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Network marketing organizations: Compensation plans, retail network growth, and profitability

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Abstract

Network marketing organizations, or NMOs, are retail selling channels that use independent distributors not only to buy and resell product at retail, but also to recruit new distributors into a growing network over time. Commissions and markups on personal sales volumes, and net commissions on the personal sales volumes of downlines, are the methods of compensation commonly used to motivate NMO distributors. In this paper, we develop, analyze, and calibrate a dynamic decision model of the growth of a retail NMO. Descriptive and prescriptive insights show how compensation and other model parameters affect distributor motivation, sales, and network growth and profitability.

Keywords: Network marketing organizations; Direct selling; Compensation plans; Decision support models

1. Introduction

Companies like Amway, Mary Kay, NuSkin, or Shaklee are examples of an increasingly popular form of retail distribution channel: the network marketing organization (or NMO). Although direct-selling organizations have historically used standard direct sales forces to distribute their products, today 70% of direct-sales revenues are generated by network marketing organizations and business units. In 1995, that amounted to US$11.6 billion in annual sales (Direct Selling Association/USA, 1995). These companies have grown significantly not just in the United States, but throughout the world. Independent distributors play two key roles in NMOs: they sell product, and they recruit new distributors. The NMO's compensation plan structure can have a profound effect on how distributors' time is spent, and therefore plays a critical role in the company's overall growth and success through time. In this paper, we define what NMOs are, how they are operated, and how they use compensation to incentivize their distributor salespeople. We then develop and discuss a model of NMO network growth that shows how compensation and other network characteristics affect growth and profitability of the NMO distributor and the network as a whole. We use original data collected from NMOs to illustrate how the model can be used to calibrate sales performance and make predictions about future performance of an NMO network.

Managing the productivity of retail salespeople has been a focus of many different authors. One

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stream of marketing research has contrasted the use of independent-agent sales forces with that of company-employee sales forces (Anderson, 1985; Churchill et al., 1985; Weiss and Anderson, 1992). Such comparisons have supported the claim that some marketing environments are better suited for independent agents, while others are better suited for employee salespeople. However, these approaches group all independent-agent sales forces under a single theoretical umbrella. The purpose of this research is to understand a distinct approach to managing independent retail salespeople: the network marketing organization.

NMOs differ from other retail selling channels in several important ways. We define NMOs as those organizations that depend heavily or exclusively on personal selling, and that reward sales agents for (a) buying products, (b) selling products, and (c) finding other agents to buy and sell products.

NMOs have several distinctive characteristics:

1. They are typically lean organizations, using independent distributors or reps to sell their products, rather than hiring and managing a large employee sales force.
2. Most NMOs do not advertise or have a retail-storefront presence. This makes retail sales force motivation a crucial component of business success in this form of channel.
3. Distributors in an NMO do not receive a salary, as many other retail salespeople do; their pay depends on the commissions and retail markups they can generate. Thus, the system is very heavily performance-oriented.
4. NMOs offer an effective 'menu' of compensation opportunities, similar to the menu-of-contracts concept discussed in Lal and Staelin (1986). An NMO distributor can either sell retail product or can recruit and manage other distributors. This effectively gives the NMO distributor the opportunity to work on the task that best suits her [1] ability.

These distinctive characteristics of NMOs suggest the need for a deeper understanding of how they work, what motivates their distributors to perform in various ways, and the implications of these actions for network sales, growth, and profitability over time.

1.1. Components of NMO distributor compensation

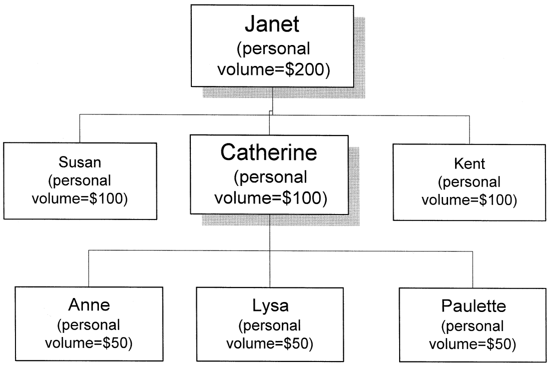
NMO distributors are compensated for each of their efforts in different ways. [2] First, distributors purchase products at wholesale prices, and may either use these discounted products themselves or retail the products to others for a profit. Suggested markups usually range from 40 to 50%. Second, distributors receive a monthly commission for their 'personal volume', which is the value of every product they personally buy or sell. Third, distributors receive a net commission on the sales of those they recruit into the network (who are called their 'downline distributors'). This third compensation component is the most complex aspect of NMO compensation, and is best illustrated with an example.

Consider the example in Fig. 1. Catherine (among others) has been recruited by Janet. As Catherine's sponsor, Janet is the first person in Catherine's 'upline', and Janet therefore receives a commission on Catherine's successful selling efforts. Anne, Lysa, and Paulette, on the other hand, have been directly recruited by Catherine, and are on the first level of Catherine's 'downline'. Thus, Catherine receives a commission on their successful selling efforts—and so does Janet. Although many compensation plans limit the number of levels upon which a distributor may earn downline commission, it is not unusual for NMOs to offer such commissions on up to six levels downline. This makes Catherine eligible for commissions not only on the sales of her direct recruits, but also on those of her recruits' recruits, her recruits' recruits' recruits, etc.

In most NMOs, the commission rate increases as a function of overall group volume. For each distributor, this group volume is the *combined sum* of all personal sales, plus all sales generated by every

[1] For expositional convenience, we will refer to distributors as female. Most NMO distributors are in fact women, so the pronoun choice is apt.

[2] Descriptions of compensation plans in this section are based on the authors' review of three industry compensation plans: Amway, NuSkin International, and Shaklee Corporation. Others will be profiled in the section below on empirical analysis.



COMMISSION SCHEDULE

Volume	Commission Rate
$0 - $99	3%
$100 - $275	5%
> $275	7%

Fig. 1. Example of an NMO network.

person in the distributor's downline network. However, in the typical NMO compensation system, each distributor's *net* commission rate on her downlines' volumes is the *difference* between this distributor's commission rate and the commission rate of her downlines.

For example, suppose Janet sells US$200 worth of product in the month of October. Susan, Catherine, and Kent each sell US$100, and Anne, Lysa, and Paulette each sell US$50. Here, Janet's *personal volume* is US$200, but her *group volume* is US$650, and it is this latter volume on which her commission is based. Suppose Janet's company has a very simple commission system where monthly volumes of up to US$99 earn commission rates of 3%; monthly volumes of US$100 to US$275 earn 5%; and monthly volumes of US$276 or over earn 7%. [3] Under this system, Janet earns 7% on her group volume of US$650, or US$45.50; but of that US$45.50, US$12.50 goes to Catherine for 5% of *her* group volume of US$250; and US$5.00 goes to each of Janet's other two direct downlines, who earn 5% on their volume of US$100. Of Catherine's US$12.50, US$1.50 is deducted to pay Anne, Lysa, and Paulette their 3% commission on their US$50 sales volumes each. Thus, in net, Anne, Lysa, and Paulette each make US$1.50 in commissions; Catherine makes US$8.00 in commissions; Janet's other two downlines each make US$5.00 in commissions; and Janet makes US$23.00 in commissions (all will also make money on wholesale-to-retail markups on their personal volume).

1.2. Sales motivators in NMOs

It is generally believed that both non-monetary and monetary factors motivate NMO distributors to sell. On the non-monetary side, buyer–seller relationships are of great importance in determining the success of a distributor, probably much more so than in conventional and industrial marketing settings. [4] In their study of an organization similar to an NMO, [5] Frenzen and Davis (1990) have supported the argument that the strength of social relations between buyer and seller correlates strongly with the likelihood of a sale. In addition, as Biggart (1989, p. 161) observes, NMOs ''work *through* social conditions and institutions''. Distributors recruit new distributors during their contact with the everyday world, and each new recruit brings a new set of social linkages for possible use by the network. Because the social impact of turning social networks into sales opportunities is particularly important to NMOs (Grayson, 1996), it will therefore be important to try to capture the notion that NMO recruiting uses personal contacts to build the network.

It is also clear that money motivates NMO distributors, just as it motivates most salespeople. In our survey of NMO executives, over 40% mention busi-

[3] Although downline commission rates begin as low as 3 to 5%, they climb as high as 12 to 27% for monthly volumes of US$7000 to US$10,000.

[4] For example, Crosby and Stephens (1987) and Crosby et al. (1990) examined the buyer–seller relationship in the insurance industry, but found conflicting, and therefore inconclusive, evidence concerning the influence of buyer–seller relationships on seller effectiveness.

[5] The study made by Frenzen and Davis (1990) used Tupperware participants as subjects. Tupperware uses a 'party plan' system, which is similar to NMOs in that individuals are rewarded for inviting others to buy products and to have parties. However, party-plan companies differ from NMOs in the following ways: (a) rewards are not heavily commission-based, and instead include significant numbers of product incentives, (b) people are usually eligible for rewards only for those on the level directly below them, and (c) those who hold parties do not have to train or supervise those they invite to the parties.

ness or financial reasons as the motivation for joining an NMO. The NMO company that can understand the linkage among compensation structure, distributor behavior, sales, and profits will improve its ability to grow its business profitably. For example, the more a company rewards retail sales, the more slowly its distributor network will grow, because recruitment is not a relatively lucrative activity. Conversely, the more intensively recruitment is rewarded, the faster the distributor network will grow. Furthermore, the number of levels on which a company offers downline commissions will influence how a distributor spends her time: commission on more levels will encourage a distributor to actively recruit and train more deeply into the network, while commission on fewer levels will encourage a distributor to recruit and train a broader downline network.

Thus, understanding the nature of marketplace demand for the company's products, along with the propensity of new distributors to join the network as a result of being recruited by upline distributors, will help the NMO company set a compensation system that effectively and profitably balances its distributors' incentives to sell product versus to grow their downline networks.

2. A model of NMO compensation and network growth

Our model of NMO compensation is comprised of three distinguishable parts. The first, described in Section 2.1 below, captures the sales response function. The second, described in Section 2.2, captures the social network attributes of an NMO. The third, described in Section 2.3, formalizes the compensation plan offered to distributors. The model then uses these three components to postulate an income-maximizing distributor who splits her time among productive NMO activities. Because our goal is to understand distributor performance in response to the incentives provided, we build a model focused on a particular distributor whom we will denote 'i'. We assume that the focal distributor, i, is recruited into the network at the same time as another distributor, 'j', and both will be building their downline networks simultaneously. We do this to account for the fact that any distributor recruiting and selling in a network marketing firm is always either directly or indirectly competing against other distributors in the network for both sales and new distributor recruits.

The model assumes certainty in the sales response functions. In light of this, the distributor's attitude toward risk is a moot point. However, a model with uncertainty and risk-neutral distributors would produce similar results; risk aversion would induce more conservative behavior, the specifics of which would depend on what activities are subject to the greatest uncertainty. The actual risk attitude of NMO distributors is an empirically unresolved issue. More broadly, the academic salesforce compensation literature (see, e.g., Coughlan and Sen, 1989; Coughlan, 1993) typically assumes salespeople to be either risk-neutral or risk-averse, although it is often claimed among practitioners that salespeople are inherently risk-preferring. As the issue is unresolved, particularly in the NMO context, we proceed with our certainty approach.

