq r(\omega_2)$. Immediately, we know that $r(0) > 1$ means that all the products sold at store 1 are more expensive than store 2 and $r(N) < 1$ indicates that all of the goods are cheaper at store 1.

Let I be the consumer's total income. Then the consumer's budget constraint can be written as:

$$(2) \quad \int_0^N [p^1(\omega)x^1(\omega) + p^2(\omega)x^2(\omega)]d\omega \leq I - t^1 \cdot \mathbb{1}_{x^1 > 0} - t^2 \cdot \mathbb{1}_{x^2 > 0},$$

where $\mathbb{1}_{x^j > 0}$ is an indicator function that equals one if the consumer purchases some good at store j and equals zero otherwise. The budget constraint can be decomposed into the following:

$$(3) \quad \begin{aligned} (a) \quad & \int_0^N p^1(\omega)x^1(\omega)d\omega \leq I - t^1 & \text{if } x^2 = 0; \\ (b) \quad & \int_0^N p^2(\omega)x^2(\omega)d\omega \leq I - t^2 & \text{if } x^1 = 0; \\ (c) \quad & \int_0^N [p^1(\omega)x^1(\omega) + p^2(\omega)x^2(\omega)]d\omega \leq I - t^1 - t^2, & \text{if } x^1, x^2 > 0 \end{aligned}$$

The budget constraint is essentially saying that there are three possible types of budget constraints that this consumer faces: a) if the consumer only purchases items from store 1. In this case, the consumer's travel cost is t^1 ; b) the consumer buys everything from store 2 and incurs the travel cost of t^2 ; c) the consumer goes to both of the two stores and pays a travel cost of $t^1 + t^2$.

Note a few things from the setup: a) In general, if there are J types of stores, then there are $(2^J - 1)$ possible different constraints for the consumer. b) The consumer's problem is a classical discrete/continuous choice problem. As discussed in [Just and Zilberman \(1983\)](#) and [Hanemann](#)

(1984), the problem can be solved in a two stage optimization: first, the consumer chooses the best consumption bundle when faced by constraint j ; second, the consumer searches for the highest indirect utility among the $2^J - 1$ discrete constraints (see Zilberman and Liu 2011 for more details).

c) When the consumer chooses to buy from more than one store, and if $x(\omega)$ is offered at both stores, then $x^1(\omega)$ and $x^2(\omega)$ are perfect substitutes.

Before we proceed with characterizing the properties of the consumer's demand functions, it is useful to introduce a price index as suggested in Dixit and Stiglitz (1977) and a lemma. In particular, the price index for store j is defined to be:

$$(4) \quad P^j = \left[\int_0^N p^j(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}.$$

The price index is frequently used in the trade literature as a measure of the cost of living in a country. In our model, the price index for store j can be deemed as a measure of purchasing power at store j . That is, lower P^j indicates that prices are overall lower at store j . In a similar fashion, we can define the price index, denoted by P^m , for a consumer who visits both stores.

$$(5) \quad P^m = \left[\int_{r(\omega) \leq 1} p^1(\omega)^{1-\sigma} d\omega + \int_{r(\omega) > 1} p^2(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}.$$

P^m is constructed by comparing the price of each item ω at both stores: if store 1 sells a certain product cheaper than store 2, then $r(\omega) < 1$ and the consumer would purchase product ω at store 1 and face price $p^1(\omega)$. Once we have integrated the price index over all the products such that $r(\omega) < 1$, the rest of the products will be purchased at store 2. There are two properties of P^m worth mentioning here: first, by definition, $P^m \leq \min(P^1, P^2)$ as P^m uses the lower price of each type of good to build the index. Second, P^m will be very close to the price index at store j P^j if there are not sufficient types of goods such that the other store can offer cheaper prices or the price difference is not sufficiently large.

One of the natural questions in the model is when would a consumer visit both stores instead of going to only one of them. The following lemma develops the necessary conditions.

Lemma 1 *If $r(N) < 1$, then a consumer would only visit store 1. If $r(0) > 1$, then there exists a \bar{t} such that a consumer would only visit store 1 if $t^2 > \bar{t}$ and only visit store 2 if $t^2 < \bar{t}$. In particular, the threshold travel cost \bar{t} is given by:*

$$(6) \quad \bar{t} = (1 - R)I + R \cdot t^1,$$

where $R = \frac{P^2}{P^1} = \frac{[\int_0^N p^2(\omega)^{1-\sigma} d\omega]^{\frac{1}{1-\sigma}}}{[\int_0^N p^1(\omega)^{1-\sigma} d\omega]^{\frac{1}{1-\sigma}}}$ is the price index ratio.

