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Endogenizing the Planning Horizon in Urban fringe agriculture

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ABSTRACT

To evaluate the nature of farm operation longevity in urban fringe agriculture, this paper develops a model that endogenizes planning horizon and estimates an empirical model whereby anticipated longevity in farming is regressed against farm, farmer, regulatory and land market related variables. The results suggest that the length of the planning horizon is directly related to farm profitability and confirm the impermanence syndrome hypothesis that land values are inversely related to the planning horizon. Contrary to farmers' claims that periodic land disposal provides an internal source of credit to support long-term viability, the disposition of portions of the farmland is found to shorten the planning horizon. Innovative farmers are found to have longer planning horizons while experiences with Right-to-Farm conflicts are found to result in decreased planning horizon. Given the expected continual increase in land values and the growing physical closeness of farmers to their non-farm neighbors, significant concerns remain about the long-term survivability of urban fringe farmers. This study suggests the importance of considering farmers' planning horizon as a key component in farmland retention programs.

The literature on urban fringe agriculture is quite extensive. It has touched on such diverse issues as impacts of suburbanization on agriculture (Berry, 1978; Fischel, 1982; Lockeretz, 1986; Lopez et al., 1988; Gardner, 1994; Walker, 2001), relationship and conflicts between farmers and their non-farmer neighbors (Lisansky, 1986; Adelaja and Friedman, 1999; Sharp and Smith, 2004), land value impacts of urbanization (Chicoine, 1981; Shi et al., 1997; Plantinga and Miller, 2001; Adelaja and Gottlieb, 2009), the critical mass of agriculture needed to sustain an agricultural industry (Dhillon and Derr, 1974; Daniels and Lapping, 2005; Lynch and Carpenter, 2003), farmland conversion (Hite et al., 2003; Hasse and Lathrop, 2003; Hailu and Brown, 2007), farmland preservation (Gardner, 1994; Lynch and Musser, 2001; Roe et al., 2004), speculative behavior and farmland development (Edelman et al., 1999; Plantinga et al., 2002), the impact of suburbanization by type of agriculture (Lopez et al., 1988), intergenerational transfer and farm continuity (Kimhi, 1994; Glauben et al., 2004, 2006), and farmer exit from agriculture (Towe et al., 2008; Kimhi, 1994; Stiglbauer and Weiss, 2000). A central notion in the literature is the idea that the urban fringe environment presents a set of unique market, social, regulatory and policy challenges that alter agricultural production and land use choices, vis-à-vis other farming locations. Perhaps the most interesting characterization of the urban fringe agricultural environment is that farmers exhibit an *impermanence syndrome* that emerges from the intense speculative environment they face.

The impermanence syndrome is defined as the shortening of farmers' *planning horizons*. Urban fringe farmers are said to be reluctant to invest in their farming operations, due to concerns about the minimal salvage value of such investments at the time of ultimate sale, which is almost always for development (Lopez et al., 1988). This reluctance itself is said to further compromise urban fringe agriculture, as necessary investments to maintain profitability are not made. The impermanence syndrome is said to be analogous to shortening of farmers' planning horizons, which itself has been attributed to opportunities to profit from ultimate land sale, due to the enhanced value of land associated with development potential (Plantinga and Miller, 2001). While farmers' planning horizons have been discussed extensively in urban fringe agriculture literature, no evaluation or analysis of the concept exists and no attempts have been made to measure or model it.

The planning horizon concept is central to agricultural land development and preservation policies at the urban fringe in North America. States in the U.S. are increasingly enacting laws to create and defend farmland preservation and open space programs. Likewise, more and more municipalities are passing and defending similar local referenda. The state of New Jersey, for example, the most urbanized state in the U.S., implemented a $1 billion Garden State Preservation Trust Fund that has preserved a significant amount of open space acres. New Jersey has also been a pioneer of

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such policies as Right-to-Farm,[1] Farmland Assessment[2] and economic development programs[3] aimed at retaining farms. For such policies to be effective in preserving land, the farmer has to be in business in the first place and hold a reasonable expectation about the future. As farm retention is a race against land development, keeping farms in business for 1, 3, 5 or 10 more years can make a difference in the effectiveness of farm and land retention programs. This extra time period may well be what it takes to line up enough public and private resources to purchase the easement on a farm.

Farmers' perceptions about operational longevity are poorly understood by researchers and policy makers. Yet these perceptions have important implications for policies directed at preserving farming and farmland on the urban fringe. A farmer's planning horizon is perhaps best defined as the time between now and when a farm operator anticipates exiting agriculture. This planning horizon, however, has not been measured or observed. By measuring it and examining its dynamics, a number of useful policy observations can be made. How farmers perceive their longevity as farm operators can reveal much about their long-term commitment to agriculture. Committed farmers, or those with longer planning horizons, are perhaps better targets for policies aimed at stabilizing the agricultural land base.

The best indicator of how much time policy makers have to impact farmland retention at the urban fringe is the length of time that each farm would remain in business. However, this is typically an unobservable factor that is observable only at the time of farm exit—often too late for policy action. The next best alternative source of information is farmers' perceptions of how long they will stay in business. This is the operational definition of planning horizon. Despite the fact that this so-called planning horizon is a revealing and useful indicator of farm survivability and has been discussed extensively in the literature, little is known about its characteristics and the factors that affect it. One reason is that data is generally unavailable about the nature of a farmer's planning horizon, despite its relevance to the knowledge base in the economics of urban fringe agriculture and public policy.

The objective of this paper is to investigate the nature of farmers' planning horizons and the relationship to hypothesized determinants. The planning horizon could be a marker for various socio-economic, regulatory and market environments of agriculture. If so, it is helpful to understand how it relates to these factors. Several theories and concepts about problems facing farmers at the urban fringe presume that the planning horizon is curtailed because of the pressures farmers face in such environments. This study, therefore, explores how some of these pressures affect the planning horizon. The study also tests three hypotheses that have been discussed in the literature on urban fringe agriculture (Plaut, 1980; Lopez et al., 1988; Nelson, 1992; Gardner, 1994) but not sufficiently tested. First, it tests the *impermanence syndrome hypothesis* that rising land values shorten the planning horizon. Second, it tests the *internal credit source hypothesis* that farmers need to be able to sell off portions of their parcels from year-to-year to lengthen their planning horizon. Third, it tests the *adaptive expectations hypothesis* that as a farmer's age increases, he/she revises upward his/her retirement date. This study, therefore, helps close the above-mentioned gaps in the literature on urban fringe agriculture.

