Advanced Agribusiness Management
Vehicle Routing, Supply Chain Management and Value Chain Management

Rodney Beard

May 23, 2017

Advanced Agribusiness Management Vehicle Routing, Supply Chain Management and Value Chain Management

Rodney Beard

Readings

Clark and Scarf: Optimal Policies for a Multi-Echelon Inventory Problem *Management Science* 50(12S), pp. 1782?1790, 2004 INFORMS

Xun Wang, Stephen M. Disney, The bullwhip effect: Progress, trends and directions, European Journal of Operational Research 000 (2015) 1?11 `http://orca.cf.ac.uk/74438/9/Wang2015.pdf`

Cachon, Randall and Schmidt (2007) Manufacturing and Service Operations Management. (on Nb)

G. Griffith, W.E. Jamandre and R.E. Piggott, (1992) A note on price levelling and price averaging in Sydney retail vegetable price spreads, Review of Marketing and Agricultural Economics, Volume 60, Number 01, 43-55.

Griffith, Garry R. ; Green, W. ; Duff, G.L., (1991) Another Look at Price Levelling and Price Averaging in the Sydney Meat Market, Review of Marketing and Agricultural Economics, Volume 59, Number 02, 189-201.

Introduction

- Supply chain management = Inventory management + Scheduling
- Supply chain management (term attibuted to Keith Oliver (Booz Allen Hamilton) 1982)

> *?Supply chain management (SCM) is the process of planning, implementing, and controlling the operations of the supply chain with the purpose to satisfy customer requirements as efficiently as possible. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption?*

- Definition makes it apparent that it combines logistics (movement and procurement of goods with inventory management) scheduling is concerned with the timing of processes so is an integral part of supply chain

Multi-echelon inventory management and supply chain management

- single echelon inventory management is standard inventory problem
- Multi-echelon inventory management involves multiple stages Clark and Scarf (1960)
- This is the origin of the supply chain idea. by combining inventory management with a network model.

Clark and Scarf

Consider an inventory problem in which there are n periods remaining, with x_1 units of stock on hand, w_1 units to be delivered one period in the future, and generally w_j units to be delivered j periods in the future, where $j = 0, 1, 2, \lambda - 1$.

Formal description

$$C_n(x, w_1, \ldots, w_{\lambda-1}) = \min_{z \geq 0} \{c(z) + L(x_1) +$$

$$\alpha \int_0^{\infty} C_{n-1}(x_1 + w_1 - t, w_2, \ldots, w_{\lambda-1}, z)\phi(t)dt \Big\}$$

where

- $c(z)$ is the cost of purchasing
- $L(x_1)$ is the sum of holding plus stockout costs
- α a discount factor
- $\phi(t)$ is the density function of the per period n demand t.
- $E(C_{n-1}(x_1 + w_1 - t, w_2, \ldots, w_{\lambda-1}, z))$

So the expression $x_1 + w_1 - t$ refers to the stock on hand plus new orders minus demand.

Echelons

We begin by selecting a specific installation, say installation I. Associated with I will be a number of other installations which receive, directly or indirectly, stock from installation I. The total stock at I, plus the stock in transit or on hand at these other installations, will comprise the echelon associated with installation I.

Multi-echelon Problem

Clark and Scarf consider a two echelon problem:

$$C_n(x_1, w_1, x_2) = \min_{x_1+w_1 \leq y \leq x_2, z \geq 0} \{c(z) + c_1(y - x_1 - w_1) +$$

$$\tilde{L}(x_2) + L(x_1) +$$

$$\alpha \int \int C_{n-1}(x_1 + w_1 - t_1, y - x_1 - w_1, x_2 + z - t_2) f(t_1, t_2) dt_1 dt_2 \Big\}$$

where y is the amount being transported between echelons and $c_1()$ is the transportation cost. .
Multi-echelon inventory management is a complex problem, will not go into it in more detail.