Proof: See appendix A(1)

Lemmas 1 is essentially saying that: if the prices of all goods are cheaper at store 1 (i.e., $P^m = P^1$), then the consumer will not have any incentive to go to store two. Likewise, if the price of all goods at store 2 are lower (i.e., $P^m = P^2$), then the consumer will perform a benefit-cost analysis: if the benefit of cost savings at store 2 outweighs the travel cost, then the consumer will go to store 2 only. Meanwhile, the threshold travel cost to visit store 2, \bar{t} , depends on the following items: the overall cost-savings due to lower prices $\frac{P^2}{P^1}$, income level I , and the travel cost to the first store t^1 . Moreover, when the price index is much lower at store 2 ($R \rightarrow 0$), income is the dominant factor in determining \bar{t} ; when the price index at store 2 is very close to the price index at store 1 ($R \rightarrow 1$), the travel cost to store 1 is the dominant factor in determining \bar{t} .

Lemma 1 also suggests that the only reason for the consumer to visit both stores is that there are some goods sold cheaper at store 1 and other goods sold cheaper at store 2. Therefore, *the additional travel cost to another store can be viewed as an entry fee to get access to lower priced goods at the other store.*

Given that $r(0) < 1$ and $r(N) > 1$, the following proposition characterizes the optimal store choice and demand function $x(\omega)$:

Proposition 1 *A consumer will visit both stores if the following two inequalities are satisfied:*

$$(7) \quad \begin{aligned} t^2 &< (1 - \frac{P^m}{P^1})(I - t^1), \\ t^1 &< (1 - \frac{P^m}{P^2})(I - t^2). \end{aligned}$$

Furthermore, the demand for each type of good ω is given by:

$$(8) \quad x(\omega) = \begin{cases} \left(\frac{p^1(\omega)}{P^m}\right)^{-\sigma} \frac{I - t^1 - t^2}{P^m} & \text{if } r(\omega) < 1, \\ \left(\frac{p^2(\omega)}{P^m}\right)^{-\sigma} \frac{I - t^1 - t^2}{P^m} & \text{if } r(\omega) > 1. \end{cases}$$

Proof: See appendix A(2)

This proposition illustrates the consumer's optimal choice of stores, which depends on several factors: The first factor is the relative price index of the two stores $\frac{P^m}{P^1}$ and $\frac{P^m}{P^2}$. Note that if $\frac{P^m}{P^1} \rightarrow 1$ or $\frac{P^m}{P^2} \rightarrow 1$, then the inequalities are hard to satisfy. As discussed above, $\frac{P^m}{P^1} \rightarrow 1$ implies that there are not sufficient types of goods such that store 2 can sell at cheaper prices or the price difference between the two stores is not sufficiently large. Second, when the difference in travel cost is small, consumers are more likely to visit both stores. Third, the quantity of each type of good consumed is governed by the consumer's income after travel costs, the overall price index, taste parameter σ , and the price of the good.

Figure 1 about here.

Figure 1 illustrates a scenario where a consumer would consume at both places. Note that in this example, store 1 offers good 1 at a lower price and store 2 offers good 2 at a lower price. U^1 and U^2 are the indirect utilities if the consumer chooses to buy only at store 1 and store 2 respectively. When this consumer visits both stores, disposable income is reduced to $I - t^1 - t^2$, but is able to enjoy the lower price of both goods 1 and 2. U^m shows the indirect utility if the consumer goes to both stores and it is higher than both U^1 and U^2 .

Supply

The two types of stores maximize profit by choosing the range of items to carry. In the basic model, we make the simplifying assumption that the location of the two stores, hence the travel costs t^1 and t^2 are exogenously determined. We relax this assumption in later sections. For each type of product ω , each store j sources the product from a perfectly competitive upstream supply. We use $m^j(\omega)$ to denote the constant unit cost of sourcing product ω for store type j . We assume that no store have bargaining power over upstream producers. Thus, the upstream is indifferent in supplying the two type of stores, which means $m^1(\omega) = m^2(\omega)$ for all $\omega \in [0, N]$.

Each store incurs a storage cost of carrying items. We assume that the further away a store is from the consumers, the lower the storage cost is. This assumption comes from the stylized fact that small shops with higher storage costs tend to be located in neighborhoods near the consumers, and supermarkets with lower storage costs tend to be in urban peripheries relatively far from the bulk of consumers who need to travel to get to the supermarkets. We use the constant $\frac{1}{t^j}$ to measure the marginal cost of carrying one more product type ω for each store type j .

Furthermore, each type of products requires varying degrees of perishable procurement costs $l^j(\omega)$ at each store j . We assume that the store further away from consumers incurs higher perishable procurement costs $l^j(\omega)$:

$$(9) \quad l^1(\omega) < l^2(\omega).$$

This latter assumption is based on the stylized fact that in early stages of supermarket penetration, when consumers still tend to shop for perishables from wet markets and small shops near them, and supermarkets carry mainly dry goods, that supermarkets face relatively high costs of procuring and handling perishables. In sum, the price of each type of good ω at store j is:

$$(10) \quad p^j(\omega) = m^j(\omega) + \frac{1}{t^j} + l^j(\omega).$$

We now rearrange the product index ω such that higher ω indicates higher relative perishable procurement costs: $\frac{l^1(\omega)}{l^2(\omega)}$. The following proposition characterizes the stores optimal choice of items to carry given that consumers choose to visit both stores:

Proposition 2 *There exists $\bar{\omega} \in [0, N]$ such that store 1 carries the relatively more perishable items $\omega \in [0, \bar{\omega}]$ and store 2 carries the relatively less perishable items $\omega \in [\bar{\omega}, N]$.*

Proof: See appendix A(3)

The intuition of proposition 2 is the comparative advantage of the two type of stores, which coincides with the main feature of Dornbusch, Fischer, and Samuelson (1977). In the international trade context of Dornbusch, Fischer, and Samuelson (1977), each country is specialized in producing the range of items that the country has comparative advantage in producing. In our model, the source of comparative advantage comes from two parts: store 1's advantage in lower costs of carrying perishable items and store 2's advantage in lower costs of storage. Thus, proposition 2 means that each store will be specialized in carrying the items in which it has comparative advantage.