Determinants of the planning horizon

The concept of the planning horizon is intrinsically linked to the notion of the impermanence syndrome. The former is related to how long the farmer intends to stay in farming from now onwards, while the latter describes the tendency of the horizon to be shortened, due to the effects of suburbanization (Lockeretz, 1986; Andrews and Lopez, 1989; Arendt, 1994). While both concepts are important in understanding urban fringe agriculture and land retention, they have been alluded to in the literature, rather than explicitly endogenized and analyzed. For example, in emphasizing the importance of investment in urban fringe farms, Heimlich and Barnard (1992) noted that farms that successfully adapt to urbanization have investment levels per acre that are twice as high as traditional farms. The authors indirectly emphasized the importance of investments in lengthening farmers' planning horizons. In addition, Andrews and Lopez (1989) discussed the importance of a planning horizon with regard to farm investment, asserting that when the horizon becomes short, dis-investments will occur in farm infrastructure. The underlying assumption is the untested notion that rising land values shorten planning horizons (impermanence syndrome hypothesis), which in turn affects land retention efforts.

Previous literature provides some guidance on the determinants of the planning horizon and the nature of the impermanence syndrome. For example, Lopez et al. (1988) showed that farmers at the urban fringe face higher and rising land values, which not only result in higher property taxes, but also in the direct loss of farmland to development. They suggested that high land values shorten the planning horizon of farmers and discourage long-term investments in new machinery, technology and infrastructure. This implies an indirect relationship between land values and farmers' planning horizons.

Investment and innovations have also been shown to have direct implications for the planning horizon (Hottel and Gardner, 1983). If farmers are not investing in their operations, long-term viability and sustainability could be threatened, and the planning horizon will be shortened. Intergenerational transfer possibilities also affect the planning horizon (Kimhi, 1994). If a farmer does not have an heir, his/her planning horizon is likely to be shortened.

By showing that operational profitability diminishes overtime, and by further arguing that the planning horizon shortens overtime at the urban fringe, Lopez et al. (1988), Adelaja and Rose (1988) and Adelaja and Sullivan (1998) implied that profitability is directly related to the planning horizon. The regulatory environment under which farms operate is also shown to have direct implications for farmers' planning horizons. For instance, Adelaja and Friedman (1999) found that right-to-farm decisions could have a positive impact on farmland retention.

The size of farm is another factor that may affect farming longevity. An enterprise's longevity decreases as scale of operation decreases (McCloughan, 1995). In addition, a number of factors can

[1] Right-to-Farm (RTF) laws have been adopted in more than half of the states in the U.S. The law protects farmers from inappropriate regulations, nuisance suits and expensive conflicts with farm neighbors by superseding local ordinances. Right-to-Farm laws typically protect farmers whose activities fall under the category of "normal farming practice". For more details on RTF, see Adelaja and Friedman (1999).

[2] Farmland Assessment (FA) has also been adopted in the majority of U.S. states where development values are high. Under this program if farmers meet a certain size, scale, revenue and other requirements, he/she can qualify for reduced property taxes. Under FA, the tax rate is typically applied to agricultural use value of farmland, which is typically lower than the market value at the urban fringe. Hence, farmers do not pay taxes on the development value of their land. In the case of New Jersey, Plantinga and Miller (2001) estimate that about 80% of the value of farmland in New Jersey is development value.

[3] Many states, including New Jersey, have implemented programs designed to directly enhance farm viability and promote land retention. The underlying assumption is that more viable farms will have a longer planning horizon, and will be less subject to the impermanence syndrome. In New Jersey, for example, the Agricultural Economic Recovery and Development Initiative (AERDI), targets marketing assistance, marketing investment, capital improvements and efficiency improvement on farms.

affect the planning horizon, including farm, farm operator and farm market characteristics. For example, the degree of innovation can affect the farmer's outlook and, therefore, lengthen his/her planning horizon. Naturally, age is expected to be indirectly related with the planning horizon. Livestock operators have been shown to be significantly affected at the urban fringe environment (Lopez et al., 1988). Therefore, one might expect this category of farmers to have shorter planning horizons.

A more formal framework for identifying the determinants of the planning horizon is to model the optimizing behavior of farmers with regards to their land holdings. The farmer's planning horizon represents how long, from the present time into the future, he/she plans to hold the land as a productive resource before disposing of it via sale, intergenerational transfer, spousal transfer or other means. For simplicity, assume that the only alternative to keeping the land is to sell it, at which time it will be sold for development. In the empirical section, we relax this assumption to include the possibility that at the time of exit, land can be transferred to an heir. The farmer's objective is to maximize the net present value of the future stream of income from agricultural production (denoted AG_v) at each time t, and from development (denoted D_v) after conversion to urban use starting at time T, the time of development. The subscript v denotes value. The developmental value is the stream of income from investment of land sale funds elsewhere in the economy. Farmers could have other motives determining their planning horizon, such as land ethics issues, land conservation and participation in preservation programs. We assume, however, land use decisions are primarily driven by the maximizing behavior presented above.

Although the sale date is chosen by the farmer in order to maximize the present value of his/her holdings, that date cannot be known with certainty today. Therefore, the farmer's self-reported planning horizon is actually a forecast of his/her own future optimizing behavior, made under conditions of uncertainty. In the framework laid out below, it is assumed that in making this forecast, the farmer can do no better than what a standard formal model of his/her optimization problem would; but if he/she does worse, his/her forecast error will have a mean of zero. In other words, the farmer's mental model for determining his/her planning horizon is not *systematically* or *predictably* different from a simple optimization model developed by an economist or real estate analyst. Being a non-specialist, however, the farmer's forecast could exhibit larger errors.

The farmer's optimization problem is to select a single conversion date, T^*, in order to maximize the value of his/her land asset, under the assumption that development is irreversible. The farmer's choice of optimal time of development in a dynamic framework depends on the nature of the relationship between the net present value of future streams of income from agriculture and development, and on the cost of development. The stream of income from keeping land in agriculture can be given as:

$$AG_V = \int_t^T e^{-rt}[P_a f(L_a;\theta)]dt \quad (1)$$

where r is the discount rate,[4] P_a is net price (or per unit profit) of the agricultural commodity produced at time t (i.e., per unit revenue minus cost), $f(.)$ is the production function for total output using a given level of agricultural land used in farming (L_a) and θ is a vector of farm, farming climate and farmer specific characteristics that impact on farm productivity and sustainability, such as farmer's age, number of years in farming, risk-taking attitude and future expectations about the price of land, interest rate, the desirability of the location for development, and so on. Note that land is assumed to be used in fixed proportion with other inputs. The farmer is assumed to devote his/her land (L_a) to agriculture till time period T, but sells the land to development at the end of a particular planning horizon, T. The planning horizon for keeping land in agriculture is $(T - t)$, where T is the end of the planning horizon and t is the current time.

