What Does the "Family Smoking Prevention and Tobacco Control Act" Mean to Tobacco Growers?

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Abstract: The "Family Smoking Prevention and Tobacco Control Act" was signed into law on June 22, 2009. The bill grants the Federal Food and Drug Administration (FDA) an authority to regulate the manufacturing and marketing of tobacco products. Tobacco leaf is not subject to the regulation. As a result, it is not apparent what it does mean to tobacco growers. However, since the demand for tobacco is in large part determined by the demand for cigarettes, a change in demand for cigarettes due to the FDA regulation can affect the demand for tobacco. This paper explores the economic welfare consequences of the bill to tobacco growers.

1. Introduction

The "Family Smoking Prevention and Tobacco Control Act" was signed into law on June 22, 2009, for the first time granting the Food and Drug Administration (FDA) the authority to regulate the manufacturing and marketing of tobacco products. Several stakeholders, including Altria Group (formerly Philip Morris USA), the largest tobacco manufacturer, supported the passage of the legislation. Anti–smoking advocates had hailed it as the greatest move toward protecting the public health.

The legislation has two major components–manufacturing and marketing. The manufacturing component of the legislation allows FDA to set rules to reduce or eliminate harmful ingredients or otherwise modify the design and characteristics of tobacco products if it is determined that such regulation is appropriate to protect the public health. In this regard, one of the major focal points of the FDA regulation is to set rules that could reduce nicotine levels with the stipulation that FDA cannot reduce nicotine levels to zero.

The marketing component of the FDA regulation relates to the labeling, advertising, promotion, distribution and sale of tobacco products. It is aimed at limiting accessibility to tobacco products, particularly among teenagers, through advertisement bans in some facilities

and during sport and other similar events, informing the public about the health risks associated with smoking by requiring manufacturers to disclose the contents of tobacco products and use explicit and conspicuous labels of prominent warnings on packages as well as instituting additional tobacco product standards.

While the exact details of the rules on the manufacturing and marketing of tobacco products are yet to be published, they are expected to be comprehensive and to reduce use of tobacco, particularly among underage individuals. The Congressional Budget Office (CBO) estimates that the adult and underage smoking prevalence will decline by 2 percent and 13 percent, respectively, over the next ten years. As a result, manufactures could potentially face some profit loss resulting from lower demand for tobacco products. They could also lose profit because of payment of user fees and increased processing and manufacturing costs associated with the acquisition of new technologies that would reduce nicotine levels and reduce or eliminate other ingredients or modify the design and characteristics of tobacco products. But, as oligopolists, they can pass a large part of the costs of compliance onto consumers in the form of higher cigarette prices. Since the demand for tobacco leaf is derived from the consumer demand for cigarettes, the reduction of U.S. cigarette consumption as a result of higher cigarette prices could ultimately reduce manufacturers' utilization of tobacco leaf. Also, and importantly, as oligopsonists, they may pass part of the costs of compliance onto growers via marketing contracts, demanding changes or modifications in tobacco farming practices. Research shows that tobacco farming practices affect the yield of nicotine and other ingredients. The changes in farming practices could involve additional costs for new varieties, pesticides, curing structures and others on the part of tobacco growers, thus increasing the marginal cost of tobacco production, and ultimately reducing the supply of tobacco leaf. For instance, when, in recent

years, curing came to be recognized as the mechanism for TSNA formation in flue–cured tobacco, flue–cured tobacco contracts required that it be done in barns that are well equipped with properly maintained heat exchangers that prevent the tobacco from being exposed to combustion gases (Dimitri, 2003). This obviously required extra outlays on the part of tobacco growers. Manufacturers could include similar contract provisions in order to offset some of the cost of compliance associated with the reduction and /or elimination of ingredients from tobacco products. Given the balance of bargaining power between growers and manufacturers in the marketing contracts, tobacco growers could pick up some of the costs of compliance. However, since the legislation formally targets only manufactured tobacco products, not tobacco leaf, it is not apparent what it exactly does mean to tobacco growers. Yet, as pointed out above, since manufacturers may pass some of the costs of compliance onto consumers and growers, ultimately ending up reducing their utilization of tobacco, it is fair to suggest that the "Family Smoking Prevention and Tobacco Control Act" can be of major concern for tobacco growers. This paper aims to analyze the potential direct and indirect effects of the FDA regulation of the manufacturing and marketing of tobacco products on tobacco farms using literature review and simulation. The remainder of the paper is organized as follows. Section 2 provides an overview of the "Family Smoking Prevention and Tobacco Control Act". Section 3 presents an overview of the tobacco industry with a focus on pricing and non–pricing marketing strategies of the industry. Section 4 presents the potential effects of the legislation on tobacco farms, and finally conclusion and implications are presented.

2. Overview of the "Family Smoking Prevention and Tobacco Control Act"

The "Family Smoking Prevention and Tobacco Control Act" allows FDA to look into the composition of tobacco products by requiring manufacturers to disclose the level of nicotine, tar,

and other constituents and ingredients included in the contents of cigarettes and other manufactured tobacco products. If those constituents and ingredients are determined to be harmful, they could be subject to regulation. Although FDA cannot set nicotine levels at zero, it could eventually mandate the reduction of nicotine to a certain minimum level. Further, FDA cannot regulate tobacco farms and tobacco leaf that is not in the possession of a tobacco product manufacturer.

While the disclosure of ingredients can be put into effect in the next six months time, the promulgation of rules requiring the testing and reporting of tobacco product ingredients by brand and sub–brand will take effect within three years from the date of enactment when scientifically sound criteria are established by the FDA Scientific Advisory Committee on Tobacco Product Regulation. FDA would have to first evaluate their effects and establish new standards for the manufacturing of tobacco products. However, beginning three months from the date of enactment, no flavorings will be added to cigarettes except for menthol. An exception is provided for menthol until solid evidence is made available in the year following the enactment of the bill about its physiological and additive effects. Furthermore, FDA would have the authority to restrict and ban tobacco advertising and promotion to the fullest extent allowed by the First Amendment of the U.S. Constitution, which does not allow imposing a complete ban on all forms of communication since it may infringe on the freedom of commercial speech. However, it could put together more focused, stringent and comprehensive rules governing the labeling, advertisement, distribution and sale of tobacco products. The bill includes location and facility–specific restrictions on advertisement, prominent health warnings and other marketing strategies. Point–of–sale advertisement and vending machines will be limited to adult–only facilities and no tobacco product can be advertised as "FDA approved." A federal ban will be

imposed on sponsorship of sports and entertainment events as well as all outdoor tobacco advertisement within 1,000 feet of schools and playgrounds. In addition, cigarette packages will have several warning labels with the word "warning" written in capital letters, covering 50 percent of the display surface of the pack. Retailers who sell to minors will be subject to federal prosecution rules.

Modified risk tobacco products labeled as "low tar", "light", or "mild", will no longer be made available for sale unless they are expressly approved by the FDA. The bill also requires FDA approval of the marketing of all new products that were introduced into the market after February 15, 2007. An exception is provided for products introduced within 21 months of the date of enactment of the bill. Finally, the bill also creates a standard for good manufacturing practices, which can include testing for pesticide residues.