Market Equilibrium

The market equilibrium is defined by the demand for $x(\omega)$ equaling its supply. In general, there are three possible outcomes: a) Only store type 1 carries all items. In this case, the consumer's income level is low so that the travel cost to store type 2 is too high and the price difference would not justify the trip. b) Only store type 2 carries all items. c) The consumer would shop at both types of stores. Each store will be specialized in carrying items in which that store type has a comparative advantage. We focus on the characteristics of the type 3 equilibrium in the following discussion.

When the market could support the co-existence of both types of stores in equilibrium, the price indexes in inequalities (7) must be market equilibrium prices:

$$(11) \quad t^2 < \left(1 - \frac{P^{m*}}{P^{1*}}\right)(I - t^1),$$

$$t^1 < \left(1 - \frac{P^{m*}}{P^{2*}}\right)(I - t^2),$$

where $P^{j*} = [f_0^N [m^j(\omega) + \frac{1}{t^j} + l^j(\omega)]^{1-\sigma} d\omega]^{\frac{1}{1-\sigma}}$.

Figure 2 about here.

Figure 2 depicts the feasible region for the coexistence of two type of stores in equilibrium. In equilibrium, if the consumer shops at both stores, then, by proposition 2, we know that the price index of shopping at both stores P^{m*} is lower than both P^{1*} and P^{2*} . Here, P^{1*} and P^{2*} are the counter-factual price indexes when the consumer only shops at store 1 and 2 respectively. Moreover, from proposition 1, we can tell if the equilibrium prices and after travel cost income could support the coexistence of both stores. In figure 2, if the travel costs (t^1, t^2) fall in the gray shaded area, then the economy would be able to support the coexistence of both stores.

In the next section, we develop the main comparative statics for the market equilibrium in the context of co-existence of traditional shops and supermarkets as well as the coexistence of supermarkets and e-commerce.

Comparative Statics: from traditional shops to supermarkets to e-commerce

Local traditional shops vs. Supermarkets

In this subsection, we focus on the transition and/or co-existence of traditional stores (store type 1) and supermarkets (store type 2).

Proposition 3 *As travel cost t^2 decreases, consumers are more likely to visit both types of stores, but fewer items will be carried at supermarket. As perishables' procurement costs decrease or consumers invest in refrigerators, supermarkets will carry more types of items.*

Proof: see appendix A(3).

Proposition 3 establishes the main comparative statics results for the store choice equilibrium between traditional shops and supermarkets. Note that Proposition 3 is only valid in a neighborhood of (t^1, t^2) where coexistence could be supported by the market. In fact, when the conditions

in Proposition 2 are violated, we need to go back to Lemma 1 to see which type of store will be supported by the market. Thus, in some cases, instead of coexistence of store types, we observe transition from one type of store to another. Below, we discuss the general trends and factors driving the transition from traditional shops to supermarkets.

1. Traditional shops

Traditionally consumers went only to small shops (included among which are stalls in wet- markets and small stand-alone shops). These include small dry goods shops (selling for example rice, oil, packaged crackers) and small perishables goods shops/stalls (fruit, vegetables, meat, dairy, and fish). The traditional small shops were densely scattered around town so very close to consumers' homes. Consumers could walk a few minutes to the shop. Consumers tended/tend to buy frequently and in small units from these shops (for Philippines, see [Dannhaeuser 1980](#); for Hong Kong, [Ho 2005](#)). In the US and the UK, traditional shops had the same locational advantage, when supermarkets still had a small share of food sales (4% in the UK in the early 1960s, 20% in the US in the early 1940s), and car ownership was still limited. Consumers did nearly all their "frequent purchase" shopping at small independent shops in that era ([McClelland 1962](#)).

The traditional shops had (and where they persist, have) rapid turnover, buying a small amount then selling a small amount such as in rice and potato shops/stalls in India, Bangladesh, and China ([Reardon et al. 2012](#)). The shop neither needed to nor could (because of limited storage capacity) buy more and sell more. There was no capacity to gain economies of scale, either at the shop level, or in clusters of shops, as they tended not to have "procurement clubs". Relative to the supermarkets that would emerge, the small shops eventually had higher prices than supermarkets (as supermarkets pushed down their prices). See for example the case of Delhi, in [Minten, Reardon, and Sutradhar \(2010\)](#).