Distributor i is assumed to split her available time each period between selling product and network-building (that is, adding new distributors to her downline). [6] This decision is based on the rewards that she gets for recruiting and selling, given her view of how the rest of the network is operating in that time period. A time period is an arbitrary length of time over which performance is measured and compensation rewarded. The most commonly-used compensation periods at network marketing firms appear to be monthly or weekly. Distributor j spends a fraction μ_{jt} of her time on network-building and $(1-\mu_{jt})$ of her time on selling product; the analogous proportions for any downline distributor in either i's or j's downline network are $\mu_{\mathrm{d}t}$ and $(1-\mu_{\mathrm{d}t})$, respectively. We assume that μ_{jt} and $\mu_{\mathrm{d}t}$ are equal to the fraction of time spent recruiting by distributor i in period $(t-1)$. This permits us to represent all distributors as modifying their time allocations over time in response to changing recruit-

[6] In reality, selling product and recruiting may occur simultaneously. However, our empirical data suggest that distributors can nonetheless estimate the time spent on each activity separately. A third activity, network management, also consumes time, but because it is not a direct income-producing activity, we do not model it here.

ing conditions, while retaining model tractability. The total time available for network marketing activities per period is T_i for distributor i; T_j for distributor j; and T_{d} for downlines in i's or j's networks. Distributor i is assumed to maximize her income over a two-period horizon, given the constraint of T_i total hours available per period for selling and recruiting activities.

2.1. Sales response functions

We posit a log-reciprocal model of sales response for distributor i in any time period t, modified to include a separate intercept term:

$$r_{i,t} = a_{0i} + \exp\left[a_i - \frac{b_i}{s_{i,t}}\right], \tag{1}$$

where $r_{i,t}$ is the dollar value of sales by distributor i in period t, $s_{i,t}$ is the number of hours spent selling product by distributor i in period t, and a_{0i}, a_i, b_i are parameters.

This is an s-shaped function of selling time (see Hanssens and Parsons, 1993, for other applications of the log-reciprocal model of sales response), with sales converging asymptotically to $[a_{0i} + \exp(a_i)]$ as distributor i's time spent selling approaches an infinite number of hours. Practically speaking, however, i's sales are constrained by the total time constraint, T_i. The parameter b_i is a curvature parameter, governing how responsive on the margin sales are to selling time. Conceptually, the structure in Eq. (1) allows distributor i to vary her time allocation behavior in response to both the compensation plan facing her and the time-varying size of the network. Distributor i is assumed to know the time allocation rules of all other distributors in the network.

Similarly, the sales response functions facing j and all downline distributors in the network in period t, respectively, are:

$$\begin{aligned} r_{j,t} &= a_{0j} + \exp\left[a_j - \frac{b_j}{(1-\mu_{jt})T_j}\right], \\ r_{\mathrm{d},t} &= a_{0\mathrm{d}} + \exp\left[a_{\mathrm{d}} - \frac{b_{\mathrm{d}}}{(1-\mu_{\mathrm{d}t})T_{\mathrm{d}}}\right], \end{aligned} \tag{2}$$

where $r_{j,t}$ is the dollar value of sales by distributor j in period t, $r_{\mathrm{d},t}$ is the dollar value of sales by a downline distributor in period t, and a_{0j}, $a_{0\mathrm{d}}$, a_j, a_{d}, b_j, b_{d} are parameters.

We construe the existing legal requirements that distributors must actually sell product in order for the NMO to avoid being classified as an illegal pyramid scheme as implying that $s_{i,t}$ is strictly positive for all t. This prevents the sales response functions in Eqs. (1) and (2) above from being undefined, as they would be if $s_{i,t} = 0$ were permitted. Finally, note that sales are a recurring event each period, representing the fact that most products sold through successful NMOs are consumables (e.g., cosmetics, household products, or telecommunications services).

2.2. Recruitment of new distributors

Our discussion above notes the 'social network' aspect of recruiting new distributors into an NMO. One distributor recruits others by socially interacting with them in one form or another. We represent this process by adapting a diffusion model formulation to the recruitment process (Bass, 1969). We find this model structure attractive because it allows for network growth via both inherent attraction (the 'innovation effect') and by the spread of word-of-mouth (the 'imitation effect').

We assume that distributor i recruits new downline distributors into her network in period t according to the following functional rule:

$$\begin{aligned} q_{i,t} = {} & p_i(T_i - s_{i,t})(q - n_{i,t-1} - n_{j,t-1} - 2) \\ & + k_i \cdot \left(\frac{c_{i,t-1} + c_{j,t-1} + 2}{q}\right) \\ & \cdot (q - n_{i,t-1} - n_{j,t-1} - 2), \end{aligned} \tag{3}$$

where $q_{i,t}$ is the number of new downline distributors recruited by distributor i in period t, $n_{i,t-1}$ is the total number of distributors *ever recruited into* i's downline by the end of period $(t-1)$ (*not* including i), $n_{j,t-1}$ is the total number of distributors *ever recruited into* j's downline by the end of period $(t-1)$ (*not* including j), p_i is the coefficient of 'innovation' (a parameter) for distributor i, q is the number of distributors (ever recruited) beyond which no new recruiting can take place (a parameter), k_i is the coefficient of 'imitation' (a parameter) for distributor i, $c_{i,t-1}$ is the total number of *active* distributors in i's downline at the end of period $(t-1)$ (*not* including i), and $c_{j,t-1}$ is the total number of *active* distributors in j's downline at the end of period $(t-1)$ (*not* including j).

The first term in the $q_{i,t}$ function is the 'innovation' term, comprised of an innovation parameter, p_i; the amount of time spent recruiting; and the number of potential distributors not yet recruited into the network. We thus assume that time spent recruiting increases the number of distributors that can be recruited. The variable q represents a ceiling on the number of distributors that can ever be recruited; if this number is reached or exceeded in some time period t, no new recruiting can occur in later time periods because the network potential has been exhausted. Thus, we interpret q roughly as the potential number of distributors that can be recruited into the network, but because of the 'integer' nature of recruiting (i.e., one cannot recruit a fraction of a distributor), the ultimate number of distributors ever recruited into a particular network may exceed or fall short of q by some margin.

The second term in the recruiting function is the 'imitation' term, consisting of an imitation parameter, k_i; the proportion of all active distributors remaining in the network; and the untapped potential distributors. This is the standard imitation component of a diffusion model. We do not model the imitation effect as being influenced by recruiting time, because the inherent concept of an imitation effect is that more passive word-of-mouth and other external effects contribute to the imitation phenomenon. As in a standard diffusion model, this formulation has the property that passive word-of-mouth helps recruit new distributors, but as the network approaches maturity, it becomes harder and harder to recruit more new distributors. Eventually, the network will stop growing when all potential distributors have been recruited.

Distributor attrition is a universal issue in network marketing that we allow for by assuming that $c_{i,t-1} \neq n_{i,t-1}$ and $c_{j,t-1} \neq n_{j,t-1}$. Specifically, we assume that $c_{i,1} = n_{i,1} = q_{i,1}$ and $c_{j,1} = n_{j,1} = q_{j,1}$; but thereafter:

$$\begin{aligned} c_{i,t} &= c_{i,t-1} \cdot \alpha \cdot (1 + q_{\mathrm{d},t}) + q_{i,t} \\ c_{j,t} &= c_{j,t-1} \cdot \alpha \cdot (1 + q_{\mathrm{d},t}) + q_{j,t} \\ n_{i,t} &= n_{i,t-1} + q_{i,t} + c_{i,t-1} \cdot q_{\mathrm{d},t} \\ n_{j,t} &= n_{j,t-1} + q_{j,t} + c_{j,t-1} \cdot q_{\mathrm{d},t}. \end{aligned} \tag{4}$$

The parameter α $(\alpha < 1)$ is the fraction of downline distributors who are retained in the network each period (thus, $(1-\alpha)$ is the fraction subject to attrition). While estimates of attrition vary widely, research indicates that attrition of 100% per year is not uncommon (Brodie, 1995; Direct Selling Association/UK, 1996). We show below that the actual amount of attrition varies over time depending on the network's level of maturity.

New distributor recruitment is done by all distributors currently in the network until all potential for new recruitment is exhausted, at which point time is allocated entirely to selling effort by all distributors. Distributor j's recruiting function is analogous to i's, adjusted for the amount of time j spends recruiting, $\mu_{jt} T_j$:[7]

$$\begin{aligned} q_{j,t} = p_j \cdot \mu_{jt} \cdot T_j \big(q - n_{i,t-1} - n_{j,t-1} - 2\big) \\ + k_j \cdot \left(\frac{c_{i,t-1} + c_{j,t-1} + 2}{q} \right) \\ \cdot \big(q - n_{i,t-1} - n_{j,t-1} - 2\big). \end{aligned} \tag{5}$$

Similarly, each downline spends $\mu_{\mathrm{d}t} T_{\mathrm{d}}$ hours per time period recruiting new distributors into the network, and each one recruits $q_{\mathrm{d},t}$ new downline distributors of her own in period t according to the following function:

$$\begin{aligned} q_{\mathrm{d},t} = p_{\mathrm{d}} \cdot \mu_{\mathrm{d}t} \cdot T_{\mathrm{d}} \big(q - n_{i,t-1} - n_{j,t-1} - 2\big) \\ + k_{\mathrm{d}} \cdot \left(\frac{c_{i,t-1} + c_{j,t-1} + 2}{q} \right) \\ \cdot \big(q - n_{i,t-1} - n_{j,t-1} - 2\big). \end{aligned} \tag{6}$$

Finally, while the equations for $q_{i,t}$, $q_{j,t}$, and $q_{\mathrm{d},t}$ permit fractional downline distributors to be recruited, in the analysis we round these numbers to get more realistic integer recruitment figures.