The Bullwhip Effect

- The term bullwhip effect was first coined by Procter & Gamble (P&G) in the 1990s to refer to the order variance amplification phenomenon observed between P&G and its suppliers.
- observed in almost every industry.
- Forrester, J. (1961). Industrial dynamics. Cambridge, MA: MIT Press.

  slow moving consumer demand creates large swings in production for the suppliers at the other end of the supply chain. This is analogous to the handle of the bullwhip causing a loud crack at the popper. The bullwhip effect is sometimes referred to as "demand amplification", "variance amplification" or the "Forrester effect".

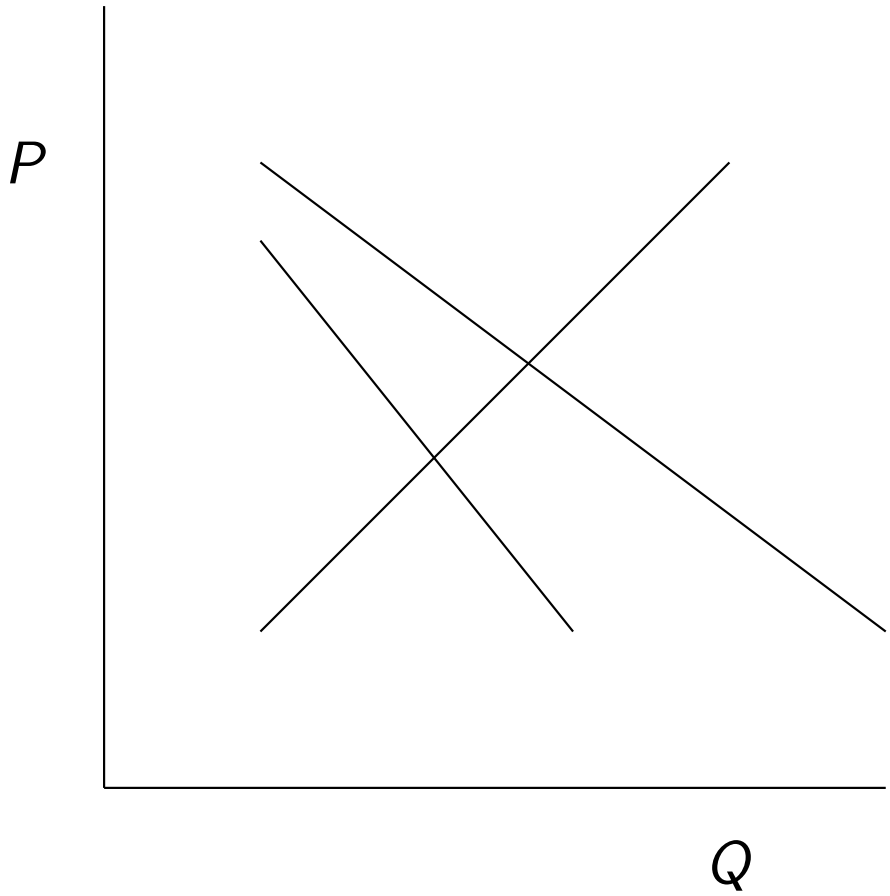
The Bullwhip Effect - Evidence

- "The bullwhip effect is the phenomenon of increasing demand variability in the supply chain from downstream echelons (retail) to upstream echelons (manufacturing)", Cachon, Randall and Schmidt (2007) Manufacturing and Service Operations Management.
- Present more in wholesale industries than retail
- Less present in seasonal industries
- Seems to be an open question as to whether the bullwhip effect is strongly present in agricultural industries