The shop's market area was/is also small, so that the shops focused on a few SKUs (shop keeping units) adapted to the needs of the consumers in the neighborhood. There was no desire or capacity to have economies of scope. Even today in the era of a proliferation of SKUs of packaged foods, small shops have far fewer SKUs than supermarkets per product category. See for example the

case of Nigeria, Liverpool-Tasie, Reardon, and Abagye-Igbudu (2017). The local shop tended to advance consumer credit because they knew the local people and had low risk of information asymmetry. They also undertook home delivery in their small radius catchment area to further reduce transaction costs.

In the US in the 1960s/1970s when supermarkets were emerging as major competitors with small traditional shops, there arose a bimodality among small independent shops, in which one set, relatively capable of surviving as supermarkets moved into the city and town peripheries, emphasized product category deepening along with customer advising and services such as delivery. The other set, with general line nonfoods and foods, relying on proximity of location but often having higher prices than supermarkets, and not having a quality or product depth advantage, quickly exited except in poor neighborhoods far from supermarkets. Their exit was accelerated as supermarkets proliferated, reducing local location advantages, and convenience store chains penetrated dense urban areas, stepping in as the replacement for the limited assortment, frequent shopping, local store. Moreover, even poor households began to own cars and have access to bus lines and sought groceries in supermarkets outside their area (see Davidson 1970, Goodman 1968, Kirby 1976 for further discussion.)

2. Supermarket chains, initial stage/penetration

Supermarkets initially only dealt in dry goods (such as rice, bottled oil, and packaged crackers). Early on in developing countries with limited food processing/packaging sectors, supermarkets sourced imported versions or luxury versions of these packaged goods. But as the local food manufactures sector developed, and stockists and indeed direct distribution from manufactures to supermarket chains developed, supermarkets quickly shifted to mass purchase of these dry goods and establishment of dry good warehouses in order to have economies of scale. The immediate effect was very rapid penetration/domination of these dry goods markets. For example, Ho (2005) paints a picture of small rice shops dominating in the 1970s/1980s, and then in the 1990s/2000s supermarkets taking over rice retail. Reardon et al. (2012) show that supermarket chains in Beijing

account for half the rice bought by consumers, and market a wide variety of rice, packaged and branded and mostly delivered to their distribution centers by large rice mills.

Supermarkets initially were relatively far from the bulk of consumers' homes (which in the 1940s/50s in the US and developing countries in the 1990s/2000s meant that most consumers had to take the bus to go to the supermarket). But for dry goods that were needed infrequently and could be stored at home, those with cars and home storage and lumpy monthly incomes tended to shop at supermarkets to gain savings. As supermarkets spread, transaction costs declined and more and more low income consumers took advantage of these low prices for dry goods such as packaged foods. In that setting large retailers with large storage capacity and "lean" supply chains could charge low prices and displace traditional dry goods shops ("general stores"), such as in the US (Ellickson and Grieco 2013) and Chile (Faiguenbaum, Berdegué, and Reardon 2002). Retail and consumer research such as McClelland (1962) and Abbott (1963) found at the time that the shift to supermarkets from small stores also occurred as consumers became increasingly prone to purchasing processed/packaged foods to save time in the kitchen, as women's opportunity cost of time for cooking and shopping increased.

However, as predicted by our Proposition 2 and 3, in the initial stage supermarkets tended/tend (in US as in developing countries) to not sell perishable products (Reardon et al. 2003). This is because it is costly to set up the storage and supply chain for perishables in order to get economies of scale to compete with small shops. So while supermarkets entered the "cheap dry goods" stage they still sold "luxury/imported perishables", in a lagged penetration product-wise.

3. Supermarket chains, second stage of penetration of dry goods and commoditization of produce retail

Supermarkets continued to diffuse and diversify formats (beyond "big box" stores on the peripheries of cities and into convenience stores for penetration of dense inner cities). Supermarkets and other modern retail such as convenience store chains used their large economies of scale on the procurement side to supply modern retail outlets whether the outlets were chains of small stores or large stores. The mega and super stores allowed for increasingly large economies of scope.

The small modern stores (convenience stores chains and small format supermarkets) relied on economies of scale on the procurement side and low transaction costs and processed product focus on the consumer side.

Supermarket chains in the US and the UK undertook a wave of innovation in supply chain management in the 1960s-1980s that drove down retailing costs and consumer prices in packaged foods. This occurred at the same time that production costs and supply chain management was being modernized by packaged food firms themselves. This involved improved inventory management, distribution center and other logistics investments, and dis-intermediation (reduction of reliance on wholesalers as middlemen) (Padberg and Thorpe 1974, for example). An example of the latter is in India, Reliance Retail and KB's Fairprice chain (the small format low-price dry goods chain of Future Venture, the leading retail firm).