In three months from the date of enactment of the bill, FDA has established a new center that is mandated to engage in rule–making pertaining to the manufacturing and marketing of tobacco products. The center is financed through assessment of user fees on tobacco manufacturers in proportion to their market shares. The Congressional Budget Office (CBO) estimates that the operational cost of the center over the next 10 years will be nearly $5.4 billion.

3. Tobacco Industry

As only five cigarette companies (Altria Group, Reynolds American Inc., Lorillard, Commonwealth Brands, and Liggett) control more than 90 percent of all sales in the US (Maxwell, 2007), they constitute an oligopolistic market structure. Altria Group is the largest manufacturer, accounting for almost one–half of the cigarette market. R.J. Reynolds and Lorillard Tobacco Co. are the industry's second and third largest manufacturers with market shares of 27.8 percent and 9.7 percent, respectively while Commonwealth Brands and Liggett are

the industry's fourth and fifth largest manufacturers with market shares of 3.7 percent and 2.4 percent, respectively.

In order to determine whether and if so how the FDA regulation could reduce tobacco consumption and by extension the demand for tobacco, it is important to understand the marketing strategies of the tobacco industry.

3.1. Pricing

As in any other oligopoly, no individual firm in the tobacco industry has the incentive to raise or lower price (i.e., pricing strategy) independently unless it is a price leader because the price elasticity of demand depends on the reaction of rivals to changes in price and output. In other words, since the actions of firms operating in an oligopolistic market structure are interdependent, pricing is not the customary marketing strategy because an action taken by one firm can easily be observed and reciprocated immediately by rivals. If, for instance, Altria Group raises the price of *Marlboro*, its largest selling brand, then Reynolds American Inc. will not follow suit because of higher substitution effect from the high price of *Marlboro* to the relatively lower price of *Camel*, one of the largest selling brands of Reynolds American Inc., thereby making the demand for *Marlboro* and *Camel* relatively more elastic so that the rise in price would lead to a fall in the total revenue accruing to Altria Group. If, on the other hand, Altria Group lowers price, then Reynolds American Inc. and other rivals are more likely to match the price fall to avoid a loss of market share. When that happens, the demand for both *Marlboro* and *Camel* will be more inelastic and the fall in price will lead to a fall in total revenue accruing to both companies, suggesting that a move by an individual tobacco firm to reduce cigarette price independently will neither increase market penetration nor increase total revenue. Therefore, there is no reason to expect an increase in cigarette consumption as a result of the industry's

pricing strategy. The plausible way manufacturers may encourage further consumption to the detriment of the FDA regulation is if they can act in concert to reduce prices. But, they have no economic reason to do so because the demand for cigarettes is inelastic. They increase their revenue not by decreasing prices but by increasing it in which case reduced consumption is achieved. They have the ability to raise prices above competitive levels and gain from it if there is a mutual agreement that does not violate legality. This will work in favor of the FDA regulation simply because consumption will go down when prices rise. The industry will benefit from increased revenue.

In light of the FDA regulation, two things appear to be at play, working against each other as far as the pricing strategy is concerned. The first one is the advertising ban and the second one is the assessment of user fees on manufacturers to finance the operation of the newly created Center for Tobacco Products to promulgate and enforce new manufacturing and marketing rules. The advertisement ban can have an unintended effect of increasing consumption if the reduction in advertising expenditure may allow manufacturers to lower prices, thereby encouraging consumption because of the price effect. In 2005, the five largest cigarette manufacturers spent over 13 billion in advertisement and promotion of which nearly three–fourth were spent on price discounts paid to cigarette retailers or wholesalers to reduce the cost of cigarettes to the consumer and the remaining was spent on coupons for discounted cigarettes, and retail value–added promotions, such as “buy one, get one free” (Federal Trade Commission, 2007).

As to the assessment of user fees on manufacturers, the CBO estimates that the operations of the newly created Center for Tobacco Products would cost nearly $5.4 billion over a period of ten years. The assessment on manufacturers would be in proportion to their market

shares as was done for the tobacco quota buyout in 2004. Hence, an increase in the price of cigarettes is to be expected as the manufacturers pass their share of the user fees onto consumers, resulting in less overall consumption. Further, as discussed earlier, given the dependence of the price elasticity of demand for tobacco products on the reaction of rivals and the user fees are assessed in proportion of their market shares, none of them would have the economic motive or incentive to invoke price competition by not passing or passing only some of its share of the user fees onto consumers and keep the price of its brands relatively cheaper. Hence, in all likelihood, all manufacturers are going to pass all of their shares of the user fees onto consumers by increasing the price of their respective brands. If one company chooses not to pass its shares of the fees at all or pass only some of its share of the user fees for a strategic reason such as gaining market share, it could end up hurting everybody including itself by inducing them to follow suit. Therefore, the user fees are likely to be effective in decreasing consumption and by extension tobacco production. Finally, since the price elasticity of demand for cigarettes by youth is higher than adults, the imposition of user fees can help to further reduce consumption by reducing smoking prevalence among the youth. Every 10 percent increase in the price of cigarettes reduces youth consumption by 7 percent (Federal Trade Commission, 2007).

3.2. Non–pricing strategies.

Non–price competition assumes increased importance in the tobacco industry to increase one company's market shares. Non–price competition involves advertising and other marketing strategies to increase demand and maintain brand loyalty among consumers and to familiarize consumers with their new products. The effectiveness of the FDA regulation on reducing consumption depends on how the new rules would make it more difficult for the tobacco firms to utilize non–market strategies to market their products. For instance, one of the rules that FDA is

going to enforce is restricting the introduction of new products that have appeal to potential smokers. Another rule involves changes in labeling. Explicit and conspicuous display of prominent warnings on 50 percent of the front and back side of the cigarette package may persuade consumers to be less willing to purchase cigarettes and quit smoking over the long run. Schneider, *et al*. (1981) has shown that labels providing information that depicts negative health consequences of smoking has been an important factor in the decrease of cigarette consumption in the U.S. Other measures such as restrictions on advertising and sales promotions could also have significant effects on tobacco use (Saffer and Chaloupka, 2000; Farrelly *et al*. 2003). Although manufacturers maintain that advertising merely enhances the market share of a particular brand without recruiting new smokers, several sources including the U.S. Department of Health and Human Services, Institute of Medicine and world health organizations have found that tobacco advertising significantly increased tobacco sales (Roemer, 1993; Lynch and Bonny, 1994; Jha and Chaloupka, 1999). Given the comprehensiveness of the provisions included in the current bill, it is likely that some reductions in consumption and by extension tobacco production are to be expected by the inhibiting the effectiveness of the marketing strategies of the industry such as development of new tobacco products that have appealing to new smokers and denying access to facilities and locations where the new products could receive more attention and promotion.