The stream of income from land converted to urban uses can be specified in two ways. One, if the assumption is that the farmer develops land to urban uses (say housing), the flow of rents minus the cost of building and maintaining structures represents the net present value of the development of land starting at T. Two, if the assumption is the farmer sells land at the end of the planning horizon, then the benefit from selling land at time T would be the return (interest income) on funds from land sales invested elsewhere in the economy. Assuming that most farmers sell their land at the end of the planning horizon to developers at prevailing market prices of land, the stream of income from development can be specified as:

$$D_V = \int_T^{\tilde{T}} e^{-rt}[i(P_d(t)L_a)]dt \quad (2)$$

where i is interest rate, P_d is the market price of disposed land, which depends on the time of sale (t) and $\tilde{T}$ is a financial planning horizon of a farmer who decided to develop land at T. P_d is assumed to embody location characteristics. Note that in Eq. (2) L_a denotes land in agricultural production until time T, but made available to development at time T.

Development of land at the end of the planning horizon could impose a one time development transactions costs that acrues to the farmer, such as fees, capital gains tax, realty transfer taxes, brokerage fees, commissions to agents, rollback taxes[5] and other transaction costs. This cost can be specified as:

$$C_d = e^{-rT}C_1 \quad (3)$$

where C_d is the present value of the total land sale cost (C_1). We made the simplifying assumption that the farmer makes an *a priori* expectation of transactions costs, which in his/her perception are fixed at the time of discounting.

The planning horizon problem of the farmer is, thus, determined by factors that influence the flow of benefits from farming, development and development costs. The dynamic optimal development timing problem of the farmer can be specified as:

$$\max_{\{T\}} V = \int_t^T e^{-rt}[P_a f(L_a;\theta)]dt + \int_T^{\tilde{T}} e^{-rt}[i(P_d(t)L_a)]dt - e^{-rT}C_1. \quad (4)$$

The farmer's optimal land decision with regards to the utilization or disposal of farmland depends on the marginal relationships between land return in agricultural versus urban use. This optimal land use decision can be given by differentiating Eq. (4) with respect

[4] Note that the discount rate, r, is introduced here in a temporal sense. Such discounting can also be provided in a spatial sense, i.e., spatial discounting. While there is potential relevance in considering spatial discounting in planning horizon problems, we limit the discussion to temporal discounting. For discussion on spatial discounting, see Perrings and Hannon (2001), Smith (1975) and Brown et al. (2002).

[5] New Jersey has a Farmland Assessment program whereby a farmer who meets specific requirements qualifies for his/her land to be taxed at agricultural use value, rather than the higher market value. If, however, a farmer chooses to pull-out of this program and sell his/her land, he/she pays back taxes that are equivalent to the added taxes he/she would have paid for a portion of the period that he/she is involved.

to L_a and rearranging:

$$P_a \frac{\partial f(L_a;\theta)}{\partial L_a} = -i\frac{\partial (P_d(t)L_a)}{\partial L_a}. \quad (5)$$

The relationship in Eq. (5) indicates that land can be kept in farming, as long as the return in agriculture sufficiently compensates for the opportunity cost of the stream of benefits if land was sold for development.

The planning horizon problem of the farmer can be solved by differentiating Eq. (4) with respect to T. Following Leibnitz's rule and rearranging, this yields:

$$i(P_d(T)L_a) - rC_1 = P_a f(L_a;\theta). \quad (6)$$

The optimal end for the agricultural planning horizon in Eq. (6) suggests that at time T, the return from keeping land in agriculture will be equal to the net benefit from the urban use of the land. Thus, time T defines the optimal switch under which the planning horizon for keeping land in agriculture ends. The condition in Eq. (6) also defines the factors that determine the span of the planning horizon. The ending time of the agricultural planning horizon (T) can be defined, at optimal, in terms of the parameters that define the optimality condition in Eq. (6) as:

$$T* = T*(P_a, L_a, P_d, i;\theta). \quad (7)$$

The function in Eq. (7) shows that the end of the agricultural planning horizon will change with the parameters of the model. This information could particularly be useful to market-based land use policies that aim at increasing the planning horizon of farmers. For instance, farm viability policies that improve net returns (influencing P_a), agricultural land preservation policies and programs (influencing L_a levels in agriculture and development uses), smart growth and land use policies (influencing P_d), macro-economic and financial policies (influencing i) and other agricultural policies and regional and local economic growth strategies will have direct and indirect impacts on farmers' planning horizons. The impact of each of the parameters in Eq. (7) on the time span of a farmer's planning horizon can be shown by differentiating Eq. (4) with respect to T using Leibnitz's rule, totally differentiating the resulting expression and solving it for the impact relationship with each parameter. Totally differentiating the derivative of Eq. (4) with respect to T (denoted V_T) yields:

$$\begin{aligned} dV_T &= f(L_a;\theta)dP_a + P_a\left[\frac{\partial f(.)}{\partial L_a}dL_a + \frac{\partial f(.)}{\partial \theta}d\theta\right] \\ &\quad - [P_d(T)L_a]\,di - i\left[\left(\frac{\partial P_d}{\partial T}dT\right)L_a\right] \\ &\quad - i\,[P_d(T)dL_a] + r\,dC_1 + C_1\,dr = 0. \end{aligned} \quad (8)$$

The comparative statics with respect to each of the parameters in Eq. (7) show how these parameters affect the length of the agricultural planning horizon. The signs and derivations are provided in the Appendix A. The results can be summarized as follows:

$$\frac{dT}{di} < 0, \quad \frac{dT}{dP_d} < 0, \quad \frac{dT}{dL_a} <,=,> 0, \quad \frac{dT}{dP_a} > 0, \quad \text{and} \quad \frac{dT}{d\theta} <,=,> 0. \quad (9)$$

The result $(dT/di) < 0$ suggests that, holding all else constant, an increase in the rate of interest earned on investment proceeds from land sales increases the return on land sale and, hence, shortens the planning horizon. This holds under the assumption that lengthening the planning horizon by one year would increase the price of land to be sold to development, i.e. $(\partial P_d/\partial T) > 0$ (see Eq. (A.1) in the Appendix A).[6]

The negative effect of the market price of land sold for development on the planning horizon, i.e., $(dT/dP_d) < 0$, suggests, all else equal, an increase in the price of agricultural land for development shortens the planning horizon (see (A.2)).