2.3. Distributor income

Distributor i makes income on (a) markup on personal retail volume sold, (b) commissions on

[7] We allow j's recruiting parameters to vary from i's in the statement of the formal model. However, in the empirical analysis below, we will restrict i's and j's parameters to be equal, for simplicity of exposition.

personal volume, and (c) net commissions on the volume of her downline distributors. We assume an average markup of Ψ cents per dollar (so that, for example, if distributor i sells a product for a retail price of US$1.00, she makes Ψ cents in markup).[8] As mentioned above, commission rates are generally quoted as a percentage of *group volume*, and they increase as group volume increases. Let i's group volume in period t be denoted as $R_{i,t}$. Then we approximate the usual step-function for commissions with the continuous function below:

$$\beta_{i,t} = g_1[1 - \exp(-g_2 R_{i,t})], \tag{7}$$

where g_1 is the asymptotic (high) commission rate that can be earned, and g_2 is a shape parameter. The commission rate function is concave: commission increases, but at a decreasing rate, with group volume. The formula for group volume can be more explicitly written as:

$$R_{i,t} = r_{i,t} + \sum_{m=1}^{t} R_{\mathrm{d},t,m}, \tag{8}$$

where

$$R_{\mathrm{d},t,m} = \alpha^{(t-m-1)} \cdot q_{i,m}\left[\prod_{k=m+1}^{t}(1+q_{\mathrm{d},k})\right] r_{\mathrm{d},t}.$$

Here, $R_{\mathrm{d},t,m}$ is the group volume in period t of a downline recruited by i in period m. Thus, the sum of the $R_{\mathrm{d},t,m}$ over all m from 1 to t is the sum of all the group volumes of all downlines recruited directly by i in any period prior to t—or more simply, the total volume generated by all downlines in i's network. $R_{\mathrm{d},t,m}$ is calculated by multiplying a single downline's volume in period t ($r_{\mathrm{d},t}$) by all downlines remaining in i's network in period t; those who are still active are all those recruited directly by i in any prior period, and all those ever recruited into their networks through time, adjusted by the attrition factor. Note that the earlier in time a downline distributor is recruited by i, the larger her own downline network is in t; thus it is important to account for each 'generation' of recruits separately.

In this paper, we model a 'unilevel' compensation plan.[9] Here, each distributor's group commission rate is calculated as in Eq. (7) above. The distributor makes this commission on every dollar of her *personal volume*, that is, the volume of product that she personally sells each period. Beyond this, the distributor makes net commissions on the sales of her downline distributors. The net commission rate is simply the difference between the distributor's group volume commission and the group commission rate of her downline distributor. Thus, as a downline's own network grows and her group commission rate rises, the upline distributor makes less and less in net commissions from that downline. It is not unusual for the upline to make *no* net commission income on a downline's group volume (which happens when both the upline and her downline are in the same commission category, frequently the maximum possible commission). More formally, a downline distributor 'd' recruited by i in period h earns a group commission rate in period t of $\beta_{\mathrm{d},t,h}$. Then the net commission rate earned by i on d's group volume is just:

$$\gamma_{t,h} = \beta_{i,t} - \beta_{\mathrm{d},t,h}. \tag{9}$$

We can then express distributor i's income in period t as:

$$y_{i,t} = (\Psi + \beta_{i,t}) r_{i,t} + \sum_{h=1}^{t} [\gamma_{t,h} \cdot R_{\mathrm{d},t,h}]. \tag{10}$$

To reflect the idea that distributors recruit downlines in the hopes of a stream of future returns (rather than just a one-period payout), we assume that distributor i maximizes her income in period t,

[8] For simplicity, we keep Ψ fixed for all distributors, including i and j. Our empirical research reveals that distributors tend to set retail prices consistent with the markups suggested by the NMO firm. Given this, the NMO's suggestion of a retail markup can be viewed as tantamount to the setting of a retail price. While we acknowledge each distributor's right to set a retail price in theory, the fact that they do not deviate in practice from suggested retail prices makes it possible to assume an average markup, rather than model the distributor as choosing retail prices.

[9] This is a very common type of network marketing compensation plan. The other most common plan type is the 'breakaway' plan, where a downline distributor 'breaks away' from her upline sponsor when she reaches a certain level of group volume herself. After this point, the upline no longer can count the breakaway's group volume in her total group volume, but does make a flat-rate override (usually on the order of 5%) on all sales of the breakaway's network thereafter. Because this compensation plan requires several significant modifications to the present model, we leave investigation of this plan's characteristics to later research.

plus the income she can plan on getting in $(t+1)$ from the downlines she recruits in period t, subject to the constraint that total time per period be no greater than T_i hours.[10] Formally, distributor i does:

$$\max_{s_{i,t}} \left[y_{i,t} + \sum_{h=1}^{t} \gamma_{t,h} \cdot R_{\mathrm{d},t,h} \cdot \alpha(1+q_{\mathrm{d},t}) \right] \qquad (11)$$
$$\text{s.t. } s_{i,t} \leqslant T_i.$$

Finally, for reference we give the NMO firm's gross profit function.[11] The NMO itself does not set any decision variables in this model, but we will use the profit function to report below on the profitability implications of different scenarios. The firm's profit in period t is expressed as:

$$\pi_t = (1-\beta_{i,t} - \Psi) \cdot R_{i,t} + (1-\beta_{j,t} - \Psi) \cdot R_{j,t}, \qquad (12)$$

where

$$\beta_{j,t} = g_2\left[1 - \exp(-g_2 \cdot R_{j,t})\right]$$

and $R_{j,t}$ is the distributor j's group volume (with a form analogous to that for $R_{i,t}$).

Distributor i's optimand in Eq. (11) above is a highly nonlinear objective function, with no analytic closed-form solution to the first-order conditions for each period. Thus we proceed below to illustrate the properties of the model through a numerical analysis, using original data collected from a sample of network marketing firms to calibrate the parameters of the model.

3. Empirical analysis and model insights

Because of the complexity of our model, closed-form analytic solutions cannot be derived. Realism in depicting the factors in a network marketing system is necessary, however, to adequately analyze the incentives for the different types of distributor activities. We use a numerical analysis to show these incentives, but go a step beyond a general numerical analysis to use data from an original survey of network marketing firms to calibrate the model parameters. This gives us some confidence that the numerical scenarios we are investigating are representative of real network marketing firms' and distributors' experiences. Our empirical analysis lets us examine how changes in the compensation plan, or investments in sales-producing or recruitment-enhancing assets, influence the activities of our focal distributor as well as the overall growth and profitability of the network marketing firm.

Below, we first discuss the data and present summary statistics. We then summarize the process of initial model parametrization and the development of a baseline scenario. Following this is a full numerical analysis of the model around the baseline. Finally, we discuss general insights emerging from the analysis regarding incentives, growth, and profitability in a network with a unilevel compensation plan.

3.1. The data

The data were collected through a survey sent to the presidents of 150 NMOs.[12] Presidents were encouraged to complete the survey, but if they could not, they were asked to pass the survey on to another executive (a sales manager, for example). Of all surveys returned, seven could not be delivered to the address on our mailing list, and three were returned by companies that no longer operate as network

[10] Many salesforce compensation models now use a utility-maximizing approach rather than an income-maximizing one. Our data indicate that a specific amount of total time is spent on network marketing activities and that the time is then allocated between selling and network-building activities. We can represent the distributor's utility therefore as $U_{i,t} = y_{i,t}(s_{i,t}, v_{i,t}) - d(s_{i,t} + v_{i,t})^2$ where $y_{i,t}$ is income over whatever horizon distributor i has; $s_{i,t}$ is selling time; $v_{i,t}$ is network-building time; and d is a parameter representing the disutility of time. The total time available is some T_i hours, so that the constraint that $T_i = s_{i,t} + v_{i,t}$ implies that the distributor's optimization problem is to choose $s_{i,t}$ to maximize $U_{i,t} = y_{i,t}(s_{i,t}, (T_i - s_{i,t})) - dT_i^2$. This is equivalent to an income maximization problem, and is the problem we solve here.

[11] Gross profit here is defined as profit gross of cost of goods sold (COGS) and any other expenditures. This is a valid diagnostic measure for our purposes: first, because COGS does not vary in kind for differences in distributor compensation decisions or other underlying parametric levels in our model; and second, because NMOs generally make very low or no expenditures on other marketing-mix activities, like advertising.

[12] We thank Corey Augenstein, editor of *Downline News*, for sharing his mailing list with us.

Table 1
Overview of survey respondents

	Average	Maximum	Minimum
Current size of network	40,000	300,000	250
Annual revenues	US$31,600,000	US$360,000,000	US$150,000
Years in business	6	18	1
% of business outside the U.S.	12%	93%	0%

marketers. After two mailings to every address on the list, a total of 32 viable surveys were completed and returned, constituting a response rate of 23%. We found no systematic lack of response to any particular question on the survey. [13]

Tables 1 and 2 outline the characteristics of the respondent pool. Respondents' average network size at the time of the survey was 40,000, and average annual revenues were US$31.6 million. However, the range figures indicate considerable variance around these averages. In addition, the average commission rates seem to accurately reflect the general industry trends.

We also collected information on how respondents believed distributors split their time among productive activities. [14] Because NMO presidents typically were distributors themselves in the past, we felt comfortable with their responses. These data are presented in Table 3, expressed in hours per month, for three different ability levels of distributor: average, above average, and top. [15] The data show that an above-average distributor spends slightly more than twice (2.24 times) the total time that average distributors do on network marketing, and top distributors spend slightly more than twice (2.22 times) the total time that above average distributors do. This contradicts a common stereotype of the top distributor as a 'freeloader' on the rest of the network who does no work but makes large amounts of money. Further, on a percentage basis, of the total time spent selling and recruiting (omitting network management time), average distributors spend 45% on recruiting; above average distributors spend 59% on recruiting; and top distributors spend 74% on recruiting. Thus, the differences in productivity of different levels of distributors come both from differences in total time spent *and* from differences in the allocation of that time between selling and recruiting.

How productive are distributors with the time they spend in network marketing? Table 4, along with Table 3, summarizes the evidence from our sample. It takes an average distributor 5.5 hours to recruit a downline (11 hours to recruit two distributors); an above average distributor recruits a downline in 5.2 hours (26 hours to recruit five distributors); and a top distributor recruits a downline in a considerably lower 3.8 hours (61 hours to recruit 16 downlines). Selling productivity varies by distributor level as well. Tables 3 and 4 shows that average distributors sell, on average, US$34 of merchandise (wholesale value) per hour (8 hours to sell US$275 of merchandise); above average distributors sell US$53 of merchandise per hour (16 hours to sell US$855 of merchandise); and top distributors sell US$295 of merchandise per hour (17 hours to sell US$5008 of merchandise). For these productivity levels, Tables 3 and 4 also show the compensation that distributors receive. An average distributor

[13] The discussion here follows the '1993 Multi-Level Marketing Executives Industry Survey Summary Report' (Coughlan and Grayson, 1993).

[14] We asked about time spent not only on retail selling and recruitment, but also on network management (holding rallies for downline distributors, training, etc.). Because we focus in this model on selling and recruiting specifically, we omit the network management function from our model.

[15] In our numerical analysis below, we depict distributors i and j as *top* distributors, and all downlines as *average* distributors. Respondents said that on average, 21% of their distributors were above average performers, while 71% were average performers and 8% were top performers. A discriminant analysis of our data revealed significant differences between top and other distributors, but not between average and above average distributors. Modeling top and average distributors therefore appears to adequately represent the diversity among distributors of different levels.

Table 2
Survey respondents' compensation structures

	Average	Maximum	Minimum
Highest commission rate available in the plan	30%	75%	8%
Minimum wholesale group volume required to earn highest commission rate	US$3600	US$5000	US$0
Lowest commission rate available in the plan	10%	33%	4%
Minimum wholesale group volume required to earn lowest commission rate	US$186	US$2000	US$0
Retail markup[a]	49%	100%	20%

[a]An overwhelming number of respondents reported that distributors tend to sell at the suggested markup.

makes US$12 per hour (US$418 in 34 hours); an above-average distributor makes US$33 per hour (US$2523 in 76 hours); and a top distributor makes US$72 per hour (US$12,217 in 169 hours).