4. Potential Effects

This section presents an estimate of the potential effects of the FDA regulation on tobacco farms in terms of change in tobacco revenue and producer surplus. It will also present potential changes in tobacco farming practices. The changes in manufactures' utilization of tobacco could result from both the demand and supply–sides of the tobacco industry. Figures 1

and 2 demonstrate how the FDA regulation could affect manufactures' utilization of tobacco leaf.

4.1.1. Demand–side effects

The FDA rules associated with, for example, the disclosure of the contents of cigarettes, display of prominent labels, restricted advertisement, etc are expected to raise public awareness about the health risks associated with smoking and result in persuading smokers to reduce consumption. Figure 1 (a & b) illustrates the mechanism by which a cut in U.S. smoking due to increased awareness of its health risks is translated into a decrease in demand for tobacco leaf. Figure 1(a) shows that as the demand for U.S. smoking decreases, the short–run domestic demand curve of cigarette will shift downward from Q_d to Q'_d with the quantity supplied of cigarettes decreasing from Q to Q' along the supply curve. Given that the supply curve of cigarettes is horizontal (i.e., perfectly elastic), the key is the change in the equilibrium quantity of cigarettes. There will be no change in the price of cigarettes. Price remains unchanged at w. Since we are assuming a partial equilibrium model, the shift in the demand curve does not trigger a shift of the supply curve. The area $A + B$ represents the consumer surplus from consumption of American–made cigarettes before the decrease in demand and leftward shift of the cigarette demand curve. Following the shift, the consumer surplus reduces to area A. They would lose area B.

As consumers cut their consumption of cigarettes, manufacturers make fewer cigarettes than before, thus resulting in tobacco farmers contracting and selling less tobacco leaf at each price point, shifting the demand curve of tobacco leaf from X_d to X_d' (Figure 1(b)). With the upward sloping tobacco supply remaining unchanged X, the downward shift of the tobacco leaf

demand will create an excess supply at the original equilibrium price p, thus prompting suppliers to bid down the tobacco leaf price from p to p'. As the price falls, the quantity demanded increases from x'' to x' and the quantity supplied decreases from x to x', both acting to reduce the amount of the excess supply. Finally the entire excess supply is eliminated and equilibrium is restored at p'. With downward sloping demand curve and upward sloping supply curve, the decrease of the tobacco price from p to p' and the accompanying decrease of the quantity of tobacco from x to x' results in the loss of producer surplus. The magnitude of loss of the producer surplus depends on the price elasticity of supply and demand.

The loss of producer surplus caused by the decrease of the price from p to p' is depicted by area $D + K + E$ in Figure 1(b). The larger part of the producer surplus loss (area $D + K$) would be borne by those growers who would continue to be willing to supply in spite of the price fall while the smaller part of the loss depicted by area E would be borne by those growers who would no longer be willing to supply after the price fall and thus exit tobacco farming. The higher the price elasticity of the supply of tobacco, the lower would be the producers' loss.

4.1.2. Supply–side effects

The FDA regulation could also affect tobacco farms through the decrease in supply of tobacco products resulting from the increase in manufacturers' marginal cost of cigarette production. The increase in marginal cost of cigarette production shifts the supply curve of cigarettes upward. Increased costs are reflected by an upward shift in supply curve. The supply–side effect result from manufacturers passing along the cost of compliance (i.e., user fees and the cost of additional investments in new technologies that would reduce nicotine and reduce or eliminate other ingredients or modify the design and characteristics of tobacco products) to

consumers in the form of higher prices, leading to the reduction of the quantity demanded of cigarettes, and shifting the demand curve of tobacco leaf from X_d to X_d' (Figure 2(b)). With the upward sloping tobacco supply remaining unchanged X, the downward shift of the tobacco leaf demand curve results in the decrease of the tobacco leaf price from p to p' and the quantity supplied of tobacco from x to x'. The loss of producer surplus caused by the decrease of the price from p to p' is depicted by area $D + K + E$ in Figure 2(b).

MODEL

The model consists of a system of demand and supply equations of vertically linked markets for cigarettes at the wholesale level and tobacco leaf at the farm level. The domestic and export demand functions of cigarettes can be given by:

(1) $$Q_d = h(W, R)$$

(2) $$Q_e = l(W_e)$$

where Q_d is the domestically consumed quantity of cigarettes; W is the wholesale price of cigarettes; R is an exogenous domestic demand shifter (i.e. FDA regulation); Q is the quantity of cigarette production; Q_e is the exported quantity of cigarettes and W_e is the wholesale price of exported cigarettes.

The domestic tobacco production and demand for domestic tobacco are given by:

(3) $$X = h(P).$$

(4) $$X_d = g(P, Q).$$

where X is domestic tobacco production; X_d is the demand for domestic tobacco by U.S. cigarette manufacturers; P is domestic tobacco price and Q is domestic cigarette production.

Since we are assessing the effect of changes in the system of demand and supply equations of the tobacco industry due to tobacco product market regulation, we take the total differentials of the above system of demand and supply equations and present the results as Equilibrium−Displacement Model.

The domestic demand for cigarettes (Eq. 1) can be expressed as:

(5) $$dLnQ_d = \eta dLnW + \lambda.$$

(5.1) $$dLnQ_d = \eta(dLnW + \delta),$$

where $dLnQ_d = dQ_d/Q_d$ be the percentage change in the domestically consumed cigarettes; η is the own price elasticity of the domestic demand for cigarette; $dLnW$ be the percentage change in domestic wholesale cigarette price; λ represents the percentage change in initial equilibrium quantity for domestic cigarette due to the exogenous demand shift (e.g., the percent decrease in quantity of cigarettes smoked per annum as a result of the new FDA regulation); δ represents the percentage change in initial equilibrium price of cigarettes following the upward shift of the cigarette supply curve. As the cigarette supply curve shifts upward due to the increase in marginal cost of cigarette production, the price of cigarette increases by δ, representing the percentage shift up of the cigarette supply curve.

Eq. (5) represents the proportional change in equilibrium quantity demanded of cigarettes as the domestic demand for cigarettes shifts leftward due to, for example, increased awareness of the health risks of smoking as part of the FDA regulation (refer to Figure 1). Eq. (5.1) represents the proportional change in equilibrium quantity demanded of cigarettes as the price of cigarette increases following the upward shift of the supply of cigarette curve due to increased marginal cost of cigarette production (refer to Figure 2).

The export demand for cigarettes (Eq. 2) is given as:

(5.2) $$dLnQ_e = \eta_e dLnW_e,$$

where $dLnQ_e$ be the percentage change in the quantity of exported cigarettes; η_e is the own price elasticity of the exported cigarettes; $dLnW_e$ be the percentage change in domestic wholesale price of exported cigarettes.

Assuming that the FDA regulation will not result in cigarette stocks, the equilibrium percentage change in both the supply and demand for cigarettes can be given as:

(6) $$dLnQ = \beta dLnQ_d + (1-\beta) dLnQ_e,$$

where $dLnQ$ be the percentage change in domestic cigarette production; β is the proportion of domestic cigarette output consumed domestically and $(1-\beta)$ is the proportion of exported cigarettes and $dLnQ_e$ be the percentage change in exported cigarettes.