Supermarket chains began (in the 1980s/1990s in the US and in the 2000s in developing countries) to make major invest in perishables procurement and storage capacity. Illustrations are provided for the US, France, and the Netherlands in Zuurbier (1999). Moreover, in developing/emerging markets supermarkets also began to make such investments in particular in the 2000s, for example by the Walmart-Mexico and Soriana chains in Mexico (Reardon et al. 2007). That allowed the chains to take the second step that they had already taken in dry goods, into the cheap commodity phase for perishables, competing with produce shops and wet markets. That also reduced quickly the share of small shops and wet markets in produce and meats in large cities such as in India (Minten, Reardon, and Sutradhar 2010), China, and Mexico. In a further product differentiation, supermarkets introduced credit and delivery and differentiated (high quality) perishables to attack the niches held still by small perishables shops. Sometimes this was done in alliance with importers of quality produce, such as supermarket chains in China sourcing from Hong Kong's produce distributor Joy Wing Mau, that represents leading produce companies such as Zespri in New Zealand and Sunkist in the US. Sometimes this was done in alliance with large processing and packaging companies that wanted the symbiosis with supermarket chains to develop economies of

scope in processing and retail (Farina et al. 2005 for Brazil dairy with links between for example Nestle and Carrefour and Tetrapak).

In general at this stage and the former stage, independent supermarkets and small shops endured if they were protected by high transport costs to modern stores (like shops in rural towns or slums), or they had some quality/social capital/service combination that allowed them to persist. An example is in Brazil (see Farina, Nunes, and Monteiro 2005).

Walmart and other large supermarkets co-locate in the urban periphery and compete on groceries (perishables). In the US (Ellickson and Grieco 2013), Walmart has won that peri-urban (and small town) grocery battle because of lower storage and procurement costs. If the latter procurement side advantage was absent, then consumers would be indifferent between Walmart and other “big box” grocery stores. By contrast, in situations where supermarkets have competed down the share of small traditional shops to very little, there usually is a medium-long term stickiness in market shares of the large supermarket chains until one of them develops a decisive advantage. Alternatively, there is an evolution to another model such as e-commerce, discussed below.

Supermarket vs. E-commerce

In this subsection, we discuss the transition and/or co-existence from supermarkets to e-commerce. To do so, we modify the store choice model in a few ways listed below:

1. We use store type 1 and 2 to indicate supermarkets and e-commerce respectively.
2. We assume that the marginal cost of storage for e-commerce goes to 0. That is $t^2 \rightarrow \infty$. However, since the nature of e-commerce allows the separation between shopping and purchasing, a consumer does not have to incur the infinite travel cost to shop at e-commerce warehouses. Thus, instead of paying a travel cost t^2 , we assume that consumers pay a fixed shipping cost s^2 for purchasing online.
3. We add the assumption that the travel cost of going to supermarkets is an increasing function of the wage rate, denote by w : $dt^1(w)/dw > 0$.

Proposition 4 *As shipping costs decrease or consumers’ wage rates increase, e-commerce carries more items.*

Proof: see appendix A(4).

Proposition 4 depicts the fundamental difference between the traditional store vs supermarket choice equilibrium and supermarket vs e-commerce choice equilibrium: e-commerce allows for the separation of shopping and purchasing. One does not have to incur the travel cost to shop online. In a traditional store vs supermarket choice equilibrium, a higher wage, thus higher shadow cost of time, implies that consumers would have less willingness to pay for additional travel costs. Consequently, the coexistence condition is hard to meet. However, with the separation of shopping and purchasing, e-commerce allows for a higher likelihood for coexistence between supermarkets and e-commerce. Below, we discuss the emergence and evolution of e-commerce.

1. E-commerce, first stage of penetration/evolution, introduction of niche

The first stage of e-commerce exactly parallels the early portion of the first stage of supermarket penetration, that is, in selling only dry goods (e.g. books or machines in the case of e-commerce whether for retail with Amazon or business-to-business wholesale with Alibaba), and economies of scale in procurement but not yet economies of scope (as the early e-commerce had relatively narrow product lines). This early stage is that of e-commerce in the US in 1990s, urban China in the 2000s, and rural China (with for example the “Village Taobao” of Alibaba in rural China today). Early e-commerce competed on cost, just as supermarkets had, but whereas supermarkets could not compete with traditional stores or e-commerce on travel time, they had competed with traditional stores on shopping time. But as proposition 4 illustrated, e-commerce could compete with both shops and supermarkets on travel costs, as well as shopping time, besides equaling supermarkets in economies on product costs. The transaction cost reduction of early e-commerce was a mimicry of fast pizza delivery arranged by phone. Their product cost reduction was a mimicry of what supermarkets had done with efficient supply chains and distribution centers.

2. E-commerce, second stage of evolution, diversification and commoditization

The second stage of e-commerce paralleled the late part of the first stage of supermarket penetration, with the joint introduction of economies of scope and economies of scale in storage and marketing. This is occurring for example in urban China in the 2010s and the US 5-10 years ago,

with commoditization cum diversification of e-commerce. In this stage, e-commerce as consumer retail as still mainly of dry goods, nonfood and food.

The economies of scale displayed by the various leading firms (such as Amazon and Alibaba) were basically similar, with minor differences (such as initially owning, such as the case of Amazon, or initially renting when the market was still thin then later owning/building logistics infrastructure, such as the case of Alibaba. Interestingly, when Amazon or Alibaba enter third markets where logistical infrastructure for e-commerce is still poorly developed (such as in India), both need to rely on renting existing facilities and patching together small and medium logistic firms services.