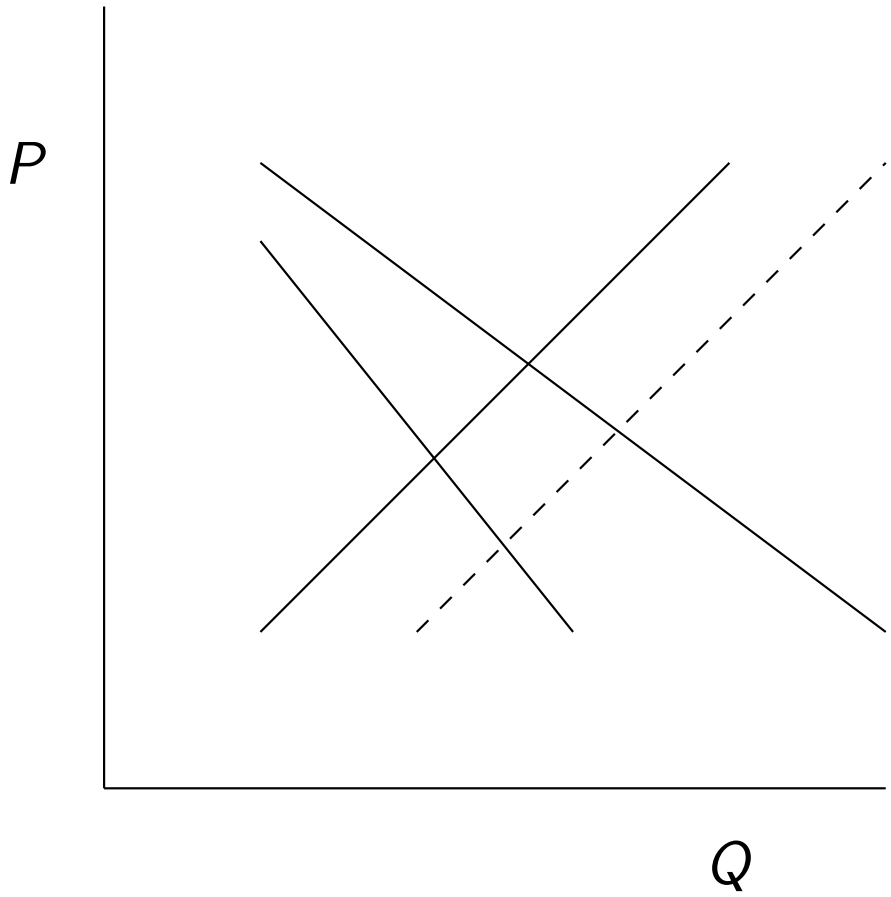
Price levelling and price averaging

- Price levelling is the practice of holding wholesale (retail) prices relatively constant in the face of changes in auction/farmgate (wholesale) prices
- This leads to price smoothing which comes from a supply shift.
- Price average is the practice of charging different spreads for different types of meats.