The effect of farm size on the planning horizon is not certain, i.e., $(dT/dL_a) <,=,> 0$, because it depends on the value of land for agriculture versus its value for development, i.e., $P_a(\partial f(\cdot)/\partial L_a) - i(Pd(T))$ (see (A.3)). If the marginal value of the land from farming, $P_a(\partial f(\cdot)/\partial L_a)$, is greater than the return from selling the land for development, $i(Pd(T))$, the planning horizon will be lengthened.

The effect of net prices (unit profits) on the planning horizon is positive, i.e., $(dT/dP_d) > 0$ (see (A.4)). This suggests that a robust net return per unit of agricultural production lengthens a farmer's planning horizon. Therefore, while agricultural price support policies that increase the net return can potentially lengthen the planning horizon, high taxes and business costs can increase production costs and shorten the planning horizon. P_a enables the relationship to be tested between policies designed to increase net farm income,[7] or reduce taxes and business costs and farming longevity. P_a also allows testing of the impact of the regulatory environment on farm longevity through, among other things, the effect of regulation on costs and productivity. Previous studies have particularly showed that restrictive farming regulations at the urban fringe discourage investment in farming and lead to reduced farm productivity (Whittaker et al., 1995). If farmers at the urban fringe face a more restrictive regulatory environment (e.g. ordinances constraining fertilizer and herbicide use, large lot zoning and restrictions on farm retail markets), the planning horizon will likely be shorter. On the other hand, a more conducive regulatory environment (e.g. right-to-farm protections and preferential property tax assessment at agricultural use values) would likely lengthen the planning horizon.

Finally, the effects of farm, farmland and farmer's personal characteristics and expectations about the future on the planning horizon are not certain, i.e., $(dT/d\theta) <,=,> 0$. The directional impact depends on $\partial f(\cdot)/\partial\theta$ (see (A.5)). If the farm or farmer has characteristics that can enhance productivity, such as education, positive expectations about farm returns and lower expectations about urban use returns on his/her land, then these factors will lengthen the planning horizon. On the other hand, if the farmer has characteristics, such as a lower education, a bleak outlook on the future of farming and/or a higher expectation on the development value of farmland, then these characteristics will shorten the planning horizon.

The objective of this study is to endogenize and explain the planning horizons of farmers at the urban fringe. Based on the theoretical model above, proxies for profitability, value of land in development, farm size and farmer characteristics are regressed

[6] It should be noted that $\partial P_d/\partial T$ cannot always be expected to be >0, especially in light of the recent decline in real estate values. However, since real estate bubbles are market disequilibria that are naturally corrected, the long-run sign of $\partial P_d/\partial T$ is expected to be >0. This implies that, all else equal, the value of land for development increases over time.

[7] Price support policy may be relevant at the urban fringe. While the literature has shows that urban fringe farmers with a long planning horizon tend to grow high value trees, vegetables and nursery crops (Lopez et al., 1988), it is also shown that the impermanence syndrome encourages many urban fringe farmers to grow low value price-supported commodities, like corn, wheat and hey. This was attributed to the fact that investment in more intensive agriculture may not be justifiable because of concerns that the equipment required to grow these crops tend not to have much salvage value at the time of farm sale (impermanence syndrome) (Lopez et al., 1988; Lisansky, 1986).

against the number of years that farmers intend to remain in farming (planning horizon) as determined by a survey of farmers. The specification enabled the testing of the adaptive expectations, the internal credit and impermanence syndrome hypotheses.

In the next section, the conceptual model above is operationalized using a unique dataset collected for the state of New Jersey. As the most urbanized state in the nation, the issue of planning horizon emerges frequently in public policy debates about farmland retention. The entire state of New Jersey is considered to be metropolitan, and agriculture is subject to significant urban pressures. In virtually all of the states 21 counties, the farmland appreciation rate is extremely and uniformly high. For example, Plantinga and Miller (2001) indicate that over 80% of farmland values in New Jersey is attributable to development pressures, while <20% is attributable to agricultural use. Sandwiched between Philadelphia, New York City and several other New Jersey cities, the state's farmland base is uniformly under speculative and other pressure on farmland. Our evaluation of the variation in farmland values suggests little variation from the mean, vis-à-vis farmland in almost every other state.

Data, empirical model and estimation procedure

To operationalize the model in Eq. (7), information on the planning horizon of farmers is needed as an endogenous variable. Such data does not typically exist and is difficult to obtain at the farm-level, which is the more appropriate level for evaluating the planning horizons of individual farmers. While farm-level data on proxies for P_a, P_d, i and L_a are easier to get from secondary sources, data on proxies for θ, the individual characteristics of farmers, are not always available. One of the reasons is the need for publicly provided data sources to suppress personal information on farmers for confidentiality reasons. For example, the Farm Cost and Return Survey (FCRS), generated annually by the U.S. National Agricultural Statistics Service (NASS), provides data on a sample of individual farms. However, it does not make available more detailed personal information on farmers and the type of farmer perception – related information (such as self-assessed longevity) needed for the analysis in this study. We were able to find a farmer-level database that is close enough to the needs of this study by combining two existing data sources. One is the 1991–1993 FCRS data, and the other is the 1993 Survey of New Jersey Farms (SNJF).

The SNJF is a unique database, as Congressional approval was needed in order to conduct that survey. The SNJF involved a resurvey of 216 of the New Jersey farmers that had previously participated in the 1991, 1992 and 1993 FCRS. Each of the annual FCRS surveys did not provide a sufficiently large enough sample size to meet the re-surveying needs, thus necessitating the surveying of participants from 3 years. This provided a sample size of 206 observations. The fact that these two data sources exist for New Jersey, the most urbanized state in the U.S. (Lopez et al., 1988), and the one deemed most subject to urban pressures (Plantinga et al., 2002), made this a unique opportunity for evaluating farmers' planning horizons. Unfortunately, due to the high cost of SNJF, the even higher cost of conducting a survey that would have the features of both the FCRS and SNJF, and the difficulty in obtaining approval to conduct an extensive survey of farmers that provide detailed information on their thoughts and preferences, as required for endogenizing planning horizons, it was not feasible to utilize a more recent database than the combined dataset. Despite the fact that the 1993 data on attitudes was being combined with FCRS data from 1993 and 2 prior years, we are reasonably assured that significant operational changes did not occur between 1991 and 1993.

The SNJF was designed to obtain information about the structure of farms and the nature of farmers, especially for those factors for which data is usually lacking. Information was obtained about farmers' socio-economic and demographic characteristics, and their opinions about regulations, taxation, business climate, land use, marketing, farmland retention, production system, leadership, communication, public policy and planning horizons. Information was also obtained about farmers' plans with respect to land use, investments, sale of land and other issues. A total of 152 questions covering topics related to various dimensions of farming were in the survey. The SNJF was administered in 1993, the same way as the NASS survey by NASS enumerators, to farmers involved in the 1991, 1992 and 1993 FCRS. Each farmer was interviewed face-to-face. Upon compilation of the data, complete information was available for 206 farmers.