Again, assuming that the scale elasticity of domestic tobacco with respect to cigarette production is unity, the percentage change in the quantity of domestic tobacco purchased by domestic manufacturers can be given as:

(7) $$dLnX_d = \omega dLnP + dLnQ,$$

The export demand for U.S. tobacco can be given as:

(7.1) $$dLnX_e = \omega_e dLnP,$$

where $dLnX_d$ be the percentage change in domestic tobacco purchased by domestic cigarette manufacturers; and $dLnX_e$ be the percentage change in quantity of exported tobacco; ω is the own price elasticity of the domestic demand for tobacco, ω_e is the own price elasticity of the

export demand for domestic tobacco and $dLnP$ be the percentage change in domestic tobacco price.

The domestic tobacco production or supply (Eq. 3 and Eq. 4) can be given as:

(8) $$dLnX = \varepsilon dLnP.$$

where $dLnX$ be the percentage change in domestic tobacco production and ε is the price elasticity of the supply of domestic tobacco that reflects the response of tobacco growers to changes in market price.

The market–clearing identity for tobacco can be given as

(9) $$dLnX = \alpha dLnX_d + (1-\alpha) dLnX_e.$$

where α is the proportion of domestic tobacco production purchased by domestic cigarette manufacturers and $(1-\alpha)$ is the proportion of the quantity of exported tobacco.

The system of equations 5–9 is solved for $dLnP$ and $dLnX$ through repeated substitution method. Once $dLnP$ and $dLnX$ are determined, we will assess the economic welfare consequences of the decrease in U.S. cigarette consumption and increase in cigarette prices prompted by the FDA regulation.

Starting with $dLnX$ we substitute Eq. (7) for $dLnX_d$ and Eq. (7.1) for $dLnX_e$ into Eq. 10, yielding

10. $$dLnX = \alpha\omega dLnP + \alpha dLnQ + (1-\alpha)\omega_e dLnP.$$

Note that Eq. (10) creates the link between tobacco production and cigarette production through $dLnQ$.

To split the total cigarette production into the domestic demand for cigarettes $(dLnQ_d)$ and the export demand for U.S. cigarettes $(dLnQ_d)$, we substitute Eq. (6) for $dLnQ$.

(11) $$dLnX = \alpha\omega dLnP + \alpha\beta dLnQ_d + \alpha(1-\beta)dLnQ_e + (1-\alpha)\omega_e dLnP.$$

Continuing to substitute Eq. (5) for $dLnQ_d$ and Eq. (5.2) for $dLnQ_e$ into Eq. (11), we find that

(12)

$$dLnX = \alpha\omega dLnP + \alpha\beta\eta dLnW + \alpha\beta\lambda + \alpha(1-\beta)\eta_e dLnW_e + (1-\alpha)\omega_e dLnP.$$

Now, equating equation Eq. (12) with Eq. (8) and assuming no change in price of cigarettes and export tobacco, the proportional change in tobacco price due to the FDA regulation resulting from, for example, increased awareness of the health risks associated with smoking, can be determined as:

(12.1) $$dLnP = \frac{\alpha\beta\eta}{\varepsilon + \alpha\omega + (1-\alpha)\omega_e} dLnW + \frac{\alpha(1-\beta)\eta_e}{\varepsilon + \alpha\omega + (1-\alpha)\omega_e} dLnW_e + \frac{\alpha\beta}{\varepsilon + \alpha\omega + (1-\alpha)\omega_e}\lambda.$$

Eq. (12.1) gives us the demand–side effect of the FDA regulation, assuming no change in both export and domestic prices of cigarettes. This is depicted in Figure 1 (a & b) where there is no change in equilibrium price of cigarettes as the demand for cigarettes shifts downward and the quantity of cigarettes supplied recedes along the horizontal or perfectly price elastic supply curve. As a consequence, manufacturers reduce their utilization of tobacco leaf, and the quantity supplied of tobacco and price of tobacco go down, which is depicted in Figure 1b.

Hence, the proportional change in tobacco price due to the leftward shift of the demand for cigarettes prompted by the FDA regulation can be expressed as:

(12.2) $$dLnP = \frac{\alpha\beta}{\varepsilon + \alpha\omega + (1-\alpha)\omega_e}\lambda.$$ [Refer to Figure 1(a & b)]

On the supply side, the effect of the FDA regulation involves an increase in cigarette prices. Refer to Figure 2 (a & b). The supply–side effect results from the increase in

manufacturers' cost of cigarette production because of the cost of compliance (i.e., the cost of additional investments in new technologies that would reduce nicotine and reduce or eliminate other ingredients or modify the design and characteristics of tobacco products). Also, manufacturers must pay user fees to the federal government to continue selling cigarettes according to their market shares in the domestic market. In other words, user fees are implicit taxes or inputs required in the production of cigarettes. These implicit costs are passed onto consumers in the form of higher prices, resulting in reduction of consumption of cigarettes. As a consequence, the demand for tobacco would decline.

Substituting Eq. (5.1) for $dLnQ_d$ and Eq. (5.2) for $dLnQ_e$ in Eq. (11) we find that

$$dLnX = \alpha\omega dLnP + \alpha\beta\eta dLnW + \alpha\beta\delta\eta + \alpha(1-\beta)\eta_e dLnW_e + (1-\alpha)\omega_e dLnP \tag{13}$$

We establish the relationship between the price of cigarettes and compliance fees as

$$dLnW = \gamma_{dt} dLnP + \gamma_{cf}\delta. \tag{14}$$

where γ_{dt} is domestic tobacco share of domestic wholesale cigarette price; γ_{cf} is the cost share of compliance fees in wholesale cigarette price and δ is the percentage change in compliance fees, representing the increase in marginal costs and accompanying upward shift of the supply curve.

Since the regulation does not apply to exported cigarettes or the payment of the user fees is based on the domestic market share, not export market share, the export price is the domestic whole sale price net of the compliance fees, which can be given as:

(14.1) $$dLnW_e = \left[\frac{1}{(1-\gamma_{cf})}\right](dLnW - \gamma_{cf}\delta)$$

Substituting Eq. (14) for $dLnW$ into Eq. (14.1) will yield

(14.2) $$dLnW_e = \left[\frac{1}{(1-\gamma_{cf})}\right]\gamma_{dt}dLnP$$

Continuing to substitute Eq. (14) for $dLnW$ and Eq. (14.2) for $dLnW_e$ into Eq. (13) and equating the resulting equation with Eq. (8) will give the proportional change in tobacco price due to the increase in marginal cost of cigarette production prompted by the FDA regulation as:

(15) $$dLnP = \frac{\alpha\beta\eta(1+\gamma_{cf})}{\left[\varepsilon + \alpha\omega + (1-\alpha)\omega_e + \alpha\beta\eta\gamma_{dt} + \left(\frac{1}{1-\gamma_{cf}}\right)\alpha(1-\beta)\eta_e\gamma_{dt}\right]}\delta$$ [Refer to Figure 2(a & b)]

[Refer to Figure 2(a & b)]

Now that the effects on tobacco price of the exogenous factors (i.e., the decrease in the rate of U.S. cigarette consumption due to the FDA regulation $(\lambda)$and the increase in compliance costs (δ) have been determined through equation (15), we can calculate the proportional change in tobacco revenue and the change in producer surplus.