Price levelling and price averaging



Price levelling and price averaging



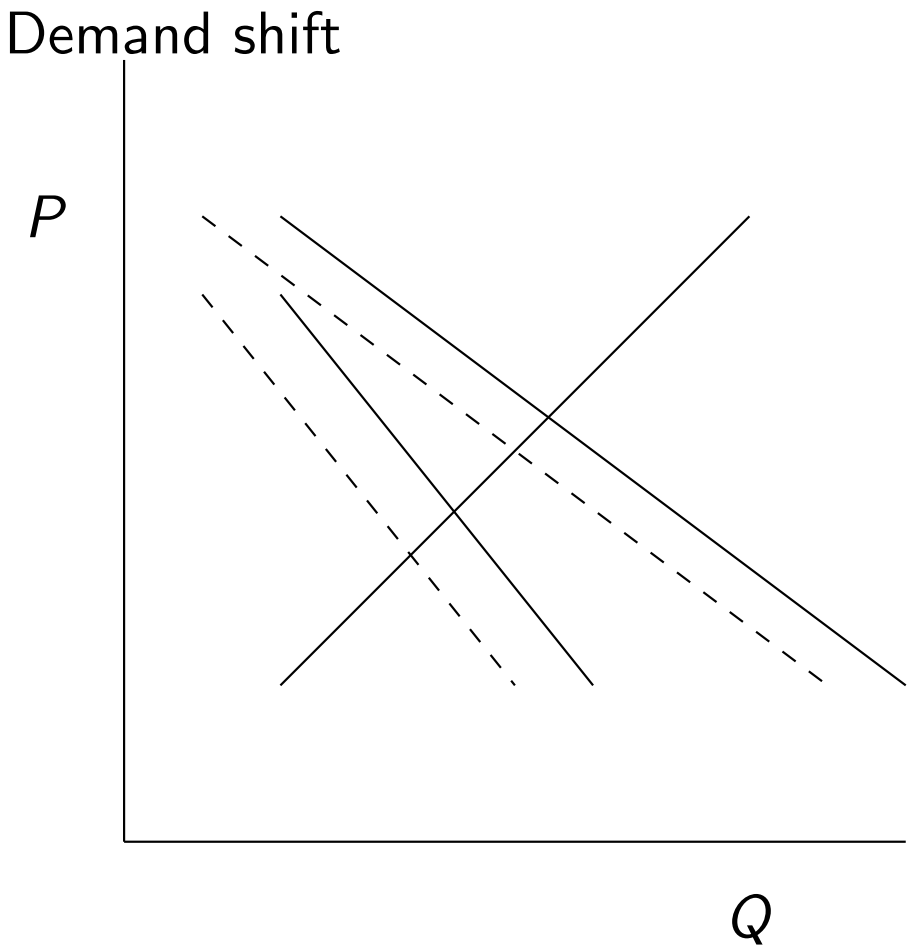
The wholesale price changes more than the retail price.

Price levelling and price averaging literature

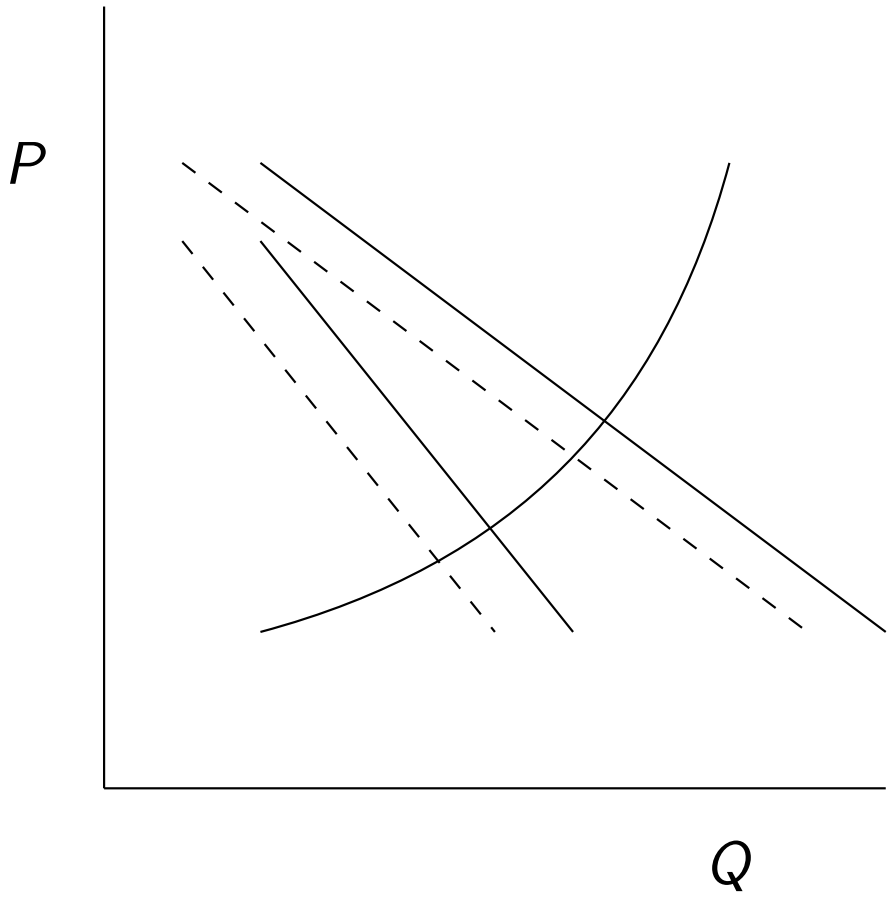
G. Griffith, W.E. Jamandre and R.E. Piggott, (1992) A note on price levelling and price averaging in Sydney retail vegetable price spreads, *Review of Marketing and Agricultural Economics*, Volume 60, Number 01, 43-55.