The survey response on how long farmers intend to remain in farming was used as the dependent variable. Other survey questions provided the basis for variables that were used as proxies for the determinants of planning horizons. These variables are explained next in the context of the theoretical model in Eq. (7).

P_a is a measure of farm net price (profit per unit of output). Net farm income per acre (NFI), measured in dollars, was chosen as the primary proxy for P_a. Tax burden perception (TAXBRD) was also chosen as a proxy for P_a. It is a measure of whether or not the operator perceives that high taxes or business costs, in the state have adversely affected his/her operations. This binary variable takes on the value of 1 if respondents felt the tax burden to be high, and 0 otherwise. Since interest rates (i) are not expected to vary significantly across farms in a given period, given the fact that farmers lend primarily from the same lending sources, it was not included in the empirical model. In general, we expect that operators of more profitable farms are more positive about the future and are, therefore, likely to plan for a longer tenure in farming (Hennessy, 2002; Ranjan and Tapsuwan, 2008).

The primary proxy used for P_d is the county average rate of appreciation of the value of farmland (LANDVAL). According to the literature, the impermanence syndrome is an outcome of rising development value of land. That is, farmers shorten their planning horizons and are reluctant to invest in their land when land values escalate (Lopez et al., 1988; Edelman et al., 1999). Therefore, the inclusion of LANDVAL enables the testing of the impermanence syndrome hypothesis that higher land values have the effect of shortening farmers' planning horizons. LANDVAL (appreciation rate) averaged approximately 7.4% between 1991 and 1993.

Farm size has been found in the literature to affect exit from farming (Towe et al., 2008; Kimhi and Bollman, 1999; Stiglbauer and Weiss, 2000). The larger the farm, the less likely it is for farms to exit, vis-à-vis gentlemen farms. It seems, therefore, reasonable to expect farm size to affect planning horizons. In previous studies, farm size was proxied by parcel size in acres (Towe et al., 2008), by land owned and rented, farm value and total sales (Kimhi and Bollman, 1999), and by acres under cultivation (Stiglbauer and Weiss, 2000). In this study, similar to Stiglbauer and Weiss (2000), the total acreage of land operated (ACOPER) was used as the primary proxy for farm size. Consistent with the comparative statics in Equation (9), no *a priori* expectations were formed about the effects of ACOPER on the planning horizon.

To supplement ACOPER, decreased acreage (DDECAC) was selected to enable the testing of the *internal source of credit hypothesis*. On one hand, farmers argue that their viability is enhanced by the ability to sell off portions of their land, from time to time, as a source of internal credit for their farm operations (Lopez et al., 1988). On the other hand, the prior sale of farmland can create structural and economies of scale challenges that further compromise planned longevity. To construct DDECAC, a dummy variable, farmers were probed if they had reduced their land holdings in the previous 5 years (1 if yes, 0 otherwise).

Two categories of determinants, farmer personal and family characteristics, relate to θ from the theoretical model, including innovation and knowledge factors; and farming climate characteristics, including regulatory issues, such as right-to-farm conflicts. Smith and Sharp (2005) found significant differences in the degree of support for agriculture by non-farm neighbors at the urban fringe, and a correlation between the degree of support for agriculture and the extent of farmer outreach. Adelaja and Friedman (1999) provide a list of factors that contribute to favorable attitudes about protecting farmers, while Adelaja and Sullivan (1998) found that right-to-farm conflicts affect farm profitability. A dummy variable indicating whether a farmer has experienced right-to-farm complaints from neighbors (DRTFCON), coded 1 if yes, and 0 otherwise, is included to capture the impact of local support or conflict on the planning horizon. The expectation is that these complaints shorten farmers' planning horizons by making the prospects for long-term profitability less rosy.

Operator age (OPERAGE) is included as another proxy in the θ set to test the effect of farmer age on planning horizons. Kimhi and Bollman (1999), Stiglbauer and Weiss (2000), Pietola et al. (2003) and Kimhi and Nachlieli (2001) found a positive relationship between farmers' age and their exit from farming. Therefore, farmer age is expected to have a negative impact on the planning horizon. Furthermore, under a situation where farmers do not revise their expectations (target retirement age), the planning horizon is expected to be inversely related to age on a one-for-one basis. That is, for every year lived, the planning horizon would shorten by one year. However, in the case where expectations are revised, the planning horizon may shorten by <1 year (the adaptive expectation hypothesis).

Pietola et al. (2003) found that the existence of a spouse reduces the probability of farm exit, thus lengthening the planning horizon. Similarly, Glauben et al. (2004, 2006) found that farm succession is postponed if a farmer's spouse also works on the farm. Kimhi (1994) focused on the existence of more heirs (large family effect) and found that as the family size increases, farmers delay their optimal timing of intergenerational farmland transfer to take time before making such a decision, thus lengthening the planning horizon. These studies generally suggest that the existence of heirs lengthen planning horizons. A dummy variable indicating whether the farmer has one or more heirs that plan on farming (DHEIR) was included, since the presence of an heir may affect a farmer's long-term outlook, and could lengthen the planning horizon.

The literature suggests a direct relationship between the degree of innovation and profitability (see, e.g. Klepper, 1996). However, the relationship between innovation and farm exit is not well-established, let alone the implications for planning horizons. A measure of innovation (INNOV) was included, with the expectation that its effect is positive. The innovation measure is a dummy variable for farmers who have increased production without farming additional land through techniques, such as double cropping, improved irrigation systems, improved fertilizer and herbicide management, etc. We hypothesize that such farmers would have a lengthened planning horizon. In addition, a second measure of innovation is included to capture the effects of innovative marketing (DMKT), including participation in an online marketing. The survey simply provided questions about types of activities that farmers engaged in related to direct marketing (bed and breakfast, pick your own operations, farm stands, farmers' markets, online promotion and product labeling. Based on this information, a dummy variable was constructed on whether farmers engaged in such marketing approaches as online promotion and product labeling. We also expect its effect to be positive.

A dummy variable constructed based on a survey question that probed farmers about their willingness to sell at least some of their land in the future (DLANDSELL); 1 if yes, and 0 otherwise. It is included as a proxy for farmers' expectations about the future of farming. Ranjan and Tapsuwan (2008) have shown the impact of anticipated regulation or resource shortage on the probability of exit from farming, suggesting the negative effect of anticipated regulatory and resource constraints on planning horizon. In this study, DLANDSELL is considered as an indicator of a farmer's outlook, with the expectation that farmers that are willing to sell their land are more predisposed to have shorter planning horizons. Note that DLANDSELL is capturing a different effect than DDCAC. While DDCAC is past observed land sale behavior that helps test the internal credit hypothesis, DLANDSELL is willingness to sell land in the future, which is used as a proxy for farmers' optimism about their future in agriculture.

