**Review Problem – Joe Wilck**

**Hot Dog:**

Oliver Meyer hopes to follow his uncle Oscar's success in the hot dog business by creating a low-calorie, low-fat, low-cholesterol hot dog made of at least 25% beef and 25% pork plus either chicken or turkey, or both. Oliver will market the 2 ounces dogs as all-meat with no fillers. Each dog will must have no more than 6 grams of fat, 27 grams of cholesterol, and 100 calories. The cost of ingredients and their relevant information is shown. Create a min-cost Hot Dog that meets all requirements at 2 ounces.

Classification: Product Mix Problem

*Algebraic Formulation:*

Decision Variables:

Beef: pounds of beef in hot dog

Pork: pounds of pork in hot dog

Chicken: pounds of chicken in hot dog

Turkey: pounds of turkey in hot dog

Objective: Minimize Cost of Hot Dog

Minimize 0.76(Beef) + 0.82(Pork) + 0.64(Chicken) + 0.58(Turkey)

Constraints:

640(Beef) + 1055(Pork) + 780(Chicken) + 528(Turkey) ≤ 100 [Calorie constraint]

32.5(Beef) + 54(Pork) + 25.6(Chicken) + 6.4(Turkey) ≤ 6 [Fat constraint]

210(Beef) + 205(Pork) + 220(Chicken) + 172(Turkey) ≤ 27 [Cholesterol constraint]

Beef ≥ 0.25(Beef + Pork + Chicken + Turkey) [Beef must be ≥25% of total weight]

Pork ≥ 0.25(Beef + Pork + Chicken + Turkey) [Pork must be ≥25% of total weight]

Beef + Pork + Chicken + Turkey ≥ 2/16 [Hot Dog must be at least 2 ounces]

*(Note, for the last constraint, 1/16 of a pound is one ounce. The right-hand side includes the conversion.)*

Beef, Pork, Chicken, Turkey ≥ 0 *(Non-negativity constraints)*

*Comments:*

*Logically, we are going to make a hot dog that is exactly 2/16 pounds. Thus, the last constraint could be set equal to 2/16. Also, the two “≥ 25%” constraints could be set equal to 1/32 pounds (and thereby avoiding the mixing issue. But for practice, we will do it the “hard” way.*

Note, the Excel formulation and example for this question was provided in the Module 5 handout.

**Python output:**

Hot Dog Problem

status=Optimal

Beef = 0.03125

Chicken = 0.0

Pork = 0.03125

Turkey = 0.0625

Objective = 0.085625

Beef = 0.03125 Reduced Cost = 0.0

Chicken = 0.0 Reduced Cost = 0.06 #if you can reduce the cost of chicken by 6 cents, can reach

Pork = 0.03125 Reduced Cost = 0.0 #an optimized solution

Turkey = 0.0625 Reduced Cost = 0.0

name shadow price slack

0 C1 0.000 14.031250 (14 units of slack, can mark calorie constraint as <= 100-14 =86)

1 \_C2 0.000 2.896875

2 \_C3 0.000 3.281250

3 \_C4 0.180 -0.000000 #binding constraints, no slack, solving at equilibrium

4 \_C5 0.240 -0.000000

5 \_C6 0.685 -0.000000

First, with respect to the Variables, we use Beef, Pork, and Turkey in the solution, but do not use Chicken. Chicken has a reduced cost of 0.06 per pound. Basically, it is 6 cents per pound more expensive than turkey; thus, turkey is preferred. Notice we are using the minimum amount of Beef and Pork to satisfy the 25% requirement and we are making exactly a 2 ounce hot dog. *(As we expected.)*

Second, with respect to the Constraints, the 25% constraints and the 2 ounce constraint are binding. You will notice we are not binding on our nutritional constraints (Calories, Fat, and Cholesterol); thus, they have a Shadow Price of 0.