Griffith, Garry R. ; Green, W. ; Duff, G.L., (1991) Another Look at Price Levelling and Price Averaging in the Sydney Meat Market, *Review of Marketing and Agricultural Economics*, Volume 59, Number 02, 189-201.

The Bullwhip Effect - Again



The Bullwhip Effect - with Non-linear Supply



Here we see demand amplification at work.

The Beer Game

We will try in class next week

> *The beergame is a role-play supply chain simulation that lets students experience typical supply chain problems. In the beergame students enact a four stage supply chain. The task is to produce and deliver units of beer: the factory produces and the other three stages deliver the beer units until it reaches the customer at the downstream end of the chain.*

Source: `http://beergame.org/the-game`

Vehicle Routing Problem

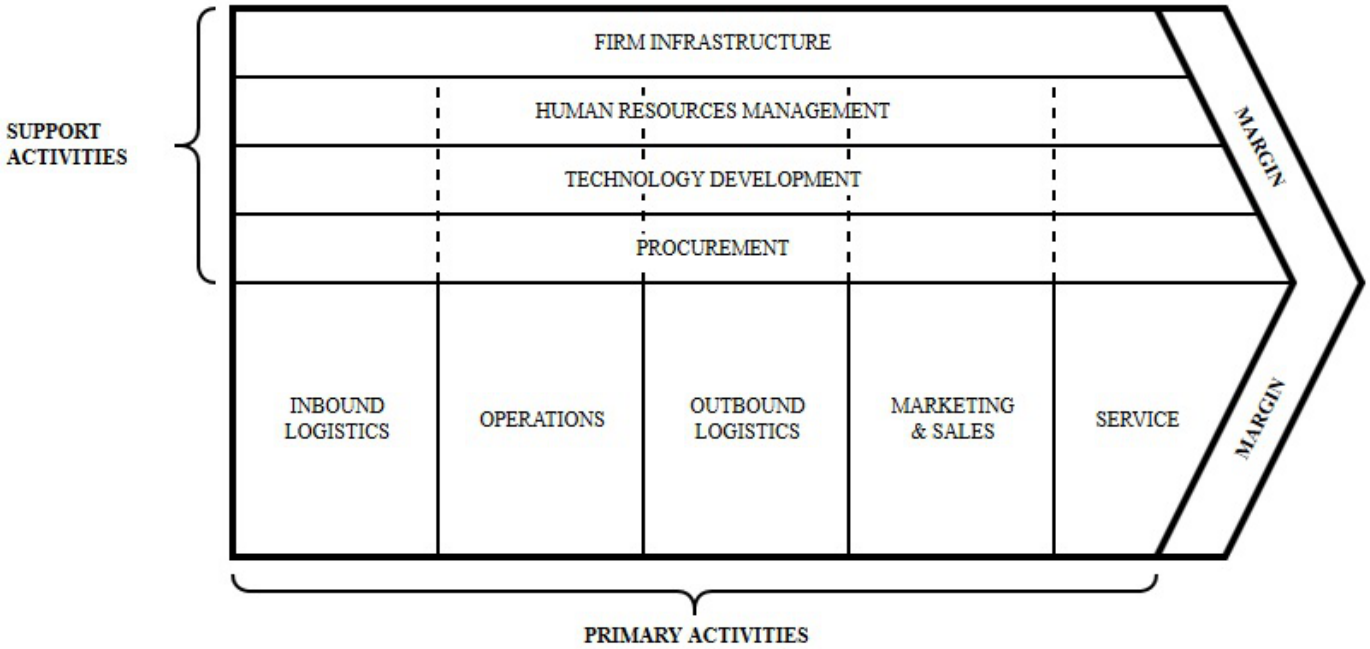
- Goods need to be transported between installations (Distribution centers, facilities, etc.)
- This requires transportation vehicles.
- What route should these follow?
- How much should be transported?