Several studies have shown the relationship between farm structure, nature and function and the probability of exit. For example, Kimhi (1994) found the timing of farm transfers to vary by farm characteristics. Pietola et al. (2003) found regional differences in prospects of exit from farming. Lopez et al. (1988) found that animal-based agriculture is the most stressed in urban fringe settings, suggesting greater likelihood that animal farm operators will have relatively shorter planning horizons, vis-à-vis other farm enterprises. A dummy variable (DANIMAL) for animal operations was included as a proxy to test the impact of type of farming activity on the planning horizon. The expected effect is negative.

The empirical model for the determination of planning horizons is presented in Eq. (10) below. It is specified in linear form to explain the ith farmer's planning horizon:

$$\begin{aligned} PH_i = {} & \beta_0 + \beta_1 \mathrm{NFI}_i + \beta_2 \mathrm{DANIMAL}_i + \beta_3 \mathrm{ACOPER}_i + \beta_4 \mathrm{DECAC}_i \\ & + \beta_5 \mathrm{LANDVAL}_i + \beta_6 \mathrm{LANDSELL}_i + \beta_7 \mathrm{DRTFCON}_i \\ & + \beta_8 \mathrm{OPERAGE}_i + \beta_9 \mathrm{DHEIR}_i + \beta_{10} \mathrm{DMKT}_i \\ & + \beta_{11} \mathrm{INNOV}_i + \beta_{12} \mathrm{TAXBRD}_i + \varepsilon_i \end{aligned} \tag{10}$$

where NFI is net farm income, DANIMAL is a dummy variable for animal farms, ACOPER is total acres operated, DDECAC is whether or not there was decreased acreage over the previous 5 years, LANDVAL is the value of land in agriculture, LANDSELL is a dummy variable capturing whether or not farmers anticipating selling their land, DRTFCON is whether or not farmers experienced Right-to-Farm conflicts, OPERAGE is operator age, DHEIR is a dummy variable capturing whether the farmer has an heir or not, DMKT is a dummy variable for whether or not farmers engaged in innovative marketing, INNOV is a dummy variable for innovative farming practices (including conservation), and TAXBRD is farmers' perception of the tax burden in the state. The β coefficients are parameters to be estimated, and ε is equation error, assumed to be independently and normally distributed with a mean of zero and a constant variance.

The model was estimated using a Generalized Least Squares (GLS) procedure. Differences across individuals in their characteristics, decisions about planning horizon, in their farm size and operations, and so on, introduced efficiency losses due to heteroskedasticity. A GLS estimation procedure was introduced to provide efficient estimates. The GLS estimates of Eq. (10) are shown in Table 1. The estimates of standard and adjusted R-squared were 0.45 and 0.41, respectively. Six of the estimated coefficients were statistically significant at the 5% level and five at the 10% level. Two estimated coefficients were not statistically significant.

Table 1
Parameter estimates of the planning horizon models.

Variable	Estimates	Significance	Description
INTERCEP	44.21	*	Intercept
NFI	8.4×10^{-6}	*	Net farm income
DANIMAL	3.85	*	Poultry cattle horse farm
DDECAC	−4.37	**	Decreased acreage
LANDVAL	−2.51	**	Land Appreciation – County
ACOPER	0.004		Acres Operated
DLANDSELL	−1.16	*	Would sell land for farm viability
DRTFCON	−4.14	**	Right-to-Farm conflicts
OPERAGE	−0.38	*	Age of operator
DHEIR	−1.72	**	Heir plans on farming
DMKT	−3.54		Innovative marketing
INNOV	1.51	*	Innovation index
TAXBRD	1.22	*	Perceived tax (business cost) burden
R-Squared	0.4476		
Adj. *R*-squared	0.4146		

* The coefficient is significant at the $\alpha = .05$ level.
** The coefficient is significant at the $\alpha = .10$ level.

Empirical results

Recall that the issue at hand and, thus, the dependent variable, is planning horizons, or the time between 1993 and the future time period within which farmers expect to stop farming. The coefficients of the estimated model provide direct tests of the extent to which planning horizons are affected by a variety of factors. The coefficient of LANDVAL provides a direct test of the impermanence syndrome hypothesis. The result confirms this hypothesis, as land value appreciation is found to have shortened the planning horizons of farmers. The coefficient of DDECAC provides some evidence on the internal credit source hypothesis. The result rejects this hypothesis, as farmers that reduced their land holdings had shorter planning horizons. The coefficient of OPERAGE provides evidence on how farmers adjust their planning horizons as they age (adaptive expectation hypothesis). The result confirms this hypothesis, as farmers revise their planning horizons downward as they age. Detailed discussion of results is provided below.

Effects of profitability

The coefficient of net farm income (NFI) is found to be statistically significant (at the 5% level) and positive, suggesting that profitability lengthens farmers' planning horizons. The result suggests that for every $10,000 in additional profits, farmers increase their planning horizon by 0.8 years. This finding is interesting, given the earlier findings that farmers pay more attention to non-farm land market conditions than to agricultural market indicators at the urban fringe (Lopez et al., 1988; Parks and Quimio, 1996). The implication of this is that policies targeting farm profitability (value-added, agro-tourism, farm-based recreation, etc.) can supplement programs, such as easement purchase, in enhancing farmland retention.

The coefficient of tax, or business cost, index (TAXBRD) is statistically significant (at the 5% level) and positive, suggesting that farmers who think that property taxes in New Jersey are too high actually have longer planning horizons, by an estimated 1.22 years. The *a priori* expectation was that the TAXBRD coefficient would be negative. One possible explanation for the positive coefficient is that farmers who complain about high taxes are committed farmers who are in agriculture for the long haul. They, therefore, must fully realize the erosive impact of taxation. TAXBRD may be capturing the concern of committed farmers who actually have a reason to complain about high taxes and business costs. Further research can shed some light on the impact of taxes, and perceived tax burdens, on farm viability.

The coefficient of LANDVAL is statistically significant (at the 10% level) and negative. It suggests that a 1% increase in land value causes farmers to shorten their planning horizon by approximately 2.5 years on average. This is a direct confirmation of the impermanence syndrome hypothesis.