The summary statistics lead us to believe that (a) distributors differ in their productivity at both selling and recruiting across levels, particularly contrasting top with other distributors; and (b) the averages are illuminating, but there still appears to be considerable variation in the data from firm to firm. We take these factors into account in our numerical model analysis below.

3.2. Initial model parametrization and development of baseline scenario

In this section, we parametrize the analytic model and report both the results of running the model using the parameters developed and the implications for NMO salesforce management. In Section 3.3 we will vary these baseline parameters to show how different circumstances affect such outcomes as network growth and NMO profits.

Because our sample of respondents was small relative to the between-firm variance in our data, we decided to parametrize our analytic model for a single firm rather than in the aggregate, and perform sensitivity analysis around that baseline scenario. Our questionnaires asked the respondent to provide three data points on the relationship between selling time and sales for each level of distributor, which was sufficient to fit sales response functions at a firm-specific level. We similarly asked for enough information to fit recruiting response functions by firm and by level of distributor. Time and compensation information was directly provided and did not need to be fitted. All parameters were fitted from data provided by the firm, except for the value of $b_i = b_j$, which was adjusted to give reasonable sales results for the time allocations reported on in the data. Our baseline set of parameter values, along with parameter definitions, are report in Table 5.

In this scenario, distributors i and j are 'top' performers, while the downlines are 'average.' We provide for i to spend more time per month on network activities than j. These parameter values imply maximum *personal* sales volumes per period (given total time available) of US$50,615 and US$47,266 for distributors i and j, respectively, and US$700 for a downline, if each allocates all her time to selling. Of course, the effective commission rate facing each distributor is a function of her *group* volume, not her personal volume. The commission-rate parameters imply a group-volume commission rate that varies with group sales volume according to the schedule in Table 6.

Note again that the continuous function reflected above is an approximation of the standard step function usually offered by NMOs. Clearly, distributor i

Table 3
Distribution of distributor activities (expressed as hours per month)

		Average distributor	Above-average distributor	Top distributor
Total hours spent	Average	34	76	169
	Maximum	110	240	500
	Minimum	2	13	11
Hours managing network	Average	15	32	88
	Maximum	105	160	300
	Minimum	0	4	10
Hours retail selling	Average	8	16	17
	Maximum	48	72	60
	Minimum	0	0	0
Hours recruitment	Average	11	26	61
	Maximum	54	80	315
	Minimum	0.2	2	1

Table 4
Productivity of distributor activities

		Average distributor	Above-average distributor	Top distributor
Number of new recruits per month	Average	2	5	16
	Maximum	15	20	100
	Minimum	0	0.5	0
Income per month (in dollars)	Average	418	2523	12,217
	Maximum	1100	12,500	63,000
	Minimum	24	500	1000
Value of product sold (wholesale dollars)	Average	275	855	5008
	Maximum	1000	3000	40,000
	Minimum	0	0	0

Table 5
Model parameters and their definitions

Total time parameters	Recruiting parameters	Sales response function parameters	Commission and markup parameters
$T_i = 61$	$q = 206{,}800$	$a_{0i} = a_{0j} = 280$	$g_1 = 0.59$
$T_j = 40$	$p_i = p_j = 3.27923 \cdot 10^{-6}$	$a_i = a_j = 10.9576$	$g_2 = 0.00223494$
$T_d = 9$	$p_d = 1.45743 \cdot 10^{-6}$	$b_i = b_j = 8$	$\Psi = 0.325$
	$k_i = k_j = 3.15642 \cdot 10^{-6}$	$a_{0d} = 140$	
	$k_d = 2.42194 \cdot 10^{-4}$	$a_d = 12.6269$	
	$\alpha = 0.9$	$b_d = 56.6904$	

Commission and markup parameters: g_2 = shape parameter in commission rate function. Higher g_2 implies that commission rises faster with increases in sales performance. g_1 = asymptotic maximum commission rate that can be earned on sales, as sales volume grows very large. Ψ = average markup (in cents per dollar of sales) that a distributor gets by virtue of buying at wholesale and selling at retail.
Recruiting parameters: q = cumulative number of distributors ever recruited, beyond which no new recruiting can occur in future periods. Referred to as 'network potential.' p_i, p_j, p_d = coefficient of 'innovation' for i, j, and downlines, respectively: as parameter is higher, recruiting time is more productive in recruiting new distributors. k_i, k_j, k_d = coefficient of 'imitation' for i, j, and downlines, respectively: as parameter is higher, word-of-mouth effects are stronger at attracting new distributors to the network. α = fraction of downline distributors retained in the network from the previous period. Thus, $(1-\alpha)$ is the attrition fraction.
Total time parameters: T_i, T_j, T_d = total time (in hours) available per period for both selling and recruiting activities for i, j, and downlines, respectively.
Sales response function parameters: a_{0i}, a_i; a_{0j}, a_j; a_{0d}, a_d = components of asymptotic maximum sales of i, j, and downlines, respectively. E.g., as distributor i's selling time approaches infinity, sales approach $[a_{0i} + \exp(a_i)]$ for i. b_i, b_j, b_d = shape parameter in (s-shaped) sales response function, for i, j, and downlines, respectively. As parameter increases, marginal sales productivity falls, or equivalently, more selling effort is necessary to reach the same personal sales level.

Table 6
Group-volume commission rate and group sales volumes

Group sales volume	Commission rate	Group sales volume	Commission rate
0	0	3500	58.98%
500	39.70%	4000	58.9923%
1000	52.69%	4500	58.9975%
1500	56.94%	5000	58.9992%
2000	58.32%	5500	58.9997%
2500	58.78%	6000	58.9999%
3000	58.93%	6300 +	59%

can make positive net commission income from her downline recruits, particularly in the first few periods after they are recruited (before their own downline network grows too large), but *i* also makes both commission and markup percentages on her own personal volume, the product she sells directly.

The *total time* spent on selling and recruiting by *i* (61 hours), *j* (40 hours), and the downlines (9 hours) are near the median of their respective distributions among the firms in our dataset. Total time spent selling and recruiting ranged from 1.5 to 80 hours per month for average distributors, and from 10 to 350 hours per month for top distributors, among the firms in our dataset. The *total potential number of distributors* for this network marketing firm, 206,800, is in the 25th percentile among the firms in our sample (the range of total potential network sizes is from 31,000 to 1,000,000 in the sample).[16] The *diffusion rate parameters* are such that it takes just under 1.5 hours to recruit one downline distributor in the first period (however, the amount of time needed to recruit one downline changes over time as the network grows).

The results from this run of the model are summarized in Table 7. Notice that the amount of time allocated to recruiting (equal to 61 minus the time spent selling) *increases* over time, until the market matures in period 24. This reflects the increasing value of recruiting a downline distributor (who will herself recruit more downlines next period) as the network grows and word-of-mouth effects strengthen. However, the productivity of recruiting never becomes so great that distributor *i* allocates all of her time to recruiting. When it is no longer possible to recruit new distributors (after period 23), attrition (equal to the number of distributors ever recruited minus the number active) causes the number of active distributors to decline until, by period 50, only about 10,000 remain. Thus, depending on the set of time periods over which one measures attrition, total attrition may look fairly minor (as in the middle periods) or very severe (as in the later periods). The discounted present value of income for distributor *i* over the 50-period horizon is US$531,791, and the DPV of profits over the 50-period horizon for a firm with these parametric values is US$5,970,790 (in all of our analyses, we assume a 10% discount rate on future cash flows).

Can a firm like this make a higher discounted present value of profit if it either changes compensation parameters or invests in changing other underlying model parameters? We consider this issue in Section 3.3 with a full numerical analysis of the model around our baseline case.

3.3. Numerical analysis of the model: variants on the baseline scenario

Our approach in this section is to vary model parameters individually from their baseline levels to investigate their effects on time allocation by distributor *i*, network growth, and firm profitability, doing the numerical equivalent of comparative-static analysis. We examine the whole 'reasonable range' for each parameter, in order to show the full possible effect of each variable on model outcomes. This 'reasonable range' is the range of parametric values within which our focal distributor optimally chooses to spend time both recruiting *and* selling, since the combination of these two activities is what uniquely distinguishes NMO retailing activity from standard retailing activity. For comparison purposes, we also

[16] We did not have an estimate of steady-state network size from our respondents. However, we did ask them what proportion of people would be very likely, moderately likely, or unlikely to join the network out of 100 people randomly called out of the phone book. We calculated what percentage was represented by all the 'very likely's' plus half of the 'moderately likely's,' and made a distribution of that percentage across the firms in our sample. If our sample is representative of NMOs in general, then the maximum of the percentages in our distribution would mirror the maximum in the population at large. We then estimated Amway's U.S. network size to be about 1 million distributors strong (Amway officials told us that their worldwide network has over 2 million distributors, but would not reveal the size of their U.S. distributor base). Then if Amway is the biggest NMO in the United States, 1 million is an upper bound on steady-state network size in our database as well. We therefore associate the firm with the maximum value of [very likely + (moderately likely)/2] with a steady-state network of 1 million distributors, and prorated the other firms accordingly. Thus, for example, the focal firm in our numerical analysis below had 5% of people 'very likely' to join and 10% 'moderately likely' to join, yielding a value of 10% for [very likely + (moderately likely)/2]. The maximum value of this variable in the dataset was 48.36677 (and that firm was estimated to have a steady-state network size of 1 million). The ratio of 10/48.36677 is 0.2068, yielding a steady-state network size for our focal firm of (1,000,000)·(0.2068) or 206,800.