The Travelling Salesman Problem

Given a collection of cities and the cost of travel between each pair of them, the traveling salesman problem, or TSP for short, is to find the cheapest way of visiting all of the cities and returning to your starting point.
Source: `http://www.math.uwaterloo.ca/tsp/problem/index.html`
Can be solved via integer programming or dynamic programming or any variety of other methods, exact solutions are elusive. This is a HARD problem

Value Chain Analysis

Due to Porter



Competitive advantage -Cost Advantage

https://www.strategicmanagementinsight.com/tools/value-chain-analysis.html

This approach is used when organizations try to compete on costs and want to understand the sources of their cost advantage or disadvantage and what factors drive those costs.

Steps

1. . Identify the firm?s primary and support activities.
2. . Establish the relative importance of each activity in the total cost of the product.
3. . Identify cost drivers for each activity.
4. . Identify links between activities.
5. . Identify opportunities for reducing costs.

Competitive advantage - Differentiation advantage

1. . Identify the customers? value-creating activities.
2. . Evaluate the differentiation strategies for improving customer value.
3. . Identify the best sustainable differentiation.

Value chain analysis -Tabular Template

Step 1 - Firm's primary activities			
Step 2 - Toal cost and importance			
Step 3 - Cost drivers			
Step 4 - Links between activities			
Step 5 - Opportunities for reducing costs			