Animal agriculture

U.S. Census of Agriculture figures indicate that New Jersey's animal agriculture contributed 12.3% of total agricultural sales in 2002, which had increased to 13.7% in 2007. The equine industry is one of the dominant animal agriculture sectors in the state. From the 176,000 acres of land occupied by 7200 equine operations; 96,000 acres are directly related to equine activities, putting the total land use in this industry at 0.2 of the farmland in the state (Rutgers Equine Science Center, 2007). The coefficient of animal farms (DANIMAL) is statistically significant at the 10% level. This suggests that animal farms in general, at the urban fringe, have longer planning horizons. The estimate suggests that animal farms are expected to have 3.85 more years in their planning horizon. This result challenges prior findings by Lopez et al. (1988) that animal agriculture is the most susceptible type of agriculture in an urbanized region in terms of profitability. The positive impact on planning horizons may reflect the capital intensity of this type of operation and the possibility that despite the challenges of the urban environment, animal farm operators tend to be optimistic.

Farm size

The coefficient of acres operated (ACOPER) is found not to be statistically significant, suggesting that farm size does not affect planning horizons, and that small and large farms are equally disposed in terms of planning horizons. Previous findings that size matters to exit from farming have indeed measured farm size differently, including as parcel size (Towe et al., 2008) and total sales (Kimhi and Bollman, 1999). Stiglbauer and Weiss (2000) have similar definition of farm size as in this study – acres under operation. Their finding that farm size affects farm exit, though not directly comparable as actual farm exit is different from planning horizons, the two are nonetheless related. Farmers with different farm sizes have no significant difference in their farming longevity outlook but perhaps face a different propensity to exit from farming that may suggest that at some point the reality of farm size and structure becomes more relevant, and that there is a standard gap between farmer expectations about the future and farm size and structure-dependent future realities.

The coefficient of decreased acreage (DDECAC) is statistically significant (at the 10% level) and negative. This suggests that farmers who have disposed of farmland have planning horizons that are approximately 4.5 years shorter, on average. This result suggests that while decreasing acreage may provide short-term cash flow, it also affects long-term commitment to agriculture. This challenges the internal credit hypothesis that flexibility to sell land is critical to long-term farmland retention. In the short-run, however, it may be relevant to the ability to stay afloat, though beyond the scope of this study, two considerations are in order about the relationship between decreased acreage and planning horizons. First, the relationship can be endogenous, i.e., shorter planning horizons can trigger land sales, and land sales can encourage shorter planning horizons. Endogenizing planning horizons, along with land sales behavior, can be informative about this intricate relationship.

Second, the spatial distribution of observed land sale and planning horizon relationships may inform about how this endogenous relationship varies by place, particularly by urban adjacency and non-urban adjacency geographic classifications.

Farming climate and farmer characteristics

The coefficient of DRTFCON is particularly relevant at the urban fringe, an environment epitomized by New Jersey where recent problems resulted in government attempts to strengthen the Right-to-Farm law. The coefficient is statistically significant (at the 10% level) and negative. Apparently, farmers who have experienced conflicts with their neighbors have shorter planning horizons by an average of about 4 years. Although Right-to-Farm laws are designed to protect farmers from nuisance complaints, such complaints are still prominent. In New Jersey, it appears that these complaints decrease optimism or the perception of the ability and/or desire of farmers to stay in agriculture long-term. Farmers who have experienced nuisance complaints may envision a bleak future for farming as more and more development occurs around them.

The finding regarding the coefficient OPERAGE is interesting. The coefficient is statistically significant (at the 5% level) and negative. This confirms the notion that farmers shorten their planning horizons as they get older. However, farmers do not seem to adjust their planning horizon downward by 1 full year with each year that they age. On average, farmers adjust their planning horizons downward by approximately 0.5 year for each year that they get older. Hence, they are continually revising their planning horizons, getting more optimistic as they get older. For example, a farmer at age 50 may have a planning horizon of 15 years and plan on retiring at age 65. Two years later, the same farmer (age 52) now has a planning horizon of 14 years and plans to retire at age 66. Eventually, the farmer will no longer revise his/her planning horizon and will retire.

Fig. 1 plots the planning horizon of a farmer against his/her age to demonstrate how farmers revise their planning horizon as they age. In constructing the figure, the assumption is made that at age 20, the planning horizon is 30 years, so that the expected retirement age is 50. The coefficient of approximately 0.5 is assumed. By age 30, the planning horizon is adjusted down by 5 years, so that the anticipated retirement age is now 55. Expectations are revised until the actual and anticipated retirement age coincide and reach the equilibrium, when the farmer actually retires. This finding confirms the adaptive expectations hypothesis and suggests the existence of a built-in error in perception and error correction process overtime. One implication of this is that the assertion of younger farmers about their long-term desire to stay in farming may indeed be true.

The implication of the presence of a family member to take over the farm has been the subject of significant debate among agricultural policy makers at the urban fringe. The result suggests that the existence of an heir (DHEIR) to the farm business shortens planning horizons by 1.7 years. This supports the notion that the presence of an heir, including spouse, means that the farmer is able to plan for early retirement, knowing that there is an heir in place to take over the farm. The explanation for the shorter planning horizon is as follows. For a farmer without an heir, the exit from farming coincides with the sale of the farm, at least, usually. So, the presence of an heir might encourage holding on to the farm but shortening the planning horizon. One implication of this finding is that out-migration of agricultural youth from farming areas contributes to a