Table 7
Results from baseline run of model

Period	Time spent selling (h)	Distributor i's income	No. of active distributors	No. of distributors ever recruited	Total network sales	Network profit
1	53.02	US$45,716	21	21	US$91,060	US$7740
2	50.03	US$46,240	31	31	US$106,130	US$9021
3	50.48	US$46,822	40	43	US$106,047	US$9014
4	50.33	US$47,402	48	55	US$109,179	US$9280
5	50.35	US$47,941	56	67	US$111,322	US$9462
6	50.33	US$48,456	62	79	US$113,477	US$9646
7	50.32	US$48,936	68	91	US$115,336	US$9804
8	50.31	US$49,386	73	103	US$117,036	US$9948
9	50.30	US$49,804	78	115	US$118,552	US$10,077
10	50.29	US$50,282	84	128	US$120,207	US$10,218
11	50.28	US$50,729	88	141	US$121,718	US$10,346
12	50.28	US$51,145	92	154	US$123,071	US$10,461
13	50.27	US$51,532	96	167	US$124,298	US$10,565
14	50.27	US$51,888	100	180	US$125,395	US$10,659
15	50.26	US$54,504	191	291	US$154,521	US$13,134
16	50.05	US$55,293	356	493	US$206,888	US$17,586
17	49.74	US$53,413	654	862	US$298,414	US$25,365
18	49.20	US$50,340	1193	1531	US$458,380	US$38,962
19	48.30	US$48,385	2167	2743	US$729,484	US$62,006
20	46.91	US$48,118	3927	4936	US$1,173,200	US$99,722
21	44.89	US$48,125	10,640	12,827	US$2,753,190	US$234,021
22	39.12	US$48,438	38,382	44,824	US$8,579,990	US$729,299
23	32.20	US$45,160	172,720	198,352	US$30,230,000	US$2,569,550
24	61	US$50,807	155,448	198,352	US$24,698,900	US$2,099,400
25	61	US$46,810	139,903	198,352	US$109,276,000	US$9,288,500
26 through 50	Constant at 61	Rises to US$52,005 in period 50	Declines to 10,046 in period 50	Constant at 198,352	Declines to US$7,935,790 in period 50	Declines to US$674,542 in period 50

Discounted present value of distributor i's income over the 50-period horizon $(i = 10\%)$ = US$531,791.
Discounted present value of sales over the 50-period horizon $(i = 10\%)$ = US$70,244,600.
Discounted present value of profits over the 50-period horizon $(i = 10\%)$ = US$5,970,790.

report on the range of parameter values found in our data (the 'data range'). However, because these other parameter values may be more realistically applied in the context of the rest of that firm's set of values, we caution the reader against making inferences about other firms' experiences based on our application of just one of their parameter values to our baseline scenario. Given the many model parameters and the complexity of the model, [17] it is infeasible to sample the entire parameter space. But by starting from a reasonable baseline scenario, we can investigate a representative part of the space and draw general conclusions about the effects of certain parameters on network marketing outcomes. Of course, the model can also be implemented in any specific network marketing company in an interactive fashion to examine that particular firm's situation in detail.

We ran 36 scenarios beyond the baseline scenario. The runs are described in Table 8, and results from the runs are summarized in Table 9. We divide the scenarios into those examining the effects of changes in (a) compensation and markup parameters (scenarios 2 through 7), (b) recruiting parameters

[17] The model is run on Mathematica. Each run (50 periods long) takes about 2 h to run on a Pentium 200 MHz computer. The Mathematica file is available from the authors on request.

Table 8
Numerical analysis of the model: parametric values for scenarios run

Run no.	Commission and markup parameters	Recruiting parameters	Total time parameters	Sales response function parameters
1	$g_1 = 0.59$, $g_2 = 0.00223494$; $\Psi = 0.325$	$q = 206{,}800$; $p_i = p_j = 3.27923 \cdot 10^{-6}$, $p_d = 1.45743 \cdot 10^{-6}$; $k_i = k_j = 3.15642 \cdot 10^{-3}$, $k_d = 2.42194 \cdot 10^{-4}$; $\alpha = 0.9$	$T_j = 61$, $T_j = 40$, $T_d = 9$	$a_{0i} = a_{0j} = 280$, $a_i = a_j = 10.9576$, $b_i = b_j = 8$; $a_{0d} = 140$, $a_d = 12.6269$, $b_d = 56.6904$
2	$g_2 = 0.0001$			
3	$g_2 = 0.004$			
4	$g_1 = 0.33$			
5	$g_1 = 0.665$			
6	$\Psi = 0$			
7	$\Psi = 0.4$			
8		$q = 170{,}947$		
9		$q = 1{,}290{,}534$		
10		$p_i = p_j = 2.6 \cdot 10^{-6}$		
11		$p_i = p_j = 6.2 \cdot 10^{-5}$		
12		$k_i = k_j = 0$		
13		$p_d = 7 \cdot 10^{-7}$		
14		$p_d = 6.8 \cdot 10^{-5}$		
15		$k_d = 1 \cdot 10^{-6}$		
16		$k_d = 31$		
17		$\alpha = 0.6$		
18		$\alpha = 1.0$		
19			$T_i = 54$	
20			$T_i = 200$	
21			$T_d = 4$	
22			$T_d = 20$	
23				$a_{0i} = a_{0j} = 0$
24				$a_{0i} = a_{0j} = 2000$
25				$a_i = a_j = 8.0116$
26				$a_i = a_j = 11.2182$
27				$b_i = b_j = 0.001$
28				$b_i = b_j = 10.8845$
29				$a_{0d} = 98$
30				$a_{0d} = 446$
31				$a_{0d} = 1223$
32				$a_d = 0$
33				$a_d = 18$
34				$a_d = 19.587$
35				$b_d = 25.3699$
36				$b_d = 31$
37				$b_d = 100$

(scenarios 8 through 18), (c) total time and time allocation parameters (scenarios 19 through 22), and (d) sales response function parameters (scenarios 23 through 37). It is important to note that changes in compensation and markup parameters can be undertaken without any extraneous investment on the part of the network marketing firm, while changing the other parameters is likely to require purposeful investments on the part of management (e.g., investing in greater ‘brand equity’ could increase the attractiveness of the network, thus increasing the innovation parameters, but this is likely to cost money to accomplish). Thus, as we discuss the sensitivity of the model to these changes in parameters, we will emphasize where appropriate that investment is necessary and that this investment must be sufficiently inexpensive to make the resulting parameter change profitable on a net basis.

3.3.1. Changes in compensation and markup parameters (scenarios 2 through 7)

Here, we investigate the effects on network performance of changes in parameters g_2, g_1, and Ψ. Recollect that their baseline values are 0.00223494, 0.59, and 0.325, respectively. Summary information on these effects is presented in section A of Table 9. Overall, the analysis shows that:

1. A more concave commission rate function causes i to spend more time selling and less recruiting, and results in lower income for i as well as lower profits for the NMO.
2. Increasing the maximum achievable commission causes i to spend more time recruiting and less selling, resulting in a larger network and a changing impact on NMO profits.
3. Increasing the markup available causes i to spend more time selling, increasing i's income, and drastically reducing the NMO's profitability.

First consider changes in g_2, the parameter affecting the degree of concavity of the commission rate function. Positive values of g_2 generate positive amounts of both selling and recruiting time, so we choose $g_2 = 0.0001$ to represent a minimum value of g_2. Values of g_2 greater than 0.004, by contrast, cause i to spend all her time selling. Behavior of i for g_2 in the interval (0.0001, 0.004) lies between the levels of actions taken at the two boundary points. For comparison purposes, the values of g_2 in our sample of firms range from 0.000892574 up to 0.0693147, although most lie in the interval whose boundaries we examine here. [18]

Higher values of g_2 cause any distributor's group-volume commission rate to increase faster with group volume increases (albeit still to the same asymptotic maximum of 59%). This has two effects on distributor i's actions: first, it causes i's own income to rise faster with her own group volume; and second, it causes her net commission income earned on downline distributors to fall, because *their* income also rises faster with group volume. The results in Table 9(A) are consistent with these two effects. The higher value of g_2 in scenario 3 causes distributor i to spend more time selling and less recruiting, because of the diminished net commissions available on downline volumes. Distributor i's income also falls, again because of both lower net commission earnings and because of the resulting lower recruiting effort (and smaller downline network size). Because i, a key distributor in the network, has less incentive to recruit, the entire network grows much more slowly and high values of g_2 cause the NMO firm to lose the majority of its profits.

Scenarios 4 and 5 in Table 9(A) show the effect of changes in g_1 (the maximum achievable commission rate on group volume) on network activities. For any value of g_1 less than 33%, distributor i chooses to spend all her time selling. As all values of g_1 greater than 0.33 generate positive amounts of both selling and recruiting in the network, we examine $g_1 = 0.665$ as our maximum value—because it would lead to a profit margin for the NMO of just 1% at maximum commission levels (i.e., 100% minus 66.5% minus 32.5%, the value of Ψ for this firm). Again for comparison purposes, values of g_1 generated in our sample range from 8% up to 75%.

As g_1 increases, distributor i's time spent selling decreases. This is because higher values of g_1 cause net commissions on downline distributor sales to be more attractive to distributor i. The number of distributors ever recruited into the network therefore increases with g_1. The effect on profitability of increasing g_1 is non-monotonic, because of multiple effects on the system. First, a higher g_1 lowers the NMO's own profit margin on every sale. But on the other hand, increases in g_1 increase *all* distributors' recruiting incentives, causing the network to grow much faster and generate significant sales increases; this has an upward effect on profitability. The com-

[18] Remember that other firms' values of g_2 outside the range {0.00223494, 0.004} do not necessarily imply that either no selling or no recruiting takes place at these firms, since the values of other model parameters are also obviously different in those cases. The data range of g_2 is nevertheless indicative of the degree of curvature of NMO commission plans. The same comment is relevant for all the parameter changes examined below.

Table 9
Numerical analysis of the model

Run no.	Change from baseline model	Range of time spent selling (h)	No. of periods of new recruiting	No. of recruits over 50-period horizon	No. of recruits active in period 50	DPV of i's income (50 periods)	DPV of total network sales (50 periods)	DPV of profit (50 periods)
1	N/A	53.02–32.20 in periods 1–23; 61 after	23	198,352	10,044	US$531,791	US$70,244,600	US$5,970,790
(A) *Compensation and markup parameter changes*								
2	$g_2 = 0.0001$	45.35–28.39 in periods 1–11; 61 after	11	218,808	3159	US$1,318,430	US$238,040,000	US$20,234,500
3	$g_2 = 0.004$	60.62 in period 1; 61 after	1	14	4	US$505,061	US$1,109,600	US$94,316
4	$g_1 = 0.33$	60.55 in period 1; 61 after	1	14	4	US$361,541	US$1,109,530	US$382,788
5	$g_1 = 0.665$	51.86–31.47 in periods 1–13; 61 after	13	200,974	3488	US$569,392	US$180,843,000	US$1,808,430
6	$\Psi = 0$	41.71–26.18 in periods 1–11; 61 after	11	199,132	2866	US$346,197	US$218,727,000	US$89,678,200
7	$\Psi = 0.4$	55.33–52.12 in periods 1–50	50	507	92	US$578,336	US$1,261,770	US$12,618
(B) *Recruiting parameter changes*								
8	$q = 170{,}947$	60.99 in period 1; 61 after	1	11	4	US$505,099	US$1,099,050	US$93,419
9	$q = 1{,}290{,}534$	7.90 in period 1; 0.1 in periods 2–4; 61 after	4	1,266,029	8882	US$449,766	US$2,684,870,000	US$228,214,000
10	$p_i = p_j = 2.6 \cdot 10^{-6}$	60.08 in period 1; 61 after	1	12	5	US$505,832	US$1,101,890	US$93,661
11	$p_i = p_j = 6.2 \cdot 10^{-5}$	7.95 in period 1; 0.1 in periods 2–3; rising to 30.12 in period 16; 61 after	16	229,803	2505	US$1,368,210	US$165,340,000	US$14,053,900
12	$k_i = k_j = 0$	53.02–32.30 in periods 1–24; 61 after	24	192,088	10,805	US$528,582	US$61,471,400	US$5,225,070
13	$p_d = 7 \cdot 10^{-7}$	59.92–52.24 in periods 1–50 (fluctuating)	50	498	92	US$535,709	US$1,255,250	US$106,696
14	$p_d = 6.8 \cdot 10^{-5}$	7.97 in period 1; 0.1 in periods 2–3; 61 after	3	208,095	1320	US$430,948	US$487,261,000	US$41,417,200
15	$k_d = 1 \cdot 10^{-6}$	53.03–50.51 in periods 1–50 (fluctuating)	50	606	112	US$539,196	US$1,261,510	US$107,228
16	$k_d = 31$	7.96 in period 1; 0.1 in periods 2–3; 61 after	3	226,299	1392	US$428,883	US$521,815,000	US$44,354,300
17	$\alpha = 0.6$	60.88 in period 1; 61 after	1	14	1	US$505,086	US$1,080,450	US$91,839