Baseline: A 2% reduction in U.S. cigarette consumption and a 13% increase in cigarette prices

We use 2 percent and 13 percent as a baseline for the change in U.S. cigarette consumption and cigarette prices, respectively, while assessing the potential welfare effects of the FDA regulation on tobacco growers. They were chosen because U.S. cigarette consumption has been declining at 2 percent per annum since 2000 (ERS/USDA, 2007) and the increase of the federal excise tax from $0.39 per pack to $1.00/pack in April, 2009 represents a 13 percent

increase in cigarette prices. A decrease in U.S. cigarette consumption beyond the 2 percent and an increase in cigarette prices beyond the 13% could, in large part, be attributed to the FDA regulation.

Considering that, on average, 60 percent of the tobacco production in the country is used by domestic cigarette manufacturers, and the remainder exported, and also, 75 percent of the cigarettes manufactured in the country is consumed in the country and the remainder exported, a 2 percent reduction in U.S. cigarette consumption *with no change in the price of cigarettes* would translate into a 0.90 percent $(\alpha\beta)$reduction in the use of domestic leaf, creating excess supply at the initial equilibrium price. This would prompt tobacco suppliers to bid down the tobacco leaf price by 0.10 percent leading to a 0.70 percent reduction in equilibrium quantity. In other words, the 2 percent reduction in U.S. cigarette consumption would first translate into a 0.9 percent decrease in demand for domestic tobacco leaf used in the domestically consumed cigarettes and then result in a 0.10 percent reduction in equilibrium price and a 0.70 percent reduction in equilibrium quantity supplied of domestic tobacco leaf. The fact that the 2 percent decrease in U.S. cigarette consumption with no change in cigarette prices has led to a 0.10 percent decrease in tobacco leaf prices and then a 0.70 percent decrease in quantity supplied of tobacco leaf signifies the importance of the impact of changes in the product market on the tobacco farm. This is consistent with Womack (2003) who noted that much of the decline in domestic manufacturing utilization of U.S. tobacco is attributed to reduced cigarette consumption by Americans.

It is important to point out here that the larger part of the decline in equilibrium quantity would result from the decrease in acreage while a very small part would result from those who would totally exit the tobacco farming. With 800.5 million lbs of tobacco produced on 16,234

tobacco farms in the U.S., and supplied at $1.865/lb in 2008 (USDA) on average each farm would cut supply by 342 lbs of tobacco leaf, or reduce tobacco acreage by nearly one–sixth of an acre, as a result of the 0.10 percent reduction in domestic tobacco leaf prices caused by the 2 percent cut in U.S. cigarette consumption. Consequently, tobacco revenue would decrease by 0.80 percent, resulting in nearly $11.8 million. This amount will be distributed among tobacco growers, input suppliers, laborers, etc. In terms of producer surplus, tobacco growers would lose nearly $1.48 million (area $D + K + E$ in Figure 1(b)). The $1.48 million loss in producer surplus is totally borne by tobacco growers.

Now considering the 13 percent increase in cigarette prices with *no shift in demand for cigarettes* as a baseline, we calculate the effect of an increase in cigarette prices on tobacco farms. The 13 percent increase in cigarette prices leads to the decrease of the price and quantity of tobacco production by 0.27 percent, and 1.89percent, respectively. On average, each farm would cut supply by 934 lbs of tobacco leaf, or reduce tobacco acreage by over two–fifth of an acre. Tobacco revenue would decline by 2 percent, and growers would lose $4 million in producer surplus.

Demand–side effects of the FDA regulation: A 10% reduction in U.S. cigarette consumption

Following the same procedure as in the previous section, the changes in price, quantity supplied of tobacco, revenue as well as producer surplus are calculated under different scenarios of the rate of decline in U.S. tobacco consumption. Table 1 presents the effects of a 2 to 10 percent decrease in U.S. cigarette consumption on prices, quantities, revenues and producer

surplus. We discuss the effects under the scenario in which the U.S. consumption of American–made cigarettes would decrease by 10 percent.

The 10 percent reduction in U.S. cigarette consumption would translate into a 4.5 percent cut in the demand for tobacco leaf, causing a 0.50 percent and a 3.47 percent reduction in tobacco leaf price and quantity supplied of tobacco leaf, respectively. At this rate of decline, tobacco revenue would decline by nearly 4 percent, amounting to over $59 million. In terms of producer surplus, tobacco growers would lose nearly $7.3 million (area $D + k + E$ in Figure 1b). The larger part (98 percent) of the $7.3 million loss in producer surplus would be borne by growers continuing to be willing to supply in spite of the price fall. The other part of the producer surplus loss would be borne by exiting growers. As the rate of U.S. cigarette consumption continues to decline, more and more tobacco farms would no longer be willing to do supply tobacco.

Supply–side effects of the FDA regulation: A 30% increase in cigarette prices

Table 2 presents the effects of a 13 to 30 percent increase in cigarette prices on tobacco prices, quantities, revenues and producer surplus. The 30 percent increase in cigarette prices results in the price and quantity of tobacco production decreasing by 0.62percent, and 4.37 percent, respectively. Tobacco revenue would decline by 5percent, and growers would lose 9 over $9 million in producer surplus.

The effect of the regulation depends on the proportion of U.S. exports of tobacco and cigarettes–the higher the proportion of U.S. exports of tobacco and cigarettes, the lower the impact of the regulation on tobacco farms. Considering the fact that the supply of tobacco leaf can be highly responsive to changes to price in the long run, it can be deduced that the loss of

surplus will go down in the long run because the more elastic the supply curve is, the smaller the amount of producer surplus.

4.2. Potential changes in tobacco farming practices

The changes in the method of production could end up increasing the cost of tobacco production by affecting the choice of varieties, nitrogen application rate, topping, harvesting, , processing and curing.

3.1.1. Tobacco types/varieties

All tobacco types have nicotine, nornicotine, anabasine, and anatabine with nicotine being the predominant alkaloid, representing 90–95 percent of the total alkaloid content and the remaining three alkaloids accounting for a relatively small percentage (5–10 percent) of the alkaloid pool (Jacob *et al*. 1999; Wu, *et al*. 2002; Siminszky *et al*. 2005). Although nornicotine typically represents <5 percent of the total alkaloid content in cultivated tobacco, Siminszky, *et al*. (2005) note that nornicotine levels can dramatically increase by a mechanism termed "conversion" in which plants that accumulate nicotine as their principal alkaloid give rise to progeny that metabolize a large portion (as high as 95 percent) of leaf nicotine to nornicotine.