Discussion: further expansions of the model

As discussed earlier, one of the reason for adopting Melitz (2003) model in our framework is that Melitz (2003) allows for flexibility to modify the model and add additional features. Due to page limits, we discuss several possible additions to our main model, outline the ways to model these additional features, and provide hypotheses out of these new features.

Strategic location choice: the convergence of stores

When t^1 and t^2 are endogenously determined, we can use Hotelling's model to depict the optimal locations of the two stores. Generally speaking, jointly determining t^1 and t^2 would require certain game theoretic assumption on the market structure. One way of doing this is by adding Hotelling's spatial competition structure to our model where the two stores simultaneously choose the locations, consequently t^1 and t^2 , and then simultaneously choose prices. Under such assumptions, we will have the following hypothesis:

Hypothesis 1. *A store's optimal location is: $t^1 = t^2$. In this case, the two stores sell the same range of items and consumers are indifferent between going to the two.*

The essence of the hypothesis comes from the core prediction of the Hotelling's spatial competition model: the two stores will be close to each other. In our context, this would suggest that supermarkets and e-commerce would inevitably converge to each other, which means that super-

markets would seek for online presence and e-commerce would build offline assets. The following discussion documents the new trends in the evolution of e-commerce.

E-commerce, third stage of evolution, with entry into perishables and initial combination of "bricks and mortar" retail with e-commerce by both e-commerce firms and supermarkets

It appears that by the 2010s, the third stage of e-commerce retail evolution is beginning. This involves two steps.

On the one hand, e-commerce retail is undertaking product differentiation into both services (such as video streaming and consumer finance) and retailing of perishable products. The latter has been lagged relative to dry goods for e-commerce firms just as it was historically for supermarket chains: it is much more costly and challenging to build and manage perishables supply chains, storage, and marketing capacity.

On the other hand, there is emerging a combination of use of "bricks and mortar" retail stores and e-commerce. Examples include Amazon acquiring Whole Foods in the US, and Alibaba acquiring part of the Auchan and RT Mart chains in China. This combination allows tangible observation of products – allowing the consumer to observe and shop where alternative brands are on display for the same basic product. These physical outlets also allow product pick-up from e-commerce orders to be combined with in-person shopping. An interesting case is FruitDay in China, a produce e-commerce firm that started a decade ago. They have four modes of operation: (1) fruit and beverage vending machines for office buildings with mobile phone payment; (2) small shops with local neighborhood delivery (by internet or phone order) in addition to being regular produce shops; (3) a recently acquired chain of small supermarkets for a larger catchment area, offering e-commerce, delivery, and a wider range of products; (4) "traditional" e-commerce for a much larger catchment area, with internet orders and delivery to homes (Zhao 2017).

Moreover, as large scale e-commerce is starting to displace supermarket market share (as is happening in the US with Amazon and in China with Alibaba, especially in dry goods), leading supermarket chains are starting to adopt elements of e-commerce to compete with the newcomers, thereby reducing the share of lagging supermarket chains. That could in the longer run lead to a

convergence of supermarkets and e-commerce. The pivotal point is the operation of a distribution center and the transport of products to the sales point. Both supermarkets and e-commerce large firms have large distribution centers, thus potentially converging in size to all possible products. At present, from a large distribution center in a given region, Walmart moves a product to its stores and thence, by consumers' own efforts, to homes. Amazon or Alibaba move a given product from one distribution center or the manufacturer to satellite de-bulking facilities and thence direct to homes. The essence of the difference is that a supermarket positions the "last mile" breakdown center as a "store" and counts on a consumer wanting to come and observe and trust Walmart for the assortment to make in-person shopping worthwhile. The consumer to Amazon does the same; he or she comes to a particular product section of the e-commerce site and looks at the offerings and the ratings. The latter differs from a physical store only in allowing actual touching of the product.

The convergence point that is starting to emerge in this third stage is where supermarkets and e-commerce provide both tactile observation channels (brick and mortar base for Amazon, and the store itself for Walmart), pre-information on-line (both supermarkets and e-commerce do that now), and then the opportunity either to go to a tactile observation point (bricks and mortar) or just order on-line and receive the product. Presumably the tactile observation will only be necessary for products new to a consumer; "repeat" products can be ordered on-line without loss of credence.

Conclusions

In this paper, we develop a framework that illustrates how changes in technology, consumer income, and preferences are affecting the evolution of the structure and conduct of retailing. We use this framework to explain some of the basic patterns affecting food retailing, including the emergence of supermarkets, the introduction of e-commerce, and division of consumption between local traditional stores and large modern retailers. We provide a conceptual framework to explain the evolution in food retailing, from traditional shops to supermarkets to e-commerce. We model the store choice problem as a market equilibrium of consumer choices and stores product portfolio.