18	$\alpha = 1.0$	50.97–34.10 in periods 1–12; 61 after	12	224,342	224,342	US$521,545	US$518,517,000	US$44,073,900
(C) *Total time parameter changes*								
19	$T_i = 54$	53.02 in period 1; 54 after	1	15	5	US$497,334	US$1,103,230	US$93,774
20	$T_i = 200$	53.02–32.43 in periods 1–7; 200 after	7	223,821	2075	US$668,192	US$351,650,000	US$29,890,300
21	$T_d = 4$	60.65 in period 1; 61 after	1	14	4	US$505,064	US$1,070,690	US$91,008
22	$T_d = 20$	48.16 in period 1; 61 after	1	23	8	US$504,632	US$2,958,120	US$251,440
(D) *Sales response function parameter changes*								
23	$a_{0i} = a_{0j} = 0$	53.02–32.20 in periods 1–23; 61 after	23	198,352	10,044	US$528,997	US$70,238,500	US$5,970,270
24	$a_{0i} = a_{0j} = 2000$	53.02–32.20 in periods 1–23; 61 after	23	198,352	10,044	US$548,955	US$70,282,100	US$5,973,980
25	$a_i = a_j = 8.0116$	7.90 in period 1; 0.1 in periods 2–7; rising to 29.54 in period 18; 61 after	18	233,770	3334	US$91,305	US$134,037,000	US$11,393,200
26	$a_i = a_j = 11.2182$	60.99 in period 1; 61 after	1	14	4	US$654,639	US$1,423,420	US$120,991
27	$b_i = b_j = 0.001$	0.64 in period 1; 0.1 in periods 2–7; 61 after	7	229,643	2088	US$650,043	US$358,340,000	US$30,458,900
28	$b_i = b_j = 10.8845$	60.99 in period 1; 61 after	1	14	4	US$481,899	US$1,047,070	US$89,001
29	$a_{0d} = 98$	60.97–51.40 in periods 1–50 (fluctuating)	50	581	112	US$534,520	US$1,228,810	US$104,449
30	$a_{0d} = 446$	41.01–26.09 in periods 1–11; 61 after	11	191,513	2754	US$507,170	US$338,409,000	US$28,764,800
31	$a_{0d} = 1223$	60.96 in period 1; 61 after	1	14	4	US$505,095	US$1,200,900	US$102,077
32	$a_d = 0$	53.17 in period 1; 61 after	1	19	8	US$506,188	US$1,072,750	US$91,184
33	$a_d = 18$	41.49 in period 1; 61 after	1	27	8	US$503,667	US$14,564,900	US$1,238,020
34	$a_d = 19.587$	60.99 in period 1; 61 after	1	14	4	US$505,098	US$42,390,400	US$3,603,180
35	$b_d = 25.3699$	60.99 in period 1; 61 after	1	14	4	US$505,098	US$2,358,400	US$200,464
36	$b_d = 31$	41.01 in period 1; 61 after	1	28	8	US$505,643	US$2,244,170	US$190,754
37	$b_d = 100$	53.17 in period 1; 61 after	1	19	9	US$506,226	US$1,073,120	US$91,215

parison of scenarios 1, 4, and 5 suggests that it is most profitable to aim for an intermediate level of g_1, even though this implies lower than maximum sales levels. Attrition takes a further toll as g_1 increases: quick early network growth gives the system ample opportunity to lose distributors as time goes on.

All values of Ψ (the wholesale-to-retail markup on personal volume sales) that generate positive profit margins for the NMO (i.e., from 0 to 0.4) also produce both selling and recruiting behavior in the network. Scenarios 6 and 7 in Table 9(A) therefore show these two endpoints of the spectrum, with our base case scenario 1 using $\Psi = 0.325$. Other percentage markups found in our data range from 20% to 100%.

The results show that time spent selling increases with Ψ. The intuition is clear: the markup is earned only on personal volume sold, not on all of a distributor's group volume; thus, a higher Ψ leads to a greater emphasis on selling over recruiting. Network growth also slows as Ψ increases, again due to the increased personal sales incentive relative to the incentive to recruit. Increases in Ψ also increase distributor i's income, and drastically reduce the NMO's profitability. Profitability declines both because per-unit profit margins to the NMO fall as Ψ rises, and because there are fewer distributors in the network at any given point in time to sell and generate profits. Thus, it appears that lower values of the markup variable, Ψ, are optimal from the network marketing firm's point of view. [19]

In sum, the above analyses show us that compensation changes that induce (a) later network maturation or (b) greater payouts per dollar sold are in general unprofitable to the network marketing firm using a unilevel plan. It is important to preserve enough difference between an upline's and a downline's commission rates, in order to preserve the incentive for the upline to recruit at all. Further, attrition is greater, the faster and earlier the network grows; conversely, slowly-growing networks lose fewer distributors on a cumulative percentage basis over the 50-period horizon.

3.3.2. Changes in recruiting parameters (scenarios 8 through 18)

In these model runs, we investigate the effect of steady-state network size (q), innovation effects for i and j (p_i and p_j), imitation effects for i and j (k_i and k_j), innovation and imitation effects for downlines (p_d and k_d, respectively), and attrition effects (α) on distributor i's time allocation, network growth, and network profitability. Results of model runs are summarized in Table 9(B). Our key findings are:

1. Time to reach all potential network recruits, a negative correlate of profitability, is decreased for larger steady-state network sizes, for larger innovation parameters for any distributors, and for larger imitation parameters for downline distributors.
2. Distributor i's incentive to spend time recruiting increases with increases in steady-state network sizes, with increases in its own or its downlines' innovation parameters, and with increases in the rate of retention of new distributors.
3. Distributor i's income rises and then falls with increases in steady-state network size, and rises monotonically with increases in the innovation parameter, and with decreases in downlines' innovation or imitation parameters; but there is virtually no effect on i's income when i's imitation parameter increases.
4. Total percentage attrition over the 50-period horizon is greater, the faster the network grows (but because of the positive profitability implications of quick network growth, attrition may not be as big a problem for network marketers as has been previously thought).
5. Profitability is positively affected by increases in steady-state network size, increases in any of the distributors' innovation parameters, increases in downlines' imitation rate parameters, and an increase in the rate of retention of distributors.

The steady-state size of the network (parameter q) has a strong effect on distributor i's time allocation, as can be seen by comparing scenarios 1, 8, and

[19] Of course, this statement holds constant a distributor's fundamental incentive to join the network at all, as well as her total time allocation once she joins. If swings in Ψ are great enough, we might see these more fundamental factors enter into play. For the purposes of this analysis, however, we assume that such changes are small enough not to have a major effect on these actions.

9 in Table 9. We find that, for other parameters held at their baseline levels, a q value less than 170,947 causes distributor i to allocate all her time to selling, while a level greater than 1,290,534 causes i to spend all her time recruiting. Scenarios 8 and 9 thus present results for these two boundary values. For comparison, the q values in our sample range from 31,000 to 1,000,000, with a mean of 411,069 and a median of 385,400.

The positive relationship between q and time spent recruiting reflects the greater ease of attracting new downlines from a larger pool. Distributor i's income first increases, then decreases, with increases in q, reflecting two conflicting effects: first, the increased ability to recruit large numbers of downlines, from all of whom i makes net commissions; and second, the quicker achievement of maximum commissions of those downlines (implying lower net commissions for i). Unambiguous, however, is the increase in both NMO sales and profits as q increases: more recruiting potential naturally leads to higher sales and profits, even though accompanied by a greater rate of attrition over the 50-period horizon. Most interesting, however, is the negative relationship between q and time to maximum cumulative network penetration: it takes only four periods to exhaust network potential when q is at its maximum level, while too small a value of q prevents maximum penetration of network potential. This seemingly counterintuitive result is due to the greater size of the innovation effect in the recruiting function. The increase in the innovation term counterbalances the greater recruiting task to create the ability to recruit large numbers of distributors relatively quickly. However, while larger ultimate network sizes are clearly attractive to all in an NMO, the firm is likely to have to invest in marketing activities (e.g., brand equity, product-line expansion, etc.) to achieve a larger cumulative market penetration level. This is unlike the analyses above, where we contemplate only compensation changes, which require a much smaller investment to implement (i.e., spending on internal marketing). These costs must be subtracted from the profit gains to get a true measure of the incremental benefit of investing in larger networks. Nevertheless, the analysis suggests that it might be useful for the NMO to consider such investments.

Scenarios 10 and 11 show how changes in the innovation parameters for distributors i and j, $p_i = p_j$, influence network activity. Values of $p_i = p_j$ less than $2.6 \cdot 10^{-6}$ (scenario 10) cause distributor i to spend all her time selling, because the innovation effect is so low that recruiting activity is globally more unproductive than selling activity. Conversely, values of $p_i = p_j$ greater than $6.2 \cdot 10^{-5}$ (scenario 11) cause distributor i to spend all her time recruiting. For comparison, the values of $p_i = p_j$ in our sample range from $6.79496 \cdot 10^{-8}$ up to $1.29049 \cdot 10^{-5}$.

Distributor i's income rises as $p_i = p_j$ rises. The most noticeable effect of increasing innovation effects, however, is on the time it takes for the network to reach steady-state size: as $p_i = p_j$ increases, the steady state is reached earlier and earlier (and hence cumulative attrition percentages are also greater). As we have seen above, faster network growth is generally more profitable to the firm, and that observation is borne out here. Of course, this profit increase must be compared with any cost of achieving a higher innovation rate. The firm might need to make investments in awareness of the network, for example, by spending money on advertising above and beyond the distributors' personal recruiting efforts. Only if such investments cost less than the incremental profit gain are they worthwhile.

We next examine variations in $k_i = k_j$, the imitation effect for distributors i and j. Only one variant on the baseline scenario is presented, where $k_i = k_j = 0$. This is because the imitation effect has a very small influence on distributors i and j's behaviors. For *every* value of $k_i = k_j$, given the other values in the model, period-one time allocation is identical to that in the baseline scenario. Among the values of $k_i = k_j$ fitted for the firms in our sample, our focal firm's value of 0.00315624 was the maximum, and 0.0000901833 was the minimum. [20]

[20] Some respondents' data actually generated negative values of $k_i = k_j$. This would intuitively imply increasing returns to recruiting time, rather than a more plausible decreasing returns situation. We suspect that these firms were facing very high growth rates in their networks at the time, and reflected this in their data. However, negative values of $k_i = k_j$ are not reasonable for modeling long-term growth of such a network, and we therefore did not include negative values in our sensitivity analyses.