Research shows that nicotine is the source for the formation of a group of chemicals collectively known as tobacco–specific *N*–nitrosamines[1] (TSNAs) which are widely considered to be among the most important carcinogens in tobacco products (Stepanov *et al*. 2006). Research also shows that every step in tobacco leaf production that affects plant metabolism could influence nicotine yield to a certain degree (Tso, 1990). Further, both nicotine and nornicotine give rise to TSNAs during all stages of tobacco production, from growing in the field

[1] Nitrogen containing compounds

to curing, processing, and storage, as well as during product manufacturing (Hoffman *et al*. 1994).

Different tobacco types have different levels of nicotine yield. Burley tobacco has higher nicotine yield levels than flue–cured tobacco (Djordjevic and Doran, 2009). Burley tobacco lamina contained 35.6–47.73 mg nicotine per gram of dry tobacco (MacKown *et al*. 1988). Flue–cured Virginia bright tobacco contained 6.52–60.4 mg nicotine per gram of dry tobacco leaf (Djordjevic *et al*. 1989). The Maryland (light air–cured tobacco) and Turkish or Oriental (sun–cured types of tobacco) are generally low in nicotine content while dark fire–cured tobaccos are high in nicotine content (Djordjevic and Doran, 2009). Ding *et al*. (2008) find that tobacco type can influence the mainstream smoke delivery of nicotine and TSNAs. Genetically, flue–cured and dark tobaccos have fairly low levels of nornicotine and the trait is stable, while burley tobaccos have higher levels and tend to be highly variable (Djordjevic and Doran, 2009).

The implication is that manufacturers could reduce the amount of tobacco used in each cigarette and reconfigure the composition of tobacco types in favor of lower nicotine levels. For example, they could reconfigure the blending formula in the popular American–blend cigarettes in favor of more flue–cured and oriental tobacco. Currently, American–blend cigarettes contain approximately 45 to 50 percent flue–cured, 35 to 40 percent burley, 15 percent Oriental and one percent Maryland leaf (Presidential Commission, 2001). In light of their lower nicotine yields, the demand for flue–cured tobacco, Maryland (air–cured tobacco) and Turkish (oriental) types of tobacco could be higher than that for burley tobacco, thus potentially benefitting flue–cured growers more than burley tobacco growers. The fact that these different tobacco types are traditionally and more suitably grown in specific locations (i.e., burley in Tennessee and

Kentucky and flue–cured in North Carolina) pronounces the regional economic implications of the low–nicotine rule.

While the emerging blending formula could potentially favor tobacco types with low nicotine levels such as flue–cured and oriental tobacco, the burley tobacco still remains an important part of the blending formula in the American–blend cigarettes. This is because burley and flue–cured tobacco have different characteristics. The substitutability between them is limited (Beghin and Chang, 1992). Further, the fact that the larger proportion of the domestic burley production is exported, the FDA regulation, which is applied on tobacco products manufactured and marketed in the U.S., may not have much of an impact on burley. In fact, farms contracting with the domestic manufacturers may replace the existing burley varieties by new varieties with low levels of nicotine and low potential to convert nicotine to nornicotine. The Kentucky–Tennessee burley tobacco breeding program has recently re–released five existing varieties (TN 86 LC, TN 90 LC, TN 97 LC, KT 200 LC and KY 907 LC) that have low potential to convert nicotine to nornicotine (Denton, 2004). Since the burley tobacco for export does not have to meet the new standards of domestic manufactures, two different production schemes–one for export and another for domestic use–could potentially emerge.

The level of the major alkaloids is also significantly different among the other major tobacco types grown in the U.S. Nornicotine levels are the highest in cigar tobacco, anatabine levels are the lowest in chewing tobacco and oral snuff, and anabasine levels are the lowest in chewing tobacco (Jacob *et al*. 1999). This suggests that growers of these other major tobacco types are not out of the loop in view of the fact that the low nicotine and other alkaloids rule is not only limited to cigarettes, but is applied across all manufactured tobacco products in the country.

3.1.2. Fertilizer

A good number of studies attribute the increase in nicotine yield level in tobacco to increased nitrogen supply (Campbell *et al*. 1982; Collins and Hawks, 1994). The direct relationship between the rate of nitrogen supply and the level of nicotine concentration implies that controlling the level of nitrogen supply in tobacco production could maintain low nicotine concentration in tobacco leaves. Yet, the failure to supply the optimum level of nitrogen has a significant negative impact on leaf yield because nitrogen fertilization is an important cultural practice that significantly impacts the tobacco leaf yield (Marchetti *et al*. 2006). The opportunity not adding or reducing the recommended nitrogen rate is the amount of leaf yield forgone. Alternatively, the opportunity cost of applying the recommended nitrogen rate topping is the increase in nicotine yield. Because of its significant cost implications, the decision on nitrogen application potentially could be an important decision that tobacco growers have to make if they are required to abide by it.

Further, the lack of synchronization between nitrogen assimilation and nicotine synthesis in tobacco plants during the entire growth period (Wei–qun *et al*. 2008) and occurrence of nicotine accumulation at later growth stages, especially after topping (Mumba and Banda, 1990) makes the decision on timing and method of nitrogen application as important as the level of nitrogen applied. The proportion of nitrogen derived from soil or fertilizer changes during the growing period (Guo *et al*. 1997). They note that the nitrogen in the chemical fertilizer is derived mainly at early growth stages whereas the nitrogen in the soil is derived at later stages of the development of the plant. The later the nitrogen application, the more marked was the effect on nicotine concentration (Crockford, 1977).

Lastly, the effect of fertilizer on nicotine concentration varies with the type of tobacco and part of the tobacco plant. For instance, Djordjevic and Doran (2009) found that nicotine content increased by 57 percent in lamina and 140 percent in midribs of air–cured tobacco when nitrogen application increased from $0 - 300$ lbs per acre. However, it increased by only 1 percent in lamina and 5 percent in midribs of fire–cured tobacco. This suggests that growers have to apply different rates for different tobacco types and varieties. Mumba and Banda (1990) also found that the magnitude of the effect of nitrogen fertilizer was slightly negative in bottommost leaves and increased with ascending leaf position to the top group. This may have an important implication for timing of harvest.

3.1.3. Topping

While a good number of studies attribute the increase in nicotine yield in tobacco to nitrogen application, some studies argue that the increase in nicotine yield in tobacco is due to a mere reaction of the tobacco plants to the physical injury of the tobacco plant caused by the practice of topping (Wang *et al*. 2008). According to Baldwin (2002), the reason behind the increased nicotine synthesis in tobacco plants after topping is one of the typical responses of plants to avoid further herbivore attack. The direct relationship between topping and the level of nicotine concentration obviously implies that topping should not be done. Yet, the failure to practice topping for the purpose of reducing nicotine concentration has a significant negative impact on leaf yield. Because of its significant cost implications, the decision on topping could be an important decision that tobacco growers have to make.