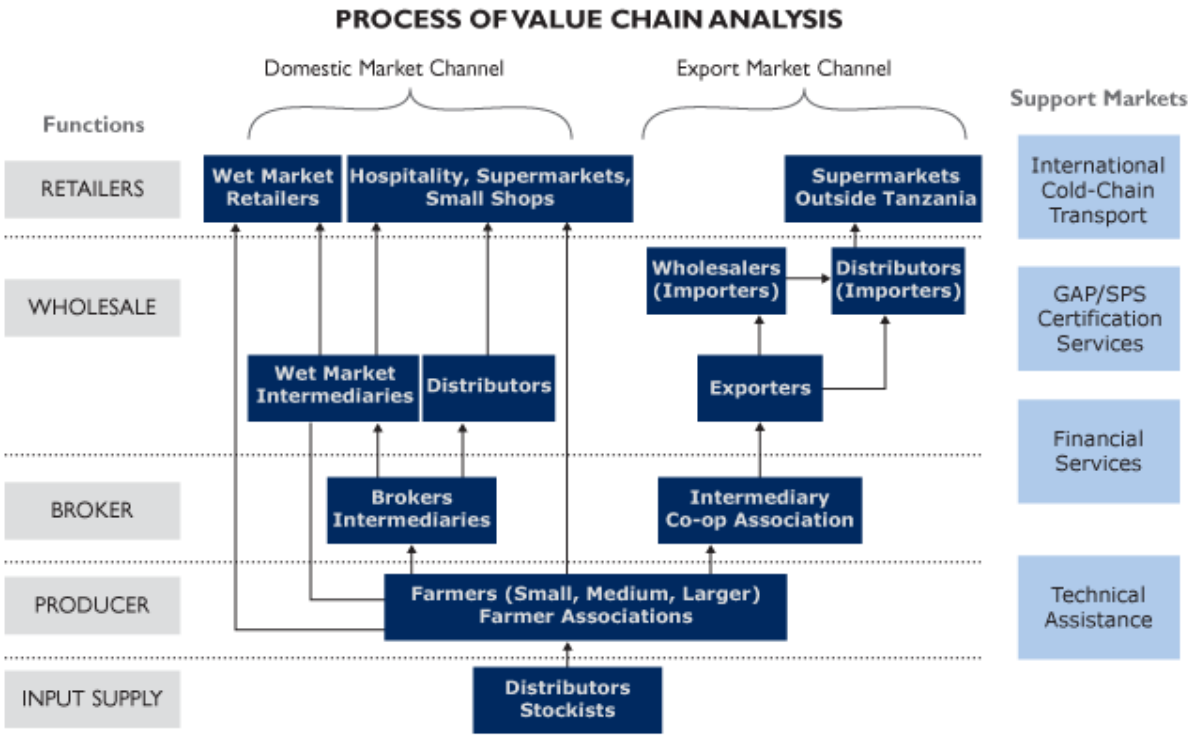
Value chain mapping

Source:
https://www.microlinks.org/good-practice-center/value-chain-wiki/value-chain-mapping-process

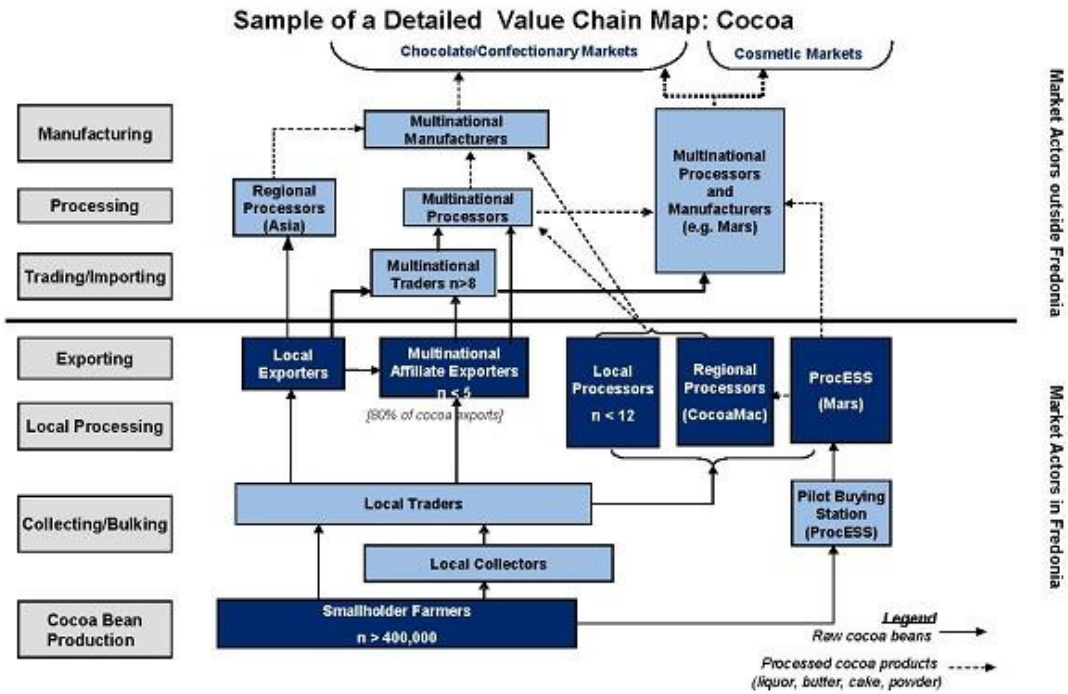
Generic Worksheet Crossing Function with Participants/Actors

FUNCTIONS	PARTICIPANTS / ACTORS							
	Village Stores	Input Supply Companies	Small-Scale Producers	Producer Associations	Medium-Scale and Commercial Producers	Traders	Processors	Wholesalers
Export								■
Wholesaling								■
Processing							■	
Assembly				■	■	■		
Production			■		■			
Input Supply	■	■		■	■			

Value chain mapping -Example



Detailed Value Chain Map



Commodity Value Chain Analysis

- Firm level
- Industry level (commodity level)
- Global commodity value chain analysis