A comparison of scenarios 1 and 12 shows only moderate variation in behavior due to differences in $k_i = k_j$. Time spent selling by distributor i is in virtually the same range; maximum cumulative distributor recruitment takes just one period longer than in the base case, and attrition rates are almost identical; distributor i's income is very similar, and network profitability varies by less than US$800,000. Thus, it appears that investing in changes in the imitation effect carry much less 'punch' than would investments in the innovation effect.

We now turn from a focus on distributors i and j to a focus on their downline distributors' recruiting parameters. Scenarios 13 and 14 show the effects of changes in the downlines' innovation parameter, p_d. Values of p_d less than $7 \cdot 10^{-7}$ (scenario 13) cause i to spend all of her time selling, because downline recruiting is not productive enough; and values greater than $6.8 \cdot 10^{-5}$ (scenario 14) cause her to engage in full-time recruiting. The maximum value of p_d fitted for a firm in our sample is $1.71397 \cdot 10^{-5}$, while our baseline (scenario 1) value of p_d is $1.45743 \cdot 10^{-6}$.

As p_d increases in the three scenarios, the speed of recruiting and cumulative network growth both increase significantly. Intuitively, *every downline* is more capable of recruiting as p_d increases, and as the network grows through the recruitment of downlines, this increased productivity exhibits itself throughout the whole network. The amount of time allocated to selling by distributor i also declines as p_d increases. Distributor i's income drops somewhat as p_d increases, because more successful downlines increase their group-volume commission rates faster, diminishing the net commission earning opportunities for distributor i. Finally, as one would expect, firm profitability increases as p_d rises, because the number of distributors is greater (and hence sales and network earnings are greater) at any point in time as p_d increases.

In contrast to the effect of the imitation parameter for upline distributors i and j, the effect of the downline distributors' imitation parameter, k_d, is quite strong (shown by comparing scenarios 1, 15, and 16). We can once again attribute the difference in strength of effect to the fact that changes in this parameter apply to almost all of the distributors in the network, not just to two. We ran the model for k_d equal to $1 \cdot 10^{-6}$ (scenario 15) and to 31 (scenario 16) (the baseline value in scenario 1 is $2.42194 \cdot 10^{-4}$). Distributor i's time allocation does not change for positive values of k_d smaller than that in scenario 15 (although for $k_d = 0$, distributor i spends all her time selling); and for values of k_d greater than 31, i spends all her time recruiting.

As k_d increases (i.e., word-of-mouth effects add more recruiting power to downlines' efforts), the number of periods to recruit all potential distributors into the network decreases, similarly to the effect through p_d. Distributor i's income falls moderately as k_d increases, again because her downlines' success at building their own networks diminishes net commission income opportunities for i. And firm profitability increases as k_d increases, to over US$44 million for the higher value of k_d. For investments in either innovation effects or imitation effects for downlines, the firm must weigh the cost versus the profit benefits of the investments. As our profitability numbers show, part of what drives the optimal investment decision involves the number of distributors whose performance will benefit from the investment; our model shows much bigger profit gains for investments in downlines than for those in distributors i and j, at least in part simply because there are many more downlines in the network.

Changes in the retention rate parameter, α, also have a strong impact on NMO sales and profitability. For α less than 0.6 (scenario 17), recruiting is not attractive for distributor i because too many of her recruits drop out of the network; for all values of α up to and including 1.0 (no attrition at all, as in scenario 18), i chooses to split her time between selling and recruiting until new recruiting opportunities in the NMO have been exhausted.

Both sales and profitability increase strongly as α increases, because new recruits have a greater propensity to stay with the network. Interestingly, however, distributor i's income first increases as α increases (i.e., as the retention rate increases), but then falls with further increases in the retention rate. This is because increases in α increase early word-of-mouth effects in recruiting. For lower levels of α, such increases help i recruit new distributors faster herself, increasing her net commissions on the downline network. Past some point, however, higher network retention rates (i.e., higher α) increase the amount of competition facing i to recruit new distributors and thus reduce i's ability to earn net commissions from downlines as the network matures. But as the decline in i's income is fairly slight, the NMO is advised to take all sensible steps to maximize retention rates in order to maximize profitability.

3.3.3. Changes in total time parameters (scenarios 19 through 22)

The total time spent by distributors on selling and recruiting are investigated below. Results from model runs varying these parameters are presented in Table 9(C). Our results show the following.

1. Steady-state network size is reached more quickly, and sales and profitability are higher, the more total time is spent by i, and for intermediate levels of total time spent by downlines.
2. Distributor i's income is greater, the more total time i spends on network marketing activities, and for intermediate levels of total time spent by downlines.
3. Distributor i's absolute amount of time spent selling is roughly the same for low or high total time spent by i. This means that as i's total time increases, the incremental time is spent essentially entirely on recruiting.

We first look at varying the total time spent by distributor i on combined selling and recruiting activities. Scenarios 1, 19, and 20 set T_i to 61, 54, and 200, respectively. For total time less than 54 hours per month, distributor i chooses to focus solely on selling. There is a large range of total time values where early time allocation by distributor i is totally invariant. We thus capped our investigation at 200. Reported total time spent selling and recruiting per month for top distributors ranges from 10 hours to 350 hours, with a median of 70 hours and a mean of 85 hours.

Increasing the total time spent by i greatly increases the speed of network growth: the network fails to mature for $T_i = 54$, takes 23 periods to do so for $T_i = 61$, and takes only seven periods to do so when $T_i = 200$. This is largely because as T_i increases, the extra total time is being spent essentially completely on recruiting. Greater time spent also naturally translates into higher income for distributor i, with decreasing returns to greater time spent (over the 50-period horizon, distributor i makes an average of US\$184.20 per hour when $T_i = 54$; US\$174.36 per hour when $T_i = 61$; and US\$66.82 per hour when $T_i = 200$). Increased total time also increases the sales and profitability of the network marketing firm. Thus, both the distributor and the firm are better off if the distributor spends more time in total on network marketing activities.

We also investigate, in scenarios 21 and 22, various total time allocations for all the downlines in the network. In our sample as a whole, average distributors' total time spent on selling and recruiting ranges from 1.5 hours to 80 hours per month, with a median of 10 hours per month and a mean of 20 hours per month. We find that both 'too lazy' (i.e., T_d less than 4) and 'too industrious' (i.e., T_d greater than 20) downlines cause i to sell full-time rather than recruit: the former because downlines do not work hard enough to generate sufficient net commission income to be of interest, and the latter because downlines are *so* productive that they earn as high a group commission rate as i does, thus depriving i of net commission income on their group volumes. Scenarios 21 and 22 thus look at these two limiting values of T_d.

Not only does i's time spent selling first fall, then rise again, as T_d increases; i's income first rises, then falls, at T_d increases also. Cumulative network growth, sales, and profitability also first rise, then fall, as T_d increases, driven by the optimal time allocations of distributors in the network. The NMO firm has the same incentive as i does, given the compensation plan in place: to recruit downlines who will work appropriately hard, but not so hard as to prevent the upline from making any net commissions from their sales.

3.3.4. Changes in sales response function parameters (scenarios 23 through 37)

In this section, we examine how changes in the sales response function parameters of distributor i and the downlines affect i's incentives for behavior, as well as network growth and profitability. Table 9(D) summarizes the results of these model runs. A summary of the results indicates the following.

1. The network's growth rate is invariant to changes in $a_{0i} = a_{0j}$, but is faster when the values of

$a_i = a_j$ or $b_i = b_j$ are lower. The network grows fastest for intermediate levels of $a_{0\mathrm{d}}$, a_{d}, or b_{d}.

2. NMO profitability is almost invariant to changes in $a_{0i} = a_{0j}$, but increases as the values of either $a_i = a_j$ or $b_i = b_j$ decrease, because these cause distributor i to allocate more time to recruiting, causing the network in turn to grow more quickly. Profitability is highest for intermediate levels of $a_{0\mathrm{d}}$, a_{d}, and b_{d}.
3. Distributor i's income increases with $a_{0i} = a_{0j}$ or $a_i = a_j$, or with decreases in $b_i = b_j$. Distributor i's income increases as $a_{0\mathrm{d}}$ falls, and is highest for intermediate levels of a_{d} or b_{d}.

We first consider changes in the parameters of distributor i's and j's sales response function: $a_{0i} = a_{0j}$, $a_i = a_j$, and $b_i = b_j$. Changes in $a_{0i} = a_{0j}$ are essentially changes in the intercept term of the sales response function, and as such shift distributor i's behavior only when they imply differences in the group-volume commission rate that i faces. At the other parameter levels in our baseline model, no such difference is implied by changing $a_{0i} = a_{0j}$; even when $a_{0i} = a_{0j} = 0$, the number of hours spent selling is still the same. Our baseline model sets $a_{0i} = a_{0j} = 280$. Thus, for illustrative purposes, we also examine $a_{0i} = a_{0j} = 0$ (scenario 23) and $a_{0i} = a_{0j} = 2000$ (scenario 24). For comparison, the range of $a_{0i} = a_{0j}$ in our sample is 135 to 2131.5.

There is no difference among scenarios 1, 23, and 24 in the time allocations of distributor i, nor in the number of periods to network maturity (23 in all cases). Distributor i's income does increase with $a_{0i} = a_{0j}$, as does profitability, but the profit gains are relatively modest (less than US\$4000 from scenario 23 to scenario 24). Thus, changes in i's and j's sales response function intercept do not change network growth patterns and only moderately change profitability; unless they are very low-cost to achieve, they are probably not profitable investments to make.

Increases in $a_i = a_j$ increase the asymptote to which sales converge as selling time approaches an infinite number of hours. We find that, for other parameters set to their baseline levels, any value of $a_i = a_j$ less than 8.0116 leads distributor i to spend all her time on recruiting (because selling has such a low productivity), and any value of $a_i = a_j$ greater than 11.2182 leads i to focus entirely on selling and do no recruiting. We therefore present in scenarios 25 and 26 these lower- and upper-bound values of $a_i = a_j$, respectively. Values of $a_i = a_j$ in other firms in our sample range from 6.53621 to 12.8823.

Distributor i's income increases with $a_i = a_j$. However, distributor i's diminished emphasis on recruiting causes the network to mature in size more slowly (the maximum cumulative number of recruits being reached in period 18 when $a_i = a_j = 8.0116$, but not until period 23 when $a_i = a_j = 10.9576$ and never when $a_i = a_j = 11.2182$), resulting in slower sales growth and lower profitability over the 50-period horizon. Thus, if the firm makes any purposeful investments in $a_i = a_j$, they should be to keep it lower, rather than to raise it, because of the adverse effect it has on incentives to grow the network quickly.