We use and adapt a combination of [Melitz \(2003\)](#) and [Just and Zilberman \(1983\)](#) to model the discrete/continuous problem that consumers face. We use trade theory, in particular [Melitz \(2003\)](#), to develop a new way of looking at the rationale for the evolution in agrifood retailing: different types of stores carry items according to their comparative advantage.

We find that under certain conditions, traditional stores compete with and can coexist with supermarkets, and supermarkets with emerging e-commerce. When the coexistence of different types of stores can be supported by consumers, the key question for the retail types is what product portfolio to market. Our model suggests that the stores will be specialized in carrying items according to their comparative advantage where the source of advantage may come from procurement and storage costs for perishable versus dry packaged food products, and transaction costs that face consumers shopping at the different retail types.

We also analyze how different factors could change the evolution of different types of stores. Our analysis develops testable hypotheses about several important factors. First, as travel costs to supermarkets decline, consumers are more likely to visit both local stores and supermarkets. Second, new technologies that lower the perishables' procurement cost at supermarkets would result in supermarkets' carrying more types of items, including perishables. Third, as consumers' wages increase (and thus opportunity costs of time) or shipping costs of online shopping decrease, consumers will buy more products online and more types of items will be carried online.

There are several future directions in which our model can be extended. First, it can be expanded to understand the strategic competition between supermarkets and e-commerce. An example of such extension would be a game theoretic framework on the strategic location of different types of stores. This approach would allow us to give more precise predictions on the convergence of supermarkets and e-commerce. A second strand of extension is how the bargaining between retail stores and upstream producers affects the equilibrium types of goods to be carried at different stores. Finally, our modeling framework could be further expanded to allow new features such as the role of risk, information, and dynamics. [Heiman et al. \(2015\)](#) discuss how money-back guarantees could reduce the risk that consumers face. In our model, we could introduce this by allowing

for random loss of goods due to perishability during shipping. This feature would predict that risk from shipping of perishable items reduces consumers purchase highly perishable items online. The recent theoretic development of information design (Bergemann and Morris 2017) can also be incorporated in our model to depict how e-commerce could design different information disclosure methods (such as return rate, satisfaction, etc.) to maximize profit. Melitz (2003) provides a way to model dynamics of this model, which would allow one to depict the path dependence of retail evolution.