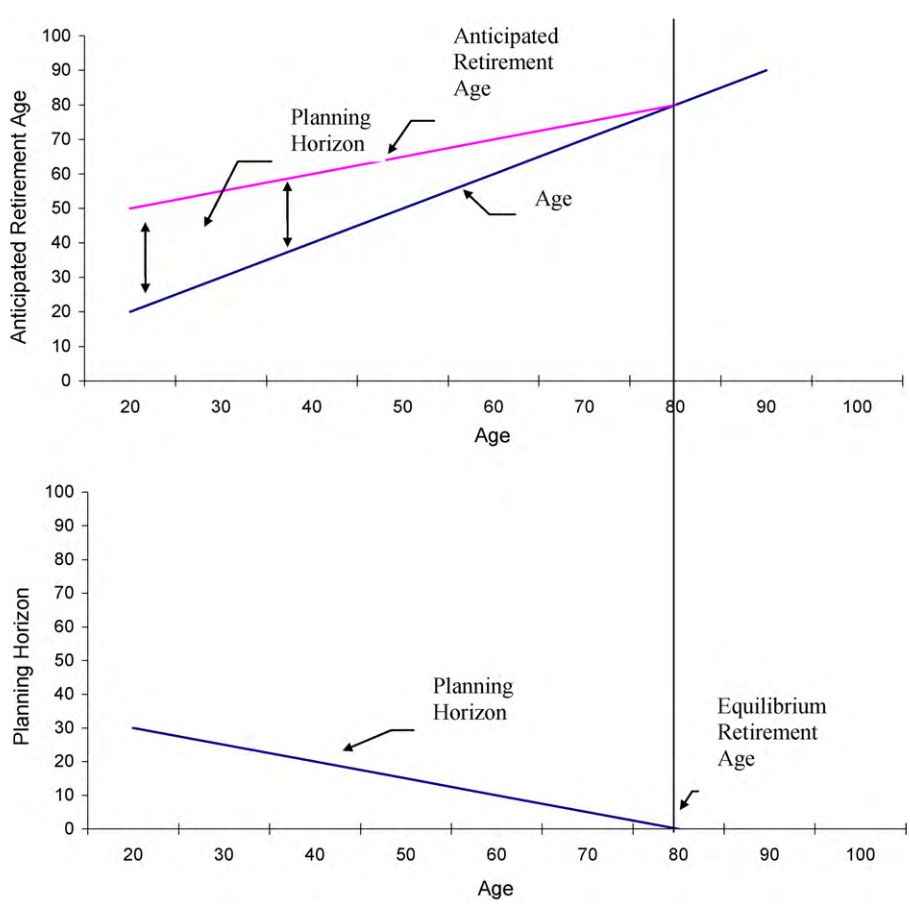

Fig. 1. Aging, planning horizons and proposed retirement for New Jersey farmers assuming initial age of 20 and initial planning horizon of 30.

bleak outlook with respect to agriculture and, hence, the planning horizons.

The coefficient of innovation (INNOV) is statistically significant (at the 5% level) and positive. Innovative farmers who increase production without farming additional land through various techniques are positively associated with longer planning horizons, on average by 1.51 years. This is an important finding. It may suggest that farmers who, as a result of self-motivation or policy encouragement, have adopted new technologies tend to plan to farm longer. A longer planning horizon could also potentially spur investment, as investment influences potential long-term outcomes and, hence, the planning horizon. One implication of this finding is that innovation translates into greater commitment. Another is that policies to spur innovation also enhance long-term outlook and commitment, at least at the perception level. A direct relationship between innovation and planning horizons signals an underlying assumption of the impermanence syndrome, that lack of investment shortens the planning horizon, eventually leading to the transfer of farmland to developers, particularly at the urban fringe.

Summary and conclusions

The importance of farmer planning horizons has been extensively discussed in the literature on agriculture, especially with regard to investment, farmland retention, speculation and intergenerational transfer in urban fringe agriculture. However, endogenizing and explaining its determinants have been a major gap in the literature. In this study, using a unique dataset, which provides individual farmer-level information on the planning horizon itself, as well as information on several hypothesized determinants, the planning horizon of urban fringe farmers is endogenized and modeled. By evaluating the factors that influence the planning horizon of urban fringe farmers, important hypotheses about land use and farmland retention are directly tested. Examples include the impermanence syndrome hypothesis, the internal credit hypothesis and the adaptive expectations hypothesis.

There are eight major findings: (1) profits influence planning horizons, and profitable farms have longer planning horizons; (2) the internal credit hypothesis is refuted, i.e., farmers who have disposed of land have shorter planning horizons (by 4.5 years, compared to others); (3) the impermanence syndrome hypothesis is confirmed, i.e., appreciation of land value at the urban fringe shortens the planning horizon; (4) the regulatory environment affects planning horizons, i.e., for instance, Right-to-Farm conflicts shorten the planning horizon; (5) innovative farmers have longer planning horizons, thus the finding lends credence to public policy tools, such as the Production Efficiency Grants (PEG) and Business Incentive Grants (BIG), which were implemented in New Jersey to provide incentives for farmers to invest in technology and equipment to increase production efficiency; (6) the adaptive expectation hypothesis is confirmed, i.e., farmers revise their planning horizon over-time; (7) animal agriculture farmers at the urban fringe have longer planning horizons; and (8) farmers with heirs have shorter planning horizons, suggesting that they are encouraged with early retirement. With these findings in mind, the link between the environment of farming and farmers' perceptions is better explained.

A number of policy implications arise from this research. One is that farmers do indeed face added pressures and challenges at the urban fringe and that these challenges impact on their ultimate decision to exit agriculture. This implies that agricultural policy at the urban fringe must take into account this differential in the plight of farmers at the urban fringe, vis-à-vis elsewhere, and that added tools may be needed to enhance agriculture at the urban fringe. The second implication is that policy makers have a choice as to whether to target the revenue side of farms (e.g. promote eco-tourism, farm-based recreation, bed and breakfast, farm markers and alternative markets) or target the cost side through regulation. Both affect the long-term commitment to stay in agriculture. The third is that farmland retention policy will be more effective when targeted toward farmers that take a more serious approach, such as those engaged in innovative marketing. Farmers have used the planning horizon issue to explain their plight and the link between their business environment and performance. This paper lends credence to some of their arguments.

In conclusion, between any given point in time and when farmers actually exit farming, they form expectations and develop ideas about their long-term stay in agriculture. These expectations are shaped, apparently, by a number of socio-economic, demographic, market, regulatory and personal factors. The dynamics of such perceptions, however, change overtime as the dynamics of the farm operation, the market and personal considerations change. It is important to understand these factors and their influences, especially considering that all that agricultural policy makers can gauge directly from the farmer and utilize in fashioning intervention is what farmers say. By the time farmers actually act, it is probably too late to intervene with policy. Perhaps more important is the notion that policy can, in fact, shape planning horizons and, therefore, long-term perception about commitment to agriculture.

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Appendix A.

$$\frac{dT}{di} = -\frac{[(P_d(T,z)L_a)di]}{iL_a[\partial P_d/\partial T]} < 0, \tag{A.1}$$

$$\frac{dT}{dP_d} = -\frac{iL_a}{iL_a[\partial P_d/\partial T]} = -\frac{1}{(\partial P_d/\partial T)} < 0, \tag{A.2}$$

$$\frac{dT}{dL_a} = \frac{P_a(\partial f(\cdot)/\partial L_a) - i(Pd(T,z))}{iL_a(\partial P_d/\partial T)} <, =, > 0, \tag{A.3}$$

$$\frac{dT}{dP_a} = \frac{f(\cdot)}{iL_a[\partial P_d/\partial T]} > 0, \tag{A.4}$$

$$\frac{dT}{d\theta} = \frac{P_a}{iL_a[\partial P_d/\partial T]} \cdot \frac{\partial f(\cdot)}{\partial \theta} <, =, > 0. \tag{A.5}$$

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