The parameter $b_i = b_j$ shapes the marginal sales productivity of each hour spent selling by distributor i: the lower it is, the higher are sales for any given value of selling time. However, there is an additional aspect to the effect of $b_i = b_j$, due to the multiplicative relationship between it and s_{it}. This is that, for *very small* values of $b_i = b_j$, distributor i's income essentially is invariant with respect to changes in selling time. Thus, we find that for values of $b_i = b_j$ less than 0.001, distributor i optimally allocates all of her time to recruiting; and for values of $b_i = b_j$ greater than 10.8845, i sells full-time and does no recruiting. In the values between these two boundaries, the amount of time spent selling by i increases as $b_i = b_j$ increases. We thus present results for $b_i = b_j = 0.001$ (scenario 27) and $b_i = b_j = 10.8845$ (scenario 28). For comparison, other firms in our sample generated $b_i = b_j$ values ranging from 6.26386 to 180.284 (although almost all are well below 100 in value).

Distributor i's income, network sales, and network profitability all fall as $b_i = b_j$ rises. Increasing $b_i = b_j$ also decreases the speed of network growth, and stifles it for high enough values. Low values of $b_i = b_j$ are thus clearly the most attractive to all actors in the NMO.

Turning to the parameters of the downlines' sales response function, three different levels of $a_{0\mathrm{d}}$ are evaluated in addition to the baseline level of 140: 98 (scenario 29), 446 (scenario 30), and 1223 (scenario 31). For values of $a_{0\mathrm{d}}$ less than 98, the optimal allocation rule for i is to spend all of her time selling; the amount of selling time drops steadily until $a_{0d} = 446$; then it steadily rises again until, for values of a_{0d} greater than 1223, all time is again spent selling. For reference, our data produces values of a_{0d} ranging from 48 up to 688.

Distributor i's income falls with higher and higher levels of a_{0d}. Intuitively, more productive downlines make more income and hence enjoy higher group-volume commission rates, causing i's net commission income to fall on a per-dollar basis. Eventually, this effect causes distributor i to turn away from recruiting and back toward personal selling. This reversion to personal selling caps i's effective earning potential, because she stops recruiting new downlines who may have lower group-volume commission rates than more seasoned downlines do.

The NMO's sales and profitability move inversely to the amount of time i spends selling, because intensive selling comes at the expense of recruiting and total network growth. Thus, the NMO firm's incentives are not totally aligned with those of distributor i, who prefers less productive downlines.

The parameter a_d plays the same role in the downline distributor's sales response function as a_i plays in that of distributor i: it affects the asymptotic level of sales achievable as selling effort reaches very large levels. We find that, given our baseline parameter values, even reducing a_d to zero (scenario 32) still preserves distributor i's incentive to both sell and recruit, so there is no 'corner solution' for time allocation at the lower end of this parameter. As a_d increases from 0 to 18 (scenario 33), i spends less time selling and more recruiting; as a_d increases from 18 to 19.587 (scenario 34), i spends *more* time selling and less recruiting, until for a_d greater than 19.587, i sells full-time. This non-monotonicity reflects the dual incentives generated by an increase in a_d: on the one hand, a higher a_d means more productive downlines from whom i can make more net commissions. On the other hand, for a_d 'too high,' downline group commission rates rival i's own rate, thus decreasing the potential for net commission earnings. For comparison, we found values of a_d in our data ranging from 4.44794 up to 17.4876.

An intermediate value of a_d, such as our baseline value of 12.6269 (scenario 1), generates the highest income for i, NMO sales, and NMO profitability. Such a value not only generates balanced sales and recruiting effort initially, but also over time to bring the network to full fruition. Too high a value of a_d may make very early recruitment desirable, but quickly negates the recruitment incentive because downlines themselves grow their sales and networks too fast to provide net commission earnings potential to an upline distributor. As above, we see here that the NMO must try to balance the attractiveness of productive downlines against the risk that they are so productive as to generate no income potential for their upline sponsor.

Finally, changes in b_d (the shape parameter of the downline sales response function) are investigated through a comparison of scenarios 1 ($b_d = 56.6904$), 35 ($b_d = 25.3699$), 36 ($b_d = 31$), and 37 ($b_d = 100$). From $b_d = 25.6399$ to $b_d = 31$, recruiting time in the first period increases, but the incentive to recruit disappears thereafter. In the range (31, 100), early time allocations to selling increase, until all values of b_d greater than 100 produce the same time allocation for i. We can compare these values with those in the rest of our data; the minimum value of b_d found is 1.02337, and the maximum is 166.355.

As in the case of changes in a_d, here we also see that both distributor i and the NMO as a whole prosper the most with an intermediate value for b_d. Such a value generates balanced growth and continued recruiting as well as selling activity in the whole network. Beyond some point, increases in b_d fail to have any effect on distributor i's time allocations and hence on the growth and profitability of the NMO.

3.3.5. Summary of sensitivity analyses

The effects of changes in model parameters on firm profitability, time to reach steady-state network size, focal distributor i's income, and the proportion of i's time spent selling are summarized in Table 10. The flavor of this table is similar to that of a table of comparative static results in an analytic model, although it must of course be remembered that this table reflects results derived using one set of parameters as the baseline scenario.

Profitability comparisons between one parametric change and another must be made with the recognition that these figures are gross of any marketing investments necessary to effect them. Changing some parameters (e.g., compensation parameters) is essentially costless, but other parametric changes may only be achievable with considerable marketing mix expenditures. It would therefore be inappropriate to make conclusive statements about the relative desirability of increasing or decreasing one parameter versus another without access to investment cost data.

Nevertheless, the sensitivity analyses presented above generate many useful insights for both structuring compensation plans for maximal network growth and profitability, as well as investing in more productive sales and recruiting functions. We can summarize the following insights.

1. Even attrition rates as low as 10% per period, as our baseline scenario depicts, lead to a very severe loss of network size over time, especially under conditions of explosive early growth. This suggests that maturing networks need to look for creative ‘re-launch’ strategies, such as transnational expansion or product-line expansion, to expand the potential pool of recruits.
2. Nevertheless, faster network growth, ceteris paribus, is profitable from the NMO firm’s point of view. This can help explain why network marketing firms are always emphasizing recruiting, particularly early in the network’s life.
3. Holding down distributor earnings can be profit-creating, *as long as it does not stifle incentives to work*. We cannot state conclusively where the appropriate point on this tradeoff function lies, but recognize that the tradeoff is important.
4. Achievements that seem profit-enhancing on the surface may in fact be profit-reducing if they hamper quick network growth. Examples include investments that increase the selling productivity of distributor i and thus draw her away from recruiting activities. A balance must be struck that generates high sales while also stimulating quick network growth.
5. On the other hand, investing in high sales performance can be a profit-enhancing strategy, even if it stifles some upline distributors’ incentives to recruit, *if it affects a large enough set of downline distributors*. That is, the positive effect on sales performance of the downlines may actually swamp any negative effect on upline recruiting behavior.
6. Significant shifts in profitability are possible through changes in the compensation plan, partic-

Table 10
Directional effects of parametric changes on model performance

Effect of increase in parameter	Effect on: Profitability	Speed/intensity of network growth	Distributor i's income	% of time i spends selling
g_2	⇓	⇓	⇓	⇑
g_1	⇑, then ⇓	⇑	⇑	⇓
Ψ	⇓	⇓	⇑	⇑
q	⇑	⇑	⇑, then ⇓	⇓
$p_i = p_j$	⇑	⇑	⇑	⇓
$k_i = k_j$	⇑	⇑	⇑	n.c.
p_d	⇑	⇑	⇓	⇓
k_d	⇑	⇑	⇓	⇓
α	⇑	⇑	⇑, then ⇓	⇓
T_i	⇑	⇑	⇑	⇓
T_d	⇑, then ⇓	⇑, then ⇓	⇑, then ⇓	⇓
$a_{0i} = a_{0j}$	⇑	n.c.	⇑	n.c.
$a_i = a_j$	⇓	⇓	⇑	⇑
$b_i = b_j$	⇓	⇓	⇓	⇑
a_{0d}	⇑, then ⇓	⇓, then ⇑	⇓	⇓, then ⇑
a_d	⇑, then ⇓	⇑, then ⇓	⇑, then ⇓	⇓, then ⇑
b_d	⇑, then ⇓	⇑, then ⇓	⇑, then ⇓	⇓, then ⇑

n.c. = no change.

ularly through changes in g_2, the curvature parameter in the commission function. Optimizing NMO compensation involves a balancing of increasing incentives for sales productivity against the threat that one's downlines too quickly reach the same group commission level as the upline, therefore diminishing the upline's net earnings potential. It is generally wise not to be too 'stingy' with distributor compensation, because it is the key to network growth and profitability.

7. Investing in a larger steady-state network size increases profitability in two ways. First, it increases the pool of distributors generating sales at any point in time. But second, it has positive effects on the innovation term of the recruiting function, making recruiting time more productive, ceteris paribus—so that larger steady-state network sizes are actually associated with *faster* network growth, not slower.

4. Summary, conclusions, and future research directions

Our model shows how an NMO's network growth, distributor performance, and network profitability will be affected by differences in compensation and other underlying market factors. Although these insights are indeed useful for understanding the unique challenges of salesforce management in NMOs, they also have relevance for any company that compensates employees or customers for capitalizing on their social networks. For example, some companies give their customers referral bonuses, and many reward salespeople for developing new business. To the extent that these rewarded activities reflect the properties of a diffusion function, our model is particularly useful.

In this paper, we have used the model mainly to describe the general effects that parametric changes can have on NMO and network performance. But it can also be used prescriptively on the individual-firm level to make suggestions about profitable changes in compensation plans or investments in other parametric changes. It can also be used as a forecasting tool with appropriate calibration on historical data or network analogs.

The insights derived here also have relevance for retail productivity in retail formats other than NMOs. In particular, anywhere where retail salespeople have multiple productive tasks to do, a model of this type is a useful tool for understanding how to manage not only the total productivity of a retail salesperson's time, but the allocation of that time among competing activities.

There are many avenues for future research in the area. One involves examining the other major type of compensation plan currently used in network marketing: the breakaway plan. Some of its implications for distributor behavior may be quite different than those found here, and a similar modeling analysis will help network marketing retailers decide which plan best fits their market and product situations.

Expanding our empirical data collection would increase our knowledge of the variation in model parameters in the network marketing world. This can be done through further cross-sectional studies or alternatively through a more in-depth study of one firm and all of its distributors. If we poll all the distributors themselves instead of using single informants, we are likely to increase the reliability of the data on sales and recruiting response.

Network marketing carries negative connotations in many marketplaces worldwide. This is because it is often incorrectly associated with deceptive 'pyramid schemes', which frequently result in financial ruin for participants and legal action against the instigators. In contrast, true network marketing involves the development of a legitimate retail selling and distribution network that grows via social networks. Our analysis has examined the unique marketplace tensions that an NMO executive must balance in order to create and manage a compensation structure that both motivates distributors and achieves the company's business goals. Our work also illustrates that the successful management of an NMO does not require deception or fraudulence, but instead requires the standard managerial concerns for salesperson satisfaction, company growth, and net profitability.

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