3.1.4. Degree of ripening/harvesting

The fact that flue–cured tobacco does not get ripe all at the same time causes growers to harvest from the same plant several times rather than all at a time thereby making harvesting costly. Because bottom leaves get ripe before the upper and middle leaves, the practice of waiting for all leaves to ripe and harvest them together may save costs; however, it has a downside since it not only allows the quality of the already ripe bottom leaves to deteriorate but also allows the upper and mid leaves to accumulate nicotine. Xiao–Tang *et al*. (2007) finds that the later the leaves harvested, the higher the proportion of nitrogen taken from the soil, causing the upper and middle leaves to accumulate more nicotine than the bottom leaves. Finally, although physical injury inflicted on the plant during frequent harvesting was thought of stimulating increased activity of nicotine production, Wang *et al*. (2008) found that reducing the leaf harvest times did not reduce leaf nicotine yield.

3.1.5. Processing and Curing

Green and freshly harvested tobaccos are virtually free of TSNAs or contain extremely low levels of TSNA (Parsons *et al*. 1986). The way tobacco is cured (Peele *et al*. 1995) and the conditions under which it is stored (Burton *et al*. 1989) are identified to have a profound influence on the alkaloid content in tobacco. Several of the minor alkaloids are thought to arise by bacterial action or oxidation during processing rather than by biosynthetic processes in the living plant (Leete, 1983). TSNAs typically form in tobacco during the post–harvest period, with some fraction being transferred into mainstream smoke when a cigarette is burned during use (Brown *et al*. 2003). Because nornicotine serves as the precursor in the synthesis of carcinogens during the curing and processing of tobacco, researchers at North Carolina University developed genetically modified tobacco cultivars that have a 50 percent overall reduction in TSNAs (Science Daily, 2008). However, tobacco growing states have so far shunned genetically

modified tobacco. Therefore, given the significance of direct–fired curing as a source of TSNA formation in flue–cured tobacco (Peele *et al*. 1999), the plausible way to reduce the TSNA concentrations has been to change from direct–fired to indirect–fired barns for curing flue-cured tobaccos. Since cigarette blends also contain burley tobacco leaves that can increase smoke TSNA concentrations, use of burley varieties recently released by the Kentucky–Tennessee burley tobacco breeding program for their low potential to convert nicotine to nornicotine appear to be the practical way to address the problem.

3.1.6. Physical characteristics

Research shows that the level of nicotine and other constituents can be influenced by environmental/physical characteristics (Djordjevic and Doran, 2009). Soil type, weather and climatic conditions are important factors influencing the level of nicotine yields in tobacco plants. This has an important implication for site, variety selection and crop rotation.

Conclusion and Implications

The study has examined the potential effects of the FDA regulation of the manufacturing and marketing of tobacco products through simulation and literature review. Results of the simulation exercise suggest that the FDA regulation could affect the price, quantity, revenue, and producer economic rent of tobacco. Under the maximum–effect scenario in which U.S. cigarette consumption declines by 10 percent, the price and quantity of tobacco would decrease by 0.50 percent, resulting in about 3.5 percent decline in quantity supplied of tobacco. Consequently, tobacco growers would lose over $59 million in gross revenue and nearly $7.3 million in producer surplus. On average, each farm would cut supply by 1,711 lbs of tobacco leaf, or reduce tobacco acreage by about four–fifths of an acre. This leads to a loss of about $ 3,632 per farm in

gross revenue and about $448 per farm in producer surplus, though not all growers lose the same amount.

The increase in cigarette prices has a similar negative impact on the prices, revenue and producer surplus of the tobacco sector. Under the maximum–effect scenario in which the price of cigarettes increases by 30 percent from the base year (2008), the price and quantity of tobacco production would decrease by 0.62percent, and 4.37percent, respectively. Tobacco revenue would decline by 4.99 percent, amounting to over $ 74 million and growers would lose 9.1million in producer surplus. On average, each tobacco farm would lose about $ 4568 in gross revenue and about $562 in producer surplus.

The combined effect of the FDA regulation under the two maximum–effect scenarios will have significant economic welfare consequences, affecting nearly one–tenth of the value of the tobacco farm sector ($132 million in gross revenue) and $16.1million in producer surplus. The losses per farm in tobacco revenue and producer surplus are equivalent to about $8,160 and $990, respectively. However, the negative effect of the regulation on tobacco farms gets weaker with the increase in the price elasticity of tobacco supply, the proportion of U.S. exports of tobacco and cigarettes.

Results of the literature review also suggest that the manufacturing regulation could affect how to produce tobacco by influencing agricultural practices. Tobacco growers may have to make several pre–harvest and post–harvest decisions ranging from the selection of the soil type the tobacco is grown on; to the choice of the tobacco type; to the type, rate, method and timing of fertilizer application; to decisions on topping; to the time when to harvest; to the place where to store; to the method to process and cure. Nevertheless, the major changes could be in terms of varieties (e.g., use of genetically modified tobacco varieties and use of varieties with

'low' conversion potential of nicotine to nornicotine), change in the type and rate of pesticides, record keeping of farm operations, and processing and curing methods. Given the prevailing balance of bargaining power between growers and manufacturers in the marketing contracts, tobacco growers could potentially pick up some of the costs of compliance associated with the FDA regulation. Therefore, we conclude that even if the bill excludes from FDA authority tobacco leaf at the farm level, it has the potential to affect tobacco farms and growers.

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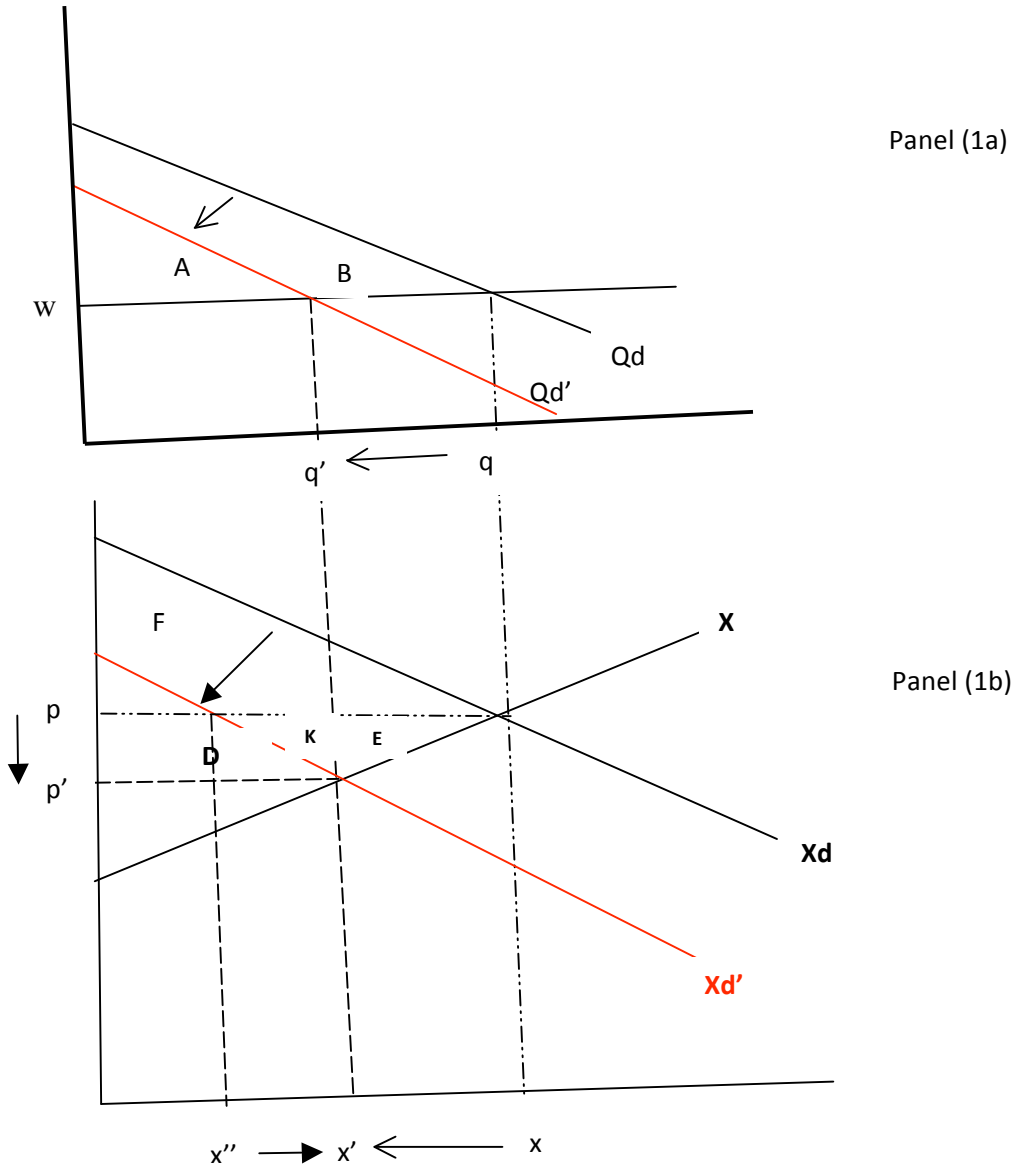