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Figures

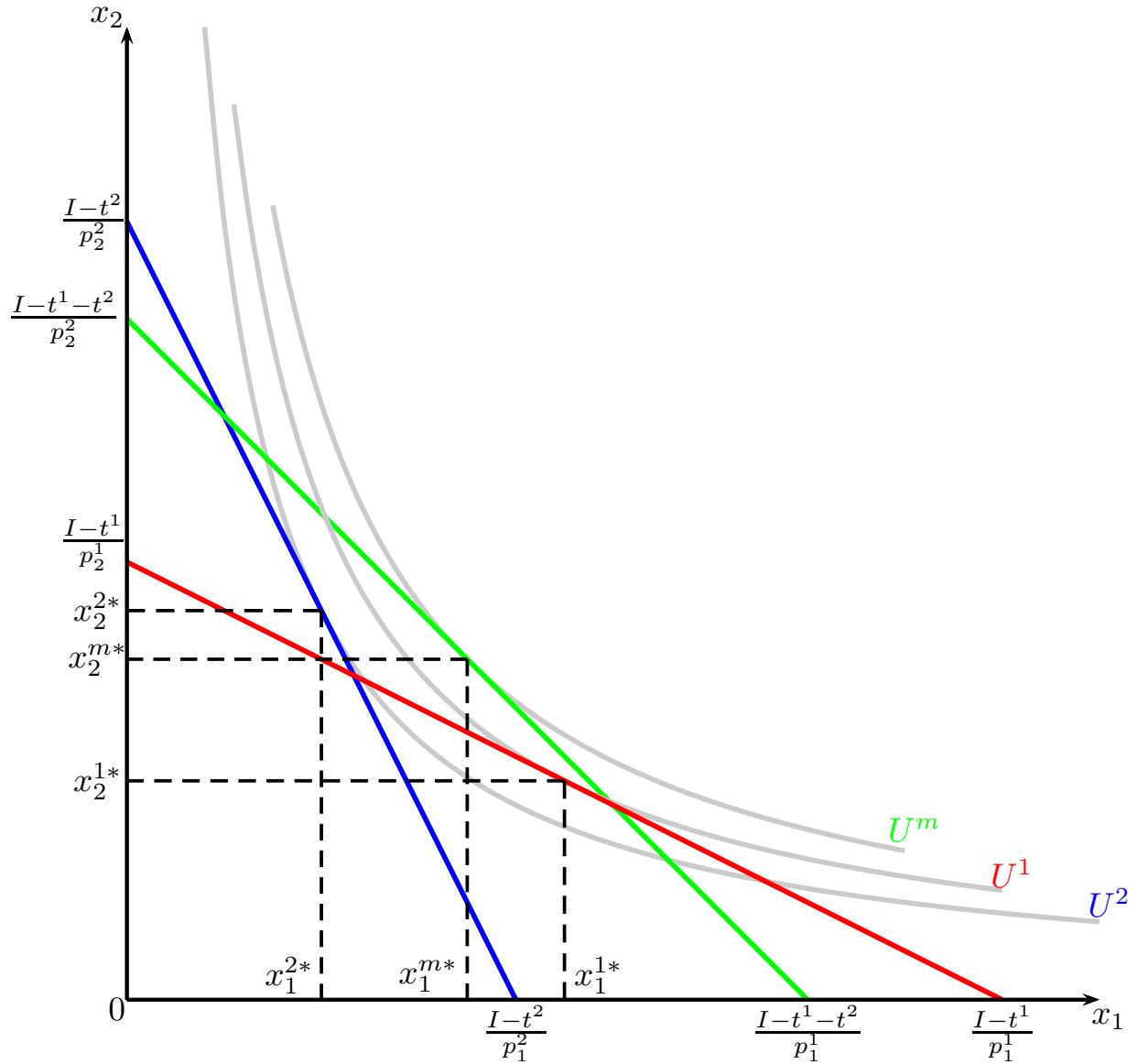


Figure 1. Consumer's optimal store choice

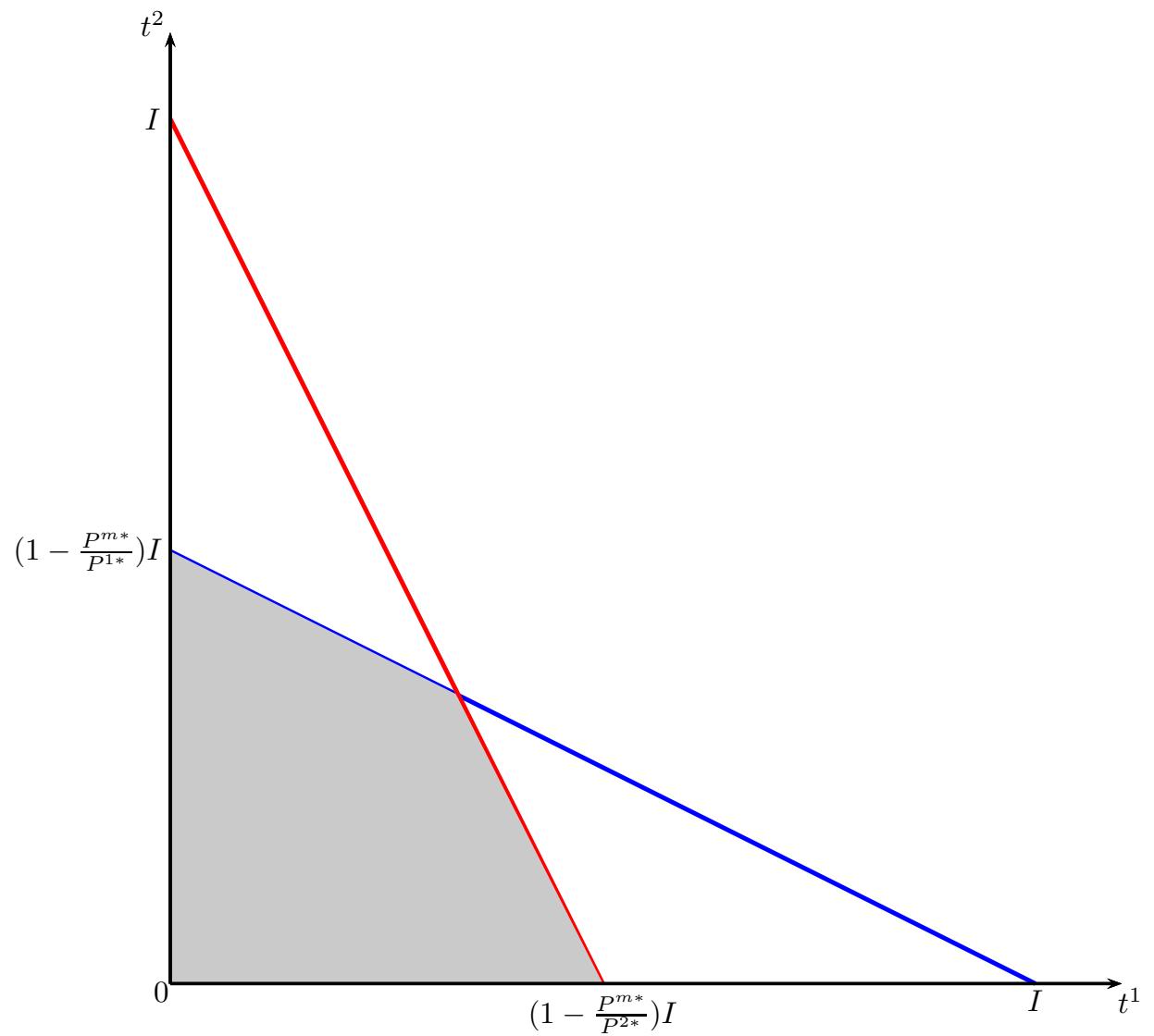


Figure 2. Feasible region for store coexistence in equilibrium