Figure 1: The shift in demand for tobacco caused by the decrease in demand for cigarettes due to increased awareness of the health risk associated with smoking prompted by FDA regulation

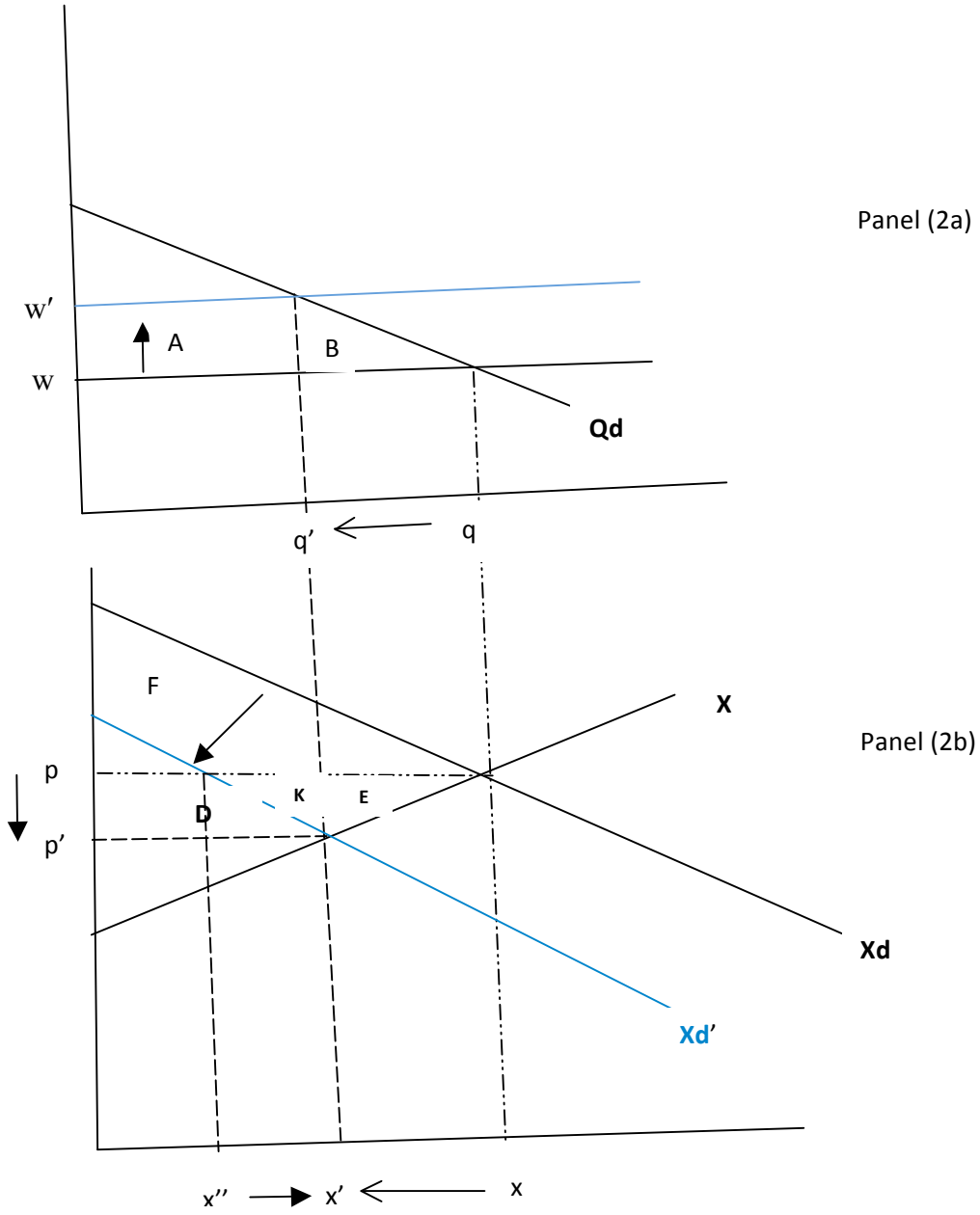

Figure 2: The shift in demand for tobacco caused by the increase in marginal cost of cigarette production prompted by the FDA regulation

Table 1: Effects of a decrease in U.S. cigarette consumption on tobacco prices, quantities, revenues and producer surplus

Effects	% of decrease in U.S. cigarette consumption				
	2	4	6	8	10
dLnP	-0.10	-0.20	-0.30	-0.40	-0.50
dLnX	-0.69	-1.39	-2.08	-2.78	-3.47
dLnTR	-0.79	-1.59	-2.38	-3.17	-3.97
ΔPS	-1.48	-2.94	-4.40	-5.84	-7.27

Note: 2 percent is the baseline

Table 2: Effects of an increase in cigarette prices on tobacco prices, quantities, revenues and producer surplus

Effects	% of increase in cigarette prices				
	13	15	20	25	30
dLnP	-0.27	-0.31	-0.42	-0.52	-0.62
dLnX	-1.89	-2.18	-2.91	-3.64	-4.37
dLnTR	-2.16	-2.50	-3.33	-4.16	-4.99
ΔPS	-4.00	-4.61	-6.12	-7.63	-9.12

Note: 13 percent is the baseline